SLOCAT Transport, Climate and Sustainability Global Status Report

3rd edition

SLOCAT Partnership on Sustainable, Low Carbon Transport

About the SLOCAT Partnership

SLOCAT is the international, multi-stakeholder partnership powering systemic transformations and a just transition towards equitable, healthy, green and resilient transport and mobility systems for the people and the planet. We deliver on our mission through co-creation, co-leadership and co-delivery across knowledge, advocacy and dialogue activities in the intersection between transport, climate change and sustainability. Our multi-sectoral Partnership engages a vibrant and inclusive ecosystem across transport associations, NGOs, academia, governments, multilateral organisations, philanthropy and business; as well as a large community of world-class experts and change-makers. Going where others do not or cannot go individually, our Partnership is leveraged to set ambitious global agendas and catalyse progressive thinking and solutions for the urgent transformation of transport and mobility systems worldwide.

About the Report

The *SLOCAT Transport, Climate and Sustainability Global Status Report – 3rd Edition* tells the global and regional stories of where we are and where we need to get to urgently on climate and sustainability action for transport and mobility. With contributions from 100 world-class experts and organisations, this flagship report is a one-stop shop for the latest available data, trends, targets and developments on transport demand, emissions and policies. The GSR equips decision makers towards knowledge-based action and aims to raise ambition in transport policy and investment for people and the planet.

The report consists of 5 thematic sections covering 12 transport areas: integrated transport planning, walking, cycling, public transport, informal transport, app-driven shared transport, rail, road transport, aviation, shipping, transport energy sources, and vehicle technologies. It includes 5 spotlights on cross-cutting issues (global supply chains, health, small island developing states, capacity building and stakeholder engagement in the United Nations Framework Convention on Climate Change) as well as 30 country fact sheets. An updated version of the open-source SLOCAT Transport Knowledge Base that forms the basis of the report will be released along with the full report.

New for this edition, the report was released in a modular approach from June to September 2023, which synthesises knowledge and data more systematically and helps our readers comprehend specific issues more effectively. The full report was launched at Germany's Transport and Climate Change Week 2023 on 13 September 2023.

This edition has been made possible thanks to financial support by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), supported by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) through their International Climate Initiative (IKI) by the Volvo Research and Educational Foundation.

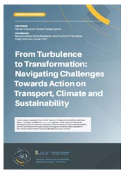
How to navigate this report

Modular approach:

While the report and modules can be downloaded as a single file and read from start to finish, sections of interest can also be accessed individually via the website.

Structure:

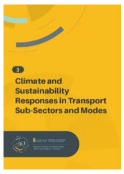
The report is divided into five main sections. Sources for the information provided are listed at the end of each section, and cross-references among sections are included where relevant. The five main sections are as follows:



- ***Takeways for Decision Makers:***
  From Turbulence to Transformation: Navigating Challenges Towards Action on Transport, Climate and Sustainability

- ***Module 1:***
  Transport Pathways to Reach Global Climate and Sustainability Goals

- ***Module 2:***
  Regional Trends in Transport Demand and Emissions, and Policy Developments

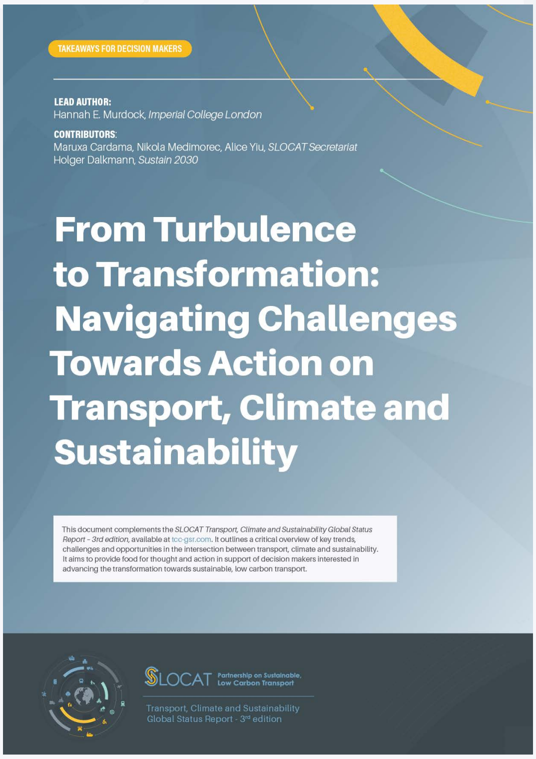


- ***Module 3:***
  Climate and Sustainability Responses in Transport Sub-Sectors and Modes

- ***Module 4:***
  Transport and Energy

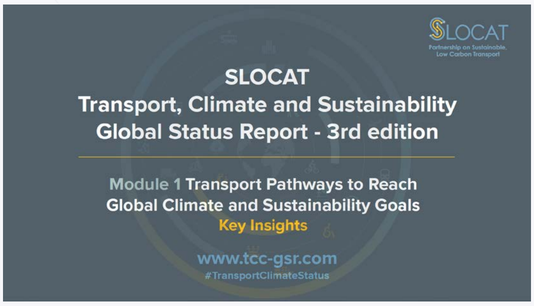
- ***Module 5:***
  Enabling Climate and Sustainability Action in Transport: Finance, Capacity and Institutional Support

- ***Country Fact Sheets:***
  30 country fact sheets were developed for countries that had the highest absolute transport carbon dioxide (CO_2) emissions in 2021.



Click here to read the Takeaways for Decision Makers

This section outlines a critical overview of key trends, challenges and opportunities in the intersection between transport, climate and sustainability. It aims to provide food for thought and action in support of decision makers interested in advancing the transformation towards sustainable, low carbon transport.



Click here to read the key insights of all modules.

Acknowledgements

This report should be cited as:

SLOCAT (2023), Global Status Report on Transport, Climate and Sustainability – 3rd edition, www.tcc-gsr.com.

Data access and licensing

The development of this report was led by Maruxa Cardama, Angel Cortez, Emily Hosek, Agustina Krapp, Nikola Medimorec, and Alice Yiu from the SLOCAT secretariat.

Our warm thanks to the many SLOCAT partners and experts from the wider transport community who have shaped this report. A significant share of the research for this report was conducted on a voluntary basis.

Financial supporters

This edition has been made possible thanks to financial support by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), supported by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) through their International Climate Initiative (IKI) and by the Volvo Research and Education Foundations (VREF).

Chief Advisor

Holger Dalkmann (Sustain2030)

Advisory team (alphabetical by affiliation's full name)

Suzanne Spooner (AFD), Carolina Chantrill (Asociación Sustentar / LEDS LAC), Nicholas You (Citistates), Friedel Sehlleier and Urda Eichhorst (GIZ), Andrea San Gil Leon (Global Network for Popular Transportation), Tu My Tran (ICLEI), Yann Briand (IDDRI), Maisarah Abdul Kadir and Nicholas Wagner (IRENA), Atiq Ahmad and Olatunji Yusuf (IsDB), Jacob Mason (ITDP), Wei-Shiuen Ng and John Pritchard (ITF-OECD), José Holguin-Veras (RPI), Rik Arends and Gabriela Domingo (Smart Freight Centre), Alok Jain (Trans Consult), Madan Bandhu Regmi (UNESCAP), Yarob Badr (UNESCWA), Bronwen Thornton (Walk21), Benjamin Welle (WRI).

Contributing authors by section

Takeaways for Decision Markers

Lead author: Hannah E. Murdock, Imperial College London
Contributors: Maruxa Cardama, Holger Dalkmann, Nikola Medimorec, Alice Yiu

Module 1: Transport Pathways to Reach Global Climate and Sustainability Goals

1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals
Authors: Maruxa Cardama, Agustina Krapp, Nikola Medimorec and Alice Yiu, SLOCAT secretariat

1.2 Transport Adaptation and Resilience
Authors: Juliet Mian, Amy Leitch and Áine Ní Bhreasail, ARUP; Kerem Yilmaz, Resilience Rising; Savina Carluccio, International Coalition for Sustainable Infrastructure
Contributors: Mathieu Verougstraete, United Nations Office for Disaster Risk Reduction

Spotlight 1. Transport-Health Nexus
Author: Alison Doig, Health Climate Network
Contributors: Karl Peet and Ambika Sairam, SLOCAT secretariat; Thiago Hérick de Sá, World Health Organization

Spotlight 2. Transport Adaptation and Decarbonisation in Small Island Developing States
Authors: Hannah E. Murdock, Imperial College London; Arjay Dineros, SLOCAT secretariat
Contributors: Karl Peet, SLOCAT secretariat; Raffael Held and Janina Marie Laurent, GIZ; Nicole Baker, ARUP; Sam Johnson, World Bank

1.3 National and Subnational Action for Sustainable, Low Carbon Transport

1.3.1 National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and the SDGs on Transport
Author: Nikola Medimorec and Alice Yiu, SLOCAT secretariat
Contributors: Shivam Ghai, Rohit Nepali, SLOCAT secretariat

Spotlight 3. Transport Stakeholders Engagement in the United Nations Framework Convention on Climate Change process
Author: Maruxa Cardama and Alice Yiu, SLOCAT secretariat

1.3.2. Subnational Actions for Sustainable, Low Carbon Transport
Author: Tsu-Jui Cheng, National Cheng Kung University; Agustina Krapp, SLOCAT secretariat
Contributor: Tu My Tran, ICLEI – Local Governments for Sustainability;

1.3.3. The Role of Business in Decarbonising Transport
Author: Sophie Punte, Smart Freight Centre
Contributors: ; Yann Briand, IDDRI; Charlene Kouassi, MovinOn' LABS Africa; Joachim Roth, World Benchmarking Alliance

Box on The Role of Companies in Decarbonising Global Freight and Logistics
Author: Sandra Rothbard, Rik Arends and Tharsis Teoh, Smart Freight Centre

Spotlight 4. Shortening Global Supply Chains as a Key to Decarbonising Transport
Authors: Yann Briand, IDDRI; Sandra Rothbard, Freight Matters

Module 2: Regional Transport and Climate Change Trends

2.1 Africa Regional Overview
Author: Robert Ambunda, University of Namibia: School of Engineering and the Built Environment
Contributors: Verena Knoell, GIZ; Chris Kost, ITDP

2.2 Asia Regional Overview
Authors: Hannah E. Murdock, Imperial College London; Ambika Sairam, SLOCAT secretariat
Contributors: Urda Eichhorst, GIZ

2.3 Europe Regional Overview
Authors: Hannah E. Murdock, Imperial College London; Arjay Dineros, SLOCAT secretariat
Contributor: Mark Major, Kühne Foundation

2.4 Latin America and the Caribbean Regional Overview
Author: Agustina Krapp, SLOCAT secretariat
Contributors: Carolina Chantrill, Asociación Sustentar; Lina Quiñones, Despacio; Arturo Steinvorth, Center for Urban Sustainability

2.5 North America Regional Overview
Author: Nikola Medimorec, SLOCAT secretariat

2.6 Oceania Regional Overview
Author: Angel Cortez, SLOCAT secretariat
Contributors: Helen Rowe and Margot Delafoulhouze, Climateworks Australia

Module 3: Climate and Sustainability Responses in Transport Sub-Sectors and Modes

3.1 Integrated Transport Planning
Author: Hannah E. Murdock, Imperial College London
Supporting Author: Tokam Cabrel, SLOCAT secretariat
Contributor: Todd Litman, Victoria Transport Policy Institute

3.2 Walking
Author: Jim Walker, Walk21

3.3 Cycling
Author: Philip Amaral, European Cyclists' Federation (ECF)
Contributor: Jill Warren, ECF;
Isabella Burczak and Ben Barrett – Union Cycliste Internationale ;
Lina Quiñones, Despacio;
Sam Johnson, World Bank

3.4 Shared Mobility
3.4.1 Public Transport
Authors: Anna Kustar, Thet Hein Tun and Benjamin Welle, World Resources Institute

3.4.2 Informal Transport
Author: Andrea San Gil León and Adriana Quesada Valverde, Global Network for Popular Transportation

3.4.3 App-Driven Shared Transport
Author: Sebastian Castellanos, NUMO
Contributor: Agustina Krapp, SLOCAT secretariat

3.5 Rail
Author: Joo Hyun Ha and Lucie Anderton, International Union of Railways (UIC)

3.6 Road Transport
Author: Hannah E. Murdock, Imperial College London
Support Author: Tokam Cabrel, SLOCAT secretariat
Contributor: Mark Major, Kühne Foundation; Todd Litman, Victoria Transport Policy Institute

3.7 Aviation
Author: Karl Peet, SLOCAT secretariat

3.8 Shipping
Author: Karl Peet, SLOCAT secretariat

Module 4: Transport and Energy

4.1 Transport Energy Sources
Author: Marion Vieweg, Current Future
Contributor: Hannah E. Murdock, Imperial College London

4.2 Vehicle Technologies
Author: Oliver Lah, Alvin Mejia and Kanya Pranawengkapti, Urban Electric Mobility Initiative, Wuppertal Institute
Contributor: Nikola Medimorec, SLOCAT secretariat

Module 5: Enabling Climate and Sustainability Action in Transport: Finance, Capacity and Institutional Support

5.1 Financing Sustainable Transport in Times of Limited Budgets
Author: Jyoti Bisbey, World Association of PPP Units and PPP Professionals

Spotlight 5: Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport
Author: Armin Wagner and Viviane Weinmann, GIZ

Peer reviewers (alphabetical by affiliation's full name)
Nicole Baker, Paola Bueno and Daniel Philips (ARUP), Carolina Chantrill and Martina Pugno (Asociacion Sustentar), Alimou Lembo (Association Global Humaniste), Richard Lambert (Cities Forum), Tania Martha Thomas and Mélaine Assè-Wassa Sama (Climate Chance), Divya Sharma (Climate Group), Lóri Tavasszy (Delft University of Technology), Mbuh Raphael (FIMOAT), Esteban Bermudez Forn (GEF), Mateo Gomez, Urda Eichhorst, Verena Flues and Martin Schaefer (GIZ), Yann Briand (IDDRI), Andre Luiz Lopes Toledo (IFRN), Maria Golda Hilario (Institute for Climate and Sustainable Cities (ICSC), Sudarmanto Budi Nugroho (Institute for Global Environmental Strategies Japan), Nicholas Wagner (IRENA), Atiq Ahmad and Olatunji Yusef (Islamic Development Bank (IsDB)), Clarisse Cunha Linke (ITDP Brazil), John Pritchard (ITF-OECD), Stefan Bakker (KiM Netherlands Institute), Alan McKinnon (Kühne Logistics University), Jad Baba (REN21), Sukma Larasiti (Transportologi), Susan Shaheen (TRSC UC Berkeley), Hassiba Benamara and Frida Youssef (UNCTAD), Sean Cooke (UNEP), Madam Regmi and Wei-Shiuen Ng (UNESCAP), Winnie Mitullah (University of Nairobi), Ahmad Alimin (University Tun Hussein Onn Malaysia), Antonio Chammorro Sanmiguel (Urban Mobility Secretariat of Quito City, Ecuador), Marie Venner (Venner Consulting), Todd Litman (Victoria Transport Policy Institute), Henrik Nolmark (VREF), Andrew Losos, Sam Johnson and Shokraneh Minovi (World Bank), Joachim Roth (World Benchmarking Alliance).

Editing, design and layout
Lisa Mastny (Editor)
Kadi (Design) - Alexander Moolman, Kerry Moolman

Disclaimer
SLOCAT releases issue papers and reports to enable collaborative knowledge and action for sustainable, low carbon transport. While SLOCAT papers and reports have benefited from the considerations and input from the SLOCAT community, they do not necessarily represent a consensus among network participants on any given point. Although the information given in this report is the best available to the authors at the time, SLOCAT and its participants cannot be held liable for its accuracy and correctness. The designations employed and the presentation of material in the maps in this report do not imply the expression of any opinion whatsoever concerning the legal status of any region, country, territory, city or area or of its authorities, and is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers or boundaries and to the name of any territory, city or area.

Foreword

Maruxa Cardama, Secretary General,
SLOCAT Partnership

A just transition to equitable, healthy, green, and resilient transport and mobility systems is central to socio-economic prosperity for people and the planet. In addition to reducing greenhouse gas emissions from transport, such a transition will yield social, environmental and economic multiplier effects that go well beyond the scale of the necessary financial investment. To achieve this, systemic transformations in transport and mobility – linked to wider socio-economic transformations – are needed.

The past couple of years have changed the world. Most transport and mobility systems globally have become more vulnerable to systemic shocks, disproportionately affecting people living in vulnerable situations. Wide-ranging challenges have put the already-elusive progress towards the Sustainable Development Goals and the Paris Agreement at increased risk.

The SLOCAT Transport, Climate and Sustainability Global Status Report – the 3rd edition in this flagship knowledge series – continues to tell the global and regional stories of where we are and where we need to get to urgently on climate and sustainability action for transport and mobility. With contributions from 100 world-class experts and organisations, it is a one-stop shop for the latest available data, trends, targets and developments on transport demand, emissions and policies. The GSR equips decision makers towards knowledge-based action and aims to raise ambition in transport policy and investment for people and the planet.

The report consists of five thematic modules covering 12 transport areas. It includes five spotlights on cross-cutting issues as well as 30 country fact sheets. An updated version of the open-source SLOCAT Transport Knowledge Base that forms the basis of the report was released along with the full report. New for this edition, the report was released in a modular approach from June to September 2023, which synthesises knowledge and data more systematically and helps our readers comprehend specific issues more effectively.

On behalf of SLOCAT I would like to express our deepest gratitude to the impressive community of changemakers who have contributed to this co-creation, co-leadership and co-delivery process. A significant share of the research for this report was conducted on a voluntary basis. It has been a great privilege to listen to the diversity of voices and learn from the expertise across our Partnership and beyond the transport community.

This edition has been made possible thanks to financial support by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), supported by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) through their International Climate Initiative (IKI), as well as by the Volvo Research and Educational Foundation.

By catalysing and driving collaborative, open data and flagship knowledge product, SLOCAT facilitates access to the world-class knowledge and solutions available across our Partnership. I hope you will find this report a valuable tool to enable combined transport, climate and sustainability impact.

Table of Contents

About the SLOCAT Partnership	ii
About the Report	ii
Acknowledgements	iv
Foreword	vi
Table of Contents	vii
Methodological Note	391
List of Abbreviations	393
Endnotes	395

Module 1: Transport Pathways to Reach Global Climate and Sustainability Goals

Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals	**5**
Transport Adaptation and Resilience	**25**
Transport - Health Nexus	**41**
Transport Adaptation, Resilience and Decarbonisation in Small Island Developing States	**49**
National and Sub-national Action for Sustainable, Low Carbon Transport	**57**
Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs	**59**
Engagement of Transport Stakeholders in the United Nations Framework Convention on Climate Change Process	**73**
Sub-national Actions for Sustainable, Low Carbon Transport	**81**
The Role of Business in Decarbonising Transport	**91**
Shortening Global Supply Chains as a Key to Decarbonising Transport	**115**

Module 2: Regional Trends in Transport Demand and Emissions, and Policy Developments

Africa Regional Overview	128
Asia Regional Overview	140
Europe Regional Overview	152
Latin America and the Caribbean Regional Overview	164
North America Regional Overview	178
Oceania Regional Overview	186

Module 3: Climate and Sustainability Responses in Transport Sub-Sectors and Modes

Integrated Transport Planning	200
Walking	216
Cycling	228
Shared Mobility	244
Public Transport	245
Informal Transport	261
App-Driven Shared Transport	277
Rail	287
Road Transport	299
Aviation	313
Shipping	323

Module 4: Transport and Energy

Transport Energy Sources	338
Vehicle Technologies	352

Module 5: Enabling Climate and Sustainability Action in Transport: Finance, Capacity and Institutional Support

Financing Sustainable Transport in Times of Limited Budgets	367
Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport	383

1

Transport Pathways to Reach Global Climate and Sustainability Goals

SLOCAT Partnership on Sustainable, Low Carbon Transport

Contents

1.1	Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals	5
1.2	Transport Adaptation and Resilience	25
Spotlight 1	Transport - Health Nexus	41
Spotlight 2	Transport Adaptation, Resilience and Decarbonisation in Small Island Developing States	49
1.3	National and Sub-national Action for Sustainable, Low Carbon Transport	57
1.3.1	Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs	59
Spotlight 3	Engagement of Transport Stakeholders in the United Nations Framework Convention on Climate Change Process	73
1.3.2	Sub-national Actions for Sustainable, Low Carbon Transport	81
1.3.3	The Role of Business in Decarbonising Transport	91
Spotlight 4	Shortening Global Supply Chains as a Key to Decarbonising Transport	115

Section Spotlight

List of Figures

Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals

Figure 1. Global temperature change, 1880-2020 . . . 9
Figure 2. Annual change in transport CO_2 emissions (including international aviation and shipping), 1971-2021. . . 10
Figure 3. Changes in CO_2 emissions by sector, 2010-2021 . . . 11
Figure 4. CO_2 emissions from ground transport and aviation, 2019-2022. . . 11
Figure 5. Per capita transport CO_2 emissions versus per capita gross domestic product, by country grouping, 2021. . . 12
Figure 6. Transport CO_2 emissions, by region and for international shipping and aviation, 2010-2021 . . . 13
Figure 7. Transport CO_2 emissions by activity and mode, 2019 . . . 13
Figure 8. CO_2 emissions from international aviation and shipping, 2015-2021 . . . 14
Figure 9. Global CO_2 transport emission trajectories by mode required to achieve IEA net zero emissions scenario . . . 16
Figure 10. Regional transport decarbonisation pathways for 2030 and 2050, by scenario. . . 18
Figure 12. SLOCAT transformations for sustainable, low carbon land transport . . . 20
Figure 11. SLOCAT Wheel on Transport and SDGs . . . 20
Figure 13. Synergies and trade-offs between transport mitigation options and the SDGs . . . 22
Figure 14. Avoid-Shift-Improve framework for transport. . . 24
Figure 15. Actions to reduce oil dependency in transport, through Avoid-Shift-Improve measures. . . 24

Transport Adaptation, Resilience and Decarbonisation in Small Island Developing States

Figure 1. Per capita transport CO_2 emissions in SIDS. . . 54

Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs

Figure 1. Transport targets, by type, in countries' second-generation NDCs. . . 65
Figure 2. Impact of transport greenhouse gas mitigation targets in NDCs. . . 66
Figure 3. Number of specific transport targets mentioned in 2022 Voluntary National Reviews. . . 71

Sub-national Actions for Sustainable, Low Carbon Transport

Figure 1. Number of regions committing to net zero targets, as of June 2023 . . . 86
Figure 2. Number of cities committing to net zero targets, as of June 2023 . . . 87
Figure 3. Number of regions committing to net zero targets, as of June 2023 . . . 88
Figure 4. Number of cities committing to net zero targets, as of June 2023 . . . 89

The Role of Business in Decarbonising Transport

Figure 1. 4 A's of Climate Leadership by the We Mean Business Coalition. . . 94
Figure 2. Transport stakeholders for passenger and freight transport . . . 95
Figure 3. Regional market shares of original equipment manufacturers committed to zero-emission vehicles, 2020 . . 96
Figure 4. Projected production of zero-emission vehicles versus targets set in the International Energy Agency's 1.5°C scenario, 2021-2029. . . 98
Figure 5. Projected composition of the global light-duty vehicle fleet, by technology, 2021-2029. . . 98
Figure 6. Global availability of zero-emission medium-and heavy-duty vehicles, by type, 2021-2023 . . . 99
Figure 7. Policy advocacy positions across transport modes in the EU, as of January 2023 . . . 100
Figure 8. Zero-emission vehicle production and climate policy engagement, by region . . . 101
Figure 9. Transport companies with SBTi targets, by sector. . . 102
Figure 10. Transport companies with climate transition plans, by level of credible coverage . . . 104

Figure 11. Comprehensiveness of climate transition plans of 90 transport companies. 104
Figure 12. Average climate and social performance of 90 transport companies, by mode 105
Figure 13. Indicative emission intensity ranges by transport mode (well-to-wheel grams of CO_2 equivalent per tonne-kilometre) 113

Shortening Global Supply Chains as a Key to Decarbonising Transport

Figure 1. The role of longer distance trade, 1965-2020 118
Figure 2. Length and geographical distribution of international production, by key industry type 119
Figure 3. Global supply chain pressure index (higher value means higher pressure), 2015 to 2022 120

List of Tables

Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals

Table 1. Milestones towards net zero transport emissions, according to the IEA Net Zero Scenario 17
Table 2. Weaknesses and threats facing efforts to transform transport systems to achieve the SDGs 22

Transport Adaptation and Resilience

Table 1. Resilience and adaptation indicators 40

Transport - Health Nexus

Table 1. Health benefits from low carbon, active and electrified transport 43

Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs

Table 1. Transport greenhouse gas emission mitigation targets in countries' second-generation NDCs, as of end-2022 . . 64
Table 2. Transport adaptation targets in countries' second-generation NDCs, as of end-2022 65
Table 3. Transport targets in countries' LTS as of end-2022 67
Table 4. Overview of COP 26 commitments as of 14 December 2022. 68
Table 5. Specific transport targets reported in 2022 Voluntary National Reviews 72

Engagement of Transport Stakeholders in the United Nations Framework Convention on Climate Change Process

Table 1. Key milestones of transport stakeholders' engagement in UNFCCC processes 75

The Role of Business in Decarbonising Transport

Table 1. Examples of innovation in hard-to-decarbonise transport sub-sectors 99
Table 2. Climate policy engagement among auto industry associations 101
Table 3. Climate policy engagement among transport industry associations 106
Table 4. Strategies that shippers are using to "Shift" and "Avoid" emissions from freight transport. 108
Table 5. Climate policy engagement among auto industry associations in Europe 108

MODULE 1 1.1

AUTHORS:
Maruxa Cardama, Agustina Krapp,
Nikola Medimorec and Alice Yiu, *SLOCAT Secretariat*

Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Context and key challenges

- A just transition to equitable, healthy, green, and resilient transport and mobility systems is central to socio-economic prosperity for people and the planet. To achieve this, systemic transformations in transport and mobility – linked to wider socio-economic transformations – are needed.
- The past couple of years have changed the world. Most transport and mobility systems globally have become more vulnerable to systemic shocks, disproportionately affecting people living in vulnerable situations.
- The COVID-19 pandemic and other recent events have led to a greater understanding that decarbonised, resilient, and sustainable transport and mobility systems are an essential service that can increase the social return on investment, reduce the impacts of shocks and speed recovery.

Emission trends

- In November 2022, atmospheric concentrations of carbon dioxide (CO_2) reached their highest monthly mean ever recorded, at 417.8 parts per million. Estimates for the year indicate that CO_2 emissions hit a record high. Global fossil CO_2 emissions exceeded 37.6 gigatonnes in 2019, dropped to 35.6 gigatonnes in 2020, then rose to 37.5 gigatonnes in 2021.
- The Russian Federation's invasion of Ukraine, which began in February 2022, has had significant, long-lasting impacts on the climate, in addition to its wide-ranging humanitarian, social and economic impacts.
- During 2010-2019, the transport sector had the fastest growth in CO_2 emissions among combustion sectors globally, rising 2% annually on average and 18% overall. In 2020, due mainly to the impacts of the COVID-19 pandemic, transport CO_2 emissions fell 13%, dropping to 2012 levels. However, emissions nearly completely recovered in 2021 and likely resumed their upward trend in 2022.
- In 2021, high-income countries were responsible for 50.7% of transport CO_2 emissions, while low-income countries contributed less than 1%. Per capita transport CO_2 emissions have doubled in middle-income countries since 1980, while barely changing in low-income countries.
- During 2010-2021, Asia experienced the highest growth in transport CO_2 emissions among regions, at 36%, followed closely by Africa at 34%. In 2021, transport emissions continued to fall in Europe, North America and Oceania, due to the pandemic, but grew in Latin America and the Caribbean.
- In 2019, freight's share of transport emissions increased to 42%, while passenger transport's share fell to 58%. Road transport (passenger and freight) contributed 77% of global transport CO_2 emissions in 2019.
- Aviation (domestic and international) is responsible for around 4% of the human-induced climate change to date, despite contributing only 2.4% of annual global CO_2 emissions.
- In 2020, CO_2 emissions from international aviation fell 45%, returning to 1999 levels. They then increased 15% in 2021 but were still 37% below 2019 levels. An estimated 1% of the world's population is responsible for more than half of all CO_2 emissions from passenger air travel.
- International shipping produces more transport CO_2 emissions than the regions of Africa and Oceania combined. In 2020, CO_2 emissions from international shipping fell only 2.6%, and they recovered by 2021 to exceed pre-pandemic levels.

Transport emissions in a business-as-usual scenario

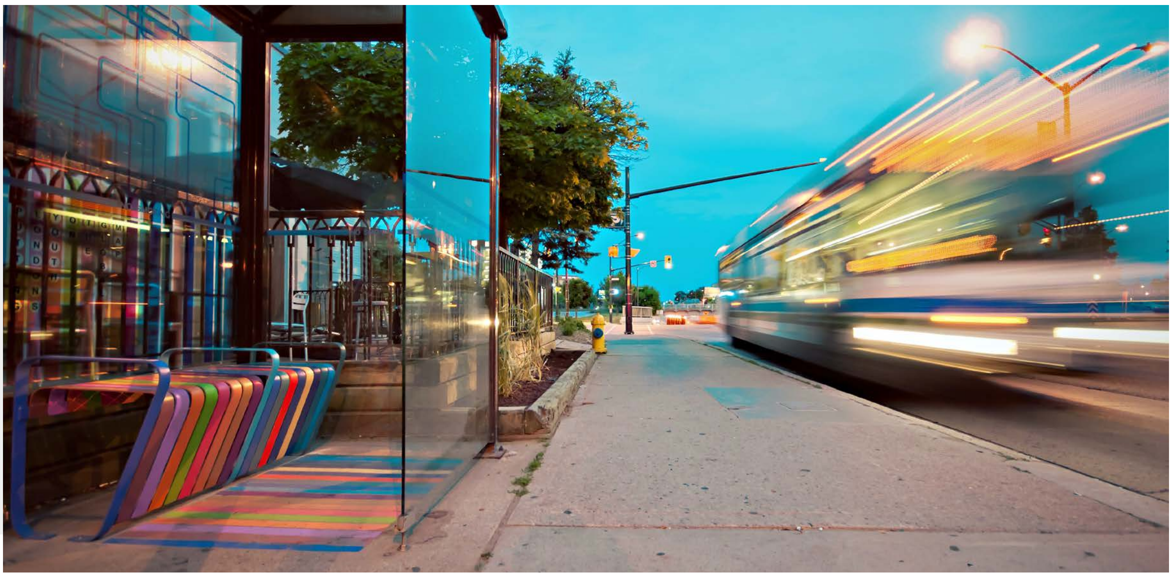
- Under business as usual, global transport activity is projected to nearly double by 2050, rising 1.8 times for passenger transport and 2.0 times for freight transport compared to 2019 levels. Without more ambitious policies, transport CO_2 emissions could grow 16-50% by 2050.
- Although countries have made progress in developing long-term visions for addressing climate change in transport, current policies and measures (focused heavily on electrification) are insufficient to put the sector on a decarbonisation pathway in line with the Paris Agreement goal of keeping global temperature rise below 1.5 degrees Celsius (°C).
- Climate action in the transport sector is still deeply insufficient, and countries' Nationally Determined Contributions (NDCs) under the Paris Agreement that feature transport lack the necessary ambition. Even if the current NDC targets for mitigating transport emissions are met, emissions in the sector will still grow.

Pathways for decarbonising transport

- Total economy-wide greenhouse gas emissions need to peak before 2025 to limit global warming to 1.5°C (with no or limited overshoot).
- Achieving low carbon transport pathways that limit global warming to 1.5°C will require a 59% reduction in transport-related CO_2 emissions by 2050, compared to 2020 levels.
- The maximum increase in passenger transport activity should be 50%, and in freight activity should be 20%, over the 2020-2050 period. Overall, the carbon intensity of the energy used in transport and of the fuels consumed needs to be halved by 2050.
- Fossil fuel dependence in road transport needs to decline drastically, from 95% in 2020 to 10% by 2050, with electricity becoming the dominant fuel in transport by the early 2040s.
- In addition to the transition of technologies ("Improve" measures), behavioural changes ("Avoid" and "Shift" measures) are needed to support transport decarbonisation, as emission reductions will not be achieved without critical transitions in transport modes. A 2021 study found that while "Improve" measures can contribute half of the required emission reductions in transport, "Avoid" and "Shift" actions are needed to meet the other half.
- Different regions need to contribute differently to the reduction of transport CO_2 emissions, with stronger reductions required in high-income countries than in low- and middle-income countries.

Transforming transport and mobility systems for more sustainable societies

- Achieving equitable, healthy, green, and resilient transport and mobility systems has both explicit and implicit implications for the success of the United Nations' 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs).
- Since the 2015 adoption of the landmark 2030 Agenda and the Paris Agreement, rising inequalities coupled with the COVID-19 pandemic and geopolitical conflicts have led to significant setbacks in the accomplishment of these agendas and their transport-related targets.
- In a world of interconnected challenges, the opportunity lies in finding solutions for systemic transformation that cut across transport, sustainability and climate action. Applying "Avoid-Shift-Improve" measures across passenger and freight transport through integrated, inter-modal and multi-dimensional approaches remains critical to deliver such cross-cutting solutions.
- Global fossil fuel subsidies have continued to rise, whereas strong financial support is lacking for sustainable, low carbon transport and mobility options. A fundamental reform of transport economics is urgently needed to deliver the necessary just transformations at the speed and scale required to achieve the targets of the Paris Agreement and the SDGs.



Overview

A just transition to equitable, healthy, green, and resilient transport and mobility systems is central to socio-economic prosperity for people and the planet. In addition to reducing greenhouse gas emissions from transport, such a transition will yield social, environmental and economic "multiplier effects" that go well beyond the scale of the necessary financial investment. This is why the transformation of transport and mobility systems has both explicit and implicit implications for the success of the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), as well as of the Paris Agreement on climate change.

To achieve this, systemic transformations in transport and mobility – linked to wider socio-economic transformations – are needed. The reality is that most of the world's population does not have access to affordable, sustainable transport. Human-caused greenhouse gas emissions continue to rise, including from transport. Although the transport sector experienced the largest decline in emissions among combustion sectors in 2020, transport emissions recovered almost completely in 2021.[1] Without a structural transformation and more ambitious policies, transport emissions could increase 16-50% by 2050.[2]

The past couple of years have changed the world. Most transport and mobility systems globally have become more vulnerable to systemic shocks, disproportionately affecting people living in vulnerable situations. The COVID-19 pandemic has amplified longstanding, unresolved, and interconnected challenges and inequalities, and has greatly impacted emerging and low-income economies. The Russian Federation's invasion of Ukraine has made even more apparent the multi-pronged consequences of humanity's addiction to fossil fuels.

Wide-ranging challenges have put the already-elusive progress towards the SDGs and the Paris Agreement at increased risk. Such challenges include: fast-growing inequalities within and among countries; rocketing prices for energy and essential goods; crises around raw materials, semiconductors and global supply chains; escalating extreme weather events; low levels of climate financing for low- and middle-income countries despite pledges; and the threat of sovereign default in many of these countries.

The Intergovernmental Panel on Climate Change (IPCC) has revealed an important gap between countries' pledged emission reductions for 2030 (outlined in their Nationally Determined Contributions, or NDCs, submitted to the United Nations in 2021) and the models for the emission reduction pathways that are needed to keep global temperature rise within 2 degrees Celsius (°C).[3] Modelled pathways to 2030 that are consistent with the NDCs submitted as of November 2021 were estimated to result in median global warming of 2.8°C by 2100.[4]

Although countries have made progress in developing long-term climate visions, current transport policies and measures are insufficient to put transport on a decarbonisation pathway in line with the Paris Agreement's goal of keeping global warming within 1.5°C. According to the International Energy Agency (IEA), electric vehicles are the only transport-related area on track with scenarios for net zero greenhouse gas emissions. Although reducing fossil fuel dependence in transport is key, electrification of transport – even if powered with renewable energy – will not be enough. A shift to more energy-efficient transport modes, complemented with behavioural changes, is mandatory.

Moreover, the substantial threat that natural hazards pose to transport systems around the world is only expected to increase due to climate change. The cascading impacts of disruptions in other sectors, as well as macroeconomic and geopolitical shocks or societal events, also can disrupt transport networks, leading to monetary costs that far exceed the damage to physical assets alone. This reinforces the need for greater adaptation and resilience of transport systems, and for holistic notions of socio-economic resilience through transport. (*See Section 1.2 Transport Adaptation and Resilience.*)

Yet, the magnitude of the challenges should not obscure the opportunities that lie ahead. Transport systems have always created prospects for socio-economic development. Humanity's inexorable desire to explore, connect, exchange and learn requires the use of transport. **The pandemic and other recent events have led to a greater understanding that decarbonised, resilient, and sustainable transport and mobility systems are an essential service that can increase the social return on investment, reduce the impacts of shocks and speed recovery.** As countries have experienced, shifting to active modes of transport can deliver a host of resilience, social and environmental benefits. Pressures on the energy supply have reinvigorated discussions about energy efficiency and independence, as well as interest in reforming energy policies to transform transport.

The current circumstances confront us with the urgent need for profound and systemic socio-economic transformations – many of which directly impact the ability to transform transport systems over the coming decade. However, policy responses to today's transport challenges remain insufficient and are too slow. In a world of interconnected challenges, the opportunity lies in finding solutions for systemic transformation that cut across transport, sustainability and climate action. Applying the "Avoid-Shift-Improve" framework through integrated, inter-modal multi-dimensional solutions across passenger and freight transport remains critical to deliver on such cross-cutting solutions.

As global subsidies for fossil fuels have continued to rise, there remains a lack of financial support for sustainable, low carbon transport. A fundamental reform of transport economics is urgent to deliver the needed transformation at the speed and scale required to achieve the goals of the Paris Agreement and the SDGs.

Emission trends

Economy-wide emissions

In the previous (2021) edition of this report, it was reported that atmospheric concentrations of carbon dioxide (CO_2) had reached their highest level in more than 800,000 years (as of March 2019).[5] Since then, **global CO_2 levels have continued to rise, and in November 2022 they reached their highest monthly mean ever recorded, at 417.8 parts per million.**[6] The world has exceeded 1.2°C of global warming since the start of the industrial era, with each decade registering higher temperatures than the preceding one.[7] So far, in every year of the 21st century, the global average temperature has been at least 0.5°C above the average of 1951-1980, with 2016 and 2020 surpassing 1.0°C above the average (see Figure 1).[8]

Human-caused greenhouse gas emissions have risen in every major sector since 2010.[9] Efficiency improvements (measured as the energy intensity of gross domestic product, and carbon intensity) have been outweighed by absolute increases in emissions in all sectors. Starting from a 2020 baseline, the remaining "carbon budget" to keep global temperature rise within 1.5°C (at a 66% likelihood) is 400 gigatonnes of CO_2.[10] This means that, as of 2023

FIGURE 1. Global temperature change, 1880-2020

Source: See endnote 8 for this section.

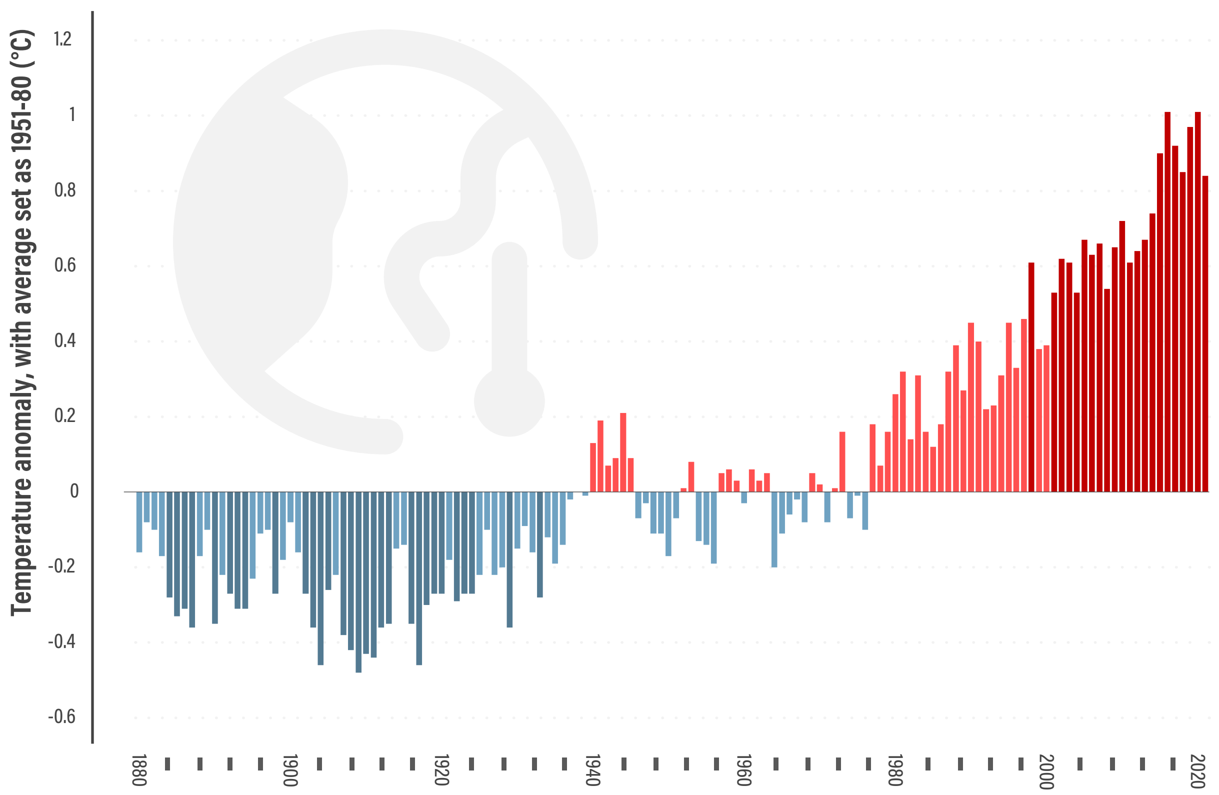
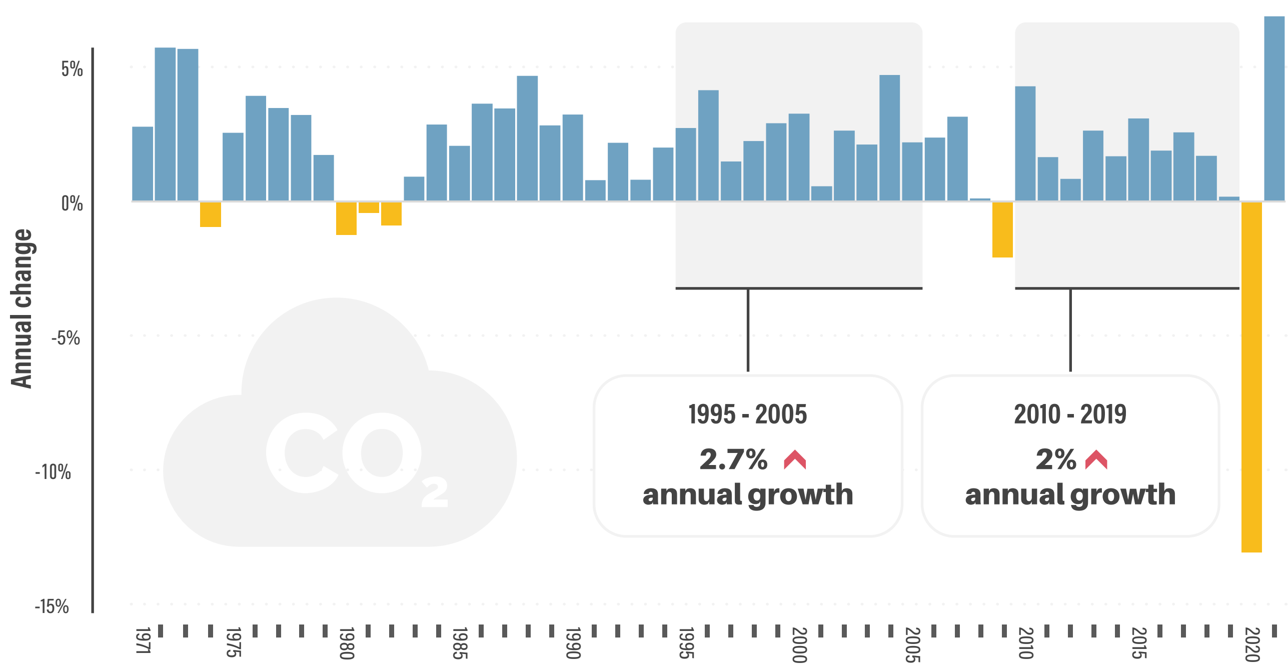


FIGURE 2. Annual change in transport CO_2 emissions (including international aviation and shipping), 1971-2021

Source: See endnote 21 for this section.



(assuming current emission rates), only nine years remain until humanity "uses up" its carbon budget to keep warming within 1.5°C by the end of this century.[11]

Global fossil CO_2 emissions exceeded 37.6 gigatonnes in 2019, dropped by 2 gigatonnes to reach 35.6 gigatonnes in 2020, then rose to 37.5 gigatonnes in 2021.[12] **Estimates for 2022 indicate that global CO_2 emissions hit a record high.**[13] Emissions from oil outpaced those from coal and gas, driven by rising travel demand as the sector recovered from pandemic-related declines in 2020 and 2021.[14]

The Russian Federation's invasion of Ukraine, which began in February 2022, has had significant, long-lasting impacts on the climate, in addition to its wide-ranging humanitarian, social and economic impacts.[15] In just the first seven months of the invasion, related activities resulted in the release of an estimated 100 million tonnes of CO_2-equivalent emissions, or as much as the entire country of the Netherlands emitted in this period.[16] The emissions are attributed to the movement of refugees (1.4%), warfare (9.1%), fires (24.4%), reconstruction of civilian infrastructure (50%) and pipeline leakages (15%).[17]

Global transport emissions

The average annual growth in greenhouse gas emissions slowed during 2010-2019 in most sectors globally except for transport, which has remained heavily dependent on fossil fuels.[18] In 2010, oil and petroleum products accounted for 97.4% of the energy use in transport, a share that fell slightly to 95.9% in 2020.[19] Transport emissions have continued to grow in both absolute and percentage terms (their share in total emissions). The slow progress in reducing emissions in "hard-to-abate" sub-sectors – such as aviation, long-distance road freight and shipping – has made it difficult to translate efficiency gains into absolute emission reductions.

During 2010-2019, the transport sector had the fastest growth in CO_2 emissions among combustion sectors globally (excluding "other sectors"), rising 2% annually on average and 18% overall.[20] However, this was slower than the 2.7% annual average growth during 1995-2005 (see Figure 2).[21] CO_2 emissions from transport, including international aviation and shipping, reached 8.2 gigatonnes in 2019, or 22% of total fossil CO_2 emissions.[22]

FIGURE 3. Changes in CO_2 emissions by sector, 2010-2021

Source: See endnote 24 for this section.

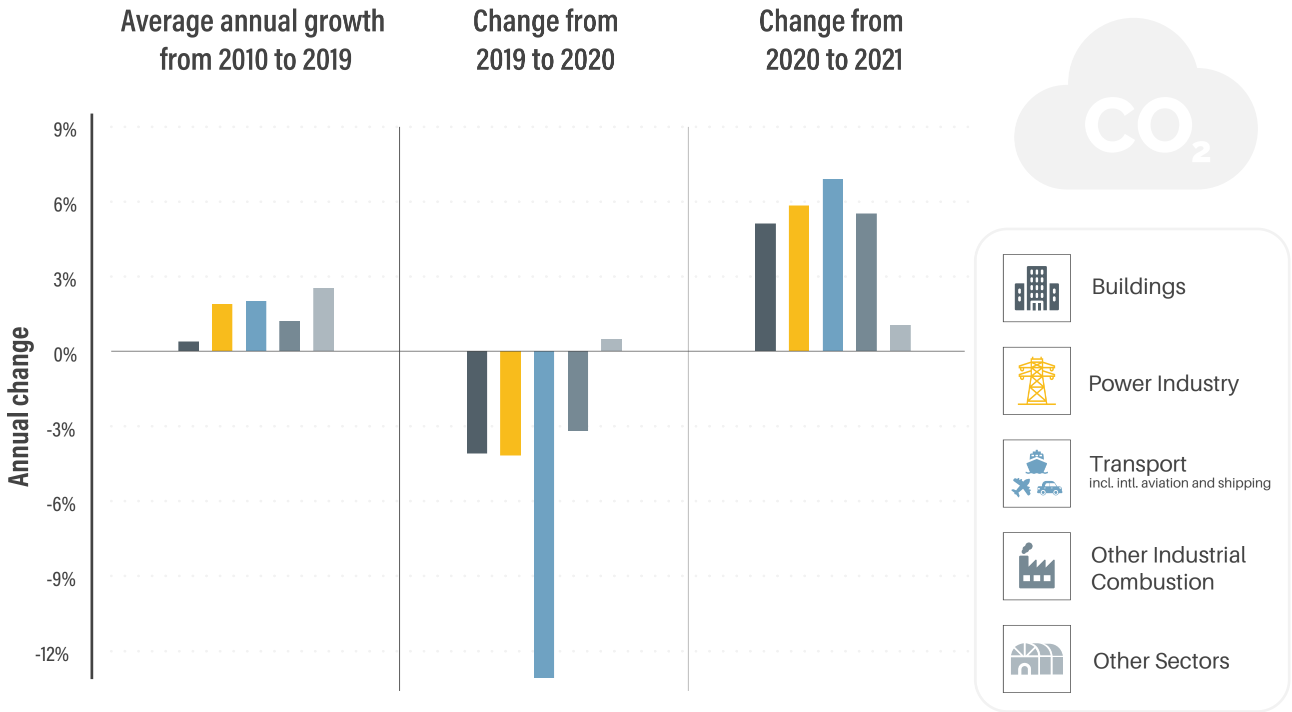


FIGURE 4. CO_2 emissions from ground transport and aviation, 2019-2022

Source: See endnote 25 for this section.

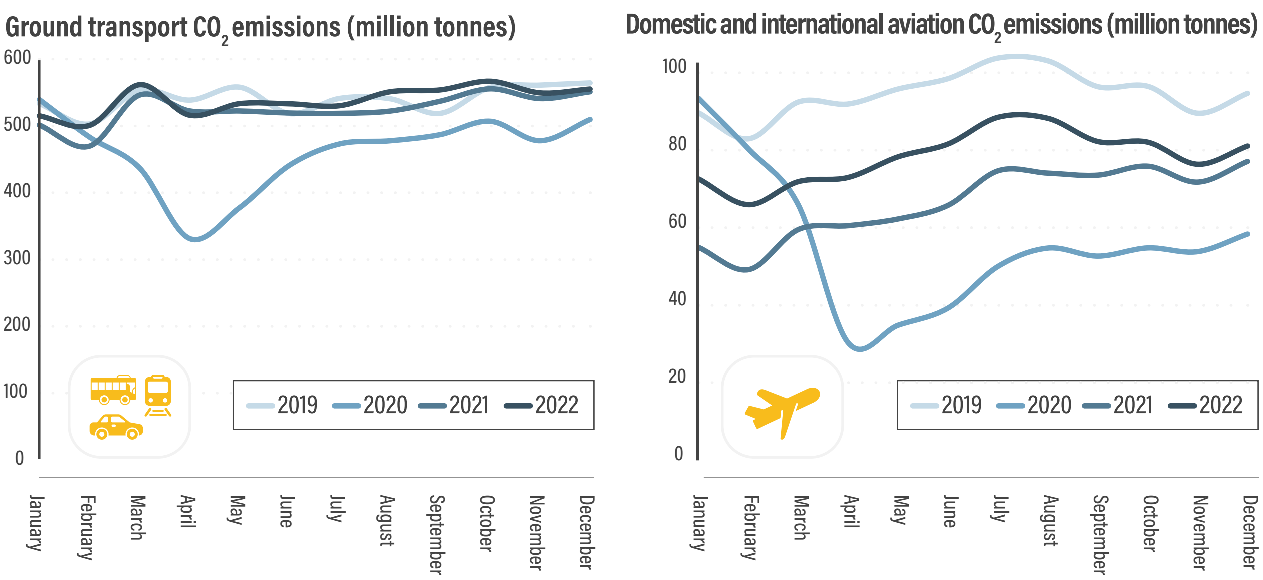
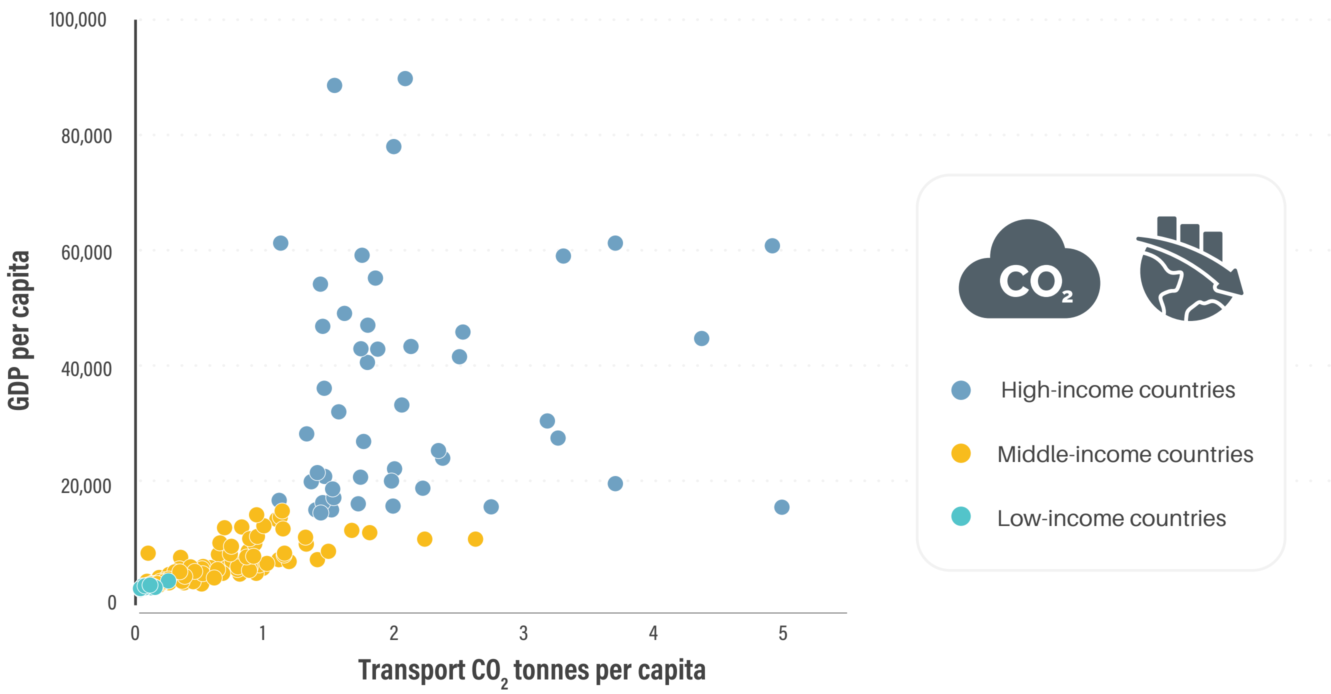


FIGURE 5. Per capita transport CO_2 emissions versus per capita gross domestic product, by country grouping, 2021

Source: See endnote 27 for this section.



In 2020, due mainly to the impacts of the COVID-19 pandemic, transport CO_2 emissions fell 13%, dropping to 2012 levels at 7.1 gigatonnes.[23] Transport experienced the greatest emission decline among combustion sectors, although it also showed the strongest rebound in 2021, to 7.6 gigatonnes of CO_2, or an average of 0.83 tonnes per capita (see Figure 3).[24] Early estimates for 2022 indicate that emissions from ground transport (road and rail) nearly recovered to pre-pandemic CO_2 levels, whereas aviation emissions (domestic and international) were still 20% below 2019 levels (see Figure 4).[25] **Overall, transport emissions nearly completely recovered in 2021 and likely resumed their upward trend in 2022.**[26]

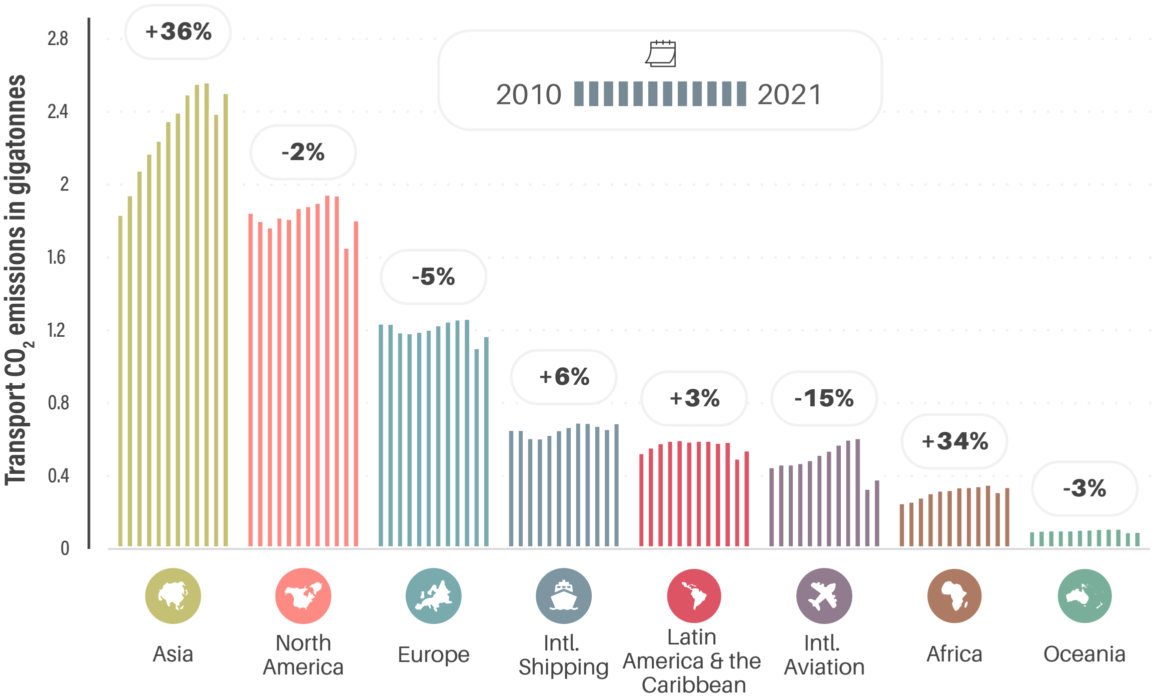
Emissions by income level

In 2021, high-income countries were responsible for 50.7% of transport CO_2 emissions, while low-income countries contributed less than 1% (see Figure 5).[27] Per capita transport CO_2 emissions totalled 2.8 tonnes in high-income countries, 0.53 tonnes in middle-income countries and 0.07 tonnes in low-income countries.[28] **Per capita transport CO_2 emissions have doubled in middle-income countries since 1980, while barely changing in low-income countries.**[29]

Examining income inequalities further, the top 1% of individual emitters globally contribute more than 1,000 times the CO_2 emissions of the bottom 1%, with the highest disparities being experienced in transport.[30] In North America, road transport makes up as much as one-quarter of the CO_2 emissions from the richest income group.[31] Globally, the gap in transport emissions between the 38 member countries of the Organisation for Economic Co-operation and Development (OECD) and the 160 non-OECD countries has nearly closed, with OECD countries contributing 51% of transport emissions in 2021.[32]

FIGURE 6. Transport CO_2 emissions, by region and for international shipping and aviation, 2010-2021

Source: See endnote 33 for this section.



Regional transport emissions

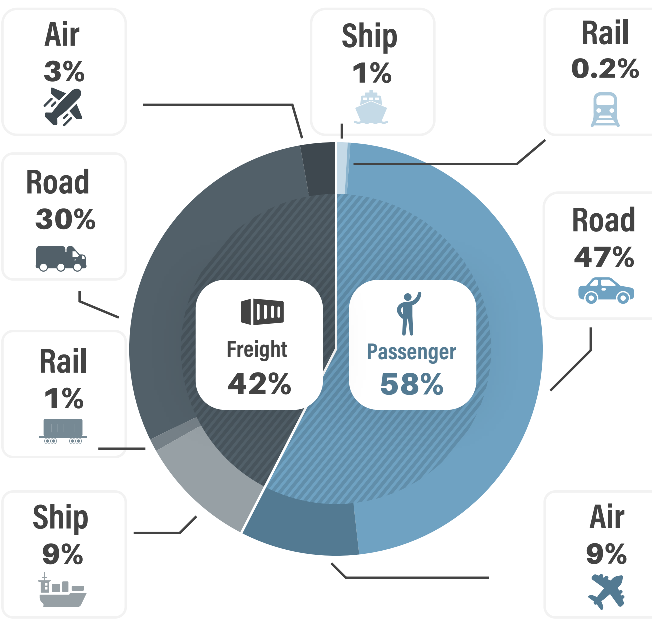
During 2010-2021, Asia experienced the highest growth in transport CO_2 emissions among regions, at 36%, followed closely by Africa at 34% (see Figure 6).[33] However, Africa's absolute emissions were the second lowest regionally, after Oceania's, in 2021.[34] **Transport emissions continued to fall 2-6% in Europe, North America, and Oceania in 2021 due to the pandemic, but grew 3% in Latin America and the Caribbean.**[35] (*See Sections 2.1 to 2.6 Regional Overviews.*)

Passenger and freight transport emissions

Emissions from freight transport comprise a growing share of transport emissions. In 2018, freight accounted for 40% of global transport CO_2 emissions, and passenger transport accounted for 60%.[36] **In 2019, freight's share of emissions increased to 42%, while passenger transport's share fell to 58%** (see Figure 7).[37] Freight was less affected by the impacts of the pandemic, with the CO_2 emissions from road freight in 2021 estimated to be only 1% below 2019 levels.[38] Freight transport emissions will likely continue to grow with rising demand for deliveries and transport of goods, as well as shifts to air freight.[39]

FIGURE 7. Transport CO_2 emissions by activity and mode, 2019

Source: See endnote 37 for this section.



Road transport (passenger and freight) contributed 77% of global transport CO_2 emissions in 2019 (see Figure 7).[40] Road transport was responsible for 82% of passenger transport emissions and 69% of freight transport emissions that year.[41] In 2020, urban travel contributed one-third of the total emissions from passenger transport.[42]

Aviation and shipping emissions

Aviation (domestic and international) is responsible for around 4% of the human-induced climate change to date, despite contributing only 2.4% of annual global CO_2 emissions.[43] This is because, in addition to the CO_2 emitted through the combustion of jet fuel, aircraft release water vapour that leads to the formation of cirrus clouds, trapping additional heat in the atmosphere.

During 2010-2019, CO_2 emissions from international aviation grew 3.6% annually on average.[44] In 2018, commercial aviation contributed the vast majority of global aviation emissions (an estimated 88%), followed by military operations (8%) and private flights (4%).[45]

In 2020, CO_2 emissions from international aviation fell 45%, returning to pre-millennium (1999) levels at 338 million tonnes.[46] **They then increased 15% in 2021, to 390 million tonnes, but were still 37% below 2019 levels.**[47] Domestic and international aviation accounted for more than 2% of global energy-related emissions in 2021, reflecting faster growth than road, rail or maritime transport emissions since 2000.[48]

An estimated 1% of the world's population is responsible for more than half of all CO_2 emissions from passenger air travel.[49] In 2018, only around 11% of the global population travelled by air, and only 2-4% took international flights.[50] The vast majority of the global population (90%) flies only one time a year or not at all, whereas 6% flies more than twice a year and 1% flies more than five times a year.[51] An analysis of private jets owned by US celebrities found that these jets emit 482 times more CO_2 emissions collectively than the average person emits in a year.[52]

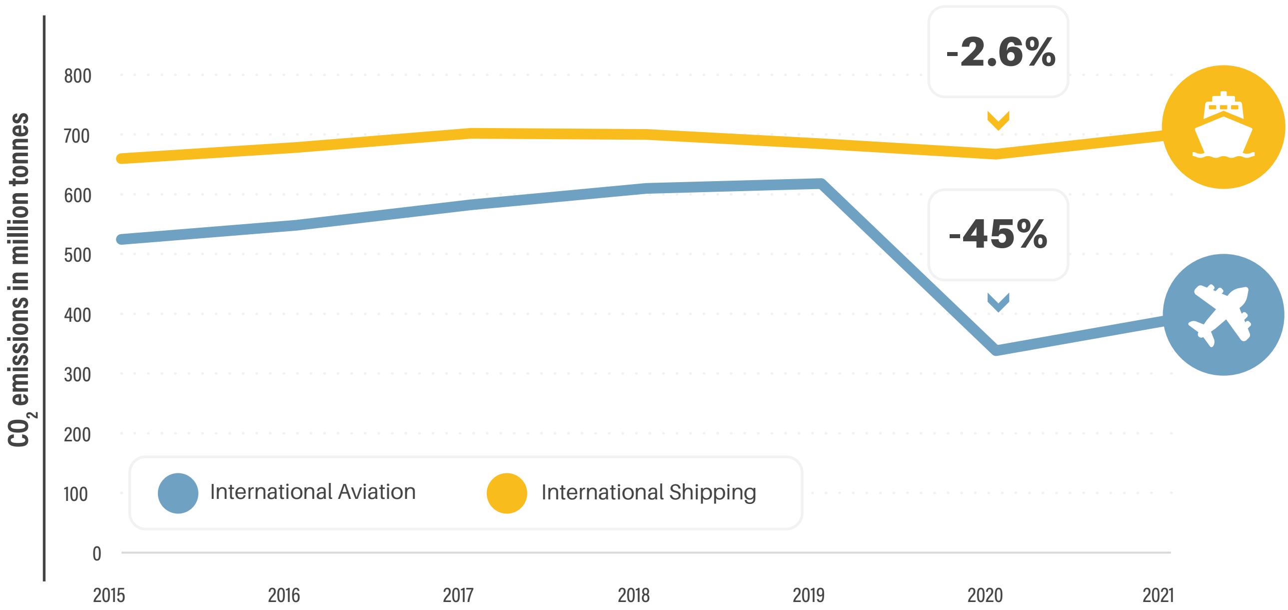
The Russian Federation's invasion of Ukraine has stalled the recovery of the airline industry and driven up jet fuel prices.[53] Moreover, closure of the Russian and Ukrainian airspaces has led to longer-distance rerouting of some flights between Asia and Europe or North America, likely driving up emissions.[54] In 2022, Finnair reported 40% longer flights to China, British Airways had a 20% longer diversion to China, and other European airlines added flight times of 15-40% for the same routes.[55] (*See Section 3.7 Aviation.*)

International shipping produces more transport CO_2 emissions than the regions of Africa and Oceania combined.[56] As much as 40% of maritime trade consists of transporting fossil fuels (including coal, oil and liquefied natural gas) from points of fuel production to points of fuel consumption.[57]

Emissions from international shipping decreased 2.2% in 2019 due to a stagnant economic year.[58] **In 2020, despite the pandemic's drastic impacts on global trade, international**

FIGURE 8. CO_2 emissions from international aviation and shipping, 2015-2021

Source: See endnote 59 for this section.



shipping CO_2 emissions fell only 2.6%, and they grew 5% in 2021 to nearly 700 million tonnes, returning to 2017 levels and exceeding pre-pandemic (2019) levels (see Figure 8).[59]

The Russian invasion of Ukraine added to the prevailing pandemic-related impacts on maritime transport (port congestion, disrupted trade, etc.), resulting in rising energy costs, higher food prices and the rerouting of supply chains (including port delays and pressure on storage).[60] It is yet unclear how this will affect shipping emissions. *(See Section 3.8 Shipping.)*

Transport emissions in a business-as-usual scenario

Under business as usual, transport activity is projected to nearly double by 2050, rising 1.8 times for passenger transport and 2.0 times for freight transport compared to 2019 levels.[61] Growing demand for freight and passenger services is expected across all transport modes, particularly in Africa and Asia.[62] The global passenger car fleet is projected to reach between 1.4 billion and 1.55 billion vehicles by 2050, up from nearly 1.2 billion vehicles in 2020.[63]

Without more ambitious policies, transport CO_2 emissions could grow 16-50% by 2050.[64] As a result, CO_2 emissions from freight transport would be 22% higher in 2050 than in 2015.[65] Without proper interventions, international aviation CO_2 emissions would grow from 617 million tonnes in 2019 to more than 1,500 million tonnes by 2050.[66] International shipping CO_2 emissions would increase 40% over this period.[67] Under current policies, urban transport emissions would decrease slightly, by 5%.[68] In Asia, the largest regional emitter in 2019, transport CO_2 emissions could grow an estimated 1.5% annually to 2030, with the share of freight in Asia's transport emissions rising from 48% in 2000 to 57% in 2030.[69]

Current transport policies and measures are insufficient to put transport on a decarbonisation pathway in line with the 1.5°C target of the Paris Agreement. A 2022 assessment of 13 transport targets (such as public transport development, cycling infrastructure, sustainable aviation fuels, etc.) found that none of them were on track, with 2 of the targets (electric light-duty vehicle sales and electric bus sales) showing promise (although off track) and 7 of the targets heading in the right direction but well off track.[70] The indicator showing the least progress was kilometres travelled by passenger cars, with private passenger cars accounting for as much as 44% of the total kilometres travelled in 2020.[71]

The International Energy Agency considers electric vehicles to be the only transport-related area that is on track with global scenarios for net zero emissions.[72] In 2022, electric car sales surpassed 10 million to account for 13% of the global new car market, resulting in 25 million electric passenger cars on the world's roads.[73] For road freight, technical solutions are less mature and not yet readily available, but important developments are under way.[74]

BOX 1. Nationally Determined Contributions and Long-Term Strategies under the Paris Agreement

To achieve the goals of the Paris Agreement, the transport sector must accelerate climate action immediately. Under the agreement, Parties to the UN Framework Convention on Climate Change are required to submit Nationally Determined Contributions, or frameworks and strategies outlining their specific targets and actions to reduce emissions. NDCs communicate planned mitigation and adaptation actions by countries, including plans to achieve resilient, low carbon transport systems. To complement the NDCs, the Paris Agreement invites (but does not require) countries to formulate and communicate Long-Term Strategies (or long-term low greenhouse gas emission development strategies) (LTS) to help establish low carbon trajectories to 2050. *(See Section 1.3.1 Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs.)*

Countries have made progress in developing long-term visions for addressing climate change in transport through their Nationally Determined Contributions (NDCs) and Long-Term Strategies (LTS) under the Paris Agreement (see Box 1)**, with a growing number of countries committing to net zero targets.**[75] **However, the current policies announced or implemented will still contribute to average global temperature rise of 2.8°C by 2100.**[76] Achieving unconditional and conditional targets set in NDCs would reduce this to 2.6°C and 2.4°C respectively.[77] By 2030, an emissions gap will remain of 15 gigatonnes of greenhouse gases for a 2°C pathway and 23 gigatonnes for a 1.5°C pathway, reflecting the difference between emissions under business as usual and those required to achieve the Paris Agreement goals.[78]

Even if all 23 countries with transport greenhouse gas mitigation targets in their NDCs (as of the end of 2022) meet them, emissions will still grow.[79] In many cases, targets for reducing transport CO_2 emissions are relative to business-as-usual scenarios that imply absolute growth in transport emissions. Therefore, the growth in emissions will only be slowed; the 23 countries with transport targets would slow the emission growth 50% below business as usual.[80] (*See Section 1.3.1 Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs.*)

Pathways for transport decarbonisation

Total economy-wide greenhouse gas emissions need to peak before 2025 to limit global warming to 1.5°C (with no or limited overshoot).[81] Because the remaining carbon budget is limited, rapid and deep mitigation of emissions is needed until 2050. Net zero CO_2 emissions are required by 2050 for pathways limiting warming to 1.5°C, and by the early 2070s for pathways limiting warming to 2°C.[82]

Achieving low carbon transport pathways that limit global warming to 1.5°C (with no or limited overshoot) will require a 59% reduction in transport-related CO_2 emissions by 2050, compared to 2020 levels.[83] The previous edition of this report in 2021 noted that to comply with the 1.5°C target, transport CO_2 emissions must be reduced to roughly 3 gigatonnes or less by 2050.[84] This would mean a decrease in per capita transport CO_2 emissions from 0.83 tonnes in 2021 to 0.20 tonnes in 2050.[85] Global reports released between 2021 and 2023 share similar CO_2 thresholds for 2050:

- International Transport Forum (ITF) Transport Outlook: 1.6 gigatonnes
- IEA net zero emission pathway: 0.68 gigatonnes
- IPCC Sixth Assessment Report scenarios for 1.5°C: between 0.7 and 2.9 gigatonnes
- International Renewable Energy Agency pathway: 0.4 gigatonnes.[86]

In the IEA's net zero emission scenario, a 90% drop in transport CO_2 emissions (below 2020 levels) is required by 2050, with transport modes contributing differently to these reductions (see Figure 9).[87]

Shipping and aviation will contribute less than other modes due to the differing levels of technology maturity and readiness of scalable solutions.[88] To achieve a transport low carbon pathway, several key milestones need to be met (see Table 1), including shifts to more energy-efficient modes, such as electric vehicles powered by renewable electricity

FIGURE 9. Global CO_2 transport emission trajectories by mode required to achieve IEA net zero emissions scenario

Source: See endnote 87 for this section.

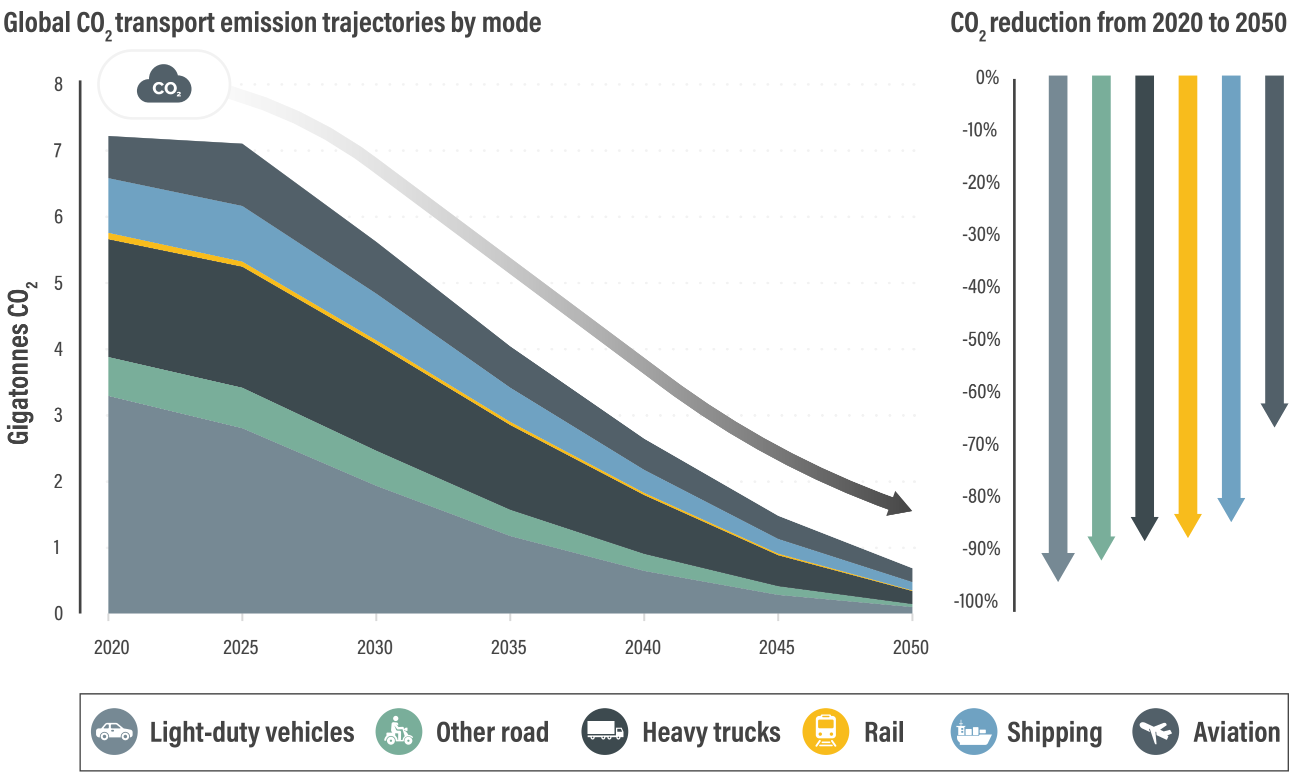


TABLE 1. Milestones towards net zero transport emissions, according to the IEA Net Zero Scenario

Source: See endnote 89 for this section.

2030	2035	2040	2045	2050
■ 65% of rail is electric ■ 60% of global car sales are electric ■ 13% of energy consumption is from advanced biofuels ■ 20% of aviation fuels are sustainable aviation fuels	■ 50% of heavy truck sales are electric ■ No new internal combustion engine cars and two-/three-wheelers are sold after 2035	■ 50% of fuels used in aviation are low emission ■ 60% of shipping is based on low-emission fuels	■ All heavy trucks sold are electric or fuel cell	■ Passenger rail nearly doubles its share of total transport activity, to 20% ■ Regional flights are shifted to high-speed rail where feasible

sources, as well as public transport.[89] A 2023 World Bank report highlights that electric buses and electric two- and three-wheelers can be cost-effective, feasible entry points for transitioning to electric mobility in low- and middle-income countries, while at the same time promoting inclusive mobility, improving air quality and enhancing energy security.[90]

Transport mitigation actions except biofuels have been identified as providing more benefits than costs over their lifetime.[91] Transport is the only energy end-use sector where this is the case for all identified actions.[92]

However, even in a low carbon pathway, transport will be the second highest emitter of CO_2 among energy end-use sectors (after industry) by 2032, and by 2050 transport will be the most-polluting sector due to long-distance air travel.[93] The reduction of direct and indirect emissions from transport will contribute only 16% of the total reductions required to reach net zero emissions economy-wide, less than the 28% reductions by buildings and 29% reductions by industry.[94]

Looking at transport demand, in a low carbon pathway, the maximum increase in passenger transport activity should be 50%, and in freight activity should be 20%, over the 2020-2050 period.[95] **Overall, the carbon intensity of the energy used in passenger and freight transport and of the fuels consumed needs to be halved by 2050.**[96] The CO_2 intensity for passenger and freight transport needs to be cut 45-51%, which corresponds to average annual energy efficiency improvements of 2.0-2.4%, to contribute to the Paris Agreement goals.[97] In parallel, the carbon intensity of fuels and other direct energy used needs to decrease 37-60% by 2050, compared to 2020 levels.[98]

For freight transport, the picture is less clear, although at least moderate reductions are needed. Freight transport emissions could be reduced 76% below 2020 levels by 2050 with policies that support higher operational efficiencies, optimised routing and asset sharing, freight consolidation, enhanced collaboration in supply chains, shift to railways or inland waterways, standardisation and low carbon solutions.[99] Ambitious actions on urban passenger transport can reduce emissions more than 80% below 2019 levels by 2050.[100]

Fossil fuel dependence in road transport needs to decline drastically, from 95% in 2020 to 10% by 2050, with electricity becoming the dominant fuel in transport by the early 2040s.[101] Advanced biofuels will play a role in the transition to a zero-emission vehicle fleet in the short to medium term.[102] Biofuels will represent a 15% blending share in oil by 2030, and thereafter be used mainly for aviation and shipping.[103]

Vehicle electrification will happen faster in high-income countries, with a delay of only around five years for low- and middle-income countries.[104] Electric cars will represent 20% of all cars globally by 2030 and 60% by 2040, resulting in 350 million electric cars on the roads by 2030.[105] Electric two- and three-wheelers will double from the current 300 million to 600 million by 2030 and surpass 1.2 billion by 2050.[106] For buses, 23% of all buses in operation will be electric by 2030 and 79% by 2050, when more than 50 million electric buses will be in operation.[107] Vehicle electrification will raise electricity demand. The electric vehicle fleet consumed around 100 terawatt-hours annually in 2022 and will add another 380 terawatt-hours of electricity demand by 2030.[108]

In addition to the transition of technologies ("Improve" measures), behavioural changes ("Avoid" and "Shift" measures) are needed to support transport decarbonisation, as emission reductions will not be achieved without critical shifts in transport modes. In urban areas, a shift of 20-50% of all car trips to public transport, ridesharing, walking and cycling is required.[109] Car ownership can be reduced 35% by providing adequate public transport services and ridesharing schemes.[110]

For **international aviation,** pathways towards net zero emissions require aviation CO_2 emissions to peak in 2025 at 950 million tonnes and then fall to 210 million tonnes by 2050.[111] Governments will need to reinforce a shift to high-speed rail and constrain long-distance business travel. The difficulty is that aviation fuels require a high energy density.[112]

In 2021, the International Air Transport Association, the trade association of the world's airlines, committed to achieve net zero emissions by 2050.[113] In 2022, the International Civil Aviation Organization (ICAO) adopted a similar long-term aspirational goal for international aviation.[114] The most ambitious scenario for achieving the ICAO goal aims to reduce aviation CO_2 emissions from 600 million tonnes in 2019 to 203 million tonnes by 2050.[115] Technological improvements would contribute 21% of the reductions, operational improvements 11% and fuels 55%.[116]

Critically, none of the current ICAO scenarios are able to reach zero CO_2 emissions by 2050.[117] Moreover, the ICAO's long-term goal does not cover non-CO_2 gases, which account for two-thirds of aviation's climate impacts, nor does it reflect any short- or medium-term targets or binding commitments by countries. This goal would result in global warming of between 1.6°C and 2.3°C.[118] It has been criticised for these reasons and for its failure to create incentives to take meaningful action towards the goal.[119]

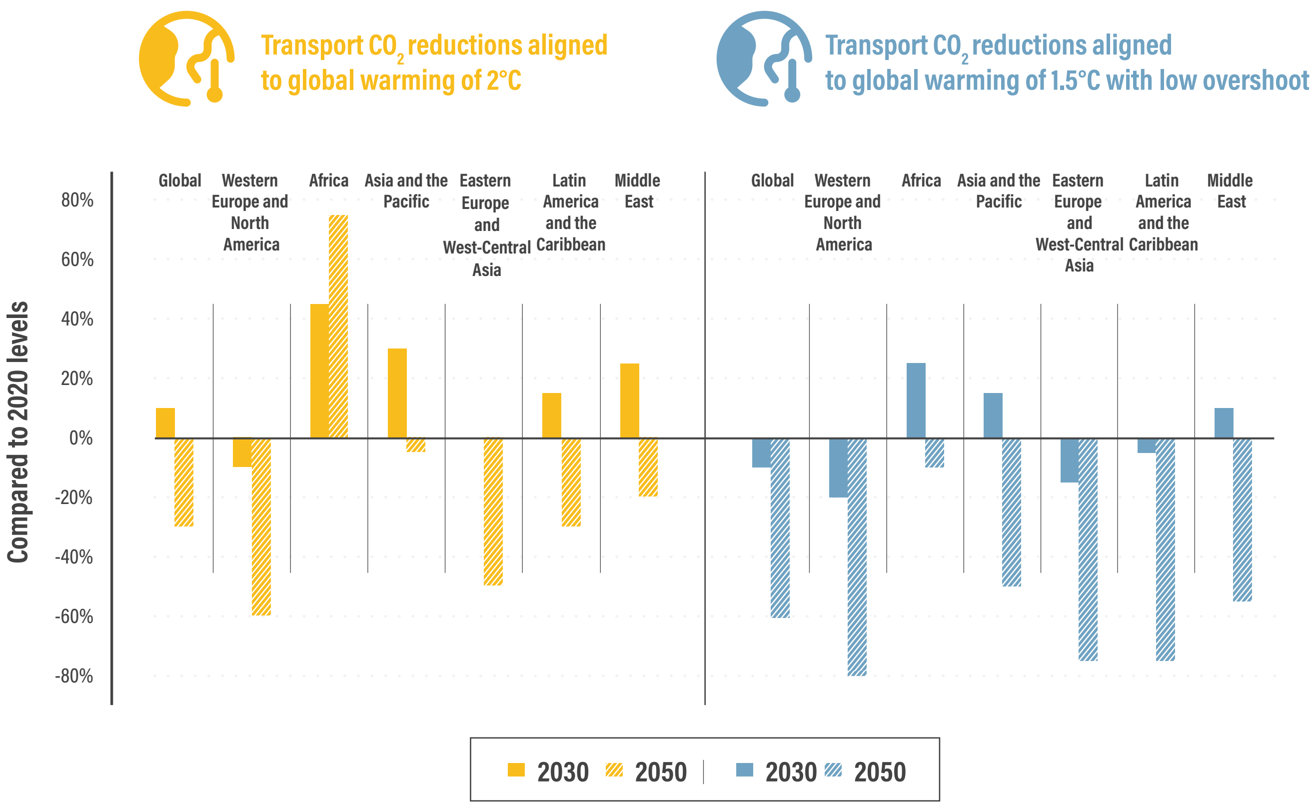
To contribute to achievement of the Paris Agreement targets, **international shipping** will need to become more efficient in the short term and to switch to low carbon fuels in the medium to long terms. This requires implementing approaches such as low steaming, wind-assistance technologies and low carbon fuels (ammonia, biofuels and hydrogen). Advanced biofuels can supply 20% of the shipping sector's energy consumption by 2050, while ammonia and hydrogen can cover 60%.[120]

In 2023, the International Maritime Organization (IMO) planned to release a revision of its 2018 Initial Greenhouse Gas Strategy.[121] The IMO's current targets are to reduce the carbon intensity of international shipping at least 40% by 2030 and 70% by 2050 and to reduce total annual greenhouse gas emissions from international shipping at least 50% by 2050 (compared to 2008 levels).[122] National governments have pressed the IMO to strengthen its regulations and targets, moving towards new interim goals for 2030 as well as zero emissions no later than 2050.[123]

Looking at regional transport decarbonisation pathways, different regions need to contribute differently to the reduction of transport CO_2 emissions (see Figure 10)**, with stronger reductions required in high-income countries than in low- and middle-income countries.**[124]

FIGURE 10. Regional transport decarbonisation pathways for 2030 and 2050, by scenario

Source: See endnote 124 for this section.



- **Western Europe and North America** need to reduce their transport CO_2 emissions drastically – at least 60% by 2050 to be aligned with the 2°C scenario and at least 80% by 2050 to be aligned with the 1.5°C scenario with low overshoot (compared with 2020 levels).[125]

- **Eastern Europe and West-Central Asia** will require extensive reductions of at least 50% below 2020 levels by 2050 for the 2°C scenario and 75% for the 1.5°C scenario with low overshoot.[126]

- **Asia and the Pacific** should reduce their transport CO_2 emissions 50% below 2020 levels by 2050 to be aligned with the 1.5°C scenario with low overshoot.[127]

- **Latin America and the Caribbean** will require transport CO_2 emission reductions of 30% below 2020 levels by 2050 for the 2°C scenario, and 75% for the 1.5°C scenario with low overshoot.[128]

- To be aligned with the 1.5°C scenario with low overshoot, countries in **Africa** can increase their transport CO_2 emissions around 20% by 2030, more than any other region, as long as emissions are at least 10% below 2020 levels by 2050.[129]

- Like Africa, the **Middle East** can increase its transport CO_2 emissions by 2030, but then should achieve significant reductions below 2020 levels – at least 20% by 2050 for the 2°C scenario and 55% for the 1.5°C scenario with low overshoot.[130]

Transforming transport and mobility systems for more sustainable societies

A just transition to equitable, healthy, green and resilient transport and mobility systems is central to socio-economic prosperity for the people and the planet.

To achieve equitable, healthy, green and resilient transport and mobility systems, a series of key transformations in land transport - linked to wider socio-economic transformations, are needed (see Figures 11 and 12).

The SLOCAT Wheel on Transport and the SDGs defines equitable, healthy, green and resilient transport and mobility systems based on the positive interactions with the UN 2030 Agenda and its SDGs (Figure 11). Under each theme, fundamental notions related to socio-economic and environmental systems on which sustainable, low carbon transport can affect positive change are highlighted. The analysis is complemented by a detailed list of targets across all SDGs for which action on sustainable, low carbon transport and mobility has the strongest impact.

FIGURE 11. SLOCAT Wheel on Transport and SDGs

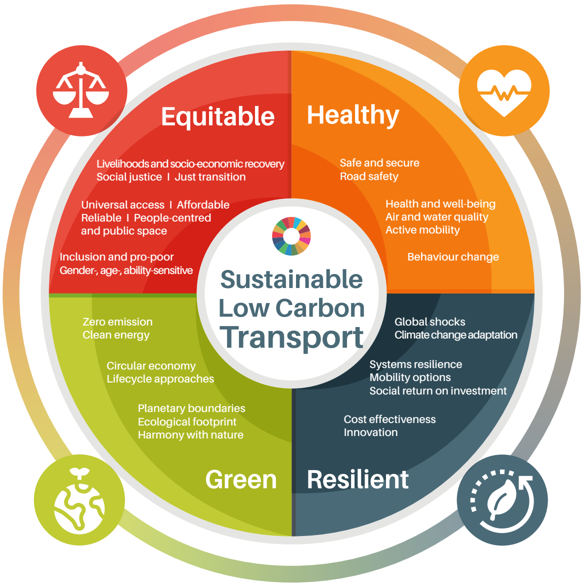


FIGURE 12. SLOCAT transformations for sustainable, low carbon land transport

- I. Transport connects people and prosperous societies, and works for them as a system of multiple modes and services.
- II. Cities are compact and managed to maximise access to socio-economic opportunities, health and equity for all.
- III. Rural and interurban mobility services are low in emissions and focus on users' needs to improve access.
- IV. Walking, cycling and public transport get priority.
- V. Well-managed transport demand reduces kilometres and car use.
- VI. Electrification drives low carbon land transport and puts the most sustainable modes first.
- VII. Digital technologies increase access and transport efficiency.
- VIII. Pricing and fiscal policy guide market forces and, together with finance, channel public and private funds towards the most sustainable transport services.
- IX. Freight systems efficiently combine different low carbon modes, share capacities and rely on sustainable first and last mile delivery.
- X. Industry, trade and transport are shaped to support a circular economy, local value creation, and short and resilient logistic chains.
- XI. Transport systems and services are resilient in extreme weather events and other shocks.

Click on the icons to read the details of each of the key transformations

Achieving equitable, healthy, green, and resilient transport and mobility systems has both explicit and implicit implications for the success of the UN 2030 Agenda and its 17 Sustainable Development Goals. Areas where transport has the greatest positive impacts include: ending poverty (SDG 1); ending hunger (SDG 2); promoting healthy lifestyles and well-being (SDG 3); empowering women and girls (SDG 5); ensuring sustainable and modern energy (SDG 7); building resilient infrastructure (SDG 9); making cities sustainable (SDG 11) and taking action to combat climate change and its impacts (SDG 13) (see Box 2).[131]

However, the reality is that most of the world's population does not have access to affordable, sustainable transport. Efforts to transform transport systems to achieve the SDGs are faced with a variety of weaknesses and threats (see Table 2).[132]

Important synergies and trade-offs exist between transport actions to implement the SDGs and actions for transport decarbonisation, adaptation and resilience. For example, every mitigation option listed in Figure 13 has a relation to SDG 7 (affordable and clean energy) and SDG 8 (decent work and economic growth).[133] Electric light-duty vehicles have both synergies and trade-offs with several SDGs (SDG 3 on good health and well-being, SDG 7 on affordable and clean energy, SDG 10 on reduced inequality and SDG 12 on responsible consumption and production), as this option continues to support car dependency and has strong infrastructure investment needs. Biofuels have synergies and trade-offs with SDG 2 (zero hunger) and SDG 3 (good health and well-being), because biofuels take land away from food production.[134]

Overall, synergies exceed trade-offs. The trade-offs can be further minimised by emphasising activities, such as capacity building, finance, technology transfer and making considerations for governance, gender and equity and with participation of Indigenous peoples, local communities and vulnerable populations.[135]

Since the 2015 adoption of the landmark 2030 Agenda and the Paris Agreement, rising inequalities coupled with the COVID-19 pandemic and geopolitical conflicts have led to significant setbacks in the accomplishment of these agendas and their transport-related targets. The gap between carefully agreed words in global agreements and real actions is growing ever wider.

A report from the Sustainable Development Solutions Network revealed that the pandemic has inflicted "massive humanitarian costs".[136] Coupled with geopolitical conflicts such as the Russian invasion of Ukraine, this has hampered progress towards SDG 2 (zero hunger) and SDG 7 (affordable and clean energy) and "crowd[ed] out space for long-term thinking and investments".[137]

BOX 2. Voluntary National Reviews under the 2030 Agenda for Sustainable Development

The High-Level Political Forum on Sustainable Development is the UN's apex body on sustainable development. It has a central role in the follow-up and review of the 2030 Agenda and the SDGs at the global level. The 2030 Agenda encourages UN member states to "conduct regular and inclusive reviews of progress at the national and sub-national levels, which are country-led and country-driven". This mechanism, known as the Voluntary National Review (VNR), aims to facilitate the sharing of experiences among countries, including successes, challenges and lessons learned, with a view to accelerating the implementation of the 2030 Agenda.

The VNRs from 2016 to 2022 revealed consensus about transport being a key contributing factor for the implementation of the SDGs. In 2022, 21% of the VNRs mentioned specific transport targets, up from 20% in 2021, 18% in 2020 and 17% in 2019. A number of 2022 VNRs highlight sustainable transport actions in the context of COVID-19 pandemic recovery and the urgent transition from fossil fuels to renewable energy sources. However, most 2022 VNRs only describe the adverse impacts of the ongoing crises instead of presenting concrete policy measures. And when they do, the measures do not fully address the urgent systemic transformations necessary to enable equitable access to transport and mobility for all.

(*See Section 1.3.1 Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs.*)

IISD/ENB | Kiara Worth

TABLE 2. Weaknesses and threats facing efforts to transform transport systems to achieve the SDGs

Source: See endnote 132 for this section.

SDG 3 (healthy lifestyles and well-being)	The number of road deaths fell 2% annually on average during 2010-2019. In 2020, road fatalities dropped a remarkable 19.2%, although this was still well below the target of 50% reduction by 2020 set under the United Nations Decade of Action for Road Safety.
SDG 7 (ensuring sustainable and modern energy)	Fossil fuel subsidies nearly doubled in 2021, and the Russian invasion of Ukraine drove energy prices higher while eroding energy security and geopolitical stability.
SDG 9 (building resilient infrastructure) **SDG 11** (making cities sustainable)	In rapidly urbanising areas of low- and middle-income countries, access to transport and mobility services is inequitable. In Africa, the average person walks for 56 minutes per day, and 95% of roads fail to meet an acceptable level of service. Only 32% of the urban population in Africa and 38% in Asia has convenient access to public transport.
SDG 7 (ensuring sustainable and modern energy) **SDG 13** (combating climate change and its impacts)	Electric vehicles are the fastest growing sector of the clean energy industry, with sales of electric cars, vans, trucks, buses more than doubling in 2021 to reach a record 6.7 million units. However, most of the attention is focused on private electric vehicles, and many current narratives fail to consider realities in the Global South.
SDG 13 (combating climate change and its impacts)	In most countries and regions, transport CO_2 emissions are not trending in the right direction. During 2010-2019, transport showed the fastest growth in CO_2 emissions among combustion sectors globally (excluding "other sectors"), rising 2% annually on average and 18% overall. Several international bodies and frameworks exist to support greater resilience and adaptation in infrastructure, but few activities focus on transport. Transport resilience to climate change impacts is not receiving the attention required in country plans (*see Section 1.2 Transport Adaptation and Resilience*).

FIGURE 13. Synergies and trade-offs between transport mitigation options and the SDGs

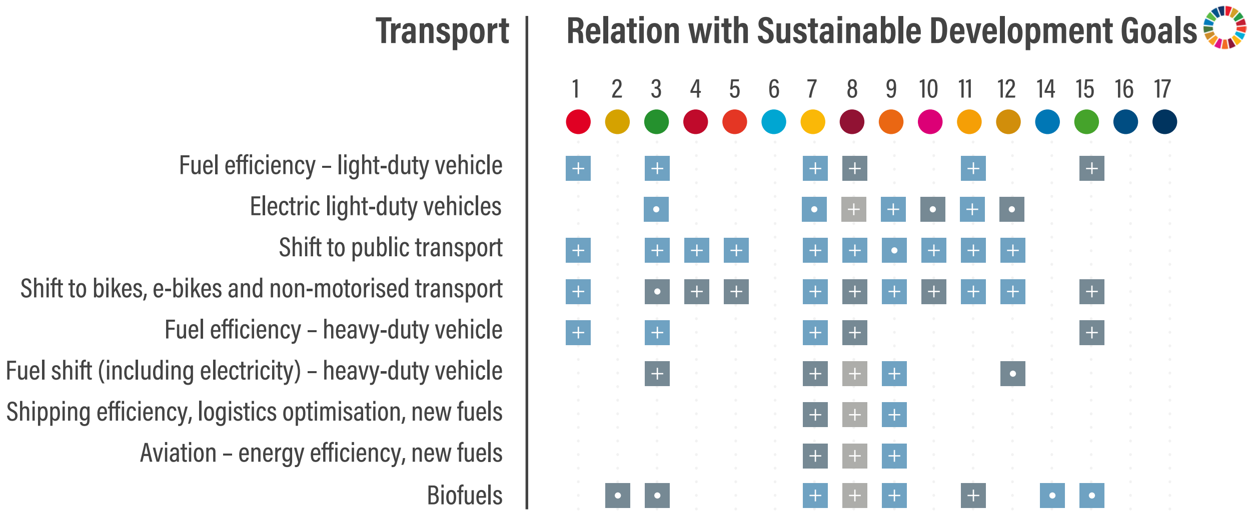
Source: See endnote 133 for this section.

Mitigation options have synergies with many Sustainable Development Goals, but some options can also have trade-offs. The synergies and trade-offs vary dependent on context and scale.

Type of relations:
- + Synergies
- − Trade-offs
- • Both synergies and trade-offs

Blanks represent no assessment

Confidence level:
- High confidence
- Medium confidence
- Low confidence



Similarly, the SDG Index revealed a slight decrease in the average national performance on SDG 1 (no poverty) and SDG 8 (decent work and economic growth) and noted particularly poor performance on SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land).[138] The 2022 International Spillover Index showed that rich countries generate negative socio-economic and environmental spillovers, including through unsustainable trade, overconsumption, and inefficient supply chains, where the transport sector plays a critical role.[139]

In the past couple of years, most transport and mobility systems globally have become more vulnerable to systemic shocks, disproportionately affecting people living in vulnerable situations. Global shocks – such as the COVID-19 pandemic, extreme weather events, disrupted global value chains and conflicts – have revealed the fragility of transport systems and services.

On top of that, natural hazards present a substantial threat to transport systems around the world that is only expected to increase due to climate change, reinforcing the need for climate adaptation and resilience. Cascading impacts of disruptions to other sectors, as well as macroeconomic and geopolitical shocks or societal events, can also disrupt transport networks, and the monetary impacts of transport disruptions far exceed the damage to physical assets alone. This reinforces the need for increased adaptation and resilience of transport systems, as well as for holistic notions of socio-economic resilience through transport. (*See Section 1.2 Transport Adaptation and Resilience.*)

However, the magnitude of the challenges should not obscure the opportunities that lie ahead. The trends of recent years have contributed to greater understanding that decarbonised, resilient, and sustainable transport and mobility systems are an essential service that can increase the social return on investment, reduce impacts of shocks and speed recovery. Countries experienced that shifting to active modes of transport can deliver a host of resilience, social and environmental benefits. Pressures on energy supply have reinvigorated discussions on energy efficiency and independence, as well as interest in reforming energy policies to transform transport.

In a world of interconnected challenges, the opportunity lies in finding solutions for systemic transformation that cut across transport, sustainability and climate action. The current circumstances confront us with the urgent need for profound and systemic socio-economic transformations, many of which directly impact the ability to transform transport systems over the coming decade. The current policy responses to transport and mobility challenges remain insufficient and too slow.

Applying "Avoid-Shift-Improve" (A-S-I) measures across passenger and freight transport through integrated, inter-modal and multi-dimensional approaches remains critical to deliver such cross-cutting solutions for systemic transformation (see Figure 14). The A-S-I framework has been central to transport decarbonisation and sustainability efforts for more than a decade. It calls for transport and mobility systems that, while guaranteeing access to transport and mobility:

- *Avoid* unnecessary motorised trips based on proximity and accessibility;
- *Shift* to less carbon-intensive modes – that is, from private vehicles to public transport, shared mobility, walking and cycling, water-based freight, electrified road-rail freight, and cargo bikes for last-mile deliveries, among others; and
- *Improve* vehicle design, energy efficiency and clean energy sources for different types of freight and passenger vehicles.

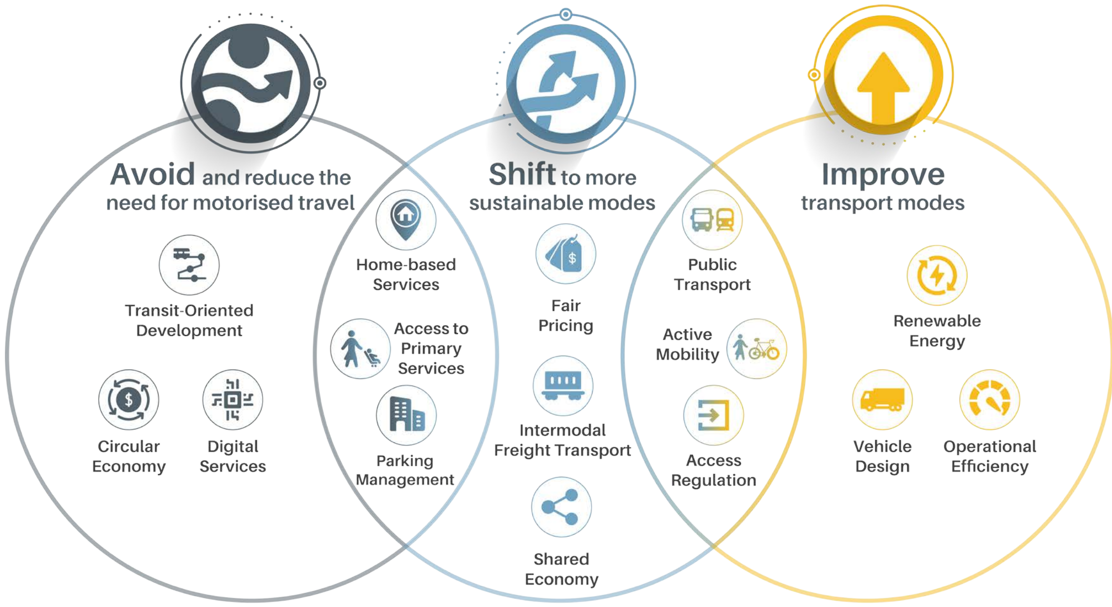
"Avoid" and "Shift" actions will contribute to half of the mitigation efforts needed by 2050. A 2021 study on demand-side mitigation actions found that, on average, emission reductions in land transport will be 10% through "Avoid" measures, 15% through "Shift" measures and 50% through "Improve" measures (compared to the 2050 baseline).[140] For aviation, "Avoid" measures (such as the implementation of carbon pricing) can lead to an average 40% reduction in emissions.[141] For shipping, on average, "Avoid" represents 47% of reductions, "Shift" 1% and "Improve" 40%.[142]

Shortly after the beginning of the Russian invasion of Ukraine in 2022, the IEA released a 10-point plan outlining how to cut oil use in advanced economies. The plan featured a detailed breakdown of how 2.9 million barrels of oil per day could be saved in the transport sector, revealing that quick measures related to "Avoid" can have a significant impact (see Figure 15).[143]

As a direct reaction to the Russian invasion of Ukraine, in March 2022 the European Commission presented the REPowerEU plan, with the aim of accelerating a shift to clean energy and reducing the region's reliance on Russian fossil fuels. Key steps relevant for transport are the transition to natural gas, liquefied natural gas and hydrogen; increased ambition to increase energy efficiency in transport; and a shift to more public transport, walking and cycling.[144]

Despite these and other steps, global fossil fuel subsidies have continued to rise, whereas strong financial support is lacking for sustainable, low carbon transport and mobility options. A fundamental reform of transport economics is urgently needed to deliver the necessary just transformations at the speed and scale required to achieve the targets of the Paris Agreement and the SDGs. (*See Section 5.1 Financing Sustainable Transport in Times of Limited Budgets.*)

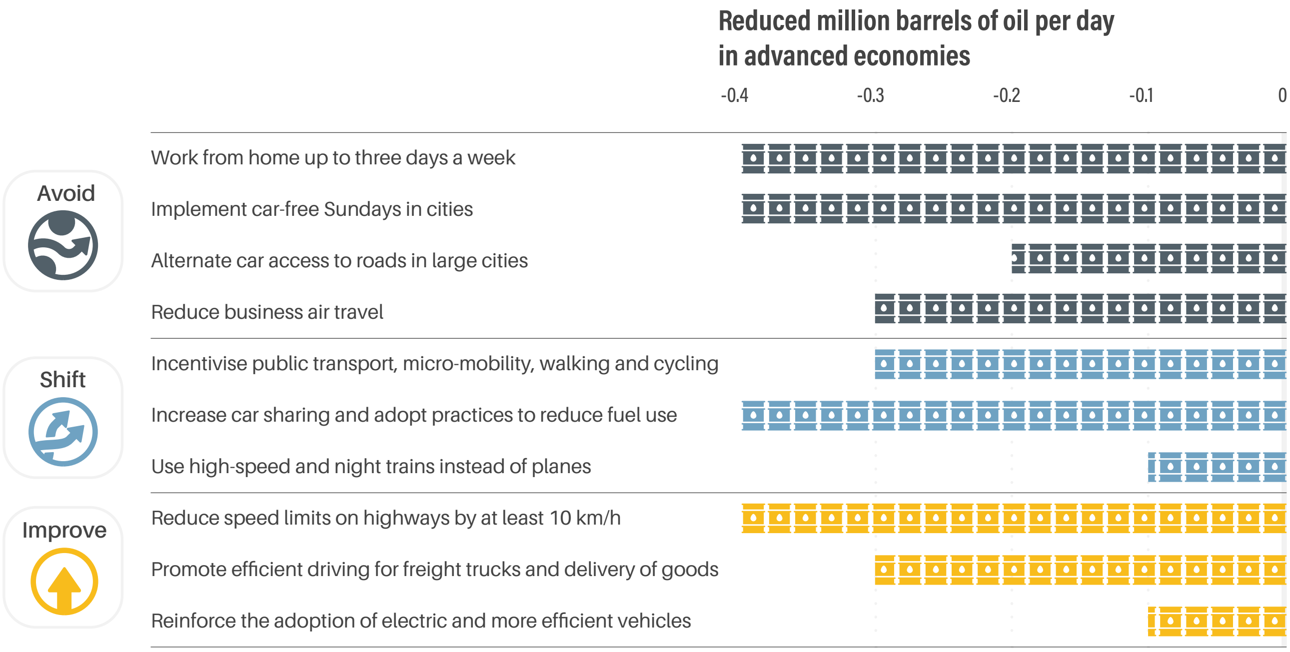
FIGURE 14. Avoid-Shift-Improve framework for transport



** The A-S-I diagramme presents a non-exhaustive list of measures for illustrative purposes only.*

FIGURE 15. Actions to reduce oil dependency in transport, through Avoid-Shift-Improve measures

Source: See endnote 143 for this section.



MODULE 1 1.2

AUTHORS:
Juliet Mian, Amy Leitch, Áine Ní Bhreasail and Louis Andrews, *Arup*
Rebecca Laberenne and Kerem Yilmaz, *Resilience Rising*
Savina Carluccio, *International Coalition for Sustainable Infrastructure*

Transport Adaptation and Resilience

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Context and key challenges

- Transport and mobility systems require not only infrastructure and operational resilience, but also resilience to shocks, macroeconomic and political disruptions, social events and climate change, to achieve financial sustainability.
- Climate change impacts – including sea-level rise and coastal flooding, more intense storms and rainfall, and more extreme temperature swings – increase the vulnerability of passenger and freight transport and heighten the impacts of other disruptors.
- Transport resilience initiatives are increasingly data dependent, but obstacles remain, including limited data collection capacity among many countries, cities, and companies, constrained access to existing data, and lack of information sharing.
- Transport systems tend to cross multiple jurisdictions, and resilience must involve non-traditional stakeholders, yet fragmentation of governance presents a continuing barrier.
- Resilience and adaptation must be balanced with the pressing need for decarbonisation and energy security, in the context of sustainability objectives.

Adaptation and resilience of transport systems

- Natural hazards cause an estimated USD 15 billion a year in direct damage to transport systems worldwide; of this, an estimated USD 8 billion occurs in low- and middle-income countries, which experience the highest costs relative to their gross domestic product.
- Cascading impacts of disruptions to other sectors can also disrupt transport networks. In extreme cases, these disruptions can undermine the viability of transport systems.
- Investment gaps continue to grow worldwide, and transport systems may become increasingly vulnerable as long-term stresses degrade assets.
- The monetary impacts of transport disruptions far exceed physical damages to assets. In low- and middle-income countries, this results in an estimated USD 107 billion in annual losses to businesses.
- Transport service interruption can bring harder-to-quantify, but no less impactful, secondary social consequences.
- Proactively adapting transport systems for future climatic conditions is far more cost-efficient than delayed adjustments or inaction.
- An "access-based" perspective on transport resilience can provide a more holistic, complex view of both the coming hazards and the available adaptation options.

Resilience through transport

- Transport is vital for supporting societal resilience during the response and recovery phases of a disaster and must be designed intentionally to serve these emergency functions.
- Transport increases people's access to jobs, health services, shelter, education and economic opportunities. These factors highlight transport's ability to deliver further "dividends of resilience": increased economic resilience and benefits for development.
- Recognition is growing of the interaction between transport investments and social inequalities, which can lead to asymmetrical impacts from climate-related events.
- Emergent approaches offer opportunities to create transport systems that both are climate resilient and have a minimal, or even beneficial, impact on the environment.
- Shifting to active modes of mobility where feasible can help deliver a host of resilience, social and environmental benefits.

International support for transport adaptation and resilience

- A global shift in perspective is helping to create frameworks that support greater resilience in infrastructure at the international level, but few of these focus specifically on transport.
- A growing number of international tools are providing incentives for transport system resilience, but gaps in capacity remain, especially in the Global South.
- International financial institutions are highlighting climate risks in infrastructure, which is producing more resilient transport investments; yet the estimated gap in adaptation finance for low- and middle-income countries is 5 to 10 times greater than current investment.

National and sub-national planning on transport adaptation and resilience

- National and sub-national actors – including governments, businesses and civil society – have begun to nominally address climate adaptation and resilience for transport, but concrete action and expenditures remain insufficient.
- National Adaptation Plans (NAPs) show promise as a means for low- and middle-income countries to prioritise actions around transport system adaptation.
- Provincial/state and municipal governments are planning and implementing transport resilience and adaptation projects with support from the private sector and civil society.
- Public-private partnerships are showing potential to mobilise private sector funding and expertise to make transport systems more resilient.
- National standards applicable to transport systems are starting to incorporate climate adaptation, building on the example of standards provided by the International Organization for Standardization (ISO).

Measuring impact – how do we know we are moving in the right direction?

- Measuring resilience and adaptation outcomes is an ongoing challenge that can be approached in multiple ways. Several methodologies have emerged that include appropriate indicators for measuring resilience and adaptation.
- Consideration of transport resilience and adaptation in combination with other critical systems offers a more robust way to ensure improved societal resilience.

Overview

Transport plays a vital role in connecting people and communities around the world, and in supporting global supply chains. Yet in the last few years, most transport and mobility systems worldwide have become more vulnerable to systemic shocks, affecting their ability to provide reliable, efficient and safe service and with disproportionate impacts on people living in vulnerable situations. Meanwhile, uncertainty about the frequency and severity of future climate-related events is growing. It is therefore urgent to consider adaptation and resilience measures, in conjunction with mitigation actions, to ensure that transport and mobility systems are both resilient to future shocks and hazards and that their development and operation contributes to social resilience and to the overall decarbonisation of our economies.

Transport resilience can be defined according to two key aspects:

- **Resilience of transport:** Ability of transport and mobility systems to withstand, respond to, recover from and adapt to a range of shocks and stresses, both now and into the future. Key elements include operational and organisational resilience (e.g., offering redundancy and diversity of mode choice for communities of differing income levels and geographic locations and various types of goods) in addition to the physical resilience of the infrastructure itself.
- **Resilience through transport:** Capacity to enhance the resilience of people and communities through passenger mobility systems, and the resilience of enterprises, economies, and supply chains through freight transport systems. Resilient transport and mobility systems provide services and deliver benefits to communities that are most vulnerable to the impacts of climate change and to the most critical supply chains.[1]

Adaptation is an integral component of resilience strategies, particularly climate resilience; however, it is not the full story. A holistic approach to resilience also takes into consideration the shocks and stresses to transport systems created by *non*-climate-related disruptors (e.g., health crises, macroeconomic and political disruptions) as well as interdependencies that transport has with other systems, both "hard" (e.g., energy and communications) and "soft" (e.g., governance and regulation).

To guide decision making, some organisations have sought to define core principles or qualities for resilience. For example, the United Nations Office for Disaster Risk Reduction's (UNDRR) six principles characterise resilient systems as those that are: continuously learning, proactively protected, environmentally integrated, socially engaged, sharing responsibility and adaptively transforming.[2]

There are many current and promising approaches for implementing adaptation and resilience in the transport sector, with the goal of mainstreaming resilience. At the same time, both trade-offs and co-benefits exist between resilience and adaptation, and mitigation. This is the first edition of the SLOCAT Transport, Climate and Sustainability Global Status Report to dedicate a full section to resilience and adaptation, with a focus mainly on road and rail transport in addition to aviation and maritime transport.

Photo: Solmaz Daryani / Climate Visuals Countdown

Context and key challenges

Transport and mobility systems require not only infrastructure and operational resilience, but also resilience to shocks, macroeconomic and political disruptions, social events and climate change, to achieve financial sustainability.[3] Several disruptors already impact transport networks around the world, and many of these are exacerbated by climatic factors.

Pandemics

In the United States, monthly total ridership on public transit dropped around 80% from 2019 to early 2020 due to the impacts of COVID-19.[4] In Brazil, the National Association of Urban Transport Companies estimates losses of around 90,000 jobs and BRL 36 billion (USD 7.3 billion) in the public transport sector between February 2020 and April 2023.[5]

Social unrest

In Peru's Amazon region, Indigenous groups blocked a large river in September 2022 to protest an oil spill, and in the United Kingdom transport unions held rail strikes throughout 2022 in a dispute over compensation and working conditions.[6]

Political conflict

As of May 2022, the Russian Federation's invasion of Ukraine had damaged up to 30% of the country's transport infrastructure, destroying 7 airports, 144,000 kilometres of roads, 1,242 bridges and nearly 6,300 kilometres of railways, with costs estimated at EUR 92.6 billion (USD 99.9 billion).[7] The impacts of the invasion on ports has affected trade flows and food security.[8] The invasion also has caused sharp increases in natural gas costs, which rose 170% from February to July 2022, in addition to impacts through inflation caused by effects on supply chains.[9]

Demographic changes and urbanisation

As more people live in cities globally, the urban population share is projected to rise from 56% in 2021 to 68% in 2050, putting greater demands on public transport systems.[10] Urbanisation will take different forms in different regions, with low-income countries expected to experience the highest urban sprawl as city land areas grow an expected 141% by 2070 (compared to 2020 levels).[11] Poor planning exacerbates this issue, and climate change will also affect land use and movement patterns, resulting in changes in transport demand.[12]

Technological innovation and disruption

Despite their benefits, new technologies can be highly disruptive, creating new pressures and vulnerabilities. For example, governments may struggle to keep up with rapidly changing transit networks for "mobility-as-a-service", often competing with established systems for users, resources and infrastructure capacity.[13] This emerging mobility trend remains largely unregulated, with an early attempt being Finland's Act of Transport Services in 2017.[14]

Ageing infrastructure assets

As insufficient maintenance budgets coincide with ageing assets and greater climate variability, this can lead to higher rates of deterioration and failure that further stretch budgets. Most road networks in high-income countries underwent major investment and expansion during the 1960s-1980s and are now approaching the end of their design life, necessitating critical upgrades.[15] Yet spending on transport systems will likely continue to be insufficient for the foreseeable future.

Consumption and commerce changes

Online shopping demand, accelerated by the COVID-19 pandemic, has resulted in a substantial increase in home deliveries. Delivery vehicles often carry poorly optimised loads along local roads that may not be well suited to freight transport, contributing to higher congestion and emissions.[16] Since the pandemic, there has been considerable upheaval in global value chains, with tendencies towards re-localisation and "friend-shoring".[17]

Climate change impacts – including sea-level rise and coastal flooding, more intense storms and rainfall, and more extreme temperature swings – increase the vulnerability of passenger and freight transport and heighten the impacts of other disruptors.[18] While uncertainty remains around specific factors and impacts, there is overwhelming scientific evidence that human-induced climate change has contributed to more frequent and intense extreme events.[19] Direct physical impacts on transport can include:

- **Sea-level rise and increased coastal flooding**, which combine with other hazards to damage ports and disrupt operations and shipping, flood airports, damage or isolate roads and railways, and impair or destroy natural coastal defences.[20]
- **More severe winds**, leading to traffic disruption, damage to bridges and to auxiliary road and rail infrastructure, and safety hazards for users.[21]
- **More intense storms**, increasing tree fall and causing damage to physical infrastructure and vehicles, widespread traffic disruption and unsafe travel conditions.[22]
- **More intense rainfall**, leading to infrastructure flooding, slope failures and landslides, washout of roads and tracks, and bridge scour.[23]
- **Changes in average rainfall**, contributing to drought and changes in the flow and sedimentation regime of rivers (affecting the navigability of inland waterways); poor road conditions and visibility; damage and obstruction to infrastructure (e.g., shrink-swell); and loss of protective vegetation.[24]
- **Increasing average and extreme temperatures**, resulting in pavement deterioration, rail deformation and buckling, air conditioning failures in vehicles due to overheating, expansion of bridge joints, impacts to underground systems through increased urban heatwaves and increased forest fires in non-urban areas, and health risks for transport workers and users.[25]
- **Unpredictable winters**, leading to potential extreme cold events, extreme snowfall and avalanche, thermal cracking of pavement, freeze-thaw deterioration and brittle failure of rails.[26]

Many of these impacts could potentially interact, creating compounded or cascading hazards.

Transport resilience initiatives are increasingly data dependent, but obstacles remain, including limited data collection capacity among many countries, cities, and companies, constrained access to existing data, and lack of information sharing. Although climate projection data are now widely available, many organisations lack the capacity to apply these to risk assessment. Data sharing among organisations is limited by barriers ranging from commercial to data security concerns.[27]

Photo: Vlad Sokhin / Climate Visuals

- Data on climate hazards are scarce in some regions, particularly in low- and middle-income countries, although efforts are under way to address these gaps in some cities and regions – for example, Rio de Janeiro's Centre of Operations links data on environment, transport and medical services.[28]
- A mismatch exists between the long-term planning required for climate adaptation and the short-term time horizons of many investors and government bodies, making it harder to secure funding.[29]
- There is a lack of consensus on metrics to track resilience and adaptation outcomes.

Transport systems tend to cross multiple jurisdictions, and resilience must involve non-traditional stakeholders, yet fragmentation of governance presents a continuing barrier.[30]

- Transport resilience requires new approaches to cross-organisational governance, such as New York City's Green Infrastructure programme, which oversees works formerly split between several city departments and resulted in the greening of nearly 850 hectares between 2010 and 2021.[31]

Resilience and adaptation must be balanced with the pressing need for decarbonisation and energy security, in the context of sustainability objectives. Because of the potential competition for attention and funding between adaptation and mitigation, it is essential to find opportunities to interweave these two focus areas. For example, improving transport infrastructure resilience improves the sector efficiency and reduces transport costs. Furthermore, using renewable resources improves sustainability and makes the sector less vulnerable to climate change and other disruptions. Finally, active travel is a resilience solution that can reduce emissions and thus can be interpreted as supporting sustainability.

Adaptation and resilience of transport systems

Natural hazards cause an estimated USD 15 billion a year in direct damage to transport systems worldwide; of this, an estimated USD 8 billion occurs in low- and middle-income countries, which experience the highest costs relative to their gross domestic product.[32] An estimated 27% of global road and rail assets are exposed to at least one cyclone, earthquake or flooding hazard.[33] Ports are even more exposed due to their placement along coastlines and rivers, with preliminary estimates indicating that 86% are exposed to three or more hazards.[34]

- Damage varies greatly among countries, with the most annual damage per kilometre of road and rail asset estimated in Vietnam, followed by Papua New Guinea and Myanmar.[35]
- In Pakistan, floods in 2022 caused more than USD 3.3 billion in damage to transport and communications, which was the third-largest sector with damages after housing (USD 5.6 billion) and agriculture (USD 3.7 billion).[36]
- Natural hazards continue to cause substantial physical damage and disruption to transport assets. In the European Union (EU), extreme weather alone contributed an average of EUR 2.5 billion (USD 2.7 billion) in direct damages to transport annually between 1998 and 2010, with indirect costs of disruption estimated at EUR 1 billion (USD 1.1 billion) .[37]
- In the aviation sector, extreme weather was responsible for around 7% of US flight delays in 2020, and a further 15% of delays were due to non-extreme weather conditions.[38]

Cascading impacts of disruptions to other sectors can also disrupt transport networks. In extreme cases, these disruptions can undermine the viability of transport systems.

An event that causes disruption to a critical infrastructure service – such as energy, water or communications – can also have substantial impacts on transport networks and public transport systems, even affecting systems that were not exposed to the initial hazard. Space weather events, for example, have the potential to cause global positioning and navigation satellite failures, which could lead to loss of communications and navigation technology, with severe consequences for all transport sectors.[39]

External stresses to upstream supply chains, such as fuel uncertainty, can also disrupt transport. Because of their complex nature, such cascading impacts are often poorly understood, with some dependencies not being appreciated until disaster brings them into focus. For example, the trend to electrify transport systems as a decarbonisation strategy creates new vulnerabilities from natural hazards that may affect power lines or transport stations.

As public transport services become more reliant on digital devices and electric vehicles, energy disruptions can have a high impact on operations.

- In 2019, an electricity outage due to a power failure affected three Indonesian provinces, rendering the MRT and the electric train inoperable and preventing customers from accessing electronic ticketing systems and ATMs to withdraw cash, thus restricting access to public bus services as well.[40]
- In Indonesia, rising floods and ground subsidence in Jakarta have led the government to begin relocating the capital to Nusantara; this points to the dual challenge facing Indonesian transport: frequent losses and damages due to natural hazards, and the need for vast new investment in the transition from existing assets to the new capital, at an estimated cost of more than USD 34 billion.[41]
- In the Maldives, 80% of the country could become uninhabitable due to sea-level rise by 2050, and climate change will have significant implications for transport connectivity, tourism and sustainability.[42]

Investment gaps continue to grow worldwide, and transport systems may become increasingly vulnerable as long-term stresses degrade assets. The projected global gap in financing for new transport infrastructure and maintenance is between USD 244 and USD 944 billion annually to 2030, for the business-as-usual development scenario, while infrastructure developments aligned to a 2-degree Celsius scenario would be lower and within the available infrastructure financing volumes.[43] Other studies estimate a financial gap of at least USD 440 billion for transport infrastructure to meet the United Nations Sustainable Development Goals by 2030.[44] This shortfall increases the maintenance and renewal backlog, further increasing the required investment and the vulnerability of assets.

The problem is compounded as climate change leads to more extreme physical stresses (e.g., shrink-swell cycles, extreme heat and precipitation), resulting in greater deterioration of assets and hence increased vulnerability to further deterioration and extreme events. For example, cracking of assets due to extreme heat leads to greater damaging infiltration of rainwater.[45] However, if decision makers act appropriately, ageing assets could provide an opportunity. As a generation of outdated infrastructure is replaced by forward-looking assets designed to withstand the future climate, resilience can be embedded – drawing on nature-based solutions, new material technology, and more flexible transport and mobility systems.

The monetary impacts of transport disruptions far exceed the physical damages to assets. In low- and middle-income countries, this results in an estimated USD 107 billion in annual losses to businesses.[46] Disruptions to transport networks have cascading impacts on the societies they exist to support. Regional economies suffer as staff and customers cannot travel, supplies are not delivered, and supporting services struggle. Climate change will exacerbate this challenge.

- Mozambique has suffered successive severe flooding events in recent decades, and changes in precipitation are projected to result in economic losses of USD 2.5 billion (roughly 15% of the country's GDP) annually to 2050.[47] This is due in part to the vulnerability of the food-transport nexus – especially in Africa – through the disruption of market access in rural areas.

Transport service interruption can bring harder-to-quantify, but no less impactful, secondary social consequences. Transport systems provide vital community links, and severing these links (particularly in remote areas) can lead to a loss of access to food, education, jobs, recreation, health, and social and government services. Disruption subsequently impacts the resilience, well-being and prosperity of affected individuals and communities.

- In Rio de Janeiro (Brazil), more affluent areas close to downtown have more resilient transport services (e.g., metro systems with multiple transfer points), while lower-income areas on the periphery are more vulnerable (e.g., bus systems dependent on infrequently maintained roads).[48] The impact of a failure in transport is therefore greater than the quantifiable monetary cost.

Proactively adapting transport systems for future climatic conditions is far more cost-efficient than delayed adjustments or inaction. When investment in resilience is used wisely, it can pay dividends that far outweigh the upfront costs. A 2019 analysis of potential infrastructure scenarios estimates that USD 1 of investment in strengthening infrastructure in low- and middle-income countries results in a median of USD 2 in benefits, which increases to USD 4 when climate change is considered.[49]

The "triple-dividend" of resilience includes avoided losses, induced economic benefits, and additional social and environmental benefits. Reduction of damages and loss of life is the first aspect of the triple-dividend; the other two aspects are discussed further in the next section.[50]

An "access-based" perspective on transport resilience can provide a more holistic, complex view of both the coming hazards and the available adaptation options. For example, the shift from mobility-based access to digitally based access (work from home, flexible work hours, satellite offices) can provide a vital risk mitigation tool. A "triple access transport planning" approach – which incorporates physical mobility, spatial proximity and digital connectivity – can be applied through the Futures Toolkit.[51]

Photo: Debarshi Mukherjee / Climate Visuals Countdown

Resilience through transport

Transport systems can enhance societal resilience by providing a range of benefits. Such systems can contribute to more-resilient communities if they are planned, delivered and managed in a way that maximises social benefits, minimises negative impacts to society and the environment, and protects and leverages natural ecosystems.

Transport is vital for supporting societal resilience during the response and recovery phases of a disaster and must be designed intentionally to serve these emergency functions. Transport links are essential parts of disaster and emergency response plans. When a disaster results in widespread impacts and disruption to transport systems, or when infrastructure and planning are insufficient to meet surges in demand, the cumulative impacts can be catastrophic (see Box 1).[52]

- Aircraft are often the first feasible means of transport for emergency response, as the basic functionality of aviation infrastructure typically can be restored quickly. An earthquake in Pakistan in 2005 killed more than 80,000 people and left up to 3.5 million without food or shelter just before the onset of the harsh Himalayan winter; road closures due to landslides cut off land access to many geographies and communities, and 168 flights delivered nearly 3,500 tonnes of relief supplies.[53]
- Following an earthquake in Nepal in 2015, more than 4,000 rescue workers and supplies were flown into Kathmandu Airport, damaging the runway and leading to closure of the airport within a week.[54]
- Unmanned drones have been utilised for humanitarian aid, including search-and-rescue efforts in Kazakhstan and vaccine delivery in Vanuatu.[55]

Transport increases people's access to jobs, health services, shelter, education and economic opportunities. These factors highlight transport's ability to deliver further "dividends of resilience": increased economic resilience and benefits for development.[56] Poverty and lack of access to markets are associated with, for example, food insecurity and dependence on sensitive assets, crops and ecosystems.[57] Rural transport in low- to middle-income countries can be key for driving development, employment opportunities and national growth.

- In Ethiopia, connection to a rural road was associated with a 10.4% decrease in residents' likelihood of being in poverty and a 2.8% increase in waged employment, over a four-year period.[58]
- A 2018 study in India identified a 5% increase in school enrolment among 5-14 year-olds in villages given access to a rural road, likely due to increased access to teachers.[59]
- In Indonesia, a modest average improvement in road quality resulted in a 20% increase in labour earnings.[60]

BOX 1. Lessons learned from transport relief efforts in vulnerable communities

Multi-modal response plans can function effectively even when some links are overwhelmed. By ensuring that transport systems are prepared for and integrated with emergency response and disaster recovery plans, communities can be much better served.

When Hurricane Katrina struck New Orleans in the US state of Louisiana in August 2005, most of the population was evacuated by private road transport; however, an estimated 100,000 to 200,000 people were without private transport. The city's evacuation plan relied on public transit for these individuals – primarily city buses – but could not be properly executed. Many drivers evacuated themselves, buses were unprotected and damaged during the floods, and there were only enough buses for around 25% of the population. Nearly 70% of fatalities were among residents over the age of 65.

The importance of public transport's role in emergency evacuation was recognised after Hurricane Katrina, and recommendations were made to integrate public transport fully into emergency response and evacuation plans. For example, when Cyclone Fani struck the state of Odisha, India in 2019, the evacuation of 800,000 people from low-lying areas using public buses, railways and inland water transport was highly praised.

Photo: NOAA / NOAA

Source: See endnote 52 for this chapter.

- Rural trail bridges in Nicaragua were found to eliminate the 18% decline in labour earnings reported during flood events.[61]

Recognition is growing of the interaction between transport investments and social inequalities, which can lead to asymmetrical impacts from climate-related events. The benefits of transport systems are not distributed evenly across society. Gender, age, social or disability status often play an important role in how people use transport. Greater mobility options could have a particularly positive impact on traditionally disadvantaged or underrepresented groups.

- A study in India found that the provision of a rural road resulted in improvements in preventative health care for women, such as a 20% increase in women seeking antenatal care.[62]

There is also the asymmetrical climate-related vulnerability created by inadequate transport and access options. This includes informal settlements in African cities (e.g., Kampala, Uganda) forming in floodplains and on unstable hillsides, due to their proximity to economic opportunities that would otherwise be unavailable to the poorest residents due to unaffordable transport services.[63]

However, transport practitioners often overlook social inequalities, and investment and innovation can reinforce existing inequalities. For example, mobility services for first- and last-mile trips (such as ride hailing services) typically require a smartphone and bank account, but in the United States half of Black households are unbanked, and only 58% of Black individuals own a smartphone or computer.[64] Social inequalities lead to greater vulnerability to hazards, and people who are marginalised prior to a disaster often receive inferior support afterwards.[65]

Evidence reveals a gender discrepancy in disaster mortality, where women's life expectancy is affected more than men's; however, this discrepancy vanishes as women's socio-economic status increases (at lower socio-economic statuses, women tend to have most of the caring responsibilities, and in disaster settings, women are more likely to be at home protecting family members).[66] By ensuring that the needs of all users are considered, transport systems can deliver benefits that contribute to a more equitable society, and subsequently to more resilient communities.

Emergent approaches offer opportunities to create transport systems that both are climate resilient and have a minimal, or even beneficial, impact on the environment. There is a need to balance trade-offs between resilience and wider sustainability goals. Nature-based solutions and green infrastructure can create resilience of (and through) transport systems (see Box 2).[67]

Green drainage solutions, such as permeable pavements, bioswales, retention basins, rain gardens, and engineered wetlands, can mitigate flooding hazards and support ecosystems, allowing a more natural water cycle. Planting trees and other vegetation along urban infrastructure can help combat heat-island effects, reducing peak summer temperatures by 1 to 5 degrees Celsius (°C) and surface temperatures by 11° to 25°C, easing heat stress on both road users and assets.[68]

Shifting to active modes of mobility where feasible can help deliver a host of resilience, social and environmental benefits. Active mobility options such as cycling and walking reduce emissions and create societal resilience by providing healthier and more active lifestyles. Simultaneously, greater flexibility provided by a variety of active mobility solutions creates a more resilient transport system than one dependent on large-scale fixed infrastructure.

With more than 75% of urban journeys potentially short enough for active travel (including electric-assist bicycles), this presents an enormous opportunity to achieve both resilience and sustainability goals.[69] During the COVID-19 pandemic, many cities created temporary infrastructure to reduce dependence on public transport and private vehicles, and the increase in remote working reduced the need for many journeys entirely; this has spurred rising interest in "15-minute cities" connected by active travel.[70]

BOX 2. Restoring mangrove forest to enhance the resilience of coastal highways

Colombia's Ciénaga Grande de Santa Marta marsh ecosystem has been more than 50% lost, due in part to highway construction. The government is now considering expanding the highway further. A "green-grey" solution to coastal erosion has been proposed that would restore 344 hectares of mangroves annually through strategic placement of elevated roadways. This solution would also sequester around 23 tonnes of carbon a year and has around half the cost of the proposed hard-engineered solution.

Source: See endnote 67 for this chapter.

International support for transport adaptation and resilience

A global shift in perspective is helping to create frameworks that support greater resilience in infrastructure at the international level, but few of these focus specifically on transport. This shift is promoting international co-operation through co-ordinated governance mechanisms and impact frameworks as well as establishing funding, tools and incentives for action at an international scale. The transport sector is a key focus across these global co-operation mechanisms, with several noteworthy international agreements and partnerships helping to encourage co-operation between public and private sector organisations.

- The Marrakesh Partnership for Global Climate Action (MPGCA) seeks to implement the Paris Agreement with a view towards adaptation and resilience alongside climate mitigation.[71] Initiatives include increasing climate preparedness and resilience in the maritime and road sectors, among others.[72]

- The Marrakesh Partnership is complemented by the Race to Resilience campaign, which aims to catalyse action by non-state actors. At the 2022 United Nations Climate Change Conference in Egypt (COP 27), the campaign endorsed a joint statement to create a climate-smart and resilient maritime sector.[73]

- The Coalition for Disaster Resilient Infrastructure (CDRI), Global Resilience Partnership and G20 Global Infrastructure Hub are prominent partnerships among various government bodies and private sector and academic institutions that aim to promote resilient action, awareness, knowledge sharing and policy.[74]

- The International Coalition for Sustainable Infrastructure hosted the Transport Infrastructure Implementation Lab at the 2022 United Nations Climate Change Conference (COP 27), exploring the implementation of resilience in transport through engineering with a range of organisations, including the MPGCA and CDRI.[75]

A growing number of international tools are providing incentives for transport system resilience, but gaps in capacity remain, especially in the Global South.

- The Intergovernmental Panel on Climate Change (IPCC) data platform presents global climate change data and scientific consensus.[76] The IPCC's comprehensive report on *Impacts, Adaptation and Vulnerability* outlines the latest scientific understanding of climate risks faced by the transport sector.[77]

Photo Credit: Brigitte Leoni / UNISDR

- The Task Force on Climate-related Financial Disclosures' (TCFD) 2017 report recommends reporting on the financial impacts of climate change risks, including physical impacts, building resilience, addressing natural hazard risks and making transport more resilient.[78] As of 2022, more than 3,800 public and private companies supported the TCFD; for public companies in the transport industry, the average percentage of disclosure of TCFD-recommended information was 32%.[79]
- International standards include the International Organization for Standardization's ISO 14090:2019 (Adaptation to climate change – Principles, requirements and guidelines) and ISO 14091:2021 (Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment). The former details how organisations should monitor and evaluate their adaptation to climate change.[80]
- The Highway Development and Management Model Four (HDM-4) is a software tool for planning and management of road improvement and investment decisions. The tool is scheduled to be updated in 2023 by the Asian Development Bank, the World Road Association (PIARC), the UK Foreign, Commonwealth & Development Office and the World Bank) – with parameters to include resilience of highways to natural disasters.[81]

International financial institutions are highlighting climate risks in infrastructure, which is producing more resilient transport investments; yet the estimated gap in adaptation finance for low- and middle-income countries is 5 to 10 times greater than current investment.[82]

- At the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), high-income countries pledged to double funding provided to low- and middle-income countries for adaptation action by 2025.[83] It remains to be seen how this will materialise for transport.[84]
- As of October 2022, USD 4.25 billion of the Green Climate Fund's USD 11.4 billion portfolio was focused on climate change adaptation; however, only USD 0.93 billion of the Fund's portfolio was invested in transport, and thus an even smaller fraction was invested in adaptation for transport.[85]
- At the 2022 UN Climate Change Conference in Egypt (COP 27), the Sharm el-Sheikh Implementation Plan established a dedicated fund to compensate vulnerable countries for climate disaster losses and damage, which is intended in part to help bridge the gap in adaptation investment in low-income countries.[86]
- The Multilateral Development Bank Joint Methodology for Tracking Climate Change Adaptation Finance assesses the climate resilience of investments (including in the transport sector) through a three-step approach based on a set of common principles.[87]

National and sub-national planning on transport adaptation and resilience

National and sub-national actors – including governments, businesses and civil society – have begun to nominally address climate adaptation and resilience for transport, but concrete action and expenditures remain insufficient.

National and sub-national actors are promoting resilience and adaptation for transport through the development of national adaptation plans, public infrastructure investment, and codes and standards – all aligned to the ambitions of global co-operation.

National governments are investing in resilience-enhancing programmes for their transport systems.

- In the United States, the Bipartisan Infrastructure Law provides USD 550 billion for new federal investments in infrastructure, which includes USD 108 billion to prioritise safety, modernisation, climate and equity in public transport.[88]
- The US Federal Highway Administration has provided USD 7.1 million in funds to 25 state transport departments as part of its Climate Challenge programme, including a grant to protect a coastal road in the state of Rhode Island with permeable pavement.[89]

Efforts by local governments to engage directly with civil society and the public have demonstrated the value of inclusive engagement in resilient transport projects.

- In Freetown (Sierra Leone), as part of data collection efforts for the road climate vulnerability assessment, local civil engineering students used mobile applications to map 4,038 kilometres of transport network.[90]
- Miami-Dade County in the US state of Florida engaged with the community while working to improve access to multi-modal and equitable mobility, through the use of an online platform where citizens could submit and vote on proposals to improve the transport network.[91]

While considerable progress has been made across multiple levels of government to promote the adaptation and resilience agenda – and to put in place adaptation plans – much work remains. Although governments are developing resilience plans that set out actions and priorities, there is less evidence of implementation and investment in these plans.[92] City and local governments will need to make much faster progress in the coming years to transform and embed resilience within transport systems.

Equally important is for the practice of transport planning itself to be more resilient. Emerging areas of research in "resilient transport planning" and "decision making under deep uncertainty" are still in their infancy, but they are growing in impact and influence around the topic of complex risk.[93] These principles were applied in the recent reform of the long-term transport planning practices of the City of Cape Town, South Africa and hold useful lessons for planning practices in other urban contexts.[94]

National Adaptation Plans (NAPs) show promise as a means for low- and middle-income countries to prioritise actions around transport system adaptation. Established in 2011, NAPs identify medium- and long-term adaptation needs for these countries as well as strategies to address them. A total of 21 NAPs were submitted between April 2021 and January 2023, out of 45 NAPs available in total since 2015.[95] All of these mention transport in some capacity, and more than 80% (17 NAPs) include an adaptation action or priority directly related to transport (compared with only 50% of the NAPs submitted between October 2015 and March 2021).[96] Meanwhile, 16 of the recently submitted NAPs refer to potential climate change impacts on transport.[97]

- Niger assesses climatic impacts on the transport sector in its NAP, including an analysis of the chain of impacts of climate change on transport and cross-cutting gender considerations. The NAP proposes five distinct transport-specific adaptation programmes, ranging from adaptation of design standards for road, air and rail to the reinforcement of protective dykes along roads and railways. Each programme outlines key objectives, the main activities over a five-year period, indicators, a budget and other considerations.[98]
- Tonga's NAP assesses both climatic impacts and adaptation issues surrounding transport infrastructure, including pointing to underdeveloped drainage and poor design in storm drains, flood mitigation devices and causeways.[99] Since 2019, the country has implemented the Tonga Climate Resilient Transport Project, which is financed under the World Bank's Pacific Climate Resilient Transport Program, which began in 2018 and includes seven projects to date.[100]

Provincial/state and municipal governments are planning and implementing transport resilience and adaptation projects with support from the private sector and civil society.

- Hong Kong (China) completed its most comprehensive assessment ever of the present and future flood risk to the city's rail infrastructure, combining climate projections and detailed urban topography datasets.[101]
- In Spain, a key component of the Barcelona Nature Plan is planting trees along streets, creating 1 additional square metre of greenery per resident with the aim of easing extreme heat and supporting biodiversity.[102]

- Montevideo (Uruguay), embraced large-scale, real-time data to improve the resilience of its transport network, including using a centralised Mobility Management Centre.[103]
- A thorough assessment of the climate resilience of the Port of Durban (South Africa), reviewed the port and its interdependent systems (road and rail) to assess their preparedness, options to adjust, and ability to rebound from various climate impacts, ultimately making recommendations for adaptation.[104]

Public-private partnerships (PPPs) are showing potential to mobilise private sector funding and expertise to make transport systems more resilient. In 2020, private investment in infrastructure in low- and middle-income countries reached a historic low due to the COVID-19 pandemic. However, investment has since recovered, led by the transport sector which received USD 43.8 billion in private investment in 2021, up from only USD 10.5 billion in 2020 (but still 9% below 2019 levels).[105]

- In Japan, a concessions-based PPP was used to procure funding for restoration and operations at Sendai International Airport following damage caused by the 2011 tsunami.[106] Although the high-risk environment presented a barrier to many private investors, the PPP was made possible by employing strict numerical systems for risk allocation.[107]

National standards applicable to transport systems are starting to incorporate climate adaptation, building on the example of standards provided by the ISO.

- In the United Kingdom, the 2021 standard BS 8631:2021 (Adaptation to climate change – Using adaptation pathways for decision making) builds on the ISO standards.[108]
- The American Society of Civil Engineers' ASCE MOP 140 standard is focused on Climate-Resilient Infrastructure Adaptive Design and Risk Management.[109]
- Austroads' Guide to Road Design for Australia and New Zealand incorporates means of accounting for the effects of climate change through the design of drainage for floodwaters.[110]
- In France, a systematic review of all standards applicable to transport systems, conducted in 2015, recommended that relevant climatic factors be included in revised standards in subsequent years.[111]

Other Initiatives

- CDRI's risk and resilience assessments of transport infrastructure include the Global Study on Disaster Resilience of Airports and the Strategy for Disaster Resilient Seaports and Port Communities in small island developing states. [112]
- The Sharm El Sheikh Adaptation Agenda, an outcome of the 2022 United Nations Climate Change Conference in Egypt (COP 27), sets out five key interventions for transport: two to make transport accessible and three to make transport resilient through infrastructure hardening, improved planning and management, and remote solutions.[113]
- UNDRR's Sendai Framework for Disaster Risk Reduction 2015-2030, now more than halfway through its duration, aims to support and implement measures to prevent and reduce hazard exposure and vulnerability.[114] Although few achievements specific to transport have been recorded to date, the framework encourages the development of early warning systems, risk monitoring and reporting, and establishing indicators and targets.[115]

Photo: Silke von Brockhausen / UNDP

Measuring impact – how do we know we are moving in the right direction?

Measuring resilience and adaptation outcomes is an ongoing challenge that can be approached in multiple ways. Resilience-focused metrics and measurements are essential to help transport planners, designers and financers regularly assess the performance of transport systems in the face of changing climate-related shocks and stresses, to inform plans, investments and operational decisions. Measuring climate resilience and adaptation is more complex than measuring mitigation because no single metric is used to measure resilience; for example, metrics to measure the resilience of maritime and inland shipping transport may include resilience of trade flows, minimisation of port delays and reliability of schedules.[116]

Although avoided losses resulting from resilience and adaptation efforts are the gold standard, they are difficult to estimate accurately. Furthermore, defining *outcome* indicators and metrics is even more challenging than defining *output* indicators and metrics, which underscores the critical need to develop climate resilience metrics for transport investment.[117]

Co-benefits of resilience approaches (such as improvements to well-being) can also be measured, but this is complex because the benefits of resilience tend to be distributed across facets of society and over time. Process indicators of the collective movement towards a more resilient transport sector are more easily measured and are often used as a proxy. These indicators can include, for example, money invested in transport resilience projects, or the prevalence of regulations that recognise changing climate hazards. However, progress on process-related indicators does not necessarily translate to impact.

Several methodologies have emerged that include appropriate indicators for measuring resilience and adaptation (see Table 1).[118] However, consensus is lacking on which methodologies are most suitable for different situations.

Consideration of transport resilience and adaptation in combination with other critical systems offers a more robust way to ensure improved societal resilience. Increasingly, methods for long-term monitoring and evaluation of systemic impacts – such as the recent EU Directive on resilience of critical entities – consider the place that transport has among other critical infrastructure systems, including its dependencies and interdependencies.[119] Strategic performance indicators with an outcome-orientated design (as opposed to technical performance indicators that provide real-time insight into performance) can focus on future aspirations rather than past performance, thereby better managing transport systems for the communities they serve.[120]

Photo: Sujan Sarkar / Climate Visuals

TABLE 1. Resilience and adaptation indicators

Source: See endnote 118 for this section.

Indicator	Description	
Service continuity	Resilience measurement of transport can be approached through assessing service continuity – for example, tracking cumulative delays resulting from disruptions. In the United Kingdom, National Highways tracks the difference between the observed travel time and the speed limit travel time, as well as the availability of the network and the time taken to clear incidents from it. Travel duration and its monetary value can then be used in cost-benefit analyses.	Global, National, Local; In Use; Impact
Risk assessments	By evaluating the likelihood and potential consequences of hazards to the transport system, risk assessments can help identify areas where systems are vulnerable and where investments in resilience can have the greatest impact. A risk assessment is a means of quantifying direct and indirect costs of not investing in resilience. It can also help track the effectiveness of the implemented risk reduction and management measures over time.	National, Local; In Use; Impact
Adherence to principles of resilience systems	UNDRR's six principles of resilient systems have associated quantifiable indicators that reflect the different qualities of a resilient system. For example, indicators that show that the system is "proactively protected" include the total number of possible alternative routes or modes to deliver the same critical service, or the depth and breadth of formalised emergency management mechanisms for critical infrastructure. A series of indicators exist for each of the six principles.	National; In Use; Impact
Life-cycle costs	Transport that is cheap to build but expensive to maintain can indicate poor resilience, as maintenance can interrupt service. Spending money up front often increases the cost of design and construction, but can save costs during operation, resulting in reduced overall life-cycle costs and increased resilience. Tracking the balance of costs across the whole life cycle of the transport is a proxy for resilience.	National, Local; In Use; Process
Standards uptake	Uptake of globally recognised standards for resilience and adaptation is a telling rubric for whether transport is moving in the right direction.	Global, National; Developing; Process
Finance allocated	The amount of finance dedicated to resilience and adaptation of transport infrastructure continues to rise but is far short of what is required.	Global, National, Local; In Use; Process
Post-disaster evaluations	These evaluations assess how well the transport system stood up to the hazards that it was exposed to, and how well it was able to maintain or quickly restore service. Post-disaster evaluations can identify vulnerabilities and weaknesses in the system including issues with infrastructure design, construction, or maintenance, as well as issues with emergency response or evacuation plans. Such evaluations can also help to identify the dependency and interdependency with other systems, such as the dependency of road transport on the availability of power, and the interdependency of different modes of transport.	National, Local; In Use; Impact
Policy and regulatory changes	This includes enforcement of regulations, construction codes and procurement rules (for example, NAPs). Peru, a country with significant exposure to natural hazards, recently adopted a Framework Law on Climate Change and a national disaster risk management plan that aims to develop a prevention culture and an integrated national system for disaster risk management, which all public entities must comply with.	National; Developing; Process
Triple bottom line	Quantification of co-benefits using triple-bottom-line approaches can support the business case for resilience and adaptation interventions in transport. Co-benefits can include economic, environmental, and social benefits, such as reduced maintenance costs, reduced greenhouse gases and improved accessibility. By quantifying the co-benefits of resilience investments in transport, the full range of benefits generated by the investment can be demonstrated, which can make it more attractive to potential funders and investors. The US city of San Francisco wanted to make its transport system more equitable and sustainable, so it used scenario planning and early involvement of external stakeholders to identify potential benefits (such as safety and economic vitality) and trade-offs (such as paying more taxes or giving up resources).	National, Local; In Use; Impact

Geographical Scope
- Global
- National
- Local

Implementation Stage
- In Use
- Developing

Processor Impact Indicator
- Impact
- Process

MODULE 1 SPOTLIGHT 1

AUTHOR:
Alison Doig, *Health and Climate Network*

CONTRIBUTORS:
Karl Peet and Ambika Sairam, *SLOCAT Secretariat*
Thiago Hérick de Sá, *World Health Organization*

Transport - Health Nexus

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Health impacts of transport

- Ambient air pollution increases the risk of cardiovascular and respiratory diseases, contributing to 4.2 million premature deaths in 2019.
- Land traffic contributes an estimated 5% of the mortality from small particulate matter ($PM_{2.5}$) globally, and as much as 32% in North America.
- The average level of $PM_{2.5}$ pollution in the world's largest cities is nearly four times higher than World Health Organization guidelines.
- An estimated one-in-four adults and four-in-five adolescents are not sufficiently active, due in part to urban and transport infrastructure that prioritises vehicles, not people.
- Around 1.35 million people worldwide were killed due to road traffic crashes in 2016 (latest available data), with pedestrians, cyclists and motorcyclists accounting for more than half of these deaths.
- Traffic crashes are the leading cause of death among young people ages 5-29 and the eighth greatest cause of death among all age groups. Despite ambitious targets, there has been no reduction in traffic deaths for a decade.
- In 14 of 20 countries (mostly in the Organisation for Economic Co-operation and Development), road traffic crashes increased in the first half of 2022 but remained lower than pre-pandemic levels.
- Investment in safe, reliable and affordable public transport systems can reduce crashes by attracting motorcycle users even in areas with high motorcycle ownership.
- Inaccessibility to transport can reduce opportunities for people to get the healthcare services they need, and at times even discourage them from seeking care.
- Studies have shown that safe, active transport can boost mental health and that safe and efficient public transport can reduce commuter anxiety.

Policy measures and targets for a transport-health nexus

- The indirect costs of fossil fuel subsidies (including respiratory disease and traffic crashes) are an estimated ten times greater than their direct financial cost.
- Redirecting fossil fuel subsidies towards sustainable, low carbon transport modes (and to directly benefit healthcare systems) can lead to improved health outcomes.
- Urban and national decision makers can choose from an increasing number of policy tools to promote health-focused transport systems.
- In response to stronger emission standards in many jurisdictions, decision makers are increasingly turning to newer vehicle technologies to curb outdoor pollution and promote better health.
- In the post-pandemic world, national and sub-national governments are increasingly recognising the health benefits of active mobility and are investing in policies to promote walking and cycling, such as cycle lanes and bike sharing schemes.
- After the world failed to meet road safety targets set for the decade 2010-2020, the United Nations General Assembly in 2020 declared a second Decade of Action for Road Safety (2021-2030), setting an ambitious target to halve road traffic deaths and injuries by 2030.

Overview

As cities recover from the experience of the COVID-19 pandemic, there is heightened awareness of the relationship between urban settings and people's exposure and vulnerability to health risks, which include air pollution, road crashes and sedentary lifestyles.[1] Achieving equitable, healthy, green, and resilient transport and mobility systems has implications for the success of the United Nations' (UN) 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) – particularly for synergistic implementation of SDG 3 on health and well-being and SDG 11 on sustainable cities, while responding to SDG 13 on climate action.[2]

The planning of healthy cities strongly favours public and active transport, and the health benefits from reduced car dependence are increasingly influencing urban planning processes. The promotion of active transport modes, such as walking and cycling, provides a wide range of health and economic co-benefits by reducing healthcare costs linked to cardiovascular disease, improving labour productivity and decreasing congestion costs.[3] Reducing high emissions and environmental externalities in port cities is also essential to addressing these recognised health hazards.[4]

The Intergovernmental Panel on Climate Change (IPCC) highlighted the nexus between transport, climate and health in its Sixth Assessment Report, released in 2022.[5] The IPCC notes that many strategies for mitigating climate change in the transport sector also have health benefits, including from air quality improvements, reduced fatalities, equitable access to transport services and reduced stress (see Table 1).[6] The electrification of transport, combined with renewable energy and shifts to public and active transport, can enhance health outcomes.[7] The report shows that decision making that is focused on health benefits will encourage cities to place greater emphasis on public transport, walking and cycling.[8]

TABLE 1. Health benefits from low carbon, active and electrified transport

Source: See endnote 6 for this section.

Improved air quality	Low-emission transport reduces air pollution and contributes to positive health outcomes.
Reduced traffic injuries	Public transport systems have the potential to reduce injuries and deaths from road traffic crashes, although active transport also can increase vulnerability to crashes.
Active transport	Walking and cycling have major health benefits, such as reducing the risk of obesity and other chronic health conditions, as well as improving mental health and well-being; however, active transport also may increase exposure to air pollution.
Access to services	Accessible, affordable public transport can improve access to health care and other essential services for disadvantaged population groups.
Reduced stress	Reductions in personal driving can result in reduced stress levels.

Health impacts of transport

Analysis of the health impacts of transport demonstrates the range of health and mobility inequalities experienced across the world.[9] Negative health impacts associated with transport are typically felt more acutely by people in vulnerable situations (including those in lower-income groups, people of colour, older people, children and people with disabilities) due to greater exposure to air pollutants and lower access to safer transport options. Transport impacts have higher health risks in middle- and low-income countries, and interventions to address impacts are most effective when they also aim to reduce inequalities.[10]

Air quality

Ambient air pollution increases the risk of cardiovascular and respiratory diseases, contributing to 4.2 million premature deaths in 2019.[11] In higher-income countries, more marginalised populations are often disproportionately affected, with studies showing that low-income, Black, Asian and Hispanic communities in the United States are exposed to higher levels of particulate matter 2.5 ($PM_{2.5}$) which stems from historical policy inequities.[12]

Land traffic contributes an estimated 5% of the mortality from small particulate matter ($PM_{2.5}$) globally, and as much as 32% in North America.[13] In addition to pollution impacts from urban land transport, freight transport activities in ports are key contributors to air pollution (nitrogen oxides and sulphur oxides) and leading causes of premature deaths.[14] The International Maritime Organization has a key responsibility to reduce emissions of pollutants in maritime port areas.[15]

The average level of $PM_{2.5}$ pollution in the world's largest cities is nearly four times higher than the World Health Organization's guideline of 10 micrograms per cubic metre.[16] The worst-affected urban areas are all in Asia, with cities in Pakistan, India, and China, respectively, having the highest measured levels of pollution.[17] Lockdowns during the COVID-19 pandemic led to estimated $PM_{2.5}$ reductions of 29.7% in China and 17.1% in Europe, resulting in a significant decline in premature deaths.[18] In rapidly growing African cities, rising traffic congestion is a major threat to social and economic resilience and sustainable growth (see Box 1).[19]

Active mobility and obesity

The WHO estimates that one-in-four adults and four-in-five adolescents are not sufficiently active, due in part to urban and transport infrastructure that prioritises vehicles, not people.[20] Many countries are facing health challenges associated with reduced physical activity, which include obesity, diabetes and cardiovascular diseases. Evidence suggests that promoting active mobility plays a huge role in reducing obesity and in minimising individual motorised transport, a major cause of air and noise pollution.[21] A shift to sustainable, active transport through walking, cycling and public transport is thus critical to meet both climate targets and health objectives.

- Research on transport policy in nine countries (Brazil, China, Germany, India, Indonesia, Nigeria, South Africa, the United Kingdom and the United States) found that a shift towards greater active transport would help save around 1.15 million lives across the nine countries by 2040 due to increased physical activity (while also reducing 1.18 million deaths related to air pollution).[22]
- An assessment of lessons from the world's largest bike sharing system in Shanghai (China) shows the immediate health benefits of encouraging safe active transport, including increasing levels of exercise and decreasing respiratory events (see Box 2).[23]

BOX 1. The cost of traffic congestion and air pollution for African cities

The negative impact of traffic congestion on air quality and health is understated. In Ghana, the World Bank reports that air pollution is costing the economy close to USD 2.5 billion per year. A study of four of the fastest growing African cities (Accra, Cairo, Johannesburg and Lagos) estimates that if development follows the business-as-usual scenario, the total cost related to air pollution from 2023 to 2040 will reach USD 115.7 billion[i]. Government-provided public transport options are limited in many African cities, and planning approaches that focus on private vehicles continue to have grave implications for human health.

i This number reflects the "Value of Statistical Life" applied to an estimation of premature deaths.

Source: See endnote 19 for this section.

BOX 2. Lessons from bike sharing in Shanghai

Shanghai's bike sharing scheme is being managed as part of China's first urban cycling strategy. The strategy includes a set of policies and regulations supporting the integration of cycling into the wider transport network and prioritises cycling safety to help maximise the benefits of urban cycling.

In 2020, researchers assessed data on more than 2 million trips made by bicycle in Shanghai and considered the impact that increased cycling has on air quality, levels of exercise and numbers of traffic accidents. They found that the city's bike sharing scheme, after only a year and a half of operation, prevented an estimated 23 premature deaths, hundreds of hospital visits and tens of thousands of respiratory events (such as asthma attacks). The scheme reduced greenhouse gas emissions equivalent to removing around 9,000 vehicles from Shanghai's roads[i].

i The authors accounted for the mode share and distance of the trips. Only 20% of trips are made by car in Shanghai (well below the average mode share), and bike trips under 1 kilometre are assumed to have been walked.

Source: See endnote 23 for this section.

Road traffic injuries[24]

Around 1.35 million people worldwide were killed due to road traffic crashes in 2016 (latest available data), with pedestrians, cyclists and motorcyclists accounting for more than half of these deaths.[25] Deaths of users of motorised two- and three-wheelers are increasing as a share of overall road traffic deaths.[26]

Traffic crashes are the leading cause of death among young people ages 5-29 and the eighth greatest cause of death among all age groups.[27] **Despite ambitious targets, there has been no reduction in traffic deaths for a decade.** Studies show that crash survival rates increase with good post-crash care, including access to timely care.[28]

In 14 of 20 countries (mostly in the Organisation for Economic Co-operation and Development), road traffic crashes increased in the first half of 2022 but remained lower than pre-pandemic levels.[29] Motorcycle use has risen rapidly (especially in emerging economies in Africa and Asia) in the wake of the pandemic due to restricted and uneven access to public transport. **Investment in safe, reliable and affordable public transport systems can reduce crashes by attracting motorcycle users even in areas with high motorcycle ownership** (as was demonstrated by research in Khon Kaen City, Thailand).[30]

- The WHO estimates that 93% of road crash deaths in 2016 occurred in low- and middle-income countries, where pedestrian and motorcycle vulnerability is high and road safety infrastructure and regulation are not prioritised.[31] The Southeast Asia and Western Pacific regions have the highest percentage of road traffic fatalities involving two- and three-wheeled motorised vehicles, with shares of 43% and 36% among all transport modes, respectively.[32]
- Brazil ranked fifth in the world for traffic deaths[i] in 2018, with most of the fatalities occurring among pedestrians, cyclists and motorcyclists.[33] Crashes involving motorcycles accounted for 62.2% of all traffic crash visits performed by emergency services in Brazil in 2019.[34] Disaggregation of data by gender, race and age is needed to determine the relative impacts by demographic group.

Other health-related concerns

Inaccessibility to transport can reduce opportunities for people to get the healthcare services they need, and at times even discourage them from seeking care.[35] Limited access to transport often means limited access to health care, with critical barriers including poor road infrastructure, an absence of available and connected transport routes, and a lack of affordable transport options.[36] The COVID-19 pandemic further highlighted the importance of access to transport for health care.

i Ideally, these data would be further disaggregated by gender, race, and age, to determine relative impact.

- A 2019 study in Malawi confirmed that both cost and access to transport posed significant barriers to healthcare access for rural residents, who comprise 90% of the population.[37] This challenge is higher for those with impaired health or disabilities, who may lack suitable modes of transport.[38]
- In the Philippines, studies found that the closure of public transport during the pandemic severely reduced the ability of individuals to access health care.[39]

Studies have shown that safe, active transport can boost mental health and that safe and efficient public transport can reduce commuter anxiety.[40] Conversely, the lack of access to quality transport can impact mental health in different ways, including by creating isolation, longer commutes, noise and anxiety about personal safety.[41]

- A study in Hong Kong (China) demonstrated that public transport routes using multiple modes (e.g., bus and metro) create mental and physical health benefits for older adults. The study shows that satisfaction with sidewalk width also has a positive impact on mental health.[42]
- A study in New Zealand found that promoting active mobility improved the mental well-being of low-income communities, as walking and cycling offered greater control over individual travel conditions and were less expensive.[43]
- A study in Sanandaj (Iran) showed that frequent urban traffic jams affect mental health at a human relationship level (both for urban drivers and general residents), reducing tolerance, causing discord and eroding cohesion among family members.[44]

Policy measures and targets for a transport-health nexus

Policies that target a healthy and just energy transition in transport can greatly enhance physical and mental health outcomes by providing better living and work environments. This includes increasing active transport options that enable walking and cycling and providing safer and less-congested travel solutions that improve well-being and mental health.

The indirect costs of fossil fuel subsidies (including respiratory disease and traffic crashes) are an estimated ten times greater than their direct financial cost.[45] Fossil fuel subsidies – including direct subsidies to oil producers and consumers, as well as indirect subsidies to sectors such as aviation and shipping – continue to incentivise unsustainable, unhealthy transport investments.

Redirecting fossil fuel subsidies towards sustainable, low carbon transport modes (and to directly benefit healthcare systems) can lead to improved health outcomes.

Reforming fossil fuel subsidies and scaling up the use of renewable energy in the transport sector can help reduce emissions of carbon dioxide (CO_2) and other greenhouse gases, as well as $PM_{2.5}$. It also can reduce air pollution deaths, generate economic benefits and increase social spending.

- In Egypt, fiscal savings from energy subsidy reforms were redirected towards social spending on health and education.[46]
- India has demonstrated the benefits of shifting energy subsidies to direct cash transfers to low-income households, as a way to alleviate the unintended consequences of subsidies (e.g., loss of public and private revenues, inefficient consumption of fossil fuels).[47]
- The Glasgow Climate Pact, agreed to at the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), makes a clear call for countries to phase out inefficient fossil fuel subsidies and to support a just transition towards low-emission energy systems.[48]
- Recognising the health implications of making this transition, in 2022 more than 200 professional health organisations from around the world – including the WHO – signed on to the Fossil Fuel Non-Proliferation Treaty, which calls for a planned phase-out of all fossil fuels.[49] The WHO Director-General has called the continued addiction to fossil fuels an "act of self-sabotage".[50]

Other measures to reduce air pollution from transport include command-and-control measures such as fuel standards (for example, low sulphur content for ship bunkers when at port). Such standards have been mandated by the IMO and at the national and regional levels (for example, in the European Union (EU), Baltic Sea region, China and the United States). These measures have shown success in the EU and are highly relevant to increasing health outcomes in port cities worldwide.[51]

Urban and national decision makers can choose from an increasing number of policy tools to promote health-focused transport systems. Recent initiatives have aimed to encourage good practice on health-centred sustainable transport systems.[52] This work shows that healthy, fossil fuel-free cities can be designed to be energy efficient and to support new ways of living, travelling and working that allow for healthier lifestyles and safer urban spaces.

- The SLOCAT Partnership on Sustainable, Low Carbon Transport, in collaboration with the Health and Climate Network (HCN), have put a spotlight on transport and health in the global drive for a just energy transition. SLOCAT and HCN have produced a knowledge base (and user guide) to help prioritise packages of transport policies that contribute to health and climate objectives and to complement existing resources from other HCN members.[53]
- The WHO's Health Economic Assessment Tool (HEAT) for cycling and walking assesses policy options and outcomes for health, transport and climate.[54] Through a set of questions, HEAT enables governments to assess the health benefits of active mobility among populations.[55]
- The Global Climate and Health Alliance's Healthy NDCs Scorecard ranks 94 different Nationally Determined Contributions (NDCs) submitted under the Paris Agreement, covering proposed emission reduction measures in 120 countries.[56] The scorecard ranks countries' NDCs based on five health categories: health impacts, health in adaptation measures, health co-benefits, economics and finance.

In response to stronger emission standards in many jurisdictions, decision makers are increasingly turning to newer vehicle technologies to curb outdoor pollution and promote better health. With an aim to phase out fossil fuels and meet climate targets, countries are moving away from fossil fuels and focusing on greater adoption of zero-emission vehicles. This transition has public health benefits, as it leads to reduced air pollution caused by emissions from the transport sector.

- At the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), many countries, cities and companies joined transport initiatives to phase out vehicles with internal combustion engines and to scale up electric heavy-duty vehicles and electric vehicle charging.[57]
- In Brazil, an ordinance within the scope of the RENOVABIO programme to promote biofuels regulates the issuance, bookkeeping, registration, negotiation and retirement of the avoided carbon credit, which has been marketed since June 2020.[58]
- To curb outdoor air pollution, in 2022 the Israeli Ministry of Environmental Protection set mandatory targets for 100% zero-emission vehicles in new public transport procurements by 2026.[59]
- In 2022, the US Environmental Protection Agency updated its truck emission rules, the first time since 2001, with a view to halve nitrogen oxide emissions from trucks by 2045.[60]
- A study found that electrification of Mexico City's Metrobus bus rapid transit fleet, targeted for completion in 2028, is a viable option to reduce local and climate pollutants, leading to as much as an 85% reduction in CO_2 emissions.[61]
- In Ecuador, every bus that intends to enter public transport service from 2025 on must be electric, according to the Energy Efficiency Law.[62]

In the post-pandemic world, national and sub-national governments are increasingly recognising the health benefits of active mobility and are investing in policies to promote walking and cycling, such as cycle lanes and bike sharing schemes.

- In response to the pandemic, Barcelona (Spain) carried out measures such as widening sidewalks and building more cycling lanes to encourage active mobility.[63]
- In 2020, India's Ministry of Housing and Urban Affairs launched two initiatives, Cycles4Change and Streets4Change Challenge, to support cities in implementing more pedestrian and cycling initiatives.[64]
- To improve health and well-being and reduce air pollution, Canada introduced a national active transport strategy in 2021 to promote active mobility across the country.[65]
- Local associations in Argentina and Moldova are calling for speed limits of 30 kilometres per hour to improve pedestrian and cycling safety, and in Wales driving speeds will be limited to 20 kilometres per hour on all urban and village roads to reduce injuries and deaths from road crashes.[66]
- Austria's 2030 Mobility Master Plan, adopted in 2021, highlights the importance of active mobility in meeting health targets and aims to double the share of cycling in the country to 13% by 2030.[67]

After the world failed to meet road safety targets set for the decade 2010-2020, the United Nations General Assembly in 2020 declared a second Decade of Action for Road Safety (2021-2030), setting an ambitious target to halve road traffic deaths and injuries by 2030.[68] Led by the WHO, this initiative takes a holistic approach to road safety, with calls for continuing improvements in the design of cities, roads and vehicles; enhancing laws and law enforcement; and providing timely, life-saving emergency care.[69]

Countries also acknowledge the urgent need to deliver on road safety, noting that recent efforts to reduce traffic fatalities have fallen short, especially in low- and middle-income countries.[70]

- In response to the Decade of Action, Brazil's Ministry of Infrastructure revised in 2021 the National Plan of Traffic Deaths and Injuries Reduction, which has a goal to reduce traffic fatalities by 50% as a means to save around 120,000 lives between 2018 and 2030.[71]
- The European Commission's plan to improve road safety in the EU, announced in 2023, seeks to set the legal age for taking a driving exam at 17 years old, with new licence holders facing a two-year probation period.[72]
- In 2021, Colombia introduced the Julián Esteban road safety law, named after a 13-year-old killed by a truck while cycling. The law aims to implement stronger regulation of road and infrastructure design as well as speed limits of 50 kilometres per hour in urban areas and 30 kilometres per hour in residential areas and school zones.[73]
- In 2022, the United Nations Environment Programme (UNEP) established a Pan-African Action Plan for Active Mobility, recognising that millions of people in Africa are dependent on active transport (see Box 3).[74]

Other Initiatives

- The Bloomberg Philanthropies Initiative for Global Road Safety focuses on five key areas: strengthening national legislation; enhancing data collection; improving user behaviour; improving road infrastructure; and enhancing vehicle safety.[75]
- The BreatheLife Campaign (led by the WHO, the UN Environment Programme and the Climate & Clean Air Coalition) calls for local, regional and national governments to commit to achieving WHO Air Quality Guidelines by 2030.[76]
- In 2023, more than 20 African countries adopted the Dakar Declaration on road safety, with the aim of improving data collection in support of the goal to halve road traffic deaths by 2030.[77]
- The Global Road Safety Partnership provides road safety programme co-ordination at a global level, supports capacity building of road safety practitioners and traffic police, and offers an expert source of road safety knowledge and good practice.[78]
- Vision Zero is a multidisciplinary strategy to bring together traffic planners and engineers, policy makers, and public health professionals to eliminate traffic fatalities and increase safe, healthy, equitable mobility.[79]
- The WHO's Global Plan for the Decade of Action, released in 2021, outlines the need to reduce road traffic injuries and to accelerate measures and targets on walking, cycling and safe public transport.[80]

BOX 3. The Pan-African Action Plan for Active Mobility

The Pan-African Action Plan for Active Mobility (PAAPAM) is focused on helping the more than 1 billion people in Africa who walk or cycle for more than 55 minutes every day to reach their workplaces, homes, schools and other essential services. The PAAPAM aims to raise the profile of active mobility, while improving the safety of people walking and cycling in every country in the region and reducing the number of fatalities and serious injuries among road users.

Source: See endnote 74 for this section.

Credit: Mohamed Mambo, via AmendPolicy

MODULE 1 SPOTLIGHT 2

AUTHORS:
Hannah E. Murdock, *Imperial College London*
Arjay Dineros, *SLOCAT secretariat*

CONTRIBUTORS:
Karl Peet, *SLOCAT secretariat;* Raffael Held and Janina Marie Laurent, *GIZ;*
Nicole Baker, *Arup;* Sam Johnson, *World Bank*

Transport Adaptation, Resilience and Decarbonisation in Small Island Developing States

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Context and key challenges

- Because of their limited land area and geographic location and isolation, small island developing states (SIDS) are highly vulnerable to the impacts of climate change, and the resilience of transport infrastructure and services is closely tied to the resilience of SIDS communities.
- SIDS have experienced increasing incidences of climate change-related events such as tropical cyclones, storm surges, droughts, changing precipitation patterns, coral bleaching and invasive species.
- SIDS are highly dependent on fossil fuels for their transport systems, which contributes to greenhouse gas emissions and environmental degradation and undermines the resilience of countries to climate change impacts, such as sea-level rise and extreme weather events.
- Addressing transport access, decarbonisation, resilience and adaptation pathways in SIDS is crucial for achieving sustainable social, economic and environmental development and resilience.

Demand trends

- SIDS are highly dependent on maritime and air transport, although road transport is the dominant transport mode in terms of fuel use.
- The often small and dispersed nature of island communities leads to high transport costs and limited access to markets and services; meanwhile, transport infrastructure is often in poor condition and subject to the "build-neglect-rebuild" paradigm.
- Despite having strong renewable energy potential, SIDS remain highly dependent on fossil fuels for electricity and transport; fossil fuels accounted for 22.7% of total imports in 2019, and electricity costs in SIDS are among the world's highest.
- The average motorisation rate across SIDS is an estimated 121 vehicles per 1,000 people. As elsewhere, car dependency often results from automobile-centric urban design and limited policy incentives for other forms of transport, while SIDS have the additional issue of inexpensive second-hand imported vehicles.
- Electric cars may not be economically or environmentally feasible in SIDS in the near term for a variety of reasons, and other decarbonisation measures could be prioritised instead, such as cycling and micromobility. Still, electric vehicle uptake is on the rise in some SIDS, notably in the Caribbean islands, and in some cases the vehicles are being charged with renewable energy.
- Some SIDS have been identified as key sources for raw materials needed in global supply chains to produce electric vehicles, leading to controversy in some cases.

Emission trends

- Despite rising emissions within SIDS, together these countries represented just 1% of global carbon dioxide (CO_2) emissions in 2019, yet they disproportionately experience the effects of climate change.
- SIDS contributed just 0.5% of global transport CO_2 emissions in 2021 (excluding international aviation and shipping), despite their emissions growing 9.6% during 2010-2021.
- in 2020, transport CO_2 emissions in SIDS fell 10% to 31.2 million tonnes, due to the impacts of the COVID-19 pandemic.
- Per capita transport CO_2 emissions in SIDS vary from 0.07 tonnes in Guinea Bissau to 4.96 tonnes in Seychelles.

Photo: Sujan Sarkar / Climate Visuals

Policy measures

- For many SIDS, land transport accounts for the bulk of imported fuel use, followed by electricity generation and maritime transport. Thus, phasing out fossil fuels in these sectors is the main lever for both reducing emissions and increasing energy security.
- Strategies identified for SIDS to decarbonise transport are largely similar to those for decarbonising urban and land transport systems in other regions. However, strategies in SIDS also must include integrated planning for inter-island transport, greening of ports and maritime and aviation operations, use of small boats for coastal travel, a regional approach to aviation services, and adoption of low-emission aviation and shipping technology.
- SIDS have implemented a wide range of measures to enhance the resilience of their transport sectors, from systems planning and risk-based asset management systems to smartphone apps.
- Some SIDS have increased their efforts to decarbonise shipping while also pushing for greater ambition globally.
- Many SIDS have led the charge on efforts to increase climate equity, address loss and damage from the effects of climate change, and restructure financial systems.

Overview

Small island developing states (SIDS) are a group of 37 United Nations (UN) Member States[i] and 20 non-UN Members / Associate Members located in the Atlantic, Indian, and Pacific oceans and in the Caribbean, Mediterranean and South China seas. Despite their diverse cultures and histories, their common characteristics mean that they share many of the same challenges.[1]

Because of their limited land area and geographic location and isolation, SIDS are highly vulnerable to the impacts of climate change.[2] This places them at a distinct disadvantage compared with larger nations, making the approach to sustainable transport in SIDS somewhat different than in other contexts. **The resilience of transport infrastructure and services in SIDS is closely tied to the resilience of these communities.**[3]

SIDS have experienced increasing incidences of climate change-related events such as tropical cyclones, storm surges, droughts, changing precipitation patterns, coral bleaching and invasive species.[4] Between 1970 and 2020, hazards related to weather, climate and water led to an estimated USD 153 billion in cumulative losses in SIDS.[5] By comparison, the average gross domestic product (GDP) in these countries was USD 13.7 billion in 2020.[6]

The transport sector is a critical component of SIDS economies, facilitating trade, tourism and access to essential goods and services. However, populations in some SIDS lack adequate access to roads and transport services. For example, the Rural Access Index[ii] has rated Pacific Island nations among the lowest in the Asia Pacific region for access to roads, with the Maldives having a particularly large number of people lacking access.[7]

SIDS are highly dependent on fossil fuels for their transport systems, which contributes to greenhouse gas emissions and environmental degradation and undermines the resilience of countries to climate change impacts.[8] Extreme weather events, sea-level rise and coastal erosion can damage transport infrastructure such as airports, ports, and roads, leading to service disruptions and increased maintenance costs. For SIDS whose land lies only a few metres above sea level, projected sea-level rise represents is a direct threat to their existence.[9] This highlights the urgent need for the transport sector to play a role in tackling climate change through decarbonisation efforts.

Despite rising emissions in SIDS, these countries represent only a small share of global carbon dioxide (CO_2) emissions.[10] However, they disproportionately experience the effects of climate change, leading to calls from SIDS and others for greater international climate finance to aid with mitigation and adaptation (see Box 1).[11] By 2019, SIDS collectively had access to only USD 1.5 billion of the USD 100 billion pledged in climate finance for developing countries.[12]

i SIDS UN Members are as follows (entries with an asterisk are also least-developed countries, LDCs): Antigua and Barbuda, Bahamas, Barbados, Belize, Cabo Verde, Comoros*, Cuba, Dominica, Dominican Republic, Fiji, Grenada, Guinea-Bissau*, Guyana, Haiti*, Jamaica, Kiribati*, Maldives, Marshall Islands, Federated States of Micronesia, Mauritius, Nauru, Palau, Papua New Guinea, Samoa, São Tomé and Príncipe*, Singapore, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Seychelles, Solomon Islands*, Suriname, Timor-Leste*, Tonga, Trinidad and Tobago, Tuvalu* and Vanuatu. See https://www.un.org/ohrlls/content/list-sids.

ii A World Bank index estimating the share of the rural population with access to roads within a two-kilometre walking distance.

Across the Pacific Islands, the lack of options and infrastructure for active transport (walking and cycling) has contributed to low rates of physical exercise.[13] In 2014, these islands were home to 9 of the world's 10 most obese countries, with up to 95% of the adult population overweight in some countries.[14]

Addressing transport access, decarbonisation, resilience and adaptation pathways in SIDS is crucial for achieving sustainable social, economic and environmental development and resilience. At issue are both the resilience *of* transport and resilience *through* transport, given the sector's importance to SIDS economies. (*See Section 1.2 Transport Adaptation and Resilience.*)

SIDS have often led the call for greater climate ambition internationally and have set ambitious decarbonisation goals themselves. Many measures taken thus far have contributed to development in line with the UN Sustainable Development Goals (SDGs) that are most relevant to SIDS, promoting more equitable, healthy, green and resilient communities.[15] With their unique transport demands and the urgency of policies and strategies around decarbonisation, resilience, and adaptation of the transport sector, it is helpful to focus on the special case of SIDS and their vulnerability to climate and sustainability challenges.

Demand trends

SIDS are highly dependent on maritime and air transport, although road transport is the dominant transport mode in terms of fuel use.[16] Transport modes vary among SIDS depending on the country's size, location and main economic activities. In general, SIDS rely heavily on transport for tourism. For nearly two-thirds of SIDS, the tourism sector represents more than 20% of the gross domestic product (GDP), and this share reaches 58% in Palau and 65% in the Maldives, underscoring the importance of maintaining the sector's resilience.[17] In the Maldives, tourism accounted for around 45% of total economic activity and for around 35% of all jobs in 2021.[18]

The often small and dispersed nature of island communities leads to high transport costs and limited access to markets and services; meanwhile, transport infrastructure is often in poor condition and subject to the "build-neglect-rebuild" paradigm.[19] The reliance on fossil fuels for transport contributes to environmental degradation and undermines the resilience of SIDS to climate change impacts such as sea-level rise and extreme weather events.[20] In 2019, fossil fuel imports – mainly for electricity and transport – accounted for 22.7% of total imports among SIDS.[21] Electricity costs in these countries are among the highest globally due to the high costs of transporting fuel.[22]

Photo: Milos Bicanski / Climate Visuals

SIDS collectively accounted for 17.5% of ship registrations globally in 2020, just below the combined share for industrialised countries (21.6%); however, they experience low shipping connectivity[i], accounting for 29 of the 50 least-connected economies, according to a 2021 report.[23]

For road transport, the average motorisation rate across SIDS is an estimated 121 vehicles per 1,000 people.[24] The rate ranges from 527 vehicles per 1,000 people in Saint Kitts and Nevis, to only 10 vehicles per 1,000 people in Papua New Guinea.[25] For comparison, the European Union (EU) averages 560 vehicles per 1,000 people.[26] **As elsewhere, car dependency in SIDS often results from automobile-centric urban design and limited policy incentives for other forms of transport, while SIDS have the additional issue of inexpensive second-hand imported vehicles.**[27]

Traffic congestion has been increasing in several SIDS, in some cases leading to political tension.[28] While the traditional response to congestion globally is to add or widen roads (which, paradoxically, can lead to more traffic), this is not a viable option in SIDS, where land is scarce and financing can be challenging.[29] This has led some SIDS, such as Singapore, to develop or consider other solutions for congestion (*see Policy Developments section*).[30] The World Bank has proposed cycling support measures to help address congestion in the Pacific Islands – such as removing car parking, lowering speed limits, and adding segregated cycling lanes and bicycle parking – as well as demand management measures for private vehicles.[31]

A World Bank study found that electric cars may not be economically or environmentally feasible in SIDS in the near term for a variety of reasons, and that other decarbonisation measures could be prioritised instead.[32] In SIDS, imports have increased of low-cost, high-emitting cars from markets that have already achieved high levels of fleet decarbonisation, and electric vehicles have higher upfront (import) costs and a small market size; meanwhile, the environmental benefits from electric vehicles are limited until further deployment of renewable energy occurs, since much of the electricity in SIDS comes from generators running on imported diesel fuel.[33] Still, **electric vehicle uptake is on the rise in some SIDS, notably in the Caribbean islands, and in some cases the vehicles are being charged with renewable energy.**

- Bermuda has been developing a strategy for transitioning to an all-electric public bus fleet.[34] By 2022, the country had electrified a third of its bus fleet, replacing 30 diesel-powered buses with electric buses.[35] Bermuda also has committed to 85% renewable energy by 2035.[36]
- Barbados has become a regional leader in electric vehicle deployment, with around 430 electric vehicles on the road by 2020; as of 2013, around 1.3% of new car sales in the country were electric (a greater share that year than in some high-income countries, such as Canada).[37]
- Utilities in some SIDS, such as the Bahamas and Saint Lucia, were installing electric vehicle charging infrastructure as of 2019.[38]

The World Bank has noted that the expansion of cycling and micromobility[ii] is an untapped opportunity in many SIDS, which tend to have compact settlements and often struggle to accommodate rising motorisation rates.[39] Several Pacific Islands have large populations that, by using cycling or micromobility, could easily reach locations within a five-kilometre radius in 20 minutes or less. Micromobility would be well-suited to the Pacific context but so far has lacked a concerted push from government and the private sector to begin the self-reinforcing cycle of uptake.[40]

Although most of the electricity in SIDS remains fossil based, many of these countries have large potentials for renewable energy sources such as solar, wind, tidal, and ocean energy, and in some cases geothermal and hydropower.[41] Greater local use of renewables has the potential to boost energy independence, increase energy security, and build resilience, while providing a clean energy source for electric vehicles. The installed renewable energy capacity in SIDS has grown from 3.5 gigawatts (GW) in 2014 to more than 6.5 GW in 2021, led by solar power and followed by hydropower, bioenergy, and wind power, with smaller amounts of geothermal and marine energy.[42]

Some SIDS have been identified as key sources for raw materials needed in global supply chains to produce electric vehicles, leading to controversy in some cases.

- Tesla announced in 2021 that it would purchase nickel from a mine in New Caledonia, the fourth largest nickel producer globally.[43]
- A controversial copper mine in Papua New Guinea was set to re-open following an agreement in 2022, despite widespread opposition and a decade-long conflict over the mine.[44]
- Companies were active in resource mining in Fiji, which has had a pro-mining government.[45]

i Connectivity includes, for example, the number of shipping lines servicing the country, the number of services connecting the country to others, and the number and capacity of vessels in the country. See endnote 23 for this section.

ii Including electric sidewalk/"kick" scooters, dockless electric and traditional bicycles, and electric moped-style scooters.

Emission trends

Despite rising emissions within SIDS, together these countries represented just 1% of global CO_2 emissions in 2019.[46] For transport specifically, SIDS contributed just 0.5% of global transport CO_2 emissions in 2021 (excluding international aviation and shipping).[47] Transport CO_2 emissions from SIDS grew 9.6% during 2010-2021.[48] In 2020, transport CO_2 emissions in SIDS fell 10% – from 34.7 million tonnes to 31.2 million tonnes – due to the impacts of the COVID-19 pandemic.[49] Per capita transport CO_2 emissions in SIDS vary from 0.07 tonnes in Guinea Bissau to 4.96 tonnes in Seychelles (see Figure 1).[50]

Policy Developments

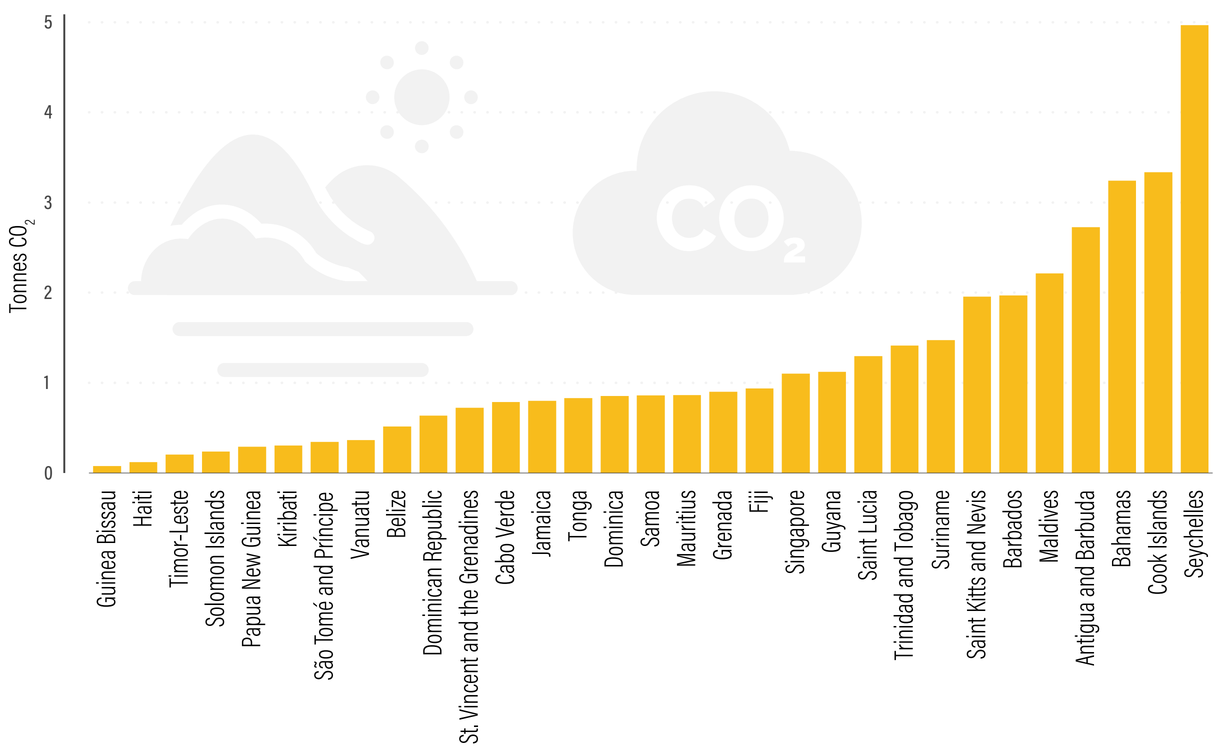
For many SIDS, land transport accounts for the bulk of imported fuel use, followed by electricity generation and maritime transport.[51] **Thus, phasing out fossil fuels in these sectors is the main lever for both reducing emissions and increasing energy security** (through greater resilience to price spikes). Strategies identified for SIDS to decarbonise transport are largely similar to those for decarbonising urban and land transport systems in other regions (*see Section 3.1 Integrated Transport Planning*).[52] However, strategies in SIDS also must include integrated planning for inter-island transport, greening of ports and maritime and aviation operations, use of small boats for coastal travel, a regional approach to aviation services, and adoption of low-emission aviation and shipping technology.[53]

SIDS have implemented a wide range of measures to enhance the resilience of their transport sectors.

- To reduce its vulnerability, Samoa pushed for a coherent and multi-pronged approach to systems planning, with the adoption of sectoral and spatial planning tools, investments in road network redundancy for critical infrastructure such as roads and bridges, the construction of pedestrian evacuation routes, and policies and planning that address disaster and climate risks.[54] Beginning in 2012, the Samoa Post Tsunami Reconstruction Project supported building the East Coast Inland Route and upgrading the Lepa-Lalomanu Route, both of which are inland routes that provide all-weather alternatives to coastal roads, helping to increase the resilience of communities to climate change.[55]

FIGURE 1. Per capita transport CO_2 emissions in SIDS

Source: See endnote 50 for this chapter.



- In Dominica, the roadway network is prone to flooding and landslide hazards, and after Tropical Storm Erika hit the island in 2015 around 60% of the roads were inaccessible.[56] In 2016, a sustainable risk-based asset management system was implemented for roadway infrastructure, to keep track of reconstruction, continuously assess conditions, assess disaster vulnerability, and prepare a multi-year investment and mitigation action plan. The system also identifies optimal investment strategies to reduce the roadway's risk and vulnerability to hazards and to maintain its functionality at an acceptable level.[57]
- In Saint Lucia, the Ministry of Infrastructure adopted a smartphone app, RoadLab Pro, as a low-budget and easy-to-use geo-mapping tool for assessing road conditions, including road roughness.[58]

Some measures in SIDS also have supported decarbonising road transport:

- Although intended to address congestion, Singapore has implemented various measures since the 1970s that also support a lower-emission transport system. To manage the increasing number and use of vehicles, measures have included vehicle and fuel taxes, parking charges and a vehicle quota system.[59] In 1971, Singapore developed a mass rapid transit system to allow for island-wide connectivity without reliance on private vehicles, and recently it enacted a walking and cycling plan.[60]
- In 2019, Bermuda set targets to reach 100% electrified public transport by 2030 and an 85% renewable share in the overall energy supply by 2035.[61]
- In Antigua and Barbuda, an electric vehicle pilot project was launched in 2017 with the donation of two electric school buses, which were integrated into the system at the start of the 2020 school term.[62]

Some SIDS have increased their efforts to decarbonise shipping while also pushing for greater ambition globally:

- In 2020, the Marshall Islands set the objectives of reducing domestic shipping emissions 40% by 2030 and fully decarbonising the sector by 2050.[63]
- The Marshall Islands, Kiribati and the Solomon Islands have been influential within the International Maritime Organization (IMO) in advocating for scaled-up ambition in decarbonising shipping.[64]

Because SIDS face disproportionate impacts from climate change, many have led the charge on efforts to increase climate equity, address loss and damage from the effects of climate change, and restructure financial systems. For example, in 2022 Barbados adopted the Bridgetown Agenda as a call to the international community for greater financial support for developing countries affected by climate change (see Box 1).[65] In March 2023, six Pacific Island countries – Fiji, Niue, the Solomon Islands, Tonga, Tuvalu and Vanuatu – signed the Port Vila Call for a Just Transition to a Fossil Fuel Free Pacific, a call to action encompassing many measures to transition the region away from fossil fuels, including reforms to international climate finance to help enable the transition.[66]

BOX 1. The Bridgetown Agenda for climate finance

In 2022, Barbados adopted the Bridgetown Agenda, calling on the International Monetary Fund, the World Bank, the G20 countries and others in the international community to increase financial support to low- and middle-income countries. The agenda is aimed at efforts to deal with climate change as a top crisis, alongside the cost of living and debt crises (which themselves have been exacerbated by climate-related disasters, the COVID-19 pandemic and the Russian Federation's war on Ukraine). The agenda outlined three actions:


Photo credit: Timothy Sullivan (UNCTAD)

1. **Provide emergency liquidity to countries in need to stop the debt crisis.**
2. **Expand multilateral lending by USD 1 trillion, placing a priority on achieving the SDGs and building climate resilience.**
3. **Activate private sector savings for use in climate mitigation, as well as funding for reconstruction following climate-related disasters using new multilateral mechanisms.**

This initiative proved to be a significant development that has had implications for the UN international climate negotiation processes, including catalysing debate at the 2022 UN Climate Change Conference in Sharm El-Sheikh, Egypt (COP 27). It also resulted in the organisation of the first Global Supply Chains Forum, scheduled to be held in Barbados in May 2024, organised by the government of Barbados and the UN Conference on Trade and Development.

Source: See endnote 65 for this section.

In addition, outside governments and organisations have taken an interest in providing **international support** to SIDS on transport-related projects, typically with the aim of also reducing emissions.

- Germany's Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has administered the Regional Pacific Nationally Determined Contribution Hub to support Pacific Island countries in reviewing, enhancing and implementing their climate commitments, including helping to identify opportunities to bring the transport sector to the fore and connect climate ambitions at the national and local levels.[67] This hub is implemented in partnership with the Global Green Growth Institute, the Pacific Community, and the Secretariat of the Pacific Regional Environment Programme, and served 14 member countries as of early 2023: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Palau, Papua New Guinea, Nauru, Niue, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.
- From 2017 to 2023, GIZ supported the Marshall Islands in reducing emissions and transitioning to energy efficient transport in the maritime sector through the Transitioning to Low Carbon Sea Transport project.[68]
- The Global Green Growth Institute has supported the SIDS within its membership – Fiji, Kiribati, Papua New Guinea, Tonga and Vanuatu – in pursuing a low carbon development approach while also promoting increased resilience.[69]
- Implemented by the IMO and funded by the EU, the Global Maritime Technology Cooperation Centre's (MTCC) Network Project was established in 2017 and extended to March 2022, with the objective of supporting least-developed countries and SIDS in particular to improve energy efficiency and decrease emissions in the shipping sector.[70]
- The Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE), supported by the United Nations Industrial Development Organization (UNIDO), has been working on standards and regulations for electric vehicles and e-micromobility in the Pacific Islands, following other work focused on exploring options for integrating electric mobility and renewable energy.[71]
- The International Renewable Energy Agency (IRENA) has supported SIDS in their efforts to transition from fossil fuel dependence to renewable energy through its SIDS Lighthouses Initiative.[72] The initiative brings together a multi-stakeholder group of countries, regional and international organisations, development agencies, the private sector, research institutes and non-governmental organisations to support SIDS in this effort.[73]
- For over 50 years, the US Department of State has supported Pacific Island countries through its Pacific Islands Forum across a range of issues, including sustainable growth, environmental challenges and natural disasters.[74] In 2022, the first ever US-Pacific Island Country Summit was held to increase co-operation on issues including climate change; it included the launch of the Pacific Partnership Strategy to support the Pacific Islands on dealing with such issues.[75]

Photo: Silke von Brockhausen / UNDP

MODULE 1 1.3

National and Sub-national Action for Sustainable, Low Carbon Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

1.3.1 Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs 59

Spotlight 3 Engagement of Transport Stakeholders in the United Nations Framework Convention on Climate Change Process 73

1.3.2 Subnational Actions for Sustainable, Low Carbon Transport 81

1.3.3 The Role of Business in Decarbonising Transport 91

Section Spotlight

MODULE 1 1.3.1

AUTHORS: Nikola Medimorec and Alice Yiu, *SLOCAT Secretariat*

CONTRIBUTORS: Shivam Ghai and Rohit Nepali, *SLOCAT Secretariat*

Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

- To achieve the objectives of the Paris Agreement and of the 2030 Agenda on Sustainable Development – including decarbonisation by 2050 and improved accessibility, resilience and sustainability by 2030 – the transport sector must accelerate its transformation immediately.
- The Nationally Determined Contributions (NDCs) submitted as of 23 September 2022 are insufficient to avoid an average temperature increase of 2.5°C by the end of this century.

Nationally Determined Contributions in the framework of the Paris Agreement

- Most countries (169 countries in total) submitted second-generation NDCs before the end of 2022 and strengthened their overall climate ambitions.
- On average, the second-generation NDCs included more transport mitigation and adaptation actions than the first generation of NDCs. Each second-generation NDC featured nearly twice as many transport mitigation actions as did first-generation NDCs.
- The second-generation NDCs also featured twice as many transport targets (109 targets in total in 64 NDCs) as the first-generation ones. However, this does not translate into more impact because targets do not result in absolute reductions in transport emissions.
- Of the second-generation NDCs, 23 (or 16%) had a target for mitigating transport greenhouse gas emissions, mostly for countries in Europe and Africa and for the year 2030; this was up from only 13 first-generation NDCs (or 8%).
- Adaptation is still neglected in transport, as few second-generation NDCs feature transport adaptation targets and actions. In both generations of NDCs, there is little explicit mention of freight-related actions.
- The level of ambition on transport (i.e., targets and actions) in second-generation NDCs remains insufficient to achieve the goals of the Paris Agreement, and implies a further 11% increase in transport greenhouse gas emissions by 2030.

Long-Term Low Emission Development Strategies (LT-LEDS or LTS) in the framework of the Paris Agreement

- By the end of 2022, only a quarter of the world's countries had developed LTS.
- All LTS mentioned transport, although only 22% of LTS (13 countries) outlined transport targets, with nearly all having a target year of 2050.

Initiatives and commitments at recent United Nations (UN) climate conferences

- During the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), stakeholders launched an unprecedented number of commitments and initiatives on sustainable, low carbon transport (i.e., zero-emission passenger and freight vehicles, shipping, aviation), and several of these have since expanded in scope and/or signatories.
- At the 2022 UN Climate Change Conference in Sharm El-Sheikh, Egypt (COP 27), the COP 27 Presidency of Egypt launched an initiative on low carbon transport for urban sustainability that aims to activate systemic change beyond the legacy "mode-first" mindset (i.e., focus on specific transport modes).

Linkages between national planning processes and Paris Agreement mechanisms

- Linkages between national strategies (such as transport development plans, electric vehicle plans and multi-year infrastructure plans) and Paris Agreement mechanisms have been strengthened as more climate strategies reference national strategies.
- The number of countries working on transport decarbonisation strategies has increased since the second edition of this report in 2021. At the sub-national level, several jurisdictions released transport decarbonisation plans.

Voluntary National Reviews (VNRs) in the framework of the 2030 Agenda for Sustainable Development

- The VNRs from 2016 to 2022 revealed consensus on the role of transport as a key contributor to implementation of the Sustainable Development Goals (SDGs). In the first VNR reporting cycle (2016-2019), 92% of VNRs highlighted progress in the transport sector, and 18% of VNRs reported specific targets covering 12 areas in sustainable transport.
- In 2022, 21% of the VNRs (9 out of 42 VNRs) mentioned specific transport targets, up from 20% (9 out of 40) in 2021 and 17% (8 out of 47) in 2020.
- Most of the 2022 VNRs described only the adverse impacts of global issues, without presenting concrete policy measures; when they did, these measures did not fully address the urgent systemic transformations necessary to enable equitable access to transport and mobility for all.

Impacts of global shocks

- Global shocks since 2020 – such as the COVID-19 pandemic and the Russian Federation's invasion of Ukraine – have put at increased risk any overall progress towards the SDGs and the Paris Agreement goals.
- The COVID-19 pandemic induced long-lasting negative impacts on urban mobility, land use and transport systems across low-, middle- and high-income countries.

Overview

To achieve the objectives of the Paris Agreement and of the 2030 Agenda on Sustainable Development – including decarbonisation by 2050 and improved accessibility, resilience and sustainability by 2030 – the transport sector must accelerate its transformation immediately. Different mechanisms under the Paris Agreement on Climate Change, the UN 2030 Agenda and the Sendai Framework for Disaster Risk Reduction provide countries with framework avenues to set their transport ambitions, targets, and actions and to learn from each other.

Under the Paris Agreement, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are required to submit Nationally Determined Contributions (NDCs), outlining their specific ambitions, targets and actions to reduce emissions and enhance adaptation and resilience.[1] In addition to NDCs, the UNFCCC provides several mechanisms under the Paris Agreement to describe intended ambitions, targets and actions on climate change mitigation and adaptation. These include: Long-Term Low Emission Development Strategies (LT-LEDS or LTS), National Adaptation Plans (NAPs), National Adaptation Programmes of Action (NAPAs) and Nationally Appropriate Mitigation Actions (NAMAs).[2]

The Paris Agreement also provides a mechanism for collaboration among Parties and non-Party stakeholders (all stakeholders that are not national governments) through the Marrakech Partnership for Global Climate Action.[3] The Marrakech Partnership elaborates Climate Action Pathways, which set out visions for various sectors – including transport – to achieve a world where global temperature rise is kept within 1.5 degrees Celsius (°C) by 2050.[4]

Countries also have the opportunity to achieve sustainable, low carbon transport through their implementation of the UN global agendas on sustainable development and adaptation and resilience – namely the 2030 Agenda for Sustainable Development and its Voluntary National Reviews (VNRs) for tracking progress towards the Sustainable Development Goals (SDGs), as well as the Sendai Framework for Disaster Risk Reduction and its Global Assessment Report.

Overall, there remains significant need to strengthen the linkages between the UNFCCC mechanisms for the Paris Agreement and the 2030 Agenda and the Sendai Framework, helping to assure that progress towards climate change mitigation and adaption yields broader positive impacts on sustainable development.

Global shocks since 2020 – such as the COVID-19 pandemic and the Russian Federation's invasion of Ukraine – have put at increased risk the overall progress towards the SDGs and the Paris Agreement goals.[5] In the words of UN Secretary-General Antonio Guterres, the war is "putting our world at immediate risk of hurtling past the 1.5-degree temperature increase limit".[6] **Already, the NDCs submitted as of 23 September 2022 are insufficient to avoid an average temperature increase of 2.5°C by the end of this century.**[7]

Global events also have had long-lasting impacts on mobility. Ridership levels on public transport and other collective urban mobility in 2021 and 2022 were still below pre-COVID-19 levels (*see Section 3.4 Shared Mobility*). Meanwhile, aviation has suffered from the rerouting of air traffic resulting from the closure of Russian skies (*see Section 3.7 Aviation*), and the Russian invasion of Ukraine has disrupted maritime shipping and raised trade costs (*see Section 3.8 Shipping*).

Since the previous two editions of this report, many countries have responded to the request to enhance their NDCs under the terms of the Paris Agreement, by submitting second-generation or updated versions. While a few submissions occurred in 2023, the available analysis to the end of 2022 provides a near-complete picture of the second generation of NDCs and the role of transport in them. Similarly, the VNRs submitted in the second reporting cycle (2020-2022) for the 2030 Agenda for Sustainable Development reveal a general consensus that transport is a key contributing factor to implementation of the SDGs, following a similar pattern to the first reporting cycle (2016-2019).

Nationally Determined Contributions in the framework of the Paris Agreement

NDCs are submitted in a five-year cycle, with the first generation submitted in 2015 and subsequent generations to be submitted every five years thereafter. The NDC process is supported by a set of "global stocktakes" to assess progress towards implementation of the Paris Agreement, with the first stocktake scheduled to occur in 2023 (and subsequent ones every five years thereafter).

Most countries (169 countries in total) submitted second-generation NDCs before the end of 2022, taking the opportunity to strengthen their overall climate ambitions.[8]

- By the end of 2022, a total of 169 countries had submitted 16 second-generation NDCs and 128 updated NDCs.[9] This was up from only 54 second-generation and updated NDCs submitted as of May 2021.[10] (The analysis includes a single NDC submitted on behalf of the European Union Member States but excludes the NDCs of Kiribati and Turkmenistan, which were submitted in 2023.)
- Between 2021 and 2022, 23 countries added enhanced economy-wide targets for greenhouse gas mitigation to their second-generation NDCs.[11]

On average, the second-generation NDCs included more transport mitigation and adaptation actions than the first generation of NDCs. Each second-generation NDC featured nearly twice as many transport mitigation actions as did first-generation NDCs.[12]

- Whereas only 66% of first-generation NDCs featured transport among their climate mitigation actions, 80% of second-generation NDCs did so.[13]
- In the **first-generation NDCs**, the most popular transport-related mitigation actions were vehicle improvements, public transport improvements, infrastructure improvements, and alternative fuels, followed by electric mobility (e-mobility).[14]
- In **second-generation NDCs**, the attention moved away from public transport actions and towards e-mobility actions, with the most popular mitigation actions being e-mobility, mode shift, demand management and low carbon fuels. The e-mobility actions featured a diversity of road transport modes, with buses and cars each representing 20% of all e-mobility actions mentioned.[15]

The second-generation NDCs featured twice as many transport targets (109 targets in total in 64 NDCs) as the first-generation ones.[16] **However, this does not translate into more impact because targets do not result in absolute reductions in transport emissions.**

- A total of **64 second-generation NDCs (45%) contained transport targets** (either transport greenhouse gas mitigation targets and/or non-greenhouse gas targets for transport that feature a quantitative target for a specific year); this was up from only 21% of first-generation NDCs with any kind of transport target in 2021.[17]
- Overall, second-generation NDCs identified **109 non-greenhouse gas transport targets** (a single NDC can include several targets).[18] The most frequent non-greenhouse gas targets were related to zero-emission vehicles (39%), followed by vehicle efficiency (25%), mode share (10%), biofuels (10%), infrastructure (9%), "Avoid" strategies (4%) and renewable energy (3%).[19]

Of the second-generation NDCs, 23 (or 16%) had a target for mitigating transport greenhouse gas emissions, mostly for countries in Europe and Africa and for the year 2030 (see Figure 1 and Table 1)**; this was up from only 13 first-generation NDCs (or 8%).**[20]

- Grenada and Japan reiterated their targets from their first-generation NDCs, while Bangladesh, Burkina Faso and Dominica revised their transport greenhouse gas mitigation targets.

Adaptation is still neglected in transport, as few second-generation NDCs feature transport adaptation targets and actions. Only six second-generation NDCs had transport adaptation targets as of the end of 2022 (see Table 2).[21] Such targets relate to climate-proof infrastructure as well as the deployment of public transport and active mobility systems towards more robust and resilient transport systems.[22]

However, the second-generation NDCs featured more transport adaptation actions than did the first-generation NDCs.

- Of the total second-generation NDCs, 63 (43%) included transport adaptation actions, compared to 22% of first-generation NDCs.[23]
- More than two-thirds (67%) of the NDCs of low-income countries featured transport adaptation measures, compared to 30% of the NDCs of high-income countries.[24]
- Transport adaptation actions in second-generation NDCs included structural and technical actions (56% of the total), institutional and regulatory actions (27%), informational and educational actions (16%) and other adaptation actions (less than 1%).[25]

TABLE 1. Transport greenhouse gas emission mitigation targets in countries' second-generation NDCs, as of end-2022

Source: See endnote 20 for this section.

Country	Targeted reductions in transport emissions (in carbon dioxide equivalents)	Type of target
Andorra	50% in road transport by 2030	Unconditional
Bangladesh	9.3% below business as usual (BAU) by 2030, to 32.9 million tonnes (unconditional) 27% below BAU by 2030, to 26.6 million tonnes (conditional)	Unconditional, Conditional
Belize	Reduce conventional transport fuel 15% by 2030, to avoid 117 kilotonnes annually Achieve 15% efficiency per passenger- and tonne-kilometre through appropriate policies and investments	Unconditional
Burkina Faso	Limit the emission increase to 1,210 gigagrams (Gg) by 2025, 3,563 Gg by 2030 and 8,265 Gg by 2050 (unconditional) Further limit to 267 Gg in 2025, 867 Gg in 2030 and 4,153 Gg in 2050 (conditional)	Unconditional, Conditional
Dominica	20% below 2014 levels by 2030; 100% below 2014 levels for shipping by 2030	Unconditional
Egypt	7% by 2030, reducing from 124,360 Gg under BAU to 8,960 Gg	Unconditional
El Salvador	Limit transport emissions to 334 kilotonnes below BAU by 2030	Unconditional
Fiji	40% below BAU for domestic maritime shipping by 2030	Unconditional
Gambia	22.2% below BAU by 2030	Conditional
Georgia	15% below BAU by 2030	Unconditional
Grenada	20% below 2010 levels by 2025, with further reductions by 2030 (continuation from first NDC)	Conditional
Guinea	2,300 kilotonnes per year below BAU by 2030 (unconditional) 2,600 kilotonnes per year below unconditional scenario by 2030 (conditional)	Unconditional, Conditional
Israel	No more than 3.3% above 2015 levels by 2030; 96% below 2015 levels by 2050	Unconditional
Japan	27% below 2013 levels by 2030, to reach 163 million tonnes or less (continuation from first NDC)	Unconditional
Liberia	15.1% below BAU by 2030	Conditional
Mauritania	5.21% by 2030, avoiding 92.7 Gg between 2021 and 2030	Unconditional
Mauritius	Limit to 129 kilotonnes per year by 2030	Unconditional
Seychelles	30% below BAU for petrol vehicles by 2030	Conditional
Samoa	5.2 Gg (land transport) and 3 Gg (maritime transport) by 2030	Unconditional
South Sudan	44% below BAU by 2030	Unconditional
Sri Lanka	4% below BAU by 2030 (1% unconditional, 3% conditional)	Unconditional, Conditional
Uganda	29% below BAU by 2030, reducing from 9.6 million tonnes under BAU to 6.8 million tonnes	Conditional
United Arab Emirates	14% below BAU by 2030 (due mainly to enhanced vehicle standards in road transport)	Unconditional

CO_2

Type of Target

- Conditional
- Unconditional

FIGURE 1. Transport targets, by type, in countries' second-generation NDCs

Source: See endnote 20 for this section.

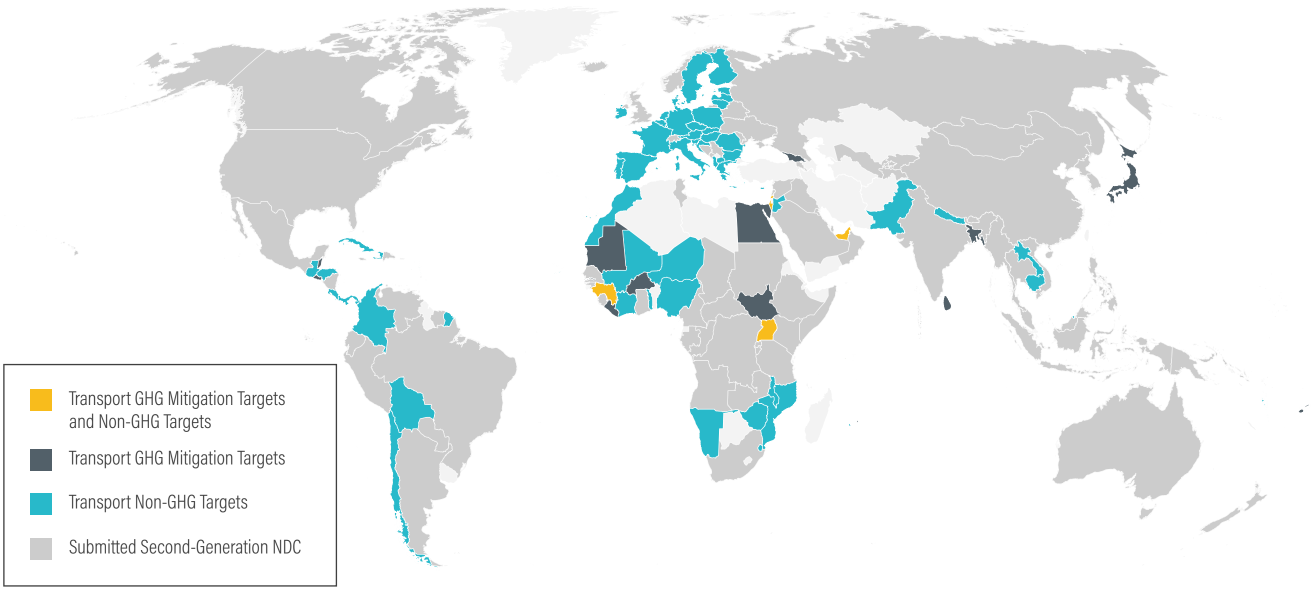


TABLE 2. Transport adaptation targets in countries' second-generation NDCs, as of end-2022

Source: See endnote 21 for this section.

Country	Transport adaptation target
Antigua and Barbuda	Ensure that all waterways are protected to reduce the risks of flooding and health impacts by 2030.
Burundi	Build 7.5 kilometres (unconditional) and 42.5 kilometres (conditional) of infrastructure exclusively for active mobility, and 3 modern ports with 6 ships to be acquired for Lake Tanganyika (conditional).
Cambodia	Develop a guidebook with design standards for climate-proof roads by 2022, establish a monitoring and evaluation framework for such roads by 2023 and ensure that road construction and repair follow these standards by 2030.
Kenya	Promote the use of appropriate designs and building materials to enhance resilience of at least 4,500 kilometres of roads.
Liberia	Implement infrastructure that fosters the development of a bus public transport network for Monrovia and that ensures that low-income groups can reach jobs, education and healthcare services through improved access to economic and social opportunities.
Papua New Guinea	Build and rehabilitate USD 1.2 billion (PGK 4.2 billion) worth of air, sea and land transport infrastructure and assets according to climate-resilient codes and standards.

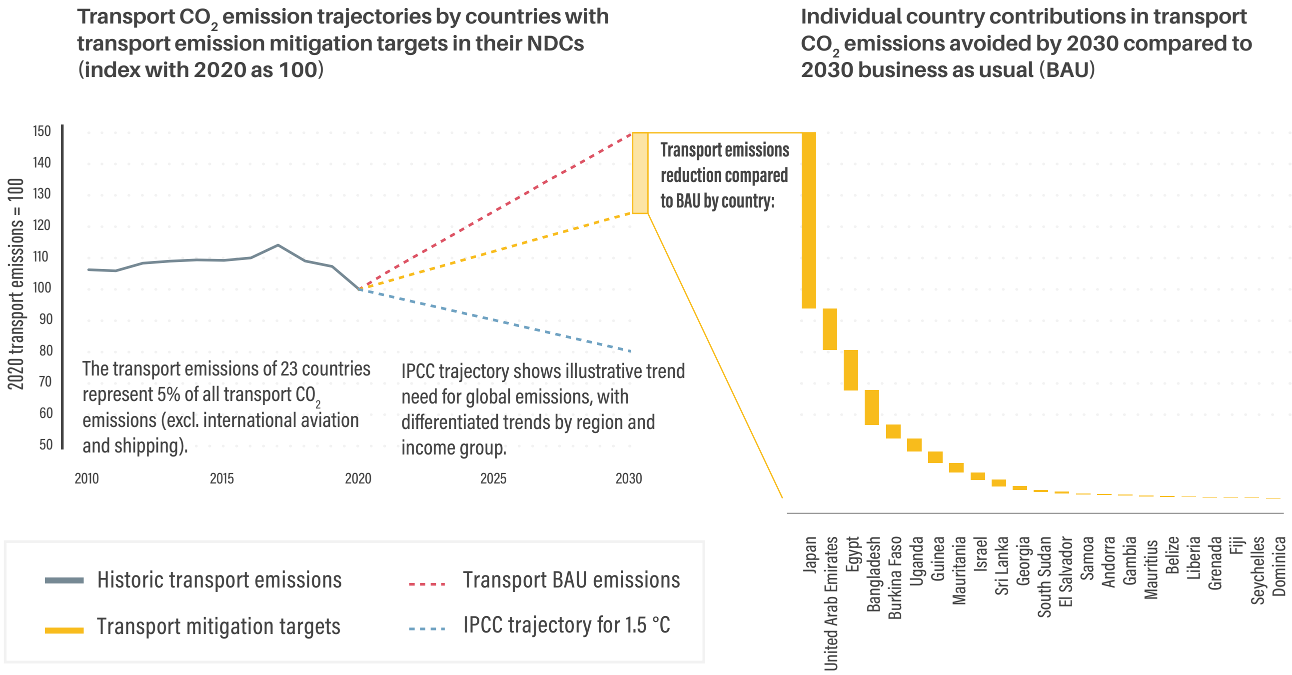
In both generations of NDCs, there were very few explicit mentions of freight-related actions. Around two-thirds of the transport mitigation actions in each generation of NDCs did not explicitly mention freight or passengers, while 25% mentioned passenger transport and only around 5% mentioned freight transport.[26]

The level of ambition on transport (i.e., targets and actions) in second-generation NDCs remains insufficient to achieve the goals of the Paris Agreement, and implies a further 11% increase in transport greenhouse gas emissions by 2030.[27] An October 2022 report found that under the current NDCs, the average global temperature would increase by 2.5 degrees Celsius (°C) (range of 2.1°C to 2.9°C).[28]

SLOCAT analysis of the transport greenhouse gas mitigation targets in the second-generation NDCs shows that while the growth in transport carbon dioxide (CO_2) emissions will slow, overall emissions will not be reduced in absolute terms, due to the shortfall in NDC ambitions. The main reason is that many transport greenhouse gas mitigation targets in the second-generation NDCs are set against a business-as-usual growth. Rather than reducing absolute transport CO_2 emissions, this just results in less growth than under business-as-usual projections (see Figure 2).[29]

FIGURE 2. Impact of transport greenhouse gas mitigation targets in NDCs

Source: See endnote 29 for this section



Long-Term Low Emission Development Strategies in the framework of the Paris Agreement

To complement the NDCs, the Paris Agreement invites (but does not require) countries to formulate and communicate Long-Term Low Emission Development Strategies (LT-LEDS or LTS), to help establish low carbon trajectories to 2050.

By the end of 2022, only a quarter of the world's countries had developed LTS.[30] **All LTS mentioned transport, although only 22% of LTS (13 countries) outlined transport targets, with nearly all having a target year of 2050.**[31] This continued the pattern from 2021, when all 29 of the LTS at the time mentioned transport.[32]

- In addition to the 58 LTS officially submitted, 19 individual European Union Member States submitted their respective LTS, resulting in a majority of LTS submissions (51%) coming from Europe.[33] Except for Australia, the Gambia, New Zealand and Nigeria, all of the LTS that had transport greenhouse gas mitigation targets were from European countries (see Table 3).[34]
- Seven countries – Canada, France, Germany, Japan, Thailand, the United Kingdom and the United States – submitted updated LTS in 2021 and 2022.[35]

Only nine LTS (Austria, Cambodia, Colombia, Fiji, Japan, Lithuania, Malta, Singapore and Tonga) discussed the topic of transport adaptation, covering 52 transport adaptation actions.[36] This was a significant contrast to the 176 adaptation actions mentioned in second-generation NDCs.[37] Among these countries, Cambodia and Colombia also feature transport adaptation in their second-generation NDCs.

TABLE 3. Transport targets in countries' LTS as of end-2022

Source: See endnote 34 for this section.

LTS	Targeted reductions in transport CO_2-equivalent emissions
Australia	53-71% below 2005 levels by 2050
Belgium	Zero emissions for passenger and freight transport by 2050
The Gambia	From 1,026 Gg in 2020 to 315 Gg in 2050
Germany	40-42% below 1990 levels by 2030 (reducing around 95-98 million tonnes)
Lithuania	At least 14% below 2005 levels by 2030; 90% by 2050
New Zealand	Net zero by 2050
Nigeria	Around 4 million tonnes annually by 2030
Portugal	43-46% below 2005 levels by 2030; 84-85% by 2040; 98% by 2050
Slovenia	90-99% below 2005 levels by 2050
Spain	30% below BAU by 2030
Sweden	70% below 2010 levels by 2030 (excluding domestic aviation)
Switzerland	Zero for domestic land transport by 2050 (with few exceptions); net zero for international aviation by 2050
United Kingdom	Net zero for domestic aviation and shipping by 2050

Initiatives and commitments at recent United Nations climate conferences

During the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), stakeholders launched an unprecedented number of commitments and initiatives on sustainable, low carbon transport, and several of these have since expanded in scope and/or signatories (see Table 4).[38] Both the aviation-related commitment and the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles have gained a substantial number of new country signatories, whereas few new countries have joined the commitments on zero-emission vehicles and green shipping corridors.

Comparing the NDCs of signatory countries to the transport commitments that they have signed onto reveals that there is a weak alignment. In particular, there is a weak alignment between NDCs and the commitments related to zero-emission vehicles and green shipping corridors. The strongest alignment exists in the case of the International Aviation Climate Ambition Coalition, as the NDCs of several of the signatory countries express their intention to engage with the International Civil Aviation Organization (ICAO) or to tackle aviation emissions (in some cases, limited only to domestic aviation emissions).[39]

At the 2022 UN Climate Change Conference in Sharm El-Sheikh, Egypt (COP 27), the COP 27 Presidency of Egypt launched an initiative on low carbon transport for urban sustainability that aims to "activate systemic change beyond the legacy 'mode-first' mindset (i.e., focus on specific transport modes)".[40] Among the 14 flagship initiatives of the COP 27 Presidency is the Low Carbon Transport for Urban Sustainability (LOTUS) initiative, which aims to activate systemic change to improve and decarbonise the urban mobility landscape, and specifically to:

- Scale up investment for electric vehicles and sustainable mobility infrastructure (led by the Institute for Transportation and Development Policy, the World Resources Institute and the Smart Freight Centre).
- Empower and invest in informal transport to decarbonise and mobilise towards achievement of SDG 11 (sustainable cities and communities), achieve climate resilience, and develop a global agenda for a just transition and transformation (led by the Global Network for Popular Transportation).
- Build capacity to develop integrated, multi-modal policy frameworks in low- and middle-income countries (led by the International Association of Public Transport (UITP), the International Union of Railways (UIC) and Walk21).[41]

TABLE 4. Overview of COP 26 commitments as of 14 December 2022

Source: See endnote 38 for this section.

COP 26 COMMITMENTS	Total signatories at COP 26 in November 2021	Total signatories as of 14 December 2022	New country signatories since COP 26 as of 14 December 2022	Other updates
Accelerating to Zero Coalition (A2Z)	178 (38 countries)	221 (40 countries)	2 (Greece and Spain)	Previously called the Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans
Breakthrough Agenda on Transport	33 countries	33 countries	0	Previously called the Breakthrough Agenda on Road Transport. The scope has since been widened to include aviation and shipping. In 2022, the focus was on implementation.
Clydebank Declaration for Green Shipping Corridors	22 countries	24 countries	2 (Palau and Singapore)	No update since April 2022.
Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles	15 countries	27 countries	12 (Belgium, Croatia, Dominican Republic, Ireland, Liechtenstein, Lithuania, Portugal, Ukraine and the United States, plus constituent countries Aruba, Curaçao and Sint Maarten)	Introduced a progress dashboard to monitor the relevant policies by signatory countries. Also received several new endorsements in 2022.
International Aviation Climate Ambition Coalition	25 countries	59 countries	34 (Albania, Austria, Belgium, Belize, Bulgaria, Chad, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Dominican Republic, Equatorial Guinea, Georgia, Greece, Guinea, Hungary, Iceland, Latvia, Lithuania, Luxembourg, Madagascar, Mexico, Monaco, Montenegro, Niger, Republic of North Macedonia, Papua New Guinea, Poland, Portugal, Romania, Rwanda, Slovak Republic, Switzerland, Ukraine)	

However, except in the first focus area related to electric vehicles and sustainable mobility infrastructure, no national governments are part of LOTUS. Additionally, during COP 27 the following transport commitments, initiatives and campaigns emerged:

- **Green Shipping Challenge:** Countries, ports and companies made more than 40 announcements under the Green Shipping Challenge, including an agreement between the Netherlands, Norway, the United Kingdom and the United States to establish green shipping corridors.[42]
- **Partnership for Active Travel and Health (PATH):** In a letter to governments signed by more than 400 civil society organisations from around the world, PATH called on national and city governments to commit to prioritising investment in walking and cycling, including through NDCs as well as concrete actions for infrastructure, campaigns, land-use planning, integration with public transport and capacity building.[43]
- **Transport Decarbonisation Alliance's Call to Support Active Mobility Capacity Building:** The Alliance called on all Parties to the UNFCCC and global financial institutions to invest USD 100 million to train 10,000 mobility professionals in the planning, design, operations, and promotion of walking and cycling, in order to build a local knowledge base and to create a pipeline of projects to ensure sustained, high-quality investment in active mobility at a global scale.[44]

Linkages between national planning processes and Paris Agreement mechanisms

Linkages between national strategies (such as transport development plans, electric vehicle plans and multi-year infrastructure plans) and Paris Agreement mechanisms have been strengthened as more climate strategies reference national strategies. As of 2021, NDCs were increasingly referencing other national strategies, and this trend continued in the NDCs and LTS submitted by countries in 2021 and 2022. Such linkages enhance policy coherence and policy synergies towards the acceleration of transport decarbonisation and broader sustainability objectives.

- The updated NDC of Mexico mentioned progress on a National Electric Mobility Strategy, with a focus on public transport, since this mode helps advance fairness, safety and other social benefits.[45]
- The LTS of Morocco referred to the Sustainable Mobility Roadmap, which is based on the Paris Process on Mobility and Climate's Global Macro Roadmap.[46]
- Vietnam's updated NDC pointed to the National Climate Change Strategy and the Transport Development Strategy, reflecting climate actions on transport closely co-ordinated with the transport ministry.[47]
- For Latin America and the Caribbean, a 2022 analysis on both climate strategies and transport policies at the national and sub-national levels found general coherence on these high-level strategies related to transport, energy and urban planning.[48]

Several countries have implemented advanced sustainable transport policies aligned to their second-generation NDCs (2020-2022). Colombia, Peru and Uruguay sent political signals from the national level to support the sub-national level in implementing sustainable mobility.[49] Many of the capitals and largest cities of the countries featured in this analysis have made efforts towards sustainable urban mobility plans (SUMPs).[50] The World Bank's Global Facility to Decarbonize Transport (GFDT) supports national commitments to the Paris Agreement and NDCs. In 2022, activities initiated under the GFDT included bus electrification in Ghana and urban transport modernisation in Lima, Peru.[51]

The number of countries working on transport decarbonisation strategies has increased since the second edition of this report in 2021, in which Costa Rica's strategy, released in 2019, was identified as a frontrunner.

- In 2021, the United Kingdom published a national transport decarbonisation plan, labelled as the "world's first greenprint to decarbonise all modes of domestic transport by 2050".[52]
- Ireland released a Climate Action Plan in 2022 with specific transport goals for 2030: reduce CO_2 emissions 50% below 2018 levels; decrease the share of cars from 72% in 2018 to 53%; increase fuel prices 65%; improve public transport and reduce prices 50%; and have all new car sales be electric.[53]

At the sub-national level, several jurisdictions released transport decarbonisation plans:

- Auckland (New Zealand) adopted the Transport Emissions Reduction Pathway aimed at reducing transport emissions 64% by 2030.[54]
- In early 2023, Freetown (Sierra Leone) launched a Climate Action Plan, including goals to encourage public transport while maintaining low shares of private transport, to pro-actively address historical land-use planning challenges to support efficient, low carbon transport and transit-oriented development, and to promote behaviour change in support of public transport, cycling and walking.[55]
- Mumbai is India's first city with a Climate Action Plan, released in 2022, and the first member of C40 Cities in South and West Asia with such a plan.[56] As one of the six key action areas, sustainable mobility aims to improve the availability and accessibility of public transport, provide inclusive planning for walking and cycling, and induce a shift from private to public transport.[57]
- In 2020, Vancouver (Canada) released its Climate Emergency Action Plan 2020-2025, with goals for 2030 that include conducting 66% of all trips by public transport, walking and cycling; and using zero-emission vehicles for 50% of all kilometres driven.[58]

Voluntary National Reviews in the framework of the 2030 Agenda for Sustainable Development

A just transition to equitable, healthy, green, and resilient transport and mobility systems is central to socio-economic prosperity for people and the planet. To achieve such systems, key transformations in land transport – linked to wider socio-economic transformations – are needed.[59]

The UN 2030 Agenda on Sustainable Development is a cross-cutting, interconnected agenda, wherein the achievement of one of the 17 Sustainable Development Goals (SDGs) is often dependent on the achievement of others. Although sustainable, low carbon mobility is not represented by a stand-alone SDG, its successful implementation supports the achievement of almost every SDG. The SLOCAT Wheel on Transport and the SDGs (*see Section 1.1*) shows the extent of positive interactions to define equitable, healthy, green, and resilient transport and mobility systems. SDG 13 (climate action) provides a direct linkage between the actions to support the 2030 Agenda and the Paris Agreement.

The 2030 Agenda encourages UN Member States to submit Voluntary National Reviews (VNRs) to the annual UN High-Level Political Forum on Sustainable Development. The VNR process facilitates sharing of successes and challenges, with a view towards accelerating the implementation of the 2030 Agenda. Since the first High-Level Political Forum in 2016, countries have reported on transport as a vital sector to implement the SDGs, showcasing on-the-ground implementation and best practices. SLOCAT has conducted detailed annual analyses of the VNRs.

The development, implementation and reporting of NDCs and VNRs can be leveraged through concerted and co-ordinated efforts to scale up sustainable transport **(see Box 1)**.[60]

The VNRs from 2016 to 2022 revealed consensus on the role of transport as a key contributor to implementation of the SDGs.[61] In the first VNR reporting cycle (2016-2019), 92% of VNRs (144 of 156 VNRs) highlighted progress in the transport sector, and 18% of VNRs reported specific targets covering 12 areas in sustainable transport.[62] The majority of targets were short- to medium-term targets (for 2020 and 2030), with only five countries setting long-term targets for 2050.[63] The transport dimension of the VNRs reported between 2020 and 2022 revealed consensus around transport as a key contributor to implementation of the SDGs, largely following a pattern similar to the first reporting cycle (2016-2019).

All 40 VNRs submitted in 2021 included references to sustainable transport policies and, for the first time since the inaugural High-Level Political Forum in 2016, they also included transport measures.

In 2022, the number of VNRs mentioning transport decreased to 36 out of the 42 submitted VNRs, or 86%, the lowest share since 2017.[64] Yet more VNRs reported specific transport targets and included explicit references to the four themes on transport and sustainability of the SLOCAT Wheel on Transport and the SDGs: equitable, healthy, green and resilient.[65]

Possible factors that may have contributed to the decrease in transport mentions in 2022 include:

- Lack of reporting in a number of VNRs on the SDGs that have the most transport relevance (e.g., SDG 3 on good health and well-being, SDG 9 on industry, innovation and infrastructure, and SDG 11 on sustainable cities and communities) because these were not a focus of the High-Level Political Forum of 2022.
- A possible and persisting gap in incorporating green and equitable recovery strategies for transport systems in COVID-19 pandemic response packages.
- Severely limited data collection for transport infrastructure and services development due to the pandemic, especially in developing countries.
- Pandemic-related budgetary cuts in national strategies and programmes for the transport sector.

BOX 1. Synergies among Nationally Determined Contributions and Voluntary National Reviews

Creating a common methodological framework between the Paris Agreement and the implementation and monitoring mechanisms for the 2030 Agenda for Sustainable Development can maximise the combined potential of both global frameworks for accelerating sustainable, low carbon transport.

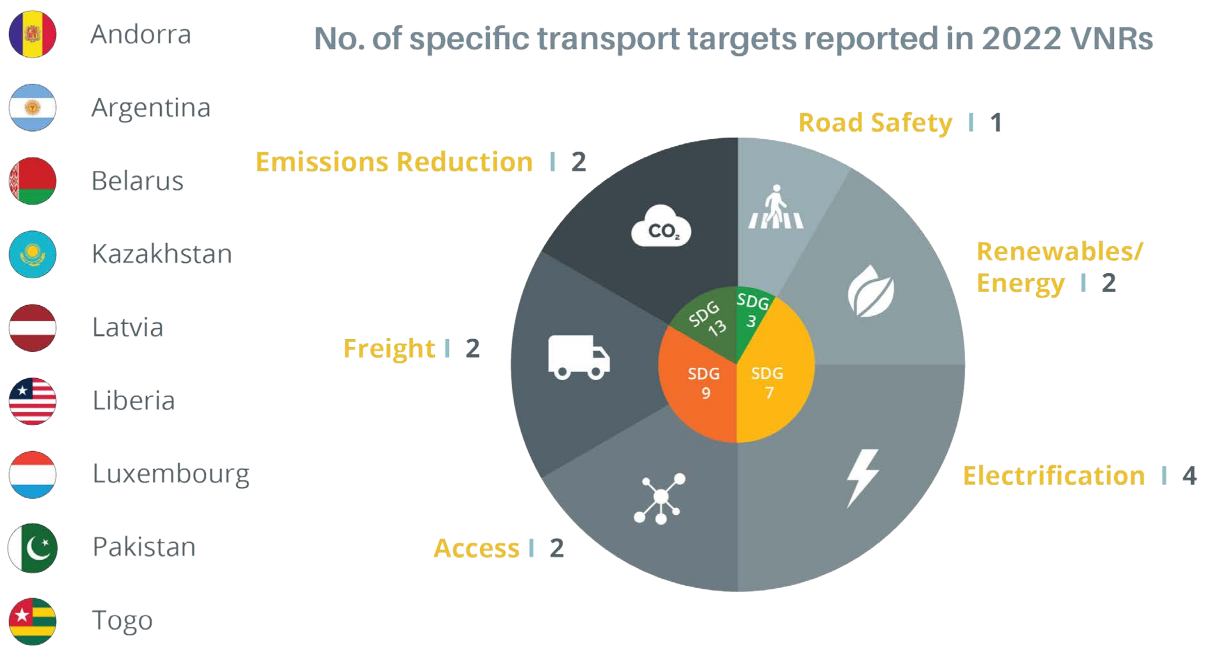
A successful implementation of sustainable transport measures in the context of the Paris Agreement and the 2030 Agenda must involve concerted and co-ordinated efforts to more closely link the processes of developing, implementing and tracking progress towards both Nationally Determined Contributions and Voluntary National Reviews. Such alignment is required both in the governance of the processes themselves and in the co-ordination among the national and sub-national actors that are formulating and putting them into practice.

In response to this identified need, in 2020 the Islamic Development Bank and the SLOCAT Secretariat proposed guidance to support the implementation of NDCs and SDGs for the transport sector at the national level. The guidance presents a set of eight components for mainstreaming the 2030 Agenda and the Paris Agreement objectives within the transport sector, to support convergence between climate action and sustainable development.

Source: See endnote 60 for this section.

FIGURE 3. Number of specific transport targets mentioned in 2022 Voluntary National Reviews

Source: See endnote 66 for this section.



In 2022, 21% of the VNRs (9 out of 42 VNRs) mentioned specific transport targets, up from 20% (9 out of 40) in 2021 and 17% (8 out of 47) in 2020 (see Figure 3).[66] Targets were focused on, among others, electrification, freight, road safety and renewable energy (see Table 5).[67]

In the 2022 VNRs, the majority of the mentions focused on developing transport infrastructure in the context of passenger and freight activities (SDG 9 on industry, innovation (SDG 9 on industry, innovation and infrastructure), all-season rural roads (SDG 9) and public transport systems (SDG 11 on sustainable cities and communities). Significant attention was also given to reducing traffic fatalities and injuries (SDG 3 on good health and well-being) and increasing renewable energy; reducing final energy consumption in the transport sector (SDG 7 on affordable and clean energy) and curbing mobile-source greenhouse gas emissions (SDG 13 on climate action).[68] Compared to previous years, there was a slight increase in mentions of gender-sensitive transport policies (SDG 5), possibly because SDG 5 was a focus of the 2022 High-Level Political Forum. Relatively fewer of the VNRs mentioned measures to phase out fossil fuel subsidies (SDG 12) and curb mobile-source greenhouse gas emissions (SDG 13), despite 40% of the VNRs spelling out connections with SDG 13.[69]

The 2022 VNRs gave ample attention to urban transport measures, based on the transport-relevant indicator 11.2.1 (public transport), although there were very few references to rural access (indicator 9.1.1). Whereas in the 2020 VNRs, both urban and rural transport received similar levels of attention, this gap widened in the 2022 VNRs.[70]

A number of the 2022 VNRs (such as Andorra, Greece, Japan, Jordan, Kazakhstan, Luxembourg, Pakistan and the Philippines) highlighted sustainable transport actions in the context of pandemic recovery efforts and the need to urgently transition to renewables from fossil fuels. However, **most of the 2022 VNRs described only the adverse impacts of global issues, without presenting concrete policy measures; when they did, the measures did not fully address the urgent systemic transformations necessary to enable equitable access to transport and mobility for all.**[71]

Impacts of global shocks

Global shocks since 2020 – such as the COVID-19 pandemic and the Russian Federation's invasion of Ukraine – have put at increased risk any overall progress towards the SDGs and the Paris Agreement goals.[72] In 2022, the UN released briefs on the global impact of the Russian invasion on food, energy, and finance systems, including the ongoing cost-of-living crisis expanding worldwide.[73]

Research revealed that the invasion affected the biodiversity-focused SDGs (SDG 6 on clean water and sanitation, SDG 13 on climate action, SDG 14 on life below water and SDG 15 on life on

TABLE 5. Specific transport targets reported in 2022 Voluntary National Reviews

Source: See endnote 67 for this section.

Countries	Focus	Targets
Andorra	Electrification	Increase the electric vehicle share to 20% by 2030 and become one of the top five European countries in the share of electric vehicle sales
Argentina	Freight	Increase the share of freight transported by rail to 9% by 2025 and 11% by 2030
	Road safety	Reduce the rate of road fatalities per 100,000 inhabitants to 8.2% by 2030
Belarus	Access	Have 100% of the rural population living within two kilometres of a year-round road by 2021 (already met)
Kazakhstan	Access	Upgrade 100% of national roads to normal conditions and improve up to 95% of local roads by 2025
	Renewables/Energy	Switch all urban passenger transport to environmentally friendly fuels by 2030
Latvia	Renewables/Energy	Increase the share of renewable energy systems in the transport sector to 7% by 2030
Liberia	CO_2 emissions	Reduce transport CO_2 emissions 15% by 2030
Luxembourg	Electrification	Increase the share of electric and plug-in hybrid cars to 49% by 2030
	CO_2 emissions	Reduce transport CO_2 emissions 57% by 2030
Pakistan	Electrification	Achieve a 30% shift to electric vehicles by 2030
Togo	Electrification	Increase the share of electric vehicles in newly sold vehicles to 3% by 2025

Focus

- Electrification
- Freight
- Road safety
- Access
- Renewables/Energy
- CO_2 emissions

land); society-focused SDGs (SDG 1 on no poverty, SDG 2 on zero hunger, SDG 3 on good health and wellbeing, SDG 4 on quality education, SDG 5 on gender equality, SDG 7 on affordable and clean energy, SDG 11 on sustainable cities and communities, and SDG 16 on peace, justice and strong institutions) at the local and global level, as well as the economic SDGs (SDG 8 on decent work and economic growth, SDG 9 on industry, innovation and infrastructure, SDG 10 on reduced inequalities and SDG 12 on responsible consumption and production).[74] To overcome the multiple global shocks, the UN Secretary-General has proposed the SDG Stimulus, which calls for tackling the high cost of debt and the rising risks of debt distress, massively scaling up affordable long-term financing for development, and expanding contingency financing to countries in need.[75]

The COVID-19 pandemic induced long-lasting negative impacts on urban mobility, land use and transport systems across low-, middle- and high-income countries.[76] The Sustainable Development Solutions Network analysed progress towards the SDGs and concluded that the pandemic, coupled with geopolitical conflicts, has led to significant setbacks in SDG 2 (zero hunger) and SDG 7 (affordable and clean energy). The report found a slight decrease in national performance on SDG 1 (no poverty) and SDG 8 (decent work and economic growth). Particularly poor was the national performance on SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land).

MODULE 1 SPOTLIGHT 3

AUTHORS: Maruxa Cardama and Alice Yiu, *SLOCAT secretariat*

Engagement of Transport Stakeholders in the United Nations Framework Convention on Climate Change Process

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

The engagement of transport stakeholders in the United Nations Framework Convention on Climate Change (UNFCCC) process refers to several different but interconnected aspects: the intergovernmental negotiations on climate change; the national strategies elaborated by countries to contribute to the implementation of the Paris Agreement, the so-called Nationally Determined Contributions (NDCs) and the international multi-stakeholder initiatives that stem from annual UN Climate Change Conferences (Conferences of the Parties, or COPs).

Over the past 30 years, intergovernmental processes on climate have helped put a focus on shifting economic systems away from 200 years of dependence on fossil fuels. The transport sector is central to such a paradigm shift. Despite the recent rapid increases in electric vehicles and renewable power globally, as well as steady increases in biofuels, fossil fuels have continued to supply nearly all of the energy demand in transport (96% in 2021).[1] This share has barely changed over the past decade, due mainly to increasing overall energy demand in the sector (see *Section 4.1 Transport Energy Sources*).[2]

Many criticisms have been raised about the intergovernmental processes on climate change and their weaknesses. These include concerns about their painstakingly slow pace, insufficient political ambition, and lack of legally binding accountability, with many critics suggesting that the negotiations are simply "greenwashing talk shows" or a "polluting world tour of a climate circus." Despite such (often legitimate) concerns, these intergovernmental processes have also helped catalyse new ways of thinking over the years that have resulted in positive impacts for people and the planet.

When the UNFCCC was signed in 1992, it triggered a wave of national legislation and policies across nearly all countries. In 1997, the Kyoto Protocol brought into the equation carbon markets and the crucial role of private sector investment. The Paris Agreement, agreed to at the 2015 UN Climate Change Conference in Paris (COP 21) drew attention to the social interventions needed to secure workers' rights and livelihoods as economies shift to paradigms of sustainability and climate action. This so-called just transition is central to the transformation of the transport sector.

At COP 21, negotiators also agreed that mobilising stronger and more ambitious climate action by all Parties, as well as by all other public and private actors, is urgently required to achieve the goals of the Paris Agreement. To that end, the 2016 UN Climate Change Conference in Marrakesh, Morocco (COP 22) gave birth to the Marrakech Partnership for Global Climate Action, which brings together stakeholders working in key sectors and themes. Transport was recognised among the key sectors to spur enhanced climate ambition and action. The SLOCAT Partnership on Sustainable, Low Carbon Transport was officially appointed as the focal point for the engagement of the transport sector and has been reappointed since. In 2021, for the first time in the history of the UN climate negotiations, a specific call was made at COP 26 for countries to reduce the use of fossil fuels.

Over the past 30 years, intergovernmental climate processes have moved the needle in numerous ways, including having a critical impact on long-term global warming. Projections of the expected average global temperature rise over the long term have been lowered from warming of as much as 4 to 6 degrees Celsius (°C) before the finalisation of the Paris Agreement, to warming of around 1.8 to 2.7 °C now, assuming that countries will implement the pledges made at the COPs.[3] Countries must not become complacent, however, as any projected warming above 1.5°C is still likely to be disastrous for people and the planet, and the need for greater action remains unquestionable and urgent.

Over the years, the transport dimension of UNFCCC processes has grown in intensity and impact, thanks to the increasing mobilisation and engagement of the global transport community in these processes (see Table 1).

TABLE 1. Key milestones of transport stakeholders' engagement in UNFCCC processes

Year	Milestone
1992	The UN Framework Convention on Climate Change (UNFCCC) was agreed on to serve as the fundamental platform for the negotiation and adoption of a series of protocols, modifications and agreements related to the Convention's mandate. It triggered a wave of national legislation and policies across countries.
1997	The Kyoto Protocol brought into the equation carbon markets and the crucial role of private sector investment. It shed light on a global, future issue (unusual at that time), resulting in growing demand and opportunities for research and initiatives for sectoral issues.
2013	The first SLOCAT Transport Day was organised in Warsaw, Poland at the fringe of COP 19. Under the theme, "Rethink Transport and Climate Change", the event brought together more than 200 stakeholders from the transport community and adopted the Warsaw Statement on Low Carbon Transport and Sustainable Development, which was endorsed by 450 individuals and 145 organisations.
2015	The Paris Agreement, agreed to at COP 21, drew attention to the social interventions needed to secure workers' rights and livelihoods as economies shift to paradigms of sustainability and climate action. This so-called just transition is central to the transformation of the transport sector. At COP 21, negotiators called for mobilising stronger and more ambitious climate action by all Parties to the Paris Agreement, as well as by all other public and private actors. The first UN Climate Change High-Level Champions were appointed to facilitate voluntary efforts, initiatives and coalitions. Inspired by the call to action by UN Secretary General Ban Ki-moon at the 2014 Climate Summit, and followed up by the Lima Paris Action Agenda, 15 transport initiatives established by non-state actors in the transport sector were showcased at COP 21. The SLOCAT Partnership, on behalf of the Paris Process on Mobility and Climate, released progress reports on these transport initiatives in 2016, 2017 and 2018. The Paris Process for Mobility and Climate (PPMC) was created to bring together the diverse ecosystems of SLOCAT and Movin'On (formerly Michelin Challenge Bibendum) – a mix of public and private sector entities – and to support their engagement at COPs.
2016	The Lima Paris Action Agenda – later renamed the Marrakech Partnership for Global Climate Action (MPGCA) was agreed to at COP 22, recognising transport as one of the thematic areas. SLOCAT was officially appointed as the focal point for the facilitation of the transport sector's engagement. The PPMC Global Macro Roadmap, an actionable vision for decarbonised, resilient mobility by 2050 and beyond, was produced and showcased at COP 22 as a UNFCCC-endorsed "discussion document" in the context of the MPGCA, with active support from the UN Climate Change High-Level Champions.
2018	At total of 38 countries from five continents and 1,200 companies and international organisations, representing more than 1,500 cities and regions and including SLOCAT, joined the Driving Change Together: Katowice Partnership for Electromobility convened by the Polish Presidency of COP 24. SLOCAT continued actively engaging the global transport community through SLOCAT Transport Day at COP and the co-organisation of other multistakeholder discussions, including related to the new Regional Climate Weeks.
2019	The Marrakesh Partnership (MPGCA) launched the first Global Climate Action Yearbook and the thematic Climate Action Pathways. The Transport Climate Action Pathway reflected on existing climate action initiatives and activities and recognised the progress made by non-party stakeholders. It presented a vision of a climate-resilient world compatible with the Paris Agreement goal of keeping global warming below 1.5°C and laid out concrete actions for policy making, financing, technology, businesses and civil society by 2020, 2030 and 2050. SLOCAT was invited by the Chilean Ministry of Transport and Telecommunications to join the Transport Core Group in support of the Chilean Presidency of COP 25. The Chilean Presidency of COP 25 planned the first-ever transport ministerial meeting at a COP, as part of its vision to direct climate change conversations to specific economic sectors. Plans did not materialise due to the movement of the COP from Chile to Madrid. However, the approach of thematic ministerial meetings at COPs was part of the Chilean Presidency's legacy, and the transport focus was resumed in 2021.

2020

COP 26 was postponed due to the COVID-19 pandemic. Scheduled to mark one year before the postponed date, En Route to COP26 was co-created and co-organised by SLOCAT and partners to empower action for zero-emission transport. The online event featured 11 sessions with a line-up of 150 speakers, attracting more than 1,000 registrations from audiences across the globe.

SLOCAT's mandate as the focal point for facilitating engagement of the transport sector in the MPGCA was renewed by direct appointment by transport sector peers, under a process conducted by the UNFCCC Secretariat.

The UN High-Level Climate Champions launched a series of thematic Race to Zero Dialogues to reflect the commitment and ambition of non-state actors to the climate process and to provide critical input to the 2020 UNFCCC Climate Dialogues in a year without a COP. The Transport Race to Zero Dialogue showcased how the MPGCA Transport Climate Action Pathway can be implemented in different regional contexts.

In its capacity as MPGCA focal point, SLOCAT facilitated a Transport Stakeholders' Task Force, which provided thought leadership on the enhancement of the MPGCA Transport Climate Action Pathway.

2021

In the Glasgow Pact agreed to at COP 26, Parties coalesced on a historic call to "phase down unabated coal power and phase out inefficient fossil fuel subsidies".

An unprecedented number of commitments and initiatives on sustainable, low carbon transport were launched at COP 26, reflecting the increasing attention to transport at COPs over the years. These included:

- the Breakthrough Agenda: Road Transport, an unprecedented international clean technology plan to help keep the 1.5°C goal in reach, with the aim of establishing zero emission vehicles as the new normal and accessible, affordable and sustainable vehicles in all regions by 2030;
- the International Aviation Climate Ambition Coalition, established by the UK Presidency of COP 26 to support ambitious action on international aviation emissions, including a new global goal and promotion of cleaner fuels and technologies;
- the Clydebank Declaration for Green Shipping Corridors, established by the UK Presidency of COP 26 to put the maritime sector on track to achieve net zero emissions by 2050;
- the Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans, established by the UK Presidency of COP 26 to work towards all sales of new cars and vans being zero emission globally by 2040, and by no later than 2035 in leading markets;
- the COP26 Cycling Letter, issued by the European Cyclists' Federation, a global coalition of more 60 pro-cycling organisations, to boost cycling levels to reduce carbon emissions and reach global climate goals quickly and effectively;
- the Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles, established by CALSTART's Global Commercial Vehicle Drive to Zero program and campaign, to work towards three goals: 1) enabling 100% zero-emission new truck and bus sales by 2040; 2) achieving 30% zero-emission vehicle sales by 2030; and 3) achieving net zero carbon emissions by 2050;
- the Call to Action: Charge Forward to Zero Emissions Transportation by the Transport Decarbonisation Alliance, which aims to accelerate electric vehicle charging infrastructure;
- the Zero Emission Bus Rapid-deployment Accelerator (ZEBRA) Partnership, established by C40 and the International Council on Clean Transportation to accelerate the deployment of zero-emission buses in major Latin American cities; and
- the Beyond Oil and Gas Alliance (BOGA) Declaration, established by Denmark and Costa Rica to promote the phase-out of oil and gas production in international climate dialogues and create an international community of practice.

The UK Presidency of COP 26 established the Zero Emission Vehicles Transition Council as the world's first political forum to discuss how to accelerate the global transition to zero-emission vehicles. The forum consisted of ministers and government representatives from the world's largest and most progressive auto markets, collectively accounting for more than half of all new car sales globally.

The SLOCAT Secretariat was invited by the UK Presidency of COP 26 to facilitate the Knowledge Sharing and Signposting Working Group under the Zero-Emission Vehicles International Assistance Taskforce of the ZEV Transition Council.

The Just Energy Transition Partnerships were launched as a new mechanism to help emerging economies accelerate the shift from fossil fuels to clean energy sources, including a USD 700 million agreement to support the development of climate-conscious transport infrastructure in five Indonesian provinces.

(For more information, see the SLOCAT COP26 Outcomes for Sustainable, Low Carbon Transport, which provides an analysis of COP 26 outcomes from a transport and mobility lens. Events that SLOCAT helped organise at COP 26 can be found on this Trello board.)

2022

The COP 27 Sharm el-Sheikh Implementation Plan made unprecedented reference to loss and damage and called for broad financial system reform. However, it failed to strengthen ambition toward the 1.5°C goal and fossil fuel phase-out, which are central to transport decarbonisation.

The First Global Stocktake was convened to assess the world's collective progress in achieving the Paris Agreement. Two meetings of the Technical Dialogue were conducted at the Bonn Climate Change Conference in June and at COP 27 in November, with the final meeting taking place in June 2023 (see SLOCAT engagement and submissions to the First Global Stocktake).

The Independent Global Stocktake (iGST) was established as a coalition of civil society analysts and advocates providing technical capacity and expertise to help the UNFCCC create a more robust global stocktake. At COP 27, the iGST joined forces with the Climate Action Network (CAN) to co-ordinate the informal global stocktake process on behalf of civil society actors.

On 17 November, the Egyptian Presidency of COP 27 convened the first-ever Ministerial Meeting on Urbanisation and Climate Change, focusing on housing, urban development and multi-level action in relation to climate change.

Several new international multi-stakeholder initiatives on transport were launched at COP 27, including:

- The COP27 Presidency flagship initiative Low Carbon Transport for Urban Sustainability (LOTUS), which aims to activate systemic change to improve and decarbonise the urban mobility landscape, responding to the urgent need and willingness to move away from the legacy "mode-first" mindset. LOTUS was developed in a collaborative multi-stakeholder consultation process under the leadership of Egypt, jointly facilitated by the SLOCAT Secretariat and Boston Consulting Group.
- The PATH (Partnership for Active Travel and Health) Letter to Governments and Cities was issued, calling for greater investment in walking and cycling to achieve climate goals and improve people's lives.
- The Transport Decarbonisation Alliance's Call to Support Active Mobility Capacity Building calls on all UNFCCC Parties and global financial institutions to invest $100 million in the training of 10,000 mobility professionals in the planning, design, operations, and promotion of walking and cycling.
- The COP27 Global Commitment to Strengthening International Assistance for Emerging Markets and Developing Economies in the Road Transport Sector was endorsed by Germany, Japan, the Netherlands, the Republic of Korea, Sweden, the United Kingdom and the United States.
- Developments related to the commitments and initiatives launched at COP 26 in 2021 included:
- The Global Memorandum of Understanding on Zero Emission Medium- and Heavy-Duty Vehicles (MHDV), signed by 12 additional countries to reach 27 signatories.
- The Accelerating to Zero Coalition (A2Z), originally launched at COP 26 as the Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans, reached more than 220 signatories, including 40 country signatories.

The SLOCAT Transport Day at COP27 was focused on enabling meaningful investment across walking, cycling and public transport towards a transformative systemic shift in mobility. The event attracted nearly 100 in-person and online participants and a line-up of world-class experts to curate a multi-stakeholder trust space for peers in the transport community and beyond to exchange, learn from each other and collaborate.

(For more information, see the SLOCAT COP27 Outcomes for Sustainable, Low Carbon Transport, which provides an analysis of COP 27 outcomes from a transport and mobility lens. Events that SLOCAT helped organise at COP27 can be found on this Trello board.)

Transport ambition in national climate strategies in the framework of the Paris Agreement

Positive opportunities have emerged in the ways that countries address transport in their so-called Nationally Determined Contributions (NDCs), or the national strategies that they develop to contribute to global emission reductions and the implementation of the Paris Agreement.

Of the second-generation NDCs submitted as of 2022, 23 (or 16%) had a target for mitigating greenhouse gas emissions from transport, mostly for countries in Europe and Africa and for the year 2030 (see Figure 1).[4] On average, the second-generation NDCs included more transport mitigation and adaptation actions than the first generation of NDCs. Each second-generation NDC featured nearly twice as many transport mitigation actions, as well as twice as many transport targets (109 targets total in 64 NDCs), compared to the first-generation NDCs.[5] Adaptation in transport is still neglected, as few second-generation NDCs feature adaptation targets and actions. In both generations of NDCs, freight-related actions are barely mentioned (see *Section 1.3.1. Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs*).

SLOCAT analysis of the transport greenhouse gas mitigation targets in the second-generation NDCs shows that while the growth in transport carbon dioxide (CO_2) emissions will slow, overall emissions will not be reduced in absolute terms, due to the shortfall in NDC ambitions.[6] The main reason is that many transport greenhouse gas mitigation targets in the second-generation NDCs are set against business-as-usual growth. Rather than reducing absolute transport CO_2 emissions, this just results in less growth than under business-as-usual projections (see Figure 2).[7]

Global Stocktake

The global stocktake was established as a central element of the Paris Agreement and is intended to take a "temperature check" of progress on a five-year cycle. It is a key element of the ratchet mechanism, which is intended to incrementally raise ambition on mitigation, adaptation and means of implementation to meet Paris Agreement targets. The first global stocktake operates on a two-year cycle, consisting of an 18-month technical phase that kicked off in 2022, to be followed by a political phase in 2023.

The **First Technical Dialogue** (TD 1.1) of the First Global Stocktake took place at the Bonn Climate Change Conference (SB56) in June 2022. SLOCAT delivered transport-focused technical interventions at the TD 1.1 Roundtable 3, focusing on broadening shared electric mobility, expanding capacity building and phasing out fossil fuel subsidies to fill the financing gap.

The **Second Technical Dialogue** (TD 1.2) took place at COP 27 in November 2022, with transport issues being addressed in the "systems transformations" segment. The policy of inclusion of non-party stakeholders in these dialogues also allowed for the participation of fossil fuel lobbyists, which resulted in amplified calls to include strategies such as carbon capture and storage in outcome documents. These strategies are seen by many experts as a "false solution" to meeting Paris Agreement targets.

The **Third Technical Dialogue** (TD 1.3) took place at the Bonn Climate Change Conference (SB58) in June 2023 and allowed stakeholders to provide vital inputs to improve understanding of global efforts and priority actions towards sustainable, low carbon transport. Equity between recent and historic emissions continued to be a source of division among Parties during the discussions. Several Parties focused on technology and carbon capture and storage as a means to delay a fossil fuel phase-down/phase-out. A proposal was made for a Technical Annex to the global stocktake outcome to include regional and sectoral guidance towards more actionable outcomes. Although the proposal faced opposition from some Parties, SLOCAT advocates for such an Annex as it can enhance the substantive outcomes of the process and it supports more ambitious NDCs in 2025.

SLOCAT submissions to the First Global Stocktake:
Input to TD 1.1 | Interventions at Technical Dialogue 1.1 | Input to TD 1.3 | National Urban Mobility Policies and Investment Programmes in support of Climate Commitments in Latin America and the Caribbean I Voces de América Latina y el Caribe sobre Acción Climática en el Transporte

With the process of the official global stocktake still taking shape and its impact yet to be determined, a complementary avenue to take stock has been established in the **Independent Global Stocktake (iGST)**. Established in 2020 and endorsed by former UNFCCC Executive Secretary Christina Figueres, the iGST consists of a coalition of civil society analysts and advocates aiming to provide technical capacity and expertise to help the UNFCCC create a more robust global stocktake that empowers countries to accelerate climate action.

The next Global Stocktake Synthesis Report is expected to be released in September 2023, with a workshop in October 2023 to frame the transition from the technical to the political phase of the dialogue. The United Arab Emirates Presidency of COP 28 has identified the global stocktake as a key priority. As countries continue to prepare for the next round of NDC submissions in 2025, the global stocktake will contribute to keep the Paris Agreement target alive.

Mitigation Work Programme

Parties established the **Mitigation Work Programme** (**MWP**) at COP 26 to "urgently scale up mitigation ambition and implementation" to help reach the Paris Agreement's 1.5°C goal. At COP 27, Parties further fleshed out the MWP, to be operationalised between 2023-2026 through at least two annual global dialogues and investment-focused events.[8] SLOCAT participated in the First MWP Global Dialogue at SB56 in June 2023 and submitted input on the critical challenges and opportunities in the transport sector, through the lens of a just energy transition.

Multi-stakeholder initiatives

The discussions and partnering spaces that occur outside the formal intergovernmental negotiations of a COP are setting agendas and sending market signals in clearer and faster ways than the formal negotiations. This is where the initiatives spearheaded by COP presidencies, countries, international organisations and non-governmental organisations around coalitions of the willing fit.

Over the years, there has been a substantial increase in the number and size of international multi-stakeholder initiatives stemming from or being launched on the occasion of the UN annual COPs. These initiatives recognise that transport is not only about negative climate impacts but also about access to socio-economic opportunities.

A panoply of multi-stakeholder transport initiatives began to emerge at **COP 21 in 2015.** Inspired by the call to action by UN Secretary General Ban Ki-moon at the 2014 Climate Summit and followed up by the Lima Paris Action Agenda (LPAA), 15 transport initiatives established by non-state actors in the transport sector were showcased at COP 21.[i] At COP 22, the action agenda was renamed the Marrakech Partnership for Global Climate Action (MPGCA), and 11 more transport initiatives joined the initial core group of transport initiatives to engage in the UNFCCC via the MPGCA, covering both passenger and freight transport and touching on all transport sectors and modes. Together, these transport initiatives represented a broad range of multi-stakeholder coalitions for transport mitigation and adaptation; demonstrated on-the-ground transport actions that yield significant climate and sustainability impacts; and helped to scale up the ambition of NDCs in the sector.

> SLOCAT, on behalf of the Paris Process on Mobility and Climate, released progress reports on these transport initiatives in 2016, 2017 and 2018. An overview of the transport initiatives was included in the official Transport Climate Action Pathway released by the MPGCA in 2019.

In **2018,** the Polish Presidency of **COP 24** launched the Driving Change Together: Katowice Partnership for Electromobility, a dedicated framework for encouraging technological and organisational changes in the sector to further develop zero-emission transport.[9] By the end of 2018, 38 countries from five continents and 1,200 companies and international organisations, representing more than 1,500 cities and regions, joined the partnership.[10]

At **COP 26 in 2021**, stakeholders launched an unprecedented number of commitments and initiatives on sustainable, low carbon transport, several of which have since expanded in scope and/or signatories (see *Section 1.3.1. Transport in National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and SDGs*). Both the International Aviation Climate Ambition Coalition and the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles have gained a substantial number of new country signatories, whereas few new countries have joined the commitments on zero-emission vehicles and green shipping corridors.

Nonetheless, the commitments and initiatives launched at COP 26 presented a notable lack of emphasis on the central role of public transport and walking and cycling (the main mobility modes for billions of people worldwide) in decarbonising transport and building more equitable

i SLOCAT, on behalf of the Paris Process on Mobility and Climate, released progress reports on the transport initiatives in 2018, 2017 and 2016.

societies. Remarks recognising the need to support holistic approaches to transport systems, including active travel, public transport, and shared mobility, were added at the last minute to the Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans, which was led by the UK Presidency of COP 26.

At **COP 27 in 2023**, multi-stakeholder initiatives featured an unprecedented emphasis on the central role of public transport, walking and cycling in decarbonising transport and building more equitable societies:

- As part of its 14 flagship initiatives, the Egyptian Presidency of COP 27 launched the Low Carbon Transport for Urban Sustainability (LOTUS) initiative, which aims to activate systemic change to improve and decarbonise the urban mobility landscape. Responding to the urgent need and willingness to move away from the legacy "mode-first" mindset, this approach seeks to allow existing efforts to be scaled and replicated across modes and geographies.
- The Partnership for Active Travel and Health (PATH) appealed to national and city governments to commit to prioritising investment in walking and cycling. PATH's campaign at COP 27 led to the letter to governments being signed by more than 400 civil society organisations from around the world.
- The Transport Decarbonization Alliance (TDA) called on all UNFCCC Parties and global financial institutions to invest USD 100 million to train 10,000 mobility professionals in the planning, design, operations and promotion of walking and cycling through its Call to Support Active Mobility Capacity Building.

In addition, countries, ports and companies made more than 40 announcements under the Green Shipping Challenge at COP 27, including commitments to establish green shipping corridors from the Netherlands with Norway, the United Kingdom and the United States.

These international multi-stakeholder initiatives stemming from annual climate summits demonstrate the increased attention to transport at COPs over the years, recognising that transport can reduce negative climate impacts and increase access to economic opportunities.

OPPORTUNITIES FOR TRANSPORT STAKEHOLDERS AT COP 28

1. **Thematic priority**

- The United Arab Emirates Presidency of COP 28 has identified the transport-energy nexus as its thematic priority for the transport sector. Upon request by the Presidency, the conversation opener Advancing the Energy and Transport Transitions with Railways, Public Transport and Active Mobility: A Land Transport Perspective was prepared, using the Avoid-Shift-Improve framework as a foundation and outlining key elements for mutually reinforcing transport and energy transitions. The paper was produced by a partnership of organisations, including the SLOCAT Secretariat, the International Union of Railways (UIC), the International Association of Public Transport (UITP), and the Renewable Energy Policy Network for the 21st Century (REN21), with contributions from the Institute for Sustainable Development and International Relations (IDDRI), the Institute for Transportation and Development Policy (ITDP), the International Transport Forum (ITF) and the World Resources Institute (WRI)..

2. **Official thematic day and other events**

- In addition to an official COP 28 thematic transport day scheduled for 6 December 2023, several other transport gatherings are expected at COP 28, including the annual Transport Action Event and Implementation Labs of the Marrakech Partnership for Global Climate Action (MPGCA). See the COP 28 Official Programme.

3. **Marrakech Partnership for Global Climate Action**

- The MPGCA is producing a sectoral Solutions Pathway, as well as mobilising stakeholders in the Sharm El-Sheikh Adaptation Agenda (SAA) , launched at COP 27. Transport stakeholders have been invited to engage in supporting progress on the SAA related to the resilience of infrastructure systems.

Information on SLOCAT's activities at COP 28, as well as SLOCAT's traditional tracker of transport events at COP, will be available during the event at www.slocat.net/cop28. Queries can be sent to secretariat@slocatpartnership.org.

MODULE 1 | 1.3.2

AUTHORS:
Tsu-Jui Cheng – *National Cheng Kung University;* Agustina Krapp – *SLOCAT secretariat*

CONTRIBUTOR:
Tu My Tran – *ICLEI, Local Governments for Sustainability*

Sub-national Actions for Sustainable, Low Carbon Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- Cities exhibit a wide range of urban transport profiles, with modal shares varying greatly across locations.
- A 2021 study on 25 major cities worldwide found that London (UK), Madrid (Spain) and Paris (France) were the top cities for transport availability – boasting extensive railway connections, well-developed road networks, and ample cycling lanes and pedestrian infrastructure.
- The COVID-19 pandemic presented both threats and opportunities for sustainable transport and mobility in cities.

Emission trends

- Urban transport accounted for 8% of global carbon dioxide (CO_2) emissions and around 40% of global transport emissions in 2020. In the absence of interventions, motorised mobility in cities could surge 94% between 2015 and 2050.
- Transport emissions in cities rebounded after pandemic-related mobility restrictions were removed.
- Urban passenger transport remains the largest source of CO_2 emissions and pollutants in the transport sector, although these emissions vary widely by city and region. Across most cities, urban transport contributes between 20% and 60% of the total CO_2 emissions.
- Cities in Europe, North America and Oceania had the highest per capita greenhouse gas emissions from 1960 to 2012, ranging between 10 and 25 tonnes of CO_2 equivalent, two to five times the levels in Asian and African cities.
- Urban freight transport contributed 25% of transport-related CO_2 emissions and accounted for 30-50% of other transport-related pollutants in 2015.

Policy developments

- To tackle urban emissions, more sub-national governments are declaring commitments to net zero greenhouse gas emissions and/or unveiling sustainable development plans.
- As of April 2023, 1,148 cities were participating in the Race To Zero campaign, launched in 2020 to drive net zero commitments prior to the 2021 United Nations (UN) Climate Change Conference in Glasgow, United Kingdom (COP 26). Around 80% of sub-national governments that had joined the campaign had yet to set a net zero target as of 2023. Less than 1% of cities and 4% of regions had implemented legally binding targets, and around 9% of cities and regions had included net zero targets in their policy documents. However, there is a disparity among sub-national governments in their commitments to net zero targets.
- An estimated 65% of the UN Sustainable Development Goals (SDGs) will not be achieved unless sub-national governments are fully and equitably involved in implementation. Localising implementation of the SDGs is crucial to raise awareness and to accelerate engagement and commitment via a bottom-up approach.
- Transport is a central element reported in the 153 Voluntary Local Reviews (VLRs) submitted by sub-national governments between 2021 and April 2023; however, specific transport targets are not commonly mentioned.
- Several cities have reported in their VLRs comprehensive transport strategies that encompass mobility and transport planning. Across these VLRs, all cities emphasise the importance of public transport and active mobility in achieving climate action, equity, safety and resilience.
- When comparing the sub-national net zero targets with the VLRs, it becomes apparent that the complex and fragmented nature of the transport sector, with its multi-level delivery structure, poses challenges in establishing measurable targets.
- Alignment between national net zero targets (such as those included in Nationally Determined Contributions under the Paris Agreement) and sub-national net zero commitments, as well as VLRs, is currently not evident.
- The use of sustainable urban mobility plans (SUMPs), initially introduced in Europe, has since expanded to cities in various regions worldwide.

- Sub-national transport policies and investments have placed increased focus on active mobility and public transport, serving as "pull" or "carrot" approaches to encourage the adoption of zero- and low-emission transport modes.
- A growing number of cities have made available free or affordable public transport locally as a means to alleviate national economic crises (such as inflation) and to shift trips from private vehicles to public transport.
- Sub-national policy makers, particularly in Europe, also have embraced "push" or "stick" approaches – such as parking management and congestion charging – to alleviate congestion and redistribute urban space.
- Many urban areas have adopted and piloted access regulations, zero-emission zones and clear air zones to reduce emissions and improve air quality. A number of cities have established specific zero-emission zones for freight transport (ZEZ-Fs), ranging from urban delivery vans to medium- and heavy-duty trucks.
- There is growing momentum for sub-national governments to electrify bus fleets as a way to enhance the energy efficiency of public transport and car-sharing fleets.

Overview

Sub-national governments include all public authorities that are under the authority of a national government – such as municipalities, states, regions, provinces, counties and districts.[1] Sub-national governments are crucial in driving climate action and sustainability in the transport sector, mainly through implementing policies related to public transport, active mobility, transit-oriented development, parking regulation and access management (for example, through low- and zero-emission zones). Sub-national governments are fundamental to achieving national goals and turning national ambition into on-the-ground action.[2] As such, they can provide valuable insights and experience in implementing measures and empowering other actors.[3]

As of 2020, cities hosted more than half of the world's population and contributed 80% of the global gross domestic product (GDP); they also consumed more than two-thirds of the world's energy and contributed more than 70% of global carbon emissions.[4] The transport sector contributes nearly a quarter (23%) of global energy-related emissions, and urban transport accounts for 40% of these, of which three-quarters are released by private vehicles.[5] The share of the world's population living in cities is expected to rise to 80% by 2050, with associated growth in urban populations, economic activity and transport demand.[6]

Urban energy consumption and emissions are projected to increase as well, making cities central to achieving sustainable, low carbon transport systems worldwide. The high density and spatial concentration of urban populations and socio-economic activities allow for economies of scale, offering great potential to reduce the costs of infrastructure and services and to leverage more efficient and equitable transport modes such as walking, cycling and public transport.[7]

In general, alignment is lacking between national and sub-national targets for achieving net zero greenhouse gas emissions. However, some sub-national governments have implemented urban mobility plans or strategies to achieve sustainability impacts beyond the reduction of carbon emissions, many of which may be more tangible to citizens. These include air quality improvement, noise pollution reduction, road safety, mobility management and less congestion. Despite this, sub-national actors often face challenges in planning and implementing sustainable mobility measures; challenges include high population growth and urbanisation rates, limited decision making power, funding constraints, limited technical expertise and the ongoing impacts of the COVID-19 pandemic.

To overcome these challenges, regional and national governments around the world have developed a range of supportive policies. Additionally, global initiatives are bringing together sub-national actors and non-governmental stakeholders to facilitate peer exchanges, capacity building, technical support and access to financing. Increasingly, sub-national governments are deploying stronger regulations, economic incentives and infrastructure investments to promote sustainable transport modes.

Context and key challenges

Sub-national governments are crucial in driving climate action and sustainability in the transport sector. As such, they are fundamental to achieving national goals and turning national ambition into action. Key measures include policies related to public transport, active mobility, transit-oriented development, parking regulation and access management (e.g., low- and zero-emission zones). However, sub-national actors have differing degrees of decision making power depending on their autonomy, mandate and scope of responsibility. This may limit the elaboration and implementation of transport policies and plans due to a lack of co-ordination, funding, technical capacity, and political will, such challenges tend to be more pronounced in low- and middle-income countries.[8]

Population growth

With the global population projected to reach 9.7 billion by 2050, the demand for mobility is set to increase.[9] However, population growth will be uneven, expanding in some regions while stabilising or declining in others. By 2037, Central and Southern Asia is expected to become the most populous region, and by 2050 the population of Sub-Saharan Africa is projected to nearly double, contributing more than half of the total population growth.[10] In 2023, 30 out of the 34 megacities with populations above 10 million were in Asia, Latin America and Africa, and by 2030 the number of megacities is expected to increase to 43 worldwide.[11]

Funding constraints

Implementing sustainable mobility measures in developing cities requires substantial investments, but often the available funding is insufficient. For example, inadequate revenue collection from the users of transport systems can lead to a reliance on subsidies. Additionally, budget allocations tend to favour the expansion of road infrastructure, benefiting car owners and perpetuating car-centric transport. The minimal contributions from car users towards infrastructure investments further exacerbate the funding challenge.[14]

Differences among sub-national governments

Sub-national governments that have greater autonomy also have more flexibility in implementing sustainable mobility measures. In contrast, those with limited autonomy rely heavily on national support to develop and execute plans towards net zero emissions.[12] Relationships between sub-national and national governments can vary greatly depending on factors such as constitutional arrangements, party politics, competitive dynamics and the willingness to collaborate.[13]

Limited technical expertise

Access to capacity development programmes is essential to promote sustainable urban mobility and ensure inclusive development. Sub-national governments may lack the technical knowledge and capacity to plan and implement sustainable mobility measures. In many cases, as sub-national governments in high-income countries advance various efforts to decarbonise transport, their counterparts in low- and middle-income countries are facing challenges simply co-ordinating transport-specific policies and plans, let alone ensuring effective implementation and sustainability measures.[15] (*See Spotlight 6. Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport*).

Demand trends

Cities exhibit a wide range of urban transport profiles, with modal shares varying greatly across locations.

- In Tshwane and Cape Town (South Africa) and Auckland (New Zealand), private cars accounted for more than 80% of trips as of 2022.[16]
- Zurich (Switzerland) and Tokyo (Japan) have the highest shares of public transport, at 35% and 28%, respectively.[17]
- Dar es Salaam (Tanzania) and Kinshasa (Democratic Republic of the Congo) rely heavily on walking as the primary transport mode, representing two-thirds of all trips.[18]
- Cycling represents a high share of trips in Amsterdam (Netherlands), at 28.7%, and Osaka (Japan), at 28.4%.[19]
- In some cities in Sub-Saharan Africa, informal transport (such as Dakar (Senegal) and Dar es-Salaam (Tanzania)) accounts for up to 95% of all trips.[20]

A 2021 study on 25 major cities worldwide found that London (UK), Madrid (Spain) and Paris (France) were the top cities for transport availability – boasting extensive railway connections, well-developed road networks, and ample cycling lanes and pedestrian infrastructure.[21]

- However, in a 2018 study on the average cost for public transport (bus, tram or metro), London had the highest costs (USD 5.66), followed by Stockholm (Sweden) (USD 5.43), Copenhagen (Denmark) (USD 4.64) and Oslo (Norway) (USD 4.49).[22]
- Cities with the lowest average costs were Cairo (Egypt) (USD 0.11), followed by Kyiv (Ukraine) (USD 0.18), Mumbai (India) (USD 0.23), Jakarta (India) (USD 0.26) and Mexico City (USD 0.29).[23]
- A few cities, including Valletta (Malta), Luxembourg City, and Tallinn (Estonia), offered free public transport options as of 2023 (*see Section 3.1 Integrated Transport Planning*).[24]

The COVID-19 pandemic presented both threats and opportunities for sustainable transport and mobility in cities. By 2021, congestion had returned to pre-pandemic levels in many cities, and in some places it worsened.[25]

- In 2020, all of the top ten cities for pre-pandemic metro ridership experienced at least a 27% drop in ridership: Tokyo (Japan), Moscow (Russian Federation), Shanghai (China), Beijing (China), Seoul (Republic of Korea), Guangzhou (China), Delhi (India), New York City (USA), Mexico City and Hong Kong (China).[26]
- By 2022, traffic delays exceeded pre-pandemic levels in 39% of US urban areas and 42% of European urban areas.[27]
- The pandemic fast-tracked the cycling agenda by presenting an opportunity to rapidly construct pop-up bike lanes, which contributed to 11-48% more cycling in 106 European cities during March to July 2020.[28]

Emission trends

Urban transport accounted for 8% of global carbon dioxide (CO^2) emissions and around 40% of global transport emissions in 2020.[29] **In the absence of interventions, motorised mobility in cities could surge 94% between 2015 and 2050.**[30]

CO_2 emissions from transport grew nearly 2% annually on average between 2010 and 2019, faster than from any other end-use sector globally.[31] Transport CO_2 emissions fell 13% in 2020 due to the impacts of the COVID-19 pandemic, then jumped 7% in 2021 as mobility restrictions were lifted.[32] (*For more on emission trends, see Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals).*

Transport emissions in cities rebounded after pandemic-related mobility restrictions were removed. According to Google Environmental Insights Explorer, as of 2022 public transport trips globally had not yet returned to 2019 levels, whereas private vehicle trips had increased.[33]

Urban passenger transport remains the largest source of CO_2 emissions and pollutants in the transport sector, although these emissions vary widely by city and region.[34] **Across most cities, urban transport contributes between 20% and 60% of the total CO_2 emissions.** [35]

- According to C40, a third of the total urban greenhouse gas emissions in some major cities worldwide come from transport.[36]
- In some cities in Latin America and the Caribbean (LAC) region, such as Guadalajala (Mexico), São Paulo (Brazil) and Quito (Ecuador), the share of transport CO_2 emissions exceeds 60%, due mainly to higher levels of urbanisation and motorisation.[37]
- In cities in low- and middle- income countries, the shares of transport CO_2 emissions are relatively, lower, although these emissions are growing rapidly, driven by economic development.[38]

Cities in Europe, North America and Oceania had the highest per capita greenhouse gas emissions from 1960 to 2012, ranging between 10 and 25 tonnes of CO_2 equivalent, two to five times the levels in Asian and African cities.[39] Cities in Asia and Africa had per capita emissions below 5 tonnes of CO_2 equivalent per capita.[40]

Urban freight transport contributed 25% of transport-related CO_2 emissions and accounted for 30-50% of other transport-related pollutants in 2015.[41]

Policy developments

To tackle urban emissions, more sub-national governments are declaring commitments to net zero greenhouse gas emissions and/or unveiling sustainable development plans. These commitments highlight the significance of climate change on their political agenda. Local sustainable development plans underscore the importance of sustainable mobility strategies as a key component of actions at the sub-national level.

As of April 2023, 1,148 cities were participating in the Race To Zero campaign, launched in 2020 to drive net zero commitments prior to the 2021 United Nations (UN) Climate Change Conference in Glasgow, United Kingdom (COP 26).[42] These include 482 cities from Western Europe, 406 from Latin America and the Caribbean, 182 from Asia-Pacific, 43 from Eastern Europe, and 32 from Africa, among others.[43] These cities adhere to the "Starting Line" criteria, which entails "Pledge, Plan, Proceed, Publish and Persuade."[44]

Around 80% of sub-national governments that had joined the Race To Zero campaign had yet to set a net zero target as of 2023.[45] **Less than 1% of cities and 4% of regions had implemented legally binding targets, and around 9% of cities and regions had included net zero targets in their policy documents.**[46]

As of June 2023, the Net Zero Tracker – which evaluates the net zero targets established by Parties to the UN Framework Convention on Climate Change, by other regions and territories, and by cities with populations exceeding 500,000 – revealed that 146 out of 709 regions and 252 out of 1,186 cities had included net zero commitments or similar objectives in their policy documents (see Figures 1 and 2).[47]

However, there is a disparity among sub-national governments in their commitments to net zero targets. For example, as of June 2023 none of the 138 regions in Western and Central Asia had set net zero targets, and Europe had 152 regions without net zero targets (see Figure 3).[48] At the city level, most cities in Africa, East Asia, South Asia, and Western and Central Asia (in the range of 84% to 92% of cities) had yet to establish net zero targets (see Figure 4).[49] In general, information is lacking about how transport decarbonisation is reflected in these commitments.

An estimated 65% of the UN Sustainable Development Goals (SDGs) will not be achieved unless sub-national governments are fully and equitably involved in implementation.[50] **Localising implementation of the SDGs is crucial to raise awareness and to accelerate engagement and commitment via a bottom-up approach.**[51] The 2030 Agenda for Sustainable Development and its 17 SDGs provide an opportunity and platform for sub-national governments to highlight their contributions to achieve the SDGs through the submission of Voluntary Local Reviews (VLRs).[52]

Transport is a central element reported in the 153 VLRs submitted by sub-national governments between 2021 and April 2023; however, specific transport targets are not commonly mentioned.[53] Amsterdam (Netherlands) stands out for its active efforts to achieve emission-free traffic within the

FIGURE 1. Number of regions committing to net zero targets, as of June 2023

Source: See endnote 48 for this section.

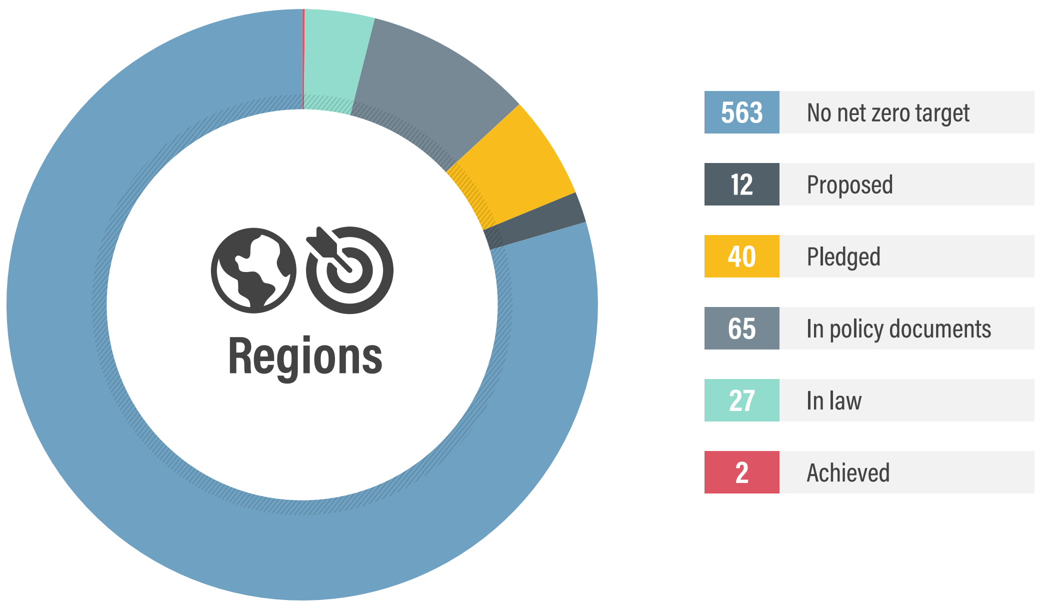
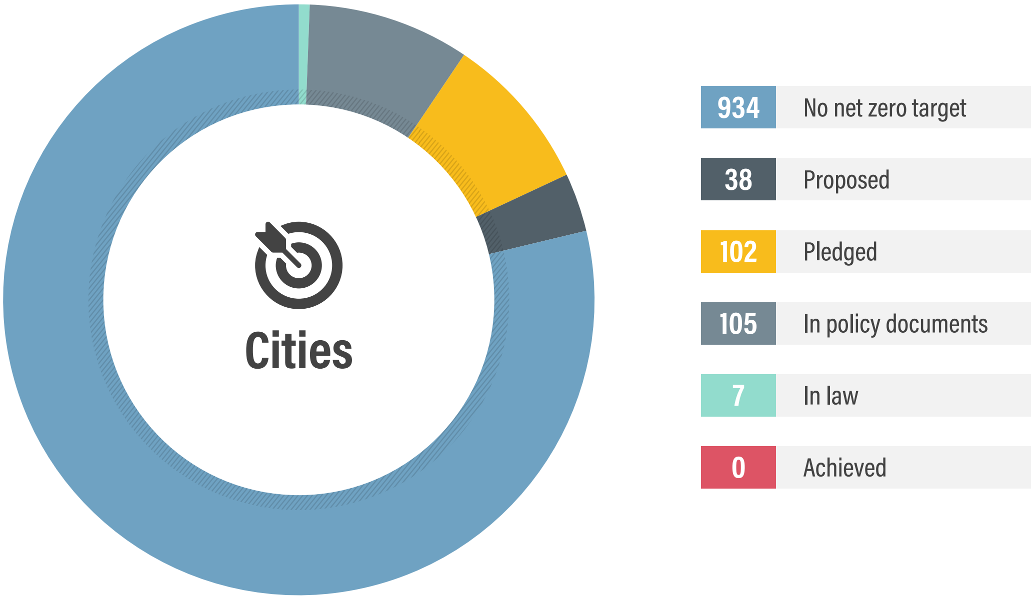


FIGURE 2. Number of cities committing to net zero targets, as of June 2023

Source: See endnote 48 for this section.



city by 2030, with the aim of staying within the World Health Organization's threshold for average annual concentrations of particulate matter (PM_{10} and $PM_{2.5}$).[54] Helsinki's VLR highlights the significant challenges in mitigating urban transport emissions, indicating that city-wide carbon neutrality targets in 2030 will not be met under the current climate actions.[55]

Several cities have reported in their VLRs comprehensive transport strategies that encompass mobility and transport planning. Across these VLRs, all cities emphasise the importance of public transport and active mobility in achieving climate action, equity, safety and resilience. Noteworthy examples include the urban mobility plans or strategies implemented in Barcelona (Spain), Malmö (Sweden), Melbourne (Australia), Tampere (Finland), and Winnipeg (Canada), as well as in the German cities of Bonn, Dortmund, Dusseldorf and Kiel. Other examples are the plans established in cities in the State of Pará (Brazil) and in the Lombardy Region (Italy), as well as the Sustainable Mobility Bill for the Basque Country (Spain).

The VLRs show that sustainable mobility offers benefits that are often more tangible to citizens than reducing carbon emissions. These include improved air quality, reduced noise pollution, enhanced road safety, and increased accessibility, among others. Even sub-national governments that do not explicitly reference urban mobility plans in their VLRs consistently recognise the significance of active mobility and public transport and the integration of sustainable mobility within regional and municipal urban planning as vital measures for environmental and social sustainability.

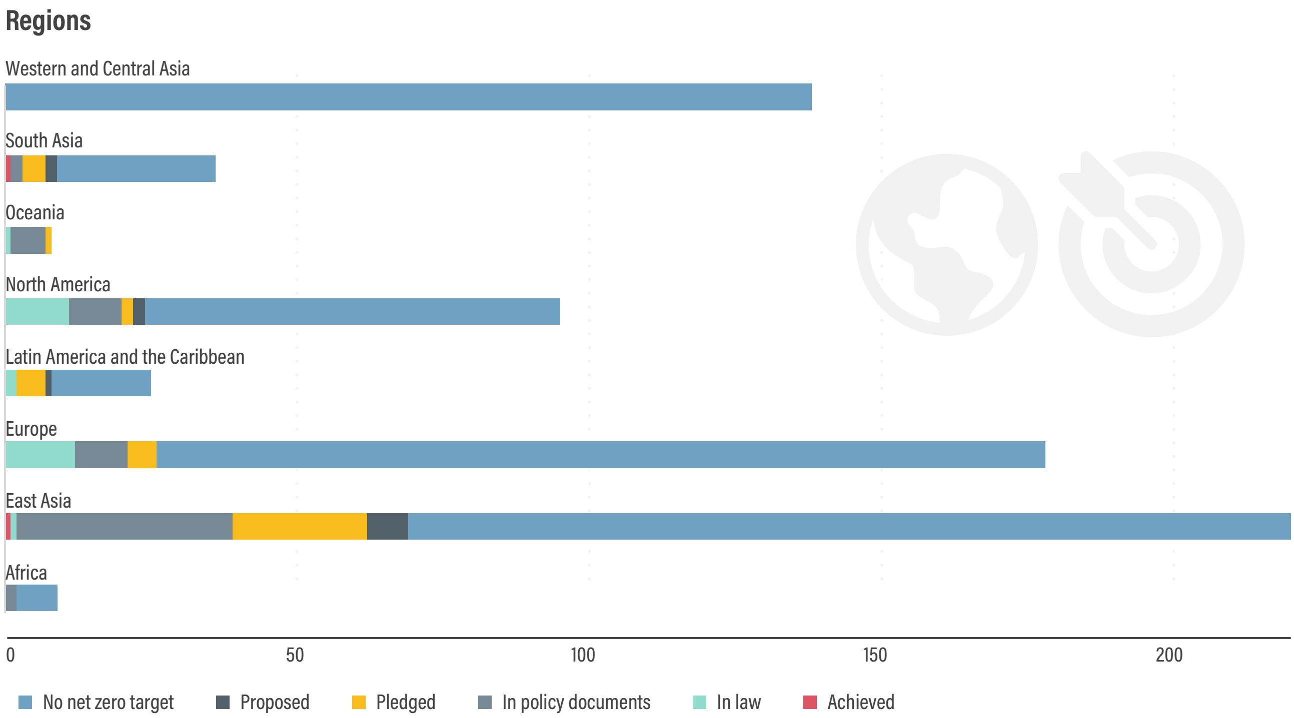
When comparing the sub-national net zero targets with the VLRs, it becomes apparent that the complex and fragmented nature of the transport sector, with its multi-level delivery structure, poses challenges in establishing measurable targets.[56] These challenges impede the capacity of sub-national governments to commit effectively to net zero targets and to adopt measures that can address the rising demand for urban mobility while minimising environmental impacts and promoting sustainable development.

Alignment between national net zero targets (such as those included in Nationally Determined Contributions under the Paris Agreement) and sub-national net zero commitments, as well as VLRs, is currently not evident.[57] Nonetheless, sub-national governments are in a favourable position to enhance climate actions vertically across different levels of government and horizontally across cities.[58] Various planning tools, case studies, precedents, and political and financial instruments are available or have been developed to facilitate sustainable transport options. Despite the lack of specific targets in the urban transport sector, sub-national governments have taken steps to address transport challenges that directly or indirectly contribute to reducing emissions.

National governments worldwide have recently developed policy frameworks and guidelines, such as national urban mobility policies and investment programmes (NUMPs), to help sub-national governments plan and implement sustainable urban mobility strategies.[59]

FIGURE 3. Number of regions committing to net zero targets, as of June 2023

Source: See endnote 49 for this section.



The use of sustainable urban mobility plans (SUMPs), initially introduced in Europe, has since expanded to cities in various regions worldwide. The aim of SUMPs is to meet the mobility needs of people and businesses in urban areas and their surroundings for a better quality of life (*see Section 3.1 Integrated Transport Planning*).

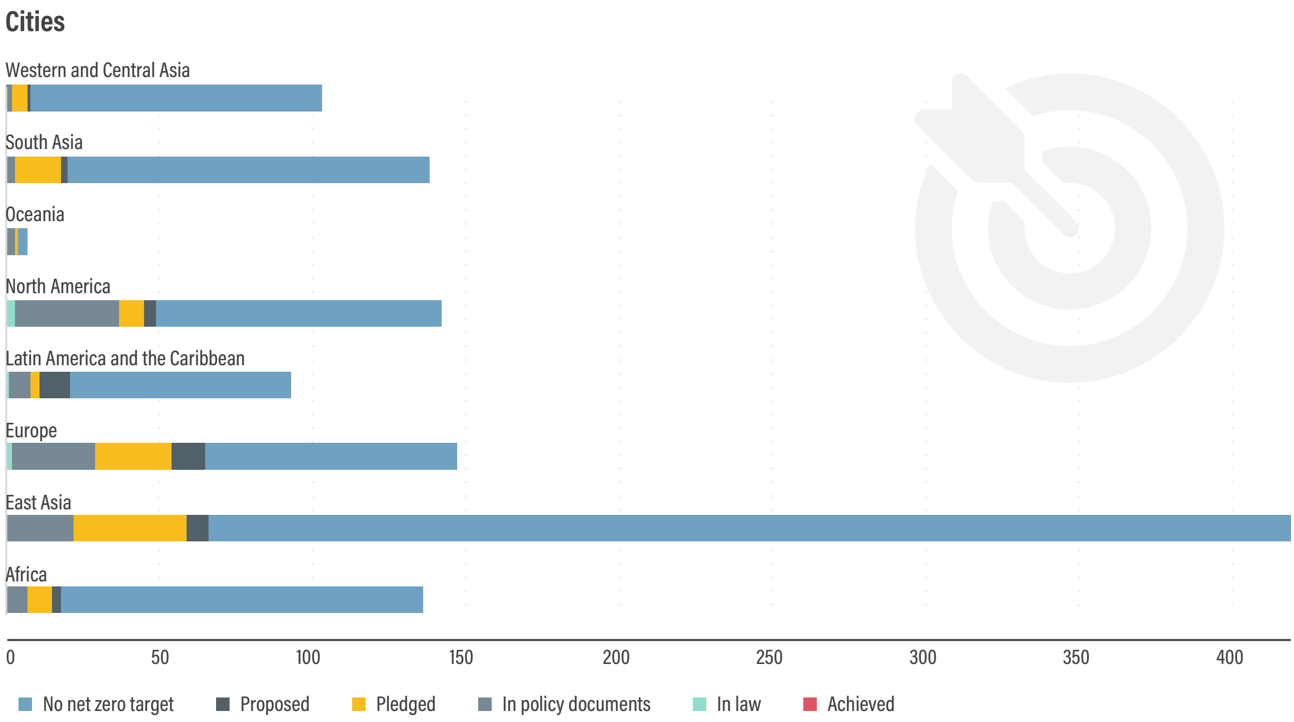
- In 2021, the European Commission released the EU Urban Mobility Framework to help cities make urban mobility more sustainable and to contribute to achieving the EU greenhouse gas reduction targets. The framework suggests measures for addressing air pollution, congestion, accessibility, urban road safety, e-commerce growth and other urban mobility challenges.[60]
- In early 2023, the European Commission released a Recommendation to Member States to establish national programmes to support cities in developing SUMPs through guidance materials, training, technical expertise and financial support.[61]
- In early 2022, Istanbul (Türkiye) completed the country's first SUMP, which was also the first SUMP in a megacity globally, covering a population of nearly 16 million.[62]
- Several initiatives were under way in India by late 2022 to support transit-oriented development, and the cities of Chandigarh, the Pune Municipal Corporation and Navi Mumbai had successfully implemented transit-oriented development in their urban planning masterplans.[63]
- Open street events held across Africa – including in Cape Town (South Africa), Kigali (Rwanda) and several Ethiopian cities – provided cities with an opportunity to reflect on and understand the benefits of people-centred development approaches.[64]

Sub-national transport policies and investments have placed increased focus on active mobility and public transport, serving as "pull" or "carrot" approaches to encourage the adoption of zero- and low-emission transport modes. The need for active mobility options, such as walking and cycling, has continue to grow even after the COVID-19 pandemic, driven mainly by local demand (see *Sections 3.2 Walking, 3.3 Cycling* and *3.4.1 Public Transport*).

- In 2022, Jakarta (Indonesia) completed 309 kilometres of bike lanes, out of a planned total of 500 kilometres, with government data showing that the average number of cyclists daily in the city had surged from 47 in 2005 to 4,000 in 2022.[65]
- In Utrecht (Netherlands), the cycling action plan outlined in the SUMP helped create a strong cycling culture, resulting in Utrecht topping the Global Bicycle Cities Index in 2020 and 2022 and ranking in the top three on the "Copenhagenize Index" of the world's most cycle-friendly cities since 2013.[66]

FIGURE 4. Number of cities committing to net zero targets, as of June 2023

Source: See endnote 50 for this section.



- In 2020, Addis Ababa (Ethiopia) launched a 10-year Non-Motorised Transport Strategy aimed at developing a comprehensive network of high-quality walking and cycling facilities to address the growing demand for better access to the city.[67]

A growing number of cities have made available free or affordable public transport locally as a means to alleviate national economic crises (such as inflation) and to shift trips from private vehicles to public transport.

- Many cities in Brazil Europe and the USA have trialled and/or fully implemented free ticketing and fares for public transport.[68]
- All public transport is free in Morungaba (Brazil).[69]
- In the United States, Albuquerque has implemented free buses, Worcester operated free buses during the summer of 2023, and Washington, D.C. enacted a zero-fare bus bill in 2023.[70]

Sub-national policy makers, particularly in Europe, also have embraced "push" or "stick" approaches – such as parking management and congestion charging – to alleviate congestion and redistribute urban space.

- In March 2023, Barcelona (Spain) implemented the Amazon tax, which charges postal operators for parking vehicles that deliver online purchases in public spaces. The tax affects the 26 postal companies, including Amazon, DHL and UPS, that bill more than EUR 1 million (USD 1.09 million) annually.[71] The tax seeks to benefit local business, encourage collecting at pick-up points, avoid excessive occupation of public space by delivery vehicles, and fight other negative impacts.[72]
- In July 2023, the Rosemont–La Petite-Patrie district in Montreal (Canada) introduced parking charges based on vehicle weight to reflect better the space they occupy.[73] Lyon (France) will implement a similar approach in 2024.[74]
- In 2023, London marked the 20th anniversary of its congestion charge, which reduced congestion 30% and emissions 16% since 2003, limiting traffic and contributing to a shift to active travel and public transport.[75] The city plans to remove its congestion pricing exemption for electric vehicles by 2025.[76] Between 2000 and 2022, London's congestion charge resulted in 1 billion fewer vehicle-miles driven by cars; however, the number of vehicle-miles driven by light commercial vehicles increased by the same amount, and taxis also filled the space left by cars.[77]

Many urban areas have adopted and piloted access regulations, zero-emission zones and clear air zones to reduce emissions and improve air quality. A number of cities have established specific zero-emission zones for freight transport (ZEZ-Fs), ranging from urban delivery vans to medium- and heavy-duty trucks.

- The zero-emission zone in Oslo (Norway), scheduled to enter into force in 2023, commenced with a "Car-Free City Life" area where pedestrians and cyclists have priority over private cars; the measure is set to expand to other areas of the city by 2026.[78]
- Jakarta (Indonesia) began implementing a low-emission zone pilot project in the Kota Tua Tourism Area in early 2021, addressing air quality, safety and social inclusion issues.[79]
- A ZEZ-F pilot in Shenzhen (China), implemented in 2018 to cover 22 square kilometres (1.1% of the total city area), applies to light-duty trucks and was scheduled to expand in July 2023.[80] In 2021, Luoyang (China) adopted a near-ZEZ-F scheme, to be implemented in 2023, that applies to urban delivery trucks and covers the city centre.[81]
- In the US state of California, the Los Angeles Cleantech Incubator and the City of Santa Monica partnered to deploy the country's first ZEZ-F in early 2021, referred to as a "zero-emission delivery zone" and covering a one-square-mile commercial area.[82]
- The Netherlands announced in 2021 that it was aiming to implement ZEZ-Fs in 30-40 of the country's largest cities by 2025.[83] As of 1 January 2025, any city in the Netherlands would be permitted to designate areas as a ZEZ-F.[84]

There is growing momentum for sub-national governments to electrify bus fleets as a way to enhance the energy efficiency of public transport and car-sharing fleets (*see Section 4.2 Vehicle Technologies*).

- At least 75 cities have joined the Accelerating to Zero (A2Z) Coalition, launched at COP 26 in 2021 to accelerate the transition to 100% zero-emission cars and vans; the aim is for all sales of new cars and vans to be zero-emission globally by 2040, and by no later than 2035 in leading markets.[85]
- Maharashtra state (India) planned to add a total of 1,900 electric buses to Mumbai's Brihanmumbai Electric Supply and Transport fleet (a public entity providing transport services and electricity).[86] The city also aims to have a 100% electric fleet by 2027, with an interim 50% target by 2023.[87]
- In 2021, California (USA) approved the Clean Miles Standard, the first programme in the country requiring ride-hailing companies to transition towards electric vehicles by 2030.[88]
- São Paulo (Brazil) banned bus companies from purchasing new diesel buses starting in 2020 and targets at least 2,600 e-buses by 2024, representing around one-fifth of the fleet.[89]
- In 2022, Bogotá (Colombia) expanded its e-bus fleet and built the largest bus depot outside of China.[90] With all 1,485 of the city's e-buses in service, annual avoided emissions are projected to reach 94,300 tonnes of CO_2.[91]

Partnership in Action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- By mid-2022, 36 cities (mostly in Europe and the United States) had committed to the **C40 Cities Green and Healthy Streets Declaration**, aiming for zero emissions in a major area of their cities by 2030; establishing a zero-emission zone is a clear pathway to reaching that commitment.[92]
- The **EcoLogistics** project of **ICLEI-Local Governments for Sustainability** promotes low-carbon urban freight policies and practices.[93] For example, in 2022 Rosario (Argentina) added 20 cargo bikes to its public bike sharing scheme, targeting merchants, entrepreneurs and workers in the city centre.[94]
- In April 2022, the **International Association of Public Transport (UITP)**, the **World Bank** and the **World Resources Institute** supported India to bid more than 5,000 electric buses for five cities, in the world's largest tender for e-bus procurement. The process, supported under the government FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicle) scheme subsidy, aggregated demand across Delhi, Bangalore, Hyderabad, Kolkata and Surat and homogenised their procurement specifications. As a result of the large size of the tender, prices were the lowest ever (up to 48% below previous tenders), very close to those for diesel buses.[95] The government now plans to procure 50,000 e-buses by 2030 for other cities.[96]
- The **Institute for Transportation and Development Policy**, in partnership with the City of Kigali (Rwanda), developed a Non-Motorised Transport Master Plan in 2023 that identifies priority corridors for greenways and active transport in the city.[97]
- Since its launch in 2015, the **MobiliseYourCity** partnership has been supporting cities in different regions in developing and implementing SUMPs.[98] These include three cities in Africa, two cities in Asia, four cities in Eastern Europe and six cities in Latin America and the Caribbean that finalised their SUMPs between 2019-2022; as well as seven cities in Africa, seven cities in Asia and three cities in Latin America and the Caribbean that are currently developing their plans.[99]
- The **World Bank** is providing financial and/or technical assistance to bus rapid transit projects in eight African cities as part of their SUMPs: Abidjan (Côte d'Ivoire), Dakar (Senegal), Dar es Salaam (Tanzania; phases 3 and 4), Douala (Cameroon), Kampala (Uganda), Kumasi (Ghana), Maputo (Mozambique) and Ouagadougou (Burkina Faso).[100] In Dakar, the introduction of low- or zero-emission vehicles in this bus corridor could save an estimated 67,700 tonnes of CO_2 annually.[101]

MODULE 1 1.3.3

AUTHOR:
Sophie Punte, *Smart Freight Centre*

CONTRIBUTORS:
Charlene Kouassi, *Movin'On LABS Africa*
Joachim Roth and Romain Poivet, *World Benchmarking Alliance*
Yann Briand, *IDDRI*

The Role of Business in Decarbonising Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

- To decarbonise transport, various types of businesses need to be involved, including transport manufacturers, public and freight transport service providers, and companies that use transport.
- Although businesses are demonstrating increasing climate leadership, collectively this remains insufficient to achieve a pathway consistent with limiting global temperature rise to below 1.5 degrees Celsius (°C).

Ambition

- While the climate ambition of transport manufacturers is increasing, targets are not enough to achieve a 1.5°C pathway.
- Transport-specific targets mostly focus on zero-emission vehicles, charging infrastructure, and renewable energy for shipping and aviation. Very few companies have set targets across all their business areas and markets and have committed to phasing out fossil fuels.
- A majority of transport companies have set goals and targets for reducing greenhouse gas emissions, but ambition must be raised. As of 2022, more than 58 countries and one-fifth of the world's largest companies had committed to reaching carbon neutrality.
- Transport companies need to commit to phasing out fossil fuels, as the transport sector relies on oil-derived products for over 90% of its energy, more than any other sector.
- Over 2,400 companies covering more than a third of the global economy's market capitalisation – including 43 transport manufacturers and 124 transport service providers – have approved science-based targets for reducing emissions.

Action

- Transport manufacturers have made significant progress on electric road vehicles, alternative fuels for ships and airplanes, and digital solutions.
- To reach the 1.5°C target, the global automotive sector needs to increase annual production of zero-emission vehicles to 52% of total vehicle production in 2029.
- Innovation has occurred in hard-to-decarbonise sub-sectors, such as zero-emission trucks, ships and planes; low carbon fuels; batteries and other technologies; and infrastructure. While policy has played a role, manufacturers also have responded to customer demand and collaborated with suppliers of infrastructure, fuel and batteries, and other technologies.
- A gap remains between transport companies' ambitions and the quality of their climate transition planning, with vast potential for improved action. Many companies may not have determined actions or allocated funding to meet their targets.
- Globally, transport companies under-perform on the social aspects of climate and sustainability, including human rights, just transition, decent work and ethical conduct, even though these are critical for the successful implementation of a climate transition plan.
- Companies have taken actions related to their own fleets, including electric vehicles, biking and working from home.
- Shippers hold the key to making structural changes to freight transport by shifting to low carbon modes and reducing demand.
- Many companies have shown greater advancement in general energy-related measures than in tackling transport.

Advocacy

- Businesses have been more supportive of infrastructure and incentives for alternative fuels and zero emissions, and more opposed to carbon dioxide targets, standards and accelerating the phase-out of internal combustion engines and fossil fuels.
- Many auto manufacturers and aviation companies advocate for climate action while simultaneously lobbying to weaken pro-climate policies. Automotive workers show greater unity on lobbying for a Just Transition.
- Transport companies' inconsistent policy advocacy risks delaying the climate action they need to meet their own emission reduction targets.
- Policy advocacy to accelerate the uptake of electric vehicles has been strong among companies that have fleets and use transport services.
- Industry associations that cover multiple sectors but also cover transport have tended to take a more conservative approach to climate policy advocacy.

Accountability

- Disclosure of companies' climate-relevant information is becoming mainstream – with over 18,000 companies disclosing to CDP in 2022, including 419 transport manufacturers and 930 transport service providers – but accountability gaps remain.
- Weaknesses include a lack of climate expertise at the board level in companies, and of financial incentives tied to emission reductions.
- The new ISO 14083 standard on quantification and reporting of greenhouse gas emissions from transport operations is expected to increase and improve disclosure.
- Little is known about the disclosure of companies (other than transport manufacturers and companies that provide transport services) on their transport emissions, targets and emission reduction efforts.

Opportunities to accelerate industry action

- Improving business climate leadership can help prevent greenwashing, as leaders must follow through on their ambition with credible action, advocacy and accountability.
- Companies can be leveraged for wider system change to complement technological changes and in responding to climate impacts.
- Companies can enhance their collaboration with other stakeholders in climate and sustainability, working with all partners in the value chain, supporting just transition pathways for transport and joining initiatives that truly help deliver the transition.

Overview

The private sector plays an essential role in climate action, as roughly 100 companies around the world were responsible for 71% of the global greenhouse gas emissions between 1998 and 2015.[1] Worldwide, a growing number of companies across all sectors, including transport, have committed to reducing their emissions.[2]

To realise transport decarbonisation, a wide range of businesses need to be involved, including original equipment manufacturers (i.e., **transport manufacturers**), **providers of public and freight transport services, as well as companies that use transport.** The contributions of these businesses can be assessed through the framework of the "4 A's of Climate Leadership" (see Figure 1).[3]

Across these areas, key collaboration and climate leadership opportunities exist to accelerate businesses action to decarbonise transport. The key private stakeholders in transport span businesses of all sizes, from global and national corporations, to state-owned enterprises, to small and medium enterprises, to individual contractors. Governments, civil society and research organisations, and customers other than companies all have an influence on these businesses (see Figure 2).

Businesses and companies can support conditions that enable transport decarbonisation at scale, by pursuing activities such as capacity building and awareness raising among company management and staff, technicians and professionals, policy makers and the public; and collaboration among businesses and with government, civil society and research.

FIGURE 1. 4 A's of Climate Leadership by the We Mean Business Coalition

Source: See endnote 3 for this section.

Ambition

Commit to net zero and set science-based targets in line with Paris Agreement goals and a just transition

Action

Take concrete action across the business value chain and involve employees, suppliers and customers

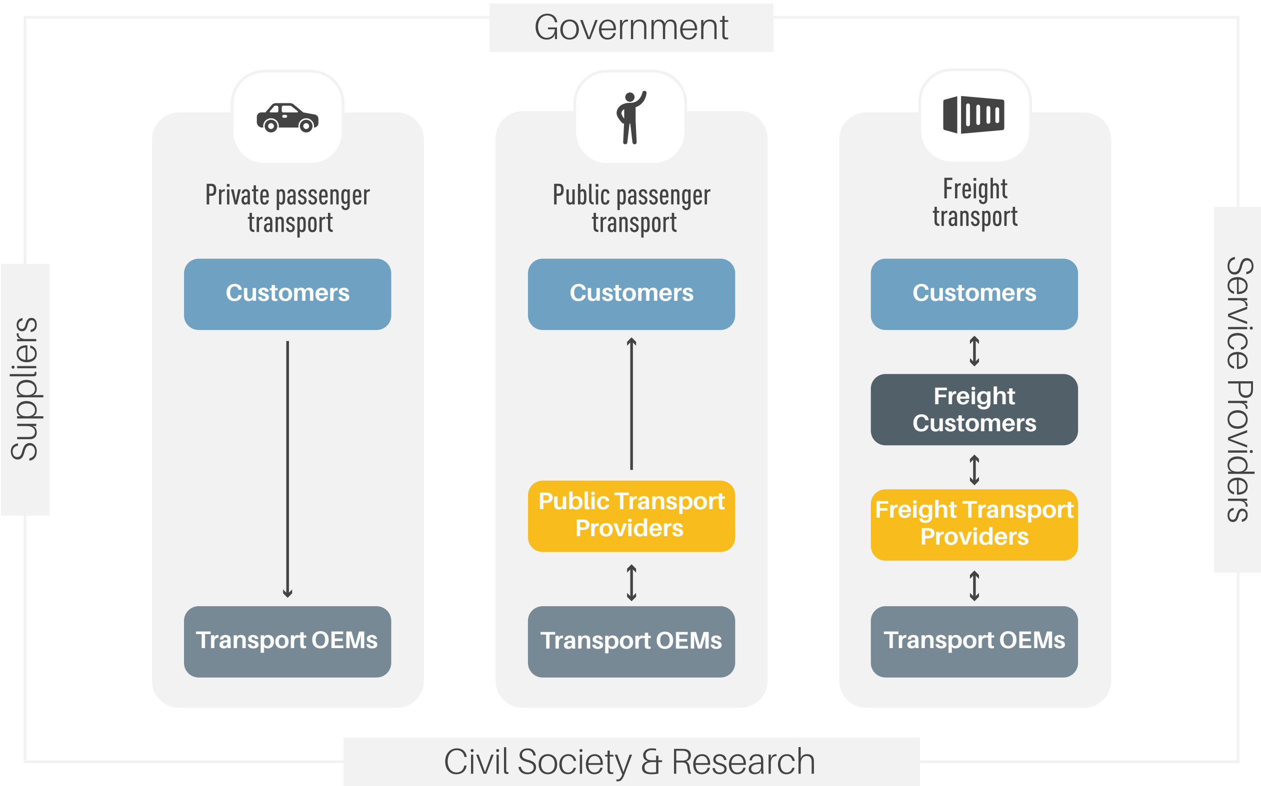
Advocacy

Speak up to secure wider change through ambitious government policy and aligned trade associations

Accountability

Disclose emissions, progress against targets and plans, risk management, policy engagement and governance

FIGURE 2. Transport stakeholders for passenger and freight transport



KEYWORDS

Customers
consumers, companies, organisations

Transport OEMs
original equipment manufacturers of vehicles, aircraft and marine/inland vessels and their engines, components and other equipment

Public transport providers
providers of public bus, metro, rail, taxi, bike, metro, ferry, aviation services

Freight transport providers
carriers, freight forwarders, logistics service providers covering all transport modes

Customers of freight
"shippers" including businesses, government and other organisations

Government
multilateral, national, state, local government and affiliated organisations

Suppliers
fuel/energy, technology, utilities, information technology, construction, other

Service providers
financiers, insurers, auditors, consultancies, other

Civil society & research
non-profit organisations, Indigenous groups, labour unions, professional associations, foundations, research institutes, universities

Business efforts to decarbonise transport

Different businesses – including transport manufacturers, public and freight transport providers, and companies that use transport – are taking different steps to decarbonise transport and to reduce emissions to contribute to international goals. **Although businesses are demonstrating momentum in climate leadership across the 4 A's, collectively this remains insufficient to achieve a pathway that is consistent with the goal of keeping global temperature rise below 1.5 degrees Celsius (°C).**[4]

Transport manufacturers

Original equipment manufacturers include manufacturers of vehicles, aircraft, and marine/inland vessels, as well as their engines, components and other equipment. These transport manufacturers are responsible for providing zero-emission solutions at scale to other business stakeholders.

While the climate ambition of transport manufacturers is increasing, targets are not ambitious enough to achieve a 1.5°C pathway, especially for land transport, shipping and aviation. Moreover, regional differences in these commitments are apparent, especially for medium- and heavy-duty trucks and buses.[5]

Ambition

Transport-specific targets tend to focus on zero-emission vehicles, charging infrastructure, and renewable energy for shipping and aviation. Very few companies have set targets across all of their business areas and markets and have committed to phasing out fossil fuels.

- Of the 114 transport manufacturers that had joined the Science Based Targets initiative (SBTi) as of March 2023, 62% (71 companies) had committed to targets to reduce greenhouse gas emissions, and 38% (43) had approved targets, with more likely to follow once the initiative releases sector-specific guidelines.[6]
- In a global benchmark of 30 auto manufacturers in 2021, 56% (17 companies) had set targets to reduce emissions and 83% (25) had set targets to increase sales of light-duty low carbon vehicles, including battery electric, fuel cell electric, and plug-in hybrid cars and vans.[7] However, no company had targets covering all of its business areas and fully aligning with the International Energy Agency's (IEA) 1.5°C pathway for light-duty electric vehicles.[8]
- Ford, General Motors, Mercedes Benz Group and Volvo Cars have all announced plans to fully phase out internal combustion engine vehicles in the 2030s and to shift to manufacturing light-duty zero-emission vehicles.[9]
- By market share, as of 2020, 97% of manufacturers in Europe and 94% of manufacturers in the United States had committed to a complete transition to zero-emission vehicles, compared to 34% in China, despite Chinese dominance in electric vehicle manufacturing (see Figure 3).[10]

Nearly all of the world's major **aviation** industry associations and largest aircraft and engine makers have committed to achieving net zero carbon emissions by 2050, supported by accelerated efficiency measures, energy transition, and innovation across the aviation sector, in partnership with governments around the world.[11]

The global **shipping** industry, through the Getting to Zero Coalition, has committed to operating commercially viable zero-emission vessels by 2030, along with the associated infrastructure, with the goal of full decarbonisation by 2050.[12] The International Maritime Organization has targeted halving global shipping emissions by 2050 (from 2008 levels) and aimed to approve a revised greenhouse gas strategy in 2023.[13] Alignment with a 1.5°C pathway requires reducing emissions from international shipping at least 34% below 2008 levels by 2030 and achieving zero emissions by 2050.[14]

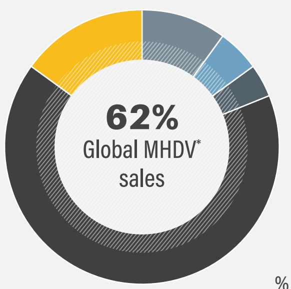
Weaknesses include a lack of climate expertise at the board level in companies, and of financial incentives tied to emission reductions for executives and employees. Of 30 benchmarked automotive companies, 90% (26 companies) had board-level oversight on climate change, but only 40% (12) had financial incentives tied to emission reductions for executives and 53% (16) had such incentives for employees; only 10% (3) had significant climate change expertise at the board level.[15] The benchmark also found that:

- Companies that have in place both financial incentives and board climate expertise, such as Renault and Volkswagen, scored higher for transition plans as well.

FIGURE 3. Regional market shares of original equipment manufacturers committed to zero-emission vehicles, 2020

Source: See endnote 10 for this section.

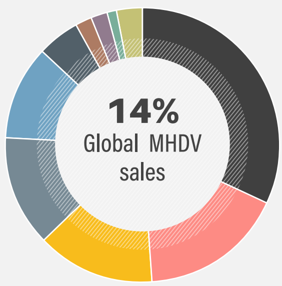
China



	%
GM Group	10
Changan Automobile	5
Great Wall Motor Company Ltd.	4
Non-committed OEMs	66
Other OEMs	15

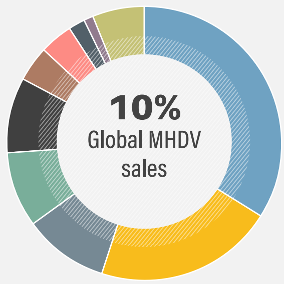
* medium- and heavy-duty vehicles

Europe



	%
Stellantis	32
Renault-Nissan- Mitsubishi Alliance	17
Daimler Group	14
VW Group	13
Ford Group	11
CNH Industrial	5
Volvo Trucks Group	2
Toyota Group	2
Paccar	1
Other OEMs	3

United States



	%
Ford Group	34
Daimler Group	21
GM Group	10
Paccar	9
Stellantis	9
Volvo Trucks Group	4
Renault-Nissan-Mitsubishi Alliance	4
Isuzu	2
Toyota Group	1
Non-committed OEMs	6

- Mahindra Group's Executive Chairman is also a board member of the UN Global Compact and has chaired the High-level Commission on Carbon Pricing and Competitiveness.
- Volkswagen established a sustainability board that includes a co-director for the Potsdam Institute for Climate Impact Research, a president of the European Green faction of the European Parliament, a founding director of the UN Global Compact and a former EU Commissioner for Climate Action.

Action

The strongest progress among transport manufacturers has been on electric road vehicles and alternative fuels for ships and airplanes, as well as increasingly on digital solutions offered by multi-modal transport companies.

To reach the IEA's 1.5°C target, the global automotive sector will need to increase annual production of zero-emission vehicles (battery electric and hydrogen) to 52% of total vehicle production in 2029 (see Figures 4 and 5).[16] Globally, electric vehicle sales (including plug-in hybrids) increased 55% in 2022 to exceed 10 million units, accounting for 14% of total vehicle sales *(see Section 4.2 Vehicle Technologies)*.[17] In low- and middle-income countries in Asia, such as India, electric two- and three-wheelers dominate electric vehicle sales.[18]

- Leaders in the automotive sector include BMW, Mercedes-Benz, and Tesla, whose production of light-duty zero-emission vehicles appears to be in line with the IEA's 1.5°C pathway requiring that at least 60% of car and van sales be zero emission by 2030.[19]
- Sport utility vehicles cancel out much of the expected emission reduction between 2022 and 2030 as their share of production is projected to increase from 41% in 2022 to 47% in 2029.[20]
- China is by far the largest electric vehicle market, accounting for 59% of global sales in 2022 and with one in four cars sold being electric.[21]
- Two- and three-wheelers (both passenger and freight) accounted for 95% of the estimated 430,000 zero-emission vehicles sold in India in the fiscal year ending in March 2022 – more than three times the number of the previous year.[22]
- Electric cars are rare in Mexico due to high upfront costs and a lack of charging infrastructure.[23]

Although minimal, some manufacturers have invested in additional measures to support the energy transition in vehicles, such as loans, leasing and sharing schemes for cars and scooters.

- Manufacturers that provided battery swapping and leasing services included Ample and Octillion Power Systems (United States), Gogoro (Indonesia), NIO (China) and Sun Mobility (India).[24]

Auto companies that produce electric buses and trucks, most of which are Chinese, have rapidly gained market share. At the start of 2023, 815 models of electric (battery or fuel cell) buses and trucks were available, up 34% from 2021 and 187% from 2019 (see Figure 6).[25]

- In 2022, the global **electric bus** stock reached 700,000 vehicles (battery electric), reflecting 3% of the worldwide bus fleet.[26] Nearly 66,000 electric buses were sold worldwide, representing 4.5% of all bus sales.[27]
- China again dominated electric bus sales in 2021, while sales in the European Union (EU) picked up due to national and municipal procurement targets as well as the EU Clean Vehicles Directive.[28]
- In Brazil, BYD's sales of electric buses increased greatly after the City of São Paolo mandated that all new public buses must be electric from 2022.[29] Renault launched new electric car models in combination with a Mobilize service focused on "Shift" solutions (i.e. actions to support a shift to more sustainable transport modes) and "Improve" solutions (i.e. actions to improve efficiency of transport modes).[30]
- **Electric truck** sales accounted for only 0.4% of total sales in 2022, resulting in 320,000 electric trucks on the roads in 2022.[31]

Innovation has occurred in hard-to-decarbonise sub-sectors, including on zero-emission trucks, ships and planes; low carbon fuels; batteries and other technologies; and infrastructure (see Table 1).[32] **While policy has played a role, manufacturers also have responded to customer demand and collaborated with suppliers of infrastructure, fuel and batteries, and other technologies.**[33]

For ships and airplanes, the emphasis has been more on alternative fuels than on zero-emission fleets. Sustainable aviation fuels (SAF) that can reduce CO_2 emissions from air travel up to 80% are expected to play a bigger role.[34]

- In 2018, Norway announced that only emission-free ships will be allowed to enter the country's two western World Heritage fjords from 2026, triggering Northern Xplorer to commission construction of a cruise ship that operates on hydrogen.[35]
- The US Inflation Reduction Act stimulates investments across decarbonisation technologies, while the EU's Alternative Fuels Infrastructure Regulations of March 2023 aims to fast-track the uptake of alternative fuels and vehicles.[36]
- SAF production reached at least an estimated 300 million litres in 2022, up 200% from 2021 (100 million litres), and more than 450,000 commercial flights used these fuels during the year.[37]
- However, SAF production in 2022 was still well below the 30 billion litres by 2030 and 450 billion litres by 2050 that are projected to be required annually under the 1.5°C and net zero pathways.[38]

FIGURE 4. Projected production of zero-emission vehicles versus targets set in the International Energy Agency's 1.5°C scenario, 2021-2029

Source: See endnote 16 for this section.

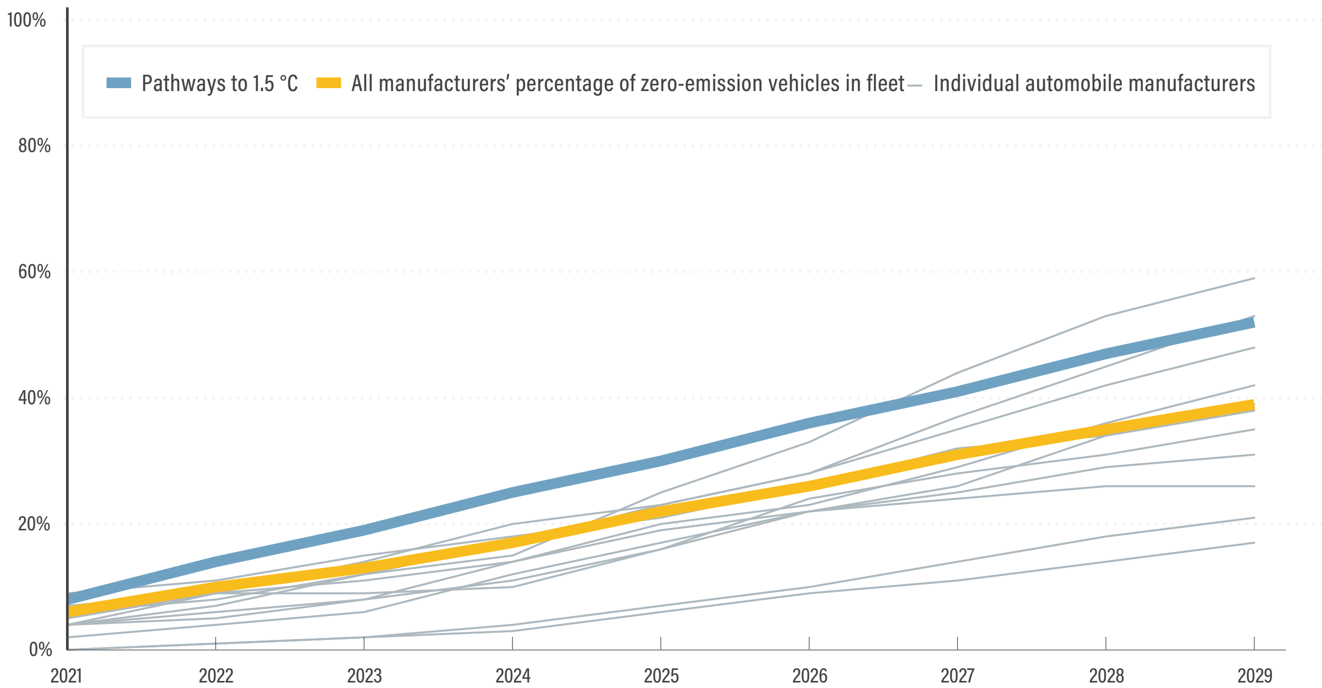


FIGURE 5. Projected composition of the global light-duty vehicle fleet, by technology, 2021-2029

Source: See endnote 16 for this section.

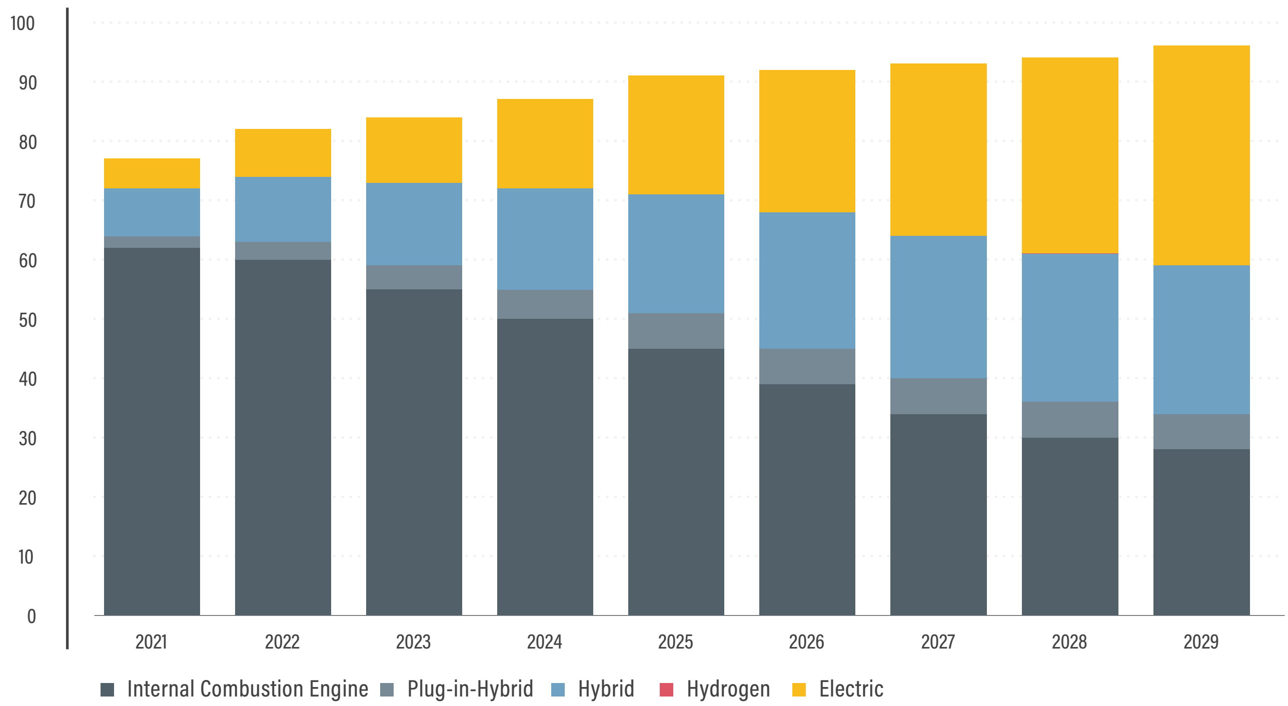


FIGURE 6. Global availability of zero-emission medium-and heavy-duty vehicles, by type, 2021-2023

Source: See endnote 25 for this section.

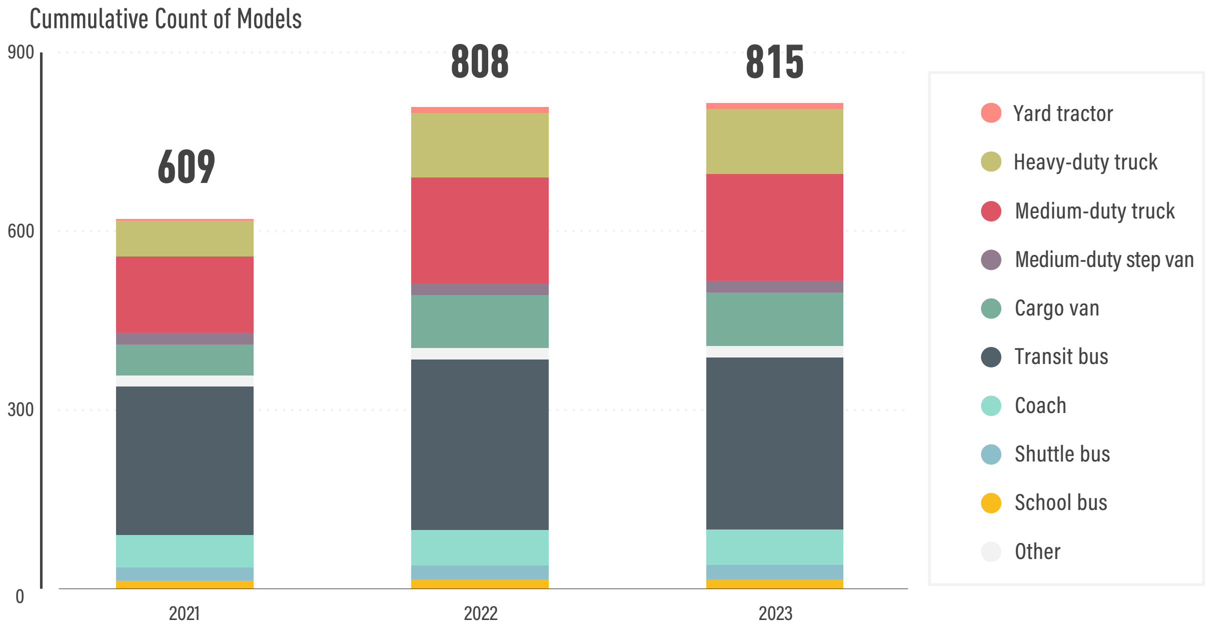


TABLE 1. Examples of innovation in hard-to-decarbonise transport sub-sectors

Source: See endnote 32 for this section.

Medium- and heavy-duty trucks

- Volvo and Man are providing battery-electric beer delivery trucks for Anheuser-Busch InBev to supply Belgian cafés.
- Volvo is testing battery-electric timber trucks with freight forwarder DFDS in Sweden.
- TEVVA is supplying UPS with battery-hydrogen delivery trucks for customers in UK cities.
- MG Motor India is manufacturing battery-electric trucks to transport finished steel rolls.
- Einride is deploying 300 electric trucks for Maersk's North American warehousing, distribution and transport business.
- Daimler, Volvo and Traton formed the joint-venture Milence to introduce public electric vehicle charging points for long-distance trucks in Europe.
- To overcome the investment barrier, Volta is introducing "Truck-as-as-Service" (TaaS), whereby customers lease an electric truck combined with charging and other services.
- Siemens, Vattenfal and Scania are collaborating on electric roads for trucks to charge on while driving, via overhead pantographs or electric coils on the road.

Shipping

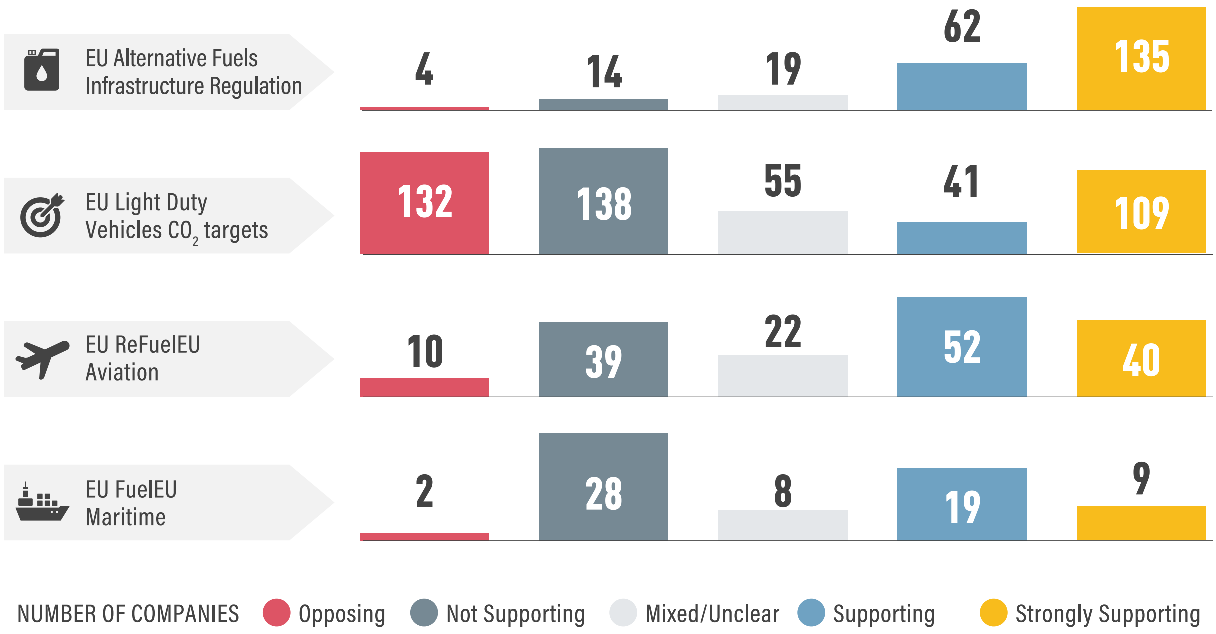
- AP Moller Maersk is exploring the use of methanol-powered ships.
- The E/S Orcelle ship for Wallenius combines electrical systems, wind and wave power, and fuel panels incorporating hydrogen.
- The container feeder vessel ZERO for GL Shipping Company is using liquid hydrogen and hydrogen-powered fuel panels.
- Futureship's zero-emission ferry concept for Scandilines uses hydrogen-powered fuel cells and Flettner rotors to capture wind.
- B9 Cargo Ships are operated through methane fuel (biogas) and wind-derived energy.
- White Orca is powered by wind and hydrogen and will carry aggregates from western to eastern Norway for HeidelbergCement Norway; on return voyages it will transport grain for Felleskjøpet AGRI.

Aviation

- Eviation Aircraft's has developed the electric passenger plane Alice.
- Universal Hydrogen launched a 40-person hydrogen-powered airplane.
- Pyka's autonomous electric Pelican Cargo plane is capable of transporting 400 pounds of cargo 322 kilometres in less than three hours.

FIGURE 7. Policy advocacy positions across transport modes in the EU, as of January 2023

Source: See endnote 39 for this section.



Advocacy

Businesses have been more supportive of infrastructure and incentives for alternative fuels and zero emissions, while being more opposed to carbon dioxide (CO_2) targets, standards and accelerating the phase-out of internal combustion engines and fossil fuels. As of January 2023, a mix of policy advocacy positions existed in the EU among manufacturers and others across transport modes, including strong opposition to CO_2 targets for light-duty vehicles (see Figure 7).[39]

A majority (57%) of 30 benchmarked auto companies in 2021 publicly supported climate policies.[40] Companies with high forecasted production of zero-emission vehicles have tended to be more positively engaged with climate policy as compared to companies that produce mainly internal combustion engine vehicles (see Figure 8).[41] **Meanwhile, many auto manufacturers from Europe, Japan, the Republic of Korea, and the United States, as well as aviation companies, have continued to advocate for climate action while simultaneously lobbying actively to weaken or delay pro-climate policies.**[42]

Companies have often lobbied via their industry associations, which tend to take a more conservative approach to climate policy engagement (see Table 2).[43] **Meanwhile, there is greater unity on lobbying for a Just Transition for automotive workers.**

- Volvo Cars left the European Automobile Manufacturers Association in 2022 over misalignment on climate goals, and other companies may follow, upon assessments of their respective industry associations.[44]
- In Europe, both non-governmental organisations and industry associations called for the EU to develop a Just Transition framework for automotive workers, arguing that "Alongside higher climate ambition, we want to see industrial transformation and innovation in Europe rather than deindustrialisation and social disruption".[45]
- The German government and several European organisations established the Just Transition in the European Car Industry project to support the sector in the just and climate-friendly transition.[46]

Accountability

Disclosure of climate-relevant information by companies is becoming mainstream – with more than 18,000 companies disclosing to CDP in 2022 – but gaps in accountability remain. In 2022, 419 transport manufacturers (including 251 automakers) responded to the 2022 CDP climate questionnaire, the results of which are used to inform investors and other stakeholders.[47]

FIGURE 8. Zero-emission vehicle production and climate policy engagement, by region

Source: See endnote 41 for this section.

The graphic below compares the climate policy engagement score (assessed by InfluenceMap) of major automakers with their forecasted percentage production of zero-emission vehicles by 2029 (InfluenceMap analysis of S&P Global Mobility data). The bubble size represents the relative proportion of vehicle production compared to other major global automakers.

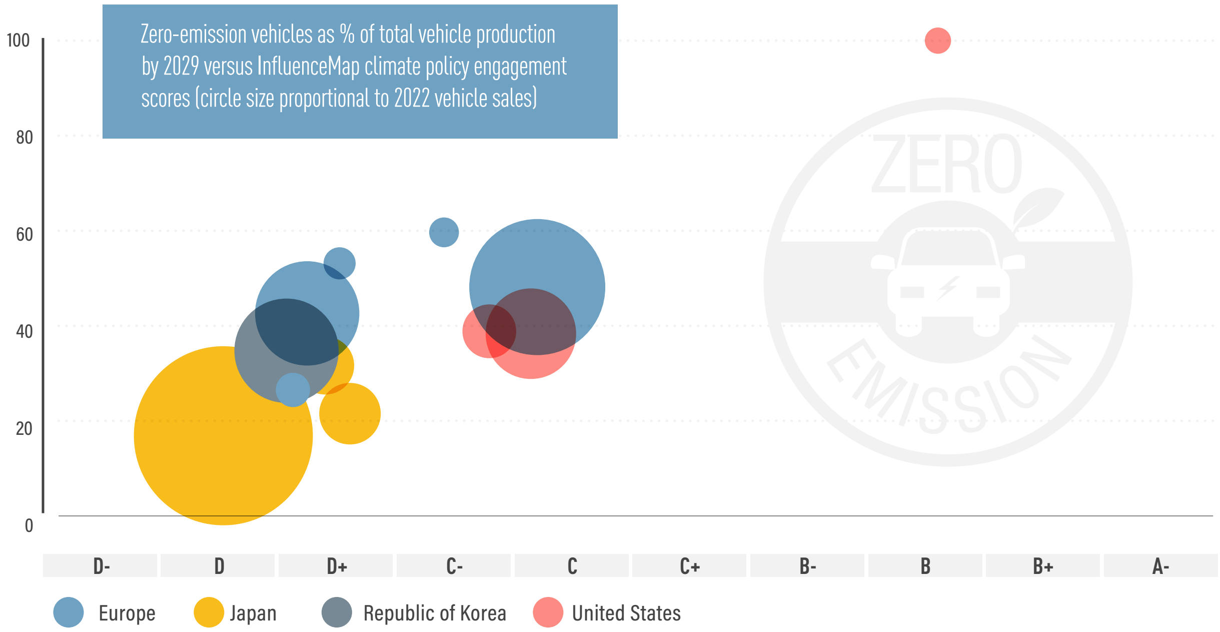


TABLE 2. Climate policy engagement among auto industry associations

Source: See endnote 43 for this section.

Auto industry association	Region	InfluenceMap rating	Engagement intensity
European Association for Electromobility (AVERE)	EU	B+	37%
European Automobile Manufacturers Association (ACEA)	Europe	C-	42%
Society of Motor Manufacturers and Traders (SMMT)	Europe	C-	17%
European Association of Automotive Suppliers (CLEPA)	Europe	D+	37%
German Association of the Automotive Industry (VDA)	Europe	D-	51%

Note: The rating (A+ to F) is a measure of how supportive or obstructive a member company's direct engagement is towards climate policy aligned with the Paris Agreement. Engagement intensity is a measure of the level of policy engagement by the company, whether positive or negative.

Providers of public and freight transport

Providers of public and freight transport include companies that provide public transport services, such as taxi, bus, rail companies and ferry operators, and companies that provide freight transport, delivery and logistics services including by road, rail, water and air.

Ambition

A majority of transport companies have set goals and targets for reducing greenhouse gas emissions, but ambition must be raised. As of 2022, more than 58 countries and one-fifth of the world's largest companies had committed to reaching carbon neutrality.[48]

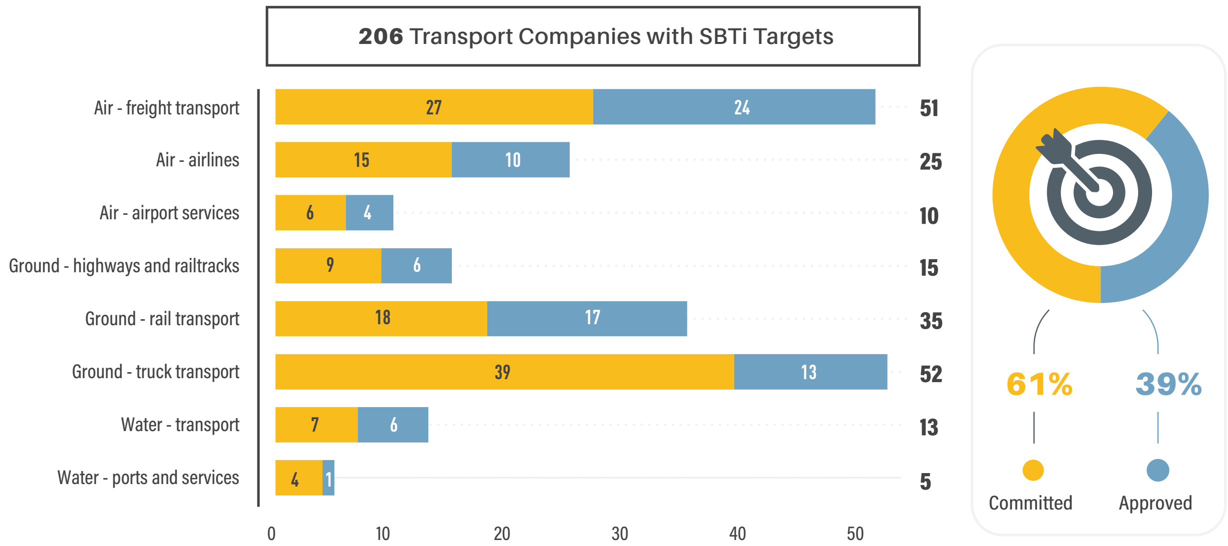
- As of March 2023, 206 transport companies had joined the Science Based Targets initiative (SBTi), of which 61% (125) had committed targets and 39% (81) had approved targets (see Figure 9).[49]
- However, a 2022 benchmark of 90 of the world's largest transport companies found that while 51% (46 companies) had set net zero goals, of those only 7% (6) had set interim targets between 2030 and their net zero year.[50]

A next frontier is for transport companies to commit to phasing out fossil fuels in the transport sector, which relies on oil-derived products for more than 90% of its energy and is more dependent than other sectors on the oil industry.[51]

- Of 90 benchmarked transport companies, only 7% (6 companies) have committed to phasing out fossil fuels: Deutsche Bahn, DSV, MSC Mediterranean Shipping Company, JD Logistics, NS Groep and ZTO Express.[52]
- Logistics firm DP-DHL has set a net zero target for 2050 as well as SBTi-approved 1.5°C-aligned targets for 2030, broken down between scope 1, 2 (42% reduction) and 3 (25% reduction) emissions; it has allocated EUR 7 billion (USD 7.5 billion), mainly for alternative fuels for air transport, expansion of the zero-emission electric vehicle fleet and climate-neutral buildings.[53]
- Dutch railway company NS Groep committed to both a net zero target and to phasing out fossil fuels, and has a business model for electrification and inter-modal transport to make this happen.[54]
- Singapore-based Comfortdel Gro, which offers car rentals, taxis, buses and light-rail transport, has SBTi-approved 1.5°C-aligned targets for scope 1, 2, and 3 emissions, backed by a detailed transition plan informed by scenario analysis; in addition, its board has climate change oversight and significant expertise related to the low carbon transition.[55]
- The UK's Royal Mail plc has set a 2045 new zero target along with executive incentives and a detailed low carbon transition plan informed by climate scenario analysis including a 1.5°C scenario.[56]
- Rail freight company ÖBB RCG has committed to carbon neutrality of its mobility sector by 2030 and of the entire company by 2040/50 through six key strategies; already, its rail operations in Austria, Germany and the Czech Republic are powered exclusively by green traction current.[57]

FIGURE 9. Transport companies with SBTi targets, by sector

Source: See endnote 49 for this section.



Action

A clear gap remains between transport companies' ambitions, as set in their targets, and the quality of their climate transition planning, with a variety of surveys and studies pointing to vast potential for improved action.

- Among the 930 transport services companies worldwide that disclosed to CDP in 2022, only 2 companies had climate transition plans that included all 21 of the indicators of a "credible plan"; meanwhile, 685 companies (74%) had plans that included fewer than 7 of the 21 indicators of a credible plan (see Figure 10).[58]
- A transport benchmark that assessed 90 leading transport companies and the comprehensiveness of climate transition plans found that while most companies had elements of plans, half or less included specific targets, financial details or data around how to achieve them (see Figure 11).[59]
- An assessment found that 2,000-plus transport companies scored an average of 48 out of 100 for environmental performance in 2022, with little difference between the scores of large companies (49.3) and small and medium-sized companies (47.7).[60]

Based on what companies have disclosed, it is evident that many may not have determined the actions or allocated the funding required to meet their targets. However, some companies have disclosed new business models and strategies that, if scaled across the sector, could have a significant impact.

- Of the 90 benchmarked transport companies, only 4 (4%) – CJ Logistics Corporations, MTR, Tokyu Corporation and NS Group – provided data on their current and future fleets, and only 5 (6%) provided information on research and development investments for low carbon technologies.[61]
- Of 27 benchmarked multi-modal companies, 22% (6 companies) have disclosed modal shifts.[62] The US Postal Service plans to switch its sub-contracted air operations to a ground fleet, and J.B. Hunt Transport Services has an agreement with a railway company to switch from road-only to inter-modal road and rail operations that are expected to be 2.5 times more fuel efficient.[63]
- Of the 90 benchmarked transport companies, 9% (8 companies) have disclosed plans to change demand patterns towards low carbon transport modes through, for example, route electrification or inter-modal transport; of these, 4 companies – Go-Ahead Group, J.B. Hunt Transport Services, NS Groep and UPS – have profitable and substantial business models.[64]
- In 2022, Amazon announced that it would invest more than EUR 1 billion (USD 1.1 billion) by 2027 towards fleet electrification, including tripling its electric fleet in Europe from 3,000 to more than 10,000 units by 2025.[65]
- Of 37 companies that offer multi-modal freight transport, 55% (20 companies) disclosed that they invest in **digital solutions** such as route optimisation and reducing empty kilometres, with UPS and Royal Mail plc reporting that these solutions reduce emissions.[66]

FIGURE 10. Transport companies with climate transition plans, by level of credible coverage

Source: See endnote 58 for this section.

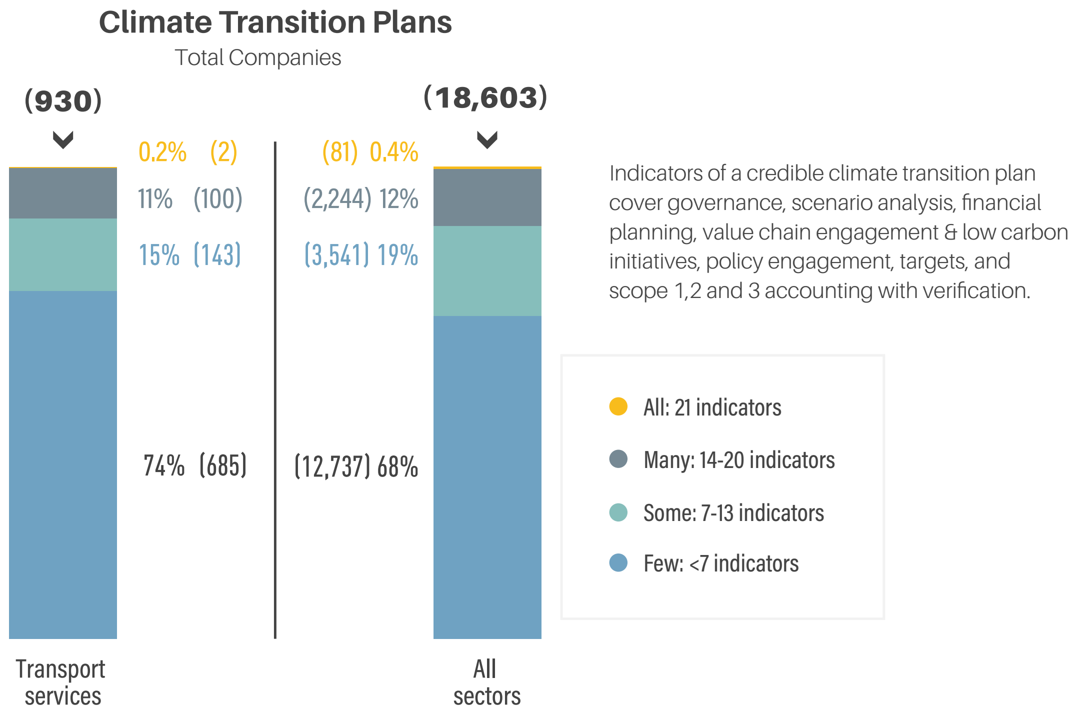


FIGURE 11. Comprehensiveness of climate transition plans of 90 transport companies

Source: See endnote 59 for this section.

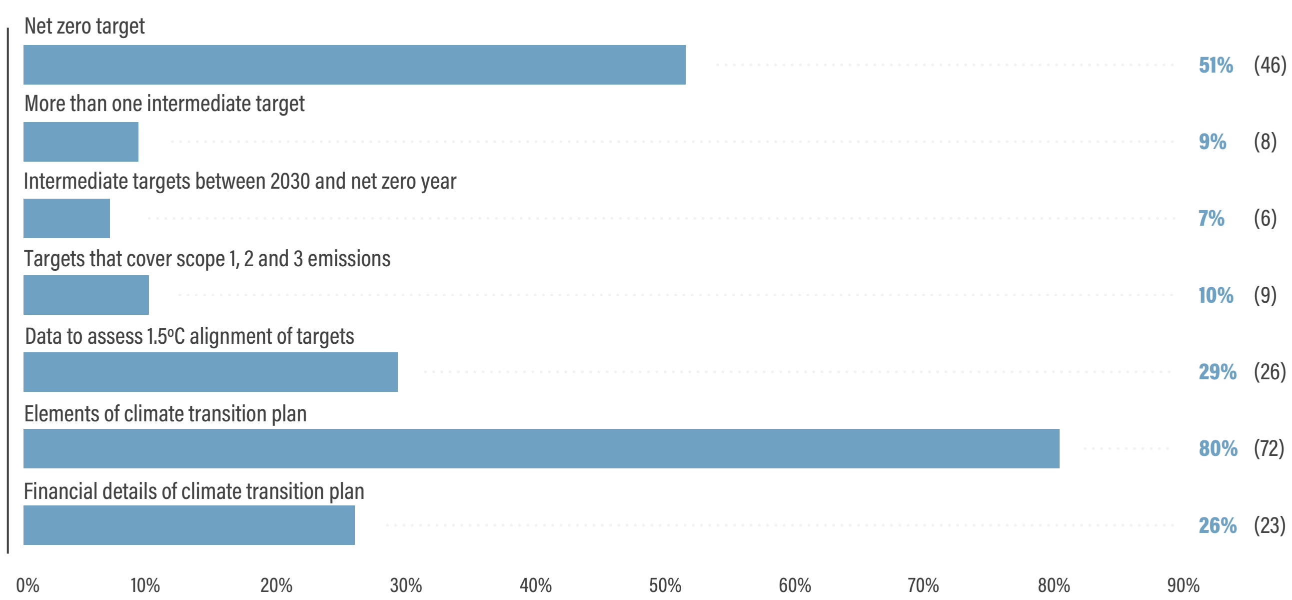
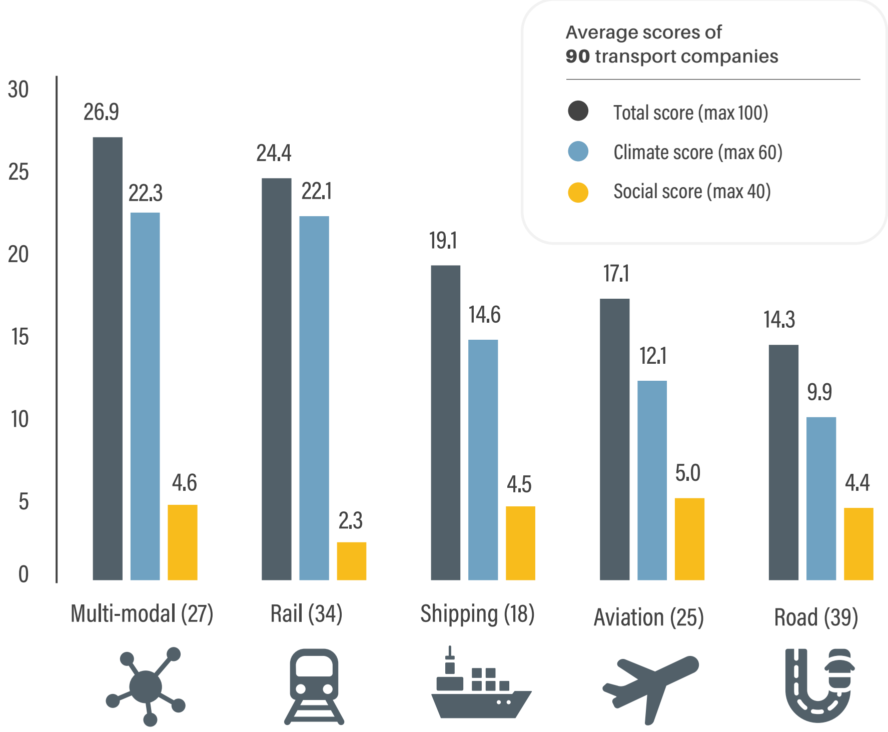


FIGURE 12. Average climate and social performance of 90 transport companies, by mode

Source: See endnote 67 for this section.



Globally, transport companies under-perform on the social side of climate and sustainability, including human rights, just transition, decent work and ethical conduct (see Figure 12)**, even though this is considered critical for the successful implementation of a climate transition plan.**[67] Highlights in stakeholder engagement by 90 transport companies include the following.[68]

- None of the 90 companies cover planning for a **just transition** with time-bound targets, putting an estimated 10 million workers at risk.[69] However, 13% (12 companies) commit to **social dialogue** with workers, unions and other groups, and A.P. Moller Maersk notes its engagement with stakeholders including workers, unions, local communities, governments, civil society and multi-stakeholder initiatives.[70]

- In the survey, 38% (34) of companies undertake measures for **skills, training, and education**, including job opportunities for women and vulnerable groups (13%, 12 companies) and reskilling (7%, 6), with FirstGroup making a public commitment to reskilling and upskilling.[71]

- Among the 90 companies, 43% (39 companies) have **human rights policy** commitments, but only 3% (3) have a due diligence process covering human rights risks.[72] At the 2021 UN Climate Change Conference in Glasgow, UK (COP 26), the Maritime Just Transition Task Force was founded to look after seafarers in the transition towards a decarbonised shipping industry.[73]

- Among the 90 companies, 44% (31 companies) **engage with suppliers** on environmental issues that go beyond integrating climate considerations into the supplier code of conduct.[74] Of the 43 shipping and aviation companies surveyed, only 9% (4 companies) show evidence of working with manufacturers or fuel providers on low carbon vehicle research and development that has led to emission reductions.[75]

- Of the 44 companies with **sub-contracted activities**, 48% (21) have a strategy for working with sub-contractors to reduce emissions, despite 17 of these companies having a net zero target.[76] Deutsche Post DHL Group has a clear strategy for sub-contractors, including targets for alternative fuels and vehicles and a proven record of reducing emissions.[77]

- Of the total 90 companies, 48% (43 companies) have a strategy to **influence customers** to reduce emissions, for example through marketing campaigns or by offering customers low carbon alternatives; however, no company has set reduction targets for its customers.[78]

Advocacy

Inconsistent policy advocacy by transport companies risks delaying the climate action that companies need in order to meet their own emission reduction targets. Many of these companies are members of transport-related industry associations that tend to take a conservative approach to climate policy advocacy, particularly for shipping and aviation (see Table 3).[79]

- Around 54% (49 companies) of the 90 surveyed transport companies publicly support climate policies, but nearly half do not, despite many of them having climate targets and plans.[80]
- Only three companies – Maersk, Deutsche Bahn and Mediterranean Shipping Company – showed sufficient support for climate policy to be aligned with the low carbon transition.[81]

Accountability

Disclosure of climate-relevant information by large transport companies is becoming mainstream, with 930 transport service providers responding to CDP's climate change questionnaire in 2022.[82]

- Of 90 benchmarked transport companies, 84% (76 companies) had board-level oversight on climate change, but only 40% (36) had financial incentives tied to emission reductions for executives, and 10% (9) had such incentives for employees; only 6% (5) had significant climate change expertise at the board level.[83]
- The British transport service company FirstGroup offers incentives in the executive director's long-term incentive plan, with sustainability metrics accounting for 10% of this area of remuneration.[84]
- Hundreds of transport companies, as well as their customers, apply the **GLEC Framework**, the only globally recognised methodology to help companies harmonise the calculation and reporting of the logistics greenhouse gas footprint across the multi-modal supply chain.[85]
- **The new ISO 14083 standard on quantification and reporting of greenhouse gas emissions from transport operations, covering all transport modes, was released in March 2023 and is expected to increase and improve the quality of disclosure.**[86]

TABLE 3. Climate policy engagement among transport industry associations

Source: See endnote 79 for this section.

Industry association	Region	InfluenceMap rating	Engagement intensity
Airports Council International Europe (ACI Europe)	Europe	C-	26%
World Shipping Council (WSC)	North America	D+	33%
European Regions Airline Association (ERA)	Europe	D+	22%
European Community Shipowners' Associations (ECSA)	Europe	D	34%
Airlines For Europe (A4E)	Europe	D	49%

Note: The ranking (A+ to F) is a measure of how supportive or obstructive the company's direct engagement is towards climate policy aligned with the Paris Agreement. The engagement Intensity is a measure of the level of policy engagement by the company, whether positive or negative.

Companies that use transport

Companies are customers of transport through their own fleets and through public and freight transport services provided by third parties. Companies that have goods and products transported by third parties are also referred to as "shippers". These customers of freight can use their purchasing power to increase climate and sustainability ambition, advocacy, action and accountability for freight transport.

Ambition

More than 2,400 companies covering more than a third of the global economy's market capitalisation – including 43 transport manufacturers and 124 transport service providers – have approved science-based targets for reducing greenhouse gas emissions.[87] However, it is unclear how many of these companies have set specific transport-related emission reduction targets. Meanwhile, a growing number of companies have committed to decarbonising their fleets.

- **EV100** brings together more than 120 companies across 98 markets to transition their own or sub-contracted fleets of 5.5 million vehicles to electric vehicles, and to install charging infrastructure for employees and customers that will avoid 85 million tonnes of CO_2 by 2030.[88]
- In 2022, this was expanded with **EV100+** to cover zero-emission medium- and heavy-duty vehicles, sending a powerful demand signal to vehicle manufacturers and governments to accelerate the market scale-up worldwide.[89]
- The **Corporate Electric Vehicle Alliance (CEVA)** accelerates the deployment of zero-emission vehicles in the United States by aggregating demand, advocating for strong policies at multiple levels and sharing best practices on fleet electrification.[90] CEVA's 28 corporate members include Amazon, AT&T, IKEA, the National Grid and Uber, which collectively represent more than USD 1 trillion in annual revenue, and own, lease or operate more than 1.3 million on-road fleet vehicles in the United States alone.[91]
- Through the **First Movers Coalition**, shippers commit that by 2030 that they will: 1) use transport providers that only purchase zero-emission medium- and heavy-duty trucks; 2) ship at least 10% of goods internationally on ships using zero-emission fuels (and 100% by 2040); and 3) replace at least 5% of conventional jet fuel demand for air transport with SAF and/or zero-carbon emitting propulsion technologies.[92]

Photo: Ennis Schroeder / NREL

Action

Companies have taken actions related to their own fleets, including electric vehicles, biking and working from home.

- By 2022, **EV100** members had collectively deployed more than 200,000 electric vehicles and installed over 20,000 charging units at more than 3,000 locations, with 91% of members procuring at least some renewable energy for their chargers.[93]
- Research found that electric cars and vans could exceed 50% of new vehicle sales by 2032, with **electrified fleets** generating nearly half of those sales in certain more advanced geographic regions.[94]
- Companies have encouraged employees to **bike to work**, such as Tableau, Google, and Facebook in the United States, and an increasing number of companies are offering **work-from-home** opportunities, such as Amazon, Apple, Salesforce, and Wells Fargo.[95]

Shippers hold the key to making structural changes to freight transport by shifting to low carbon modes and reducing demand. Although statistics are lacking, numerous examples are available from leading shippers (see Table 4).[96]

Many companies have shown greater advancement in general energy-related measures than in tackling transport. In a survey of 129 supply chain executives, 71% stated that their business is undertaking environmental initiatives covering logistics warehousing, especially LED lighting (29%), followed by the use of alternative energy (22%), such as solar panels and ground-source heat pumps, but only 7% electric vehicles for delivery and distribution.[97]

TABLE 4. Strategies that shippers are using to "Shift" and "Avoid" emissions from freight transport

Source: See endnote 96 for this section.

Strategies	Examples from leading shippers
Revisit existing industrial processes and business models to reduce the number of freight movements.	■ **Interface** has been collecting and recycling post-consumer vinyl backed carpet tiles for over 20 years and produced its first 100%-recycled nylon carpet in 2010. ■ **Patagonia** introduced its Take-Back programme in 2021 to recycle old cotton products while supporting recycling chains for clothing waste.
Revamp industrial facilities and suppliers to reduce spatially fragmented supply chains.	■ **Cisco Systems, Schneider-Electric and Colgate-Palmolive** lead the Gartner Supply Chain Top 25 companies on excellence in supply chain management. ■ **LG Energy Solutions** (Republic of Korea) plans battery factories in Europe and US markets where demand is high.
Change logistics organisations and lower transport service levels to support the consolidation of flows and facilitate modal shift.	■ **IKEA** works with its transport providers and peers to reduce shipments and energy, replace with cleaner fuels and modes, and rethink the supply chain.

Advocacy

Policy advocacy to accelerate the uptake of electric vehicles has been strong among companies that have fleets and use transport services.

- Up to 78% of EV100 members believe that supportive policies from state, regional and city governments are vital to creating the right political climate for systemic change.16 Letters from EV100 members and supporting organisations to EU policy makers called for, among others, stronger CO_2 performance standards, sales of new buses to be zero emission by 2027 (and for new cars, vans and trucks by 2035), revision of the Alternative Fuels Infrastructure Directive to support more charging infrastructure, and exclusion of road transport from EU emission trading.[98]
- India's Ministry of Power issued guidelines for electric vehicle charging infrastructure in early 2022, which included four recommendations based on electric vehicle policy guidelines and an EV Ambition Statement initiated by the World Business Council for Sustainable Development (WBCSD) together with 30 companies.[99]
- Globally, nearly 800 companies called on government leaders to accelerate climate action, including the electrification of transport.[100]
- In Europe, it was mainly companies as transport customers that called for acceleration of the shift to electric fleets and for all new trucks sold to be net zero emissions by 2035.[101]

Industry associations that cover multiple sectors but also cover transport have tended to take a more conservative approach to climate policy advocacy, as shown for European associations (see Table 5)**.**[102]

TABLE 5. Climate policy engagement among auto industry associations in Europe

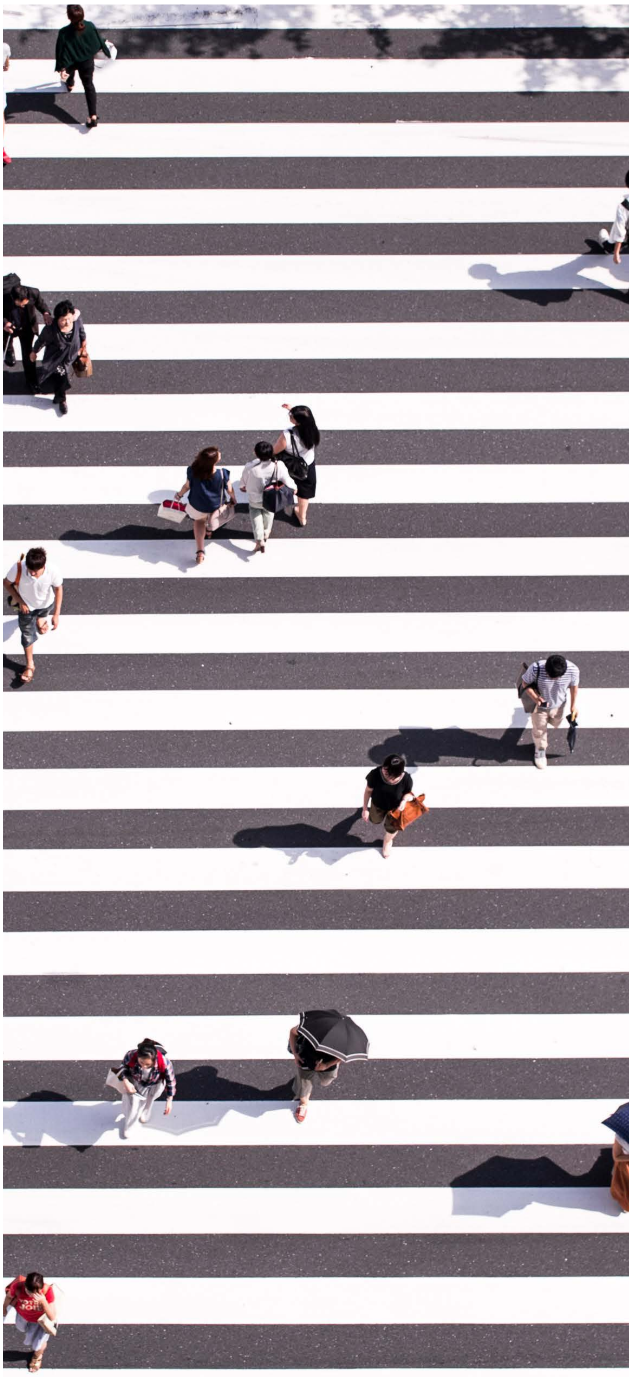
Source: See endnote 102 for this section.

Industry association	InfluenceMap rating	Engagement intensity
Corporate Leaders Group (CLG)	A	53%
Confederation of British Industry (CBI)	B+	36%
European Round Table for Industry (ERT)	C+	22%
Dutch Employers' Federation (VNO-NCW)	C-	27%
Mouvement des Entreprises de France (MEDEF)	D	38%
Spanish Confederation of Business Organizations (CEOE)	D	32%
Federation of German Industries (BDI)	D	60%
Confederation of Italian Industry (Confindustria)	D	54%
International Federation of Industrial Energy Consumers (IFIEC)	D-	34%

Note: The rating (A+ to F) is a measure of how supportive or obstructive the company's direct engagement is towards climate policy aligned with the Paris Agreement. Engagement Intensity is a measure of the level of policy engagement by the company, whether positive or negative.

Accountability

Although the disclosure of climate-relevant information by companies is becoming mainstream, little is known about the disclosure of companies (other than transport manufacturers and companies that provide transport services) on their transport emissions, targets and efforts to reduce emissions.[103] A 2019 survey of 2,604 companies concluded that disclosure is lacking, with just over 500 companies (around 20%) reporting scope 3 or supply chain emissions for transport, covering only 10% of global transport emissions.[104]



Opportunities to accelerate industry action

While many gaps remain to be addressed, there are three areas where the biggest opportunities lie to deliver on transport decarbonisation with strong support from businesses.

1

Improving business climate leadership can help prevent greenwashing, as leaders must follow through on their ambition with credible action, advocacy and accountability.

Setting science-based and other targets is not sufficient. The UN High Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities provided 10 recommendations for companies to ensure that pledges towards net zero do not lead to greenwashing.[105] Companies that do not have a plan yet can develop one using the ACT Step-by-Step methodology. To enhance the credibility of plans they can use CDP guidance to report on their plans, take part in global benchmarks and publish third-party reviews of plans.[106]

Companies can improve the comprehensiveness of their climate transition plans that detail emission reduction measures, how action is integrated in business governance and strategy, policy lobbying and advocacy efforts, and a just transition for the workforce, suppliers and communities.[107] For transport, actions should focus more on shifting and avoiding transport – through, for example, walking, cycling, public transport, fuller truck loads, local sourcing and working from home – while integrating gender considerations. Companies should balance out unabated emissions by purchasing only high-integrity carbon credits.

More companies should engage in policy advocacy, showing that business backs ambitious climate policy and bringing their expertise on what it will take to put it into practice. This includes:[108]

- Make a public commitment to advocate for ambitious climate policy and engage key stakeholders.
- Publicly advocate for bold science-based climate policies, and call out those that obstruct the 1.5°C pathway.
- Align the climate policy advocacy of a company's trade associations, alliances and coalitions with the goal of net zero by 2050.
- Allocate advocacy spending to advance climate policies, not obstruct them.
- Disclose how memberships, financial contributions and direct engagement on climate policy support own climate ambition and action, while reporting misalignments and plans to address them.

For enhanced accountability, companies should be pro-active in disclosing on climate before they are eventually forced by investors and regulators to do so.

- The **International Sustainability Standards Board (ISSB)** has a new climate disclosure standard to meet investors' needs for sustainability reporting, starting as early as 2024.[109]
- The **EU Corporate Sustainability Reporting Directive** will require large companies and all listed companies that operate in the EU to disclose on sustainability issues to inform investors and other stakeholders, from 2024 onwards.[110]

2

Companies can be leveraged for wider system change to complement technological changes and in responding to climate impacts.

There is an over-reliance on technology-focused "Improve" strategies, despite growing evidence that "Avoid" and "Shift" strategies can contribute to 40-60% of transport emission reductions at lower costs.[111] The Intergovernmental Panel on Climate Change has further identified 10 systemic changes for transport to complement technological changes that will also contribute to sustainable economies and societies more broadly: 1) changes in urban form, 2) investment in transit and active transport infrastructure, 3) changes in economic structures, 4) teleworking, 5) dematerialisation of the economy, 6) supply chain management, 7) e-commerce, 8) smart mobility, 9) shared mobility and 10) vehicle automation.[112]

Companies can bring unique expertise, innovation and financing to the table. For example, logistics companies are best placed to help redesign freight transport systems to facilitate a circular economy. In all of this, inclusivity is key, taking into account gender, race, and age and ensuring that small and medium-sized businesses in the transport sector are active participants in the transition.

Transport companies will be essential to help prepare the world for the impacts of climate change, in at least three main areas: 1) by supporting climate adaptation efforts through, for example, construction to strengthen infrastructure, or providing water with trucks/trains to drought-stricken cities; 2) by providing services for climate disaster relief, such as transporting food, medicines, and shelters, as well as transporting people to safer areas; and 3) by building resilience in supply chains to increasing disruptions, for example by switching from just-in-time to just-in-case supply chains.[113]

3

Companies can engage in more effective collaboration by complementing other stakeholders in climate and sustainability actions, working with all partners in the value chain, supporting just transition pathways for transport and joining initiatives that will truly help deliver the transition.

Several key opportunities exist for more effective collaboration.

First, companies should identify their unique roles alongside other stakeholders. The **Roadmap towards Zero Emission Logistics 2050** gives examples of complementing roles for different freight decarbonisation actions.[114]

Second, transport manufacturers and other companies should play to their strengths to mobilise change together with value chain partners:

- Support customers from transport, who cover virtually all sectors, to reduce their transport carbon footprint and to move towards circularity that includes the (re-)design of the transport system. Both manufacturers and logistics companies have hundreds of customers, both from industry and government, and virtually all small and medium-sized businesses are transport customers.
- Educate consumers about sustainability and climate to reduce transport emissions not only from (retail and online) purchases but also from the products they buy, as shops and online platforms provide a unique opportunity to communicate with consumers.
- Truly collaborate with suppliers in realising joint long-term climate and sustainability goals instead of allowing short-term contracts and lowest-cost suppliers to override sustainability decisions.

Third, companies should step up their role in the just transition through **Just Energy Transition Partnerships (JETPs)** or other country-level frameworks. In South Africa, the National Business Initiative led the development of just transition and climate pathways for transport together with the private sector and other relevant stakeholders.[115] South Africa's transport sector can decarbonise by 2050 via four key levers including improved spatial planning; mode-shift to rail and public transport; accelerated zero-emission technology adoption, coupled with the decarbonisation of the national grid; and use of green fuels for hard-to-abate aviation and shipping.

The IEA expects investments in clean energy to reach USD 1.7 trillion and to outpace the USD 1 trillion in fossil fuel investments in 2023, as investors turn to energy efficiency, electrification, and renewables, including in the transport sector. Factors contributing to this investment boom include the COVID-19 pandemic, the Russian Federation’s war in Ukraine, and increasing concerns about energy security and climate change.[116]

Finally, ample coalitions, partnerships and initiatives on transport exist to support manufacturers, transport providers and customers on the road to a decarbonised transport sector. The key lies in pro-actively identifying those that can best help to deliver on a company’s climate and sustainability goals.

Photo: ADB

BOX 1. The Role of Companies in Decarbonising Global Freight and Logistics

AUTHORS: Sandra Rothbard, Rik Arends and Tharsis Teoh – *Smart Freight Centre*

Achieving net zero greenhouse gas (GHG) emissions by 2050 will not be possible without major changes in global supply chains. Freight transport accounted for around 42% of the GHG emissions from transport in 2019, and these are projected to grow 22% between 2019 and 2050 under a business-as-usual scenario (if no further action is taken) (*see Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).[1] Freight transport is a key component of supply chains that connect businesses across the economy. Because nearly all companies have outsourced at least some of their logistics operations, their efforts to achieve net zero emissions would require assessing the entire value chain, which is a complex undertaking but could be achieved using existing programmes focused on operations.

Opportunities by transport mode

In the longer term, the decarbonisation of freight transport will be achieved mainly through the transition of the energy supply from fossil fuels to renewables. However, the development of sustainable fuels for maritime transport and aviation has been much more limited than for other modes. As of 2019, the GHG emissions from road and aviation freight – measured as well-to-wheel CO_2 equivalent emissions per tonne-kilometre – were higher than the emissions from rail, inland waterways and maritime shipping **(see Figure 13)**.[2]

The International Energy Agency's scenario for net zero GHG emissions requires reducing transport CO_2 emissions (passenger and freight) 90% below 2020 levels by 2050, with the highest reductions being in road transport, followed by rail, shipping and aviation.[3] Freight transport emissions could be reduced 76% below 2020 levels by 2050 with policies that support higher operational efficiencies, optimised routing and asset sharing, freight consolidation, enhanced collaboration in supply chains, shifts to railways or inland waterways, standardisation and low-carbon solutions (*see Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).[4]

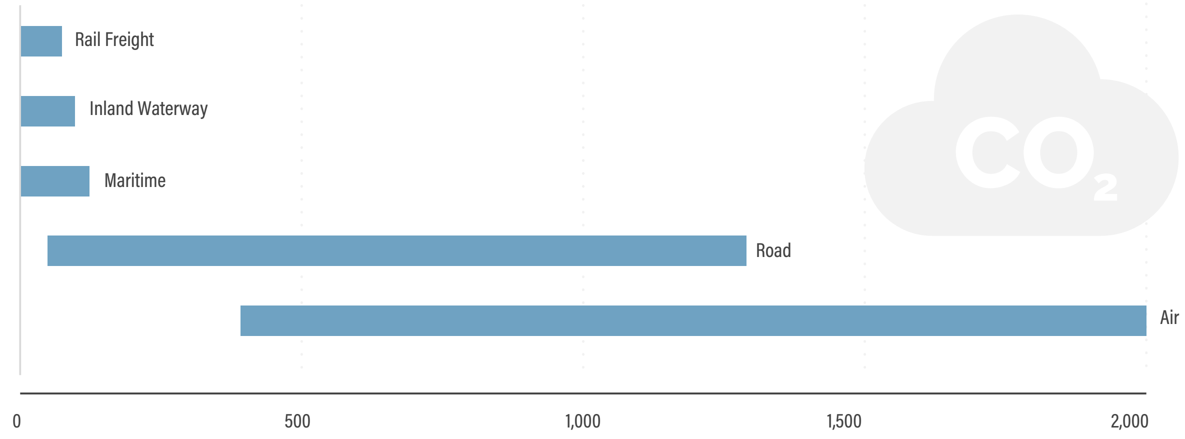
Rail: Already, around half of all rail freight activity is electrified (*see Section 3.5 Rail*).[5] Increasing the modal share of rail thus could be an opportunity to reduce overall emissions. Rail is expected to account for a growing share of non-urban freight activity, particularly over longer distances.[6] Companies can capitalise on existing rail freight networks by collaborating horizontally to consolidate shipments and by partnering with reliable intermodal operators. IKEA collaborated with partners on transporting goods on a 2,000-kilometre non-stop rail trip (round-trip from Poland to Spain), reducing the need for around 4,500 trucks.[7]

Road: Around 60,000 electric medium- and heavy-duty trucks were sold in 2022 (1.2% of all trucks globally), with around 85% of the sales taking place in China.[8] Electric light-duty vehicles made up 8.3% of global car sales in 2021.[9] By 2030, 40% of all new truck sales in Europe and the United States are projected to be zero emission, in line with the Global Memorandum of Understanding for Medium- and Heavy Duty Vehicles; this is more than the currently planned supply of vehicles.[10] Through the EV100 campaign, 121 companies worldwide committed to transitioning their fleets to electric by 2030, covering 5.5 million vehicles and

BOX 1

FIGURE 13. Indicative emission intensity ranges by transport mode (well-to-wheel grams of CO_2 equivalent per tonne-kilometre)

Source: See endnote 2 for this section.



potentially avoiding 85 million tonnes of CO_2.[11] Companies must begin now to develop the appropriate infrastructure, increase the sectoral expertise, and test new collaborative models with carriers, most of which are small and medium operators. Holcim, a company that creates building materials, announced a plan to deploy up to 1,000 electric trucks by 2030.[12]

Maritime: In 2023, the International Maritime Organization (IMO) adopted a revised strategy to reduce GHG emissions from international shipping at least 70% (and striving for 80%) below 2008 levels by 2040. This is a major improvement to the IMO's initial (2018) strategy that aimed only for a 50% reduction by 2050. Shipping lines must begin by calculating the Energy Efficiency Existing Ship Index and Carbon Intensity Indicator of their vessels. Deep reductions require the adoption of zero-emission fuels, which are not yet produced at scale. Companies should team up with carriers to swiftly implement efficiency measures such as slow steaming (slowing speeds to reduce fuel use), even if it affects product time-to-market, and prioritise the prompt deployment of low-emission fuels. Maersk is working to decarbonise its fleet by introducing carbon-neutral methanol-powered container vessels as of 2024.[13]

Aviation: In October 2021, the member airlines of the International Air Transport Association committed to achieving net zero emissions by 2050.[14] A year later, the International Civil Aviation Organization set a new long-term global aspirational goal of net zero carbon emissions by 2050.[15] Sustainable aviation fuels (SAF) and e-fuels have been promoted as solutions for achieving net zero emissions in the sector. SAF is produced from second-generation biogenic feedstocks (for example, waste products) but is constrained by limited availability, while e-fuels are produced synthetically and reduce CO_2 emissions up to 80%, although they are not yet produced at scale and remain costly.[16] Despite this, companies can make major changes now. Shipping companies should support the decarbonisation efforts of air freight carriers by choosing and paying premiums associated with carriers that use SAF, invest in fuel-efficient aircraft and optimise air traffic management. Boeing has launched a dashboard that tracks and projects SAF production.[17]

Approaches for companies to tackle emission reductions

Many companies today have a corporate social responsibility (CSR) plan – a business model developed in-house that outlines how the company will remain socially, economically and environmentally accountable. Despite good intentions, however, there is risk of simply "checking the box" and doing the minimum to comply with such standards and regulations. A disconnect is observed between the CSR targets of companies and their day-to-day operations focused on efficiency and cost.[18]

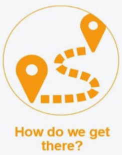
The Smart Freight Centre has developed a four-step framework to offer a systemic approach for companies to decarbonise global freight and logistics:

Report and calculate credible emissions across the multi-modal supply chain

Private sector entities, such as Unilever and DHL, understand their logistics footprint by using the guidance and calculation framework provided by the Global Logistics Emissions Council (GLEC) framework.[19] This is built on the GHG Protocol and meets legislative requirements, such as the monitoring, reporting and verification scheme from the IMO and the European Union's (EU) forthcoming Corporate Sustainability Reporting Directive requirements in 2024.[20]

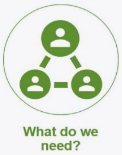
Set targets for emission reduction thatare sceince-based

Initiatives such as the Science Based Targets Initiative (SBTi) guide and vet the emission reduction targets of companies to ensure that they are consistent with the Paris Agreement.[21] Once targets are set, businesses can be held accountable and must adjust operations to achieve their goals. These external commitments also support internal alignment within the company to achieve said targets (see *Section 1.3.3 The Role of Business in Decarbonising Transport*).



Reduce emissions by implementing solutions as buyer or supplier

Across all modes of freight, companies are implementing operational changes to decarbonise supply chains by increasing filling rates, reducing empty kilometres and optimising their logistics systems. Currently, substantial under-utilisation of vehicle capacity exists, with 20% of truck-kilometres running empty in the EU.[22] By working together, multiple businesses can share vehicles to save space and money. Digitalisation and operational improvements can greatly reduce emissions and energy consumption through improvements in efficiency.



Collaborate and advocate for sector-wide and supportive policy

Decarbonisation of transport is a systemic change that will require alignment, co-operation and even active collaboration by shippers, logistics actors, solution providers and policy makers. Highlights of collaborations among SLOCAT partners to help freight businesses track and reduce their emissions include:

Smart Freight Centre's Clean Cargo advances the decarbonisation of container logistics through partnerships among ocean container carriers, freight forwarders and cargo owners.[23]

ICLEI EcoLogistics advances effective regulatory, planning and logistical instruments at all levels of government to support low-carbon urban freight.[24] Participating cities develop viable alternatives to low-quality, diesel-powered freight vehicles, particularly for last-mile logistics.

Polis Network's Urban Freight Working Group encourages public-private strategic dialogue to identify collaborative solutions for clean and efficient urban logistics, bringing together cities, countries and companies.[25]

Sustainable Freight Buyers Alliance brings together freight buyers and suppliers to provide exposure to projects, scale solutions, and streamline procurement, supported by regional programmes in China and India.[26]

MODULE 1 SPOTLIGHT 4

AUTHORS:
Yann Briand, *IDDRI*
Sandra Rothbard, *Freight Matters*

Shortening Global Supply Chains as a Key to Decarbonising Transport

Key findings

The historical development of global supply chains: past drivers

- In the past 50 years, the length and fragmentation of supply chains have exploded due to new manufacturing, transport and logistics, and communication technologies, as well as international economic regulations related to trade liberalisation.
- Today, international production is highly organised within global value chains, where the different stages of the production process are located across different countries. As of 2021, an estimated 70% of international trade involved global value chains.
- These drivers enabled an internationalization of supply chains in offering new business opportunities to increase profits, access new markets and reduce costs due to international trade competition.

Recent disruptions to global supply chains revealed vulnerabilities

- The global financial crisis of 2007-08 and the multiple recent events of 2020-22 such as the COVID-19 pandemic, the Russian Federation's invasion of Ukraine, and the blockage of the Suez Canal caused supply shortages, raising awareness of the fragility of global supply and logistics chains and their international dependencies. These disruptions resulted in the Global Supply Chain Pressure Index recording an all-time high value of 4.3 above the historical average of 1997 to 2022.
- These past drivers and system organisation led supply chains to become more vulnerable to external disruptions.

The future of global supply chains: a changing context

- In the future, an ongoing changing context could lead to more regional value chains that are closer to customers, corresponding to a shortening of global supply chains.
- Key structural changing drivers include a shift in economic policies towards protectionism of employment and industries; changes in the international security context to reinforce security of supply and value chain independence; rising pressures to reduce carbon emissions; and the continuous evolution of manufacturing technologies.

Perspectives for the international climate co-operation agenda

- A review of the long-term strategies of the five leading economies – China, India, Japan, the United States and the EU – published between 2020 and 2022 found that none of them mention phrases related to shortening supply chain distances, reducing freight movements or reducing long-distance freight, shifting supply chains closer and developing local production-consumption ecosystems. This reveals an important gap between science and policy.
- These changes are overlooked in existing international climate discussions and are not taken enough into account by companies in their long-term climate strategies.
- The possibility of a reduction of movements and distances should be considered as a core component of any realistic freight decarbonisation strategy to reach zero emissions by 2050. This demand-side component of the strategy should be articulated with necessary technological changes in a coherent systemic change.

- In the perspective of the first Global Stocktake (2022-23) and future revisions of countries' Nationally Determined Contributions and Long-Term Strategies under the Paris Agreement, an international climate policy agenda on identifying barriers and enablers for strengthening international co-operation towards shorter and more resilient supply chains should be opened. Critical international co-operation activities should help to discuss opportunities and issues related to the changing context, and co-ordinate collective action to avoid unilateral and unfair decisions.

Introduction

Global freight transport activity, measured in tonne-kilometres, grew 68% between 2000 and 2015 and is projected to further increase 2.0 times from 2019 to 2050.[1] If unchecked, this growth poses a critical challenge to efforts to decarbonise freight transport.[2] Key to addressing this challenge is to consider the role of structural and systemic factors, and their interaction with technology factors, in the effort to reach net zero emissions.[3] International trade and the geographically long global supply chains of many industries have contributed greatly to the rapid increase in emissions from freight transport.[4]

This spotlight complements *Spotlight 4 - The Role of Companies in Decarbonising Global Freight and Logistics*. While Spotlight 4 delves into decarbonisation trends pertaining to global supply chains across different transport modes, this spotlight focuses on the historical evolution of global supply chains, recent disruptions and future outlooks.

In the wake of the global financial crisis of 2007-2008, the factors that have traditionally determined the geographical organisation of supply chains (see Box 1) have changed.[5] More recently, supply crises related to the COVID-19 pandemic and the Russian Federation's invasion of Ukraine have raised awareness about the interdependencies and resiliency challenges related to global supply chains. At the same time, ongoing shifts could accelerate reductions in the lengths of supply chains.

Given that technological solutions for reducing freight transport emissions – such as zero-emission vessels, aircraft and long-distance trucks – are still far from maturity, it will be necessary to give greater attention to the systemic reorganisation of global supply chains in the effort to reach net zero emissions, and to minimise risks to industry during the energy transition.[6]

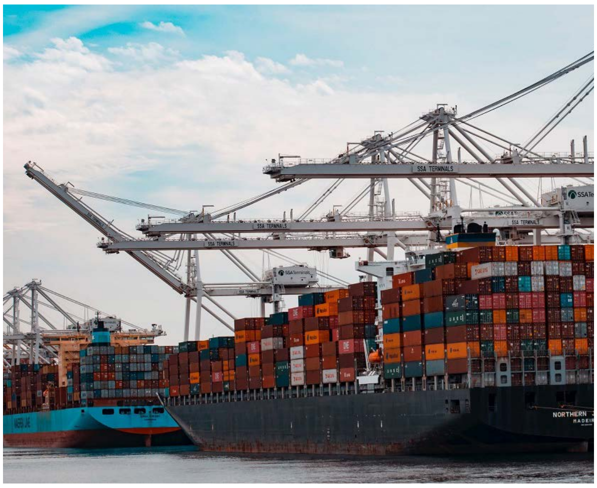
BOX 1. Five key determinants of the geographical organisation of supply chains

Traditionally, five key factors have determined the structure of supply chains, although these factors vary depending on the value chain as well as on the step of the value chain being considered. They are:

1. **Labour costs and other non-economic labour-related regulations**
2. **Sunk investment costs and public investment incentives**
3. **Trade and transaction costs and non-economic transaction-related regulations**
4. **Access to know-how/talents, technologies, infrastructure and supply sources**
5. **Access to distribution markets, transport and logistics costs and lead time.**

These five determinants also can depend on the relative cost structure and final price of the products, on the degree of reliance on extractive industries, and on the modularity of the production process, among others. Understand these five determinants makes it possible to better analyse the underlying changes that are affecting global supply chains.

The historical development of global supply chains: past drivers

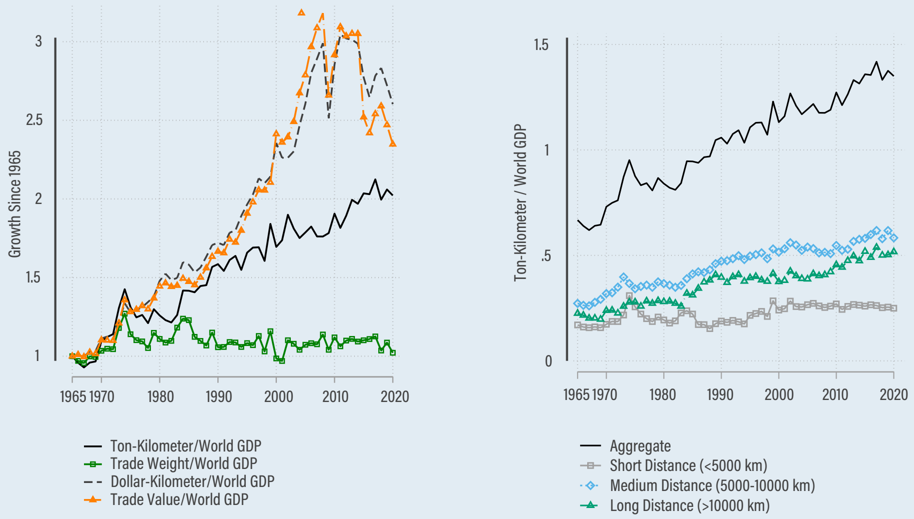


Historically, supply chains were shorter and simpler, typically located in a small geographic area and stretching only as far as a few kilometres. Longer-distance, international supply chains were needed only for specific processes that were not available in all countries, such as natural resource extraction or agricultural production. More recently, however, global supply chains have evolved dramatically **(see Box 2)**[7].

BOX 2. Historical development of global supply chains

Starting in the mid-1980s, the development of global value chains with very long and scattered supply exploded. Companies started to offshore parts of their supply, production, operations and service processes, adding longer distances, more steps and additional time zones to the production process. From 1965 to 2020, the average distance of one internationally traded tonne almost doubled **(see Figure 1)**. During this period, the number of international tonne-kilometres traded grew 120% for longer distances (more than 5,000 kilometres), but it grew only 45% for shorter distances (less than 5,000 kilometres).

FIGURE 1. The role of longer distance trade, 1965-2020



Source: See endnote 7 for this section.

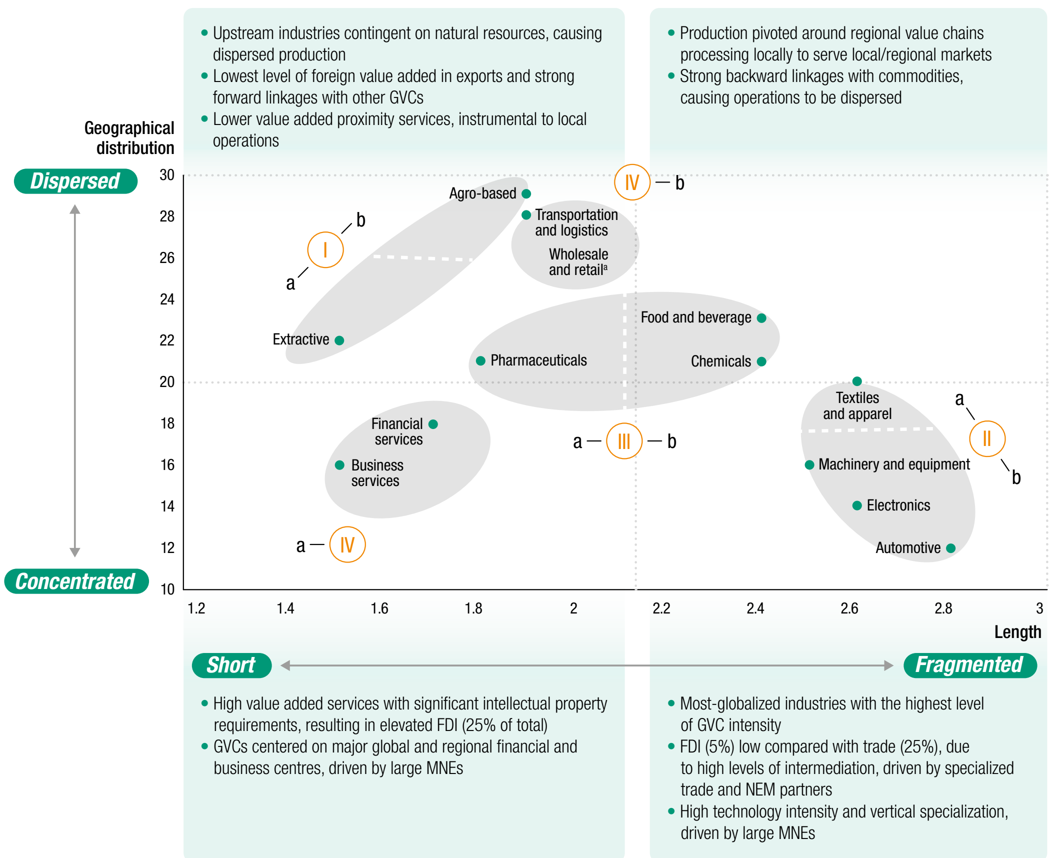
Today, international production is highly organised within global value chains, where the different stages of the production process are located across different countries.[8] As of 2021, an estimated 70% of international trade involved global value chains.[9] Figure 2 characterises the current organisation of value chains according to their geographical distribution and length. This helps to identify four main industry types (I to IV): primary industries (low or high capital intensive), global value chain-intensive industries (low or high tech), geographically distributed industries (global or regional hubs) and services industries (low or high value added).[10] The industries with the longest and most fragmented global value chains are chemicals, electronics, automotive, machinery and equipment, textiles and apparel, and food and beverages.[11]

Several important transformations have influenced the determinants of the geographical structure of supply chains (see Box 1). They include the development of new manufacturing, transport, and communication technologies, as well as international economic policies related to trade liberalisation.

- For example, advanced manufacturing technologies facilitated the scattering and offshoring of production processes; new communication technologies enabled complex cross-border co-ordination; and the containerisation of shipping contributed to lower transport costs.[12]
- On the policy side, economic liberalisation and the development of international and multilateral trade agreements after World War II contributed to the reduction or elimination of tariffs, quotas, preferences and other trade barriers.[13] The General Agreement on Tariffs and Trade (GATT) grew to cover more countries, goods, and activities, leading in the 1990s to the creation of the World Trade Organization, involving more than 125 countries. Global competition among firms and economies led to dedicated national investment policies and export-oriented industrial policies.[14]

FIGURE 2. Length and geographical distribution of international production, by key industry type

Source: See endnote 13 for this section.



Recent disruptions to global supply chains: revealed vulnerabilities

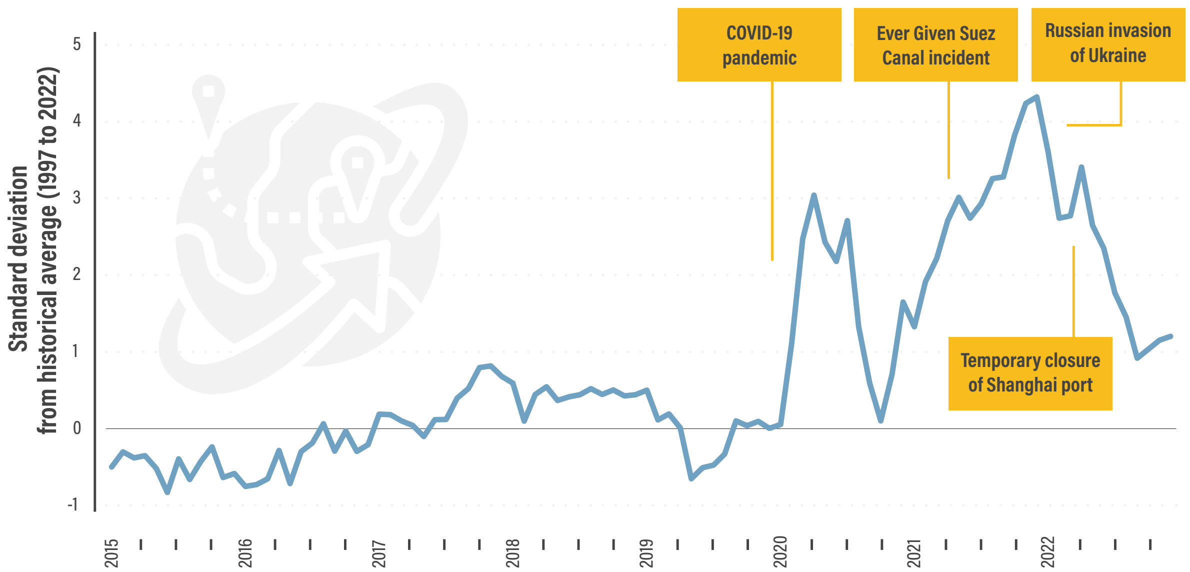
Business decisions to increase profits, reduce product costs and access new markets created additional complexity in the scattering of value chains and increased their physical distance. Combined with manufacturing innovations such as just-in-time inventory management, global supply chains have become more vulnerable to external disruptions.

In recent years, multiple crises such as the COVID-19 pandemic, the Russian Federation's invasion of Ukraine, and the blockage of the Suez Canal caused supply shortages, raising awareness of the fragility of global supply and logistics chains and their international dependencies. These disruptions resulted in the Global Supply Chain Pressure Index recording an all-time high value of 4.3 above the historical average of 1997 to 2022 **(see Figure 3)**.[15]

- The COVID-19 pandemic created supply shortages related to higher demand for medical and pharmaceutical goods such as face masks, protective gear, respirators, tests, medications and vaccines. The crisis led many to question the locations where critical safety- and health-related products are made, and the commercial rules surrounding them, for national security reasons.[16]
- The pandemic also raised awareness about the huge role that China's economy and ports play in global supply, particularly after the entire port of Shanghai was shut down for two months in 2022 due to high COVID-19 incidence.[17]
- The Russian Federation's invasion of Ukraine led to a critical shortage in the global trade of cereals, revealing the strong dependency of grain markets on this region of the world.[18]
- The grounding of the *Ever Given* container ship, which blocked the Suez Canal for a week in March 2021, created delays in global supplies along the largest container route for Asia-Europe trade.[19] This incident, caused by a sand storm and strong wind, provided a reminder of the vulnerability of international trade to extreme weather. As climate change increases the frequency and intensity of extreme weather events, closures of key trade chokepoints could increase.[20]

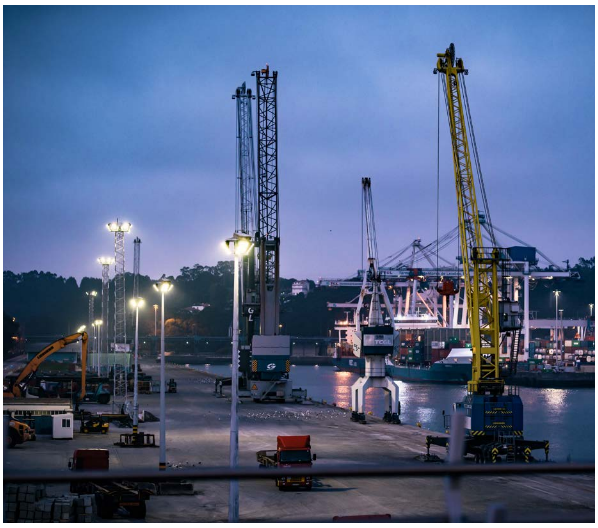
FIGURE 3. Global supply chain pressure index (higher value means higher pressure), 2015 to 2022

Source: See endnote 16 for this section.



The future of global supply chains: a changing context

As both companies and policy makers express rising concerns about resiliency, many are considering associated strategies to relocate production facilities and suppliers closer to customers.[21] A growing literature has emerged around reshoring (when manufacturing activities return to their initial country of origin) and nearshoring (when manufacturing is relocated to a country that is closer to "home").[22]



Increasingly, the key factors determining the geography of supply chains (see Box 1) are changing, which could lead to greater regionalisation of international trade and a shortening of supply chains. According to a 2019 analysis, a reduction in the average length of supply chains began in 2012.[23] Four structural changes are contributing to the reduced distances for value chains and international trade.

1

The shift in economic policies from market liberalisation towards protectionism

Since the global financial crisis of 2007-2008, the international economic policy agenda has shifted towards the development of protectionist measures among the G20 economies, contributing to the recent trade wars between the United States and China.[24] Between 2010 and 2020, at least 110 countries increased the adoption of both formal industrial policies and individual policy measures related to protectionism. These policies were aimed at job creation and economic development but also reflected efforts to support achievement of the Sustainable Development Goals.[25]

- In 2022, the US Inflation Reduction Act created tax credits for the domestic production of specific goods and for building and maintaining new factories in the United States.[26]
- Recent trade policies reflect the rapid proliferation of regional trade agreements that use local content requirements to require manufacturers in the region to source goods and services produced in member countries.[27]

2

Changes in the international security context to reinforce security of supply and ensure the independence of critical value chains

New investment restrictions or regulations in recent years have reflected concerns about national security and foreign ownership of technology firms, strategic assets, and land and natural resources.

- In the European Union (EU), the adoption of the Directive on Cross-Border Mobility expanded the screening of foreign investments in European companies and takeovers.[28]
- In 2017, the EU launched a USD 7 billion plan for German and French firms to jointly produce batteries based on the model of Airbus, including through USD 1.5 billion in public subsidies targeting this strategically important industry.[29]
- In the wake of the COVID-19 pandemic, governments re-launched national subsidies for specific pharmaceutical goods.[30]

3

Rising pressures to reduce emissions

Since the Paris Agreement in 2015, environmental concerns related to the impact of human activities on climate change and biodiversity loss have grown in importance. As of 2022, more than 58 countries and one-fifth of the world's largest companies had committed to reaching carbon neutrality.[31] Governments have been pushed to act by adopting more and better sustainability policies.

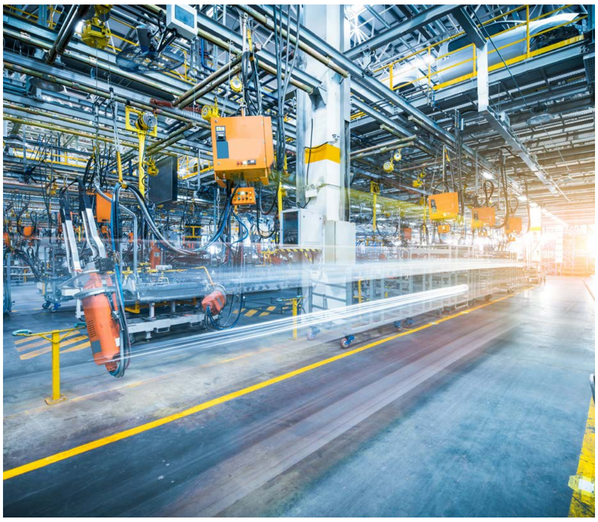
- In 2022, the European Commission adopted the European Carbon Border Adjustment Mechanism, the first climate-oriented border tariff on imports of carbon-intensive industrial products.[32]
- The EU regulation on deforestation-free supply chains, adopted in 2022, reinforces control and transparency in the value chains of specific agricultural products to ensure that they do not contribute to additional deforestation.[33]

Businesses are turning to life-cycle assessments to measure the environmental impacts along the value chain for each step of a product's life cycle, from production to transport, distribution and disposal. The Smart Freight Centre's Global Logistics Emission Council (GLEC) Framework is the only globally recognised methodology to help companies harmonise the calculation and reporting of the logistics greenhouse gas footprint across the multi-modal supply chain.[34]

4

New manufacturing technologies

Finally, new manufacturing technologies such as automation and additive manufacturing have impacted industrial production costs by favouring reshoring and nearshoring. However, innovations in communication technologies such as 5G, cloud computing and artificial intelligence could have the opposite effect on the length of value chains.[35]



Perspectives for the international climate co-operation agenda

The international scientific community has noted that "systemic changes" related to transformations in structural demand could play a large role in keeping global temperature rise below 1.5 degrees Celsius (°C). A key recommendation is for the transport sector to better articulate the needed transformations related to supply chain management, which include reducing movements and distances, alongside technological changes.[36] However, a review of the long-term strategies of the five leading economies – China, India, Japan, the United States and the EU – published between 2020 and 2022 found that none of them mention phrases related to shortening supply chain distances, reducing freight movements or reducing long-distance freight, shifting supply chains closer and developing local production-consumption ecosystems. This reveals an important gap between science and policy.

The international strategy for reducing maritime greenhouse gas emissions, which were responsible for 10% of all transport CO_2 emissions in 2019, is a good example of this disconnect.[37] The demand for international maritime transport has increased from around 4,000 million tonnes of goods transported in 1990 to more than 11,000 million tonnes in 2022, with an increasing average geographical distance of trips. Maritime transport emissions have increased proportionally and rapidly until 2010, and they now hover at around 1 gigatonne of CO_2 following a decade of energy efficiency gains; however, maritime emissions have not yet begun to decrease in line with international targets to reduce them 50% between 2008 and 2050.[38] The International Maritime Organization is supposed to revise this target in 2023 with targets that are aligned to the Paris Agreement and can enable decarbonisation of the shipping sector.[39]

Despite the need to accelerate efforts to curb maritime emissions, current strategies in the sector are focused on the technological fuel shift as a silver bullet, after having acknowledged that operational and technical energy efficiency measures on ships were insufficient. Consequently, national and international policy action in 2021 and 2022 to tackle emissions was focused on the fuel shift and related investments, including changes to vessel motors, fuel supply at ports, and energy production and supply (Green Shipping Challenge, Clydebank declaration, Global Maritime Forum's call[40]).

However, as described in this spotlight, the context is changing and this may impact the future geographical configuration of supply chains. The possibility of a reduction of movements and distances should therefore be considered as a core component of any realistic freight decarbonisation strategy to reach zero emissions by 2050. This demand-side component of the strategy should be articulated with necessary technological changes in a coherent systemic change. Furthermore, failing to analyse and anticipate what will be the future of the international production organisation could be risky and raises questions for ports, ship owners and energy providers investing in the sector, including:

- What will be the future geographical structure of maritime routes? How will existing routes be affected?
- If the route lengths are changing, how will that affect the technological choices in ships and related energy supply?

If future routes are located elsewhere, how will that affect the estimation of traffics and investments in ports? There were very few explicit mentions of freight-related actions in both generations of the Nationally Determined Contributions (NDCs) towards reducing emissions that countries had submitted under the framework of the Paris Agreement as of 2022. Only 5% of all mitigation actions referred explicitly to freight transport[41]. The most popular freight actions in the second generation of NDCs included a shift from road transport to rail or inland waterways, freight efficiency improvements and freight vehicle improvements. An example on freight action in the United Arab Emirates' second NDC outlines plans to build the 1,200 kilometre Etihad Rail network, of which the first stage of 264 kilometres has been operational for freight since January 2016; it replaces around 300 trucks with a single train journey and reduces CO_2 emissions 70-80%.[42]

An international policy agenda is needed to work on identifying barriers and enablers for strengthening international co-operation towards shorter and more resilient supply chains. Critical international co-operation activities should help to discuss opportunities and issues related to the changing context, and co-ordinate collective action to avoid unilateral and unfair decisions.

In the perspective of the first Global Stocktake (2022-23) and future revisions of countries' Nationally Determined Contributions and Long-Term Strategies under the Paris Agreement, the regionalisation of supply chains closer to customers should be better integrated.

Actions to Reduce Emissions and Boost the Resilience of Freight Transport and Global Supply Chains: SLOCAT Guidelines for NDCs[43]

To secure their place in the future net zero economy, countries can use their Nationally Determined Contributions submitted under the Paris Agreement to set their freight transport and logistics systems on track to become net zero and resilient. Some key elements of a NDC that enables impactful action on decarbonisation and resilience of freight transport and global supply chains include:

Set robust freight transport targets seeking to:

- Reduce freight transport emissions
- Ensure that a certain share of goods is transported via rail or waterways
- Mandate a share of fuels for trucks supported by renewable energy
- Transform infrastructure

Include mitigation actions for freight transport structured by the Avoid-Shift-Improve framework:

- Avoid and reduce the need for motorised travel
- Shift to more sustainable modes
- Improve transport modes

Adapt freight transport with measures that improve the resilience of infrastructure, including:

- All-weather roads and general flood protection
- Ports that account for sea-level rise and extreme weather events
- Early warning systems
- Multiple and shorter supply chains
- Plans for alternative freight transport

Feature actions to achieve more ambitious international maritime and aviation transport targets and measures.

Particular thanks to the business members of the Movin'On Community of Interest on Freight and the international participants of the transport Sectoral Conversations on "Revamping business value chains for global carbon neutrality". Part of the work for this spotlight was funded by the Michelin Corporate Foundation and the NDC ASPECTS project. This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 101003866.

2

Regional Trends in Transport Demand and Emissions, and Policy Developments

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability
Global Status Report - 3rd edition

Contents

2.1 Africa Regional Overview 128

2.2 Asia Regional Overview 140

2.3 Europe Regional Overview 152

2.4 Latin America and the Caribbean Regional Overview 164

2.5 North America Regional Overview 178

2.6 Oceania Regional Overview 186

List of Figures

Africa Regional Overview

Figure 1. Motorisation rates per 1,000 people in Africa, 2016-2020 132
Figure 2. Per capita transport CO_2 emissions in Africa, 2021 135

Asia Regional Overview

Figure 1. Motorisation levels per 1,000 people in Asia, 2016-2020 144
Figure 2. Urban transport trends in Asia, 2000, 2015 and 2021 145
Figure 3. Per capita transport CO_2 emissions in Asia, by country, 2021 147
Figure 4. CO_2 emissions from transport in Asia, 1990-2050 148

Europe Regional Overview

Figure 1. Motorisation rates per 1,000 people in Europe, 2016-2020 156
Figure 2. Greenhouse gas emissions from transport in the EU, 1990-2020, with projections to 2040 159
Figure 3. Change in greenhouse gas emission levels from transport in the EU, by mode, 1990-2020, with projections to 2040 159
Figure 4. Per capita transport CO_2 emissions in Europe, by country, 2021 160

Latin America and the Caribbean Regional Overview

Figure 1. Motorisation rates per 1,000 people in Latin America and the Caribbean, 2016-2020 168
Figure 2. Navigation requests for driving, public transport and walking in Latin America, January 2020 to April 2022 169
Figure 3. Per capita transport CO_2 emissions in Latin America and the Caribbean, 2021 171
Figure 4. Electric buses in Latin America and the Caribbean, by type, 2017-2023 172

North America Regional Overview

Figure 1. Motorisation rates per 1,000 people in North America, 2019/2020 181
Figure 2. Shares of battery electric vehicles sold in Canada and the United States, 2020-2022 181
Figure 3. Per capita transport CO_2 emissions in North America, 2021 183

Oceania Regional Overview

Figure 1. Motorisation rates per 1,000 people in Oceania, 2016-2020 189
Figure 2. Changes in kilometres driven in Oceania, 2020-2022 190
Figure 3. Per capita transport CO_2 emissions in Oceania, 2021 191

MODULE 2 2.1

AUTHOR:
Robert Ambunda, *University of Namibia: School of Engineering and the Built Environment*

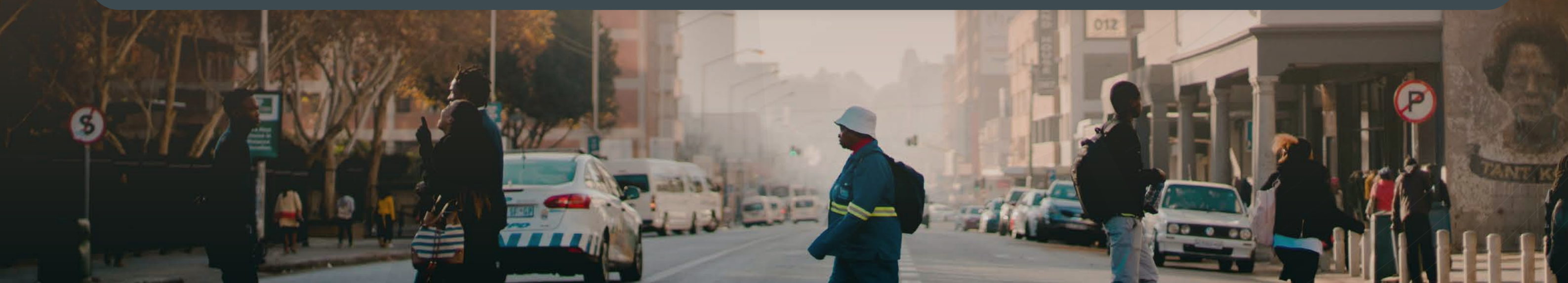
CONTRIBUTORS:
Verena Knoell, *GIZ;* Chris Kost, *ITDP*

Africa Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
1,409 million	+35%	47%	+44%	USD 1,956	+33%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.



Key findings

Demand trends

- The motorisation rate in Africa (covering four-wheeled motorised vehicles) is the lowest globally, at 43 vehicles per 1,000 people during the 2016-2020 period, compared to a global average of 197 vehicles per 1,000 people.
- Africa accounts for less than 1% of global vehicle production and is highly dependent on used vehicles. In most African countries, used light-duty vehicles comprise 85-100% of the total fleet. Between 2015 and 2018, Africa imported the largest share of used light-duty vehicles among world regions, at 40%.
- In 2022, people in Africa spent an average of 56 minutes per day walking or cycling for transport, compared to the global average of 43.9 minutes per day. Low-income households are most dependent on walking and cycling, and their urban transport expenditures represent up to 20% of the household income (10% in smaller cities)
- As many as 95% of Africa's roads fail to provide an acceptable level of service for pedestrians, and 93% fail to provide an acceptable level of service for cyclists. More than half (53%) of the population is considered "vulnerable" road users (pedestrians, bicyclists and motorcyclists), a share that is 1.5 times above the global average of 26%.
- Access to public transport in Africa is limited. In 2020, only 31.7% of the population was able to access either formal or informal public transport within a walking distance of 500-1,000 metres, well below the global average of 56%.
- At least 105 million people in African cities did not have reliable information on their collective transport systems as of 2021. This makes it difficult to achieve target 11.2 of Sustainable Development Goal (SDG) 11, aimed at ensuring that all citizens have access to safe, affordable, accessible and sustainable transport systems by 2030. In various cities across the region, informal transport accounts for between 40% and 98% of trips by public or shared transport.
- Roads are the predominant mode of transport in Africa, carrying at least 80% of goods and around 90% of passengers. Limited rail transport and the high costs of air transport leave road transport as the only practicable alternative for freight in most countries in Sub-Saharan Africa.

Emission trends

- Africa contributed the lowest share of global greenhouse gas emissions (3.9%) among world regions in 2022, despite being home to 18% of the world's population. At the same time, the region is most vulnerable to the effects of climate change and is already experiencing high temperature increases.
- Between 2020 and 2021, due to COVID-19 travel restrictions, Africa's economy-wide carbon dioxide (CO_2) emissions fell 7.4%, and transport CO_2 emissions fell 11%.
- Transport contributed nearly one-quarter (24%) of total CO_2 emissions in Africa in 2021. The region's transport CO_2 emissions increased 34% between 2010 and 2021, the second highest regional growth rate after Asia (36%).
- However, Africa's per capita transport CO_2 emissions are 3.4 times below the global average of 0.85 tonnes.

Policy developments

- The African Road Safety Action Plan, the region's framework to implement the United Nations (UN) Road Safety Decade 2021-2030 and SDGs 3 and 11, recognises the dearth of road safety data in Africa and has requested the UN Economic Commission for Africa, the African Union Commission and the African Development Bank to develop mechanisms to strengthen data collection for effective policy intervention and analysis.
- In African cities, many residents depend on walking and cycling as their primary means of transport. As of 2019, around 59% of people walking and cycling in Africa were supported by a walking and cycling policy, either stand-alone or as part of an integrated transport strategy.
- To address challenges related to safety and the quality of service, initiatives have emerged to consolidate public transport operations.

- Bus rapid transit (BRT) corridors and/or systems have been implemented or are being developed in Addis Ababa (Ethiopia), Cairo (Egypt), Dar es Salaam (Tanzania), Lagos (Nigeria), Nairobi (Kenya) and the cities of Cape Town, George, Johannesburg and Pretoria in South Africa.
- The electric mobility landscape is evolving rapidly, pushed by the need to decarbonise economies by 2050. Several African governments have put in place policies and regulatory measures for the adoption and transition to e-mobility.
- Rapidly rising urbanisation and motorisation rates have prompted an urgent response to Africa's growing transport needs, including through the development of sustainable urban mobility plans (SUMPs) and national urban mobility plans (NUMPs).
- As of the end of 2022, Africa accounted for 43% of the countries that included time-bound targets for reducing transport greenhouse gas emissions in their second-generation Nationally Determined Contributions (NDCs) under the Paris Agreement (10 out of 23 countries).

Overview

The Africa region comprises 54 countries[i] spanning from Northern Africa to Sub-Saharan Africa. Transport is key for promoting sustainable economic growth in the region and for addressing a complex set of challenges related to climate change and the demand for mobility. The United Nations (UN) 2030 Agenda for Sustainable Development recognises the importance of transport in achieving a sustainable future for all regions, through direct, indirect and cross-cutting targets that bear a direct link to green, equitable, healthy, safe and resilient mobility. For Africa specifically, Agenda 2063, released in 2013, is the blueprint to transform the region into a global powerhouse by delivering sustainable and inclusive development.[2]

The main challenges facing the transport sector in Africa include a lack of integrated planning across various transport modes, insufficient data on public transport systems, poor transport infrastructure and access, and the highest road fatality rates globally. Most African cities rely on some form of informal or semi-formal transport, which is dominated by fragmented, privately operated services.

Transport activity and transport energy demand in Africa are expected to increase significantly, alongside high rates of both urbanisation and motorisation. By 2050, around 60% of the region's population is projected to live in urban areas, with unprecedented numbers also living in peri-urban and rural areas.[3] To address the ever-increasing demand for mobility, there is a growing need for greener, more equitable, healthier, safer and more transport systems. This need has been made glaringly clear by the mobility challenges posed by the COVID-19 pandemic and by the Russian Federation's war in Ukraine.[4]

For many decades, transport investments in Africa have been skewed towards motorised transport infrastructure. However, several countries in the region, with the support of development agencies, have committed to improving the landscape of active mobility and formal public transport, through financing and the development and implementation of new and existing policies and strategies.[5]

Demand trends

Transport is essential for addressing the rising demand for mobility in Africa. The region is the world's least urbanised, yet it has the highest rate of urbanisation globally, at 3.5% per year.[6] The continent's urban population share is projected to grow from 47% in 2022 to 60% in 2050.[7] By 2050, African cities are projected to be home to an additional 300 million urban residents, of which the vast majority are expected to rely on walking, cycling and public transport for their daily journeys.[8]

The motorisation rate in Africa (covering four-wheeled motorised vehicles) is the lowest globally, at 43 vehicles per 1,000 people during the 2016-2020 period, compared to a global average of 197 vehicles per 1,000 people (see Figure 1).[9] In addition, 21.3 million motorcycles are in use in Africa.[10] In Burkina Faso and Mauritius, more than 100 motorcycles per 1,000 people were in use in 2020.[11]

Motorisation rates in Africa increased 32% on average between 2015 and 2020.[12] Rising vehicle ownership reflects the desire of Africa's expanding populations to become mobile and to gain access to more economic activities as levels of real income increase and economies develop.[13] The continent's electric mobility (e-mobility) ecosystem also has expanded, with South Africa and Uganda providing good examples of the potential of this emerging vehicle industry.[14]

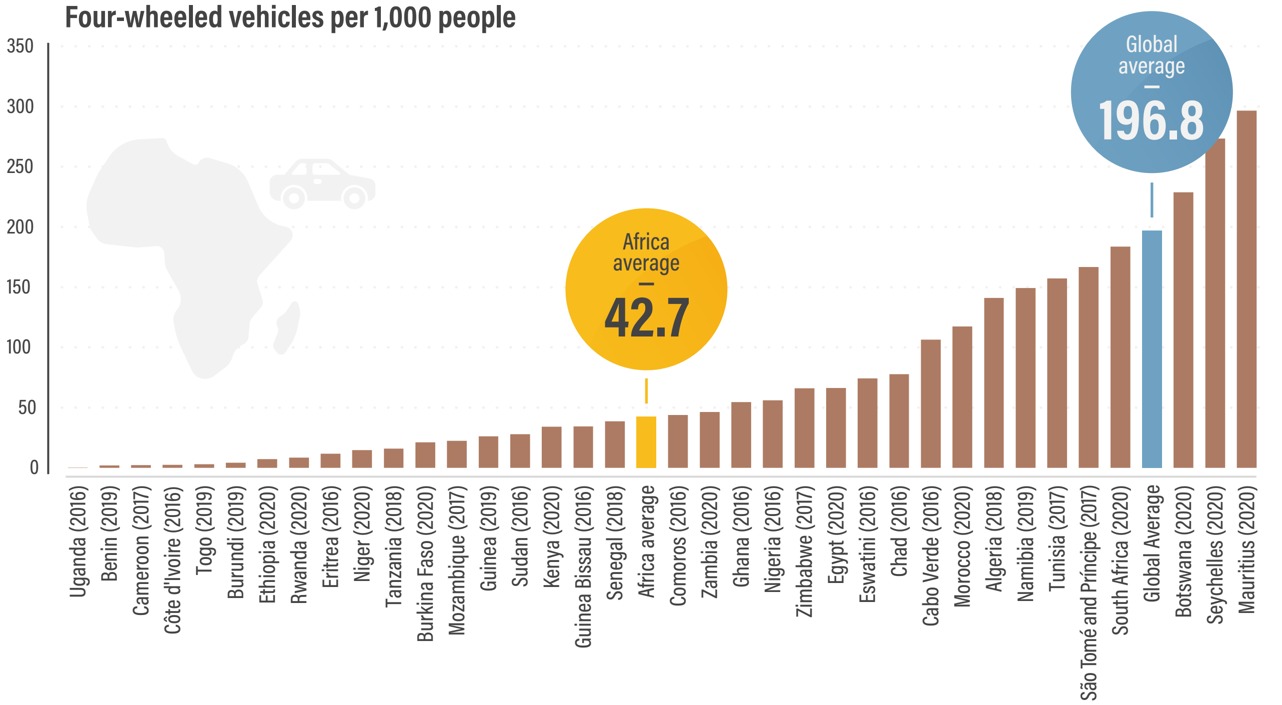
With the onset of the COVID-19 pandemic, most African cities experienced reductions in the supply of both formal and informal transport. In April and May 2020, several cities reduced their public transport passenger capacities by up to half, including Abidjan (Côte d'Ivoire), Accra (Ghana), Addis Ababa (Ethiopia), Cape Town (South Africa), Dakar (Senegal), Douala (Cameroon) and Nairobi (Kenya).[15]

Africa is regarded as the final frontier of automotive growth, largely because it is the second most populous continent, has the world's lowest motorisation rate and **accounts for less than 1% of global vehicle production.**[16] Outside of South Africa and Morocco, vehicle manufacturing is minimal.[17] Multinational vehicle manufacturers have begun setting up production plants in Angola, Ethiopia, Ghana, Kenya, Namibia, Nigeria and Rwanda.[18]

i The countries covered are Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Togo, Tunisia, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

FIGURE 1. Motorisation rates per 1,000 people in Africa, 2016-2020

Source: See endnote 9 for this section.



- Sales of new light-duty vehicles in Africa have started to recover from the pandemic, with the number of units sold increasing 32% in 2021 (1,131,249 units) compared to 2020 (856,113 units).[19] However, sales of the vehicles in 2021 were still below 2019 levels (1,150,842 units).[20]
- In Sub-Saharan Africa, sales of new light-duty vehicles increased 15% in 2021 but were still down 10% compared to 2019 volumes.[21]
- Egypt, Morocco and Tunisia all increased their sales of new light-duty vehicles in 2021, compared to 2020 and 2019; however, other North African countries showed declines in sales volumes.[22]
- Sales of new commercial vehicles in Africa increased 3% in 2021 to reach 311,990, up from 302,000 vehicles sold in 2019.[23]

Africa is highly dependent on used vehicles. In most African countries, used light-duty vehicles comprise 85-100% of the total fleet.[24] The three largest exporters of these vehicles – the European Union (EU), Japan and the United States – exported 14 million used light-duty vehicles worldwide **between 2015 and 2018, with Africa importing the largest share among world regions, at 40%.**[25]

- On average, 60% of all annual vehicle registrations in Africa are for used light-duty vehicles.[26]
- More than 95% of additions to Kenya's growing fleet of light-duty vehicles are imported used vehicles, mostly from Japan.[27]
- In East Africa, fleets of used light-duty vehicles are much older in Rwanda (which has no age limit for used vehicle imports) and in Uganda (which has a 15-year age limit on used vehicles) than in Kenya, which imposed an age limit of 8 years on used vehicle imports.[28]
- The Netherlands exported 35,000 light-duty vehicles to West Africa during 2017-2018, most of which (80%) were between 16 and 20 years old and fell below the Euro 4[i] vehicle emission standard.[29]
- Morocco has implemented Euro 4 emission standards, and Ghana has established age and fiscal policies to ensure that all imported light-duty vehicles meet Euro 4 standards.[30]
- In 2021, Mauritius introduced a set of policies and fiscal incentives to improve the quality of used vehicles; these include allowing used vehicles no older than three years, developing a CO_2-based vehicle taxation scheme, and creating an inspection and verification scheme for used vehicles.[31]
- In 2022, the East Africa sub-region adopted Euro 4/IV equivalent vehicle emission standards.[32]
- The Economic Community of West African States (ECOWAS) adopted and implemented cleaner fuels and vehicles

i The Euro 4 emission standard was introduced on all new cars from January 2005 and all newly registered cars from January 2006. To pass the Euro 4 standard, petrol cars had to emit no more than 1.0 grams per kilometre (g/km) of carbon monoxide, no more than 0.10 g/km of total hydrocarbon and no more than 0.08 g/km of nitrogen oxides.

standards in 2021.[33]

In Africa, up to 78% of people walk for transport purposes every day.[34] **In 2022, people in Africa spent an average of 56 minutes per day walking or cycling for transport, compared to the global average of 43.9 minutes per day.**[35] Low-income households are most dependent on walking and cycling, and their **urban transport expenditures represent up to 20% of the household income (10% in smaller cities).**[36] **Improving the mobility options of the urban poor is seen as key to their economic uplifting.**

- In Kinshasa (Democratic Republic of the Congo) and Dar es Salaam (Tanzania), walking accounts for two-thirds of total trips.[37]
- In Kenya's major cities, people use walking and cycling for a high share of daily trips, including 53% in Kisumu, 45% in Mombasa and 40% in Nairobi.[38] Across Kenya, an additional 41% of trips by *matatu* (privately owned mini-buses used as shared taxis) start and end with a walking journey.[39] In the country's rural areas, more than 90% of trips are by foot and 4% are by bicycle.[40]
- People in Niger spent on average 141.6 minutes per day walking and cycling for transport in 2022.[41]

Africa has the world's highest rate of fatalities related to road traffic, at 26.6 deaths per 100,000 people in 2016, compared to a global average of 17 deaths per 100,000 people.[42] This is despite having the lowest motorisation rate and being host to only 3% of all registered vehicles globally.[43] **As many as 95% of Africa's roads fail to provide an acceptable level of service for pedestrians, and 93% fail to provide an acceptable level of service for cyclists.**[44] An estimated 260,000 people were killed on African roads in 2019, **with 53% of this population considered "vulnerable" road users (40% pedestrians, 4% cyclists and 9% people using motorised two- and three-wheelers).** This share is 1.5 times above the global average of 26%.[45]

- On average, 261 pedestrians and 18 cyclists are killed every day in African cities.[46]
- Road traffic deaths due to drinking and driving account for the majority of road fatalities in Lesotho (60%) and South Africa (58%).[47]
- In 2016, the total cost of road crash fatalities and serious injuries in Africa was an estimated 9% of the continent's gross domestic product (GDP), the highest share among regions globally.[48]
- Fewer than 18% of African countries monitor key road safety performance indicators, such as helmet and seatbelt use.[49]
- Around 40% or more of African countries have not taken significant action to establish road safety data management systems.[50]
- African countries recorded significant reductions in road fatalities in 2020 due to COVID-19 lockdown measures – including in South Africa (78% fewer deaths), Morocco (65%) and Namibia (60%).[51]

Access to public transport in Africa is limited. In 2020, only 31.7% of the population was able to access either formal or informal public transport within a walking distance of 500-1,000 metres, well below the global average of 56%.[52] Public transport in African cities relies heavily on informal transport and in particular on the "target" system of operating. This involves the use of public transport (buses, mini-buses and ride-hailing services, mostly in Southern Africa) as well as taxi services (motorcycle taxis and tuk-tuks, mostly in East, West and Central Africa) operated by informal businesses.[53]

At least 105 million people living in African cities did not have reliable information on their collective transport systems as of 2021.[54] **This makes it difficult to achieve target 11.2 of Sustainable Development Goal 11, aimed at ensuring that all citizens have access to safe, affordable, accessible and sustainable transport systems by 2030.**[55] **In various cities across the region, informal transport accounts for between 40% and 98% of trips by public or shared transport.**[56]

- As of 2022, 15 African cities had mapped their public transport and mini-bus taxi networks in a standardised and open format (General Transit Feed Specification, or GTFS).[57]
- In South Africa's Gauteng Province (covering Ekurhuleni, Johannesburg and Tshwane), 70% of all trips were made using informal transport in 2007.[58]
- Motorcycle taxis were present in around 60% of cities in Africa as of 2016.[59]
- As of 2016, the share of cities with motorcycle taxis was 25% in Southern Africa, 46% in East Africa, 69% in West Africa and 74% in Central Africa.[60]
- In 2016, motorcycles and three-wheelers made up 59% of the total fleet in Uganda, 37% in Kenya, 34% in Tanzania and 23% in Ghana.[61]
- In Addis Ababa (Ethiopia), three-wheeler taxis (*bajaj*) transported an estimated 635,000 people per day in 2018.[62]

During the first year of the COVID-19 pandemic (2020), the number of public transport trips taken in African cities fell 40% on average compared to pre-COVID levels in 2019.[63] These reductions in public transport contributed to mobility disruptions, a decline in the supply of public transport, and to some extent a shift towards walking and cycling.[64]

- In Abidjan (Còte d'Ivoire), public transport ridership fell an estimated 50% at the peak of COVID-19 restrictions.[65]
- In South Africa and Zimbabwe, the number of trips declined 80% in 2020 due to COVID-19 restrictions.[66]
- Tanzania and Zambia experienced around 20% reductions in all trips during 2020.[67]
- Most African cities increased public transport fares in response to the pandemic: towns in Namibia increased fares 15%, while some routes in Johannesburg (South Africa) increased fares 10-25% due to reduced capacity (lockdown measures).[68]

Freight transport in Africa faces a multitude of infrastructure and social challenges. The African Continental Free Trade Area (AfCTA) agreement, which came into force in 2019, is projected to increase intra-Africa trade demand 28%, leading to the additional need by 2030 for 2 million trucks, 100,000 rail wagons, 250 aircraft and more than 100 vessels.[69] The region faces low inter-regional and intra-African trade, poor inland road quality, inadequate port and rail capacity, and slow development in transport technologies – all of which have been exacerbated by the pandemic and by the Russian Federation's war in Ukraine.[70]

- In 2020, transport costs along the Northern Corridor freight route from Mombasa to Kampala increased 48% due to pandemic-related delays.[71]
- Border-crossing times increased from less than 24 hours in the first quarter of 2020 (pre-pandemic), to more than five or six days during the pandemic.[72]
- In 2022, South Africa ranked highest in Africa on the Freight and Logistics Performance Index, due to the country's efficient, well-integrated and intermodal transport system.[73]
- The Liner Shipping Connectivity Index value for Africa declined from 18 in 2020 to 17.6 in 2021, as shipping lines and carriers re-assigned ships to Asia and North America due to port congestion and COVID-19 related restrictions on workforces.[74]

Roads are the predominant mode of transport in Africa, carrying at least 80% of goods and around 90% of passengers.[75] Limited rail transport and the high costs of air transport leave road transport as the only practicable alternative for freight in most countries in Sub-Saharan Africa. The immense pressure on road networks, coupled with poor maintenance cultures, has resulted in sub-standard road conditions across the region.[76]

- Cameroon has 10 times more unpaved roads (50,000 kilometres total) than paved roads (5,000 kilometres); the country's roads are poorly maintained, with routes unpassable during the rainy season, leading to high transport costs and to long delays of freight goods due to truck diversions.[77]
- In Ghana, more than 97% of passenger and freight transport is by road.[78]

The Russian Federation's war in Ukraine has had major short- and long-term implications for the transport landscape in Africa.[79] The conflict occurred at a time when African countries were still struggling to recover from the destabilising effects of the COVID-19 pandemic.[80]

- In 2022, transport costs doubled in some African countries, such as Namibia, Nigeria and South Africa.[81] This was due to a global mismatch in supply and demand in shipping, port and inland capacity caused by pandemic-related declines and the subsequent rapid recovery in trade volumes.[82]

Emission trends

Africa contributed the lowest share of global greenhouse gas emissions (3.9%) among world regions in 2021, despite being home to 18% of the world's population.[83] At the same time, the region is the most vulnerable to the effects of climate change and is already experiencing high temperature increases.[84]

Although Africa has the world's lowest motorisation rate, the region's emissions of particulate matter 2.5 (released mainly from road transport and power generation) averaged 97.4 micrograms per cubic metre in 2019, above the world average of 82.3 micrograms per cubic metre.[85] **Between 2020 and 2021, due to COVID-19-related travel restrictions, Africa's economy-wide CO_2 emissions fell 7.4% and transport CO_2 emissions fell 11%.[86]** However, the region's emissions returned to near pre-pandemic levels in 2021.[87]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
348.4 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
5.4%

Per capita transport CO_2 emissions (2021):
0.25 tonnes

Transport CO_2 emissions per USD 10,000 GDP (2021):
1.29 tonnes

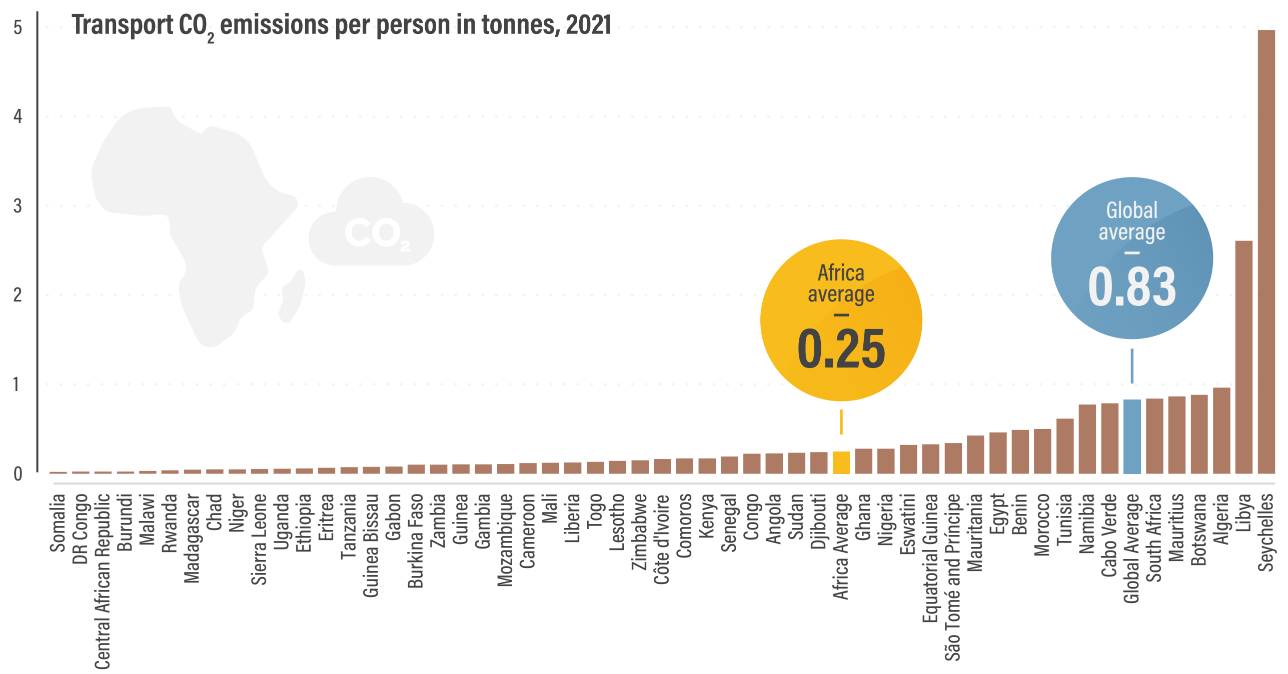
Source: See endnote 88 for this section.

Transport contributed nearly one-quarter (24%) of total CO_2 emissions in Africa in 2021.[89] The region's transport CO_2 emissions increased 34% between 2010 and 2021, the second highest regional growth rate after Asia (36%).[90] In 2021, around one-third of African countries reported per capita transport CO_2 emissions that were above the regional average (see Figure 2).[91] **However, the region's per capita transport CO_2 emissions overall are 3.4 times below the global average of 0.85 tonnes per capita.[92]** Africa's transport emissions relative to economic output were the highest among world regions in 2021, at 1.29 tonnes of CO_2 per USD 10,000.[93]

- Nigeria has the highest transport CO_2 emissions in Africa (59.3 million tonnes of CO_2), even though South Africa has a higher motorisation rate and a larger vehicle fleet (12,027,860 units, compared to 11,760,871 units in Nigeria).[94] This is due mainly to Nigeria's lower-performing vehicle emission technologies.
- Around 26% of Egypt's vehicle fleet of 10,695,694 units is more than 27 years old, and 25% of the fleet is between 17 and 26 years old, resulting in lower combustion efficiency and high emissions.[95]
- Chad, Niger and the Central African Republic have some of

FIGURE 2. Per capita transport CO_2 emissions in Africa, 2021

Source: See endnote 91 for this section.



the lowest CO_2 emissions per capita, measuring one-tenth below the regional average.[96]

Policy developments

Several countries in Africa have recognised that addressing the spiralling epidemic of road fatalities and serious injuries will require implementing effective road safety policies and action plans, with time-bound targets. **The African Road Safety Action Plan, the region's framework to implement the UN Road Safety Decade 2021-2030 and SDGs 3 and 11, recognises the dearth of road safety data in Africa and has requested the UN Economic Commission for Africa, the African Union Commission and the African Development Bank to develop mechanisms to strengthen data collection for effective policy intervention and analysis.**[97]

- In 2021, Namibia developed the 2nd Road Safety Decade of Action Strategic Plan for the period 2021-2030, which aims to reduce and eliminate latent gaps in the components of a safe road system.[98]
- Kampala (Uganda) developed and launched a Road Safety Strategy in 2021, which is aligned with target 3.6 of the SDGs to halve the number of fatalities and injuries from road crashes by 2023.[99]
- Since 2015, the World Resources Institute has worked with city governments in Accra and Kumasi (Ghana), Addis Ababa (Ethiopia) and Kampala (Uganda) to develop comprehensive speed management plans to reduce traffic speeds through evidence-based policy improvements.[100]
- Addis Ababa (Ethiopia) received the Vision Zero for Youth Award in 2021 for its efforts to prioritise pedestrians and safer speeds and to embrace the Safe System approach.[101]

Globally, disruptions related to the COVID-19 pandemic altered perceptions on the value of walking and cycling.[102] However, data for 2020 indicate that people in African cities changed their mobility habits less than in other global regions, in part because walking (and to a much lesser extent cycling) is already the primary and dominant mode of transport across Africa.[103] Despite this, urban space in Africa is disproportionally allocated to the movement of motorised transport.

The pandemic underscored the need for improved walking and cycling infrastructure across Africa. The region is increasingly developing, adopting and implementing active mobility policies that advocate for safe, comfortable and convenient active transport. Such commitments to walking and cycling are expected to support the SDGs by reducing fatalities and improving well-being (SDG 3), leading to equitable mobility systems (SDG 10), improving infrastructure resilience (SDG 11), and reducing emissions and improving air quality (SDG 13).[104]

In African cities, many residents depend on walking and

cycling as their primary means of transport. As of 2019, around 59% of people walking and cycling in Africa were supported by an active mobility policy, either stand-alone or as part of an integrated transport strategy.[105]

- Around 35% of countries in the region (19 out of 54) had a walking and cycling policy in 2019.[106]
- Ten African countries (Burundi, Cabo Verde, Ghana, Lesotho, Malawi, Rwanda, Seychelles, Sierra Leone, Tanzania and Togo) made commitments in 2020 to reduce their carbon emissions by encouraging walking and cycling in the wake of the pandemic.[107]
- Kampala (Uganda) and Nairobi (Kenya) – cities where 45% of residents use non-motorised transport as their primary mode – made major improvements to their non-motorised transport infrastructure during the pandemic.[108]
- Windhoek (Namibia) built 8 kilometres of cycling infrastructure along the non-motorised transport route from Khomasdal to Windhoek West, as part of the City of Windhoek's 2018 non-motorised transport strategy and the Transformative Urban Mobility Initiative (TUMI).[109]
- In 2020, Addis Ababa (Ethiopia) launched a 10-year Non-Motorised Transport (NMT) Strategy aimed at developing a comprehensive network of high-quality walking and cycling facilities to address the growing demand for better access to the city.[110] To realise the strategy, in 2021 the Addis Ababa Transport Bureau, supported by the Institute for Transportation and Development Policy (ITDP), developed a three-year NMT Implementation Plan outlining immediate actions, key goals, indicators and targets to improve the active transport environment from 2022 to 2024.[111]
- Open street events held across Africa – including in Cape Town (South Africa), Kigali (Rwanda) and several Ethiopian cities – provided cities with an opportunity to reflect on and understand the benefits of people-centred development approaches.[112]

Public transport services in Africa range from completely unregulated mini-buses to sophisticated public service contracts with international companies. **To address challenges related to safety and the quality of service, initiatives have emerged to consolidate public transport operations.**

- Kigali (Rwanda) has consolidated operators, shifting from a "target" system to salaried employment and integrated fare

collection systems.[113]

- Kenya has consolidated operators and provided regulations for improving operations, but a lack of regulatory compliance remains a challenge.[114]

Bus rapid transit (BRT) corridors and/or systems have been implemented or are being developed in Addis Ababa (Ethiopia), Cairo (Egypt), Dar es Salaam (Tanzania), Lagos (Nigeria), Nairobi (Kenya) and the cities of Cape Town, George, Johannesburg and Pretoria in South Africa. BRT is part of transit-oriented development approaches that offer a more equitable approach to land-use planning. In addition, several African cities have emphasised the importance of electric BRT buses in decarbonising their fleets and shifting towards sustainable public transport solutions. However, BRT system often face financial struggles in Sub-Saharan Africa due to inappropriate regulatory frameworks for system planning, inadequate risk allocation and competition from informal transport operators.[115]

- The Kampala Capital City Authority and development partners are creating a BRT implementation road map for Kampala (Uganda), with technical assistance from ITDP.[116]
- In Dar es Salaam (Tanzania), the operators of the Dar Rapid Transit (DART) BRT system, along with municipal governments and the Tanzania Ministry of Lands, are developing localised transit-oriented development policies, with ITDP support.[117]
- Passenger services on the nearly completed BRT system in Dakar (Senegal) – an 18.3 kilometre corridor with 23 stations – were expected to begin in mid-2023, carrying a projected 300,000 passengers daily.[118]
- Ethiopia has highlighted the importance of electric buses in its 10-year (2020-2030) transport policy, with a key goal to introduce 4,850 electric buses to decarbonise the country's fleet.[119]
- In 2023, Kenya and the European Commission signed a declaration of intention to finance the construction of an electric bus line in Nairobi, which is expected to be operational by 2030.[120]

The e-mobility landscape is evolving rapidly, pushed by the need to decarbonise economies by 2050.[121] Technological developments are enabling the shift from traditional internal combustion engines towards electric vehicles. **Several African governments have put in place policies and regulatory measures for the adoption and transition to e-mobility.**[122]

- In 2021, South Africa published a green paper on the advancement of new vehicles, emphasising the need to gradually convert the country's vehicle sector to battery electric vehicles.[123] However, in 2022 only 620 electric cars (battery electric and plug-in hybrid) were sold in South Africa, although this was nearly double the number sold in 2021 (271 units).[124]
- Rwanda's e-mobility programme plans for the phased adoption of electric buses, passenger vehicles, and motorcycles from 2020 onwards, with several incentives for operators in the sector.[125]
- In 2020, Egypt issued a decree to encourage local assembly of electric vehicles, with subsidies being considered for the first 100,000 of these locally produced vehicles.[126]
- Egypt's National Energy Efficiency and Conservation Strategy 2020 envisions meeting a target of a 5% electrified vehicle stock by 2025.[127]
- In 2023, Uganda began partnering with SPIRO, a vehicle and smart battery design company, to introduce electric motorbikes and charging and swapping stations across the country, with the goal of deploying 140,000 motorbikes and 3,000 recharging and swapping stations over five years.[128]
- In 2022, Ghana launched the Net Zero Advocacy Platform and tested five different e-cargo bike models for local functionality and real-world user preferences. By the end of 2022, the bikes, made of 100% recycled and local materials, had covered 45,000 kilometres, saving 3.6 tonnes of CO_2 emissions.[129]

Rapidly rising urbanisation and motorisation rates have prompted an urgent response to Africa's growing transport needs, including through the development of sustainable

urban mobility plans (SUMPs) and national urban mobility plans (NUMPs). Such policies can unlock the benefits of a well-functioning urban transport sector, including connectivity, inclusion, safety and improved quality of life.[130]

- In 2021, Kisumu (Kenya) launched the Kisumu Sustainable Mobility Plan, a 10-year roadmap that aims to foster increased access for city residents by prioritising walking, cycling and public transport.[131]
- In Cameroon, MobiliseYourCity supported the cities of Yaounde and Douala in 2020 in preparing and adopting SUMPs.[132]
- ITDP, in partnership with the City of Kigali (Rwanda), is developing a Non-Motorised Transport Master Plan, slated for completion in mid-2023, that identifies priority corridors for greenways and active transport in the city.[133]
- The World Bank is providing financial and/or technical assistance to bus rapid transit projects in eight African cities as part of their SUMPs: Abidjan, Dakar, Dar es Salaam (phases 3 and 4), Douala, Kampala, Kumasi, Maputo (Mozambique) and Ouagadougou (Burkina Faso).[134] In Dakar, the introduction of low- or zero-emission vehicles in the BRT corridor could save an estimated 67,700 tonnes of CO_2 annually.[135]

An urgent priority both globally and in Africa is to reduce the impact of transport on climate change. Several African countries have developed policies and strategies with time-bound targets, which are central to achieving both the SDGs and climate ambitions.

- Ethiopia's Non-Motorised Transport Strategy targets building 430 kilometres of pedestrian infrastructure and more than 300 kilometres of cycling track in secondary cities, as well as 600 kilometres of walkways and 200 kilometres of cycling lanes in Addis Ababa, by the year 2029.[136]
- In Kenya, the Non Motorized Transport Policy of Nairobi City County allocates 20% of the existing and future transport budget to infrastructure and services for walking and cycling.[137]

As of the end of 2022, Africa accounted for 43% of the countries that included time-bound targets for reducing transport greenhouse gas emissions in their second-generation Nationally Determined Contributions (NDCs) under the Paris Agreement.[138] The African countries – representing 10 out of the 23 total countries – were Burkina Faso, Egypt, Gambia, Guinea, Liberia, Mauritania, Mauritius, Seychelles, South Sudan and Uganda.[139] Several African NDCs also included other types of transport targets, such as for vehicle efficiency, zero-emission vehicles, modal share, biofuels and transport infrastructure.

- Burkina Faso has targets to limit its transport CO_2 emissions to 1,210 gigagrams of CO_2-equivalent (unconditional) and 267 gigagrams of CO_2-equivalent (conditional) by 2025.[140]
- South Sudan targets a 44% reduction in transport emissions below the business-as-usual (BAU) level by 2030.[141]
- The Gambia targets reducing transport emissions 22.2% below the BAU level by 2030.[142]
- Seychelles targets reducing transport emissions 30% below the BAU level (to reach 169.1 kilotonnes of CO_2-equivalent or below) by 2030, with a focus on petrol vehicles.[143]
- Liberia has committed to reducing transport emissions 15.1% below the BAU level by 2030.[144]
- Among the long-term low greenhouse gas emission development (LTS) strategies under the Paris Agreement, only Gambia and Nigeria included a specific target to reduce transport emissions. Nigeria aims to reduce transport emissions by 4 million tonnes of CO_2-equivalent by 2030, or 14% below 2019 levels.[145]
- The NDCs of Burkina Faso, Morocco, Namibia, South Sudan and Tanzania directly link transport to renewable energy sources.[146] Cabo Verde includes a target to electrify at least 25% of its land transport fleet (new road vehicles) by 2030.[147]

The Avoid-Shift-Improve (ASI) framework is crucial to unlocking the benefits of sustainable, low-carbon transport.[i] ASI actions provide a balanced approach that is key to providing integrated, inter-modal and equitable transport systems.

- ASI actions are slightly more balanced in African NDCs compared to other global regions, with 30% representing "Shift" actions (versus 25% at the global level).[148] In contrast, "Improve" actions (vehicle improvements) comprise 53% of ASI actions in Africa, the lowest share among all regions and slightly below the global level (58%).[149]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- In 2023, the **African Development Bank** and the **International Road Federation** jointly released a new training programme to improve safe and sustainable urban transport planning and project preparation for African cities.[150]
- During 2021-2022, **Changing Transport**, together with the SLOCAT Partnership and the **NDC Transport Initiative for Asia**, developed Climate Strategies for Transport in Africa.[151]
- Between 2019 and 2021, the **German Agency for International Cooperation (GIZ)** provided financial and capacity building support to 12 countries in Africa under the Sustainable Mobility 2.0 project, to implement and develop sustainable mobility systems and initiatives.[152]
- **MobiliseYourCity** has provided various levels of planning and policy support across Africa, including in Côte d'Ivoire, Ethiopia, Ghana, Madagascar, Morocco, Mozambique, Senegal and Tunisia.[153]
- In 2022, the SLOCAT Partnership, together with the **Volvo Research and Educational Foundations (VREF)**, launched the third round of the Young Leaders in Sustainable Transport programme.[154]

i From the Avoid-Shift-Improve framework. See https://slocat.net/asi.

- In 2022, the **SLOCAT** African Voices towards COP 27 Series featured a wide range of African professionals, experts and change makers to elevate voices from the region in tackling transport and mobility challenges.[155]
- The **United Nations Conference on Trade and Development (UNCTAD)** is involved in various transport-focused training and capacity building initiatives towards improving trade in Africa.[156]
- The **VREF's** programme on Mobility and Access in African Cities (MAC) has been operating since 2019, with a second phase starting in 2023. The programme has initiated 30-plus research projects involving more than 100 researchers and doctoral students at universities in Sub-Saharan Africa.[157]
- In 2022, **Walk21**, together with the UN Environment Programme and the UN Human Settlements Programme (UN-Habitat), published the first report to present data on walking and cycling from all 54 African countries.[158]

MODULE 2 2.2

AUTHORS: *Hannah E. Murdock, Imperial College London; Ambika Sairam, SLOCAT Secretariat*

CONTRIBUTOR: *Urda Eichhorst, GIZ*

Asia Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
4,676 million	+12%	52%	+31%	USD 6,802	+58%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- As their populations and economies expand, countries across Asia have recorded soaring motorisation growth (covering four-wheeled motorised vehicles) – with increases of more than 200% in some countries during 2010-2019 – as well as significant growth in two- and three-wheelers.
- Asian countries continued to be global leaders in electric vehicles. As of 2021, the region was home to 95% of the world's electric vehicles, with nearly 92% of the Asian fleet being two-wheelers.
- Cities in Asia have experienced a surge in public transport, led by a strong increase in metro rail.
- Between 2015 and 2021, the number of Asian cities with bus rapid transit systems increased 36%, while cities with metros and light-rail systems increased 49%.
- Informal transport through two-wheelers, three-wheelers, Jeepneys and other types of collective transport continue to play a significant role in many parts of Asia.
- The demand for bike sharing services in Asia has risen since 2020, making the region the world's largest bike sharing market. As of 2021, nearly 800 bike sharing schemes were operating across Asia.
- Passenger air travel in Asia had partially rebounded from the COVID-19 pandemic by late 2022 and showed stronger recovery than in other regions. Globally, passenger air travel increased 57% by September 2022 compared to 2021, whereas the Asia-Pacific region saw an increase of 465% (although global averages were still 74% below pre-pandemic levels).
- Decreased economic activity during the pandemic, followed by the Russian Federation's invasion of Ukraine, led to significant shifts in freight transport across Asia.
- The Asia-Pacific region has experienced the fastest uptake of renewable energy use in transport globally, with average annual growth of nearly 14% between 2010 and 2019 (although starting from a low baseline).

Emission trends

- Asia continued to have the highest transport-related carbon dioxide (CO_2) emissions among world regions, as well as the highest transport emissions growth, at 36% during 2010-2021.
- China remained the largest emitter of transport CO_2 in Asia and the second highest emitter globally as of 2021, followed by India, although Persian Gulf countries still dominated per capita transport emissions.
- China continued to see slight decreases in transport emissions in 2022 as lockdowns remained in place, whereas restrictions had been loosened in many other Asian countries. In countries such as India and Japan, transport emissions increased consistently, in part rebounding from lows during the pandemic.
- Air pollution contributed to 6.5 million deaths globally in 2019, with 70% of the deaths occurring in the Asia-Pacific region.
- Recent projections have shown that transport emissions in Asia deviated from pre-2015 projections, which had predicted a near-doubling in business-as-usual emissions between 2021 and 2050. Even so, at the growth rate of 2021, the region's transport emissions would not peak before 2050, whereas a net zero emissions pathway or a pathway consistent with keeping global temperature rise below 1.5 degrees Celsius would require emissions to peak by 2025.

Policy developments

- As both population and urbanisation increase in Asia, governments will need to boost efforts to achieve sustainable transport while meeting the rising demand for passenger and freight transport.
- As of 2022, at least 14 countries in the region had made economy-wide pledges towards net zero emissions, in addition to having transport-specific targets, mostly aimed at electric mobility.
- Several Asian countries and cities have prioritised electric mobility in their policy targets, with some adopting targets to reduce or ban sales of internal combustion engine vehicles.
- Some transport-specific targets are aimed specifically at improving the efficiency of the freight sector, ranging from reducing energy use to increasing efficiency and multi-modality.

- Specifically for shipping, some countries and ports in the region pledged to contribute to efforts to decarbonise the sector.
- Policies focused on sustainable mobility have continued to expand in Asia, as more countries develop policy frameworks supporting low-carbon urban mobility, as well as freight transport.
- Informal transport fleets in Asia are gradually electrifying, for example in the Philippines.
- Some Asian countries have adopted sweeping measures towards low-carbon mobility and reductions in vehicle travel, while cities have increasingly created sustainable urban mobility plans (SUMPs), often to decongest urban areas.
- Measures to support cycling are on the rise in Asian cities, with governments such as India, Indonesia and the Philippines launching initiatives since 2020 to support walking and cycling.
- A few Asian countries have long implemented fuel efficiency standards, including China, India, Japan and the Republic of Korea. As of 2022, only five countries globally had fuel economy standards for heavy-duty vehicles, among them China, India and Japan (along with Canada and the United States).
- Asia's global dominance in electric mobility has been driven by national efforts to implement specific policies and to remove barriers, as well as in some cases by initiatives to swap, recycle and re-use electric vehicle batteries.
- As countries in Asia have focused on increasing their renewable energy capacity, the most common policy measure aimed at the use of renewables in transport continued to be biofuel blending mandates, with three countries (India, Indonesia and the Republic of Korea) increasing their mandates in 2022.

Photo credits: Paul Starkey / Ashden

Overview

Despite setbacks, the Asia region[i] remained relatively economically resilient during the COVID-19 pandemic and had partially rebounded by late 2022. The Russian Federation's war in Ukraine, starting in February 2022, led to additional economic uncertainty as commodity prices rose and global demand weakened, exposing the higher risks of shocks in some Asian countries due to their economic structures.[2] The region also has experienced increasing climate-related disasters, highlighting the role that decarbonisation of the transport sector can play in contributing to greater resiliency.[3]

Asia has made advances towards several of the United Nations (UN) Sustainable Development Goals (SDGs), which would contribute to further resilience and improved equity and health, although overall progress has been slow.[4] At the pace of progress as of 2023, the region would achieve only 10% of the measurable SDG targets by 2030 (or 118 out of 169 targets).[5] The most progress has been seen on affordable and clean energy (SDG 7) and on industry, innovation and infrastructure (SDG 9), whereas progress on climate action (SDG 13) has continued to regress.[6]

Alongside several decades of economic growth, Asia has experienced rising demand for mobility and for diverse transport modes. This has led to increased motorisation as well as rising interest in electric vehicles, bike sharing systems and public transport in much of the region. Asia continued to have the highest share of electric vehicles globally in 2021, while also increasing its use of renewable energy in transport. Policy measures and targets for sustainable mobility have expanded in the region, with a growing number of policy frameworks supporting active travel and public transport.

However, absolute transport-related carbon dioxide (CO_2) emissions in Asia remained the highest among world regions in 2022, with most countries in the region experiencing increases since 2020.[7] With the rising demand for both passenger and freight transport, alongside growing populations and urbanisation, governments across Asia will need to boost their support for sustainable transport systems going forward.

Demand trends

In 2019, analysts proclaimed that the "Asian century" had begun, citing projections for robust economic growth across the region.[8] Despite some hardships from the COVID-19 pandemic in 2020 and 2021, most Asian countries remained relatively economically resilient in 2020 and beyond.[9] Growth in gross domestic product (GDP) continued to be mostly stable, and the Asian economy contracted only 1.5% in 2020, much less than the global economy at 3.2%, resulting in a more rapid rebound.[10]

Asia's population has continued to surge, and as of early 2023 the region was home to 11 of the top 20 countries globally with the largest populations.[11] As cities have expanded, an estimated 55% of the Asian population is projected to live in urban areas by 2030, up from 52% in 2022.[12]

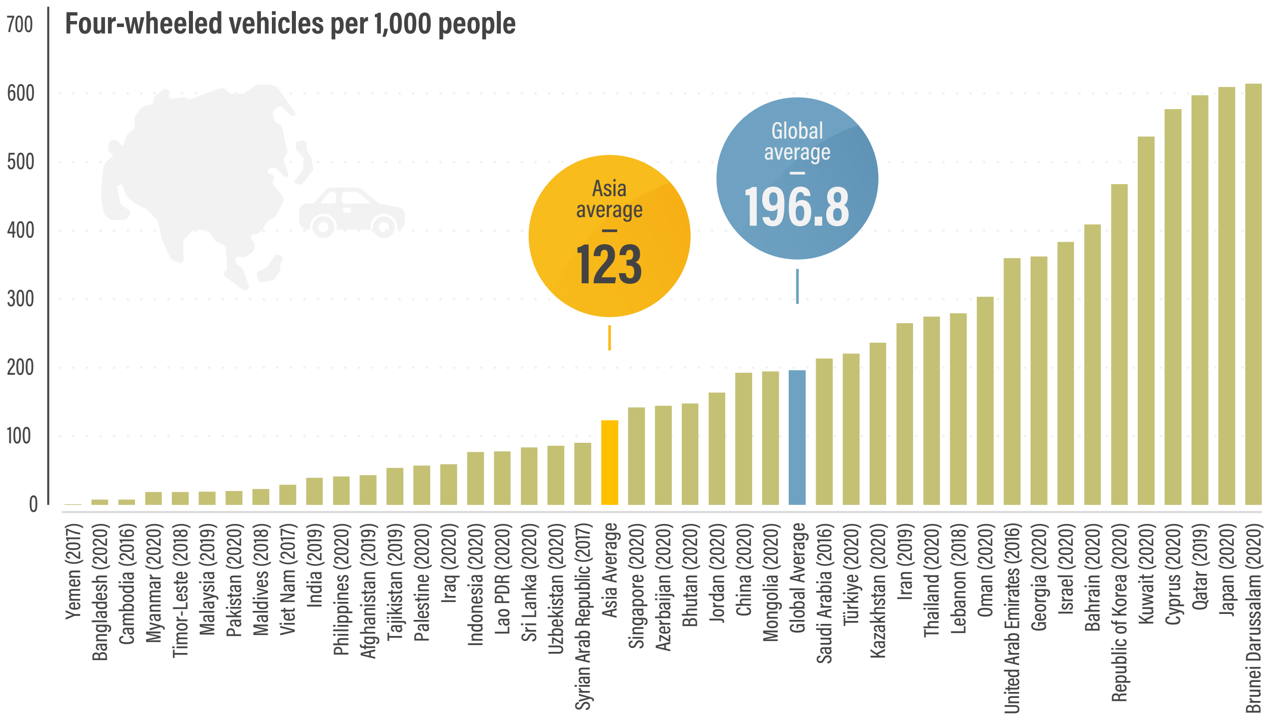
Many countries in Asia imposed strict lockdowns in response to the pandemic, restricting mobility. As in other regions, this led to a temporary plunge in all modes of passenger transport and to major shifts in freight.[13] Mobility to public transport stations in the region fell nearly 60% between January and April 2020, although it recovered to pre-pandemic levels by late 2021 as countries eased restrictions.[14] Traffic congestion levels also increased in 2021, although they were still 10% lower than in 2019.[15]

As their populations and economies expand, countries across Asia have recorded soaring motorisation growth (road motor vehicles except motorcycles) – with increases of more than 200% in some countries during 2010-2019 – as well as significant growth in two- and three-wheelers.[16] Private vehicle ownership in the region increased by nearly 1 billion vehicles between 2000 and 2020, with two- and three-wheelers taking the lead to represent more than 75% of the private vehicles owned in low- and lower middle-income countries in Asia.[17]

i SLOCAT includes in the Asia region a total of 48 countries, covering Western, Central, Eastern, Southern and South-Eastern Asia.

FIGURE 1. Motorisation levels per 1,000 people in Asia, 2016-2020

Source: See endnote 16 for this section.



- China had the region's highest growth in private motorisation during 2010-2019, at 212%, followed closely by Myanmar (209%) and Pakistan (207%), whereas Singapore's motorisation rate fell 9% during this period.[18]
- Brunei Darussalam led the region in per capita motorisation levels, at 614 vehicles per 1,000 people in 2020, followed by Japan (609 vehicles per 1,000 people) and Qatar (597 vehicles per 1,000 people); the lowest motorisation rates were in Yemen, at less than 1 vehicle per 1,000 people, followed by Cambodia and Bangladesh (both at 7 vehicles per 1,000 people) (see Figure 1).[19]
- Bangladesh experienced the fifth highest increase in motorisation rate in Asia, rising more than 150% between 2010 and 2019.[20]

Asian countries continued to be global leaders in electric vehicles. As of 2021, the region was home to 95% of the world's electric vehicles, with nearly 92% of the Asian fleet being two-wheelers.[21] Electric trucks also have increased in the region in recent years.[22] Asia's electric vehicle fleet (excluding two- and three-wheelers) grew 66% between 2020 and 2021, from 4.7 million vehicles to 7.8 million vehicles.[23]

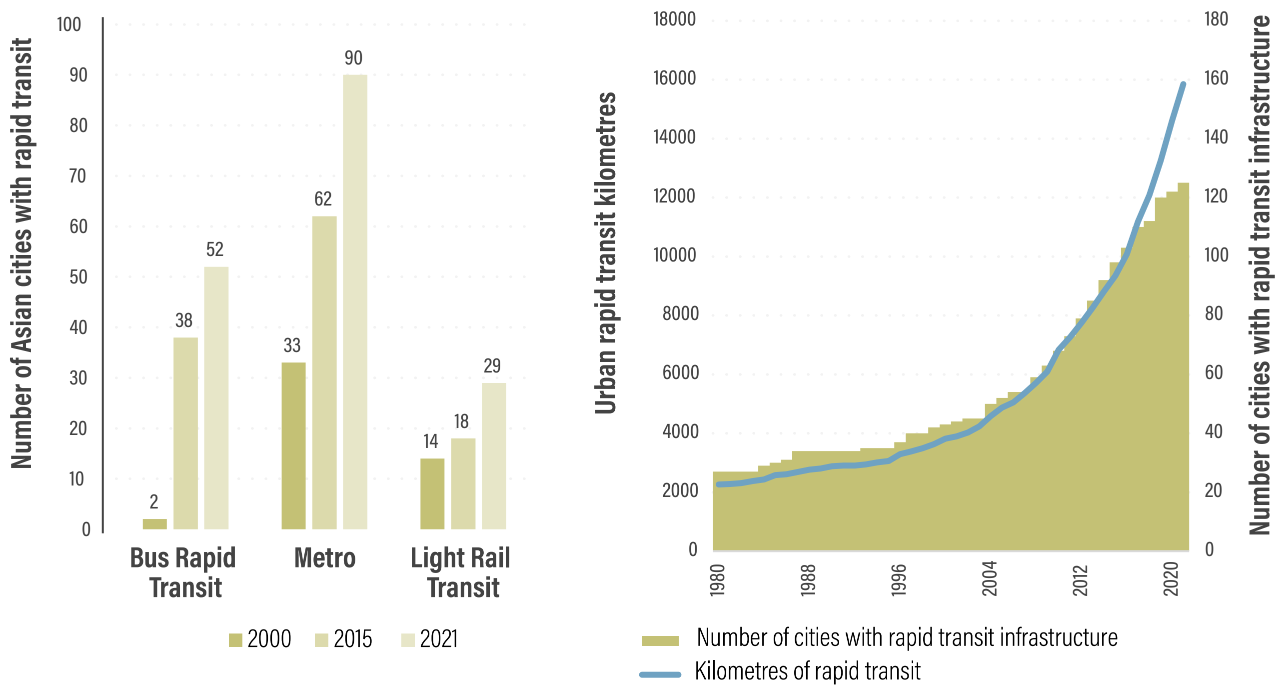
- As of 2022, China had the highest market share of electric vehicles in the region at 29%, followed distantly by the Republic of Korea (9.4%), Japan (3%) and India (1.5%).[24]
- The electric car market in China, with 14.1 million units in 2022, was more than two times larger than the market in the European Union (5.7 million) and nearly five times that in the United States (3 million).[25] Electric bus and truck registrations in China increased in 2021 after falling sharply in 2020, but did not quite return to 2019 pre-pandemic levels.[26] Price parity of battery electric trucks with diesel trucks in China is anticipated as early as 2025 for some truck types.[27]

Cities in Asia have experienced a surge in public transport services, led by a strong increase in metro rail (see Figure 2).[28] However, the modal split varies greatly across countries.[29] While the demand for high-quality public transport in cities has increased greatly, particularly since the early 2000s, as of 2021 only 125 out of 550 Asian cities with more than 500,000 people had rapid transit systems.[30]

- **Between 2015 and 2021, the number of cities in Asia with bus rapid transit systems increased 36%, while cities with metros and light-rail systems increased 49%.**[31]
- Singapore is a leader in public transport use, accounting for 83% of all trips in 2022.[32] The Philippines also had a relatively high share of public transport use, at 42%.[33] Conversely, high shares of private motorcycle use were seen in Viet Nam (82%), Cambodia (74%) and Indonesia (73%).[34]

FIGURE 2. Urban transport trends in Asia, 2000, 2015 and 2021

Source: ADB. See endnote 28 for this section.



► Several countries or cities installed their first metro lines in recent years. In 2020, Pakistan opened its first metro line in Lahore, serving 250,000 passengers along a 27-kilometre route.[35] In 2022, Bangladesh's capital Dhaka opened the country's first metro line, extending to 12 kilometres and expected to transport around 60,000 people an hour.[36] Hanoi (Viet Nam) also opened its first metro line in 2022, with nine more lines planned, although the project has been delayed by administrative and technical issues.[37]

Other places saw developments in high-speed rail, with the Lao People's Democratic Republic (PDR) and Indonesia working on their first high-speed rail services. In 2021, the first China-Lao PDR bullet train arrived in the Laotian capital of Vientiane, with the stated objective of faster connectivity between the two countries.[38] By late 2022, the Jakarta-Bandung high-speed rail line, the first high-speed rail in Indonesia, was estimated to be 88% complete and to start operating in June 2023.[39]

Informal transport through two-wheelers, three-wheelers, Jeepneys and other types of collective transport continue to play a significant role in many parts of Asia. These informal services are often connectors to major public transport services, provide access for women, children and the elderly, and are a source of employment for urban dwellers. As of 2022, there were an estimated 10 million rickshaw drivers in India and 2 million in Bangladesh.[40] Studies show that informal transport represents 38% of all commuting trips in Manila (Philippines), 40% in Kuala Lumpur (Malaysia), 50% in Jakarta (Indonesia) and 58% in Dhaka (Bangladesh).[41]

The demand for bike sharing services in Asia has risen since 2020, making the region the world's largest bike sharing market.[42] As of 2021, nearly 800 bike sharing schemes were operating across Asia.[43] (*See Section 3.3 Cycling.*)

► A 2020 study found that 360 Chinese cities were using dockless bike sharing in some capacity, with 54% of the users riding to make convenient connections to other transport modes, and nearly 36% using the bikes to commute to work.[44] The country's dockless bike sharing system has grown rapidly in response to rising traffic congestion from motorised vehicles for short-distance travel.[45] A 2022 study on shared mobility in China revealed knowledge gaps on topics such as the health impacts, life-cycle greenhouse gas emissions and equity implications of such systems.[46]

► A 2017 study reported that at least 18% of people in Beijing (China), Seoul (Republic of Korea) and Singapore were using bike sharing, often for last-mile trips in combination with public transport use.[47] Similar trends have been seen in Delhi (India), Penang (Malaysia) and Bandung and Yogjakarta (Indonesia).[48]

Some Asian countries have seen advances in **autonomous vehicles**.

- In 2022, China's largest artificial intelligence firm, Baidu, launched the country's first fully autonomous, driverless taxis in the cities of Chongqing and Wuhan.[49]
- Bayanat, a Saudi AI company, launched the United Arab Emirates' first fully autonomous taxis in Abu Dhabi in 2021.[50]

Passenger air travel in Asia had partially rebounded from the pandemic by late 2022 and showed stronger recovery than in other regions. Globally, passenger air travel increased 57% by September 2022 compared to 2021, whereas the Asia-Pacific region saw an increase of 465% (although global averages were still 74% below pre-pandemic levels).[51]

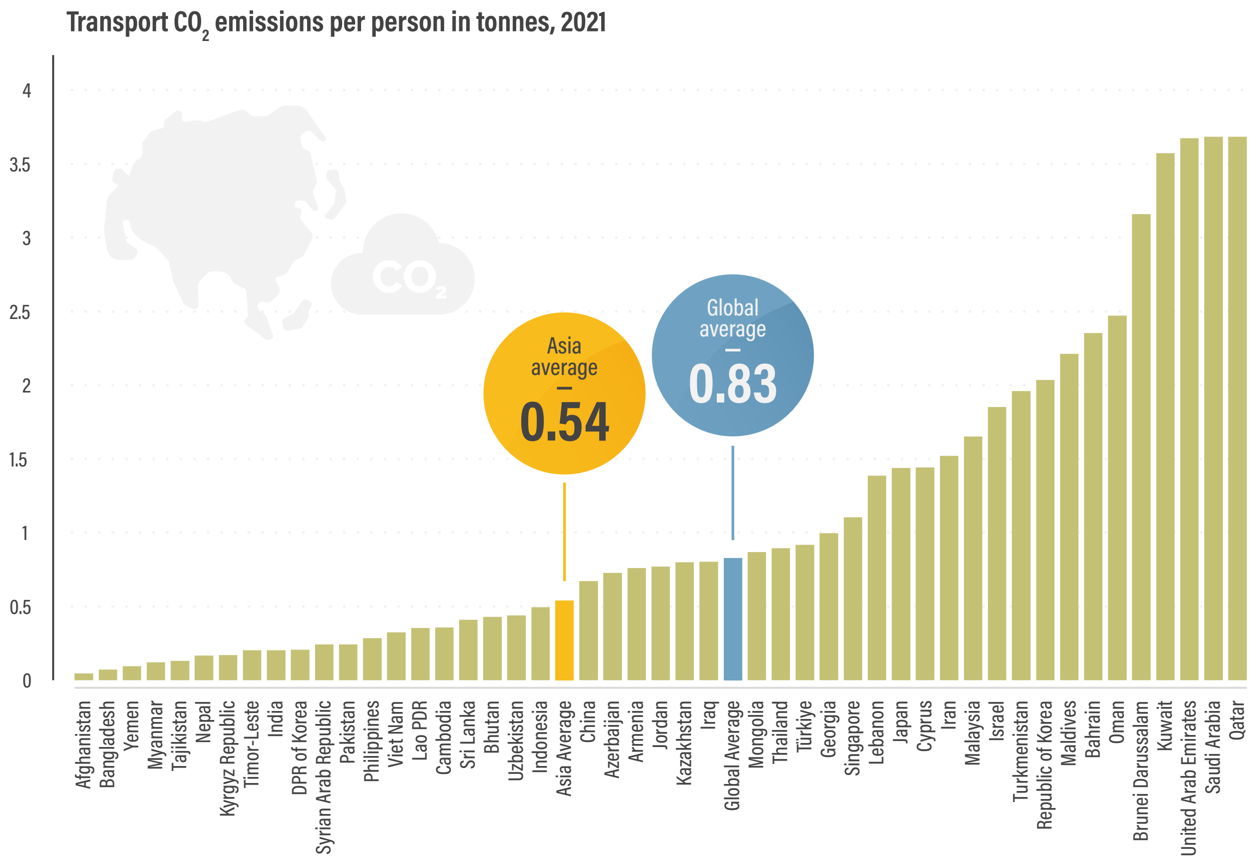
Decreased economic activity during the pandemic, followed by the Russian Federation's invasion of Ukraine, led to significant shifts in freight transport across Asia.[52] In some places, urban freight and logistics activity grew to take advantage of emerging trends, including increased online shopping and food deliveries.[53] Air cargo activity in the Asia-Pacific region fell 16% in March 2020 compared to March 2019, similar to declines seen in most world regions.[54] Air cargo volumes also fell nearly 16% in April 2022 compared to April 2021; the decline is attributed to the Russian invasion of Ukraine (as both countries have been key cargo handlers), to Chinese labour shortages, and to an overall reduction in export orders.[55] Still, the Asia-Pacific region had the highest share of the air cargo market globally in 2022, at 32.5%.[56]

- Port calls at the Chinese ports of Shanghai (the world's largest) and Yangshang fell 17% by January 2020 compared to one year earlier, which led to knock-on effects globally.[57] By May 2022, the port of Shanghai had rebounded to reach 95% of pre-pandemic activity.[58]
- Rail freight in Asia experienced mixed impacts during the pandemic, with China seeing a 24% increase in rail freight movement to Europe in the first quarter of 2020 compared to the first quarter of 2019, while India saw a 28% decline in domestic rail freight traffic in April-May 2020 compared to 2019.[59]
- Trade volumes between China and the Association of Southeast Asian Nations (ASEAN) region increased 28% in 2021, as the latter became China's biggest trading partner for the second year in a row.[60]

The Asia-Pacific region has experienced the fastest uptake of renewable energy use in transport globally, with average annual growth of nearly 14% between 2010 and 2019 (although starting from a low baseline).[61] The top renewable energy consumers for transport in the region in 2019 were Indonesia (0.17 exajoules of renewables) and China (0.12 exajoules).[62]

FIGURE 3. Per capita transport CO_2 emissions in Asia, by country, 2021

Source: See endnote 76 for this section.



Emission trends

Asia continued to have the highest transport-related CO_2 emissions among world regions – reaching 2,513 million tonnes in 2021 – as well as the highest transport emissions growth, at 36% during 2010-2021.[63] The region's share of global transport CO_2 emissions (excluding international aviation and shipping) was 39% in 2021.[64] Transport contributed the region's third highest emissions among all sectors, after the power sector and industrial combustion (and excluding other miscellaneous sectors).[65]

Per capita transport CO_2 emissions in Asia averaged 0.54 tonnes in 2021, the second lowest level after Africa.[66] Transport CO_2 emissions per USD 10,000 of GDP reached 0.80 tonnes, the third lowest level after Oceania and Europe.[67] Per capita transport CO_2 emissions increased 65% from 2010 to 2021, whereas emissions per unit of GDP fell 22%.[68]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
2,512.9 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
39%

Per capita transport CO_2 emissions (2021):
0.54 tonnes

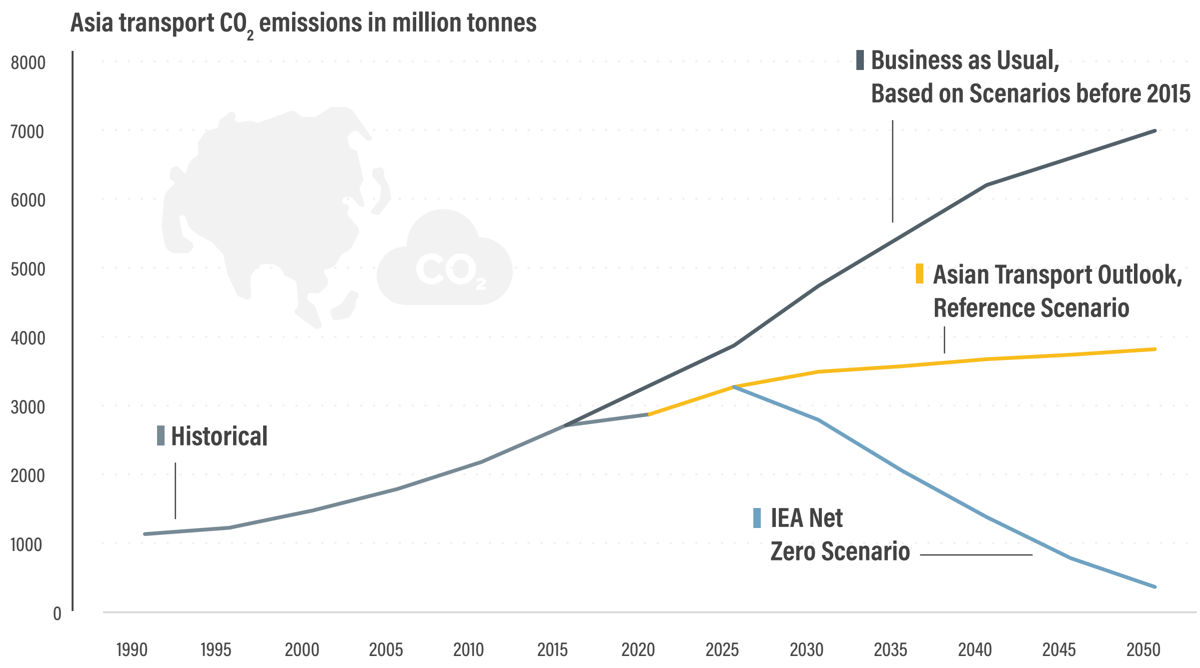
Transport CO_2 emissions per USD 10,000 GDP (2021):
0.79 tonnes

Source: See endnote 69 for this section.

China remained the largest emitter of transport CO_2 in Asia – contributing 38% of the region's total in 2021 – and was the second highest emitter globally, followed by India, although Persian Gulf countries still dominated per capita transport emissions.[70] China contributed 955 million tonnes of transport

FIGURE 4. CO_2 emissions from transport in Asia, 1990-2050

Source: ADB. See endnote 87 for this section.



CO_2 in 2021 (distantly following the United States, at 1,647 million tonnes).[71] India was the third largest emitter of transport CO_2 globally but contributed only 11% of Asia's transport CO_2 emissions.[72]

Estimates for 2015 indicate that CO_2 emissions from freight transport are slightly larger (around 55%) than from passenger transport in Asia.[73] The rising demand for road freight movement in the region is expected to further drive emissions.[74]

- Countries in the Persian Gulf dominated per capita transport CO_2 emissions in Asia in 2021, with Qatar and Saudi Arabia each emitting 3.7 tonnes per person.[75] However, in 30 of the 47 Asian countries with emission data, per capita transport CO_2 emissions were less than 1 tonne (see Figure 3).[76]
- In two-thirds of Asian countries, transport emissions remained lower in 2021 compared to pre-pandemic levels, with some countries reporting far lower emissions, such as Viet Nam (down 24% between 2019 and 2021) and Qatar (down 19%).[77]

China continued to see slight decreases in transport emissions in 2022 as lockdowns remained in place, whereas restrictions had been loosened in many other Asian countries.[78] In countries such as India and Japan, transport emissions increased consistently, in part rebounding from lows during the pandemic.

- In China, emissions from ground transport decreased 3.6%, from domestic aviation decreased 40.1% , and from international aviation decreased 14.6% in 2022, compared to 2021.[79]
- In Japan, emissions from ground transport increased 4%, from domestic aviation grew 39.8%, and from international aviation rose 11.8% during the same period.[80]
- In India, emissions from ground transport increased 8.1%, in domestic aviation grew 24.3%, and from international aviation rose 73.4%.[81]

Air pollution caused 6.5 million deaths globally in 2019, with 70% of the fatalities occurring in the Asia-Pacific region.[82] Globally, the losses in economic welfare attributable to air pollution represented 6.1% of GDP in 2019, whereas in East Asia the share was 9.3% and in South Asia it reached 10.3%.[83] From 2000 to 2019, countries in South, East and South-East Asia had the strongest increase among sub-regions globally in deaths attributable to pollution, due mostly to increased ambient air pollution, rising chemical pollution and ageing populations.[84]

Recent projections have shown that transport emissions in Asia deviated from pre-2015 projections, which had predicted a near-doubling in business-as-usual emissions between 2021 and 2050.[85] On the contrary, emissions were lower during the period 2015-2020 due to average fuel efficiency improvements, progress in electrification and other policies.[86] **Even so, at the growth rate of 2021, the region's transport emissions would not peak before 2050, whereas a net zero emissions pathway or a pathway consistent with keeping global temperature rise below 1.5 degrees Celsius would require emissions to peak by 2025** (see Figure 4).[87]

Policy developments

As both population and urbanisation increase in Asia, governments will need to boost efforts to achieve sustainable transport while meeting the rising demand for passenger and freight transport.

As of 2022, at least 14 countries in the region had made economy-wide pledges towards net zero emissions, in addition to having transport-specific targets, mostly aimed at electric mobility.[88] This included Bhutan, China, India, Japan, Kazakhstan, Lao PDR, Malaysia, Maldives, Nepal, the Republic of Korea, Singapore, Sri Lanka, Thailand and Viet Nam.[89] Many Asian countries also have **transport-specific targets**, with at least 19 countries having specific targets for electric mobility, 16 for rail, and 13 for modal share as of the end of 2022.[90]

The **Nationally Determined Contributions (NDCs)** of six Asian countries – Bangladesh, Georgia, Israel, Japan, Sri Lanka and the United Arab Emirates – are among the 23 second-generation NDCs submitted under the Paris Agreement that feature targets for transport greenhouse gas mitigation.[91] This is the second highest share by region after Africa.[92]

- Bangladesh set a target to reduce its transport CO_2 emissions 9.3% (unconditional contribution) and 27% (conditional) below projected business-as-usual (BAU) levels by 2030.[93]
- Israel aims to limit its increase in transport greenhouse gas emissions by 2030 and then reduce these emissions at least 96% below 2015 levels by 2050.[94]
- As in other regions, most of the transport-related measures included in the second-generation NDCs of Asian countries continued to be "Improve"[i] measures, although both "Avoid" and "Shift" measures increased compared to the first generation of NDCs submitted.[95]
- Sri Lanka provides a comprehensive, well-balanced set of transport mitigation actions following the "Avoid-Shift-Improve" structure.[96]

Several Asian countries and cities have prioritised electric mobility in their policy targets, with some adopting targets to reduce or ban sales of internal combustion engine vehicles (whether economy-wide or for public vehicles only, and sometimes permitting hybrid vehicles).

- By 2023, countries with targets for full or partial sales bans on internal combustion engine vehicles included the Republic of Korea (with a target year of 2025), India (2030), China (2035), Japan (2035) the Philippines (2040) and Viet Nam (2050).[97]
- Israel's Ministry of Environmental Protection set a mandatory target to have only zero-emission public transport buses in operation by 2026.[98]
- Cambodia is aiming for 40% electric cars and buses and 70% electric motorbikes by 2050.[99]
- The state of Maharashtra (India) plans to add 1,900 electric buses to Mumbai's Brihanmumbai Electric Supply and Transport fleet (a public entity providing transport services and electricity).[100] Mumbai aims to have a 100% electric fleet by 2027, with an interim 50% target by 2023.[101]

Some transport-specific targets are aimed specifically at improving the efficiency of the freight sector, ranging from reducing energy use to increasing efficiency and multi-modality.

- Since 2017, Viet Nam has included targets for changing freight transport models in its NDC to address energy consumption.[102]
- In 2022, India launched its National Logistics Policy to improve the efficiency of the freight sector.[103]
- China issued a five-year work plan in 2022 to promote multi-modality in its freight sector.[104]

Specifically for shipping, some countries and ports in the region pledged to contribute to efforts to decarbonise the sector.

- At the 2021 United Nations Climate Change Conference in Glasgow, United Kingdom (COP 26), Japan joined 18 other countries in the Clydebank Declaration, aimed at creating at least six "green shipping corridors" by 2025.[105] In early 2022, Singapore announced that it would join the agreement.[106]
- The Port of Shanghai – along with the Port of Los Angeles and industry partners – announced in 2022 that it would deliver an implementation plan for a green shipping corridor to decarbonise shipping between China and the United States.[107]

Policies focused on sustainable mobility have continued to expand in Asia, as more countries develop policy frameworks supporting low-carbon urban mobility, as well as freight transport. Policies focused on electric mobility, urban rail and active mobility have received greater importance in the region in recent years. Due in large part to policy support, particularly in China and to a lesser extent in India, Asia has the highest share of electric vehicles globally.[108]

- In 2020, Malaysia released its Low Carbon Mobility Blueprint 2021-2030, which includes several measures for reducing emissions and energy consumption in transport, such as fuel economy, electric vehicles, alternative fuel adoption and modal shift.[109]

i From the Avoid-Shift-Improve framework. See https://slocat.net/asi.

Informal transport fleets in Asia are gradually electrifying, for example in the Philippines, although informal transport operators are often neglected and do not receive support from the government.[110]

- The Philippines initiated a Jeepney electrification programme in 2017, but by early 2023 only 4% of the country's 158,000 jeepneys had been electrified.[111]

Some Asian countries have adopted sweeping measures towards low-carbon mobility and reductions in vehicle travel, while cities have increasingly created sustainable urban mobility plans (SUMPs), often to decongest urban areas. Some cities, such as in China and Singapore, also have adopted strict rules on vehicle permitting and licences in an effort to reduce the number of vehicles.[112]

- In 2022, the ASEAN region released guidelines for developing SUMPs in metropolitan areas.[113]
- The SUMP of Medan (Indonesia), completed in 2022, features USD 3.2 billion in investment to shift 15% of trips from private motorised vehicles to public transport, through the implementation of six bus rapid transit lines and a metro system, and by optimising existing public transport services.[114]
- Foshan was China's first city to introduce the SUMP concept (in 2021) and is considered a leader in sustainable transport in the country due to its well-developed public transport system – with one of the highest bus densities in China, a fully electrified bus network and a vast public bike sharing programme.[115]

Measures to support cycling are on the rise in Asian cities, with governments such as India, Indonesia and the Philippines launching initiatives since 2020 to support walking and cycling.

- India's Ministry of Housing and Urban Affairs launched its Cycles4Change and Streets4People challenges in 2020 to support active mobility.[116] By early 2023, more than 100 Indian cities had taken part in the initiatives, identifying a collective 400 kilometres of main roads and 3,500 kilometres of neighbourhood spaces that could be transformed for bike-friendly purposes.[117]
- In 2021, the Philippines' Department of Transport completed 500 kilometres of bike lanes along the metro routes of three cities: Manila (313 kilometres), Cebu (129 kilometres) and Davao (55 kilometres).[118]
- In 2022, Jakarta (Indonesia) completed 309 kilometres of bike lanes, out of a total 500 kilometres planned, with government data showing that the average number of cyclists daily in the city had surged from 47 in 2005 to 4,000 in 2022.[119]

A few Asian countries have long implemented fuel efficiency standards, including China, India, Japan and the Republic of Korea.[120] **As of 2022, only five countries globally had fuel economy standards for heavy-duty vehicles, among them China, India and Japan (along with Canada and the United States).**[121] Since 2021, ASEAN members have been introducing fuel efficiency standards in their respective countries.[122]

Asia's global dominance in electric mobility has been driven by national efforts to implement specific policies and to remove barriers, as well as in some cases by initiatives to swap, recycle and re-use electric vehicle batteries. Between 2018 and 2022, two-thirds of the global investment in electric vehicles and charging infrastructure was in Asia.[123] Some countries have invested in critical materials necessary for electric vehicle battery manufacturing, such as Indonesia (home to some 22% of global nickel reserves).[124]

- India doubled its investment in electric vehicles in 2022.[125] The government plans to introduce a battery swapping policy for electric buses to cater to the growing demand.[126] Some studies have explored the challenges and opportunities for battery re-use and recycling in India.[127] In 2022, the country released a tender for the procurement of 5,580 electric buses to be deployed across five major cities, which will induce a major shift to electric buses.[128]
- In addition to policy support, China has supported electric vehicles through targets for and investment in battery charging and swapping facilities, including for heavy-duty vehicles.[129] In 2021, China enacted several directives to promote the scaling of electric vehicle battery re-use and recycling.[130]
- Nepal lifted its import duty on electric vehicles in 2021, resulting in the import of 1,103 electric cars in the six months from July 2021 to January 2022 (up from just 51 during the same period a year prior) and 1,922 electric motorcycles (up from 695).[131]
- In 2022, Cambodia began rolling out charging stations and reduced the import duty for electric vehicles from 30% to 10%.[132]
- The Department of Transport of Hanoi (Viet Nam) approved a pilot phase for electric two-wheeler sharing, to facilitate easy travel to the city's bus rapid transit system.[133]

As countries in Asia have focused on increasing their renewable energy capacity, the most common policy measure aimed at the use of renewables in transport continued to be biofuel blending mandates.

- **Three countries in the region – India, Indonesia and the Republic of Korea – increased their biofuel blending mandates in 2022.**[134]
- Several Asian countries had biofuel blending mandates of 10% or above as of 2022, including China, India, Indonesia, and the Philippines, while other countries had lower blending mandates, such as Lao PDR, Thailand and Viet Nam.[135]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- The Asian Development Bank launched the **Asian Transport Outlook (ATO)** in 2021 to strengthen knowledge on transport in the Asia and Pacific region.[136]
- **Clean Air Asia** focuses on reducing air pollution and greenhouse gas emissions from transport and other sectors by translating research into policies and actions. Its projects and activities aim to strengthen regional and national policies and standards, enhance national and local frameworks for programmes and urban development, and increase access to information, tools and partners.[137]
- In 2022, the **Council for Decarbonising Transport in Asia** released a flagship report that advocates a vision for complete decarbonisation of transport in Asia by mid-century.[138]
- The **Global Climate Action Partnership (GCAP)** Asia regional platform – the Asia LEDS Partnership (ALP) – established a Leadership Group for Clean Transport in Asia (LG-CTA) in 2021. The membership-based group consists of policy and technical leads who are supported with multilateral activities, such as capacity building workshops, technical trainings, peer learning and study tours. The SLOCAT Partnership supports the Leadership Group as the strategic pillar of the implementing partners, along with the National Renewable Energy Laboratory and ICLEI–Local Governments for Sustainability South Asia. [139]
- The **NDC Transport Initiative for Asia** (NDC-TIA) aims to facilitate a paradigm shift to zero-emission transport across Asia, supporting China, India and Vietnam to develop comprehensive decarbonisation strategies and solutions to implement them.[140] The SLOCAT Partnership supports the NDC-TIA as a member of its consortium and steering committee.
- In 2023, the **United Nations Centre for Regional Development** led and published the first ever mapping and overview of thematic and geographic scope of transport policy support activities carried out by international organisations in participating countries of the Regional EST Forum Asia. Mapping and activities include contributions from across the SLOCAT Partnership including but not limited to France's Agence Française de Développement (AFD), Germany's Agency for International Cooperation (GIZ), Volvo Research and Educational Foundations (VREF), the World Resources Institute and the World Bank Group.[141]
- The **United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)** launched the Asia-Pacific Initiative on Electric Mobility in 2022 to accelerate the transition to electric mobility in public transport, with the aim of reducing greenhouse gas emissions from the transport sector and supporting implementation of the Paris Agreement.[142]

MODULE 2 2.3

AUTHORS:
Hannah E. Murdock, *Imperial College London;* Arjay Dineros, *SLOCAT Secretariat*

CONTRIBUTOR:
Mark Major, *Kühne Foundation*

Europe Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
744 million	+1%	75%	+38%	USD 27,769	+14%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.

SLOCAT Partnership on Sustainable, Low Carbon Transport

Key findings

Demand trends

- Passenger cars continued to be the dominant transport mode in the European Union (EU), with an 86% share in 2020 (latest data available). The number of registered passenger cars in the EU reached 253 million in 2021, up 8.6% from 2016. Vehicle preferences across Europe vary by fuel type, but nearly all countries have maintained a heavy reliance on fossil-fuelled vehicles.
- The motorisation rate (covering four-wheeled motor vehicles) continued to vary greatly across Europe, growing around 20% regionwide and 18% in EU countries, on average, during 2010-2020.
- The COVID-19 pandemic resulted in key changes in Europe's urban areas, as public transport use fell sharply and remained below 2019 levels as of July 2022 in the United Kingdom, the Netherlands, Belgium, Italy and Spain. However, in some countries, such as France and Germany, public transport sectors rebounded to pre-pandemic levels or higher.
- As public transport use declined, active travel increased in many places. Several European cities reconfigured streets to enable greater walking and cycling. Cycling in particular boomed in the region, as many cities dramatically increased funding to support bike lanes and infrastructure. Several major cities continued to have high shares of active travel among all trips as of 2022.
- Europe is the second largest electric car market in the world after China; however, despite high uptake since 2020, only 2.4% of the region's passenger cars were electric as of 2022. Sales of battery electric and plug-in hybrid cars grew more than 15% in 2022, and over 1.6 million battery-only electric cars were sold, a more than four-fold increase from 2019.
- The electric bus market in Europe grew 26% in 2022, to more than 4,100 registered vehicles, and nearly one-third of the European public bus fleet was reported to be zero-emission vehicles.
- The EU announced in 2022 that it had achieved its 2020 target of 10% renewables in transport (up from just 1.6% in 2004), with 12 of the 27 Member States surpassing the target and Sweden leading at 31.9%.
- The Russian Federation's invasion of Ukraine in 2022 contributed to rising energy prices worldwide, but the European market was particularly hard hit as countries relied heavily on Russian energy imports. Between February and July 2022, natural gas wholesale prices in Europe rose 115% and electricity prices rose 237%. The Russian war in Ukraine also has resulted in other transport-related impacts, including damage to infrastructure and major disruptions in the sector.
- Air and rail transport in Europe were heavily impacted by the COVID-19 pandemic. Air passenger transport in EU Member States fell 73% in 2020 but rebounded slightly by 2021, growing nearly 40%. Rail transport fell 46% in 2020, following years of an upward trend.
- From 2011 to 2021, the modal split in freight transport remained relatively stable in the EU, with some minor fluctuations and changes shares of maritime, rail and inland waterway transport decreased, and this trend continued through 2022. Meanwhile, the share of road freight increased slightly as it rebounded from the pandemic, and air freight transport remained stable. Maritime transport accounted for more than two-thirds of freight tonne-kilometres in the EU during 2011-2021.

Emission trends

- The transport sector contributed 22% of economy-wide carbon dioxide (CO_2) emissions in Europe in 2021. The region's transport CO_2 emissions grew a moderate 2% between 2010 and 2019, then fell 12.6% in 2020; in 2021, they rebounded 5.9% but remained below pre-pandemic levels.
- Europe contributed 18% of the world's transport CO_2 emissions in 2021 (excluding international aviation and shipping), the third largest regional share after Asia and North America.
- Based on measures planned or in place as of October 2022, total transport emissions in the EU were projected to fall below 1990 levels by 2029. In this scenario, only road transport emissions, representing 77% of the EU's transport greenhouse gas emissions, would decline until 2030. Emissions from other modes would either remain stable or increase, particularly aviation.
- Transport CO_2 emissions vary greatly across the region, from 143 million tonnes in Germany to 0.68 million tonnes in Iceland in 2021. On a per capita basis, Luxembourg emitted by far the most CO_2 from transport in 2021, while Ukraine emitted the least.

Policy developments

- With the onset of the COVID-19 pandemic, countries enacted various policy measures to stimulate transport demand, including the European Year of Rail initiative, financial aid to airlines, and many measures supporting active travel, responding to the popularity of temporary cycling and pedestrian infrastructure.
- In 2020, the European Commission released its Sustainable and Smart Mobility Strategy, which lays the foundation towards a green and digital transformation and more resiliency to future crises.
- As part of the European Green Deal, the European Commission adopted four proposals in 2021 aimed at modernising the EU's transport system to support cleaner, smarter mobility.
- In December 2021, the European Commission presented a proposal for an updated regulation on EU guidelines for the development of the Trans-European Transport Network (TEN-T), following from several initiatives in support of rail in recent years.
- In early 2023, the European Commission proposed updating the 2010 Intelligent Transport System Directive to adapt to emerging road mobility options, apps, and connected and automated mobility.
- By 2022, several European countries had adopted policies and targets aimed at promoting or discouraging certain vehicle types or fuels, and many cities had designated low-emission zones to limit polluting vehicles and improve liveability. Almost all countries in the region had biofuel blending mandates and advanced biofuel targets, in addition to those set at the EU level.
- In early 2023, the EU almost unanimously approved a ban on sales of internal combustion engine vehicles (with an exception for CO_2-neutral e-fuels) as of 2035. By 2022, at least 9 European countries had adopted either a target for 100% electric vehicles or a ban on internal combustion engine vehicles, while 11 countries had announced or made plans for such a target.
- Active low-emission zones in the EU-27, the United Kingdom and Norway increased 40% between 2019 and 2022, with projections for an additional 58% growth by 2025, to reach a total of 507 zones.
- As part of the EU's Efficient and Green Mobility Package, the EU Urban Mobility Framework was released in December 2021 to guide cities to reduce emissions, improve public health, and make urban mobility smarter and more sustainable. The framework foresees that all major cities in the network develop a sustainable urban mobility plan (SUMP) by 2025.
- Across Europe, the number of SUMPs increased from 800 in 2013 to 1,000 in 2018, with several cities having updated their SUMPs at least once.
- With the Russian invasion of Ukraine and the subsequent spike in energy prices, countries across Europe offered relief to consumers by providing subsidies for fuel and public transport. The European Commission also enacted fuel subsidies, and in May 2022 it released the REPowerEU plan, which includes a strategy to shift to imports of non-Russian gas and oil alongside accelerated adoption of renewable energy and energy conservation efforts.
- Specifically for freight, the European Commission provisionally agreed in 2022 to include emissions from shipping in the EU Emissions Trading System, and in 2023 it adopted FuelEU Maritime, aimed at reducing the greenhouse gas emission intensity of shipping fuels 80% by 2050.

Overview

Countries in Europe[i] have shown broad diversity in both transport demand and associated emissions, with the COVID-19 pandemic bringing dramatic changes to urban areas and beyond.[2] The Russian Federation's invasion of Ukraine in 2022 had a large impact on the region, with far-reaching effects on energy prices in particular.[3] Governments have responded to these major events with several key developments.

Due largely to the effects of the pandemic, the region has seen striking shifts in the modal split since 2020. While the motorisation rate has increased greatly in some countries, it has declined in others.[4] Active travel has grown strongly in many cities, while the use of public transport has mostly decreased.[5] Overall, the number of registered passenger cars has continued to rise, maintaining a heavy reliance on fossil-fuelled vehicles in most places, although electric vehicles grew five-fold between 2018 and 2021.[6]

Concerted policy action in European countries and by the European Union (EU) has focused on decarbonising transport since 2020, as demonstrated by the European Green Deal, which targets a 90% reduction in EU transport sector emissions by 2050.[7] A number of policies have focused on making mobility smarter, more resilient, and more inclusive, while creating more liveable cities.

The region advanced efforts to achieve the United Nations (UN) Sustainable Development Goals, and the EU set the world's most ambitious regional climate targets for 2030, which will require far more rapid progress than occurred by 2023.[8] Emissions from road transport are projected to continue to decline to 2050, although emissions from other transport modes are expected to remain stable or increase without further measures.[9]

Demand trends

As in other world regions, the COVID-19 pandemic greatly affected both passenger and freight transport in Europe, with some countries and cities experiencing dramatic changes in their modal shares in 2020 and beyond. These included large increases in active travel and declines in public transport, which in many cases continued through 2022.[10]

Passenger cars continued to be the dominant transport mode in the EU, with an 86% share in 2020 (latest data available).[11] The number of registered passenger cars in the EU reached 253 million in 2021, up 8.6% from 2016.[12] Vehicle preferences across Europe vary by fuel type, but nearly all countries have maintained a heavy reliance on fossil-fuelled vehicles.

- Several EU Member States experienced particularly strong growth in passenger car registrations in 2021, including Greece, Ireland and Poland.[13]
- Germany had the highest total number of passenger cars in 2021, at almost 49 million, followed by Italy (40 million) and France (39 million).[14]
- In 2021, the European countries with the highest shares of petrol-powered cars among new registrations were Cyprus (85.5%), Malta (80.5%), Lithuania (77.6%), the Netherlands (77.4%) and Finland (77.3%).[15]
- The only country that had a higher share of diesel than petrol cars among new passenger car registrations was Greece (75.8%).[16]

The motorisation rate (covering four-wheeled motor vehicles) continued to vary greatly across Europe, growing around 20% regionwide and 18% in EU countries, on average, during 2010-2020.[17] The average motorisation rate for the region was 554 vehicles per 1,000 people, well above the global average of 196 vehicles per 1,000 people (see Figure 1).[18] From 2010 to 2020, motorisation growth ranged from an increase of 76% in Romania to a decline of 12% in Greece (due to ongoing effects of the economic crisis).[19]

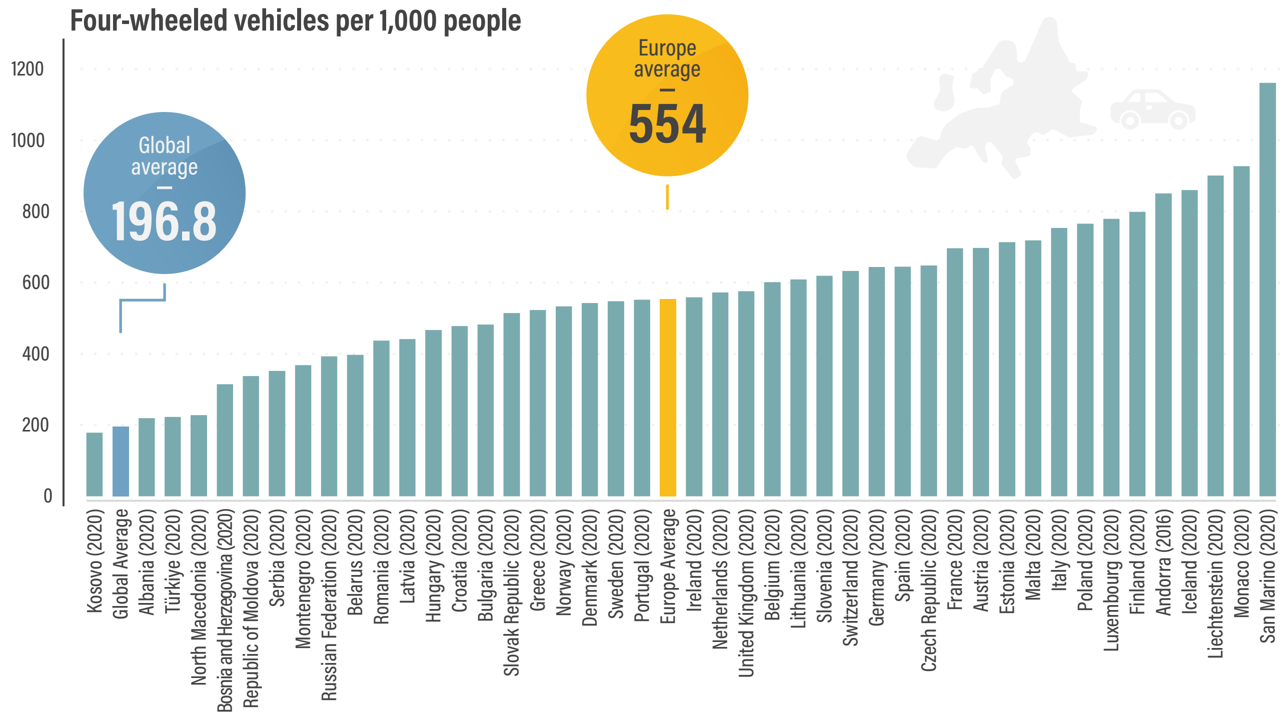
- San Marino and Monaco topped the list for motorisation in the region, with 1,161 and 927 vehicles per 1,000 people, respectively, in 2020, followed by Liechtenstein (902) and Iceland (860).[20] The lowest motorisation rate was in Kosovo (178), followed by Albania (219) and Türkiye (223).[21]
- Finland, with 798 passenger cars per 1,000 people, topped the motorisation list in EU Member States in 2020, followed closely by Luxembourg, with 779 cars per 1,000 people.[22]
- Luxembourg had the highest share of vehicles no older than two years in the EU in 2021 (19.2% of vehicles), followed by Germany (17.8%) and Sweden (15.8%), while Poland had the highest share of passenger cars older than 20 years (41.3% of vehicles), followed by Estonia (33.2%) and Finland (29.2%).[23] Eastern European countries are a large market for imported second-hand vehicles, with Serbia and Bosnia and Herzegovina among the world's top 10 importing countries for used light-duty vehicles.[24]

---

i In this section, "Europe" includes 27 Member States of the European Union (EU), four Member States of the European Free Trade Association (EFTA), as well as Albania, Andorra, Belarus, Bosnia and Herzegovina, Kosovo, Monaco, Montenegro, the Republic of North Macedonia, the Republic of Moldova, the Russian Federation, San Marino, Serbia, Ukraine and the United Kingdom. When the text refers specifically to "the EU", only EU Member States are concerned.

FIGURE 1. Motorisation rates per 1,000 people in Europe, 2016-2020

Source: See endnote 18 for this section.



- The motorisation rate in the six EU candidate countries and potential candidates for which data are available – Albania, Kosovo, Montenegro, the Republic of North Macedonia, Serbia and Türkiye – is much lower than in the EU Member States.[25]

The COVID-19 pandemic resulted in key changes in Europe's urban areas, as public transport use fell sharply and remained below 2019 levels in several countries as of July 2022.[26] However, in some countries public transport sectors rebounded to pre-pandemic levels or higher.

- Between 2019 and 2022, public transport use in the region decreased the most in the United Kingdom (down 21%), followed by the Netherlands, Belgium, Italy and Spain.[27]
- Conversely, France reported a 9% increase in public transport use in 2022 compared to 2019, while use increased 8% in Germany.[28]

As public transport use declined, active travel increased in many places.[29] Several European cities reconfigured streets to enable greater walking and cycling.[30] Cycling in particular boomed in the region, as many cities dramatically increased funding to support bike lanes and infrastructure.[31] Several major cities continued to have high shares of active travel among all trips as of 2022.[32]

- Countries with the largest additional cycling funding per capita during 2020 were Finland (USD 8.3 per person), followed by Italy (USD 5.4), France (USD 5.2) and the United Kingdom (USD 5.1).[33]
- Cities with high shares of walking among all trips included Paris (France) and London (UK) at 47%, and Stockholm (Sweden) and Oslo (Norway) at 42% each in 2022.[34] Cities with high cycling shares included Copenhagen (Denmark) and Amsterdam (Netherlands) at 19% in the same year.[35]

Europe is the second largest electric car market in the world after China; however, despite high uptake since 2020, only 2.4% of the region's passenger cars were electric as of 2022.[36] Sales of battery electric and plug-in hybrid cars grew more than 15% in 2022, meaning that every fifth car sold in Europe was electric.[37] Over 1.6 million battery-only electric cars were sold in 2022 in Europe, a more than four-fold increase from the 360,000 sold in 2019.[38]

The electric bus market in Europe grew 26% in 2022, to more than 4,100 registered vehicles, and nearly one-third of the European public bus fleet was reported to be zero emission vehicles.[39]

For its transport energy mix, **the EU announced in 2022 that it had achieved its 2020 target of 10% renewables in transport (up from just 1.6% in 2004), with nearly half (12) of the 27 EU Member States surpassing the target.[40]** By 2019, Europe as a whole accounted for 18% of the global demand for renewable fuels for transport.[41]

- Sweden had the EU's highest renewable energy share in transport in 2020, at 31.9% (due in large part to its relatively high use of biofuels in the sector), followed by Finland (13.4%), the Netherlands and Luxembourg (both 12.6%).[42] The lowest shares were in Greece (5.3%) and Lithuania (5.5%).[43]
- France, Germany and Spain together represented 44% of renewable energy use for transport in Europe.[44]

Despite significant growth in recent years, passenger cars powered by so-called alternative fuels comprised only a small share of Europe's total passenger car fleet in 2021 and remained low in most EU Member States.[45] As defined by the European Commission, alternative fuels refer to fuels other than petrol or diesel but can include other fossil fuels, so they are not always necessarily "clean" or "sustainable".[46] They can include electricity, liquefied petroleum gas (LPG), fossil natural gas, alcohols and mixtures of alcohols with other fuels, hydrogen, and biofuels, among others.[47]

In some European countries, new passenger cars powered by alternative fuels are mostly or nearly entirely battery electric, but the share varies greatly, with countries in Eastern and Southern Europe having a much smaller share of electric "alternative fuel" vehicles.[48] This variation is due in part to differing government incentives and their timing, including tax reductions, subsidies, access to lanes reserved for public transport, and free parking.[49] Other reasons for the diversity in alternative fuel car registrations include the number, variety and price of such models.[50]

The Russian Federation's invasion of Ukraine in 2022 contributed to rising energy prices worldwide, but the European market was particularly hard hit as countries relied heavily on Russian energy imports.[51] Between February and July 2022, natural gas wholesale prices in Europe rose 115% and electricity prices rose 237%.[52] In 2020, the EU relied on the Russian Federation for 29% of its crude oil imports and 43% of its natural gas imports.[53] With the rise in global oil prices due to the conflict and other factors, fuel prices for transport have surged since 2020. (*See Section 3.1 Integrated Transport Planning and Section 3.6 Road Transport.*)

The Russian war in Ukraine also has resulted in other transport-related impacts, including damage to infrastructure and major disruptions in the sector (see Box 1).[54]

BOX 1. The Russian Federation's war in Ukraine and impacts on transport

In 2021, prior to the Russian invasion of Ukraine, the EU had confirmed a plan to strengthen transport links with Eastern Partnership countries, including Ukraine, where 39 projects were planned to improve all modes of transport, for a total of EUR 4.5 billion (USD 4.8 billion). Ukraine was already connected to all 27 EU Member States through bilateral air services agreements, and in October 2021 a common aviation area agreement was signed to permit direct flights between Ukraine and any airport in the EU.

However, as a result of the Russian invasion in 2022, transport infrastructure in Ukraine has been greatly compromised. By June 2022, up to an estimated 30% of Ukraine's transport infrastructure had been damaged and major disruptions occurred in the sector, representing costs of up to EUR 92.6 billion (USD 98.8 billion). Meanwhile, the flows of refugees from Ukraine have needed transport to the EU. By the end of 2022, nearly 8 million people had fled Ukraine to other countries across Europe.

In a statement issued on 25 February 2022, the day after the invasion, the International Road Transport Union estimated that at least 12,000 truck drivers from across Europe and elsewhere remained stuck in Ukraine. In addition, the increase in fuel prices had negative impacts on commercial transport operators and supply chains, especially for road and maritime transport.

In response to the invasion, the EU adopted several sanctions linked to the transport sector, including bans on:

- sales of aircraft and related parts and equipment to Russian companies;
- Russian aircraft of any kind from entering EU airspace;
- Russian-flagged vessels from entering EU ports, with the exception of deliveries for medical, food, energy or humanitarian purposes;
- road transport businesses that were established in the Russian Federation from transporting goods into the EU, including those in public transport to other destinations; and
- the import of Russian seaborne crude oil and petroleum products, which represents 90% of previous oil imports from the Russian Federation.

In reaction to the sanctions, the Russian Federation banned from its airspace all EU airlines, as well as airlines from 36 other countries that support sanctions against the country. This resulted in reduced flight capacity by western companies, as well as higher flight costs for travellers and air cargo. (*See Section 3.7 Aviation.*)

Source: See endnote 54 for this section.

As with other regions, air transport in Europe was heavily impacted by the COVID-19 pandemic. Air passenger transport in EU Member States fell 73% in 2020 but rebounded slightly by 2021, growing nearly 40%.[55] Total air passenger transport among all European countries was expected to surpass 2019 levels (pre-pandemic) by 2024.[56]

Rail transport was also severely affected by the pandemic, falling 46% in 2020 in EU Member States following years of an upward trend.[57] By 2021, EU rail transport had partially recovered, rising 16.5%, with France and Germany showing particularly strong recoveries.[58] Night trains also resurged across the region by 2022, and rail carriers increasingly offered new routes and services to attract more customers.[59]

From 2011 to 2021, the modal split in freight transport remained relatively stable in the EU, with some minor fluctuations and changes shares of maritime, rail and inland waterway transport decreased, and this trend continued through 2022.[60] The decline was due to factors including effects from the pandemic, shrinking demand for goods, changes in port congestion, higher freight costs, supply chain disruptions, increasingly competitive truck transport, and the decline in traditional customer industries for rail freight (such as coal and petrol).[61] **Meanwhile, the share of road freight increased slightly as it rebounded from the pandemic (with strong increases in 2021), and air freight transport remained stable.**[62]

The effects of the pandemic led to a 5% decline in containerised freight transport across Europe in 2020, following continuous increases over the previous decade.[63] In 2021, inland freight grew 15% in the region.[64] However, the market for new commercial road vehicles in the EU fell nearly 15% between 2020 and 2022 due to supply chain issues limiting the availability of vehicles.[65]

Maritime transport accounted for more than two-thirds (67.9%) of freight tonne-kilometres in the EU during 2011-2021.[66]

- Latvia registered the highest growth in maritime transport during this period (up 8.5 percentage points) followed by Estonia (up 6.0), while Sweden recorded the largest drop (down 5.9).[67]
- From 2011 to 2021, the share of inland waterways in total freight transport decreased in 11 of the 17 EU Member States for which this mode of transport is applicable.[68] The largest drop in the inland waterway transport share was in Luxembourg (down 3.2 percentage points), while slight increases were seen in the Slovak Republic (up 0.7 percentage points) and Finland (up 0.1).[69]
- The share of road transport in total EU freight transport peaked at nearly 25% in 2021, after rising by 0.6 percentage points from the previous year.[70] In 2021, the share increased the most in Romania (up 3.7 percentage points), while the largest decrease was in the Slovak Republic (down 3.4).[71]
- The share of rail in total freight transport dropped in Switzerland and in 16 of the 25 EU Member States that have railways during 2011-2021.[72] Latvia had the largest fall in rail's share during the decade (down 22.9 percentage points), followed by Lithuania (down 10.8).[73]
- The share of air transport in total freight transport remained relatively stable in all EU countries during 2011-2021.[74] The highest increases in the share of air in total freight transport were in Latvia (up 0.9 percentage points) and Luxembourg (up 0.6).[75]

Emission trends

The transport sector contributed 22% of economy-wide CO_2 emissions in Europe in 2021.[76] **The region's transport CO_2 emissions grew a moderate 2% between 2010 and 2019, then fell 12.6% in 2020 with the onset of the COVID-19 pandemic; in 2021, they rebounded 5.9% but remained below pre-pandemic levels.**[77]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
1,177.6 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
18%

Per capita transport CO_2 emissions (2021):
1.58 tonnes

Transport CO_2 emissions per USD 10,000 GDP (2021):
0.57 tonnes

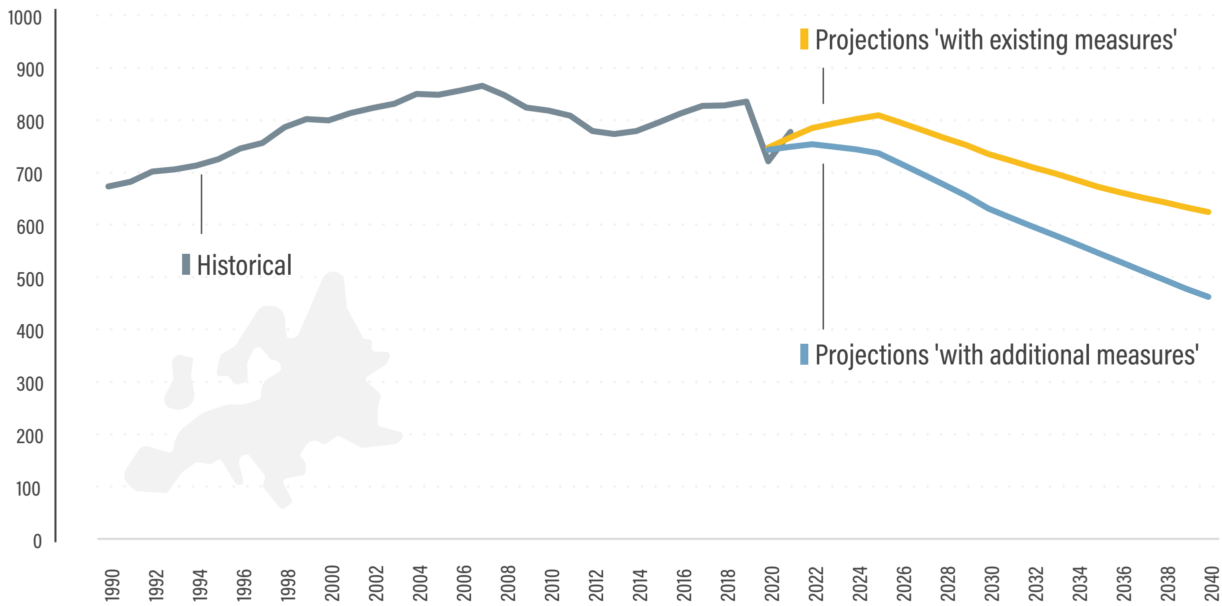
Source: See endnote 78 for this section.

Europe contributed 18% of the world's transport CO_2 emissions in 2021 (excluding international aviation and shipping), the third largest regional share after Asia and North America.[79] **Based on measures planned or in place as of October 2022, total transport emissions in the EU were projected to fall below 1990 levels by 2029** (see Figure 2).[80] **In this scenario, only road transport emissions, representing 77% of the EU's transport greenhouse gas emissions, would decline until 2030.**[81] **Emissions from other modes would either remain stable or increase, particularly aviation** (see Figure 3).[82]

Transport CO_2 emissions vary greatly across the region, from 143 million tonnes in Germany to 0.68 million tonnes in Iceland in 2021.[83] **On a per capita basis, Luxembourg emitted by far the most CO_2 from transport in 2021, while Ukraine emitted the least.**[84] Luxembourg has exceptionally high per

FIGURE 2. Greenhouse gas emissions from transport in the EU, 1990-2020, with projections to 2040

Source: See endnote 80 for this section.



Note: "With existing measures" includes those planned or in place as of October 2022.

FIGURE 3. Change in greenhouse gas emission levels from transport in the EU, by mode, 1990-2020, with projections to 2040

Source: See endnote 82 for this section.

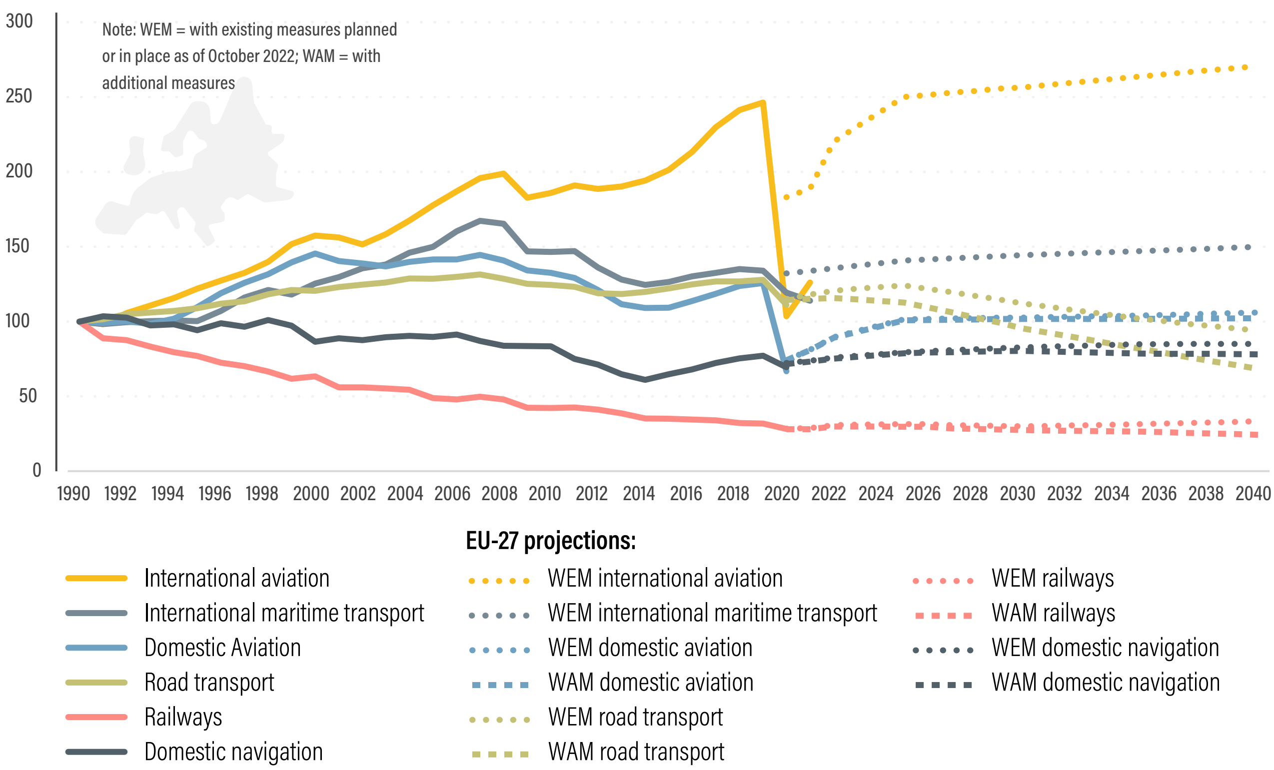
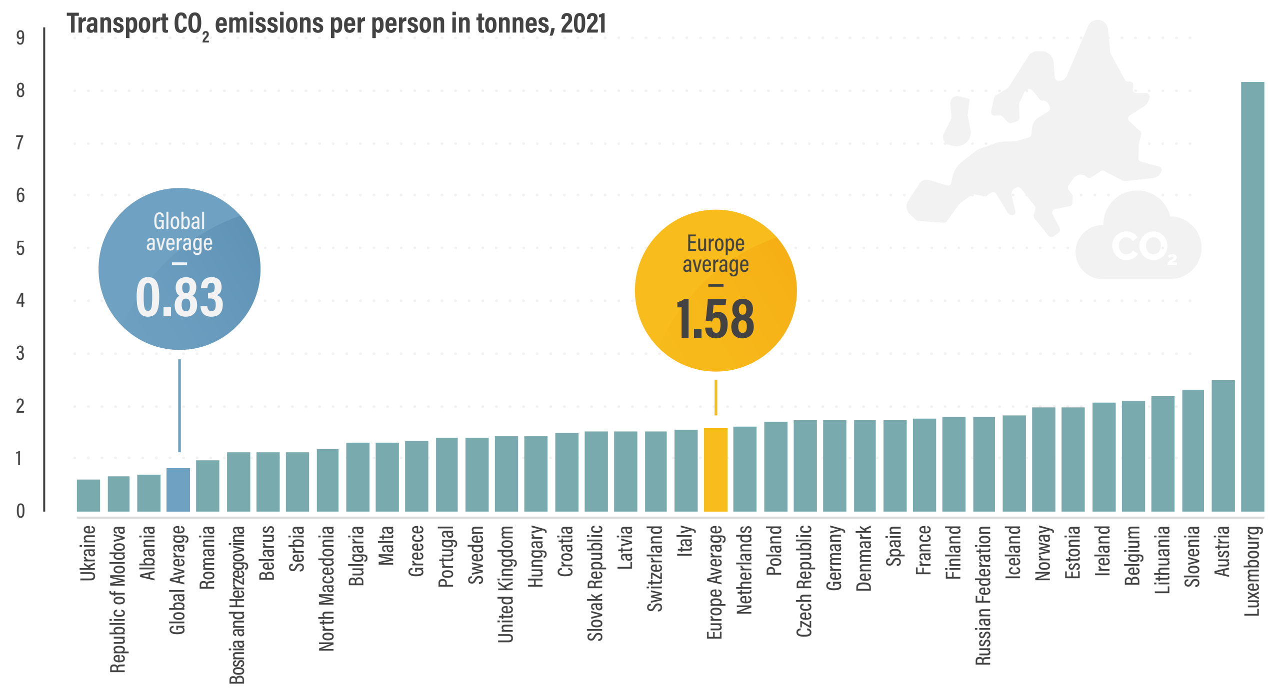


FIGURE 4. Per capita transport CO_2 emissions in Europe, by country, 2021

Source: See endnote 85 for this section.



capita emissions because calculations of CO_2 emissions include fossil fuel sales, and many citizens from neighbouring countries take advantage of lower diesel and petrol prices in Luxembourg (see Figure 4).[85]

- The European countries with the highest transport CO_2 emissions in 2021 were Germany, France, the United Kingdom, Italy, Spain, and Poland, while those with the lowest emissions were Iceland, Malta, Moldova, Albania, the Republic of North Macedonia and Estonia.[86]
- On a per capita basis, the highest-emitting European countries in 2021, after Luxembourg, were Austria, Slovenia, Lithuania and Belgium.[87] The countries with the lowest emissions per capita were Ukraine, Moldova, Albania, Romania, and Bosnia and Herzegovina.[88]

Policy developments

With the onset of the COVID-19 pandemic, countries enacted various policy measures to stimulate transport demand starting in 2020. Following the steep decline in rail usage, the EU declared 2021 the "European Year of Rail" in an attempt to increase rail transport.[89] With the similarly sharp decrease in air travel, European governments agreed to nearly EUR 38 billion (USD 40.5 billion) in financial aid for airlines by mid-2021.[90] Many national and sub-national jurisdictions increasingly supported active travel in 2020 and beyond, responding to the popularity of temporary cycling and pedestrian infrastructure installed during the pandemic. Micro-mobility[i] also benefited from such changes but saw setbacks in some markets.

- In 2020, France introduced a USD 22 million programme to support cycling, including subsidising parking and repairs, with a goal of increasing the share of bike commuting from 3% in 2020 to 9% by 2024.[91]
- London (UK) adopted a Streetspace Plan in 2020 to support the target of a ten-fold increase in cycling and a five-fold increase in walking.[92]
- Brussels (Belgium) adopted legislation in 2022 that removes certain permitting requirements for building new bike lanes, in response to the increase in cycling use since the pandemic.[93]
- In April 2023, Paris (France) became the only European capital to ban shared electric scooters following a referendum in which just 8% of registered voters cast ballots.[94]

In more sweeping action at the EU level, **in 2020, the European Commission released its Sustainable and Smart Mobility Strategy, which lays the foundation towards a green and**

i Micro-mobility refers to small, lightweight mobility devices typically operating at low to moderate speeds, such as electric scooters and bicycles. See https://www.itdp.org/multimedia/defining-micromobility.

digital transformation and more resiliency to future crises.[95] The major targets are as follows.[96]

By 2030:

- At least 30 million zero-emission vehicles will be in operation on European roads.
- 100 European cities will be climate neutral.
- High-speed rail traffic will double.
- Scheduled collective travel of under 500 kilometres should be carbon neutral within the EU.
- Automated mobility will be deployed at large scale.
- Zero-emission vessels will become ready for market.

By 2035:

- Zero-emission large aircraft will become ready for market.

By 2050:

- Nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission.
- Rail freight traffic will double.
- High-speed rail traffic will triple.
- The multimodal Trans-European Transport Network (TEN-T), equipped for sustainable and smart transport with high-speed connectivity, will be operational for the comprehensive network.

As part of the European Green Deal, the European Commission adopted four proposals in 2021 aimed at modernising the EU's transport system to support cleaner, smarter mobility.[97] Such proposals would put the transport sector on track to cut its emissions 90% by 2050, with plans to:

- increase connectivity and shift more passengers and freight away from road transport to rail and inland waterways;
- support the increased installation of charging points, infrastructure for "alternative fuels", as well as new digital technology;
- increase the focus on sustainable mobility in urban areas; and
- facilitate the choice between different transport options in an efficient multi-modal transport system.[98]

As part of both the European Green Deal and the Sustainable and Smart Mobility Strategy, **in December 2021 the European Commission presented a proposal for an updated regulation on EU guidelines for the development of the Trans-European Transport Network (TEN-T), following from several initiatives in support of rail in recent years.** The EU aims to develop a region-wide network of roads, rail, inland waterways, and short-sea shipping routes, while increasing gross domestic product by an estimated 2.4% between 2021 and 2050, reducing greenhouse gas emissions 0.4% by 2050, creating 840,000 new jobs and mobilising funds for regional infrastructure.[99] In response to the Russian invasion of Ukraine , the proposal was amended in July 2022 to extend four corridors to Ukraine and Moldova and to accelerate a shift towards the European standard railway gauge.[100]

To help the EU meet its target of doubling high-speed rail traffic by 2030, the TEN-T proposal contained an action plan to remove barriers to cross-border and long-distance travel and to make rail travel more attractive for passengers.[101] Several developments supporting rail in the region have taken place in recent years in line with these goals.

- In early 2023, plans were announced for major rail projects in the "Three Seas Region" covering 12 EU Member States adjacent to the Baltic, Adriatic and Black seas.[102] In Poland, nearly 4,500 kilometres of high-speed rail were planned to be deployed as early as 2028.[103] By 2030, the entire cross-border rail corridor of the Rail Baltica project is to be completed in Estonia, Latvia, and Lithuania running to the Polish border, with possible lines to major cities in other countries.[104]

- To support domestic rail, France enacted a ban on domestic flights in May 2023 on routes where trains can transport passengers instead in less than 2.5 hours; however, the ban affected only three routes, or 1 in 40 flights.[105]
- Overnight direct train services began operating between Brussels (Belgium) and Berlin (Germany) in May 2023, reflecting efforts and demand in the region to provide passengers alternatives to air travel.[106]

In early 2023, the European Commission proposed updating the 2010 Intelligent Transport System Directive to adapt to emerging road mobility options, apps, and connected and automated mobility.[107] To stimulate faster deployment of new and intelligent services, certain data on roads, travel and traffic related to the TEN-T will be made available in digital format.[108]

Notable developments supporting sustainable transport systems also occurred outside the EU since 2020. In 2021, the UK government published its Transport Decarbonisation Plan, which includes a proposed target to ban the sale of heavy goods vehicles fuelled by diesel and petrol by 2040, with a similar target for light-duty vehicles by 2035.[109] The plan also sets goals for improving public transport and promoting active travel, building on a pledged GBP 2 billion (USD 2.4 billion) to support active travel and GBP 2.8 billion (USD 3.4 billion) to support the switch to cleaner vehicles, as well as commitments to a net zero rail network by 2050 and net zero domestic aviation by 2040.[110]

By 2022, several European countries had adopted policies and targets aimed at promoting or discouraging certain vehicle types or fuels, and many cities had designated low-emission zones to limit polluting vehicles and improve liveability. Almost all countries in the region had biofuel blending mandates and advanced biofuel targets, in addition to those set at the EU level.[111] (*See Section 4.1 Transport Energy Sources.*)

- The EU's Fit for 55 package, introduced in 2021, targets reducing the region's greenhouse gas emissions 55% by 2030 and reaching climate neutrality by 2050; for the transport sector, this would mean that CO_2 emissions from new cars would need to reach zero by 2035.[112]
- Building on this, **in early 2023 the EU almost unanimously approved a ban on sales of internal combustion engine vehicles (with an exception for CO_2-neutral e-fuels) as of 2035**, with only Bulgaria, Italy, Poland and Romania voting against the regulation.[113]
- **By 2022, at least 9 European countries had adopted either a target for 100% electric vehicles or a ban on internal combustion engine vehicles (typically targeting sales), while 11 countries had announced or made plans for such a target.**[114] A 2021 survey found that a majority of Europeans living in cities support these bans going into effect by 2030.[115] Only three countries – Denmark, Sweden and the United Kingdom – had both a 100% electric vehicle target or a 100% ban on internal combustion engine vehicles *and* a target for 100% renewable power.[116]
- Many cities have enacted partial bans on diesel vehicles, in most cases banning the vehicles during specific times of day rather than outright.[117] In 2022, Madrid became the first major European capital to eliminate diesel-fuelled buses from its public fleet; however, most of the fleet continues to be fuelled by compressed natural gas, which studies have shown is not a "clean" solution for transport.[118]
- An increasing number of European cities have adopted low-emission zones, ultra-low emission zones, or zero-emission zones, including those targeting freight vehicles. **Active low-emission zones in the EU-27, the United Kingdom and Norway increased 40% between 2019 and 2022, with projections for an additional 58% growth by 2025, to reach a total of 507 zones** (particularly as related laws come into force in France, Poland and Spain).[119] (*See Section 3.1 Integrated Transport Planning.*)

As part of the EU's Efficient and Green Mobility Package, the EU Urban Mobility Framework was released in December 2021 to guide cities to reduce emissions, improve public health, and make urban mobility smarter and more sustainable.[120] **The framework foresees that all major cities in the network develop a sustainable urban mobility plan (SUMP) by 2025**, with the primary objectives of 1) contributing to EU greenhouse gas reduction targets; 2) improving transport and mobility to, in and around cities; and 3) improving the efficiency of deliveries.[121] **Across Europe, the number of SUMPs increased from 800 in 2013 to 1,000 in 2018, with several cities having updated their SUMPs at least once.**[122]

With the Russian invasion of Ukraine and the subsequent spike in energy prices, countries across Europe offered relief to consumers by providing subsidies for fuel and public transport. France offered a fuel rebate of EUR 0.15 (USD 0.16) per litre for motorists, while Belgium, Germany, the Netherlands and Sweden also provided fuel subsidies to help people cope with the crisis.[123] Some countries, such as Germany and Spain, provided support to public transport to reduce costs for users and to encourage a shift away from driving.[124] **The European Commission also enacted fuel subsidies, and in May 2022 it released the REPowerEU plan, which includes a strategy to shift to imports of non-Russian gas and oil alongside accelerated adoption of renewable energy and energy conservation efforts.**[125]

Specifically for freight, the European Commission

provisionally agreed in 2022 to include emissions from shipping in the EU Emissions Trading System.[126] In early 2023, it adopted FuelEU Maritime, aimed at reducing the greenhouse gas emission intensity of shipping fuels 2% by 2025 and 80% by 2050.[127]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- The **ESCALATE** project brings together a diverse and committed consortium focused on escalating zero-emission heavy-duty vehicles and logistic intelligence to power the EU's net zero future.[128]
- At the 2021 United Nations Climate Change Conference in Glasgow, United Kingdom (COP 26), the **European Cyclists' Federation** and a global coalition of pro-cycling organisations issued an open letter calling on governments to commit to greatly increase the number of people who cycle in their countries in order to reach climate goals quickly and effectively. More than 350 civil society organisations signed the letter in November 2021.[129]
- In 2020, the **European Rail Research Advisory Council (ERRAC)** launched the Strategic Research and Innovation Agenda, which outlines to the European Commission how the railway sector can use research and innovation to deliver the vibrant, efficient and customer-friendly railway of the future.[130]
- After analysing Google's Environmental Insights Explorer (EIE) since 2021, **ICLEI-Local Governments for Sustainability** developed a handbook describing key steps to access and assess EIE transport data as well as how data sets could be used for sustainable urban mobility planning in Germen cities, including Cologne, Hamburg, Ludwigsburg and Ravensburg.[131]
- In 2023, the **POLIS Network** launched the GREEN-LOG programme to accelerate systemic changes to create last-mile delivery ecosystems that are socially, economically and ecologically sustainable; the programme will test the transferability of the proposed innovations through Urban Living Labs in five initial European cities or regions (Athens, Barcelona, Flanders, Oxfordshire and Ispra) and three follower cities (Arad, Helsinborg and Valga).[132]
- **The Future Is Public Transport**, a campaign that unites mayors, workers, union leaders, activists and city residents, called on world leaders at COP 26 in 2021 to make the investments needed to drive a green and just economic recovery and to transform cities for the better.[133]

Photo credits: Miguel Discart

MODULE 2 2.4

AUTHOR:
Agustina Krapp, *SLOCAT Secretariat*

CONTRIBUTORS:
Carolina Chantrill, *Asociación Sustentar;*
Arturo Steinvorth, *Center for Urban Sustainability;*
Lina Quiñones, *Despacio*

Latin America and the Caribbean Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
653 million	+12%	84%	+18%	USD 7,861	+15%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.

Key findings

Demand trends

- From 2016 to 2020, the average motorisation rate (covering four-wheeled motor vehicles) in Latin America and the Caribbean was 267 vehicles per 1,000 people, or 1.35 times higher than the global average of 197 vehicles per 1,000 people. Nearly half of all countries in the region had motorisation rates above the global average during this period.
- Personal use of private cars and motorcycles continued to grow, as people perceived a lower risk of contagion from COVID-19 compared to public transport, and driven by other factors such as convenience, accessibility and safety.
- In two-thirds of 218 cities surveyed in Latin America and the Caribbean, just half or less of the population had convenient access to public transport in 2021. Public transport was heavily impacted by the pandemic and has taken longer to recover in the region than driving and walking.
- Because of the limited supply of adequate public transport, especially in peripheral low-income areas, the majority of public transport trips in the region are served by semi-formal and informal transport, which provides a flexible and demand-responsive service.
- Walking remained a major mode of transport in Latin American cities in 2021 and 2022. Cycling was less prevalent, but countries and cities continued to expand their cycling infrastructure.
- The uptake of micromobility (bike sharing and e-scooters) has faced challenges in the region, affected by the COVID-19 pandemic, regulatory restrictions and higher-than-expected operational costs. In April 2019 an estimated 73 systems were operating in 31 cities (mostly in Brazil), but by June 2020 these numbers had dwindled to 14 systems in 12 cities. A few new and expanding bike sharing services aim to increase access and promote social inclusion.
- Road transport dominates freight transport in the region. A 2021 study found that in South America trucks account for around 85% of national and 30% of regional freight transport and logistics, and in Central America road transport accounts for nearly 100% of freight transport.
- River and maritime transport represent 95% of international trade in Latin America and the Caribbean, although inland waterways are poorly developed.
- Cycling for first- and last-mile deliveries has increased in the region.

Emission trends

- Carbon dioxide (CO_2) emissions from transport in Latin America and the Caribbean grew nearly 11.6% between 2010 and 2019, then fell 15.6% in 2020 as a result of the COVID-19 pandemic. In 2021, the resumption in transport activity led to a 9.1% increase in transport CO_2 emissions, although they were still 7.9% below the 2019 level.
- In 2021, transport CO_2 emissions in the region contributed around 33% of overall regional CO_2 emissions and 8.5% of global transport emissions (excluding international aviation and shipping).
- Transport emissions relative to economic output were higher in Latin America and the Caribbean than in any other region except Africa in 2021, at 1.07 tonnes of CO_2 per USD 10,000, and were above the global average of 0.77 tonnes of CO_2 per USD 10,000 in 2021.
- Most countries in the region continued to subsidise fossil fuels through methods such as direct subsidies, stabilisation funds, tax reductions and exemptions, and control through state companies, thereby working against decarbonisation of the sector. Efforts to reduce these subsidies remain unsuccessful and have led to street protests and strikes.
- Although Latin America and the Caribbean remains an emerging market for electric cars (battery electric cars and plug-in hybrids), sales rose sharply from around 6,500 units in 2020 to 20,970 units in 2021 and 28,400 units in 2022. However, electric vehicles still made up only small shares of regional (less than 0.1%) and global fleets (2.1%) as of 2021.
- The number of electric public buses in the region grew more than 100% between 2020 and April 2023 (from 1,959 to 4,133 units), operating in 30 cities across 11 countries and accounting for nearly 4.7% of the combined bus fleets of major cities (around 88,364 buses).

Policy developments

- National governments in Latin America and the Caribbean have increasingly recognised the need to support city and local governments in planning and implementing sustainable urban mobility strategies – including through the development of national plans, policies and guidelines.
- Local sustainable urban mobility plans (SUMPS) continued to expand in the region – including in Brazil, Chile, Cuba, Ecuador and Peru – highlighting the role of cities as climate action leaders.
- As low-emission zones emerge in the region, two cities (Medellín and Rio de Janeiro) were beginning processes for their implementation as of early 2023. Additionally, some countries have developed vehicle efficiency labels to encourage the purchase and use of less-polluting vehicles or to regulate the circulation of certain vehicle types.
- Countries such as Chile and Mexico, and cities such as Bogotá (Colombia), Buenos Aires (Argentina), Lima (Peru) and Rio de Janeiro (Brazil), continued to expand their cycling infrastructure, boosted by measures taken during the pandemic.
- Strategic plans, financial incentives and regulatory elements have emerged to promote the electrification of road transport, many to facilitate the acquisition or operation of electric vehicles. Countries and cities in the region have set targets to electrify vehicle fleets, although electric cars still made up less than 0.1% of the total vehicle stock as of 2021. Electrified public transport modes that began operations included buses, a cable car, light rail systems and tuk-tuks.
- After economic and political delays reinforced by the pandemic, and despite ridership losses, public transport systems expanded in 2022 and 2023, including in Ecuador, Mexico and Panama. Existing metro systems added new lines, and new public transport systems began operations, including bus rapid transit, metro, cable car and light rail systems.
- Argentina, Brazil, Chile and Mexico all have programmes to improve the energy efficiency of freight transport and reduce its emissions, with a focus on innovative technologies and cutting fuel use.
- As of the end of 2022, more than 90% of Latin American and Caribbean countries had submitted a second-generation Nationally Determined Contribution (NDC) towards reducing emissions under the Paris Agreement. However, only 20% of countries had submitted Long-Term Strategies.


Photo credit: Carlos Felipe Pardo

Overview

Latin America and the Caribbean[i] is the second most urbanised region in the world after North America, with 84% of the population living in cities in 2022.[2] In 2020, as a consequence of the COVID-19 pandemic, extreme poverty in the region was the highest in two decades, reaching 13.1% of the population.[3] As economic activity recovered, the overall poverty rate fell slightly from 32.8% in 2020 to 32.3% in 2021, while the extreme poverty rate barely changed (12.9%).[4] Poverty levels in 2021 remained above 2019 levels.[5] Latin America and the Caribbean remains the second most unequal region globally (in terms of income, gender, ethnicity, etc.) after Sub-Saharan Africa and has seen very low economic growth.[6]

The effects of pandemic-related lockdowns on transport have persisted in the region, with public transport ridership in 2022 still below pre-pandemic levels despite the resumption of activities. The use of private cars and motorcycles continued to grow due to perceptions of lower contagion risk as well as factors such as convenience and accessibility. Although carbon dioxide (CO_2) emissions from transport fell sharply in 2020, they rose again as pandemic restrictions were lifted and activities resumed. The Russian Federation's invasion of Ukraine and higher energy prices led many countries in the region to provide additional fuel subsidies to alleviate the effects of inflation, impeding the decarbonisation of transport.

Despite the ongoing growth in transport emissions, promising developments in the region included the adoption of policy frameworks to promote sustainable urban mobility, the expansion of public transport systems and cycling infrastructure, and a growing focus on gender and inclusion in mobility planning. The most prominent approaches to transport decarbonisation are policies to promote the electrification of road transport and the adoption of electric buses. Many of these policy measures have clear linkages with achievement of the United Nations Sustainable Development Goals (SDGs) for 2030, such as SDG 3 (good health and well-being) through the improvement of road safety, air quality and active mobility; SDG 5 (gender equality) through the adoption of gender approaches in transport planning, and SDG 11 (sustainable cities and communities).

Demand trends

Cities in Latin America and the Caribbean have grown in both population and geographic size, often in the absence of integrated planning. As in other parts of the world, the region has prioritised planning for automobiles over other modes of transport.[7]

From 2016 to 2020 (latest data available), the average motorisation rate (covering four-wheeled motor vehicles) in Latin America and the Caribbean was 267 vehicles per 1,000 people, or 1.35 times higher than the global average of 197 vehicles per 1,000 people.[8] Nearly half of all countries in the region had motorisation rates above the global average during this period (see Figure 1).[9] Motorcycles comprised an estimated 29% of the region's vehicle fleet in 2021.[10]

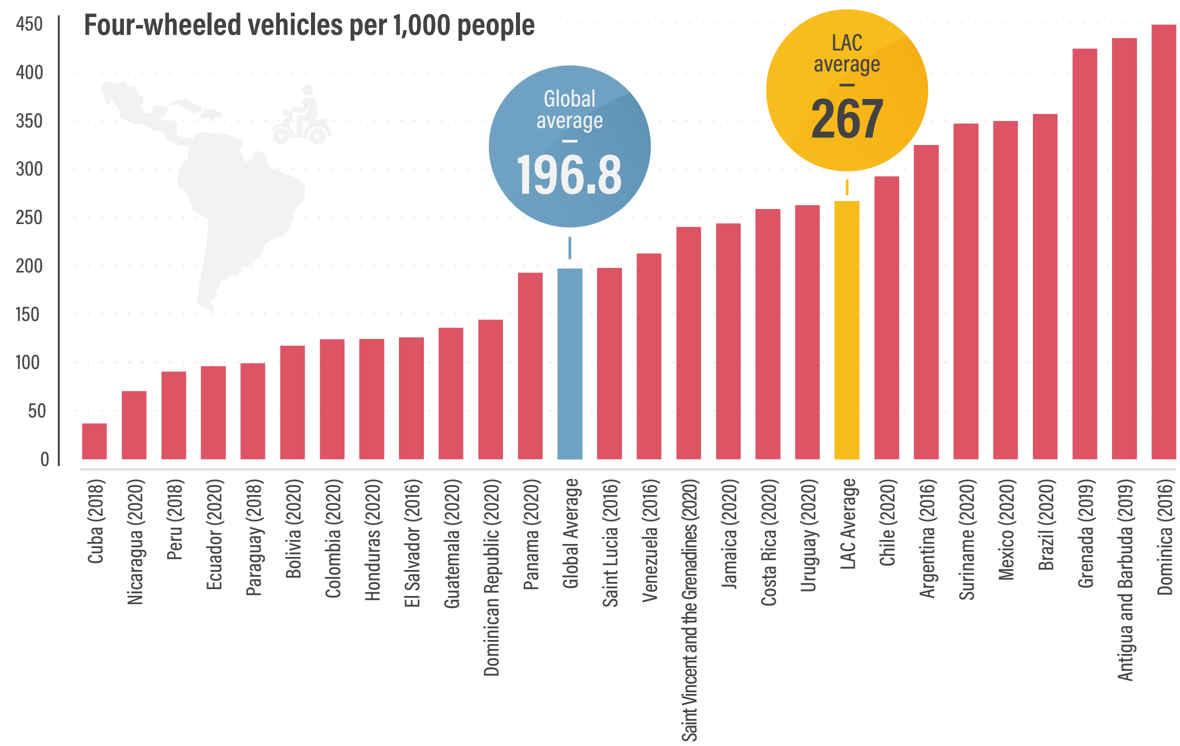
The COVID-19 pandemic profoundly impacted transport in Latin America and the Caribbean, and the region has been slow to recover. **Personal use of private cars and motorcycles continued to grow, as people perceived a lower risk of contagion from COVID-19 compared to public transport, and driven by other factors such as convenience, accessibility and safety.** These factors, as well as the lower cost of motorcycles relative to cars and the higher demand (and hence job opportunities) for delivery services, may have pushed lower-income groups to purchase motorcycles.[11]

- In Chile, sales of light- and medium-duty vehicles fell nearly 31% in 2020.[12] As the economy recovered, sales grew around 61% in 2021 and nearly 3% in 2022, the years with the highest sales in the history of the country's automotive sector (along with 2018).[13]
- In Peru, sales of new light vehicles increased 40% in 2021 and nearly 2% in 2022.[14]
- Data from 14 manufacturers in Brazil indicate that motorcycle sales increased around 26% between 2020 and 2021, from 915,157 to 1,156,776 units, their highest value since 2016.[15] Other sources show that sales of new cars grew only 3% in the same period, from 2,058,437 to 2,119,851 units.[16]
- In Colombia, the registration of new motorcycles increased nearly 41% from 2020 to 2021.[17]

i Here, Latin America and the Caribbean comprises countries of South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela), Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama) and the Caribbean (Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago).

FIGURE 1. Motorisation rates per 1,000 people in Latin America and the Caribbean, 2016-2020

Source: See endnote 9 for this section.



- In Buenos Aires (Argentina), motorcycle trips grew from 3.7% of all trips in 2019 to 5.8% in 2021.[18] Motorcycle trips in Mexico City grew from 4.7% of all trips in 2019 to 6.4% in 2021.[19]

According to UN-Habitat, **in two-thirds (144) of 218 cities surveyed in Latin America and the Caribbean, just half or less of the population had convenient access to public transport in 2021.**[20] Across the region, 43% of the urban population had convenient access to public transport, the third lowest regional average (after Asia at 38% and Africa at 32%) and below the global average of 56%.[21] **Public transport was heavily impacted by the pandemic and has taken longer to recover in the region than driving and walking.** In some countries, ridership remained below pre-pandemic levels in 2021 and 2022. Nevertheless, several new public transport systems began operations in 2022.

Ridership on the region's metro systems fell 50% between 2019 and 2020, from 6,245 million passengers to 3,116 million passengers.[22] Queries in Apple's mapping service for directions related to driving, public transport and walking in Latin America were lowest in late March to early April 2020, with public transport recovering more slowly than driving and walking (see Figure 2).[23] Although driving and walking queries recovered by July 2021, surpassing the pre-pandemic baseline of mid-January 2020, queries for public transport remained below pre-pandemic levels for seven more months and only surpassed them in February 2022.[24]

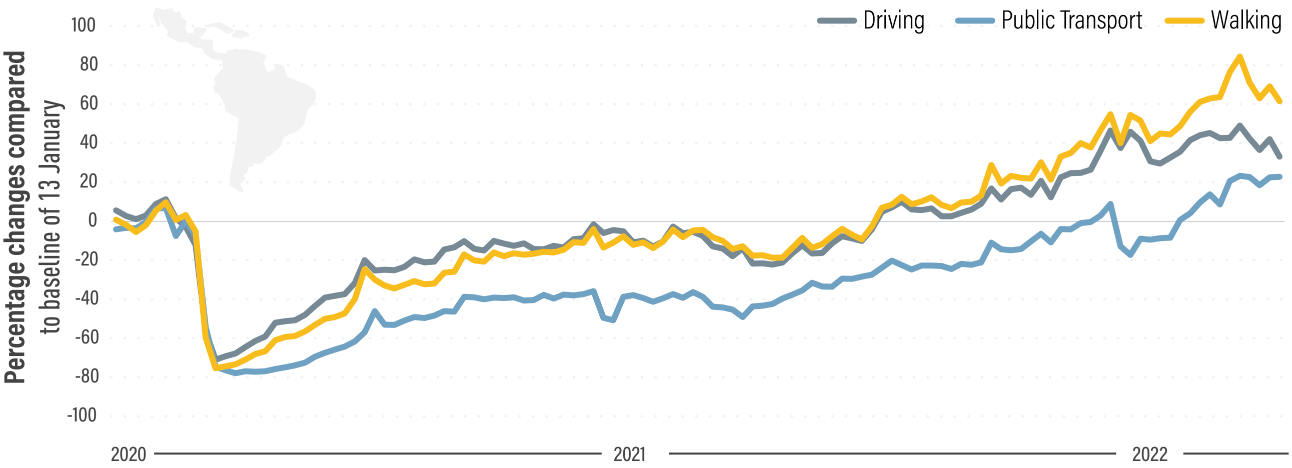
- In Buenos Aires (Argentina), the total number of trips by metro fell nearly 80% in 2020.[25] In 2021, despite the recovery, total trip numbers were still 68% lower than in 2019.[26]
- In Mexico, the number of passenger-kilometres travelled by buses and coaches fell around 39% in 2020.[27] Although the number increased in 2021, it was still 16% below 2019 levels.[28]
- In Brazil, around 1,800 urban bus companies were operating before the pandemic, and an estimated 200 operators ceased operations because of pandemic-related economic losses.[29] Following an 80% drop during the first three months of the pandemic, bus ridership in the country recovered slowly to reach around 70% of the pre-pandemic volume in 2022.[30]

After economic and political delays reinforced by the pandemic and two years of pandemic recovery, several new public transport systems started operating in the region in 2022 and early 2023, including a bus rapid transit system in Guadalajara (Mexico); the first line of the metro system in Quito (Ecuador); additional lines of Panama City's metro system and Mexico City's cable car system; and Bolivia's first electric light rail system in Cochabamba.[31]

Because of the limited supply of adequate public transport, especially in peripheral low-income areas, the majority

FIGURE 2. Navigation requests for driving, public transport and walking in Latin America, January 2020 to April 2022

Source: See endnote 23 for this section.



of public transport trips in the region are served by semi-formal and informal transport, which provides a flexible and demand-responsive service.[32] Often, the distinction between formal and informal public transport services is not clear.[33] Consolidated, robust and updated data on the use of these services is limited, corresponding with the nature of these services and with a widespread disregard for this mode in transport policy despite its immense contributions. This prevents its proper consideration in transport planning (*see Section 3.4.2 Informal Transport*) as well as in improving negative impacts – such as pollution, congestion, and reduced road and personal safety – as a result of competition for passengers and limited government oversight of vehicle maintenance and service quality.[34]

- In Mexico City, small, privately operated mini-buses are among the most prevalent modes of informal transport, accounting for 74% of all public transport trips.[35] When pandemic-related mobility restrictions were in place and metro and bus rapid transit stations were closed, informal transport provided services for essential workers and low-income residents who could not work from home.[36]
- A 2021 analysis of informal transport in Central American countries identified at least seven different types of informal transport services operating in Guatemala: informal taxis, motorcycle taxis, tuk-tuks, pick-up trucks, buses, bicycle taxis, and unregulated app-based mobility services.[37]

Walking remained a major mode of transport in Latin American cities in 2021 and 2022. Cycling was less prevalent, but countries and cities continued to expand their cycling infrastructure (*see Policy Developments section*).

- In large cities such as Buenos Aires (Argentina), São Paulo (Brazil) and Mexico City, walking accounted for nearly 30-40% of all trips in 2021, whereas cycling accounted for only 2-4% of trips.[38]
- In 2020 and 2021, bicycle sales in Brazil grew 50% compared to pre-pandemic levels, from around 4 million units in 2019 to nearly 6 million units in each of the following two years.[39] In 2022, bicycle sales fell 35% to 3.8 million.[40] However, the electric bike segment grew 9.6% in 2022, with nearly 45,000 e-bikes produced and imported, continuing a five-year growth streak.[41]

The uptake of micromobility (bike sharing and e-scooters) has faced challenges in the region, affected by the COVID-19 pandemic, regulatory restrictions and higher-than-expected operational costs.[42] **In April 2019, an estimated 73 systems were operating in 31 cities (mostly in Brazil), but by June 2020 these numbers had dwindled to 14 systems in 12 cities.**[43] **A few new and expanding bike sharing services in the region aim to increase access and**

promote social inclusion.

- The bike sharing system in Brasilia (Brazil), launched in 2014, ceased operations in 2020 due to financial difficulties aggravated by the pandemic.[44] In 2021, after a 1.5 year gap, the city launched a new bike sharing system with 500 bikes and 70 stations.[45] The system allows for easy integration with public transport, as users can use the same ticketing system to pay for both services.[46]
- In Bogotá (Colombia), the city's first shared bicycle system, Tembici, began operating in 2022 with 3,300 bikes distributed along 300 stations, with the goal of offering sustainable, gender-sensitive and inclusive mobility.[47] The fleet includes 1,500 mechanical bikes, 1,500 e-bikes, 150 hand-pedal bikes for wheelchair users, 150 cargo bikes to transport goods and 150 attachable child seats.[48] The system offers a 20% discount for lower-income users, as well as 1,600 free bike parking spots in public spaces.[49]
- In 2022, Mexico City began expanding its shared bicycle system, Ecobici, with the goal of extending coverage from three city zones to six and adding 2,980 bikes for a total of 9,480.[50]
- To promote bike use from early ages, Rosario (Argentina) added bicycles for kids at two stations of its shared bicycle system Mi Bici Tu Bici in April 2023.[51] The bikes can only be used in nearby parks, and the city aims to progressively add more bikes for kids at stations close to recreational venues.[52]

Road transport dominates freight transport in the region. A 2021 study found that in South America trucks account for around 85% of national and 30% of regional freight transport and logistics, and in Central America road transport accounts for nearly 100% of freight transport.[53] Data on performance are scarce due to the high diversity of operators, from a large number of small and informal enterprises to few large companies with a high degree of specialisation.[54] Heavy vehicles in the region have an average age of 15 years, and in several countries a large share of trucks are more than 20 years old.[55] Rail freight represents less than 3% of the region's overall freight transport.[56] **River and maritime transport account for 95% of international trade in the region, although inland waterways are poorly developed.**[57]

Cycling for first- and last-mile deliveries has increased in the region. Although this practice is deeply rooted in low-income segments as a source of informal employment, newer initiatives using cargo bikes or tricycles aim to reduce pollution and road congestion caused by freight transport and urban waste collection efforts, and to improve social inclusion.[58]

- In 2021, with support from the Development Bank of Latin America (CAF) and Germany's Agency for International Cooperation (GIZ), Fortaleza (Brazil) launched the Re-ciclo project, which donates electric tricycles to wastepicker associations to replace their heavy carts and to test the tricycles for urban logistics purposes.[59]
- Between December 2020 and May 2022, with the support of the World Bank, Bogotá (Colombia) carried out the BiciCarga project with businesses of different sectors, which implemented a distribution scheme using electric cargo bikes. The project aimed to assess the necessary requirements for the sustainability of this distribution model.[60]
- With support from ICLEI-Local Governments for Sustainability, Rosario (Argentina) added 20 cargo bikes to its public bike sharing scheme in 2022, targeting merchants, entrepreneurs and workers in the city centre.[61]

Emission trends

CO_2 emissions from transport in Latin America and the Caribbean grew nearly 11.6% between 2010 and 2019, then fell 15.6% in 2020 as a result of the COVID-19 pandemic.[62] **In 2021, the resumption in transport activity led to a 9.1% increase in transport CO_2 emissions, although they were still 7.9% below the 2019 level.**[63] Peru, Mexico and Ecuador experienced the region's highest drops in transport CO_2 emissions in 2020 (down 20% or more).[64] As transport resumed in 2021, the highest increases in emissions were in Ecuador, Colombia and Peru.[65]

In 2021, transport CO_2 emissions in Latin America and the Caribbean contributed around 33% of overall regional CO_2 emissions and 8.5% of global transport emissions (excluding international aviation and shipping).[66] Average per capita transport CO_2 emissions in the region were 0.85 tonnes, close to the global average of 0.83 tonnes.[67] The highest per capita transport emissions were in the Caribbean countries of the Bahamas and Antigua and Barbuda (close to 3 tonnes), and the lowest were in Haiti, Cuba, Nicaragua and Honduras (below 0.5 tonnes) (see Figure 3).[68]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
550 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
8.5%

Per capita transport CO_2 emissions (2021):
0.85 tonnes

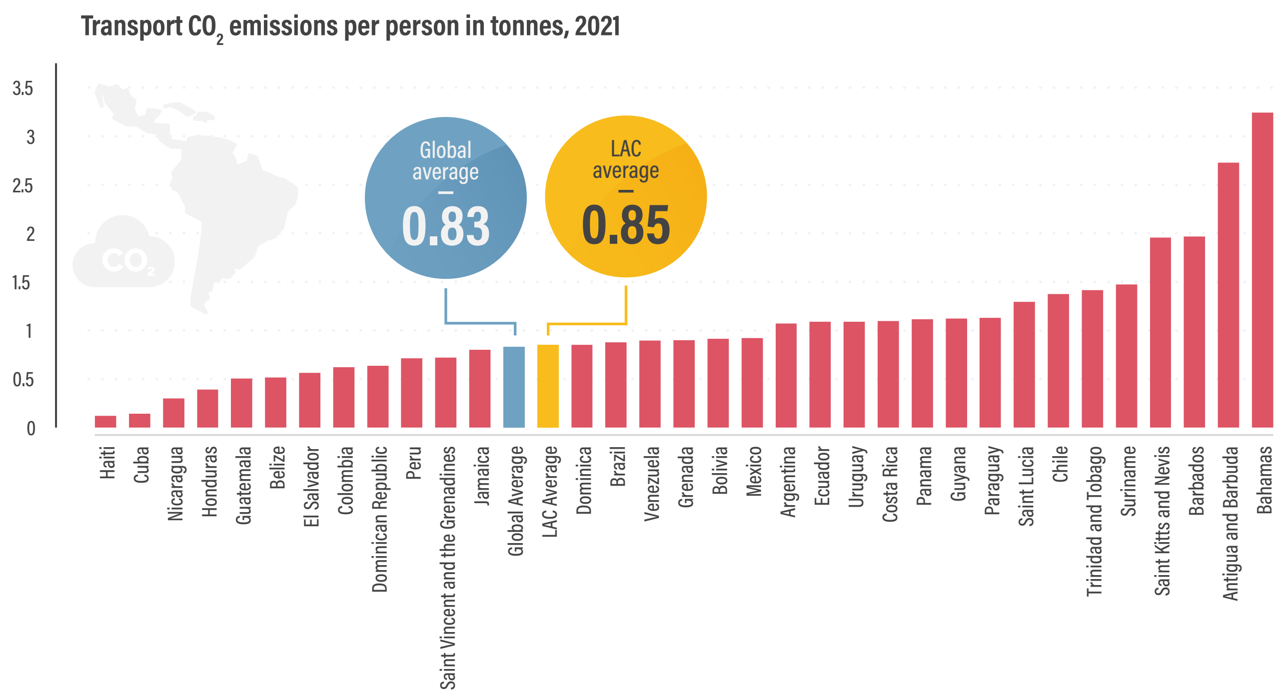
Transport CO_2 emissions per USD 10,000 GDP (2021):
1.07 tonnes

Source: See endnote 69 for this section.

Transport emissions relative to economic output were higher in Latin America and the Caribbean than in any other region except Africa in 2021, at 1.07 tonnes of CO_2 per USD 10,000,

FIGURE 3. Per capita transport CO_2 emissions in Latin America and the Caribbean, 2021

Source: See endnote 68 for this section.



and were above the global average of 0.77 tonnes of CO_2 per USD 10,000 in 2021.[70] This may be due to the dominance of road freight transport and to the absence of more cost-effective and energy-efficient modes such as rail and shipping across the region.[71]

Most countries in the region continued to subsidise fossil fuels through methods such as direct subsidies, stabilisation funds, tax reductions and exemptions, and control through state companies, thereby working against decarbonisation of the sector. Efforts to reduce these subsidies remain largely unsuccessful and have led to street protests and strikes, as nearly a third of the region's population lives in poverty, and such reductions would affect consumer purchasing power.[72] The challenge has been intensified by global events such the Russian Federation's invasion of Ukraine, which caused a slowdown in economic growth and led many countries to adopt additional fuel subsidies to alleviate the impacts of higher food and energy prices on vulnerable households.[73]

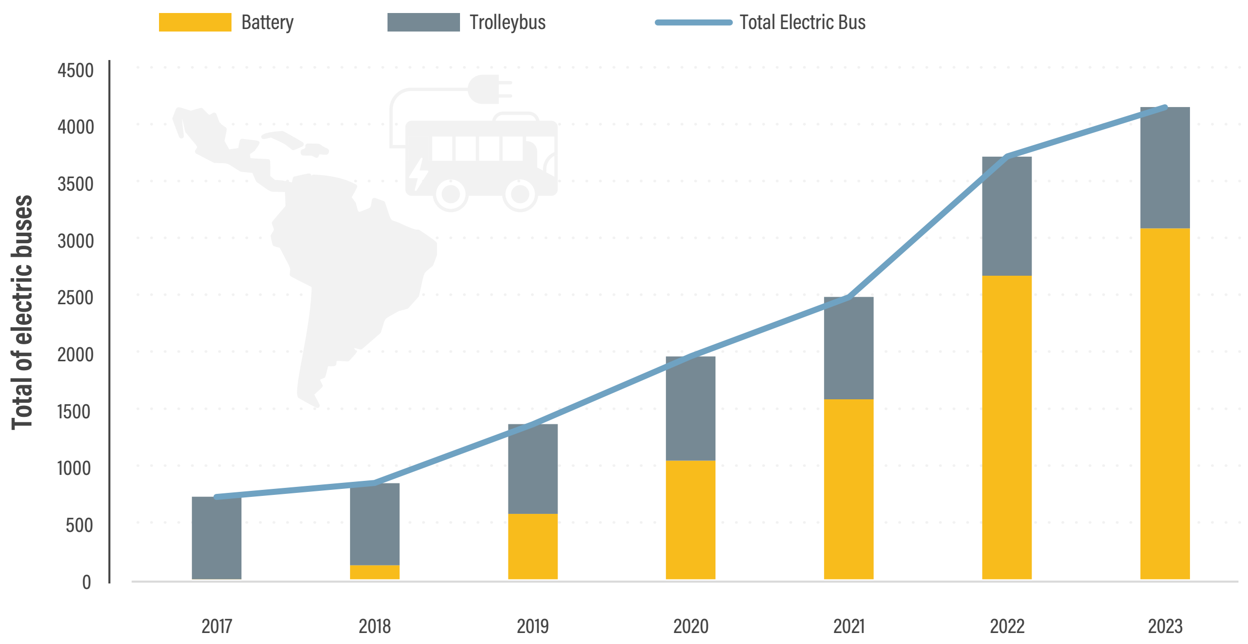
- As of February 2023, Venezuela, Bolivia, Ecuador and Colombia had the lowest petrol and diesel prices in the region, ranging from USD 0.016 to USD 0.634 per litre, whereas Chile, Uruguay, Belize and Barbados had the highest prices, ranging from USD 1.47 to USD 1.95 per litre.[74]
- In April 2022, Chile adopted the inclusive recovery plan Chile Apoya to support residents facing rising living costs, including for fuel. A key measure increases the allocation of economic resources to smooth the effects of higher international oil prices on the cost of petrol for vehicle use.[75]
- Peru adopted tax exemptions and measures in March and April 2022 to stabilise the prices of petrol, liquefied petroleum gas (LPG) and diesel.[76] These measures resulted in reductions in the fuel prices for vehicle use of around 28% for diesel and 17% for petrol.[77]
- Brazil approved a regulation in June 2022 to reduce taxes on petrol and energy, leading to a decrease in prices and in the inflation rate, which reached its lowest value since 1980.[78] The regulation reduced the average price per litre of petrol nearly 29%.[79]
- Also in June 2022, Ecuador experienced violent country-wide protests following increases in the prices of fuel, food and other basic necessities.[80] Similar protests took place in Panama in July 2022.[81] In both cases, governments responded by reducing or freezing fossil fuel prices.[82]

Although Latin America and the Caribbean remains an emerging market for electric cars (battery electric cars and plug-in hybrids), sales rose sharply from around 8,000 units in 2020 to 27,000 units in 2021 and 37,000 units in 2022.[83] However, electric vehicles still made up only small shares of regional (less than 0.1%) and global fleets (2.1%) as of 2021.[84]

- In 2021, Colombia, Mexico and Costa Rica led in the commercialisation of light-duty battery electric vehicles in the region, with between 1,000 and 1,500 units registered in each country.[85]
- Costa Rica's electric car fleet grew around 70% between 2020

FIGURE 4. Electric buses in Latin America and the Caribbean, by type, 2017-2023

Source: See endnote 90 for this section.



and 2021 (from 1,484 to 2,529 vehicles) and around 60% in 2022, to reach a total of 4,128 units.[86] Considering also electric motorcycles (1,077 units) and special equipment (1,335 units), Costa Rica had a combined 6,540 electric vehicles in 2022, accounting for 4% of all new vehicles registered that year.[87]

- In 2022, fully electric vehicles in Colombia made up an estimated 0.12% of the total vehicle fleet.[88]

The number of electric public buses in the region grew more than 100% between 2020 and April 2023 (from 1,959 to 4,133 units), operating in 30 cities across 11 countries and accounting for nearly 4.7% of the combined bus fleets of major cities (around 88,364 buses).[89] The total number of electric buses in the region's public transport fleets grew more than 110% between 2020 and April 2023 (see Figure 4).[90]

- As of April 2023, the countries with the highest numbers of e-buses in the region were Colombia (1,589 units) and Chile (1,223 units), followed by Mexico (556 units), Brazil (376 units) and Ecuador (106 units).[91] The leading cities were Bogotá (1,485 units), Santiago (1,180 units) and Mexico City (493 units).[92]
- Barbados has the largest e-bus fleet in the Caribbean, rising from an initial 33 units in 2020 to 49 units in 2022 across the island of 300,000 inhabitants.[93]
- In 2020, 32 e-buses began operating in Uruguay, and by July 2022 the buses had travelled some 3.6 million kilometres, avoiding around 1.5 million litres of fuel consumption and 3,900 tonnes of CO_2 emissions.[94]

Policy developments

National governments in Latin America and the Caribbean have increasingly recognised the need to support city and local governments in planning and implementing sustainable urban mobility strategies – including through the development of national plans, policies and guidelines. These frameworks seek to facilitate efficient co-ordination across jurisdictional levels, providing effective support and ensuring coherence across national-level objectives and sub-national transport planning.

- In 2020, a constitutional amendment in Mexico declared the universal right to safe, accessible, efficient, sustainable, inclusive and equitable mobility, leading to the adoption in 2021 of the General Law of Mobility and Road Safety. The law aims to reduce road crashes, promote equitable and sustainable access to transport services, and harmonise sub-national actions.[95]

- Chile launched its National Sustainable Mobility Strategy in 2021, establishing a vision and objectives for urban mobility by 2050 and recommending measures for cities to generate their own locally aligned strategies.[96]
- In 2022, Uruguay launched the Guide for Sustainable Urban Mobility Planning to provide sub-national governments with tools for planning and implementing sustainable urban mobility strategies.[97]
- In 2022, Colombia developed the National Strategy of Active Mobility with a Gender and Differential Approach, which provides guidelines for local governments to promote walking and cycling, consider the needs of people with reduced mobility and disabilities, and promote gender equality.[98] The complementary Guide for Shared Bicycle Systems helps local governments evaluate the technical, regulatory and financial aspects of implementing bike sharing systems in large and small cities.[99]

Local sustainable urban mobility plans (SUMPs) continued to expand in the region – including in Brazil, Chile, Cuba, Ecuador and Peru – highlighting the role of cities as climate action leaders. During 2021-2022, Ambato (Ecuador), Antofagasta (Chile), Baixada Santista (Brazil), Havana (Cuba) and Trujillo (Peru) finalised their SUMPs (with support from the EUROCLIMA+ programme) as cornerstones of their contributions to address climate change, including goals to develop high-quality public transport, promote walking and cycling, and improve road safety.[100] Cities expected to complete SUMPs in the coming years include Arequipa (Peru), Córdoba (Argentina), La Paz (Bolivia) and Lima (Peru).[101]

- In 2020, Brazil added to its National Urban Mobility Policy that cities with more than 20,000 inhabitants, cities belonging to metropolitan regions, and cities in touristic areas must present SUMPs before April 2023 as a requirement to receive federal economic support for implementing urban mobility measures.[102] As of December 2022, 343 municipalities – around 17% of the cities covered in the scope of the mandate – had finalised SUMPs, and 90 of these cities have more 250,000 inhabitants.[103]
- In October 2020, Colombia's Ministry of Transport approved a resolution requiring municipalities, districts and metropolitan areas with populations of more than 100,000 inhabitants to prepare or adjust Sustainable and Safe Mobility Plans that prioritise active mobility and low- or zero-emission public transport.[104]
- In April 2021, Costa Rica adopted a Pedestrian Mobility Law that aims to guarantee the right to inclusive mobility in all physical environments; regulate the planning, maintenance and financing of sidewalks; and require districts to develop SUMPs.[105]

As low-emission zones emerge in the region, two cities (Medellín and Rio de Janeiro) had begun processes for their implementation as of early 2023.[106] Additionally, some countries have developed vehicle efficiency labels to encourage the purchase and use of less-polluting vehicles or to regulate the circulation of certain vehicle types.

- In 2021, Medellín became the first city in Colombia to establish a protected urban air zone in the city centre, with the goal of reducing transport emissions and improving air quality.[107]
- Rio de Janeiro (Brazil) approved the creation of a low-emission district In June 2022, with the goal of making the zone partially operational by 2024 and fully operational by 2030.[108]
- In May 2022, Argentina adopted a label that provides accurate data on vehicle fuel consumption and CO_2 emissions, enabling consumers to compare vehicles when making purchase decisions.[109]
- Bogotá (Colombia) began implementing a two-year voluntary environmental labelling pilot for cargo vehicles in the first quarter of 2023, with the aim of quantifying the emissions of various vehicle technologies as a basis for issuing future permits or restrictions on circulation to improve air quality.[110]

Countries such as Chile and Mexico, and cities such as Bogotá (Colombia), Buenos Aires (Argentina), Lima (Peru) and Rio de Janeiro (Brazil), continued to expand their cycling infrastructure, boosted by measures taken during the pandemic.

- Between 2015 and 2021, Bogotá (Colombia) expanded its bicycle infrastructure 33% (from 443 kilometres to 590 kilometres), and the city's 2020-24 Strategic Plan includes the goals of further expanding it to 830 kilometres by 2024 and increasing the number of cycle trips by 50%.[111]
- In 2021, Lima (Peru) reported 294.35 kilometres of bike paths, and in November the city signed an economic support agreement of EUR 20 million (USD 21.3) with the German Financial Cooperation to build an additional 114 kilometres of bicycle lanes and 12 bike parking lots in the city.[112]
- Between 2019 and 2022, Mexico City built 206 kilometres of protected cycling lanes, more than the amount built in the previous 14 years (174 kilometres) and bringing the total network to 381 kilometres.[113] The goal is to expand the network to 600 kilometres and to reach 510,000 daily bicycle trips by 2024 to reduce transport-related emissions.[114]
- In 2022, Buenos Aires (Argentina) met its goal of having 300 kilometres of protected cycling lanes (up from 267 kilometres in 2020), and the city is set to reach 1 million daily bicycle trips by 2023, three times more than in 2019.[115]
- In March 2023, Rio de Janeiro (Brazil) launched its Cycling Expansion Plan CicloRio, which sets the targets of connecting all public transport stations of medium and high capacity (including bus rapid transit and metro) to the bicycle network by the end of 2024, and to expand the cycling infrastructure from 450 kilometres to 1,000 kilometres by 2033.[116]
- In April 2023, Chile reported having 2,072 kilometres of cycling infrastructure, up 11% from 2021 (1,866 kilometres) and up 35% from before 2018 (1,344 kilometres).[117] The Santiago metro region had 781.6 kilometres as of 2022, and another 115 kilometres was being built throughout the country.[118]

Strategic plans, financial incentives and regulatory elements have emerged to promote the electrification of road transport, many to facilitate the acquisition or operation of electric vehicles.

- In 2022, Chile passed a law promoting investment in energy storage and electric mobility as key elements to achieve the country's goal of carbon neutrality by 2050.[119] The law exempts electric vehicles from circulation taxes for two years and allows industries that generate renewable energy for productive purposes to feed excess electricity to (or withdraw energy from) the national grid.[120]
- Guatemala approved a law in 2022 on incentives for electric mobility, including exemptions from value-added tax and from taxes on the import of electrical equipment and devices used exclusively for electric vehicle charging.[121]
- In 2022, Costa Rica updated its law on incentives for the purchase of new and used electric vehicles during the next 12 years and increased the scope of incentives already established in 2018.[122]
- Panama passed a new electromobility law in 2022 that requires municipalities to exempt electric vehicles from circulation taxes for five years.[123]
- In 2022, Paraguay presented its Master Plan for Multimodal Electric Mobility for Public and Logistic Transport, which lays out a roadmap to 2040 that includes quality criteria and programmes to introduce electric vehicles in public and freight transport.[124]
- Uruguay launched the Electric Urban Mobility Guide in 2022 to provide regional departmental governments with the tools to implement electric mobility.[125] In November 2022, the country announced subsidies of USD 5,000 each for purchases of electric taxis or electric vehicles used for ride hailing, to be available until December 2023 or until the total allocation of USD 500,000 is used up.[126]

Countries and cities in the region have set targets to electrify vehicle fleets, although electric cars still made up less than 0.1% of the total vehicle stock as of 2021, well below the global share of 2.1% electric cars in the total passenger car vehicle fleet.[127]

- In October 2021, Chile launched its new National Electromobility Strategy, which calls for 100% of the sales of light, medium and public transport vehicles (buses, taxis and buses) to be zero emissions by 2035, and for 100% of the sales of cargo transport and inter-city buses to be zero emissions by 2045.[128]
- Panama's electro-mobility law of 2022 sets targets to electrify 10% of government vehicles and public transport by 2025, 25% by 2027 and 40% by 2030.[129]
- In Brazil, the city of Curitiba targets deploying around 150 articulated e-buses by 2024 and aims to operate 100% of its passenger vehicles with clean or renewable energy by 2050.[130] Rio de Janeiro targets 69 e-buses in operation by 2024 and the replacement of 20% of its public transport fleet

with zero-emission buses by 2030.[131] São Paulo banned bus companies from purchasing new diesel buses as of 2022 and targets at least 2,600 e-buses by 2024, to represent around one-fifth of the fleet.[132]

Countries and cities in the region continued to invest in the use of e-buses for public transport.

- In 2022, Guatemala City carried out a 3.5-month pilot project to evaluate the efficiency and sustainability of 20 e-buses under normal operating conditions.[133]
- Work began in 2022 on the charging terminal that will enable the initial operation of 40 e-buses in Antofagasta (Chile) in mid-2023, the first such service outside the country's capital.[134]

Electrification in the region is also reaching other public transport modes besides buses.

- Mexico City inaugurated the first line of its Cablebús cable car system in 2021, and in 2022 a second line started operating, which transported more than 23 million people during the year and reduced the travel time from 1 hour and 15 minutes to only 36 minutes.[135] A third line is expected to be operational by the end of 2023.[136]
- Bolivia's first electric light rail system, Tren Metropolitano, started operating in September 2022 as one of the country's most modern public transport systems, linking the cities of Cochabamba, Colcapirhua, Quillacollo, Sacaba, Sipe Sipe and Vinto.[137]
- In 2022, Guadalajara (Mexico) began building the fourth line of its Mi Tren light rail network, which serves the municipalities of Guadalajara, Tlaquepaque and Zapopan in the Guadalajara metro area.[138]
- San Juan Comalapa (Guatemala) received nine electric tricycle "tuk-tuks" in May 2022 to provide public transport for elderly populations and people with disabilities, and to support the work of waste pickers.[139]

After economic and political delays reinforced by the pandemic, and despite ridership losses, public transport systems expanded in 2022 and 2023, including in Ecuador, Mexico and Panama. Existing metro systems added new lines, and new public transport systems began operations, including bus rapid transit, metro, cable car and light rail systems. As of March 2023, metro systems were operating in 10 countries (Argentina, Brazil, Chile, Colombia, the Dominican Republic, Ecuador, Mexico, Panama, Peru and Venezuela), and bus rapid transit systems were operating in 13 countries (Argentina, Brazil, Chile, Colombia, Ecuador, El Salvador, Guatemala, Mexico, Panama, Peru, Trinidad and Tobago, Uruguay and Venezuela).[140]

- The second corridor of the bus rapid transit system of Guadalajara (Mexico) started functioning in 2022, with 42 stations distributed along 41.5 kilometres.[141]
- The metro system in Quito (Ecuador) began trial operations in early 2023 and was the first in the country as well as the newest in the region.[142]
- In March 2023, a new metro branch connecting the city centre of Panama City with Tocumen International Airport started operations, making the city one of the few in the region to have metro service to the airport.[143]
- The Lima and Callao Metro, which serves the Lima (Peru) metropolitan area, had one line in operation and two more under construction as of early 2023.[144]
- Bogotá (Colombia) is building its first metro line, which is expected to be finished by 2028.[145]

Argentina, Brazil, Chile and Mexico all have programmes to improve the energy efficiency of freight transport and reduce its emissions, with a focus on innovative technologies and cutting fuel use.[146]

- In 2018, Chile implemented Giro Limpio, a voluntary programme that seeks to certify and recognise efforts by transport companies to improve their energy and environmental performance. As of July 2021, the programme involved 180 carriers accounting for 15% of Chile's transported cargo, 462 million litres of diesel consumption and 1,313,080 tonnes of CO_2-equivalent emissions.[147] The programme aims to reduce 32 million litres of diesel use and avoid 91,000 tonnes of CO_2-equivalent emissions, and seeks to reach 10% of the national truck fleet by early 2024.[148]
- In 2021, Chile and Argentina began harmonising the regulations of Giro Limpio and Transporte Inteligente, Argentina's own freight transport energy efficiency programme.[149]

Photo credit: Ashden

- Chile launched the programme Vuelo Limpio in November 2021 to improve the energy efficiency of air transport (goods and passengers), with the participation of three airlines and an air taxi company.[150]
- Mexico's voluntary programme for cargo transport companies, Programa Transporte Limpio, reported 718 participating companies as of December 2022 and a total of 7 million tonnes of avoided CO_2 in 2021.[151]

As of the end of 2022, more than 90% of Latin American and Caribbean countries had submitted a second-generation Nationally Determined Contribution (NDC) towards reducing emissions under the Paris Agreement.[152] **However, only 20% of countries had submitted Long-Term Strategies.**[153] Countries in the region show the strongest linkages to renewable energy in transport globally, with nearly 12% of their NDC actions associated with alternative fuels.[154] Four countries (Belize, Dominica, El Salvador and Grenada) included targets for reducing transport greenhouse gas emissions in their second-generation NDCs.[155]

- Belize aims to reduce its use of conventional transport fuels 15% by 2030, to avoid 117 kilotonnes of CO_2 annually.[156]
- Dominica targets reducing its overall transport CO_2 emissions 20% below 2014 levels and its shipping CO_2 emissions 100% below 2014 levels by 2030.[157]
- El Salvador aims to limit its transport emissions to 334 kilotonnes below business-as-usual growth by 2030.[158]
- Grenada repeated its transport greenhouse gas mitigation target from its first NDC, which aims to reduce transport CO_2 emissions 20% below 2010 levels by 2025, with further reductions by 2030.[159]
- Eight countries in the region (Antigua and Barbuda, Barbados, Bolivia, Chile, Colombia, Costa Rica, Dominica and Panama) included e-mobility targets in their second-generation NDCs. For example, Panama envisions that by 2030, electric vehicles will represent 10% of commercial vehicles, 25% of personal vehicles, 20% of public transport and 30% of government fleets.[160]
- A comparison of national strategies against the NDCs and Long-Term Strategies submitted by Latin American and Caribbean countries as of early February 2022 found that there is coherence between countries' climate strategies and their planning instruments at the national and sub-national levels. This consistency is found in framework strategies related to transport, energy, urban planning and environmental management, and climate change.[161]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- **Asociación Sustentar**, as part of its support to the EUROCLIMA+ programme, developed extensive mapping that provides easy-to-access and centralised information about organisations and initiatives working on advancing sustainable urban mobility in Latin America; this includes a mapping of regional needs, priorities, challenges, and interests in sustainable mobility, as well as an analysis of available online training on sustainable urban mobility in English and Spanish.[162]
- The C40 Cities Finance Facility (CFF) aims to facilitate access to finance for climate change mitigation and resilience projects in cities.[163] In the region, CFF is currently working with Lima (Peru) to leverage investment for cycling infrastructure and with Rio de Janeiro (Brazil) to develop a sustainable Electric Bus Depot powered with solar energy.[164]
- The urban mobility component of **EUROCLIMA+**, the European Union's flagship co-operation programme on sustainability and climate change with Latin America, supports the development of national policies, multi-modal integrated urban planning and innovative pilot projects in 12 countries.[165] Implemented by Germany's GIZ and France's AFD, it also hosts a community of practice to strengthen exchanges and capacities of cities and national governments in the region.[166]
- The **GEF-7 Global Electric Mobility Program** is an initiative financed by the Global Environment Facility that supports low and middle-income countries around the world with the shift to electric mobility. The Latin America and the Caribbean regional platform, led by Centro de Movilidad Sostenible, includes eight countries: Chile, Antigua and Barbuda, Costa Rica, Ecuador, Grenada, Jamaica, Peru and Saint Lucia.[167]
- The **ICLEI** project EcoLogistics aims to advance effective regulatory, planning and logistical instruments to support low-carbon urban freight.[168] It currently supports cities in Argentina and Colombia to develop urban freight strategies and viable alternatives to low-quality, diesel-powered freight vehicles, particularly for last-mile logistics.[169]
- The **MobiliseYourCity Partnership** fosters more comprehensive, integrated and participatory urban mobility planning at the local and national levels by providing methodological guidelines for developing sustainable urban mobility plans (SUMPs) and national urban mobility plans (NUMPs).[170] The Partnership's guidelines for developing and implementing SUMPs include regional insights and lessons learned, including for Latin America and the Caribbean.[171]
- **PLAMOBI** (Latin American Bicycle Mobility Platform), an initiative of the World Bank, seeks to strengthen the exchange of knowledge and experience to promote bicycle use in the region's cities.[172]
- The **Zero Emission Bus Rapid-deployment Accelerator (ZEBRA) Partnership** works with the cities of Medellín (Colombia), Mexico City, Santiago (Chile) and São Paulo (Brazil) to accelerate the deployment of zero-emission buses in the region.[173]

MODULE 2 2.5

AUTHOR: *Nikola Medimorec, SLOCAT Secretariat*

North America Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
375 million	+9.4%	83%	+4.2%	USD 58,794	+24%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.

Key findings

Demand trends

- Travel activity in North America dropped sharply in 2020 following the onset of the COVID-19 pandemic. In the United States, passenger activity was down 18% after a decade of constant 1.4% annual growth.
- The pandemic induced significant shifts in US commuting patterns, with the number of people working from home increasing three-fold between 2019 and 2021, and the use of public transport falling at least 30% nationwide in 2021.
- The region's motorisation levels (covering four-wheeled motor vehicles) have remained at an all-time high.
- In 2022, vehicle sales continued to decline in North America due to a combination of inflation, rising energy prices and lingering supply chain issues. However, the demand for electric vehicles increased, with the share of battery electric vehicle sales in Canada and the United States tripling to above 6% in the third quarter of 2022, up from slightly more than 2% two years prior.
- Despite less driving in 2020 due to the pandemic, total traffic deaths in the United States increased significantly from 2019 to 2021, and the rate of pedestrian fatalities reached an all-time high. Around 20% of the people killed in road traffic crashes in 2021 were pedestrians or cyclists.
- North America experienced the biggest drop in metro ridership among world regions in 2020 due to the pandemic, with the number of passengers falling 64%, from 3.7 billion to 1.3 billion.
- In 2022, ridership increased on several US public transport systems, although numbers remained well below pre-pandemic levels.
- The Russian Federation's invasion of Ukraine put additional pressure on global supply chains and increased inflation, creating major bottlenecks for key materials used in US industries, including transport.

Emission trends

- Carbon dioxide (CO_2) emissions from the transport sector in North America were greatly affected by the COVID-19 pandemic. The region's transport CO_2 emissions fell 7% between 2019 and 2021, changing their overall trajectory: transport CO_2 emissions rose 5% from 2010 to 2019 but declined 2% from 2010 to 2021.
- In 2021, North America contributed 28% of global transport CO_2 emissions (excluding international aviation and shipping), the second highest regional share after Asia.
- Among the 11 economies with preliminary emission estimates, the United States was one of 4 countries where transport emissions fell in 2022 (the others were China, the Russian Federation and Spain).
- US transport emissions have gradually shifted from passenger transport towards freight transport.

Policy developments

- Across North America, national and sub-national stakeholders raised their ambition on climate action during 2021 and 2022.
- Support for walking and cycling was strengthened in the region.
- The US Inflation Reduction Act of 2022 is aimed in part at helping the country achieve its climate target for 2030, with the goal of reducing emissions 31-44% below 2005 levels by 2030.
- The US Infrastructure Investment and Jobs Act of 2021 (also known as the Bipartisan Infrastructure Law) allocates USD 550 billion in new infrastructure investment from 2022 through 2026.
- Improvements to public transport were implemented in North America between 2020 and 2022, and more support was generated for introducing congestion charging.
- The region has prioritised the transition to electric road vehicle fleets, enabled by charging stations along highways and a Canadian ban on sales of internal combustion engine vehicles by 2035.
- New policies in the region are poised to lead to cleaner trucks and to improvements in long-distance rail.

Overview

North America – comprising the large economies of Canada and the United States as well as the territories of Bermuda (UK), Greenland (Denmark) and Saint Pierre and Miquelon (France) – has above-average motorisation rates and transport emissions. In 2021, the region contributed 28% of the world's carbon dioxide (CO_2) emissions from transport, the second highest regional share after Asia.[2]

Canada and the United States have enhanced their climate action plans since 2020. The US Biden administration introduced key changes to policies on climate change, transport and infrastructure. The United States rejoined the Paris Agreement in 2021, increased its climate ambition and set a goal to reach net zero greenhouse gas emissions by 2050.[3] The Inflation Reduction Act backs climate action with several activities on transport, and the Bipartisan Infrastructure Law supports infrastructure improvements. Canada also upgraded its emission reduction plan and set a target for net zero emissions by 2050.[4]

Nevertheless, current climate strategies are still not enough to meet the goals of the Paris Agreement in the region. The US efforts on climate change are regarded as "insufficient", because while the country's targets are "almost sufficient" to keep the average global temperature rise below 2 degrees Celsius (°C), envisioned policies and actions are still "insufficient".[5] Canada's climate strategies are "highly insufficient", as current policies are projected to lead to a 4°C warming pathway.[6]

Demand trends

Travel activity in North America dropped sharply in 2020 following the onset of the COVID-19 pandemic. In the United States, passenger activity was down 18% after a decade of constant 1.4% annual growth.[7] US domestic aviation, inter-city rail and public transport activity fell by half in 2020.[8] Meanwhile, freight activity in the country surpassed 5,250 billion tonne-miles for the year, declining only for railroads (down 11%) and water transport (down 5%).[9]

In Canada, rail passenger activity fell from 1,729 million passenger-kilometres in 2019 to 235 million passenger-kilometres in 2020 and only recovered to 542 million passenger-kilometres in 2021.[10] Available freight statistics for the country show that rail activity increased 2% during 2015-2020, but between 2019 and 2020 the number of tonne-kilometres travelled fell from 455 billion to 423 billion.[11]

The annual vehicle miles travelled in the United States recovered in 2022, rising from 2.84 trillion in the one-year period from February 2020 to January 2021, to more than 3.26 trillion during the period from February 2021 to January 2022 – to surpass the 2019 value of 3.25 trillion vehicle-miles.[12]

The pandemic induced significant shifts in US commuting patterns, with the number of people working from home increasing three-fold between 2019 and 2021, and the use of public transport falling at least 30% nationwide in 2021.[13] The share of US work commute trips taken in single-occupancy vehicles fell from 76% in 2019 to 68% in 2021.[14] However, this did not reflect a shift to public transport, which also fell from just under 5% of work commute trips in 2019 and 2020, to only 2.5% in 2021.[15] Rather, the main shift in 2021 was to working from home, as the share of people not commuting to work grew from 5% in 2019, to 7% in 2020, to 18% (27.6 million people) in 2021.[16]

The region's motorisation levels (covering four-wheeled motor vehicles) have remained at an all-time high. The motorisation rate of North America is 4 times the global average and 18 times higher than in Africa.[17] Canada had a motorisation rate of 656 vehicles per 1,000 people in 2019, whereas the US rate was even higher, at 807 vehicles per 1,000 people in 2020 (see Figure 1).[18] The motorisation rate grew 9% in Canada and 3% in the United States from 2010 to 2019.[19]

In 2022, vehicle sales continued to decline in North America due to a combination of inflation, rising energy prices and lingering supply chain issues. However, the demand for electric vehicles increased, with the share of battery electric vehicle sales in Canada and the United States tripling to above 6% in the third quarter of 2022, up from slightly more than 2% two years prior (see Figure 2).[20]

New passenger car sales in the United States fell 8% in 2022, totalling 13.8 million.[21] Continuing the trend since 2010, growth occurred only in commercial vehicle sales, although this too has slowed since 2015.[22] Larger passenger vehicles, specifically sport utility vehicles (SUVs), are a major contributor to US CO_2 emissions, as every second passenger car sold is an SUV.[23]

- In 2022, more than a third of all vehicle models available in the United States were electric light-duty vehicles (132 out of 325 total models), nearly twice as many as in 2019.[24]
- Battery electric vehicles represented 3.1% of all registered light-duty vehicles in the United States in 2021, and 5.6% in 2022.[25]
- Twice as many battery electric vehicles were sold in the United States in 2022 compared to the previous year, or around 750,000 units in total.[26]
- In Canada, battery electric vehicles accounted for 3.6% (58,700 vehicles) of total vehicle registrations in 2021, rising to

FIGURE 1. Motorisation rates per 1,000 people in North America, 2019/2020

Source: See endnote 18 for this section.

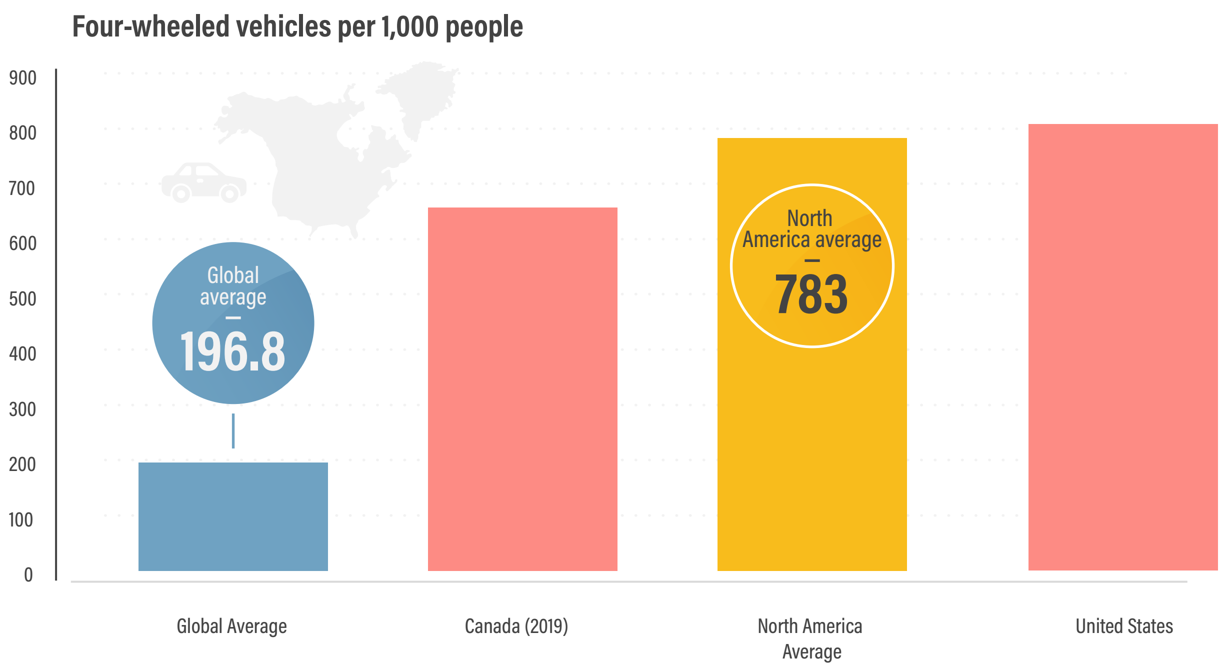
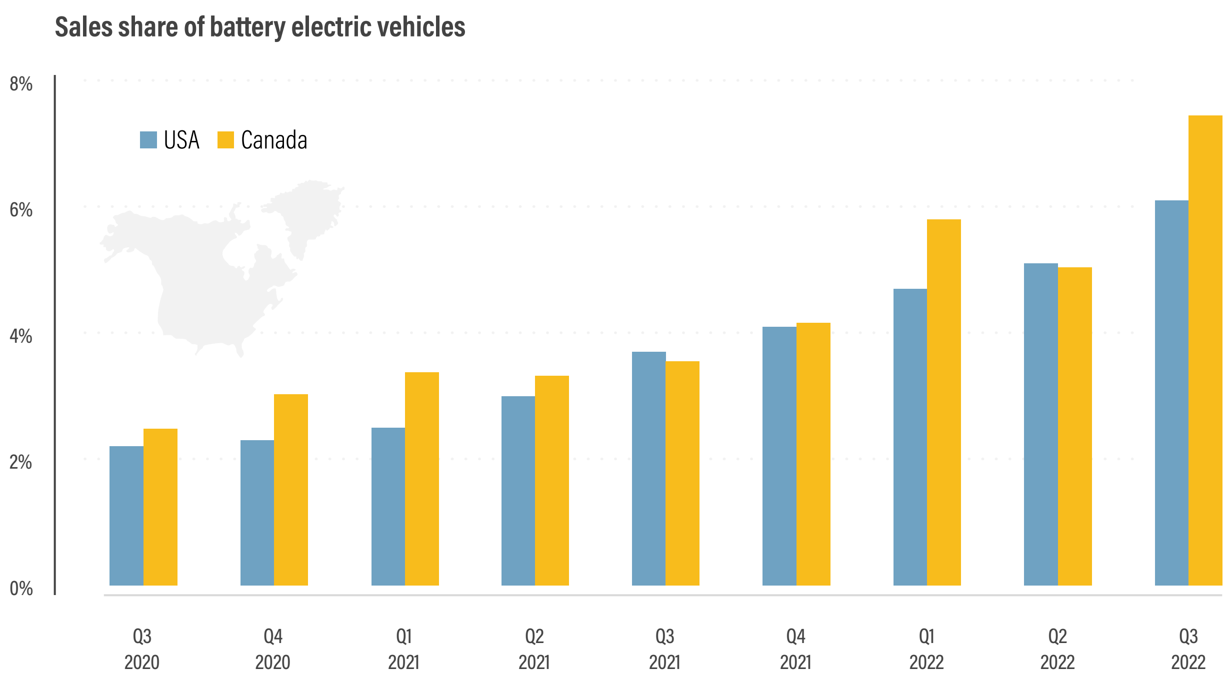


FIGURE 2. Shares of battery electric vehicles sold in Canada and the United States, 2020-2022

Source: See endnote 20 for this section.



6.1% (70,800 vehicles) in the first three quarters of 2022.[27]

Despite the rising popularity of electric vehicles, the United States Energy Information Administration projected in 2023 that the share of battery electric vehicles in the US would reach only 16% in 2030 and 21% in 2050.[28] This is well below the pathway needed to achieve the goals of the Paris Agreement, which requires more than 60% of car sales globally to be electric by 2030 and no new cars with internal combustion engines to be sold after 2035.[29]

Projections of the future energy demand from light-duty vehicles indicate that the energy savings through more efficient electric vehicles and stricter US Corporate Average Fuel Economy standards will be between 3% and 28% by 2050 compared to 2022, despite continued growth in travel demand.[30]

Sales of electric bikes (e-bikes) continued to outpace electric car sales in the United States in 2021, with US e-bike imports reaching 790,000 units in 2021, while electric car sales totalled 650,000 units.[31] Surveys in the country show that e-bike use, especially by lower-income households, can replace 35-44% of a car's vehicle-miles travelled.[32]

Despite less driving in 2020 due to the pandemic, total traffic deaths in the United States increased significantly – rising from 36,355 in 2019 to 38,824 in 2020 and 42,939 in 2021 – and the rate of pedestrian fatalities reached an all-time high.[33] Around 20% of the people killed in road traffic crashes in 2021 were pedestrians or cyclists.[34] The number of pedestrian fatalities per vehicle-mile travelled in the United States increased 21% in 2020 compared to 2019, the highest growth ever recorded.[35] Studies from this period reveal a close correlation between larger personal vehicles and pedestrian deaths.[36]

North America experienced the biggest drop in metro ridership among world regions in 2020 due to the pandemic, with the number of passengers falling 64%, from 3.7 billion to 1.3 billion.[37] Ridership on New York City's metro system dropped 62% in 2020, the second biggest decline among the world's largest metro systems (after Delhi, India).[38]

In 2022, ridership increased on several US public transport systems, although numbers remained well below pre-pandemic levels.[39] The main reasons for the increase were more people returning to workplaces, and high petrol prices.[40] In June 2022, US petrol prices reached a record high of USD 4.93 per gallon.[41] Although US petrol prices previously reached USD 4 per gallon in mid-2008 during the financial crisis, they remained steady between 2015 and 2020 at around USD 2-3 per gallon.[42] Despite the recent increase, US petrol prices have continued to be the lowest among member countries of the Organisation for Economic Co-operation and Development (OECD).[43]

During the pandemic, many cities in North America implemented pedestrian and bicycling improvements, including "pop-up" bikeways. Bike sharing systems continued to grow in the United States, with 10 systems in 25 metropolitan areas expanding or releasing expansion plans during 2021-2022.[44] The main trend is towards electrification of bike sharing fleets. Meanwhile, the region's electric scooter fleets grew 14% in 2021 and held steady in 2022.[45]

- In Canada, during the height of the pandemic in 2020, cycling was up 48% in Vancouver and 26% in Victoria, based on usage of Strava, an exercise tracking app.[46]

The Russian Federation's invasion of Ukraine put additional pressure on global supply chains and increased inflation, creating major bottlenecks for key materials used in US industries, including transport. The most affected sectors have been energy, food and semiconductors. As of 2022, the United States obtained more than 90% of its semiconductor-grade neon from Ukraine, and 35% of its palladium and 20% of its nickel from the Russian Federation.[47] Nickel and other metals are required for electric vehicle batteries. In response to the invasion, and to increase resilience to shocks, US vehicle manufacturers aim to increase efforts to secure materials and to expand and diversify supply chains.[48]

Emission trends

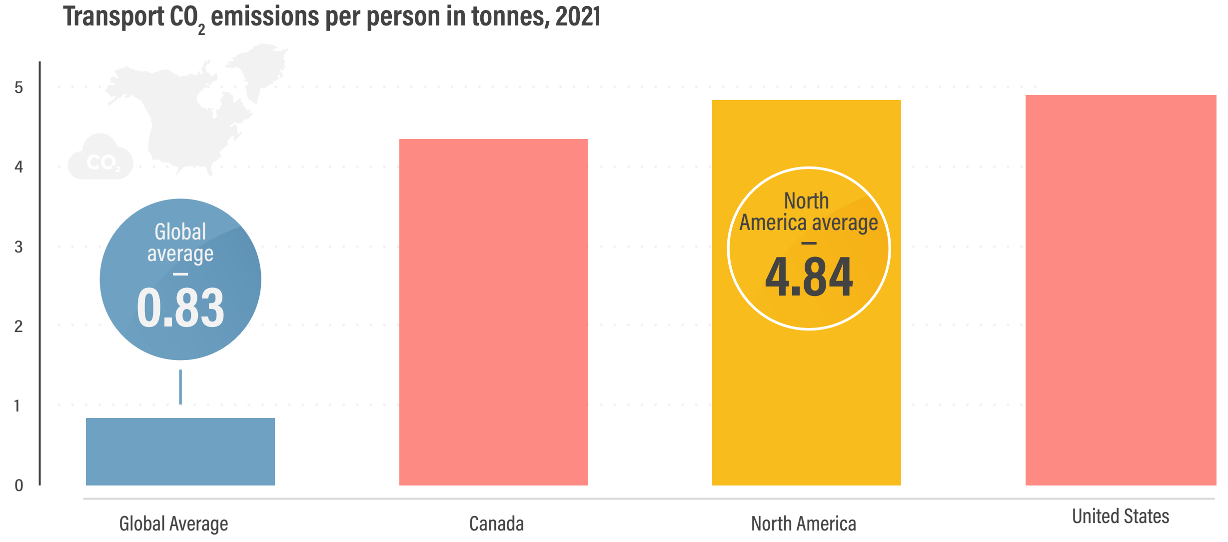
Carbon dioxide (CO_2) emissions from the transport sector in North America were greatly affected by the COVID-19 pandemic. The region's transport CO_2 emissions fell 7% between 2019 and 2021, changing their overall trajectory: transport CO_2 emissions rose 5% from 2010 to 2019 but declined 2% from 2010 to 2021.[49] Transport CO_2 emissions were close to exceeding 2 gigatonnes prior to the pandemic but fell to 1,813 million tonnes in 2021.[50] Per capita transport emissions in North America are six times the global average due to the higher rate of motor vehicle use in the region (see Figure 3).[51]

In 2021, North America contributed 28% of global transport CO_2 emissions (excluding international aviation and shipping), the second highest regional share after Asia.[52] Since 2019, transport has been the highest emitting sector in the United States, following large reductions in power sector emissions.[53] The vast majority of US transport CO_2 emissions are from road transport, with an 83% share in 2019 (58% from personal vehicles and 25% from commercial trucks and buses).[54] In Canada, transport contributed 165 million tonnes of CO_2 in 2021, or 29% of the country's total emissions, making it the second largest emitter after "other industrial combustion".[55]

Among the 11 economies with preliminary emission estimates, the United States was one of 4 countries where transport emissions fell in 2022 (the others were China, the Russian Federation and Spain).[56] The pandemic contributed to a 15% decline in North American transport emissions (down

FIGURE 3. Per capita transport CO_2 emissions in North America, 2021

Source: See endnote 51 for this section.



14% in the United States and 16% in Canada) in 2020.[57] In 2021, the region's transport CO_2 emissions again increased, rising 9% (11% in the United States and 3% in Canada).[58] Preliminary estimates for 2022 show that US economy-wide CO_2 emissions grew 3.5%, with transport CO_2 emissions falling 0.9%.[59]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
1,813 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
28%

Per capita transport CO_2 emissions (2021):
4.84 tonnes

Transport CO_2 emissions per USD 10,000 GDP (2021):
0.82 tonnes

Source: See endnote 60 for this section.

US transport emissions have gradually shifted from passenger transport towards freight transport. Between 2015 and 2020, the share of US transport sector emissions originating from light-duty vehicles fell from 60% to 57%, while the share from medium- and heavy-duty trucks grew from 23% to 26%.[61] In Canada, road transport (light-duty vehicles and trucks) was the major contributor to emission growth until 2019, but this sub-sector experienced the greatest decline in 2020.[62]

Policy developments

Across North America, national and sub-national stakeholders raised their ambition on climate action during 2021 and 2022. In 2022, Denver and Los Angeles (USA) cancelled freeway expansion plans due to concerns about equity and pollution.[63] Regional awareness has risen about induced demand and the need for alternatives to road expansions.[64]

- British Columbia (Canada) has targets to reduce light-duty vehicle travel 25% and to roughly double the number of walking, cycling and public transport trips by 2030.[65]
- In the United States, California has targets to reduce the number of light-duty vehicle miles travelled per capita 25% by 2030 and 30% by 2045 (compared with 1990) and has developed new tools for evaluating the travel and emission impacts of transport and land-use planning decisions.[66]
- The California Climate Commitment set targets to reduce air pollution 60%, refinery pollution 94%, state oil consumption 91%, and fossil fuel use in buildings and transport 92% by 2035, as well as to save USD 23 billion by avoiding the damages of pollution.[67]
- Minnesota (USA) has targets to reduce vehicle travel 14% by 2040 and 20% by 2050.[68]
- Washington state (USA) has targets to reduce per capita vehicle travel 30% by 2035 and 50% by 2050.[69]
- The US government set goals to reduce greenhouse gas emissions from US aviation 20% by 2030 and to achieve net zero emissions in the sector by 2050, including by scaling up sustainable aviation fuels.[70]

Support for walking and cycling was strengthened in the region during 2021 and 2022.

- In 2022, Boston (USA) set a goal to have 50% of the city's population be able to access a protected bike lane within a three-minute walk by 2025.[71] The plan involves building new cycling infrastructure, adding 100 new stations to the bike sharing system and installing more than 100 new speed humps or raised crosswalks to calm traffic on neighbourhood streets.[72]
- Canada released its first national active transport strategy in 2021 to provide CAD 400 million (USD 298.8 million) from 2021 to 2026.[73]
- In 2022, British Columbia (Canada) announced new funding of CAD 575,000 (USD 429,669) for Vision Zero, a strategy that supports climate goals by shifting people to walking, cycling and micromobility.[74]
- In California (USA), a bill to give every household that has zero registered vehicles a tax rebate of USD 1,000 passed the state senate in 2021 and is to be implemented in tax year 2023.[75]
- The highest court in New York (USA) confirmed in 2021 that it is a crime to drive with negligence and to injure somebody with a vehicle, thereby upholding the city's "right-of-way" law.[76]

The US Inflation Reduction Act of 2022 is aimed in part at helping the country achieve its climate target for 2030, with the goal of reducing emissions 31-44% below 2005 levels by 2030.[77] US energy-related CO_2 emissions could drop 25-38% during this period with increased electrification, equipment efficiency, and renewable technologies.[78] In its 2021 Nationally Determined Contribution (NDC) towards reducing emissions under the Paris Agreement, the United States targets cutting emissions 50-52% below 2005 levels by 2030.[79] The Inflation Reduction Act covers a variety of transport activities.[80]

- The Clean Vehicle Credit will maintain the existing consumer tax credit of USD 7,500 for the purchase of a clean vehicle.[81]
- The Neighborhood Access and Equity Grants of USD 3 billion will improve transport access and road safety as well as minimise other environmental impacts in underserved communities.[82]
- The Act provides USD 1 billion for grants and rebates to cover 100% of costs for clean heavy-duty vehicles (such as school buses and refuse trucks).[83]
- Further financial support and grants will go towards improving surface transport infrastructure, identifying low-carbon construction for highways and support for sustainable aviation fuels.[84]

However, the Inflation Reduction Act has been criticised for prioritising vehicle electrification and lacking support for sustainable transport.[85] Analysis identified that transport emissions will contribute the least to the envisioned emission reductions, as transport emissions are projected to stay steady even in the most ambitious scenario.[86]

The US Infrastructure Investment and Jobs Act of 2021 (also known as the Bipartisan Infrastructure Law) allocates USD 550 billion in new infrastructure investment from 2022 through 2026.[87] It represents the largest long-term investment in infrastructure in the United States and promises to provide significant improvements to transport.[88]

- USD 39 billion (7% of the total budget) will be invested in the improvement and expansion of public transport systems.[89]
- USD 7.5 billion (1.4% of the total budget) will be used to build 500,000 new electric vehicle charging stations by 2030.[90]
- USD 1 billion will be provided to the Safe Streets and Active Transportation programme, which covers the construction of bike lanes, pedestrian facilities and other infrastructure for walking and cycling.
- USD 1 billion will be used to develop clean energy technologies.[91]

The US Departments of Energy, Transportation, and Housing and Urban Development, together with the Environmental Protection Agency, signed a Memorandum of Understanding on transport decarbonisation in September 2022, followed by the release of the first US National Blueprint for Transportation Decarbonisation in January 2023.[92] The comprehensive strategy encompasses actions to increase convenience (through land use and planning), improve efficiency (through expanding public transport and rail and improving vehicle efficiency) and transition to clean vehicles (zero-emission vehicles).[93] It supports the target in the US Nationally Determined Contribution of reducing CO_2 emissions 50-52% below 2005 levels by 2030 and the target of net zero carbon emissions by 2050.[94]

The US Department of Transportation also published a notice for USD 1.5 billion in grant funding for the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) programme through 2023, including both the regional and local scales.[95] In 2022, the RAISE programme funded 166 freight and passenger transport projects across 50 states, along with the District of Columbia, Puerto Rico, the Northern Mariana Islands and the US Virgin Islands.[96]

Improvements to public transport were implemented in North America between 2020 and 2022, and more support was generated for introducing congestion charging.

- Canada has allocated an additional CAD 14.9 billion (USD 11.1 billion) from 2021 to 2028 for public transport projects.[97]
- The public transport operator TransLink in Vancouver (Canada) released its 2050 Regional Transportation Strategy, with the main activities focused around building 300 kilometres of new lines by 2050.[98]
- Among major US locations that trialled free public transport fares in 2022, Boston implemented free public transport on three major bus routes, and Connecticut introduced a free bus fare programme, resulting in public transport ridership levels higher than pre-pandemic.[99]
- Several US cities (foremost New York City, followed by Los Angeles and San Francisco) have worked on implementing congestion pricing schemes.[100] Los Angeles is moving ahead with plans for a congestion pricing pilot.[101]

The region has prioritised the transition to electric road vehicle fleets, enabled by charging stations along highways and a Canadian ban on sales of vehicles with internal

combustion engines by 2035.

- In 2022, Canada announced its intention to ban sales of passenger cars with internal combustion engines by 2035 and to target higher sale shares of zero-emission cars [102]
- The United States has set an ambitious target of 50% electric vehicles in total vehicle sales by 2030.[103] A 2023 survey found that more than half of interviewed Americans intend to buy an electric vehicle within the next five years, with the main challenges being the price and the lack of public charging stations.[104]
- In 2022, California (USA) passed a bill banning new petrol car sales by 2035.[105] In addition, California will require that all autonomous vehicles deployed in the state as of 2030 be zero-emission vehicles.[106]
- The United States has approved plans for electric vehicle charging stations for all 50 states as well as Washington, D.C. and Puerto Rico, together covering around 120,700 kilometres of highways.[107]
- In 2021, Petaluma (California), home to 60,000 residents, became the first US city to ban new petrol stations.[108]
- In a first US attempt to deploy vehicle-to-grid technology, in summer 2022 General Motors and the Pacific Gas and Electric Company launched a pilot project in California to test the use of electric vehicles as a back-up power source for homes during grid outages.[109]

Electric bus fleets are also set to expand across North America in the coming decades.

- The US Department of Transportation plans to double the number of electric buses in operation, expanding its share of only around 2% of all buses as of 2022.[110]
- In Seattle (USA), King County Metro Transit Department is targeting a 100% zero-emission bus fleet powered by renewable energy by 2040.[111] In Washington, D.C., the Washington Metropolitan Area Transit Authority set a target in 2021 for a zero-emission bus fleet by 2045.[112]
- Ottawa (Canada) announced in 2021 that it would add 450 zero-emission buses to its public transport fleet by 2027 and transition the fleet to fully electric by 2036.[113]

New policies in the region are poised to lead to cleaner trucks and to improvements in long-distance rail.

- In 2022, the US Environmental Protection Agency announced new pollution standards for heavy-duty vehicles, the first such updates in 20 years; the goal is to improve standards 80%, with a focus on nitrogen oxides and the transition to a cleaner truck fleet.[114]
- The US Bipartisan Infrastructure Bill of 2021 includes USD 66 billion in funding for new rail infrastructure, the biggest investment in passenger rail transport in the history of the rail provider Amtrak.[115] The bill aims to greatly improve passenger rail, including by providing high-quality train service, modernising rail stations and boosting the resilience of the US Northeast Corridor.[116]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- **CALSTART**, a US-based non-profit organisation, is working with businesses and governments to develop clean, efficient transport solutions, focusing on cars, bus, trucks and fuels.[117]
- In 2021, the **Environmental Defense Fund** worked with automakers (such as General Motors and Ford), labour unions and regulators to build consensus for achieving the US goal of having half of new passenger vehicles sold in the country be zero emission by 2030.[118]
- The **Hewlett Foundation**, a non-partisan US charitable foundation, has a Climate Initiative Strategy (2018-2023) that is committed to assessing programmes in consideration of the need for deep decarbonisation by 2050 across major sectors.[119]
- The **Institute for Transportation and Development Policy (ITDP)** uses technical expertise, direct advocacy and policy guidance to mitigate the impacts of climate change, improve air quality, and support prosperous, sustainable and equitable cities. Its activities in North America highlight the power of high-quality bus rapid transit and safe cycling streets integrated with micromobility options, while shifting away from harmful tailpipe emissions towards clean transport and mobility freedom for all.
- The **Institute of Transportation Studies at the University of California at Davis (ITS-Davis)**, a leading university centre on sustainable transport, has hosted the National Center on Sustainable Transportation since 2013 (awarded by the US Department of Transportation) and manages large research initiatives on energy, environmental and social issues.[120]
- The **World Resources Institute (WRI)** provides leadership and support across its global network and its US and Energy programmes, which engage with federal, state and city governments and also work on urban mobility issues.[121]

MODULE 2 2.6

AUTHOR: *Angel Cortez, SLOCAT Secretariat*

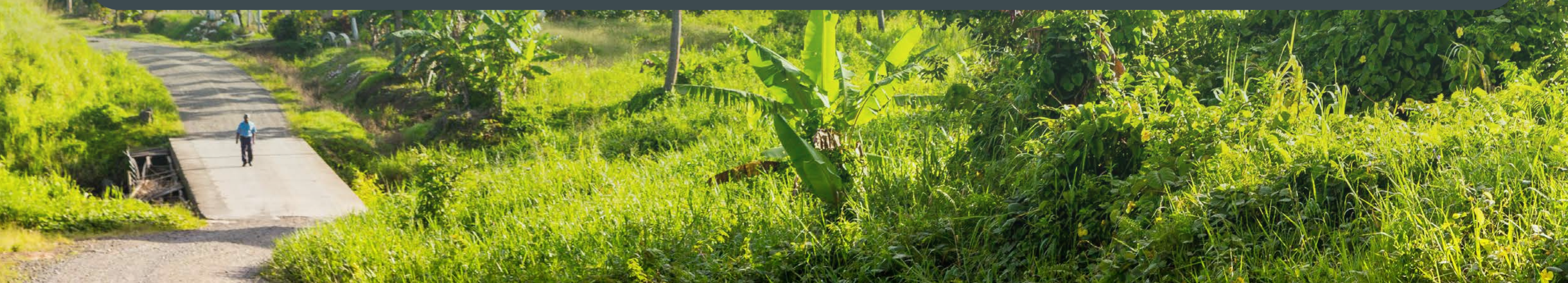
CONTRIBUTORS: *Helen Rowe and Margot Delafoulhouze, Climateworks Australia*

Oceania Regional Overview

Demographics

Population size:	Population growth:	Urban population share:	Urban population growth:	GDP per capita:	GDP growth:
44 million	+22%	66%	+19%	USD 40,469	+29%
(2022)	(2010-2020)	(2022)	(2010-2022)	(2021)	(2010-2021)

Source: See endnote 1 for this section.



SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- In the larger economies of Oceania, private car use has continued to dominate passenger transport, even though the region has good access to public transport.
- In Australia, around 87% of work commutes in 2021 were by drivers or passengers of a car, motorcycle, or truck, while only 5% were by walking or cycling and 7% by public transport.
- Small-island countries have experienced rapid growth in motorisation (covering four-wheeled motor vehicles) as economies grow and urbanise. During 2010-2019, the region's largest growth was in Fiji and the Federated States of Micronesia, with increases near or above 40%. Australia and New Zealand had the highest overall motorisation levels in the region as of 2020.
- Oceania's electric vehicle uptake still lags behind other regions, as electric passenger cars in Australia and New Zealand comprise less than 1% of the global electric car stock.
- The COVID-19 pandemic and related border closures had profound effects on the Oceania region, resulting in high revenue losses in commodity exports and tourism. The Russian Federation's invasion of Ukraine further threatened the region's economic recovery, as disruptions affected shipping and freight corridors through the Pacific.
- Small-island countries in Oceania have major needs for sustainable, low-carbon transport.

Emission trends

- Oceania remained the lowest emitter of transport carbon dioxide (CO_2) emissions (excluding international aviation and shipping) among world regions in 2021, contributing less than 2% of transport emissions globally.
- Australia continued to be the largest emitter of transport CO_2 in the region and the 17th largest emitter globally in 2021, but it was surpassed by Cook Islands in emissions per capita.

Policy developments

- During 2021 and 2022, countries in Oceania, including small-island countries, enacted policy measures to enable and support electric vehicle uptake and to improve fuel efficiency standards.
- Recent investment projects have scaled up the ability of vulnerable small-island states to build resilient transport systems.
- Since 2019, Australia has increased its ambition on alternative fuels, such as hydrogen and sustainable aviation fuels.
- National and sub-national governments in Oceania have made net zero pledges in the transport sector, including for land, maritime and air transport.
- Climate action in New Zealand is being realised through comprehensive planning approaches, active mobility and support for public transport at the national and local levels.
- The Nationally Determined Contributions (NDCs) submitted by Oceania countries under the Paris Agreement as of 2022 offer a wide-ranging set of climate change mitigation and adaptation activities.

Overview

Oceania[i], which includes the large economies of Australia and New Zealand as well as a range of island countries in the Pacific Ocean, contributed the lowest share of global transport emissions in 2021. Aviation and shipping play a large role in the region due to the many small-island countries.[2] These island countries are among the most vulnerable to climate change from rising emissions and sea levels; however, regionally they are also the most dependent on fossil fuel imports, with the transport sector consuming the majority of imports.[3] This contributes to other unique regional challenges, including high transport costs, lack of opportunities to increase economies of scale, and a large need for climate finance, among others.[4]

Transport demand and emission trends were rising steadily in the region before being temporarily offset by mobility restrictions in 2020 related to the COVID-19 pandemic. Declines in air travel and tourism and associated disruptions severely constrained the region's economies, which rely heavily on tourism and maritime corridors.[5] After restrictions were lifted, regional transport demand and emissions returned to near or above pre-pandemic values. However, the Russian Federation's invasion of Ukraine in 2022 hampered recoveries and exacerbated supply chain disruptions and fossil fuel demand in the region.[6]

Transport decarbonisation strategies in Oceania are focused on transitioning to zero-emission vehicles and enabling electric vehicle uptake through infrastructure. Although many small-island countries have begun to use electric vehicles, in many cases local energy grids are not yet able to support high deployment of these fleets. Large opportunities exist to shift from car dependence to public transport as the main mode of transport and to improve road infrastructure to support and scale up resilient transport systems.

Recent policy measures in the region have linkages to several of the United Nations Sustainable Development Goals (SDGs), including SDG 9 (industry, innovation and infrastructure), SDG 11 (sustainable cities and communities) and SDG 13 (climate action), through measures adopting national strategies to support the decarbonisation of transport, committing to net zero pledges, and scaling up green and resilient investments.

Demand trends

In the larger economies of Oceania, private car use has continued to dominate passenger transport, even though the region has good access to public transport.

- **In Australia, around 87% of work commutes in 2021 were by drivers or passengers of a car, motorcycle, or truck, while only 5% were by walking or cycling and 7% by public transport.**[7] The number of people working from home in the country increased from 500,000 in 2016 to 2.5 million in 2021.[8]
- Private cars accounted for 70% of passenger activity in Australia in 2021, or 252 billion passenger-kilometres.[9] Overall passenger activity in the country in 2020 and 2021 was 18% below the all-time high of 2018 (443 billion passenger-kilometres).[10]
- In New Zealand in 2014 (latest data available), 79% of trips were by car drivers or passengers, while 18% were by walking or cycling and 3% by public transport.[11]
- Car trips dominated in Australia and New Zealand even though these countries had the world's highest share of the urban population with access to public transport in 2021, at 82.8%, compared to a global average of 56.2%.[12]

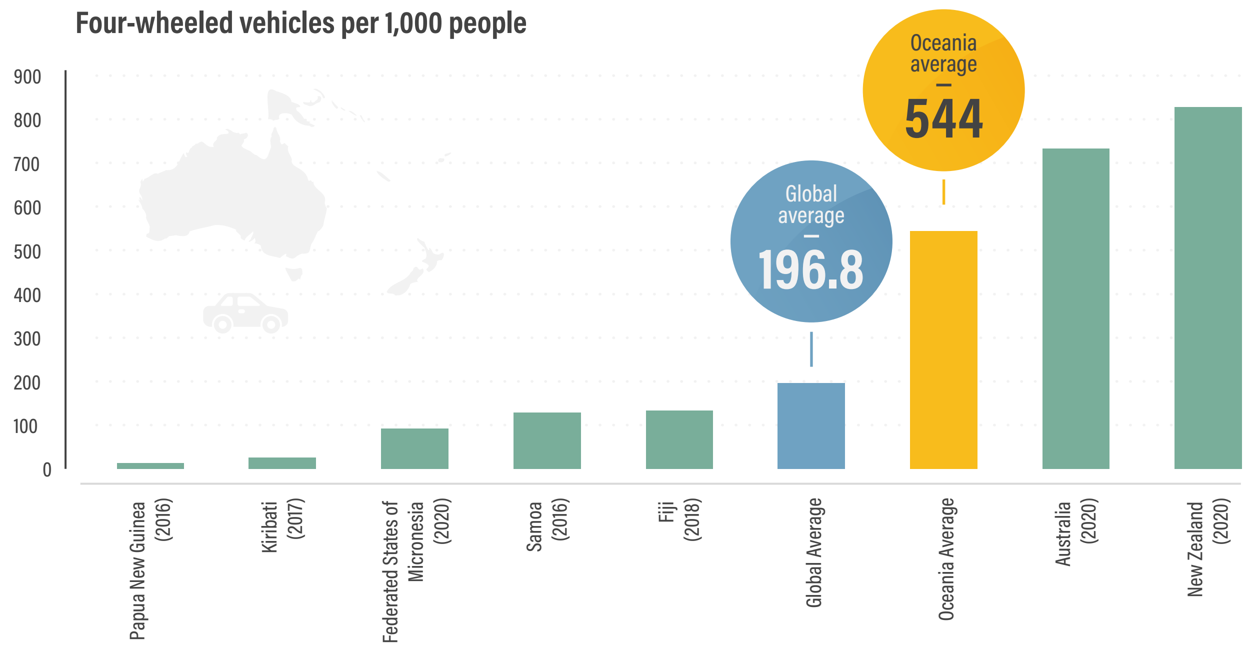
Small-island countries have experienced rapid growth in motorisation (covering four-wheeled motor vehicles) as economies grow and urbanise. During 2010-2019, the region's largest growth was in Fiji and the Federated States of Micronesia, with increases near or above 40% (much larger than in Australia and New Zealand).[13] Australia and New Zealand had the highest overall motorisation levels in the region as of 2020.[14]

- Fiji's motorisation rate grew from 95 registered road vehicles per 1,000 people in 2010 to 136 vehicles per 1,000 people in 2019 (latest data available), while motorisation in the Federated States of Micronesia increased from 74 vehicles per 1,000 people in 2010 to 104 vehicles per 1,000 people in 2019.[15]
- Australia and New Zealand maintained the region's highest motorisation levels overall (see Figure 1), at 733 and 829 vehicles per 1,000 people, respectively, in 2020, around four times the global average.[16]
- The majority of countries in Oceania for which motorisation rates are available have levels below the global average. Car

i Here, the Oceania region covers Australia and New Zealand as well as the island countries of Cook Islands, Fiji, Kiribati, Marshall Islands, the Federated States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

FIGURE 1. Motorisation rates per 1,000 people in Oceania, 2016-2020

Source: See endnote 16 for this section.



ownership and motorisation levels were smaller for Fiji and Samoa (at just over 100 vehicles per 1,000 people) and even lower for the Federated States of Micronesia, Kiribati, and Papua New Guinea, for various years.[17]

Oceania's electric vehicle uptake still lags behind other regions, as electric passenger cars in Australia and New Zealand comprise less than 1% of the global electric car stock.[18] Major opportunities exist to scale up national targets, energy supply and infrastructure.

- Electric vehicle sales have grown exponentially in Australia in recent years – from a 0.2% share in sales in 2018 to 3.8% in 2022 – but are still well below the global average of 14% in 2022.[19] Electric vehicle uptake in the country was projected to surpass 100,000 units in 2023.[20]
- Electric vehicle uptake in New Zealand grew from nearly 24,000 units in 2020 to just over 36,000 in 2021 but failed to meet the government's target of 64,000 electric vehicles by 2021, set in 2016.[21] Growth of electric vehicles in the country has been paralleled by rising sales of large utility coupes, trucks and sport utility vehicles (SUVs).[22]
- In general, the shift to larger vehicles in both Australia and New Zealand has undermined the emission gains from greater electric vehicle sales.[23]

Electric vehicle sales in small-island countries have been slower, although both Cook Islands and Fiji have in place policies to encourage their uptake (*see Policy Developments section*).[24]

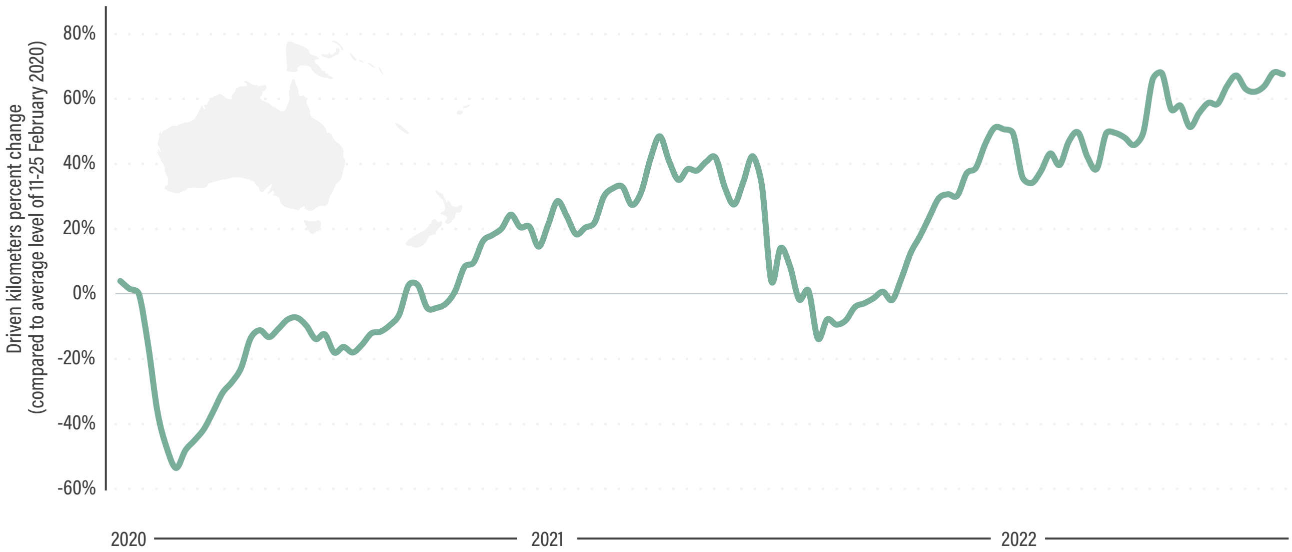
- In 2023, Cook Islands reported an electric vehicle stock of 46 electric cars, 3 electric pick-up trucks, 2 electric trucks, 24 electric two-wheelers and 4 electric scooters in operation.[25]
- Papua New Guinea imported 3 electric commercial vans in 2022, Samoa imported a battery electric SUV under a government pilot project in 2021, and Tuvalu was awaiting the arrival of 12 electric scooters from China as of 2023.[26]

The COVID-19 pandemic and related border closures had profound effects on the Oceania region, resulting in high revenue losses in commodity exports and tourism.[27] This led to large contractions in gross domestic product, surges in unemployment and increases in fiscal debts.[28] The collapse of tourism was especially devastating for already vulnerable island economies (such as Fiji, Palau, Samoa and Tonga) that rely heavily on tourism for economic activity and employment.[29] **The Russian Federation's invasion of Ukraine further threatened the region's economic recovery, as disruptions affected shipping and freight corridors through the Pacific.**[30]

- In the first 24 weeks of 2020, overall shipping activity in Oceania fell 12.3%, the second largest decline globally after Europe.[31] Passenger maritime transport fell 18% in the first half of the year.[32] Oceania also was among the most impacted regions for maritime freight (along with Africa), as container ship calls fell 12.4% in the beginning of 2020.[33]

FIGURE 2. Changes in kilometres driven in Oceania, 2020-2022

Source: See endnote 34 for this section.



- Declines in transport activity in the region were most evident during the months corresponding to COVID-19 variant outbreaks and consequential lockdowns, as indicated by Waze's data on kilometres driven, which shows strong declines in March-May 2020 and August-September 2021 (see Figure 2).[34]
- International aviation to and from Oceania started to rebound in 2022, but as of the beginning of the year international flights were still 40% below pre-pandemic levels.[35]
- By 2022, Australia and New Zealand surpassed the average for the Asia-Pacific region in recovery rates for airline capacity for international travel compared to 2019.[36]
- Fiji led small-island countries in the return to near pre-pandemic aviation activity by 2022.[37]

Small-island countries in Oceania have major needs for sustainable, low-carbon transport. This applies across all transport modes, although no recent data on modal shares exist for countries such as Cook Islands, Kiribati, Papua New Guinea, Samoa, Tonga and Vanuatu.

- The majority (80%) of Vanuatu's population lives across 6 main islands, but the country has more than 45 islands with a population of less than 1,000.[38] Only 20 of these islands have airstrips, and some islands have no road network at all.[39]
- People in Greater Suva (Fiji) are high users of public buses.[40] More than 60% of Suva residents live within 500 metres of a bus route with 20-minute service frequency.[41] In 2015 (latest data available), the largest share of travel in the city was by bus (46%) followed by car (34%).[42] (Cycling data are not available.)

Emission trends

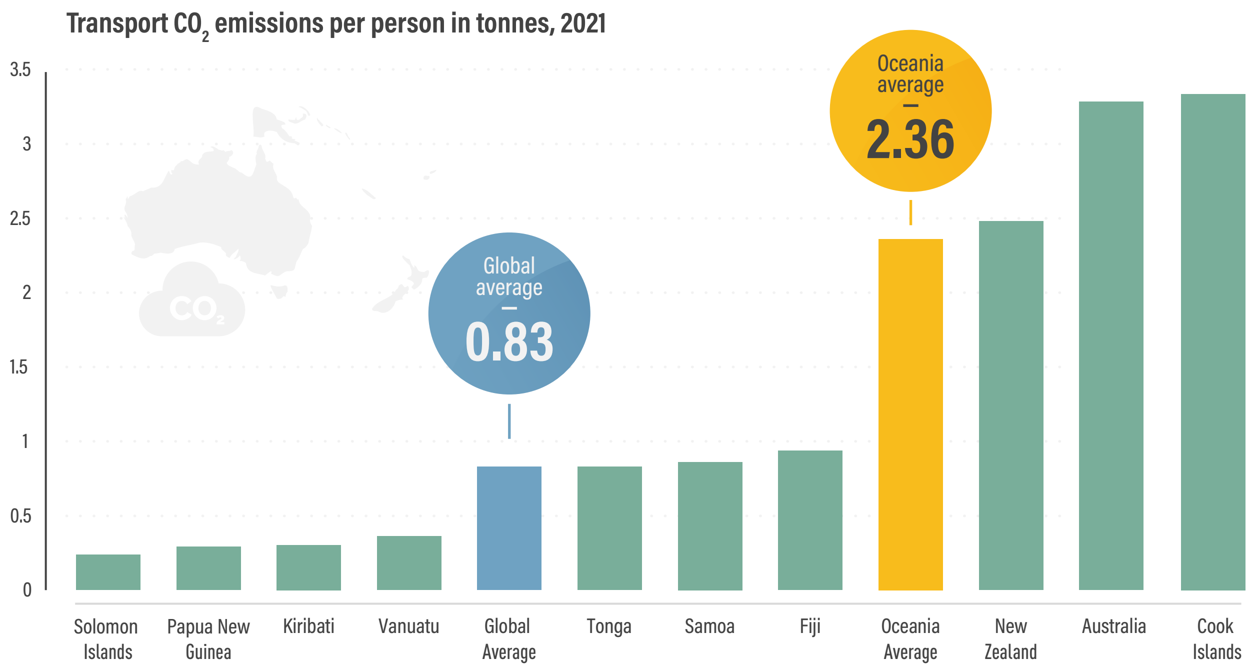
Oceania remained the lowest emitter of transport carbon dioxide (CO_2) emissions (excluding international aviation and shipping) among world regions in 2021, contributing less than 2% of transport emissions globally.[43] Transport CO_2 emissions in the region grew relatively steadily during 2010-2019, with 14% overall growth, then fell 16% in 2020 due to the decline in transport activity during the COVID-19 pandemic, before increasing slightly (1.4%) in 2021.[44]

Australia continued to be the largest emitter of transport CO_2 in the region and the 17th largest emitter globally in 2021, releasing more than 84 million tonnes.[45] This was due largely to the continued reliance on passenger vehicles with high fuel consumption, as well as energy-intensive road freight.[46]

- New Zealand came in a distant second in 2021 with just over 12 million tonnes of CO_2, followed by Papua New Guinea with nearly 3 million tonnes.[47]
- The smaller island countries measured much lower transport CO_2 emissions, ranging from less than 1 million tonnes in Fiji to only 0.04 million tonnes in Kiribati.[48]
- **Cook Islands surpassed the larger Oceanic economies**

FIGURE 3. Per capita transport CO_2 emissions in Oceania, 2021

Source: See endnote 49 for this section.



(Australia and New Zealand) in per capita transport CO_2 emissions (see Figure 3), due to its heavy reliance on road and air transport, even though its overall transport emissions totalled just over 0.05 million tonnes in 2021.[49]

- Other island countries had smaller per capita transport CO_2 emissions, ranging from less than 1 tonne in Fiji to as low as 0.24 tonnes in Solomon Islands.[50]

Regional CO_2 trends

Total transport CO_2 emissions (2021):
102 million tonnes

Share of global transport CO_2 emissions (excluding international aviation and shipping) **(2021):**
1.6%

Per capita transport CO_2 emissions (2021):
2.36 tonnes

Transport CO_2 per USD 10,000 (2021):
0.58 tonnes

Source: See endnote 51 for this section.

Policy developments

During 2021 and 2022, countries in Oceania, including small-island states, enacted policy measures to enable and support electric vehicle uptake and to improve fuel efficiency standards.

- In 2021, Australia released its Future Fuels and Vehicles Strategy, backed by the AUD 250 million (USD 170 million) Future Fuel Funds to support charging infrastructure and commercial fleet transitions.[52] Australia's consultation for a National EV Strategy began in September 2022 to define goals, objectives and actions to enable Australians to access the best transport technologies and help meet emission reduction targets.[53]
- In 2022, the Australian government doubled the existing investment in the Driving the Nation Fund, allocating AUD 500 million (USD 340 million) to support electric vehicle charging infrastructure for highways, as well as hydrogen highways for key freight routes.[54] In 2022, Australia passed Electric Car Discount legislation that exempts eligible electric cars from the fringe benefits tax and import tariffs.[55]
- Australia announced in its 2022-23 Budget that it would co-invest AUD 146 million (USD 99 million) over five years in projects to reduce emissions from road transport through the Australian Renewable Energy Agency (ARENA).[56] The funds will be used to expand electric vehicle charging points

along highways, install smart charging, develop vehicle-to-grid charging projects and explore approaches to incentivise household smart charging.[57]

- Australia is among the few remaining countries in the Organisation for Economic Co-operation and Development (OECD) that lack mandatory fuel efficiency standards.[58] Consultations have occurred on implementing fuel efficiency standards for light and commercial vehicles, as well as on addressing heavy-vehicle emissions.[59] The International Council on Clean Transportation has shown that having world class fuel efficiency standards in Australia could reduce the well-to-wheel emissions of light-duty vehicles 95% below 2019 levels by 2050.[60]
- In 2022, a voluntary industry-led CO_2 emission standard was initiated in Australia, aimed at reducing CO_2 emissions 4% annually on average for passenger cars and light SUVs.[61]
- In 2022, Australia announced that it would phase in Euro VI (Stage C) requirements for new medium-and heavy-duty vehicle models (greater than 3.5 tonnes) starting in November 2024, and for existing heavy-vehicle models still being supplied to the Australian market on or after 1 November 2025.[62]
- In New Zealand, the Clean Vehicle Standard is aimed at increasing the quantity and variety of low- and zero-emission vehicles supplied; the standard sets specific greenhouse gas emission targets for transport at 65.9 million tonnes for 2022-2025, 76 million tonnes for 2026-2030 and 56.8 million tonnes for 2031-2035.[63]
- Also in 2022, New Zealand implemented the Clean Car Import Standard, with the target to lower the CO_2 emissions of imported vehicles from an average of 171 grams of CO_2 per kilometre in 2020 to 105 grams by 2025 for cars and 132 grams for vans by 2025.[64] In 2022, New Zealand's Clean Vehicle Discount scheme encouraged purchases of zero-emission vehicles.[65]
- Fiji raised its subsidy for capital investments for electric vehicle charging infrastructure from 5% to 10% in its 2022-23 budget.[66]

Recent investment projects have scaled up the ability of vulnerable small-island countries to build resilient transport systems.

- In 2019, the World Bank launched the Pacific Climate-Resilient Transport Program, with initial projects in Samoa, Tonga, Tuvalu and Vanuatu.[67] The programme has since expanded to include projects to build and strengthen roads in Marshall Islands and Micronesia.[68]
- The World Bank's Pacific Aviation Investment Program supports Samoa, Solomon Islands and Tuvalu in improving the safety and efficiency of aviation.[69]
- The Global Green Growth Institute has supported the small-island developing states within its membership – Fiji, Kiribati, Papua New Guinea, Tonga and Vanuatu – in pursuing a low-carbon development approach while also promoting increased resilience.[70]
- In March 2023, six Pacific Island countries – Fiji, Niue, Solomon Islands, Tonga, Tuvalu and Vanuatu – signed the Port Vila Call for a Just Transition to a Fossil Fuel Free Pacific, a call to action encompassing many measures to transition the region away from fossil fuels, including reforms to international climate finance to help enable the transition.[71]
- To reduce its vulnerability, Samoa has pushed for a coherent and multi-pronged approach to systems planning, with the adoption of sectoral and spatial planning tools, investments in road network redundancy for critical infrastructure such as

TABLE 1. Zero-emission bus fleet targets in Australia

Source: See endnote 86 for this section.

States	Zero-emission bus targets
Australian Capital Territory	100% zero-emission bus fleets by 2040
New South Wales	100% zero-emission bus fleets by 2030
Queensland	100% of translink-funded bus purchases to be zero-emission from 2025 in South-East Queensland and from 2025-2030 in all of Queensland
Victoria	100% zero-emission bus purchases from 2025

roads and bridges, the construction of pedestrian evacuation routes, and policies and planning that address disaster and climate risks.[72]

Freight system improvements are under way in Australia. Through the Inland Rail Project, a 1,600 kilometre freight rail project, was initiated in 2018 and is anticipated to be complete by 2027 to service the country's freight demands and to shift more goods to rail. This priority infrastructure project is supported by USD 14.5 billion in funding from the Australian government, with the rest from the Australian Rail Track Corporation (ARTC), grants and public-private partnerships.[73]

Since 2019, Australia has increased its ambition on alternative fuels, such as hydrogen and sustainable aviation fuels.

- Australia established a Sustainable Aviation Fuel (SAF) Council in October 2022, modelled on the United Kingdom's Jet Zero Council.[74] Australia's flag carrier, the Qantas Group, is committed to using 10% SAF by 2030 and achieving net zero emissions by 2050.[75]
- Australia's National Hydrogen Strategy 2019 sets out actions for building the hydrogen industry and considers transport as a key potential use sector.[76] The country's National Freight and Supply Chain Strategy 2019 sets an agenda for co-ordinated and well-planned government and industry action across all freight modes over the next 20 years and beyond.[77] The emphasis is on economic objectives and building Australian competitiveness; some decarbonisation could occur through operational efficiencies and inter-modality, but no targets for freight decarbonisation have been set.[78]

National and sub-national governments in Oceania have made net zero pledges in the transport sector, including for land, maritime and air transport.

- In 2019, the Pacific Blue Shipping Partnership was jointly launched by Fiji and the Marshall Islands – with partnerships with Samoa, Solomon Islands, Tuvalu and Vanuatu – to raise ambitions to decarbonise respective shipping sectors and achieve net zero carbon by 2050.[79]
- In 2020, Marshall Islands set the objectives of reducing domestic shipping emissions 40% by 2030 and fully decarbonising the sector by 2050.[80] Kiribati, Marshall Islands and Solomon Islands have been influential within the International Maritime Organization in advocating for scaled-up ambition in decarbonising shipping.[81]
- In 2022, members of the Pacific Islands Forum endorsed the 2050 Strategy for the Blue Pacific Continent with the key transport ambition to increase regional connectivity.[82]
- Australia legislated targets In 2022 to reduce emissions 43% below 2005 levels by 2030 and to achieve net zero emissions by 2050, which covered a broad range of climate and energy policy, funds and sectoral-focused policies including transport.[83]
- Most states and territories in Australia have set targets for the uptake of zero-emission vehicles, which taken together would be equivalent to a target for 46% new zero-emission car sales by 2030.[84] Most states and territories have adopted financial incentives for the purchase of zero-emission vehicles, such as waiving stamp duty and registration fees, as well as investments in electric vehicle charging infrastructure.[85]
- All states and territories in Australia are shifting to zero-emission bus fleets, with specific targets in the Australian Capital Territory, New South Wales, Queensland and Victoria (*see Table 1*).[86] Tasmania, Western Australia, South Australia and the Northern Territory have been undertaking trials and investigations.[87]

Climate action in New Zealand is being realised through comprehensive planning approaches, active mobility and support for public transport at the national and local levels.

- New Zealand's Decarbonising Transport Action Plan 2022-2025 sets out four transport targets to support the goal of reducing transport emissions 41% below 2019 levels by 2035: 1) reduce total kilometres travelled by the light fleet 20% by 2035 through improved urban form and providing better travel options, particularly in the largest cities; 2) increase zero-emission vehicles to 30% of the light fleet by 2035; 3) reduce emissions from freight transport 35% by 2035; and 4) reduce the emissions intensity of transport fuel 10%.[88]

- In 2022, Auckland Council's Environment and Climate Change Committee adopted the Transport Emissions Reduction Pathway, to support and enable Te Tāruke-ā-Tāwhiri's required 64% reduction in transport emissions.[89]
- In New Zealand in 2022, Wellington City Council approved a new long-term cycling plan, Paneke Pōneke Bike Network, aimed at expanding cycling networks to connect suburbs to the city centre.[90]
- New Zealand halved public transport fare rates for several months in 2022 in response to the soaring petrol prices resulting from the Russian invasion of Ukraine.[91]

The Nationally Determined Contributions (NDCs) submitted by Oceania countries under the Paris Agreement as of 2022 offer a wide-ranging set of climate change mitigation and adaptation activities. Only five countries in the region (Australia, Fiji, Marshall Islands, New Zealand and Tonga), or 33%, had submitted Long-Term Strategies under the Paris Agreement as of the end of 2022.[92]

- Samoa was the only country in the region with a target for transport greenhouse gas mitigation in its second-generation NDC.[93]
- The NDCs of Pacific islands target improvements in shipping. Kiribati intends to develop a national maritime action plan and to introduce small and efficient freight and passenger ships; the Federated States of Micronesia will update existing vessels with renewable energy power sources and secure additional vessels for transport between islands and for emergency response operations; and Solomon Islands will promote renewable and energy efficient technologies for water and land transport.[94]
- Germany's Agency for International Cooperation (GIZ) has administered the Regional Pacific NDC Hub to support Pacific Island countries in reviewing, enhancing and implementing their climate commitments, including identifying opportunities to bring the transport sector to the fore and to connect climate ambitions at the national and local levels.[95] The Hub – implemented in partnership with the Global Green Growth Institute, the Pacific Community and the Secretariat of the Pacific Regional Environment Programme – served 14 member countries as of early 2023: Cook Islands, Fiji, Kiribati, Marshall Islands, the Federated States of Micronesia, Palau, Papua New Guinea, Nauru, Niue, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.[96]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- The **Asia LEDS Partnership (ALP)** is a voluntary regional network comprising individuals and organisations from the public, private and non-governmental sectors that are active in designing, promoting and/or implementing Low Emission Development Strategies (LEDS) in the Asia-Pacific region (including Australia and New Zealand).[97]
- **Climateworks Centre** bridges research and action to achieve the system-level transitions required to reach net zero emissions across Australia, Southeast Asia and the Pacific. It was co-founded by the Myer Foundation and Monash University in 2009 and works within the non-profit Monash Sustainable Development Institute.[98]
- The **Pacific Islands Development Forum (PIDF)**, headquartered in Suva (Fiji), is a regional organisation aimed at supporting sustainable development in the Pacific Islands.[99] In 2019, the PIDF declared the "Pacific Decade for Sustainable Transport 2020-2030" to accelerate a transition to sustainable, low carbon transport in the region.[100]
- The **United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)** supports inclusive, resilient and sustainable development in Oceania by generating action-oriented knowledge, and by providing technical assistance and capacity building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.[101] ESCAP Member States in the Pacific cover Australia, Fiji, Kiribati, Marshall Islands, the Federated States of Micronesia, Nauru, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu, as well as associate members American Samoa, Cook Islands, French Polynesia, Guam, New Caledonia, Niue and the Northern Mariana Islands.[102]
- **UITP Asia-Pacific** is the regional network of the International Association of Public Transport (UITP) in Asia and the Pacific, with more than 200 members from 14 different territories working together to foster knowledge and exchange insights between public transport practitioners for better transport developments.[103] In 2023, for example, a training on transit-oriented development with the Land Transport Authority Singapore educated authorities and planners about integrated urban mobility and land-use practices.[104]
- The **United Nations Centre for Regional Development (UNCRD)** strives to promote sustainable regional development in developing countries with a focus on development planning and management in the context of globalisation and decentralisation trends. UNCRD's Environment Unit is focusing on three urban priorities, including sustainable transport.[105]
- The **United Nations Conference on Trade and Development (UNCTAD)** helps emerging economies

access the benefits of a globalised economy more fairly and effectively – through analysis, facilitating consensus building, and offering technical assistance – to help them use trade, investment, finance and technology as vehicles for inclusive and sustainable development.[106] UNCTAD has active projects in several small-island countries such as Fiji, Papua New Guinea, Solomon Islands and Vanuatu.[107]

- The **United Nations Development Programme's (UNDP) Pacific Office** in Fiji serves 14 countries to advance the Global 2030 Agenda and help countries meet the SDGs, including SDG 7 on affordable and clean energy. UNDP is guided by a Sub-regional Programme Document for the Pacific Island Countries and Territories 2018-2022, which in turn contributes to the achievement of an overarching UN system-wide Pacific Strategy.[108]

3

Climate and Sustainability Responses in Transport Sub-Sectors and Modes

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Contents

3.1	Integrated Transport Planning	200
3.2	Walking	216
3.3	Cycling	228
3.4	Shared Mobility	244
3.4.1	Public Transport	245
3.4.2	Informal Transport	261
3.4.3	App-Driven Shared Transport	277
3.5	Rail	287
3.6	Road Transport	299
3.7	Aviation	313
3.8	Shipping	323

List of Figures

Integrated Transport Planning

Figure 1. Modal split of passenger transport in selected cities, by transport mode, 2022 . . . 206
Figure 2. Average perceived increase in transport costs across 30 countries, 2021 . . . 209
Figure 3. Sustainable transport hierarchy . . . 211
Figure 4. Active and planned low-emission zones in Europe, 2019, 2022 and 2025 . . . 212
Figure 5. Implemented and planned zero-emission zones and variants as of July 2022 . . . 214

Walking

Figure 1. Average percentage of urban population with convenient access to public transport . . . 221

Cycling

Figure 1. Active travel time per capita by gender for all age groups combined, in selected cities . . . 235

Public Transport

Figure 1. Public transport ridership in selected countries as a percentage of pre-COVID-19 levels, and the number of infected individuals from February 15, 2020 to October 15, 2022 . . . 249
Figure 2. Growth of major public transport systems by region, 2010-2021 . . . 251
Figure 3. Emissions from public transport (including buses, rails, subways and trams) versus other modes (automobiles and motorcycles) in selected cities, 2018-2021 . . . 254
Figure 4. Modal share of selected cities, by total number of trips, 2021 . . . 255
Figure 5. Snapshots of public transport closure policies on June 30 of 2020, 2021 and 2022 . . . 256
Figure 6. Allocation of green stimulus funding, March 2020 to February 2021 . . . 258
Figure 7. Number of initial and updated Nationally Determined Contributions that included public transport, as of end-2022 . . . 259

Informal Transport

Figure 1. Market shares of informal transport in 30 cities among motorised trips, selected years . . . 265
Figure 2. Share of road-based motorised trips made by informal transport services in six African cities, selected years . . . 266
Figure 3. Common informal transport modes and local names for these services in Africa . . . 267
Figure 4. Estimated modal shares of informal transport in commuting trips in six Asian cities . . . 268
Figure 5 . Common informal transport modes and local names for these services in Asia . . . 268
Figure 6. Common informal transport modes and local names for these services in Latin America and the Caribbean . . . 269
Figure 7. Estimated modal shares of informal transport in cities in Latin America and the Caribbean . . . 270
Figure 8. Motorised collective transport vehicle fleets in different cities in Latin America and the Caribbean, 2020 . . . 270

App-Driven Shared Transport

Figure 1. Number of bike-sharing systems worldwide, 1995-2022 . . . 281
Figure 2. Number of cities with dockless shared micromobility operations, 2019-2022 . . . 281
Figure 3. Estimated life-cycle greenhouse gas emissions per passenger-kilometre, by urban transport mode . . . 284

Rail

Figure 1. Passenger rail activity by region, 2010-2020 . . . 291
Figure 2. Freight rail activity by region, 2004-2020 . . . 291
Figure 3. Length of rail lines by region, 2010-2020 . . . 293
Figure 4. High-speed rail development in selected countries/regions, 2010-2021 . . . 293
Figure 5. Status of global high-speed rail network by country/region, as of 2021 . . . 294
Figure 6. Increases in rail modal share due to high-speed rail . . . 294
Figure 7. CO_2 emissions intensity of global rail, 2000-2020 . . . 295
Figure 8. Energy use in the rail sector by source, 2021 and projections for 2030 . . . 296
Figure 9. Share of electrified rail lines by region, 2011-2020 . . . 297

Road Transport

Figure 1. Average crude oil price globally, 2011-2022 . . . 303
Figure 2. Motorisation rates by region, 2020 . . . 304
Figure 3. Automobile vehicle sales (passenger and commercial) by region, 2015-2022 . . . 305
Figure 4. Top 10 cities where people spent the most time in traffic, 2022 . . . 306
Figure 5. CO_2 emissions from road transport, by vehicle type, 2000-2020 (in million tonnes CO_2) . . . 308
Figure 6. Per capita CO_2 emissions from road transport in countries globally, 2021 (in kilograms) . . . 308
Figure 7. Required emissions intensity pathway to 2050 according to the International Energy Agency's Net Zero scenario . . . 309

Aviation

Figure 1. Demand trends for international air travel, January 2021 to March 2022 . . . 317
Figure 2. Relative emissions of different classes of airline services from London to New York . . . 318
Figure 3. Energy intensity of domestic (top) and international (bottom) passenger aviation, 2000-2021 and projections to 2030 under a net zero scenario . . . 319
Figure 4. Scenarios for CO_2 emission mitigation from aviation, 2020-2050 . . . 319
Figure 5. Decarbonisation scenarios under the International Civil Aviation Organization's long-term aspirational goal of 2022 . . . 320

Shipping

Figure 1. Container shipping fleet deployment of selected countries (by capacity in 20-foot equivalent units), 2018 to mid-2022 . . . 327
Figure 2. Shares of fossil fuels in international shipping and shipping vessel propulsion, as of March 2023 . . . 327
Figure 3. Rising costs of shipping, 2019 to mid-2022 (in USD per day) . . . 328
Figure 4. Inland waterway freight transport activity in the European Union, 2011-2021 . . . 329
Figure 5. Monthly emissions from international shipping, 2019-2022 . . . 330
Figure 6. CO_2 emissions from the world's commercial shipping fleet, 2012-2022 . . . 330
Figure 7. Greenhouse gas emissions per million tonne-kilometres, by transport mode, 2019 . . . 331
Figure 8. Proportion of fuel strategies in industry commitments on maritime shipping decarbonisation, as of 2022 . . . 333

List of Tables

Integrated Transport Planning

Table 1. Selected indicators for sustainable, integrated transport systems . . . 205

Walking

Table 1. Countries with walking policies, by region and income level . . . 219
Table 2. Average time spent walking and cycling, by region and top countries . . . 220
Table 3. Walking safety, by region and top countries . . . 220
Table 4. Walking comfort, by region and top countries . . . 222

Cycling

Table 1. Cycling behaviour and characteristics of cyclists for urbanised areas across selected countries (listed in descending order by cycling modal share), 2021 . . . 232
Table 2. Cycling behaviour and characteristics of cyclists in selected cities (listed in descending order by cycling modal share), 2021 . . . 233
Table 3. Share of women represented in urban cycling modal share, by age, 2021 . . . 237

Public Transport

Table 1. Transport policy responses to COVID-19 in selected cities, 2020 . . . 257

Informal Transport

Table 1. Example policy measures and strategies to improve informal transport and include it in climate action . . . 273

Rail

Table 1. Status of high-speed rail lines, by region, as of 2021 (in kilometres) . . . 292

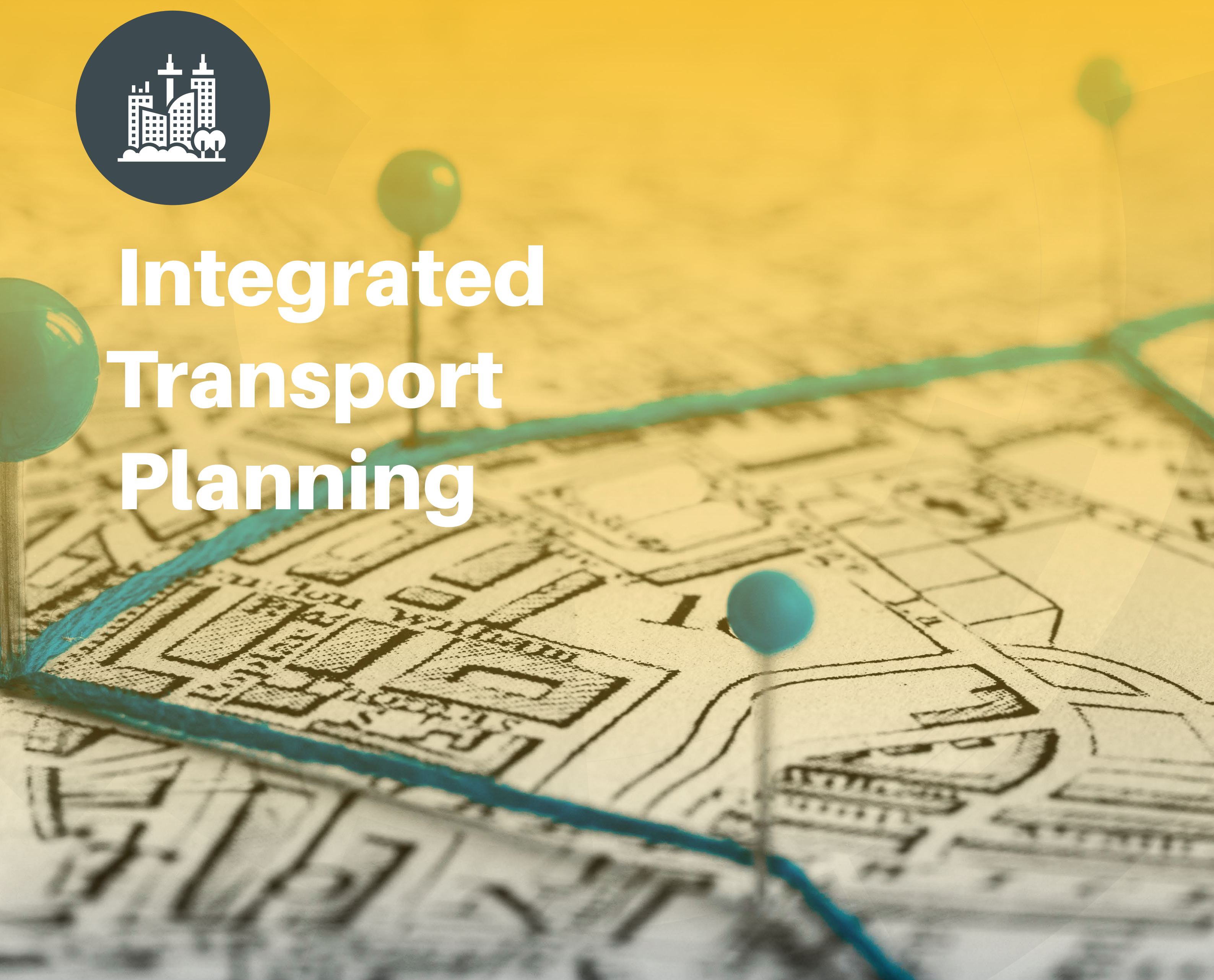
MODULE 3 3.1

LEAD AUTHOR:
Hannah E. Murdock, *Imperial College London*

SUPPORTING AUTHOR:
Tokam Cabrel, *SLOCAT Secretariat*

CONTRIBUTOR:
Todd Litman, *Victoria Transport Policy Institute*

Integrated Transport Planning



SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- While transport system performance has historically been evaluated based on automobile travel conditions, a new paradigm is emerging that is based on access – or people's ability to reach goods, services and activities.
- The shares of passenger transport modes vary depending on location. Some cities have prioritised more sustainable modes through a variety of measures and investment.
- With the onset of the COVID-19 pandemic, public transport ridership fell sharply, while the use of other transport modes increased, as did working from home.
- The modal split for freight transport was not as affected during the pandemic, although this varied by location. Cargo bikes are increasingly seen as a more sustainable alternative for delivery vans in many cities.
- Pandemic-related mobility restrictions and higher fuel prices following the Russian Federation's invasion of Ukraine contributed to changes in travel behaviour during 2020-2022, particularly teleworking and ride-hailing.
- Time spent commuting each day can reveal the degree of efficiency within a transport system, encompassing distances, connectivity, reliability and availability of transport options. Average commute times vary highly between and within countries.
- By 2021, traffic congestion had returned to pre-pandemic levels in many cities, although globally it was still 10% lower than in 2019, with peak-hour traffic also declining.
- The implementation of accessibility measures has been fragmented and often incomplete. Such measures include inclusive accessibility to public transport for diverse users, such as the elderly and people with disabilities or difficulties and other special needs. People of different genders often have different transport needs and face varying concerns and constraints, which are often heightened in low- and middle-income countries.
- In a 2021 index analysing major cities around the world, London, Madrid, and Paris were ranked the top cities for transport availability. The top cities for improving transport availability between 2018 and 2021 were Beijing, Moscow, Madrid, Milan and Tokyo.
- Transport expenditures often make up a high share of household budgets, and freight costs vary widely, placing a burden on low-income users in particular. Among low- and middle-income regions, Latin America and the Caribbean reported the highest share of household spending on transport, at 17% as of 2019. In parts of Africa, higher freight costs are due to the low quality of infrastructure, poor regional connectivity, and inefficient logistics, among other issues
- Increased fuel prices and inflation in recent years have had only a minor impact on distances travelled but have placed a growing financial burden on drivers and operators of transport services.
- As of early 2023, London remained the world's most expensive city for public transport fares, while several other cities were offering free public transport to make it more affordable and to reduce private vehicle trips.

Emission trends

- The implementation of integrated transport planning has been shown to play an important role in reducing transport emissions and minimising the use of resources.
- Due mainly to the impacts of the COVID-19 pandemic, transport experienced the greatest decline in carbon dioxide (CO_2) emissions (13%) in 2020 among combustion sectors, although it also showed the strongest rebound in 2021. Estimates for 2022 indicate that CO_2 emissions from ground transport (road and rail) nearly recovered to pre-pandemic levels, whereas aviation emissions (domestic and international) were still 20% below 2019 levels.
- To reduce emissions and pollution and to improve air quality, several cities and countries around the world have deployed low-emission zones (LEZs), ultra-low-emission zones (ULEZs) and zero-emission zones (ZEZs) in recent years. In some cases, these zones apply specifically to freight vehicles.
- Transit-oriented development is in place in many regions, as decision makers recognise that encouraging the use of public transport and active travel can greatly reduce transport emissions. The 2022 Sixth Assessment Report from the Intergovernmental Panel on Climate Change highlighted the potential of public transport-focused development and mixed land use to reduce greenhouse gas emissions 23-26% by 2050.

Policy developments

- A sustainable transport hierarchy can be helpful in integrated transport planning and policy making, as it prioritises planning and investment decisions to favour sustainable modes over expensive and resource-intensive modes that often dominate in automobile-centric models.
- Effective and cost-efficient strategies to reduce transport emissions rely on a mix of policies. In a growing number of cities, measures to promote sustainable modes of transport and to reduce the negative impacts of urban mobility have been encapsulated and expanded on in sustainable urban mobility plans (SUMPs). By the end of 2022, the MobiliseYourCity Partnership had supported the preparation of 31 SUMPs and 9 NUMPs (national urban mobility plans).
- Supporting the objectives of SUMPs, transit-oriented development has advanced through policy and funding measures in recent years. As of late 2022, the Indian cities of Chandigarh, the Pune Municipal Corporation and Navi Mumbai had successfully implemented transit-oriented development in their urban planning masterplans. The US government announced USD 13.1 million in grants in late 2022 to help cities plan for transit-oriented development.
- Some national and sub-national governments have set vehicle travel reduction targets and in some cases require that all major transport and land-use planning decisions support these targets. Many more jurisdictions have adopted targeted bans on sales of internal combustion engine vehicles.
- The number of active LEZs in Europe increased 40% between 2019 and 2022 and is projected to grow another 58% by 2025. Developments in LEZs elsewhere have been less extensive. By mid-2021, several dozen cities had implemented or planned to implement ZEZs or near-ZEZs, mostly in Europe but also in China and India. Some cities have chosen to establish specific zero-emission zones for freight transport (ZEZ-Fs), ranging from urban delivery vans to medium- and heavy-duty trucks.

Overview

Integrated transport planning supports and connects various types of travel to maximise the efficiency of moving goods and people and to address other aspects, such as equity. The concept of integrated transport planning has received increasing attention in recent years, particularly as the COVID-19 pandemic created an opportunity to rethink transport in cities. Whereas conventional, mostly automobile-centric transport systems have been fragmented, often with low efficiency and reliability, governments and the private sector have pursued a variety of improvements to create more seamless and integrated systems, particularly in locations where public transport and active travel compete with private vehicles.[1]

Integrated land-use and transport planning seeks to achieve a sustainable transport system through:

- prioritising the needs of all users, ensuring equity within and between generations;
- permitting basic needs of individuals and society to be achieved safely;
- ensuring affordability, efficiency and choice of transport modes;
- promoting sustainable transport options that support human and ecosystem health;
- optimising land use, minimising noise production, and limiting emissions, waste and use of non-renewable resources; and
- facilitating the creation of a vibrant and sustainable economy.[2]

While transport system performance has historically been evaluated based on automobile travel conditions, a new paradigm is emerging that is based on access – or people's ability to reach goods, services and activities.[3] In an integrated transport system, the arrangement of transport infrastructure is key to ensuring access[i], and improving access and mobility is key for poverty reduction and increased participation in economic and social activities.[4] Moreover, while many plans for reducing transport emissions have focused mainly on "clean" vehicles and fuels and investing in related subsidies – essentially maintaining an automobile-centric approach – studies have shown that these measures alone cannot achieve emission reduction targets.[5] Rather, prioritising measures that lead to avoiding unnecessary trips and shifting to more sustainable modes can maximise emission reductions and wider sustainability benefits.[6]

As a result, many plans are starting to give greater consideration to vehicle-travel reduction strategies as part of more people-centred holistic approaches aimed at satisfying the mobility needs of people and cities and achieving a better quality of life. At the local level, such strategies are often contained in sustainable urban mobility plans (SUMPs) – strategic frameworks designed to improve quality of life by addressing major challenges related to urban transport.[7] Similarly, sustainable urban logistics plans (SULPs) focus on city-level logistics to achieve sustainable freight operations in overall urban mobility planning.[8] At the country level, national urban mobility policies and investment programmes (NUMPs) serve as strategic frameworks to enhance the capabilities of cities to meet their mobility needs in a sustainable way.[9]

A variety of other planning tools are available to decision makers to address the interconnections between transport, land use and other factors to support the creation of sustainable transport systems, including:

- **Transit-oriented development** – the creation of compact, walkable, pedestrian-oriented, mixed-use communities centred around high-quality public transport systems.[10]
- **Complete streets** – an approach to planning, designing, building, operating and maintaining streets that enable safe access for all people who need to use them, including pedestrians, cyclists, motorists and public transport riders of all ages and abilities.[11]
- **Low-, ultra-low and zero-emission zones** – areas where access for more-polluting vehicles is restricted.[12]
- **Transport demand management incentives** – various policies and programmes that encourage travelers to use the most efficient option for each trip.[13]
- **Safe system approach** – designing the road system to account for human error and vulnerabilities to avoid injury and death.[14]
- **Parking policy reforms** – reducing parking mandates and pricing parking more efficiently so motorists pay directly for using parking facilities, with higher prices at peak times and locations.[15]

i The report uses the term "access" to refer to access to goods, opportunities and services, while "accessibility" (often "universal accessibility") looks at the degree to which a location can be reached from or by other different locations and used in a safe and equitable way by all users.

Demand trends

A basic planning principle is that "what gets measured gets managed". It is therefore important to select and track appropriate sustainable transport performance indicators that reflect specific needs and objectives. Most conventional transport performance indicators reflect an automobile-centric paradigm, evaluating transport performance based primarily on traffic speeds, delays and crash rates; however, indicator sets are evolving to include and prioritise additional factors, in line with more sustainable and integrated transport planning.

Table 1 summarises transport performance indicators that reflect economic, social, and environmental objectives, including some that are most important, and others that may be appropriate in some situations.[16] Many of these indicators are discussed below, based on data availability.

In an integrated transport system, modes compete or complement each other depending on costs, access, reliability, speed, safety, comfort and other factors.[17] However, many current policies and planning practices tend to favour private automobile travel over other more affordable, inclusive and resource-efficient modes.

Commonly used transport statistics tend to undercount active travel, which is typically far more common than most statistics indicate (*see Section 3.2 Walking and Section 3.3 Cycling*). Most travel surveys overlook or undercount non-commute trips, longer trips, travel by children, recreational travel, and the walking and cycling links of automobile and public transport trips. For example, a three-stage commute that involves biking, public transport and walking is generally coded as simply a public transport trip, and the trips between parked vehicles and destinations are ignored even if they involve several blocks of walking on public streets. Thus, if walking and cycling are recorded as having commute modal shares of 5-10%, the actual shares may be more like 10-30% of total trips.[18]

The shares of passenger transport modes vary depending on location. Some cities have prioritised more sustainable modes through a variety of measures and investment (*see Policy Developments section*).

- Cities with the highest shares of private car use included Tshwane and Cape Town (South Africa) and Auckland (New Zealand), with shares well over 80% as of 2022.[19]
- In 2022, as many as 47% of trips in London (UK) and Paris (France) were accomplished through walking, while Zurich (Switzerland) and Tokyo (Japan) had the highest shares of public transport (35% and 28%, respectively) (see Figure 1).[20]

With the onset of the COVID-19 pandemic, public transport ridership fell sharply, while the use of other modes increased, as did working from home.

- In the European Union (EU), the share of people using public transport fell from 17.5% in 2019 to 12.8% in 2020.[21]
- The share of public transport trips in the United Kingdom declined from 13% in 2019 to 5% in 2020, with rail the hardest hit.[22] Transport by car, van and taxi increased from 85% to 92.5%, while cycling grew more modestly from 1% to 1.4%.[23]
- In the United States, public transport use fell from an already low share of under 5% in 2019 to 3.2% in 2020 and 2.5% in 2021.[24] However, the share of people driving alone also fell, from 76% in 2019 to 69% in 2020 and 68% in 2021; meanwhile, working from home increased from 6% in 2019 to 16% in 2020 and 18% in 2021.[25]

The modal split for freight transport was not as affected during the pandemic, although this varied by location (*see Spotlight 4 The Role of Companies in Decarbonising Global Freight and Logistics*).[26] **Cargo bikes are increasingly seen as a more sustainable alternative for delivery vans in many cities** (*see Section 3.3 Cycling*).

Pandemic-related mobility restrictions and higher fuel prices following the Russian Federation's invasion of Ukraine contributed to changes in travel behaviour during 2020-2022, particularly teleworking (telecommunications used as a substitute for physical travel, including telecommuting, on-line schooling, e-shopping and e-medicine) and ride-hailing.[27] Studies indicated that the benefits of telecommuting in reducing work-related travel (and therefore emissions) could be offset by counter-effects, such as increased private travel and non-work-related energy use.[28] Also, a divide between income groups became more apparent across several regions during the pandemic, as people in more affluent urban areas could more easily telework and have goods delivered.[29] However, teleworking can contribute to integrated transport planning objectives of decreasing the need for motorised travel.

- A study of 100 countries found that 40-60% of workers were working from home during March-May 2020.[30] In mid-April 2020, trips to workplaces in all regions fell 40%, with a particularly large decline in high-income countries, possibly due to the higher availability of teleworking arrangements.[31]
- A US study estimated that teleworking saved 60 million hours per workday by eliminating daily commuting and found that 45% of employees stayed in remote or hybrid working arrangements through at least late 2020.[32]
- In Africa, organisations and businesses began revising their practices to accommodate remote work, although not as quickly as in other regions.[33] In Nigeria, announcements for remote working positions increased steadily in the year following the onset of the pandemic.[34] As of early 2022, an estimated 42% of African employees were working remotely at least one day a week.[35]

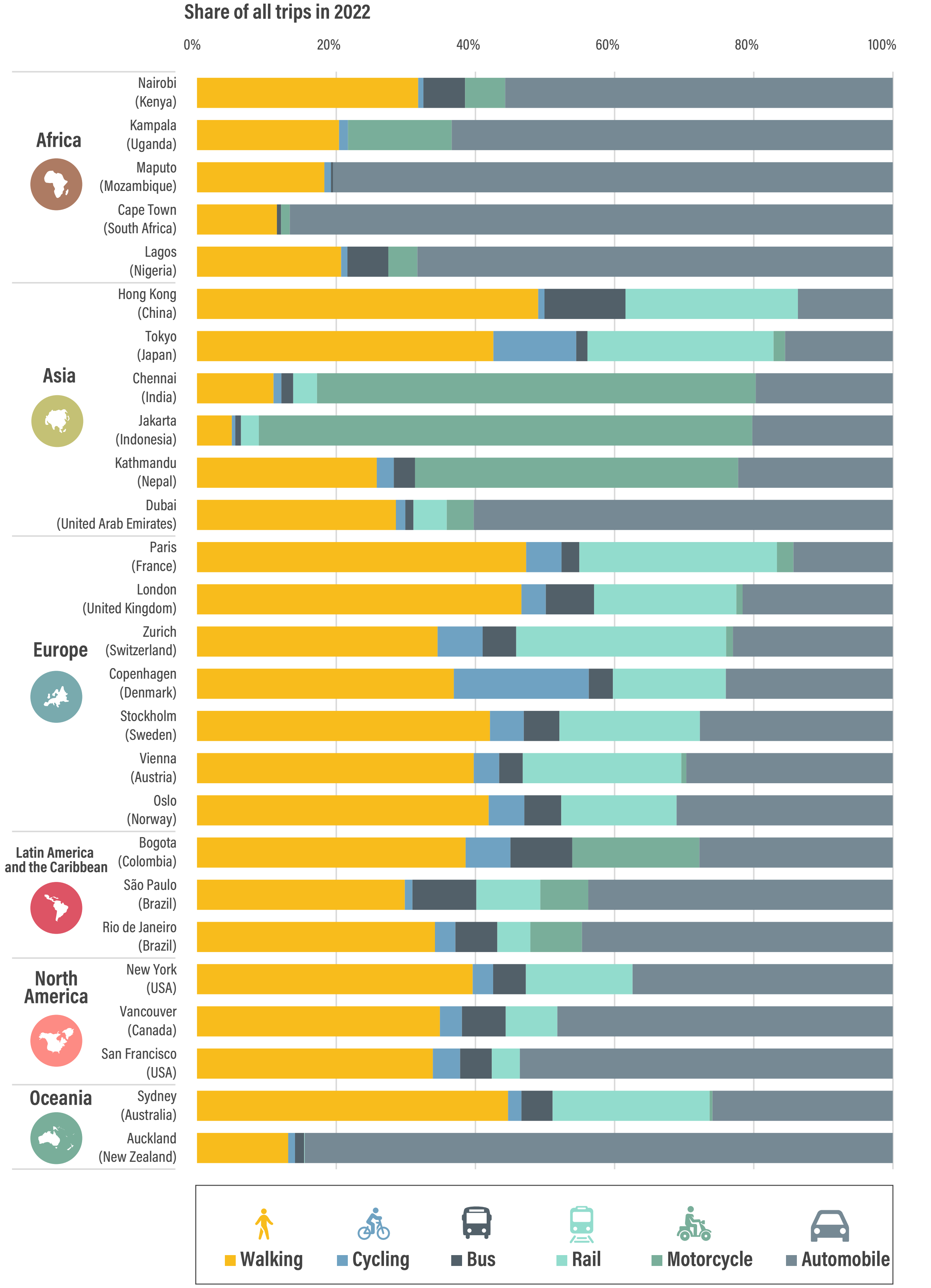
TABLE 1. Selected indicators for sustainable, integrated transport systems

Source: See endnote 16 for this section.

	Economic	Social	Environmental
Most important (should usually be used)	Personal mobility (annual person-kilometres and trips) and vehicle travel (annual vehicle-kilometres), by mode (active, automobile and public transport)	Trip-to-school mode share (active transport is desirable)	Per capita energy consumption, by fuel and mode
	Freight mobility (annual tonne-kilometres) by mode (truck, rail, ship and air)	Per capita traffic crash and fatality rates	Energy consumption per freight tonne-kilometre
	Land-use density (people and jobs per unit of land area)	Quality of transport for disadvantaged people (disabled, low income, children, etc.)	Greenhouse gas emissions
	Average commute travel time and reliability	Affordability (portion of household budgets devoted to transport, or combined transport and housing)	Air pollution emissions (various types), by mode
	Average freight transport speed and reliability	Overall transport system satisfaction rating (based on objective user surveys)	Air and noise pollution exposure and health impacts
	Per capita congestion costs	Universal design (transport system quality for people with disabilities and other special needs)	Land paved for transport facilities (roads, parking, ports and airports)
	Total transport expenditures (vehicles, parking, roads and public transport services)		Stormwater management practices
Helpful (should be used if possible)	Quality (availability, speed, reliability, safety and prestige) of non-automobile modes (walking, cycling, ride-sharing and public transport)	Portion of residents who walk or cycle sufficiently for health (15 minutes or more daily)	Community livability ratings
	Number of public services within 10-minute walk, and job opportunities within 30-minute commute of residents	Portion of children walking or cycling to school	Water pollution emissions
	Portion of households with internet access	Degree cultural resources are considered in transport planning	Habitat preservation in transport planning
		Housing affordability in accessible locations	Use of renewable fuels
		Public transport affordability	Transport facility resource efficiency (such as use of renewable materials and energy-efficient lighting)
			Impacts on special habitats and environmental resources
Planning process	Comprehensive (considers all significant impacts, using best current evaluation practices, and all suitable options, including alternative modes and demand management strategies)		
	Inclusive (substantial involvement of affected people, with special efforts to ensure that disadvantaged and vulnerable groups are involved)		
	Based on *access* rather than *mobility* (considers land use and other factors)		
Market efficiency	Portion of total transport costs that are efficiently priced		
	Neutrality (public policies do not arbitrarily favour a particular mode or group) in transport pricing, taxes, planning, investment, etc. Applies *least cost planning*.		

FIGURE 1. Modal split of passenger transport in selected cities, by transport mode, 2022

Source: See endnote 20 for this section.



- A survey across 20 European cities revealed that, in most places, around a quarter or more of people were working from home more frequently in 2021 than pre-pandemic.[36] In Portugal and Ireland – where measures supporting teleworking were implemented – the highest shares of respondents who increased their teleworking frequency were in Lisbon, Porto and Dublin.[37]

For those not working from home, **time spent commuting each day can reveal the degree of efficiency within a transport system, encompassing distances, connectivity, reliability and availability of transport options. Average commute times vary highly between and within countries** depending on factors such as modal choice and infrastructure, among others.

- In India, the average daily commute time for travelling 5-10 kilometres in urban areas in 2019 was 27 minutes, with walking being the most common mode, followed by personal motorbike.[38]
- Italy had an average daily travel time of 58 minutes in 2019, which fell to 48 minutes in 2020, in part due to pandemic-related mobility restrictions.[39]
- The average time spent commuting in Japan in 2021 was 23 minutes per day for women and 38 minutes per day for men – levels that have been roughly stable for several decades.[40]
- In the United States, average commute times varied only slightly by region as of 2019, ranging from 25 minutes in the Midwest to 31 minutes in the Northeast.[41]
- In the United Kingdom, the average daily time spent travelling was 28 minutes as of 2020 but varied by transport mode.[42] The average commute by national rail took 63 minutes, other rail 49 minutes, bus 40 minutes, car or motorcycle 25 minutes, cycling 22 minutes and walking 16 minutes.[43]

Public transport reliability can play a role in commute time and is important in an integrated transport system to keep travel flowing smoothly. Some places have focused on greatly improving reliability. For example, Singapore's mass rapid transit network decreased the number of delays experienced from 15-16 per year in 2015-2017 to just 9 in 2018 and only 3 by 2021.[44]

By 2021, traffic congestion had returned to pre-pandemic levels in many cities, although globally it was still 10% lower than in 2019, with peak-hour traffic also declining.[45] However, as of 2022 traffic delays exceeded pre-pandemic levels in 39% of US and 42% of European urban areas.[46] Congestion has been shown to have significant economic and public health costs, which has led some jurisdictions to adopt congestion pricing.[47] (*See Section 3.6 Road Transport.*)

Many places have harnessed the potential of **digitalisation** to contribute to a more efficient and integrated transport system. Integrating multiple transport modes and services into a single, on-demand service with a unified payment system is referred to as **mobility-as-a-service** (MaaS).[48] MaaS has become increasingly popular since 2020, driven in part by pandemic-related developments and by growing government support for digital payment systems (see *Section 3.4.3 App-Driven Shared Mobility*).[49]

While "access" is the overall concept of allowing better access to goods, opportunities, and services, "accessibility" looks at the degree to which a location can be reached from or by other different locations and used in a safe and equitable way by all users. **The implementation of accessibility measures has been fragmented and often incomplete. Such measures include "inclusive accessibility" to public transport for diverse users, such as the elderly and people with disabilities or difficulties and other special needs (also called universal design).**[50]

- As of 2020, 98% of bus stations and 94% of light rail stations in US urban areas were deemed accessible, in compliance with the Americans with Disabilities Act (ADA).[51] Vehicle accessibility in the United States also has improved greatly in recent decades, with the share of accessible buses increasing from 51% in 1993 to 99% in 2020, light rail from 41% to 92%, and commuter rail from 32% to 82%.[52]
- In Canada, 92% of bus stations and 93% of rail stations met ADA standards as of 2018.[53] However, people with disabilities, difficulties or long-term conditions still reported facing many barriers related to transport during 2019-2021, with the biggest barriers being waiting in lines, finding information and making reservations on websites.[54]
- Train station accessibility in Paris (France) improved significantly between 2007 and 2017, with the number of stations accessible to people with reduced mobility growing from 73 to 173.[55] However, the city's subway system remains largely inaccessible.[56]
- By 2019, 92% of the subway system in Barcelona (Spain) was wheelchair accessible – covering 144 of its 157 stations – with a goal to reach 100% by 2024.[57]
- The public transport system in Seattle (USA) was deemed completely accessible by 2022.[58]

People of different genders often have different transport needs and face varying concerns and constraints, which are often heightened in low- and middle-income countries.[59] Women and girls face increased risk of harassment or personal safety concerns on public transport, as do transgender and non-binary people.[60] For rural households in the lowest-income countries, the burden of transport is estimated to be four times greater for women than men, and women carry an estimated 90% of the physical burden.[61] In low- and middle-income countries, walking remains the primary mode of travel for women (due to access and affordability), followed by cycling and animal-drawn carriages.[62] Even in urban areas, other modes are not inclusively accessible due to cost or inconvenient locations.[63]

- In a 2018 survey in India, women who owned a personal motor vehicle reported that they would be more likely to use public transport if it were more affordable (35% of respondents), had better coverage (27%), and were more comfortable (18%), more frequent (10%) and safer (6%).[64]
- A 2022 survey in Tirana (Albania) revealed that women are much more dependent than men on the bus system, particularly for getting to and from work.[65]
- In London (UK), more than 60% of transgender and non-binary people reported experiencing discrimination when using public transport in 2021.[66]
- Ensuring security in public transport can entail high costs. For example, security costs among public transport companies in France rose from a total of EUR 148 million (USD 158 million) in 2011 to EUR 200 million (USD 213 million) in 2020.[67]

An integrated transport system increases the availability of mobility options to improve access to jobs and services for all people.[68]

- In a 2021 index analysing 25 major cities around the world, London, Madrid and Paris were ranked the top cities for transport availability, with each having major railway connections, road networks, cycling lanes and pedestrian infrastructure.[69] The top cities for improving transport availability between 2018 and 2021 were Beijing, Moscow, Madrid, Milan and Tokyo.[70]
- As of 2020, more than 91% of Germany's population had easy access to public transport, measured by residences having a bus stop within a distance of 600 metres or a train within 1,200 metres and with at least 20 daily departures from the stop or station.[71]

Transport expenditures often make up a high share of household budgets, and freight costs vary widely, placing a burden on low-income users in particular. A sustainable integrated transport system must be accessible to users of all income levels.

- **Among low- and middle-income regions, Latin America and the Caribbean reported the highest share of household spending on transport, at 17% as of 2019**.[72]
- In the United Kingdom, transport costs had the highest share in average household expenditures in 2019, reaching an annual average of GBP 4,420 (USD 5,330); they also accounted for the largest share of the increase in average household spending between 2012 and 2019.[73]
- In the United States, annual household spending on transport was second only to housing in 2021, totalling an average of nearly USD 11,000 on transport.[74] Rural households tended to spend more on transport than urban households and had a higher share of transport in household budgets (17%, compared to 13% in urban areas), while low-income households had the greatest transport cost burden (27%, compared to 10% in the highest-income households).[75]
- In 2020, total consumer spending on transport was highest in the United States, at more than USD 1.2 million, followed distantly by China (USD 507,524), Germany (USD 246,730), Japan (USD 207,900) and Brazil (USD 165,356).[76]
- In West Africa and landlocked countries in Central Africa, freight transport costs are 1.5 to 2.2 times higher than in South Africa and the United States, **due to the low quality of infrastructure, poor regional connectivity, and inefficient logistics, among other issues**.[77]

Increased fuel prices and inflation in recent years have had only a minor impact on distances travelled but have placed a growing financial burden on drivers and operators of transport services (*see Section 3.6 Road Transport*).[78]

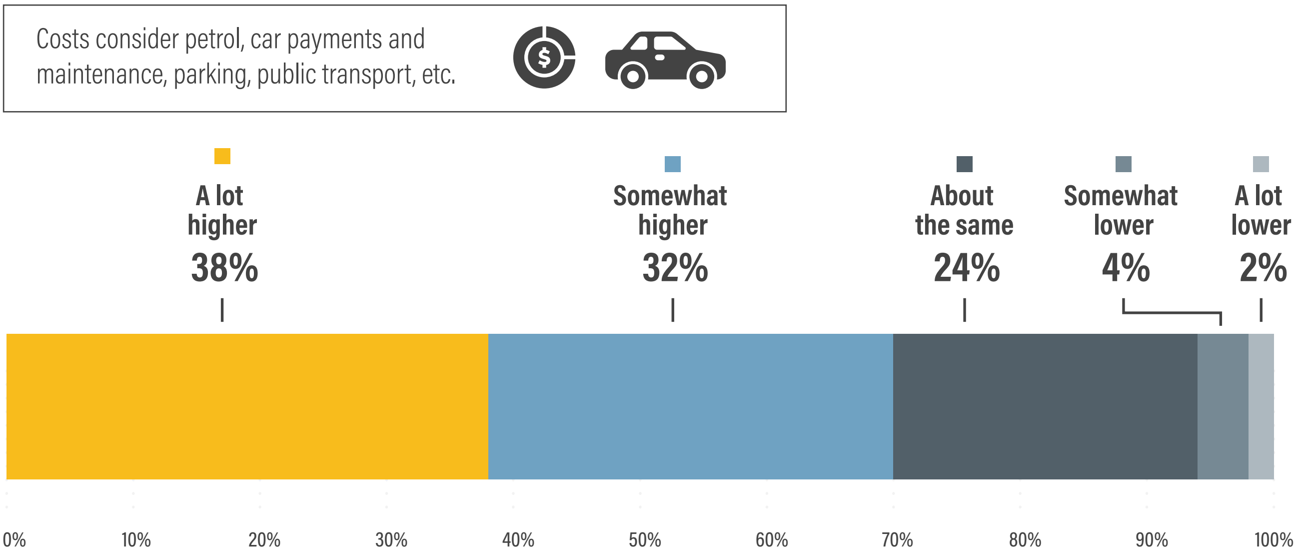
- In a survey of 20,000 people across 30 countries, 70% reported perceiving higher prices for fuel, car payments, vehicle maintenance, parking and public transport during a six-month period in 2021 (see Figure 2).[79] Prices were most often perceived to have increased in Latin America, Central and Eastern Europe, Türkiye, and South Africa, whereas Japan and China were least likely to have perceived price increases.[80]
- In 2022, Hong Kong (China) became the city with the most expensive fuel in the world, marking the highest prices globally for both petrol (USD 3.10 per litre) and diesel (USD 2.86 per litre) in August.[81] For diesel prices, Hong Kong overtook Norway, with the increased fuel costs reflecting factors such as high government taxes on fuel and the large numbers of cars on the road.[82]
- Venezuela remained the country with the lowest average fuel prices (USD 0.02 per litre) in 2022, as a result of the country's vast oil reserves and large government subsidies.[83]
- Transport costs continued to increase in 2023 in some places. In the United Kingdom, 73% of people surveyed reported an increase in fuel costs between 2022 and 2023, while 21% reported an increase in public transport costs.[84]

As of early 2023, London remained the world's most expensive city for public transport fares, while several other cities were offering free public transport to make it more affordable and to reduce private vehicle trips. Many places also have experienced recent steep increases in parking prices, which in one study were found to be correlated with higher use of public transport (*see Section 3.6 Road Transport*).[85]

- In 2023, London (UK) had the highest monthly ticket price for public transport globally, at USD 271, followed distantly by New York (USA) at USD 127, Toronto (Canada) at USD 116 and Melbourne (Australia) at USD 114.[86] Mumbai (India) was

FIGURE 2. Average perceived increase in transport costs across 30 countries, 2021

Source: See endnote 79 for this section.



among the cities with the lowest-cost monthly public transport passes in 2023 at USD 15.[87]

- London (UK) also ranked first in a 2018 study on the average cost of public transport use (bus, tram or metro), at USD 5.66, followed by Stockholm (Sweden) at USD 5.43, Copenhagen (Denmark) at USD 4.64 and Oslo (Norway) at USD 4.49.[88] The cities with the lowest average cost were Cairo (Egypt) at USD 0.11, followed by Kyiv (Ukraine) at USD 0.18, Mumbai (India) at USD 0.23, Jakarta (Indonesia) at USD 0.26 and Mexico City at USD 0.29.[89]
- Among the cities offering free public transport in 2023 were Valletta (Malta), Luxembourg and Tallinn (Estonia).[90]
- A 2021 study in the US state of California concluded that subsidies for public transport would be the most effective tool in reducing vehicle-kilometres travelled.[91]

Emission trends

Road transport, particularly passenger transport, accounts for the majority of transport energy demand and transport emissions.[92] (*See Section 4.1 Transport Energy Sources and Section 3.6 Road Transport.*) Moreover, as of 2021, fossil fuels continued to supply 96% of transport energy demand, a share that has remained virtually unchanged for a decade (despite greater use of biofuels and electric vehicles), due mainly to rising overall transport demand.[93]

The implementation of integrated transport planning has been shown to play an important role in reducing transport emissions and minimising the use of resources. At the same time, it is urgent to reduce the need for motorised travel and to shift to more sustainable fuels and transport modes.

Due mainly to the impacts of the COVID-19 pandemic, transport experienced the greatest decline in carbon dioxide (CO_2) emissions (13%) in 2020 among combustion sectors, although it also showed the strongest rebound in 2021.[94] Estimates for 2022 indicate that CO_2 emissions from ground transport (road and rail) nearly recovered to pre-pandemic levels, whereas aviation emissions (domestic and international) were still 20% below 2019 levels.[95] Transport CO_2 emissions vary greatly by region, with North America contributing the highest per capita levels (4.8 tonnes), followed by Oceania (2.4 tonnes) and Europe (1.6 tonnes) in 2021.[96]

Road vehicle size and type, as well as dependency on personal road vehicles, greatly influences emission levels, with larger vehicles typically having higher emission intensity, and hybrid and electric vehicles typically reducing emissions by one- to two-thirds depending on the fuel source.[97] Larger vehicles such as sport utility vehicles (SUVs) and trucks pose an increasing risk to decarbonisation, leading the International Energy Agency to recommend that the auto industry decrease vehicle size.[98] (*See Section 3.6 Road Transport and Section 4.2 Vehicle Technologies.*)

To reduce emissions and pollution and to improve air quality, several cities and countries around the world have deployed low-emission zones (LEZs), ultra-low-emission zones (ULEZs) and zero-emission[i] zones (ZEZs) in recent years. In some cases, these zones apply specifically to freight vehicles (*see Policy Developments section*). Although the primary aim often is to mitigate congestion and poor air quality, the zones also can lead to reduced CO_2 emissions and improved health and social equity.[99] However, deployment has faced public opposition, enforcement difficulties and challenges in establishing clear criteria for determining vehicle eligibility.[100] Nevertheless, use of such zones is seen as a big step towards improving urban air quality, and implementing cities have reported significant reductions in emissions.[101]

- In Europe, areas with LEZs have experienced reductions in nitrogen dioxide (NO_2) emissions of around 20%, and in some cases as high as 40%.[102] However, older zones based on the Euro 4 and 5 emission standards for diesel vehicles have seen fewer reductions, due mainly to the mismatch between the emissions for these vehicles in test conditions versus real-world use.[103]
- Madrid (Spain) reported a reduction in NO_2 concentrations of 15 micrograms per cubic metre after implementing its LEZ, targeting Euro 3 petrol and Euro 4 diesel vehicles.[104]
- In Germany, concentrations of particulate matter (PM_{10}) fell 15% in Munich and 10% in Berlin following a ban on pre-Euro 4 diesel and Euro 1 petrol vehicles.[105]
- An analysis of the LEZ in Lisbon (Portugal) reported reductions in both NO_2 concentrations (22%) and PM_{10} (29%).[106]
- In Glasgow (UK), the Scottish Environment Protection Agency noted that between 2018, when the city introduced its LEZ, and 2019, the number of hours where NO_2 concentrations exceeded 100 micrograms per cubic metre fell by nearly half.[107]
- In the ULEZ of London (UK), roadside NO_2 fell 44% compared to levels prior to the use of emission-based charging measures.[108]

i Limiting traffic to only vehicles that emit zero *tailpipe* emissions.

Transit-oriented development is in place in many regions, as decision makers recognise that encouraging the use of public transport and active travel can greatly reduce transport emissions.[109] The impact of transit-oriented development on emissions can be significant, as such development is typically designed to be compact, walkable and mixed-use to minimise the need for car ownership and use.

- The 2022 Sixth Assessment report from the Intergovernmental Panel on Climate Change highlighted the potential of public transport-focused development and mixed land use to reduce greenhouse gas emissions 23-26% by 2050.[110]
- The US government published a plan in early 2023 that features the role of transit-oriented development in reducing emissions and mitigating climate change.[111]
- A 2022 study in Dhaka (Bangladesh) highlighted that in low- and middle-income countries, a focus on public transport to fully capitalise on environmental benefits remains a challenge for planners.[112]

Policy developments

The COVID-19 pandemic brought significant challenges for the transport sector, including reductions in the number of people travelling, increased health and safety concerns, and economic impacts on transport operators. In response, governments around the world implemented a range of transport policy measures aimed at promoting sustainable modes of transport; enhancing public transport infrastructure, services and safety; reducing viral transmission; and encouraging active travel and remote working. Implementation of these measures has had far-reaching effects on how people travel – leading to more people-centred transport systems in many places – and will likely shape the future of transport for years to come.

A sustainable transport hierarchy can be helpful in integrated transport planning and policy making, as it prioritises planning and investment decisions to favour sustainable modes over expensive and resource-intensive modes that often dominate in automobile-centric models (see Figure 3).[113]

Effective and cost-efficient strategies to reduce transport emissions rely on a mix of policies. In Europe, for example, the policy combinations for decarbonising road transport are varied and have had equally varied results in reducing emissions.[114] The most successful combine carbon or fuel taxes with incentives for the purchase of cleaner vehicles and show that it is possible to reduce emissions by amounts consistent with EU zero-emission targets.[115] However, prioritising measures that incentivise active travel and public transport can maximise emission reductions and co-benefits, beyond what is possible from focusing on vehicles and fuels alone.[116] There is often latent demand for non-automobile travel modes, as those who would prefer to use other modes may be lacking alternative options where they live.[117]

FIGURE 3. Sustainable transport hierarchy

Source: See endnote 113 for this section.

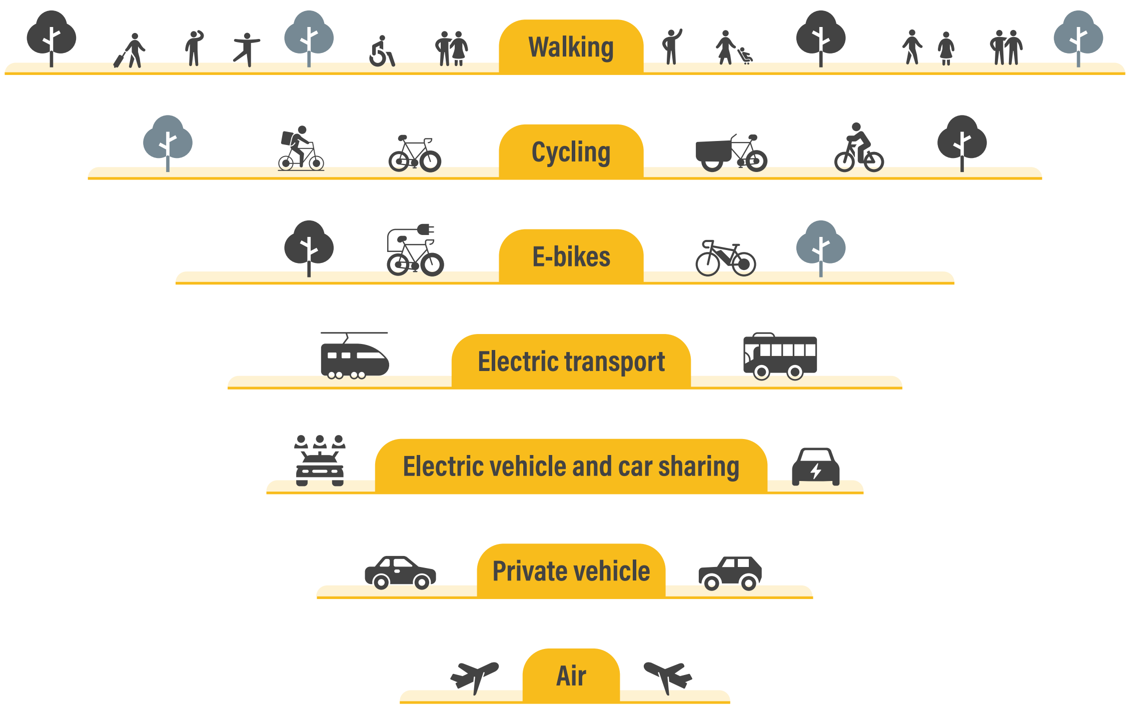
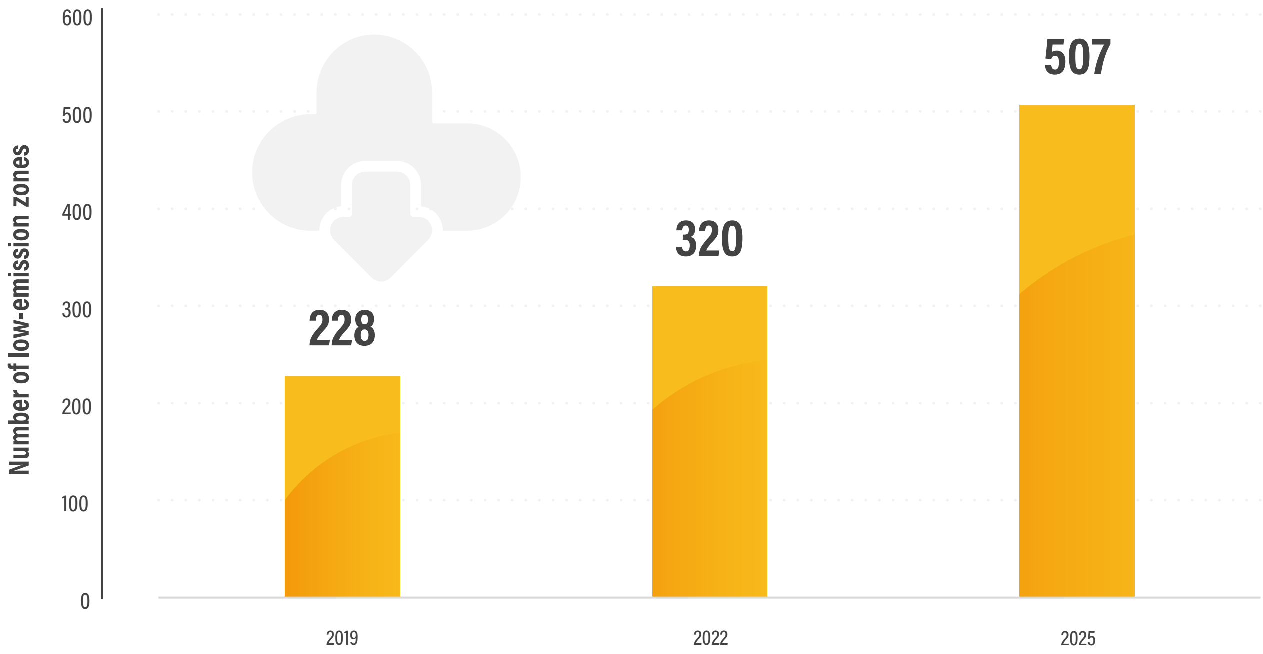


FIGURE 4. Active and planned low-emission zones in Europe, 2019, 2022 and 2025

Source: See endnote 133 for this section.



In a growing number of cities, measures to promote sustainable modes of transport and to reduce the negative impacts of urban mobility have been encapsulated and expanded on in sustainable urban mobility plans (SUMPs). These plans seek to make cities more liveable and environmentally friendly, with benefits including reduced carbon emissions and traffic congestion, and improved air quality and public health. By carefully balancing the needs of residents, businesses, and the environment, SUMPs can help cities become more sustainable and resilient in the face of growing urbanisation and climate change.[118]

- **By the end of 2022, the MobiliseYourCity Partnership had supported the preparation of 31 SUMPs and 9 NUMPs (national urban mobility plans)**, of which 16 SUMPs and 5 NUMPs were completed.[119] This included 12 SUMPs in Africa, 8 in Asia, 8 in Latin America and 3 in Eastern Europe, while NUMPs were prepared in 2 African countries, 2 in Asia and 5 in Latin America.[120]
- In Utrecht (Netherlands), the cycling action plan outlined in the city's SUMP helped create a strong cycling culture; Utrecht topped the Global Bicycle Cities Index in 2020 and 2022 and has ranked in the top three on the Copenhagenize Index of the world's most cycle-friendly cities since 2013.[121]
- A first application of the SUMP concept in China was launched in Foshan in 2021, with the goal of increasing the share of walking, cycling and public transport in the city from 52.1% in 2019 to 70% by 2035.[122]
- In early 2022, Istanbul (Türkiye) completed the country's first SUMP, which was also the first SUMP in a megacity globally, covering a population of nearly 16 million.[123]
- In Mexico, the Guadalajara Metropolitan Area launched the Metropolitan Emerging Mobility Strategy in 2021 as an update to its SUMP, with a focus on adjusting to the "new normal" after the pandemic.[124]
- In 2022, the Metropolitan Area of Medan (Indonesia) completed its SUMP, featuring a USD 3.2 billion investment plan for developing a modern public transport system for one of the country's largest metropolitan areas, with the goal of shifting 15% of trips to public transport.[125]
- Since adopting its SUMP in 2020, Tirana (Albania) has successfully implemented several actions, including extending and improving the bus network, providing financial and regulatory incentives for hybrid and electric taxis, and expanding cycling infrastructure.[126]

Supporting the objectives of SUMPs, transit-oriented development has advanced through policy and funding measures in recent years.

- **As of late 2022, the Indian cities of Chandigarh, the Pune Municipal Corporation and Navi Mumbai had successfully implemented transit-oriented development in their urban planning masterplans.**[127]
- **The US government announced USD 13.1 million in grants in late 2022 to help cities plan for transit-oriented development**, while the US state of California and British Columbia (Canada) revised laws to support it.[128]
- At the local level, Chicago (USA) passed legislation supporting transit-oriented development in a stated attempt to fight segregation and gentrification.[129]

Some national and sub-national governments have set vehicle travel reduction targets (as in New Zealand and Scotland) and in some cases require that all major transport and land-use planning decisions support these targets (as in California).[130] **Many more jurisdictions have adopted targeted bans on sales of internal combustion engine vehicles** *(see Section 4.2 Vehicle Technologies).* As of 2022, 23 countries had targets for 100% bans on sales of internal combustion engine vehicles – five of which also had targets for 100% renewable power – while several other jurisdictions had lower targeted shares.[131] *(See Section 3.6 Road Transport.)*

To spur the adoption of cleaner vehicles, many cities, particularly in Europe, either expanded or strengthened their low-emission zones (LEZ), implemented ULEZs or shifted completely to ZEZs as part of strategies for transport demand management during 2020-2022. To reduce resistance to these measures, some governments have introduced these zones incrementally and grown them progressively over time, either by increasing the strictness of policies or by expanding the geographic coverage. Ideally, governments should ensure that the zones support walkability and public transport for residents, and that businesses have access to safe, cost-competitive and low-emitting solutions for last-mile delivery.[132]

The number of active LEZs in Europe (the EU-27, United Kingdom and Norway) increased 40% between 2019 and 2022, from 228 to 320 zones (see Figure 4).[133] **By 2025, it is projected to grow another 58%** (to 507 zones), as laws mandating or supporting LEZs in France, Poland and Spain enter into force.[134]

- At least 27 of the LEZs in force in Europe as of 2022 were expected to be expanded or strengthened to reflect heavier restrictions on polluting vehicles.[135]
- In 2022, France announced that the country's LEZs would expand from 11 to 43 urban areas by 2025 – covering all large cities and towns – and that fines would increase more than tenfold.[136]

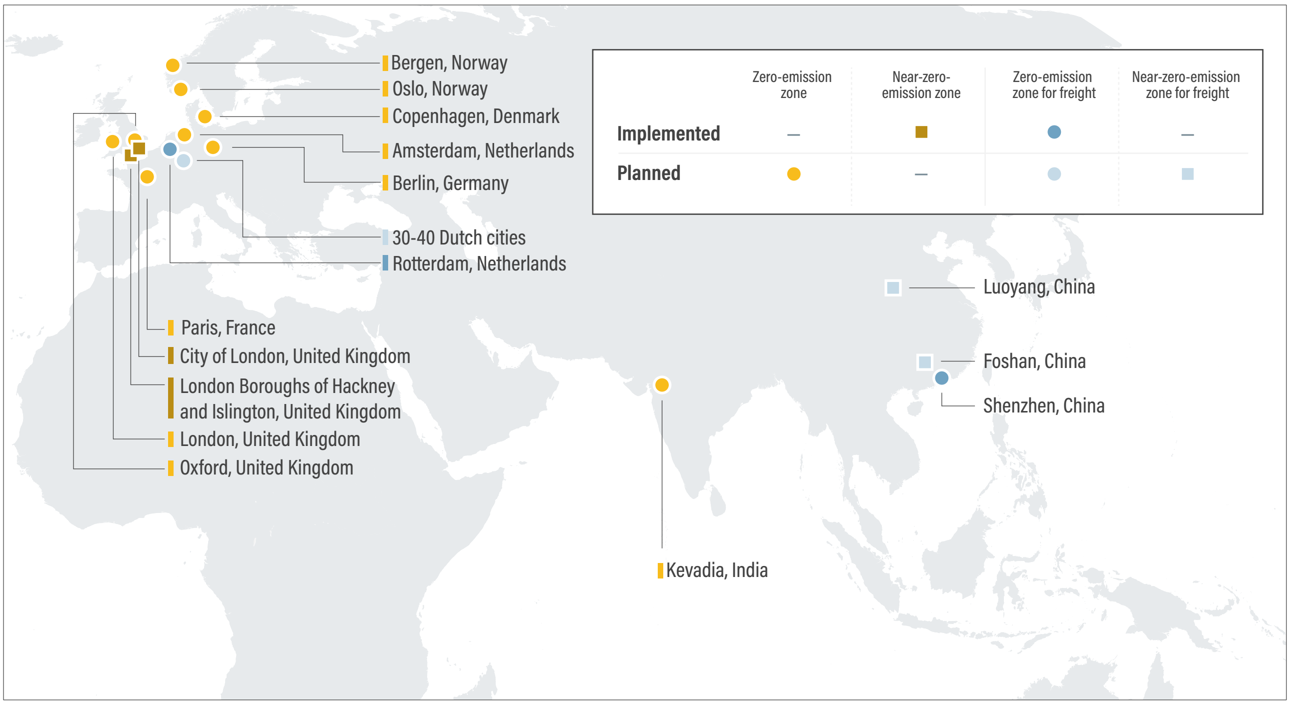
- The LEZ in Brussels (Belgium) was strengthened in 2022 to restrict the circulation of Euro 4 vehicles, the latest in a series of gradually tightened restrictions since the zone was introduced in 2018.[137]
- In 2022, Glasgow (UK) published plans to strengthen enforcement in its LEZ by mid-2023.[138]
- London announced that its ULEZ would be expanded from the city centre to all London boroughs in 2023, to cover 18 times its original size and 4 million people.[139] As of August 2021, 95% of heavy-duty vehicles operating in London were compliant with the more stringent LEZ standards introduced that March.[140]

Developments in LEZs elsewhere have been less extensive than in Europe.

- Jakarta (Indonesia) began implementing an LEZ pilot in the Kota Tua Tourism Area in early 2021, which covers a relatively small area (around 12 hectares) compared to LEZs in cities such as Beijing and London.[141] A study found that support for expansion of the LEZ to other locations in Jakarta was shaped by the level of the population's trust in government and its institutions, the level of environmental concern, as well as personal and social norms regarding LEZ implementation.[142]
- In China, in addition to LEZ policies (in place in 13 cities as of 2020), cities use permits and restrictions on freight access as popular measures to advance zero-emission freight goals and reduce congestion.[143]

FIGURE 5. Implemented and planned zero-emission zones and variants as of July 2022

Source: See endnote 154 for this section.



By mid-2021, several dozen cities had implemented or planned to implement ZEZs or near-ZEZs, mostly in Europe but also in China and India.[144] Gradually converting LEZs into ZEZs can complement transport policies that promote a switch to active modes such as walking and cycling and support the electrification of public transport, taxis, shared and private vehicles, and delivery vans.[145]

- As of mid-2022, 36 cities (mostly in Europe and the United States) had committed to the C40 Cities Green and Healthy Streets Declaration, aiming for zero emissions in a major area of their cities by 2030; establishing a ZEZ is a clear pathway to reaching that commitment.[146]
- In the United Kingdom, Oxford implemented a ZEZ in 2022, the City of London historic and financial district launched one in 2020, and the London boroughs of Islington and Hackney did so in 2018.[147]
- Copenhagen (Denmark) has taken a phased approach with its LEZ, launching it in 2020 and strengthening it in 2022, with plans to pilot a ZEZ beginning in 2023.[148]
- As of 2021, Berlin (Germany) planned to convert its LEZ into a ZEZ, covering 88 square kilometres in the inner city.[149]
- In 2020, Bergen (Norway) aimed to become fossil fuel-free by 2030, notably through a ZEZ covering the entire downtown area, to be phased in starting in 2023.[150] The ZEZ in Oslo (Norway), scheduled to enter into force in 2023, commenced with a "Car-Free City Life" area where pedestrians and cyclists have priority over private cars; the measure is set to expand to other areas of the city by 2026.[151]
- Amsterdam (Netherlands) plans to transform its ZEZ, in place since 2020, into a ZEZ by 2030.[152]
- In 2021, Kevadia (India) announced plans to develop the country's first ZEZ – referred to as an "electric vehicle only" area – in the vicinity of a main tourist attraction, the Statue of Unity.[153]

Some cities have chosen to establish specific zero-emission zones for freight transport (ZEZ-Fs) – ranging from urban delivery vans to medium- and heavy-duty trucks – to alleviate the contribution of freight transport to air pollution and emissions (see Figure 5).[154]

- In 2021, the Netherlands announced an aim to implement ZEZ-Fs in 30-40 of the country's largest cities by 2025.[155] As of 1 January 2025, any city in the Netherlands would be permitted to designate areas as a ZEZ-F.[156]
- Copenhagen (Denmark) intends to pilot a ZEZ-F, referred to as a "zero-emission delivery zone", that would apply to vans by 2023 and trucks by 2025.[157]

- A ZEZ-F pilot in Shenzhen (China), implemented in 2018 with a focus on light-duty trucks, covers 22 square kilometres (1.1% of the total city area) and was scheduled to expand in mid-2023.[158]
- In 2021, Luoyang (China) adopted a near-ZEZ-F scheme, to be implemented in 2023, that applies to urban delivery trucks and covers the city centre.[159]
- In the US state of California, the Los Angeles Cleantech Incubator and the City of Santa Monica partnered to deploy the country's first ZEZ-F in early 2021, referred to as a "zero-emission delivery zone" and covering a one-square-mile commercial area.[160] While the ZEZ-F is voluntary, the partners hope it will serve as a blueprint for other cities to implement similar zones.[161]

Partnership in action

- As of early 2023, the **MobiliseYourCity Partnership** had partnered with 31 cities in Africa on mobility projects, including the development of two SUMPs in Cameroon and one NUMP in Tunisia, directly enabling more than EUR 170 million (USD 181 million) in international loans and grants; additional SUMPs were being prepared in Côte d'Ivoire, Ethiopia and Ghana.[162]
- **Germany's Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)** supported Foshan (China) and Tirana (Albania) in developing their SUMPs, in addition to elaborating policy recommendations for the design of a SUMP in Kuala Lumpur (Malaysia).[163]
- The **Institute for Transportation and Development Policy (ITDP)** has worked with several African cities to provide technical advice on improving transport systems, influence policy and raise awareness of the ability of sustainable transport to reduce emissions, poverty and social inequality.[164]
- **ICLEI-Local Governments for Sustainability** has set up an "ecologistics community" to encourage sustainable urban freight in cities around the world and has developed indicators to serve as a guide for local governments.[165]

MODULE 3 3.2

AUTHOR:
Jim Walker, *Walk21*

Walking

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- The demand for urban trips is expected to triple by 2050. Between 2020 and 2050, the share of walking, cycling and scooter use for trips of less than 10 kilometres is expected to increase noticeably.
- On average, an estimated 20-30% of all trips globally are walked, as are 85% of all trips to and from public transport.
- Without investing in improved walkability, the situation in Africa will mirror that across Latin America and Asia, which have similarly high levels of walking and increasing motorisation.
- In many parts of the world, the amount of walking is likely to decrease as soon as a viable and affordable alternative transport mode is available.
- Walking has the potential to replace a large share of short trips and to reduce the associated emissions from transport.
- Since the COVID-19 pandemic, there has been significant and sustained behaviour change in commuting patterns, enabled by the increase in digital accessibility and remote work in many countries.
- Substantive discussion since 2012 has resulted in the development of a new global indicator system for walking. The indicators attempt to compare values for four key components: the amount of walking (the activity), the risk (safety and security), proximity to public transport (accessibility) and available infrastructure for walking (comfort).

Emission trends

- Walking and cycling are the most sustainable forms of personal transport. Enabling more people to walk and cycle safely can play a significant role in achieving climate goals and is a quick, affordable and reliable way to lower transport emissions while improving public health, strengthening the economy and supporting a fairer, more equitable society.
- The emissions increase from the shift from walking to motorised modes has not been calculated but potentially cancels out many of the benefits that can be delivered by policies that support a modal shift from cars to walking.
- Walking and cycling deliver progress towards more of the United Nations Sustainable Development Goals than any other transport mode; however, active mobility is still under-prioritised in the transport and mobility mix and in the wider climate agenda.

Policy developments

- More national governments, as well as regional and city institutions, are preparing walking policies, although only 42% of countries had a national walking policy as of 2022; up to 10% more countries had sub-national policies in place.
- Proximity planning – such as the "15-minute city" in Paris, the "super blocks" in Barcelona and the "low traffic neighbourhoods" in London – is experiencing re-invigorated momentum.
- As of 2021, 48 countries mentioned walking in their Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement, representing 25% of the countries that had an NDC at the time.
- National and sub-national governments have increasing opportunities to align their transport, health and climate policies more closely to enable walking – including through safe and accessible infrastructure, campaigns and land-use planning.
- In 2021, governments of the pan-European region adopted the Vienna Declaration "Building forward better by transforming to new, clean, safe, healthy and inclusive mobility and transport", with a strong focus on walking and cycling.

Overview

The safety, accessibility and comfort of active travel (walking, bicycling and variants such as wheelchair travel) is not sufficiently valued, planned for or invested in across the world. Ironically, it is the countries where people walk the most – in the low- and lower-middle income countries – where the value, commitment, policy and budgets are often lowest. Women, children, the elderly, those with disabilities and people on low incomes – who rely most on these active transport modes – are suffering disproportionately from the lack of policy attention and safe infrastructure. It is unsurprising that many travellers choose motorised modes, unless active travel is safe, convenient, comfortable and affordable.

Many current planning and funding practices tend to favour private automobiles over active transport. Practitioners often evaluate the performance of transport systems based on motor vehicle traffic conditions, using indicators such as the level of service of roadways, the average traffic speed and congestion delay. Planning often gives little consideration to active travel conditions, including the additional delay and risk that wider roads and higher traffic speeds impose on pedestrians and bicyclists (called the "barrier effect").

In addition, development banks and transport agencies generally provide far more funding for motor vehicle infrastructure than for active modes. Many jurisdictions further favour automobile travel by supporting fuel subsidies, low fuel taxes, and subsidised parking, which benefits motorists to the detriment of non-drivers.

Walking and cycling deliver progress towards more of the United Nations Sustainable Development Goals (SDGs) than any other transport mode, yet active mobility is still under-prioritised in the transport and mobility mix and in the wider climate agenda.[1] Many transport professional organisations are starting to recognise the unique and important roles that active modes play in an efficient and equitable transport system, and are reforming planning practices to better reflect these values.

In many communities, the demand for more walkable neighbourhoods is a visible legacy of the COVID-19 pandemic. During the pandemic, places that had an existing walking policy were more likely and more quickly able to respond to the increase in demand for safe walking every day.[2] The most common walking interventions during this period were reallocating road space more equitably, improving the accessibility of public transport interchanges, and defining walkable networks that linked residential areas to health care, green space, retail, and later education and work sites.

Recent reports identify the need to build compact, more walkable cities as a key action to address climate and equity goals by enabling a shift from private motorised travel to more walking, cycling and public transport.[3] Walking is critical to this shift for local trips and as a key feeder to public transport trips. The World Health Organization's (WHO) *Global Action Plan for Physical Activity 2018-2030* and subsequent *Global Status Report on Physical Activity 2022* document the need for more walkable environments as key to enabling more everyday walking, and thus contributing to increased physical activity and better health outcomes for communities.[4]

Previous editions of the present report found very little evidence of relevant policy for walking, so the emerging trend for national governments to prepare walking policies is both helpful and encouraging. While there is work to do, the traditional assumption that walking was not treated as a transport mode, or valued in data collection systems, policies and budgets, appears to be changing.

TABLE 1. Countries with walking policies, by region and income level

Source: See endnote 13 for this section.

	GLOBAL	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA
Countries with some level of walking policy	**103 (50%)**	**19 (35%)**	**17 (49%)**	**26 (53%)**	**34 (69%)**	**7 (35%)**
NUMBER OF COUNTRIES WITH SOME LEVEL OF WALKING POLICY, BY INCOME LEVEL						
High income	45 (44%)	1 (5%)	5 (29%)	9 (35%)	28 (57%)	2 (29%)
Upper-middle income	27 (26%)	3 (16%)	10 (59%)	6 (23%)	5 (10%)	3 (43%)
Lower-middle income	23 (22%)	8 (42%)	2 (12%)	10 (38%)	1 (2%)	2 (29%)
Low income	8 (8%)	7 (37%)	0	1 (4%)	0	0

Demand trends

The demand for urban trips is expected to triple by 2050.[5] **Between 2020 and 2050, the share of walking, cycling and scooter use for trips of less than 10 kilometres is expected to increase noticeably** under the High Ambition Scenario of the International Transport Forum, which is compatible with the Paris Agreement's goal of keeping global temperature rise below 1.5 degrees Celsius (°C) by 2050.[6] For distances of 1 to 2.5 kilometres, the share of walking, cycling and scooters will increase from around 25% of all urban passenger-kilometres to 50%.[7]

On average, an estimated 20-30% of all trips globally are walked, as are 85% of all trips to and from public transport, thereby avoiding significant emissions through existing sustainable walking behaviour. If these walked journeys were motorised, the associated emissions would greatly increase the transport sector's impact on climate change.

Without investing in improved walkability, the situation in Africa will mirror that across Latin America and Asia, which have similarly high levels of walking and increasing motorisation. In many parts of the world, the amount of walking is likely to decrease as soon as a viable and affordable alternative transport mode is available (emission free or not). In most places emissions will likely only increase, unless governments choose to value and invest in walking more. Climate-responsive planning that enables and encourages walking is needed, such as compact urban planning.

- A 2011 study by the Asian Development Bank suggested that as many as 81% of people in Asia will shift from walking to motorised modes, unless walkability is improved.[8]

Walking has the potential to replace a large share of short trips and to reduce the associated emissions from transport.

- Worldwide, an estimated 60% of urban trips are shorter than 5 kilometres, and a quarter are less than 1 kilometre, yet more than half of these trips are travelled using motorised vehicles.[9]

Since the COVID-19 pandemic, there has been significant and sustained behaviour change in commuting patterns, enabled by the increase in digital accessibility and remote work in many countries (*see Section 3.1 Integrated Transport Planning*).[10] This has brought into question whether measures of commuting shares are still helpful for providing insight into the true amount that people walk. Moreover, commuting trips account for less than half of the overall demand for mobility.[11]

The data used in previous editions of this report, showing the modal share of walking at the national and city levels, do not provide a complete picture. They are usually based on census data focused on morning commuting trips (often long distances from home) and tend to count only walking trips of more than 500 metres or sometimes 1 kilometre in distance. Walking stages to other modes of transport, including public transport, are not included in this count. Additionally, the trips that many women, elderly and young people, and people with disabilities take outside of commuting are often not recorded.

Substantive discussion since 2012 has resulted in the development of a new global indicator system for walking, in part to overcome the policy inertia due to a lack of comprehensive data. The evolving International Walking Data Standard provides a measure for walking that records how many minutes per day are spent walking.[12] These data are also helpful for assessing physical activity and road safety. The standard includes both subjective and objective measures and also borrows from existing datasets to analyse their relevance through a walking lens.

TABLE 2. Average time spent walking and cycling, by region and top countries

Source: See endnote 19 for this section.

Countries with data	GLOBAL 55 (26%)	AFRICA 19 (35%)	AMERICAS 8 (22%)	ASIA 26 (53%)	EUROPE 3 (6%)	OCEANIA 8 (40%)
LEVEL OF WALKING AND CYCLING ACTIVITY						
Average daily activity (in minutes)	44.0	54.7	40.2	40.1	61.8	23.2
Highest daily activity (in minutes) by country	141.0 Niger	141.0 Niger	140.8 Trinidad and Tobago	56.9 Bhutan	79.8 Republic of Moldova	100.8 Papua New Guinea
Lowest daily activity (in minutes) by country	4.9 Timor-Leste	15 Egypt	20.9 British Virgin Islands	4.9 Timor-Leste	33.1 Turkey	13.2 Niue

TABLE 3. Walking safety, by region and top countries

Source: See endnote 20 for this section.

Countries with data	GLOBAL 204 (98%)	AFRICA 54 (100%)	AMERICAS 35 (97%)	ASIA 49 (100%)	EUROPE 46 (94%)	OCEANIA 20 (100%)
LEVEL OF SAFETY						
Average road fatalities per 100,000	14.9	18.8	14.5	17.1	7.4	16.5
Road deaths per day	14.5	12.0	17.0	43.1	0.53	0.03
Average pedestrian fatalities per 100,000	4.8	6.7	4.9	5.4	2.3	4.8
Pedestrian deaths per day	5.0	4.3	3.0	17.4	0.27	0.01
% of pedestrians among road deaths	30%	36%	31%	40%	17%	28%
Highest road fatalities	59.7 Saudi Arabia	44.2 Lesotho	27.2 Ecuador	59.7 Saudi Arabia	15.9 Ukraine	30.6 Nauru
Lowest road fatalities	2.97 Singapore	8.3 Cabo Verde	6.7 Canada	2.97 Singapore	3.3 Iceland	6.5 Australia
Highest pedestrian fatalities	23.5 Central African Republic	23.5 Central African Republic	12.5 El Salvador	17.7 Oman	6.1 Ukraine	9.2 Nauru
Lowest pedestrian fatalities	0.51 Iceland	2.5 Nigeria	1.6 Canada	0.83 Singapore	0.51 Iceland	1.1 New Zealand

The indicators attempt to compare values for four key components: the amount of walking (the activity), the risk (safety and security), proximity to public transport (accessibility) and available infrastructure for walking (comfort). The component data sets are explained below, and Table 1 presents the available data so far by region.[13]

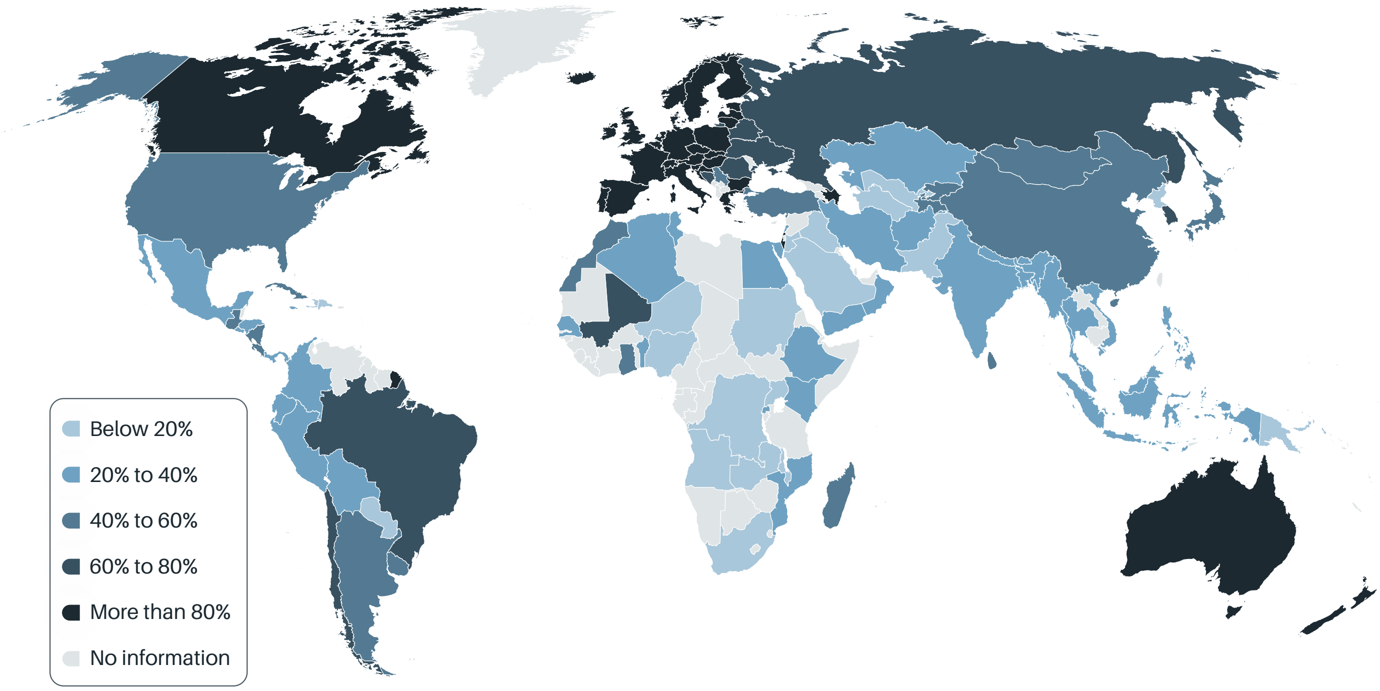
- The 2022 publication *Walking and Cycling in Africa* pioneered this approach for Africa and concluded, based on available data, that the average person in Africa walks for 56 minutes per day and that 31.7% of people in urban areas live within convenient access of public transport.[14]
- The analysis found that 95% of roads in Africa fail to meet an acceptable level of service for pedestrians and that 36% of road casualties in 2019 were pedestrians.[15]
- In many African countries, as much as 78% of trips are walked.[16] Africa has the least amount of walking infrastructure for pedestrians and is also the least safe region for walking.[17]

A key approach to establish a robust evidence base for outlining the current status of walking and for informed and appropriate action on walking is by looking at the **"time spent walking"**:

- The World Health Organization's (WHO) STEPwise approach to risk factor surveillance of non-communicable diseases provides helpful insight into the levels of walking and cycling for transport.[18] The STEPwise approach is disaggregated by gender, ability, age and income and represents a simple, standardised method for collecting, analysing and disseminating data in WHO member countries.

FIGURE 1. Average share of urban population with convenient access to public transport, by country

Source: See endnote 25 for this section.



- Specifically, the WHO's Global Physical Activity Questionnaire asks, "How much time do you spend walking or bicycling for travel on a typical day?" As a result, the WHO has collected mean minutes of travel time from 55 countries (see Table 2).[19] However, this dataset has limitations for comparability, as it does not provide the same year for each country, is only a partial dataset for a region, and does not clearly disaggregate between walking and cycling (although it is hoped that future editions will).

For measuring **safety**, the most recent data available are from the Institute for Health Metrics and Evaluation (see Table 3).[20]

- Pedestrians accounted for 36% of the 264,526 people killed on African roads in 2019, based on analysis of the Global Burden of Disease.[21]
- In addition to deaths, a further 25,908,698 road traffic injuries were recorded in Africa in 2019, and 38% of the injuries were suffered by people walking.[22]

UN-Habitat collects information on transport **accessibility** trends, using mapping data to understand the distance to public transport and to show the areas reachable within a travel time limit. UN-Habitat is the custodian of SDG 11 on Cities and Human Settlements, which in Target 11.2 calls for universal access to safe, affordable, accessible and sustainable transport systems.[23]

- Target 11.2 has a systematic and reliable methodology and dataset for universal comparison, including Indicator 11.2.1, which measures progress on the share of the population that has convenient access to public transport, disaggregated by age group, sex and persons with disabilities.[24] This core indicator helps cities identify areas that are under-served by public transport.
- This indicator is measured by the walking access threshold to public transport stops (either 500 metres or 1,000 metres, depending on the carrier capacity of the transport system) (see Figure 1).[25] However, proximity to transport alone does not ensure accessibility.[26] To inform policy and investment decisions, there is also a need for information on transit system performance (such as frequency, comfort, safety, affordability) as well as considerations of the quality of the walking infrastructure, which is key to ensure door-to-door accessibility. However, existing data are often inconsistent or non-existent.

Measurements of **comfort** are based on the International Road Assessment Programme's (iRAP) Star Ratings, which provide a simple and objective measure of the level of safety provided by a road's design (see Table 4).[27] iRAP's Star Ratings are the global guideline for road infrastructure safety and are embedded into the UN Road Safety Targets.[28] Star Ratings greatly improve awareness of pedestrian safety for those designing, building and

TABLE 4. Walking comfort, by region and top countries

Source: See endnote 27 for this section.

Countries with data	GLOBAL 45 (22%)	AFRICA 9 (17%)	AMERICAS 10 (28%)	ASIA 10 (20%)	EUROPE 12 (24%)	OCEANIA 4 (20%)
LEVEL OF COMFORT						
Highest		Senegal	Costa Rica	China	United Kingdom	New Zealand
Lowest		South Africa	Chile	Indonesia	Bulgaria	Papua New Guinea

maintaining roads. If used at the design stage for road upgrades, they will highlight where a design lacks sufficient safety measures for pedestrians. Star Ratings also can be used at the network level to track safety progress and performance over time.

- Star Ratings represent the infrastructure-related risk of death or serious injury. A five-star street is the safest and most comfortable for people that walk, while a one-star street is the least safe.[29] A three-star score (the minimum acceptable standard for pedestrians) ensures that the roads have sidewalks, pedestrian refuge, street lighting and traffic of maximum 50 kilometres per hour.[30]
- With every incremental improvement in Star Rating, a person's risk of death or serious injury is approximately halved.[31] The World Road Association (PIARC) catalogue of design safety measures estimates that investment in pedestrian facilities can reduce crashes by 13-90%.[32] Star Ratings are very sensitive to traffic speeds, so even if a road has pedestrian facilities, a change in the speed will greatly affect the safety outcome.
- iRAP has partnerships with 104 countries to work with government and non-governmental organisations to inspect high-risk roads and develop Star Ratings and Safer Roads Investment Plans; develop Star Ratings for Schools; provide training, technology and support to build and sustain national, regional and local capability; and track road safety performance so that funding agencies can assess the benefits of investments.[33]

Another assessment of walkability is performed by Walk Score, which calculates the number of common destinations (shops, schools, parks, public transport, etc.) located within convenient walking distance.[34] Residential and commercial property values tend to increase with a location's Walk Score, indicating that people want to live and work in walkable areas, and studies find positive relationships between walkability indicators and public health and safety.[35]

Emission trends

Walking and cycling are the most sustainable forms of personal transport.[36] Enabling more people to walk and cycle safely can play a significant role in achieving climate goals, and is a quick, affordable and reliable way to lower transport emissions while improving public health, strengthening the economy and supporting a fairer, more equitable society.

- According to the Intergovernmental Panel on Climate Change (IPCC), providing support for walking and cycling infrastructure can reduce greenhouse gas emissions from urban transport by 2% to 10%.[37]
- Cities that have a high-density walking fabric emit half the transport greenhouse gas emissions compared to cities that have an automobile-centred fabric.[38]
- The IPCC projects that walking and cycling activity (expressed in passenger-kilometres) will increase at least 1.4 times above 2020 levels by 2070, in scenarios aligned with keeping global temperature rise below 1.5°C.[39]

The emissions increase from the shift from walking to motorised modes has not been calculated but potentially cancels out many of the benefits that can be delivered by policies that support a modal shift from cars to walking. If walked journeys were motorised, the associated emissions would greatly increase the transport sector's impact on climate change. However, most emission models focus on the value of shifting to cleaner vehicle modes, rather than calculating the increase in emissions that would occur with a shift from walking to motorised modes.

Walking and cycling deliver progress towards more of the United Nations Sustainable Development Goals than any other transport mode (see Box 1)**; however, active mobility is still under-prioritised in the transport and mobility mix and in the wider climate agenda.**[40]

Enabling walkability – the extent to which the environment supports and encourages people to walk for a reasonable amount of time and effort – will play a significant role in reducing carbon emissions and encouraging better health outcomes by supporting citizens to make the best transport choices.

BOX 1. Leverage effects from active mobility

Improvements in active mobility (walking and cycling) often leverage additional reductions in vehicle travel, resulting in wider societal benefits:

- *Shorter trips.* A shorter active trip often substitutes for longer motorised trips, such as walking or biking to local shops rather than driving to regional shopping centres.
- *Reduced chauffeuring*. Poor walking and cycling conditions cause motorists to chauffeur non-drivers, which generates empty backhauls (kilometres driven with no passenger). For such trips, a kilometre of walking or cycling often reduces two vehicle-kilometres of travel.
- *Increased public transit.* Walking and cycling improvements can support ridership on public transport, since most public transit trips involve active mode links. Improving walking and cycling access is often one of the most effective ways to increase public transport travel.
- *Vehicle ownership reductions*. Improving alternative modes allows some households to reduce their vehicle ownership. Since motor vehicles are costly to own but relatively cheap to use, once households own a vehicle they tend to use it, including for relatively low-value trips.
- *Lower traffic speeds.* One of the most effective ways to increase active travel is to reduce urban traffic speeds. This makes walking and cycling trips more time-competitive with driving and reduces total automobile travel.
- *Land-use patterns*. By reducing road and parking space requirements and creating more livable neighbourhoods, walking and cycling improvements help create more compact, multi-modal communities, which reduces vehicle travel.
- *Social norms.* More walking and cycling can help increase social acceptance of alternative travel modes.

Not every improvement in active transport modes has all these effects, but many small changes can help make a community more multi-modal and therefore reduce total vehicle travel. Conventional planning often ignores these indirect impacts and so underestimates the potential impacts and benefits of active improvements to achieve objectives such as reducing congestion, crashes and pollution emissions.

Source: See endnote 40 for this section.

Policy developments

More national governments, as well as regional and city institutions, are preparing walking policies, a trend that is both helpful and encouraging, although there is work to do.

- In the *Global Status Report for Physical Activity 2022*, the WHO found that **only 42% of countries had a national walking policy** (listed as walking and cycling, so not exclusively for walking); **up to 10% more countries had sub-national policies in place** (see Table 1).[41]
- The WHO also found that 73% of countries had a national policy on public transport and 80% had a national road safety strategy, both of which support walking.[42]

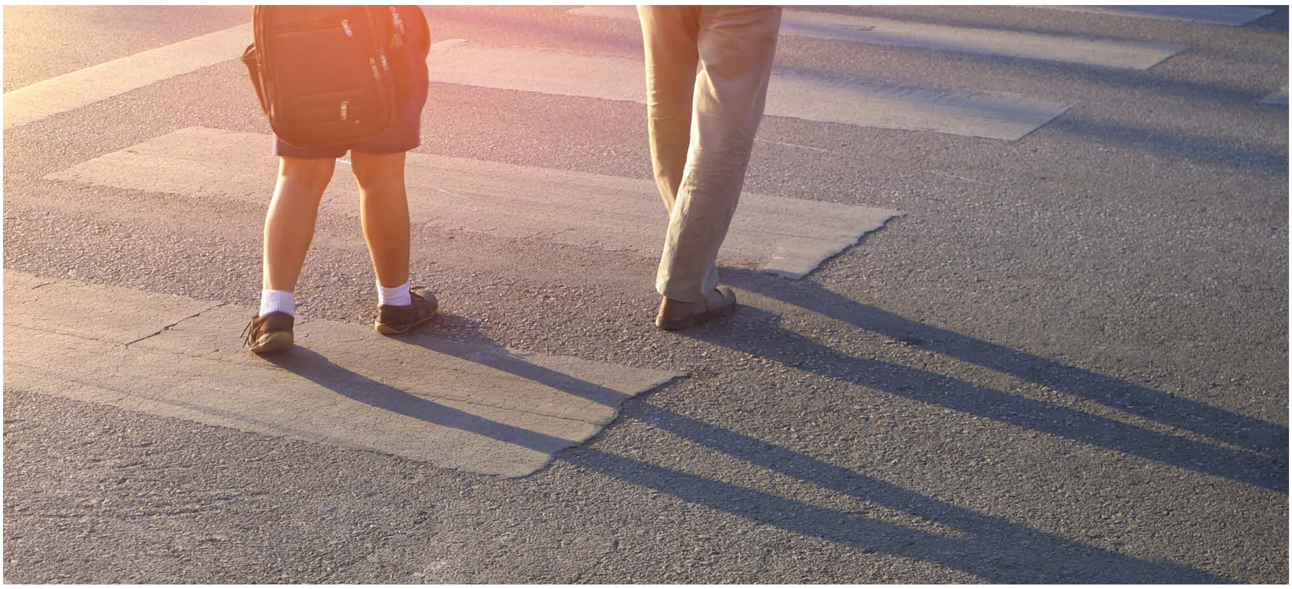
Proximity planning – such as the "15-minute city" in Paris (France), the "super blocks" in Barcelona (Spain) and the "low traffic neighbourhoods" in London (UK) – is experiencing a re-invigorated momentum.[43] Effective "Shift" and "Improve" measures related to walking include targeted behaviour change campaigns, supportive land-use policies, investment in pedestrian infrastructure and facilities design, and better-quality catchments for public transport. The places having the most success in shifting people from their cars are combining these measures, with additional restrictions on vehicle use and parking. Other identified national policies or legislation that enable more walking include infrastructure assessments and those that seek to manage or limit vehicle speeds and poor driver behaviour.

As of 2021, 48 countries mentioned walking in their Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement, representing 25% of the countries that had an NDC at the time.[44]

- Walking was mentioned by 30% of Asian countries that had an NDC, 24% of European countries, 22% of countries in the Americas, 18% of African countries and 15% of countries in Oceania.[45]
- However, only 33 of the countries that mentioned walking in their NDCs also had a walking policy at some level, meaning that 15 countries mentioned walking but had not yet taken policy action.[46] Meanwhile, as many as 70 countries were found to mention walking in a policy but not in their NDC.[47]
- Among countries' commitments to walking in their NDCs, nearly three-quarters (73%) mentioned improving walkability (infrastructure), which includes creating sidewalks, paths, walkways, crossings and pedestrian zones, and sometimes escalators (Monaco) and bridges (Azerbaijan).[48]

National and sub-national governments have increasing opportunities to align their transport, health and climate policies more closely to enable walking – including through safe and accessible infrastructure, campaigns and land-use planning. Investment in walking is a climate solution as well as a solution to improving road safety, reducing non-communicable diseases, strengthening urban resilience and enhancing equity, regardless of gender, ability, age or income. Effective support for walking in everyday life requires a set of integrated, coherent and funded actions for:

- infrastructure that not only enables safe, accessible and easy walking, but also encourages comfortable, attractive and enjoyable walking;
- campaigns to support a shift in people's mobility habits;
- land-use planning to ensure proximity and quality of access to everyday services on foot;



- integration with public transport to underpin sustainable mobility for longer trips and
- capacity building to enable the successful delivery of effective walking strategies with measurable impact.[49]

A broad range of countries, regions and cities around the world have taken action recently to support walking.

- In 2022, the Minister for Transport of Ireland announced EUR 289 million (USD 308 million) in funding for local authorities to develop more cycleways and walking infrastructure, among the largest such allocations globally.[50] The funding, equally distributed between walking and cycling projects, will be allocated by the National Transport Authority and will contribute to nearly 1,000 kilometres of new and improved walking and cycling infrastructure across the country by 2025.[51]
- In British Columbia (Canada), the Ministries of Health and Transport provided Vision Zero funding of more than CAD 500,000 (USD 370,000) to support local road safety projects, recognising the link between sustainability, activity and safety outcomes. The small grants scheme will fund priority improvements and access for active and green modes, including safer crossings, better lighting and traffic management.[52]
- Siem Reap (Cambodia) has built substantial new road infrastructure – including sidewalks, street trees, lighting and separate bike lanes – to create safer and more attractive walking networks.[53]
- In response to the COVID-19 pandemic, Barcelona (Spain) carried out numerous interventions to secure more space for pedestrians, such as widening sidewalks and narrowing roadways at intersections.[54]
- Since 2020, when Brussels (Belgium) implemented the Good Move plan outlining its mobility ambitions, walking has increased significantly in the city, alongside a drop in car use.[55] The sharpest decline in car travel has been among young people (18-34 years old), with the share of car kilometres travelled falling from 55% in 2019 to 45% in 2022, over the first six months of each year.[56] The share of walking grew from only 7.2% of kilometres travelled in the first half of 2017 to 12.0% in the first half of 2022.[57]

Globally, a key policy priority should be to develop infrastructure to make walking safe, accessible and easy to do for everyone. Footpaths and safe crossings are the essential, minimum infrastructure dedicated to walking. The design of high-quality infrastructure must be based on specific standards that guarantee all users adequate levels of safety, accessibility and comfort.

A road is not only a connection between two points. It is public space, and its characteristics can greatly influence people's quality of life and mobility choice. Well-designed public spaces connect where people live to everyday services, offices, public and private activities, and can be experienced and enjoyed at different times of day and night. Well-designed roads and streets allow the safe co-existence of multiple users in the same space, usually by moderating motorised traffic. Examples include pedestrian streets, districts with low vehicular traffic, the Dutch "woonerf" and pop-up piazzas.[i]

In 2021, governments of the pan-European region adopted the Vienna Declaration "Building forward better by transforming to new, clean, safe, healthy and inclusive mobility and transport", with a strong focus on walking and cycling.[58] The declaration is part of the Transport, Health and Environment Pan-European Programme (THE PEP) and features several objectives for 2030, including greatly increasing cycling and walking by extending and improving related infrastructure, developing relevant national policies, and increasing safety and connecting it to health policies.[59]

Also important are campaigns to support shifts in people's mobility habits, including through improved communications, awareness and persuasion tactics. In many cases, the infrastructure might be there, but people may not use it, whether because they are unaware of it, they are not motivated to use it, they lack the capability to use it, or it is of poor quality. Campaigns to promote more walking can be undertaken at every level (local to national to global) and are paramount to ensure that investments in infrastructure, innovative policies, urban planning and capacity building achieve their potential to shift mobility habits.

- Of the countries that mentioned walking in their NDCs as of the end of 2022, 37% committed to promoting walking through campaigns, community encouragement and related means; this was sometimes presented alongside parking restrictions (Barbados and the Republic of North Macedonia), vehicle import controls (Togo) and a desire for safer and healthier communities (Cabo Verde, Lesotho, Malawi and Moldova).[60]

- Colombia's new national strategy for active mobility, the ENMA, includes guidelines and actions to stimulate citizens to travel by bicycle and foot, and also takes a gender and differential approach to ensure that "no one is left behind", one of the postulates of the Paris Agreement.[61]

- In Islamabad (Pakistan), the Capital Development Authority is promoting active transport to address pollution and encourage physical activity, including by adding sidewalks on all major roads and integrating road signs and street furniture for pedestrian use.[62]

Land-use planning is key to supporting and encouraging walking as a daily mobility choice, as it can help ensure greater proximity and quality of access to everyday services on foot. Spatial planning determines the use of city areas (for example, as services, public spaces, industrial districts, retail, and residential neighbourhoods) and how people move around these. Dense urbanisation can greatly increase the potential to move by public transport, walking, and cycling, and thus have positive effects on energy consumption, carbon emissions and physical activity. When there is a viable and affordable option for public transport, whether people choose to walk is strongly influenced by the quality of the built environment and distances. (*For examples of land-use planning policies, see Section 3.1 Integrated Transport Planning.*)

- Of the countries that mentioned walking in their NDCs, 17% referenced changes in land-use planning to support and encourage walking; this includes vehicle-free zones (Fiji), pedestrian communities (Tajikistan) and greening programmes (Jordan and Suriname).[63]

Integration with public transport is also key. Walking is among the best choices when considering short-distance trips, but it is also a viable option for long trips when coupled with public transport. An effective integration of walking with public transport can lead to multiple benefits, including lower climate and environmental impacts, reduced congestion, and higher accessibility for youth and seniors.

However, one of the weak points in public transport systems is accessing the stop or the station. Many potential users are instead choosing private vehicles due to the lack of an effective solution for the first and last mile. Proper infrastructure, pricing mechanisms and policies that allow for multimodal trips are crucial to provide citizens with an effective alternative to private vehicle use. (*For examples of public transport policies, see Section 3.4.1 Public Transport.*)

- Of the countries that mentioned walking in their NDCs, 12% referenced improvements to walking for connecting to public transport.[64]

i A woonerf is a living street, as originally implemented in the Netherlands and in Flanders, Belgium. The term woonerf has been adopted directly by some English-language publications. In the UK, these areas are also called home zones.

Partnership in action

- In 2021, the **African Network for Walking and Cycling (ANWAC)** was created as a space for organisations and experts to convene and collaborate under the auspices of a common goal: making the life of people who walk and cycle in African countries safer, healthier and more comfortable through combined action, expertise and influence.[65]

- In 2022, the **Partnership for Active Travel and Health (PATH)** coalition was launched, calling on governments and cities to make a real commitment to walking and cycling as a key solution to climate, health and equity challenges.[66] The PATH coalition seeks to unlock walking and cycling's potential to accelerate the achievement of climate goals and other benefits, through greater prioritisation and investment, including through national transport, health and environment strategies and through NDCs and Voluntary National Reviews. PATH comprises leading organisations in the sustainable mobility community and is co-ordinated by the FIA Foundation, Walk21, the European Cyclists' Federation and the UN Environment Programme. SLOCAT is a partner of the initiative.

- In 2022, the **Volvo Research and Educational Foundations (VREF)** initiated a research programme on walking as a mode of transport, seeking to build a broad, international and interdisciplinary community of learning that encompasses researchers and other stakeholders in this area, as well as to support and contribute to new knowledge among "next-generation" scholars in walking research.[67]

MODULE 3 3.3

AUTHOR:
Philip Amaral, *European Cyclists' Federation*

CONTRIBUTORS:
Jill Warren, *European Cyclists' Federation*
Isabella Burczak and Ben Barrett, *Union Cycliste Internationale (UCI)*
Lina Quiñones, *Despacio*
Sam Johnson, *World Bank*

Cycling

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability
Global Status Report - 3rd edition

Key findings

Demand trends

- There are more than 1 billion bicycles in the world, and 42% of households worldwide own at least one bicycle, according to a 2015 study.
- The COVID-19 pandemic greatly influenced cycling trends, catalysing growth in both the number of people who cycle and sales of bicycles.
- The global bicycle market grew 14% between 2021 and 2022, from USD 38.4 billion to USD 43.8 billion.
- Global sales of electric bikes (e-bikes, including electric-assisted and electric moped bikes) have boomed since the start of the pandemic, in parallel to the growth in cycling.
- Bike share systems expanded during the pandemic and remained among the most resilient modes of shared mobility, rebounding after the first year of the pandemic.
- The share of cycling among transport modes has mostly remained the same across countries and cities worldwide in recent years.
- Analysis of distance-based ratios of cycling in selected countries and cities revealed that in the Netherlands, where the cycling modal share is very high, most trip distances are two kilometres or less, reflecting the density of Dutch cities and of urban cycling networks. Overall, most cycling across major world cities involves trips of five kilometres or less.
- People cycle more for trips between work and home than for other purposes. In urban areas, cycling to work is 40% more common on average than cycling for a non-work trip, with this share rising to around 60% in larger cities.
- Researchers have found mixed links between cycling and levels of education and income. The link between cycling levels and the cost of buying a bicycle is not clear, with some cyclists motivated by the affordability of cycling and others not.
- A large gender gap in cycling exists in cities across the world, with women and girls cycling much less than men for a variety of reasons, including lack of consistent access to bicycles, cultural and/or religious acceptance reasons, and lack of safe cycling knowledge or infrastructure.
- Cities that have the highest shares of cycling are also those that have a medium or high representation of women who cycle and a healthy mix of age demographics.
- Every year, an estimated 41,000 cyclists die in road traffic-related incidents worldwide, representing 3% of global road traffic deaths in 2019. A quarter of the global cyclist deaths occur in Africa. Bicycle deaths in the United States rose 5% in 2021.

Emission trends

- Cycling can lead to dramatic reductions in greenhouse gas emissions from transport. People who cycle daily emit an estimated 84% fewer carbon emissions from their daily travel than those who do not. Studies report that replacing a daily car journey with an e-bike can save an average of 249 grams of carbon dioxide (CO_2) for every kilometre travelled.
- E-bikes have the capability to reduce per capita CO_2 emissions, especially in rural areas where people typically travel longer distances and are more car dependent.
- Cargo bikes are increasingly recognised globally as a more climate-friendly and economical substitute for delivery vans, for both small and large delivery companies.

Policy developments

- Leading barriers to cycling include being too close to car traffic, a lack of quality infrastructure, perceptions of poor physical fitness, and negative community perceptions of cyclists. Globally, a key enabler for a high cycling share is the presence of safe infrastructure.
- Countries that have implemented national cycling promotion strategies include Finland, Germany, Japan and the Netherlands.
- Many cities in Asia, Europe, Latin America and the Caribbean, and North America expanded their cycling networks during the COVID-19 pandemic by adding new lanes and tracks as well as pop-up bicycle infrastructure, in response to the increased demand for cycling. More than 2,500 kilometres of temporary cycling infrastructure was added in Europe over this period, much of which is now permanent.
- In recent years, cycling policies have emerged as key measures for climate change adaptation and mitigation. Since 2018, when the United Nations declared June 3 as World Bicycle Day, several important developments have promoted cycling at the global and regional levels.
- As of March 2023, 31 (or 22%) of countries' second-generation Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement covered cycling or active mobility.

Overview

Much has changed for cycling in recent years. The COVID-19 pandemic was a primary catalyst for this change, as cities around the world took advantage of the quieter streets during pandemic-related lockdowns to implement temporary cycle lanes and tracks that enabled people to exercise outdoors while maintaining social distancing. In many places, this led to expansions in dozens and even hundreds of kilometres of new cycling routes. Bicycle sales have increased sharply since 2020, especially sales of electric bikes (e-bikes), although mainly in cities in high-income countries.[1]

The expansion of bike infrastructure and the implementation of pro-cycling policies supports the increase in demand. However, the vast majority of roads worldwide do not provide adequate quality levels for cyclists, as every year an estimated 41,000 cyclists die in road traffic-related crashes worldwide (3% of global road traffic deaths in 2019).

Governments and decision making bodies have adopted policies and plans to further promote cycling; for example, in February 2023 the European Parliament adopted a resolution calling for a cycling strategy for the European Union (EU).[2] The increased interest in cycling has promoted greater research on its environmental and climate benefits, including studies showing the enormous potential to save carbon dioxide (CO_2) emissions, especially in cities where many people's daily journeys are five kilometres or less.[3]

Demand trends

There are more than 1 billion bicycles in the world, and 42% of households worldwide own at least one bicycle, according to a 2015 study.[4] The COVID-19 pandemic greatly influenced cycling trends, catalysing growth in both the number of people who cycle and sales of bicycles. In Europe, Latin America, and North America, many people perceived cycling as a more viable transport mode during the pandemic, whereas in most African cities the pandemic had less impact on mobility habits.[5] Cities worldwide have turned to cycling not only to support the immediate mobility needs of residents, but also to advance sustainability goals, especially reductions in greenhouse gas emissions and improvements in air quality and active lifestyles.[6]

The global bicycle market grew 14% between 2021 and 2022, from USD 38.4 billion to USD 43.8 billion.[7]

- As of 2023, the countries with the largest bicycle fleets were China, with around 500 million units, followed by the United States with 120 million.[8] In per capita terms, the Netherlands was the top country with nearly 1 bicycle per person, followed by Denmark and Germany with 0.75 bicycles per person and higher.[9]
- In African cities, around 95% of transport decision makers surveyed during COVID-19 restrictions (in September 2020) reported a willingness to improve conditions for walking or cycling, although they noted that a lack of reliable mobility data, technical capacity and money inhibited progress.[10]
- Bicycle sales in Singapore increased during the pandemic, and bike sharing companies reported higher ridership.[11] The operator Anywheel said its ridership increased every month in 2021, with the exception of April when lockdowns were implemented; in July 2021, the Singapore Land Transport Authority approved the expansion of Anywheel's fleet from 10,000 to 15,000 bicycles.[12]
- In 2020, more people in Canada were biking or walking to work than using public transit, according to Statistics Canada.[13] After the onset of the pandemic, many in Canada viewed cycling as a safer alternative with a lower potential risk of contracting the virus.[14]
- In the United States, consumer spending on bicycles totalled USD 7.5 billion in 2022, up from roughly USD 6 billion pre-pandemic (in 2019).[15]
- In Brazil, bicycle sales increased 50% in 2020 then dropped 5% in 2021, although they remained well above pre-pandemic levels; in 2022, however, sales fell 35% and returned to pre-pandemic levels due to market saturation and a negative economic situation.[16]
- Between 2019 and 2021, weekday cycling levels fell in Canada, Finland, Germany, and Ireland, with the declines ranging from 4% in Canada to 15% in Ireland, likely due to increased remote working and learning as well as to travel restrictions during pandemic-related lockdowns.[17] However, weekday cycling increased 24% In Italy and 1% in the United States and Sweden.[18]
- The growth in weekend cycling during the pandemic (2019-2021) ranged from highs of 55% in the United Kingdom and 49% in Ireland, to 4% in Finland and Germany.[19]

Global sales of electric bikes (e-bikes, including electric-assisted bikes and electric moped bikes) have boomed since the start of the pandemic, in parallel to the growth in cycling.[20] Global e-bike sales were already growing at an impressive 120% in 2019, to reach USD 21 billion; the market has since increased 39% to USD 29 billion in 2022 and is expected to reach USD 62.3 billion in 2030.[21] This growth has enabled people to cycle more frequently and for longer distances, resulting in greater reductions in CO_2 emissions.

- Asia was the largest regional e-bike market in 2019, accounting for 90% of global revenue and production, followed by Europe and North America.[22]
- China experienced among the quickest uptakes of e-bikes, rising 57% between 2014 and 2019, from 191 million units to nearly 300 million units and exceeding private car ownership.[23] E-bike use has nearly replaced traditional pedal bikes, especially in small to medium-sized cities. In Beijing, e-bikes accounted for 60% of all traffic using active mobility in 2019.[24]
- A 2021 study found that in North America (Canada, Mexico and the United States), e-bike trips were 36% more common than pedal bike trips.[25] The use of e-bikes has also increased within shared mobility, with around half of 298 cities including e-bikes in their bike share and/or scooter share fleets as of 2021.[26] Between 2020 and 2021, pedal bike trips increased slightly, but e-bike trips nearly doubled.[27]
- In Europe, 35-50% of e-bike trips replaced car trips, according to studies from 2019.[28]

Bike share systems expanded during the pandemic and remained among the most resilient modes of shared mobility, rebounding after the first year of the pandemic.[29] Several factors play into the success of bike share systems, such as the geography of cities, integration with existing transport modes, and close co-operation between operators and regulators.[30]

- In Hangzhou (China), the world's largest bike share programme expanded from an operating fleet of 78,000 bikes in 2018 to 116,000 in 2023.[31] During the pandemic, the system continued to operate through disinfection and maintenance, servicing nearly 70 million people in the first 10 months after the outbreak in 2020.[32] Studies between 2008 and 2020 found that Hangzhou's bike share system was rented out 1.09 billion times, equivalent to reducing 549 million car trips and 1.46 million tonnes of CO_2 emissions.[33]
- Trip volumes for one of the largest bike share operators in Latin America, Tembici, increased 34% between 2019 and 2022 across Argentina, Brazil and Chile.[34]

The share of cycling among transport modes has mostly remained the same across countries and cities worldwide in recent years. However, in some countries, such as Singapore and the United Kingdom, the cycling share increased due to COVID-19 measures.[35] Based on varying estimates, in 2021 the Netherlands, Denmark, and Japan led with cycling shares of around 30% of all trips, while in 2022 China led with a share of 33%.[36]

- In a study of cycling behaviour in 17 countries, the Netherlands had the highest cycling share among all trips (26.8%) and across a variety of indicators, including work and non-work trips and gender (see Table 1).[37]
- Japan followed with an 11% cycling share in all trips, although its median age for cycling was older than in other countries, due likely to the generally older population.[38]

TABLE 1. Cycling behaviour and characteristics of cyclists for urbanised areas across selected countries (listed in descending order by cycling modal share), 2021

Source: See endnote 37 for this section.

Region, Country	Modal share of cycling (%): All trips	Non-work trips	Work trips	All trips (males)	All trips (females)	Share of females in cycle trips	Median age: Cyclists	All other road users	Male cyclists	Female cyclists	Median distance of cycle trip (km)	Median duration of cycle trip (minutes)
Netherlands	26.8	27.1	25.3	25.4	28.2	54.4	36	43	30	39	2	10
Japan	11.5	11.9	10.1	10.2	12.7	56.4	45	54	40	48		10
Germany	9.3	9.2	9.4	9.5	9.1	49.2	52	54	51	53	2	10
Finland	7.8	7.8	8.4	8	7.6	50.4	31	44	27	33	2	15
Switzerland	6.7	6.3	8.1	7.2	6.3	46.6	39	46	38	41	1.7	10
Argentina	3.6	3.3	5	4.9	2.4	33.6	33	30	34	31		15
Chile	2.7	2.3	3.7	3.9	1.6	30.8	36	32	40	29		20
United Kingdom	2.1	1.6	3.9	3.2	1.1	26.5	38	41	39	38	3.2	16
Australia	1.8	1.8	1.2	2.4	1.2	35.5	34	40	34	33	2.5	15
USA	1.1	1	1.3	1.6	0.6	30.2	39	50	40	37	1.9	15
Brazil	0.8	0.4	1.3	1.4	0.2	13.2	35	31	36	31		20

Asia · Europe · Latin America · North America · Oceania

TABLE 2. Cycling behaviour and characteristics of cyclists in selected cities (listed in descending order by cycling modal share), 2021

Source: See endnote 40 for this section.

		Modal share of cycling (%)						Median age (years)					
City	Country	All trips	Non-work trips	Work trips	All trips (males)	All trips (females)	Share of females in cycle trips	Cyclists	All other road users	Male cyclists	Female cyclists	Median distance of cycle trip (km)	Median duration of cycle trip (minutes)
Amsterdam	Netherlands	28.7	28.8	26.8	27.1	30.1	54.7	37	42	34	39	2	10
Osaka	Japan	28.4	28.4	28.4	21.8	34.3	64.2	52	56	53	51	-	10
Tokyo	Japan	18.7	19.2	17.1	16.9	20.2	57.5	46	49	45	46	-	10
Munich	Germany	16.3	16.6	15	15.7	16.9	51.4	-	-	-	-	2	15
Nagoya	Japan	15.7	15.4	16.5	12.1	18.9	63	44	52	41	45	-	10
Cologne	Germany	14.7	14.7	14.9	15	14.3	48.5	-	-	-	-	2	15
Berlin	Germany	14.1	14.3	13	13.1	15	53.3	-	-	-	-	2.5	15
Hamburg	Germany	13.7	14.4	11.1	13.4	14	51	-	-	-	-	2.2	10
Yokohama	Japan	8.3	8.6	7	7.8	8.7	52.8	44	48	39	46	-	15
Rosario	Argentina	8.3	7.9	10	9.8	6.9	42.3	29	32	28	30	-	15
Zurich	Switzerland	6.4	5.9	7.8	7	5.7	43.8	40	46	39	41	1.8	15
Bogotá	Colombia	6.3	4.3	9.6	9.3	3.4	27.8	34	34	34	32	-	10
Helsinki	Switzerland	5.3	5.1	7.1	5.6	5.1	49.5	37	42	35	40	3	15
Delhi	Colombia	4.8	1.3	9	6.9	1.1	8.1	38	28	40	16	3	10
Kisumu	Kenya	4.3	4.2	5	7	2.1	26.2	28	27	30	27	5	25
Bangalore	India	4	4.2	3.8	4.3	3.2	20.7	41	41	41	26	3	20
Santiago	Chile	3.7	3.4	4.6	5.1	2.5	33.3	36	36	40	30	1.6	30
Buenos Aires	Argentina	3.3	3	4.5	4.5	2.2	34.3	35	31	36	32	-	20
Montreal	Canada	2.7	2.3	3.8	3.5	2	36.7	39	43	40	38	-	20
Corboda	Argentina	2.7	2.3	3.5	3.5	1.9	35.8	31	30	35	26	2.2	20
London	England	2.6	2	4.7	4	1.3	25.3	35	37	36	34	1.9	15
Mendoza	Argentina	2.2	1.8	3.9	3.6	0.8	19.1	34	32	33	35	-	-
Mexico City	Mexico	2	1.8	2.9	3.2	1	24.1	34	34	37	29	-	15
Philadelphia	USA	1.9	1.8	2.4	3.1	1.1	33.5	-	-	-	-	2.3	15
Melbourne	Australia	1.9	1.7	2.4	2.4	1.2	26.3	35	39	36	33	2.9	20
Chicago	USA	1.5	1.5	1.5	2.2	0.9	32.2	37	46	36	37	1.5	15
Los Angeles	USA	1.3	1.3	1.6	2	0.7	29.9	-	-	-	-	2.3	20
Brisbane	Australia	1.2	1.1	1.7	1.9	0.6	27	34	38	33	36	2.8	15
New York City	USA	1.2	1.2	1.4	1.8	0.7	34.1	-	-	-	-	1.7	15
Seattle	USA	1.1	1.1	1	1.5	0.6	27.4	-	-	-	-	3.1	15
Belo Horizonte	Brazil	1	0.6	1.6	1.8	0.2	9.8	36	31	36	31	-	20
Salvador	Brazil	0.9	0.5	1.5	1.6	0.2	11.9	34	31	35	30		20
Gran Valparaiso	Chile	0.8	0.7	1.1	1.3	0.3	20.9						20
São Paulo	Brazil	0.6	0.3	1.0	1.1	0.2	12.3	30	34	31	28	2	20
Cape Town	South Africa	0.3	0.2	0.5	0.4	0.1	27	41	32	42	25		30

- The lowest cycling shares were in Brazil and the United States (near 1%), for years ranging from 2009 through 2019.[39]
- Among cities, the median share of cycling among transport modes was 3.3%, ranging from a low of 0.3% in Cape Town (South Africa) to highs of 28.7% in Amsterdam (Netherlands) and 28.4% in Osaka (Japan), which also had the highest share of cycle trips by women (64.2%) (see Table 2).[40]

Analysis of distance-based ratios of cycling in selected countries and cities revealed that in the Netherlands, where the cycling modal share is very high, most trip distances are two kilometres or less, reflecting the density of Dutch cities and of urban cycling networks.[41] At the city level, Delhi (India) has a higher share of cycling trips taken for longer distances.[42]

Overall, most cycling across major cities – including in Amsterdam (Netherlands), Berlin (Germany), Delhi (India), London (UK) and New York (USA) involves trips of five kilometres or less.[43] This has significant implications for reducing emissions from road transport, as cycling can be a reliable and potent alternative to private vehicles for these shorter journeys.

- Both Japan and the Netherlands had short median distances and durations for cycle trips, suggesting that cycling may be more frequent in countries with dense urban areas where trips are short.[44]
- The likelihood of cyclists taking a short trip relative to a longer one is similar in both high-cycling countries (such as the Netherlands and Germany) and low-cycling countries (such as Chile and the United Kingdom).[45] People in Finland and the United States also show similar cycling levels by distance – despite different overall cycling levels – with both countries having the highest propensity for trips of 0-2 kilometres.[46]
- People in high-cycling cities such as Amsterdam (Netherlands), Zurich (Switzerland) and German cities have a remarkably similar likelihood of cycling for a short trip versus a longer one as do people in low-cycling cities such as New York (USA) and Santiago (Chile).[47]
- Cities where people have the highest propensity to cycle distances of 20 kilometres or more include cities in Australia and the United States, as well as São Paulo (Brazil).[48]
- The median distance of cycle trips in selected cities ranged from 1.5 kilometres to just over 3 kilometres, with Seattle (USA) having the farthest median trip distance (3.1 kilometres).[49]
- Cape Town (South Africa) and Delhi (India) logged the longest median durations of cycling trips, at 30 minutes each, and in general trips were longer in cities with lower cycling shares.[50] For countries with high cycling shares, the median duration of trips was around 10-15 minutes.[51]
- In Bangalore and Delhi (India), people have among the lowest propensity among cities for cycling 0-2 kilometres, and much higher propensity to cycle distances of up to 2-5 and 5-10 kilometres.[52]

People cycle more for trips between work and home than for other purposes. In urban areas, cycling to work is 40% more common on average than cycling for a non-work trip, with this share rising to around 60% in larger cities.[53]

- Countries where more people tend to cycle to work include Brazil, Chile, Finland, Switzerland and the United Kingdom.[54]
- Among cities, Amsterdam (Netherlands) and Osaka (Japan) have very high ratios of home-work cycling trips, along with Delhi (India) and Zurich (Switzerland).[55]
- Cycling is more frequently done for non-work trips in countries where the share of cycling is already high, such as the Netherlands, Japan, and Germany, which have above-average rates of non-work cycling.[56]

Researchers have found mixed links between cycling and levels of education and income.

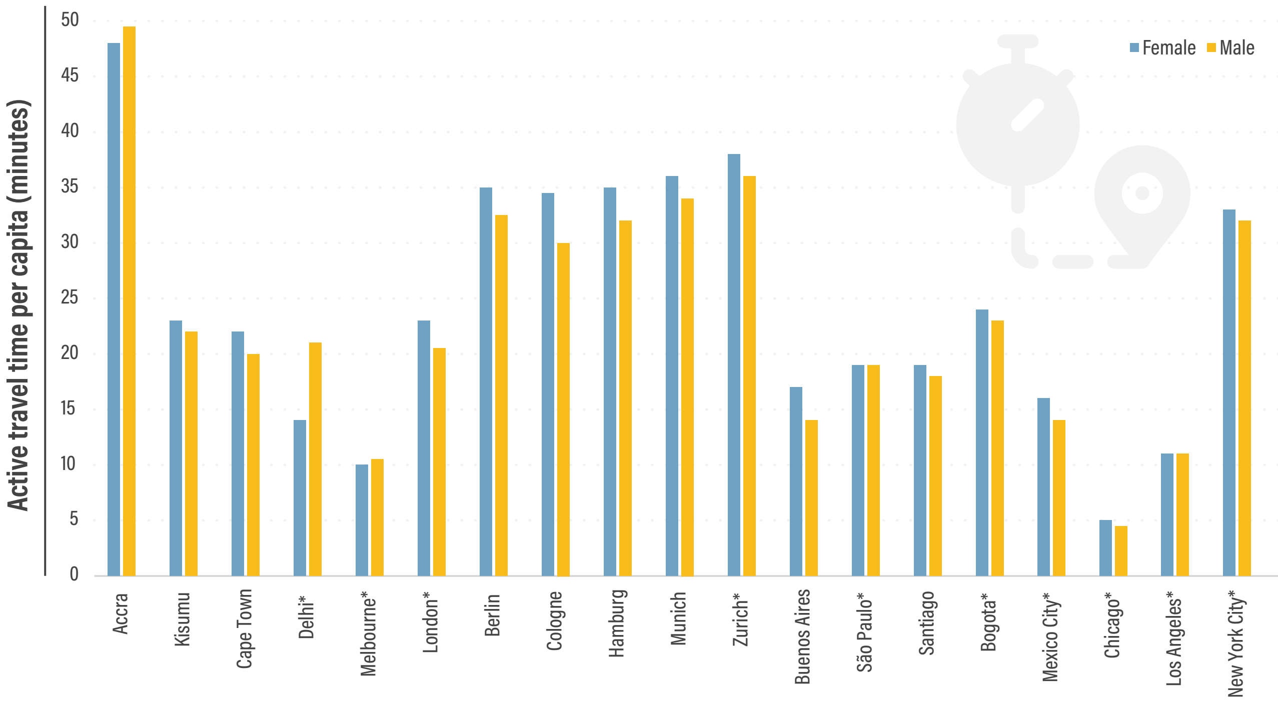
- In cities in Sub-Saharan Africa, cycling is more frequent among individuals with less formal education because of links to socio-economic status, such as not owning a car and having low income.[57]
- However, in cities in high-income countries, cycling is more frequent among people with high formal education, whose motivations for cycling are more for social, economic, environmental and personal benefits.[58]
- It is difficult to isolate the effect of income level in cities in low- and middle-income countries, as cycling is commonly used for last-mile connections as well as for sport and leisure, making it popular among varying income groups.[59]

The link between cycling levels and the cost of buying a bicycle is not clear, with some cyclists motivated by the affordability of cycling and others not.

- Studies in cities in Sub-Saharan Africa show a strong association between living in poverty and the likelihood of cycling.[60] In 2022, people in Africa spent an average of 56 minutes per day walking or cycling for transport (compared to 43.9 minutes globally), despite unsafe road infrastructure and high fatalities among pedestrians and cyclists.[61] Low-income households in Africa are most dependent on walking and cycling, and their urban transport expenditures represent up to 20% of household income.[62] (*See Section 2.1 Africa Regional Overview.*)
- In South Africa, cycling in Johannesburg is highly correlated with medium and high incomes, and a study in Cape Town found that high-income individuals take 0.5 bicycle trips per person, whereas low-income individuals take 0.3 trips per person.[63]

FIGURE 1. Active travel time per capita by gender for all age groups combined, in selected cities

Source: See endnote 75 for this section.



Note: Active time is defined as total walking and cycling duration across all trips divided by the total number of sampled individuals. Cities with an asterisk use reported data, and others represent harmonised estimates.

- Some studies found correlations between income levels and cycling in US cities, while other studies did not.[64]
- Researchers found that lower costs for bicycle purchases in Dar-es-Salaam (Tanzania) would likely lead to slightly higher levels of cycling.[65]
- Studies in Uganda identified a link between the affordability of bicycles and their maintenance and the ability for people to keep cycling.[66]
- In Ireland, low costs were among the top three factors encouraging cycling.[67] However, other studies globally have found that frequent cyclists do not perceive the low cost of using a bicycle as a significant motivator for bicycle use.[68]

A large gender gap in cycling exists in cities across the world, with women and girls (especially from marginalised populations) cycling much less than men for a variety of reasons, including lack of consistent access to bicycles, cultural and/or religious acceptance reasons, and lack of safe cycling knowledge or infrastructure. Many care-related trips – done mostly by women – require adaptations for cycling (e.g., child seats, cargo bikes) that may be costly and unavailable. Gender-based violence and street harassment may discourage women from cycling, especially at night. Still, many women, even from marginalised communities, view the bicycle positively as an effective way to make short trips, save on transport costs, travel more quickly and freely, and break the cycle of gender violence.[69]

- In Kisumu (Kenya), men account for 96% of all cyclists and use cycling for 7% of their trips, whereas women cycle for only 1% of their trips.[70]
- In downtown Rio de Janeiro (Brazil), women accounted for between 2.4% and 10.9% of all cyclists, whereas men represented between 89% and 97.6% of cyclists, as of 2021.[71]
- In Delhi (India), where 21% of all trips are by bicycle, women constituted only 2% of cyclists in 2006.[72]
- Since 2013, women in Saudi Arabia have been allowed to ride a bicycle only at beaches and parks, with a male guardian.[73] In 2019, authorities in Isfahan (Iran) announced a ban on women cycling in public.[74]
- A 2022 gender analysis of the active travel time per person in selected cities found that women spent more time walking and cycling than men in all cities except Accra (Ghana) and Delhi (India) (see Figure 1).[75] On average, women had 5% more active travel time (24.4 minutes per capita) than men (23.3 minutes).[76]

Cities that have the highest shares of cycling are also those that have a medium or high representation of women who cycle and a healthy mix of age demographics (see Table 3).[77]

- In almost all surveyed locations where the cycling share was above 7%, women made as many cycle trips as men, and sometimes even more; in contrast, in places with cycling shares below 7%, the share of cycling trips by women was much lower.[78]
- In places with higher cycling shares, children under 16 were often over-represented.[79] Older adults (above 60 years) remain under-represented in all geographies but have relatively better representation where levels of cycling are high.[80] In low-cycling settings, women are under-represented across all age groups, especially women older than 16 years.[81]

Such figures demonstrate the need to enable more inclusivity among gender and age demographics in urban mobility systems. Cities that are safe for cycling and have a high cycling modal share are also cities where women and people of all ages enjoy cycling, which can lead to improved health outcomes, societal equity and lower CO_2 emissions.

Every year, an estimated 41,000 cyclists die in road traffic-related incidents worldwide, representing 3% of global road traffic deaths in 2019.[82] **A quarter of the global cyclist deaths occur in Africa** (*see Section 2.1 Africa Regional Overview*).[83] In a study of urban populations aged 20 to 64 years in 17 countries, researchers concluded that shifting to high bike-use scenarios by 2050 could prevent 205,424 annual road traffic-related premature deaths (assuming that 100% of bike trips replace car trips).[84] In a more conservative scenario, where only 8% of bike trips replace car trips, 18,589 annual premature deaths could be prevented by 2050.[85]

- **Bicycle deaths in the United States rose 5% in 2021**, according to the US National Highway Transportation and Safety Administration.[86]
- In all countries and scenarios studied, the mortality benefits related to bike use (compared to car use) outweighed the mortality risks; the biggest impact would be in India, where even in the conservative scenario 6,957 premature deaths could be avoided, with China following with 4,127 avoidable premature deaths.[87]
- More than 1,000 premature deaths in car traffic could be avoided in Austria, the United States, and Indonesia, in high bike-use scenarios.[88]

TABLE 3. Share of women represented in urban cycling modal share, by age, 2021

Source: See endnote 77 for this section.

City	Country	Modal share	Women's share	0-15 years	16-59 years	60+ years	Cluster	Cluster description
	Brazil	0.8	13	0.35	1.24	0.48	*	Low-cycling, gender-unequal, highly age-unequal
	Chile	2.7	31	0.68	1.26	0.68	1	
Belo Horizonte	Brazil	1	10	0.33	1.22	0.58	1	
Chicago	USA	1.5	32	1.08	1.16	0.35	1	
London	United Kingdom	2.6	25	0.76	1.15	0.47	1	
Montreal	Canada	2.7	37	0.57	1.22	0.38	1	
Salvador	Brazil	0.9	12	0.45	1.22	0.39	1	
Santiago	Chile	3.7	33	0.7	1.17	0.54	1	
Seattle	USA	1.1	27	0.91	1.17	0.25	1	
	Argentina	3.6	34	0.66	1.11	0.95	*	Low-cycling, gender-unequal, age-equal (older adults)
Buenos Aires	Argentina	3.3	34	0.64	1.11	1.01	2	
Cordoba	Argentina	2.7	36	0.84	1.06	0.9	2	
Mendoza	Argentina	2.2	19	0.29	1.18	0.99	2	
Mexico City	Mexico	2	24	0.77	1.04	0.99	2	
	Australia	1.8	36	1.06	1.07	0.67	3	Low-cycling, gender-unequal, age-equal (children only)
	United Kingdom	2.1	27	0.88	1.15	0.65	3	
	USA	1.1	30	1.58	1.04	0.54	3	
Bangalore	India	4	21	1.22	1.05	0.73	3	
Bogotá	Colombia	6.3	28	0.67	1.11	0.71	3	
Brisbane	Australia	1.2	27	1.44	0.98	0.56	3	
Los Angeles	USA	1.3	30	1	1.05	0.61	3	
Melbourne	Australia	1.9	26	1	1.09	0.61	3	
New York City	USA	1.2	34	0.76	1.12	0.67	3	
Philadelphia	USA	1.9	33	0.85	1.11	0.49	3	
Rosario	Argentina	8.3	42	1.07	1.05	0.58	3	
Zurich	Switzerland	6.4	44	1.49	1.07	0.52	3	
	Finland	7.8	50	2.74	0.77	0.63	4	Medium-cycling, gender-equal, children over-represented
	Germany	9.3	49	2.07	0.97	0.92	4	
	Switzerland	6.7	47	1.84	1	0.6	4	
Berlin	Germany	14.1	53	1.61	0.97	0.67	4	
Hamburg	Germany	13.7	51	1.53	0.96	0.75	4	
Helsinki	Finland	5.3	50	1.92	0.9	0.84	4	
	Japan	11.5	56	1.17	1.14	0.79	5	High-cycling, women over-represented, age-equal
	Netherlands	26.8	54	1.36	0.92	0.94	5	
Amsterdam	Netherlands	28.7	55	1.25	0.96	0.91	5	
Cologne	Germany	14.7	49	1.13	1.11	0.55	5	
Munich	Germany	16.3	51	1.27	0.99	0.83	5	
Nagoya	Japan	15.7	63	0.85	1.23	0.71	5	
Osaka	Japan	28.4	64	0.84	1.09	0.9	5	
Tokyo	Japan	18.7	58	0.97	1.05	0.91	5	
Yokohama	Japan	8.3	53	0.87	1.12	0.82	5	
Cluster 1 Average		2	24	0.61	1.2	0.48	1	
Cluster 2 Average		3.1	28	0.61	1.11	0.95	2	
Cluster 3 Average		3.4	31	1.12	1.07	0.62	3	
Cluster 4 Average		9.6	50	1.84	0.93	0.73	4	
Cluster 5 Average		18.8	56	1.08	1.07	0.82	5	

Note: The table presents five clusters with a minimum of 6 geographies in one cluster and a maximum of 12, depicting the level of cycling, representation of women and representation of age groups among cyclists.

Emission trends

Cycling can lead to dramatic reductions in greenhouse gas emissions from transport. People who cycle daily emit an estimated 84% fewer carbon emissions from their daily travel than those who do not.[89] Studies report that replacing a daily car journey with an e-bike can save an average of 249 grams of CO_2 for every kilometre travelled.[90]

- Cycling has the lowest life-cycle CO_2 emissions (i.e., emissions caused during the production of a vehicle) among all wheeled transport modes, contributing just 8 grams per kilometre.[91]
- In one study, urban residents who switched from driving to cycling for just one trip per day reduced their CO_2 footprint by around half a tonne over the course of a year, saving the emissions equivalent of a one-way flight from London to New York.[92] If just one in five urban residents made this change permanently over the next few years, the emissions from all car travel in Europe could be cut by around 8%.[93]
- Studies from 2018 found that in the EU, cycling saves more than 16 million tonnes of CO_2-equivalent emissions annually, equal to the yearly emissions of Croatia and resulting in estimated savings of up to EUR 5.6 million (USD 6 million), depending on the social cost of carbon.[94]
- If everyone in the world cycled 1.6 kilometres a day (the average distance cycled in Denmark), an estimated 414 million metric tonnes of carbon emissions could be reduced; if everyone cycled 2.6 kilometres per day (the daily cycling distance in the Netherlands), the emission reduction would rise to 686 million metric tonnes.[95]

E-bikes have the capability to reduce per capita CO_2 emissions, especially in rural areas where people typically travel longer distances and are more car dependent.[96]

- A 2022 study in England found that e-bikes can reduce 24.4 million tonnes of transport CO_2 emissions annually.[97] The reduction was highest in urban areas (excluding conurbations[i]), was lower in rural areas (which tend to be more car-dependent) and was lowest in conurbations (which have greater access to public transport).[98] Despite this, mobility service providers and initiatives such as e-bike sharing schemes largely overlook rural areas.[99]

Cargo bikes are increasingly recognised globally as a more climate-friendly and economical substitute for delivery vans, for both small and large delivery companies; however, this is limited to the context of last-mile logistics, rather than for long-distance freight transport.

- A 2016 study found that cargo bikes could replace up to 51% of all freight journeys in European cities.[100]
- In Brussels (Belgium), public-private partnerships provide a cargo bike sharing service to tackle air pollution. A free two-week trial service for electric cargo bikes was successfully launched in 2021 and was later expanded in 2022 with more bikes and stations.[101]
- Using GPS data from the cargo bike company Pedal Me, which operates within a nine-mile (14.8 kilometres) radius of central London, researchers compared cargo bike deliveries on 100 random days with the routes that vans would have taken to get the parcels to customers and found that the cargo bikes saved nearly 4 tonnes of CO_2 emissions in 2021.[102]
- A US study found that e-cargo bikes are more cost-effective than delivery trucks for deliveries near urban centres when there is a high density of residential units and low delivery volumes per stop.[103]
- In a UK study, cargo bikes resulted in cost savings of 80-90% compared to using commercial vans.[104]
- FedEx aims to expand its fleet of e-cargo bikes in the United Kingdom as its moves towards a zero-emission delivery service.[105]
- A 2022 study in Ghana found that if e-cargo bikes claimed a large share in the modal split, they could reduce the greenhouse gas emissions from the country's urban freight transport system 4-8% per tonne-kilometre.[106]

Policy developments

Leading barriers to cycling include being too close to car traffic, a lack of quality infrastructure, perceptions of poor physical fitness, and negative community perceptions of cyclists.[107] Globally, a key enabler for a high cycling share is the presence of safe infrastructure.[108] People are more encouraged to cycle in locations that have good-quality paved roads, well-lit streets with low traffic volumes, and adequate physical on-street separation from motor vehicle traffic (for example, concrete barriers, metal bollards, planter boxes, a grass verge, railings, curbs or landscaping).[109] Cycle paths through parks and other car-free areas are also considered physically protected. Other enablers of cycling include secure bicycle storage, economic factors or incentives, environmental and health benefits, and seeing other people ride bikes.[110]

- In Tamale Metropolis (Ghana), researchers found that good-quality roads encourage bicycle commuting, as cyclists prefer paved main roads.[111]

i A conurbation is "a large area consisting of cities or towns that have grown so that there is very little room between them"; see Encyclopedia Britannica, https://www.britannica.com/dictionary/conurbation.

- In contrast, a study in Quelimane (Mozambique) found that people who commute by bicycle between the city periphery and suburban areas tend to take unpaved roads, as these are perceived as being safer (less motorised traffic), even if less comfortable.[112]
- In Addis Ababa (Ethiopia) and in townships in South Africa, people are discouraged from cycling due to poor road quality.[113] Ethiopia's Non-Motorised Transport Strategy targets building more than 300 kilometres of cycling track in secondary cities, as well as 200 kilometres of cycling lanes in Addis Ababa, by the year 2029.[114]
- Researchers in Vancouver (Canada) found that poorly lit bicycle lanes are strongly linked to low levels of cycling.[115]
- In a UK study, a top motivator influencing a person's decision to cycle was being able to make a cycling trip during daylight hours.[116]
- A global survey of 28 countries found that 52% of people consider cycling too dangerous in their area.[117]

Countries that have implemented national cycling promotion strategies include Finland, Germany, Japan and the Netherlands.[118] In 2022, studies found that Flanders (Belgium) leads in government financial investments in cycling, at EUR 45 (USD 49.5) per capita, followed by Ireland and Norway.[119]

- The Netherlands remains the European leader in planning for cycling. In 2015, the country's Tour de Force plan brought together various government and non-governmental entities, as well as businesses and academia, to promote cycling; in 2022, a proposed national vision for cycling called on the Dutch government to invest EUR 950 million (USD 1.03 billion) in cycling from 2022 to 2025, resulting in investments of EUR 13.6 (USD 14.8) per capita.[120]
- In November 2022, the Dutch government announced that it would make new investments of up to EUR 1 billion (USD 1.09 billion) from central government and city financial sources in new cycle routes, bicycle parking, and additional bridges and tunnels for cyclists.[121]
- Germany's national cycling plan for 2021-2030 is one of the most complete in Europe, with the aim of developing seamless cycling infrastructure, creating a country of cycling commuters and cyclists, and putting cycling at the heart of mobility systems.[122] The German government allocated EUR 1.5 billion (USD 1.9 billion) from 2021 to 2023 to support implementation of the plan.[123]

- In 2021, the German government's International Climate Initiative initiated a project to transform Ghana's freight transport system through the use of e-cargo bikes produced locally from 100% recycled materials.[124]

- Finland and Japan both have national strategies for cycling, demonstrating that those countries where the share of cycling is highest are also those that have implemented national cycling promotion plans, linked with financial investments.[125]

- In 2020, India launched the India Cycles4Change Challenge to inspire more than 100 cities to become cycling havens, resulting in pilot cycling-friendly solutions along 400 kilometres of main roads and 3,500 kilometres of neighbourhood streets.[126] The 25 most successful cities are receiving support to further integrate cycling in their streets through new cycling plans.[127]

- Canada released its first national active transport strategy in 2021 to provide CAD 400 million (USD 298.8 million) from 2021 to 2026.[128]

- In 2022, Colombia developed the National Strategy of Active Mobility with a Gender and Differential Approach (ENMA), which provides guidelines for local governments to promote walking and cycling, consider the needs of people with reduced mobility and disabilities, and advance gender equality.[129] The complementary Guide for Shared Bicycle Systems helps local governments evaluate the technical, regulatory and financial aspects for implementing bike sharing systems in large and small cities.[130] (*See Section 2.4 Latin America and the Caribbean Regional Overview.*)

- in 2022, Wellington City Council (New Zealand) approved a new long-term cycling plan, Paneke Pōneke Bike Network, aimed at expanding cycling networks to connect suburbs with the city centre.[131]

Many cities in Asia, Europe, Latin America and the Caribbean, and North America expanded their cycling networks during the COVID-19 pandemic by adding new lanes and tracks as well as pop-up bicycle infrastructure, in response to the increased demand for cycling. More than 2,500 kilometres of temporary cycling infrastructure was added in Europe over this period, much of which is now permanent.[132]

- Several dozen European cities announced or implemented pandemic-related cycling measures, of which 77% were new cycle lanes and tracks.[133] Studies found that cities that provided temporary cycling infrastructure (such as reallocating travel lanes to bikes) saw a much greater increase in cycling than those that did not.[134]

- During March to July 2020, the implementation of pop-up bike lanes contributed to 11-48% more cycling across 106 European cities.[135] For the cities that built pop-up lanes, if people stuck with their new cycling habits, the overall health cost savings would be more than USD 1 billion per year.[136]

- In recent decades, Paris has transformed its streets to become more people-oriented, a trend that accelerated following the onset of the pandemic.[137] Cycling lanes increased from just 5 kilometres in the 1990s to more than 240 kilometres by early 2023, while much of the city has been increasingly pedestrianised.[138] The share of walking among all trips increased from 38% in 2018 to 47% in 2022, while cycling increased from 2% to 5% during the same period.[139]

- London (UK) implemented 75 kilometres of new cycle lanes and tracks in 2020, the largest amount in Europe, followed by Milan (Italy) with 51 kilometres.[140]

- The municipal government of Beijing (China) committed in 2022 to improving walking and cycling infrastructure, and by October it had introduced 21 cycling routes totalling 730 kilometres.[141] In 2021, the city implemented around 52 kilometres of improvements in walking and cycling, and the share of these two modes among all trips reached an all-time high of 47.8%.[142]

- In 2021, the Philippines' Department of Transport completed 500 kilometres of bike lanes along the metro routes of three cities: Manila (313 kilometres), Cebu (129 kilometres) and Davao (55 kilometres).[143]

- In 2022, Jakarta (Indonesia) completed 309 kilometres of bike lanes, out of a total 500 kilometres planned, with government data showing that the average number of cyclists daily in the city had surged from 47 in 2005 to 4,000 in 2022.[144]

- Across India, 28 cities have identified a total of 210 square kilometres of neighbourhood areas to use to create cycling infrastructure, as well as a 340-kilometre pilot corridor.[145]

- Several cities in Canada set up temporary bike lanes to accommodate the pandemic cycling boom. Cities that have extended their bike lane networks since the onset of the pandemic include Calgary, Kitchener, Moncton, Montreal, Ottawa, Toronto, Vancouver, Victoria and Winnipeg.[146]

- In Montreal (Canada), the Société du parc Jean-Drapeau, which runs the park area that includes Île Sainte-Hélène and Île Notre-Dame, opened a year-round cycling route in winter 2022 between the Jacques-Cartier and Concorde bridges.[147]

- In 2022, Boston (USA) set a goal to enable half of the city's population to access a protected bike lane within a three-minute walk by 2025.[148] The plan involves building new cycling infrastructure, adding 100 new stations to the bike sharing system and installing more than 100 new speed humps or raised crosswalks to calm traffic on neighbourhood streets.[149]

- In February 2023, Fayetteville, Arkansas (USA) updated its Active Transportation Plan with a vision to "develop and promote an interconnected and universally accessible network of sidewalks, trails and on-street bicycle facilities that encourage citizens to use active/non-automotive modes of transportation to safely and efficiently reach any destination".[150]

- In 2020, Wollongong (Australia) developed a comprehensive 2030 cycling strategy with a 10-year vision to make cycling the preferred option for transport by the city's inhabitants.[151] The strategy includes commitments to build 50 kilometres of on-street cycling routes and 30 kilometres of off-street cycling routes via partnerships with state and federal partners, to expand the city's cycle infrastructure from 130 kilometres to 215 kilometres.[152]
- Abu Dhabi (United Arab Emirates) launched the Bike Abu Dhabi platform in 2021 to encourage cycling as a way to stay healthy and fit. Abu Dhabi provides 300 kilometres of dedicated cycle tracks, including a 20-kilometre urban track that is fully separated from car and pedestrian traffic; the government plans to link the city's cycling infrastructure with Dubai and to connect all city hubs in a loop with no interference from other modes of transport.[153]

In **Latin America**, cities are poised to advance cycling due to their high densities and mixed land uses, which would ensure high accessibility to resources and services via bicycle.[154] Several large cities in the region have started to adopt bike-friendly policies and to invest in cycling initiatives.[155] The pandemic fast-tracked cycling agendas in the region by presenting an opportunity to rapidly construct pop-up bike lanes that many cities hope to make permanent.[156]

- Bogotá (Colombia) attracted worldwide attention as one of the first cities to install temporary bike lanes to promote socially distanced transport during the pandemic; the city later integrated 28 kilometres of its 84-kilometre temporary bike lane system into its rapidly growing permanent system.[157] Bogotá had a total of 590 kilometres of cycling infrastructure in 2021 and plans to expand this to 830 kilometres by 2024.[158]
- Between 2019 and 2022, Mexico City built 206 kilometres of protected cycling lanes, more than the amount built in the previous 14 years (174 kilometres) and bringing the total network to 381 kilometres.[159] The goal is to expand the network to 600 kilometres and to reach 510,000 daily bicycle trips by 2024 to reduce transport-related emissions.[160]
- In 2021, the Buenos Aires (Argentina) set a goal to of achieving 1 million bike rides a day, along with a 17 kilometre expansion of protected bike lanes in the city centre.[161] Authorities report that demand for bicycles in Argentina since the pandemic grew 50%, and online bike sales increased 130%.[162] In 2022, the city met its goal of having 300 kilometres of protected

cycling lanes (up from 267 kilometres in 2020), and the city was set to reach 1 million daily bicycle trips in 2023, three times more than in 2019.[163] During the pandemic, there was also a surge in the bike share system, with 4,000 bicycles operating across 400 stations.[164]

- With the onset of the pandemic, Zapopan (Mexico) presented an emerging cycle lane strategy, which involves building three lanes totalling 15.3 kilometres to connect the city with Guadalajara, at an investment cost of MXN 30 million (USD 1.75 billion).[165] The first lane was built on Avenue Guadalupe from May to July 2020, in response to a 43% increase in morning ridership and a 33% increase in evening ridership on the corridor over the previous three years.[166] Ridership grew 26% from May to August of 2020, to 2,875 cyclists (31.6% more than in April 2016).[167]

In recent years, cycling policies have emerged as key measures for climate change adaptation and mitigation. Since 2018, when the United Nations (UN) declared June 3 as World Bicycle Day, several important developments have promoted cycling at the global and regional levels.[168]

- In March 2022, the **UN General Assembly** unanimously adopted a resolution on cycling promotion that makes several recommendations to member states, including above all "to integrate cycling into public transportation in urban and rural settings in developed and developing countries" to promote sustainable development and cut transport emissions.[169]
- The **Pan-European Master Plan for Cycling Promotion**, adopted in May 2021, aims to politically acknowledge the growing importance of cycling in transport and to give national-level guidance on how to support cycling through central government policies.[170] Covering 56 countries, including all 27 EU Member States, the plan was developed under the umbrella of the Transport, Health and Environment Pan-European Programme (THE PEP), co-ordinated by the World Health Organization Europe and the UN Economic Commission for Europe.[171]
- In February 2023, the **European Parliament** adopted a resolution calling for an EU cycling strategy with benchmarks for new funding and cycling infrastructure, marking the highest ever political endorsement of cycling made by an EU institution.[172] The resolution earmarks EUR 20 billion (USD 21.8 billion) to create 100,000 kilometres of cycle infrastructure in urban hubs and to extend the European cycle route network (EuroVelo) to boost rural connectivity and cycle tourism; the goal is to increase the number of kilometres that people cycle in Europe to 312 billion by 2030.[173]

As of March 2023, 31 (or 22%) of countries' second-generation Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement covered transport mitigation actions on cycling or active mobility.[174]

- Albania's second-generation NDC includes a target for cycling to comprise 5% of all passenger activity by 2030.[175]
- In its NDC, Egypt mentions the adoption of a national active mobility strategy, encouraging citizens to cycle and cities to build designated cycling lanes.[176]
- Vanuatu's updated NDC targets a fleet of 1,000 electric bicycles and rickshaws by 2030.[177]
- At the 2021 UN Climate Change Conference in Glasgow, United Kingdom (COP 26), ministers agreed on a global transport declaration that incorporated active travel for the first time ever at this level.[178] The last paragraph, added at the end of negotiations thanks to persistent lobbying from non-governmental organisations, states that "alongside the shift to zero emissions vehicles, a sustainable future for road transport will require wider system transformation, including support for active travel".[179]

Partnership in action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- In 2021, the **African Network for Walking and Cycling (ANWAC)** was created as a space for organisations and experts to convene and collaborate under the auspices of a common goal: making the life of people who walk and cycle in African countries safer, healthier and more comfortable through combined action, expertise and influence.[180]
- At COP 26 in 2021, the **European Cyclists' Federation (ECF)** spearheaded the joint open letter signed by 350 non-governmental organisations that helped influence transport ministers to include active mobility in their final declaration as a key means to decarbonise road transport.[181] Signatories included ECF, the Institute for Transportation and Development Policy (ITDP), PeopleForBikes, Union Cycliste Internationale (UCI), the International Association of Public Transport (UITP), the World Cycling Alliance (WCA) and Greenpeace.[182]
- At the 2022 UN Climate Change Conference in Sharm el-Sheikh, Egypt (COP 27), the **Partnership for Active Travel and Health (PATH)** co-ordinated a joint open letter signed by around 400 organisations from 73 countries urging government and city leaders to invest more in walking and cycling to achieve climate goals and improve quality of life.[183] PATH members include the Africa Network for Walking and Cycling, BYCS, the Dutch Cycling Embassy, ECF, the FIA Foundation, ITDP, SLOCAT, the Transport Decarbonisation Alliance, UCI, the UN Environment Programme, Walk21, WCA and the World Resources Institute.

- In 2021, the **Institute for Transportation and Development Policy** launched the **Cycling Cities** global campaign to influence 250 cities to design, adopt and implement more cycling-friendly plans by 2050. As of early 2023, the campaign had reached 28 cities and more than 40 partners working at the local, national and international level, with key milestones including reports on the economic case for cycling and on how cycle lanes cut CO_2 emissions.[184]

- In 2021, **Union Cycliste Internationale (UCI)** launched its new sustainability strategy with a vision to make cycling "one of the world's most sustainable sports and promote the bicycle as a key transport mode in combating climate change, improving population health and building a more sustainable future for all".[185] In 2022, UCI launched its Climate Action Charter. Both efforts are closely linked to UCI's Cycling for All Programme and objective of getting more people to cycle for daily transport.[186] UCI's Bike City label network, advocacy partnerships and resources promote cycling at the international level, in connection to the UN Sustainable Development Goals.[187]

- The **Bloomberg Initiative for Cycling Infrastructure**, a collaboration between Bloomberg Philanthropies and the Global Designing Cities Initiative, was launched in October 2022 with the aim of providing USD 400,000 to USD 1 million to 10 different cities (of more than 100,000 residents) worldwide to transform their cycling infrastructure.[188]

- In 2022, the **European Cyclists' Federation** published an annual review of national cycling strategies in Europe, covering 44 countries and showing good examples of national cycling strategies and plans, while also demonstrating the need for many countries to improve their implementation of cycling measures.[189]

Photo: Mikael Colville-Andersen

Shared Mobility

3.4.1	Public Transport	252
3.4.2	Informal Transport	268
3.4.3	App-Driven Shared Transport	284

MODULE 3 3.4.1

AUTHORS:
Anna Kustar, Thet Hein Tun and Benjamin Welle, *World Resources Institute*

Public Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Note: This section *3.4.1 Public Transport* covers any collective transport services in cities operated and regulated by public authorities. Informal transport is covered in *3.4.2 Informal Transport*, and any other shared services are covered in *3.4.3 App-Driven Shared Transport*.

Key findings

- The COVID-19 pandemic has had ongoing detrimental impacts on both mobility and public transport systems globally, with particularly severe impacts in low-income countries.
- As cities and countries opened up to travel and daily commuting, some public transport agencies piloted reduced fares and/or free service to incentivise ridership while maintaining safe and clean conditions.

Demand trends

- Ridership on public transport worldwide dropped 90% between March and August 2020 due to the COVID-19 pandemic but recovered gradually by late 2021.
- In many cases, the initial drop in ridership was not associated with infection rates but rather with people's fears of infection, as well as government stay-at-home orders. Subsequent declines in ridership were more often linked to infection rates, but as the pandemic persisted the correlation between infection rates and ridership decreased as people returned to regular mobility patterns.
- Many changes in working habits related to the COVID-19 pandemic have become permanent, affecting people's travel patterns and threatening funding for public transport.
- Among the major public transport modes (bus rapid transit, metro and light rail), metro systems showed the strongest growth between 2015 and 2021. Despite budget cuts, delays, and low ridership, public transport expansion projects continued during 2020-2021 in all major regions, with the opening of dozens of new train, bus, light rail and tram lines.
- Global bus rapid transit networks expanded modestly between 2020 and 2022, with operations starting in six new cities in Brazil, India, Kenya, and the United States, adding nearly 90 kilometres of corridors.

Emission trends

- Passenger emissions from both public transport and private motorised transport decreased dramatically in 2020 due to pandemic-related lockdowns. Commuting and the use of transport fell sharply and urban air quality improved, although essential workers continued to rely on both public and private transport to commute to work.
- To reduce emissions, many cities have introduced electric buses to their transport fleets. However, the largest emission reductions will occur only if the e-buses are charged using renewable rather than fossil fuel-based electricity. In 2021, electric bus sales grew 40% and an estimated 670,000 e-buses were in circulation worldwide, representing around 4% of the global bus fleet.
- China has dominated the e-bus market, hosting around 99% of the global stock in 2017 and expanding its fleet by nearly 100,000 e-buses annually. As of 2021, China remained home to more than 90% of the global fleet and accounted for 91.6% of global electric heavy-duty vehicle sales.

Policy developments

- Early in the COVID-19 pandemic, concerns about high transmission rates on public transport led to strict closures, severe policies, reduced services and social distancing protocols; however, as experts studied the mechanisms of transmission, and as public transport was considered safe, most countries loosened restrictions.
- As travel restrictions eased and as countries enacted economic recovery policies, many governments provided strong subsidies for public transport. Between March 2020 and February 2021, USD 130 billion in stimulus funding was leveraged globally to support green transport, with 30% going towards stabilising public transport and 26% towards rail construction and services.
- Some governments reduced transport fares to combat low ridership rates and to assist low-income populations and those most reliant on public transport.
- Although free access to public transport addresses equity concerns by eliminating the cost barrier, it may not be enough to encourage private vehicle users to shift towards more sustainable urban mobility options.
- As countries recognise the benefits of leveraging public transport as a climate tool, many have included public transport improvement plans in their Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement.
- In low- to middle-income countries, where most people do not own private vehicles, enhancing public transport is crucial for economic growth and improving living standards, although funding is challenging.

Overview

The COVID-19 pandemic has had ongoing detrimental impacts on both mobility and public transport systems globally, with particularly severe impacts in low-income countries. Even before governments intervened to restrict or modify public transport services to prevent transmission of the virus, ridership was down sharply as people feared close contact with others and high risk of infection.

During 2020-2022, public transport ridership recovered relatively quickly in some parts of Asia, South America, and Africa, even surpassing pre-pandemic levels (for example, in Colombia, India and Kenya).[1] However, public transport systems in North America and Europe continued to suffer from decreased ridership, lower revenue and difficulty maintaining the same level of reliable services for essential workers and those who rely on public transport for daily mobility. The pandemic revealed that public transport is a necessity in cities, not only for mobility and equity but also to reduce emissions and to prevent a shift to private vehicles.

As cities and countries opened up to travel and daily commuting, some public transport agencies piloted reduced fares and/or free service to incentivise ridership while maintaining safe and clean conditions. This led to innovations in monitoring, data collection and transport apps that allow riders to stay informed about schedules and crowds. Meanwhile, public transport networks – including bus routes, bus rapid transit corridors and light rail lines – resumed their expansions to reach more residents. Strategic investments in public transport can kickstart local economies by providing mobility and connecting people to economic and social opportunities that are beyond walking or biking distance.

In 2022, global markets were further hit by the Russian Federation's invasion of Ukraine, with rippling impacts on human lives, businesses and the global economy. Fuel prices rose sharply, with particularly heavy impacts across Europe, the largest market for Russian oil and gas. Many countries responded by reassessing their energy security policies and supply mixes, sparking investments in domestic renewable energy sources as well as greater support for electric vehicles.

The electrification of public transport and the development of charging infrastructure is a critical tool not only for reducing urban emissions and improving air quality, but also for improving the quality of public transport systems and preventing growth in private vehicle use. In 2022, the United States, a predominantly car-centric nation, committed unprecedented funding for climate change mitigation and transport infrastructure, including USD 40 billion for public transport through 2026, setting an example for federal investment in equity in mobility.[2]

As the urban population continues to expand globally, public transport improvements in low- and middle-income countries are critical. By establishing policies for clean transport, governments can help advance many of the United Nations Sustainable Development Goals (SDGs), improving air quality and equity while also providing economic opportunity and incentives to invest in clean energy solutions.

Demand trends

Ridership on public transport worldwide dropped 90% between March and August 2020 due to the COVID-19 pandemic but had recovered gradually by late 2021.[3] Global metro use fell 40% in 2020 compared to the previous year, with the highest decline in North America at 63%.[4] However, the resilience of public transport to rising infection rates, and the recovery time of ridership, have varied widely by country and region (see Figure 1).[5] In 2022, public transport levels remained below pre-COVID-19 levels in Japan, Sweden, the United Kingdom and the United States, among other countries.[6]

- In Europe, operators sought to maintain public transport services at 70% of pre-pandemic levels in 2020 to guarantee reliable access; however, fare revenue still fell 90% due to low ridership.[7] Passenger capacity in Italy remained at 50% in 2021, requiring government subsidies to support public transport.[8]
- In Singapore, public transport ridership recovered to around 75% of the 2019 level by January 2022, and taxi and private-hire cars experienced even quicker recovery.[9]

- In the United States, public transport ridership is projected to rebound only gradually in the short term, to achieve 75% recovery by the end of 2025.[10]
- In regions where a large share of the population relies on public transport for daily mobility – such as Latin America and Africa – ridership recovered relatively quickly and was more resilient to further spikes in infection rates.[11]

In many cases, the initial drop in public transport ridership was not associated with infection rates but rather with people's fears of infection (see Box 1)**, as well as government stay-at-home orders** (see Figure 1).[12] **Subsequent declines in ridership were more often linked to infection rates, but as the pandemic persisted the correlation between infection rates and ridership decreased as people returned to regular mobility patterns.**

- In 2020, metro ridership globally fell 40% on average compared to 2019, with declines ranging from 32% in the Asia-Pacific region to 63% in North America.[13]
- New York City, with the largest metro system in the United States, experienced one of the sharpest declines in ridership in 2020, losing nearly two-thirds of passenger volume.[14] Ridership on the city's metro is projected to reach 69% of pre-COVID-19 levels in 2023 and 80% by 2026, with a structural deficit of USD 2.5 billion by 2025.[15]
- Among cities studied, Delhi (India) had the greatest loss in metro ridership in 2020, due to a five-month closure.[16]
- Of the top 15 cities for pre-pandemic metro ridership (Tokyo, Moscow, Shanghai, Beijing, Seoul, Guangzhou, Delhi, New York City, Mexico City, Hong Kong, London, Paris, São Paulo, Shenzhen and Singapore), all of them experienced a decline in ridership of 27% or more, except Shenzhen, China, where ridership fell only 13%, likely due to the expansion of the city's network by around one-third during this period.[17]
- In China, bus ridership was on the decline even before the pandemic, notably in Guangzhou, where ridership fell from 7.1 million in 2015 to 3.7 million in 2020.[18] This was likely due to the rise of alternative mobility options such as expanded metro access and shared mobility services. Guangzhou's metro lines exceeded 600 kilometres in 2022, with the partial opening of Line 22 and additional construction under way.[19]

Many changes in working habits related to the COVID-19 pandemic have become permanent, affecting people's travel patterns and threatening funding for public transport. As flexible and hybrid working schemes have been adopted, many workers are continuing to work remotely some days of the week even after the lifting of pandemic-related restrictions.[20] Remote working, initially widely adopted for public health reasons, is increasingly becoming a combination of personal choice and business need.[21] The increase in remote work also has affected residential choices, leading more people to relocate outside of cities to smaller towns or to areas without good public transport.[22]

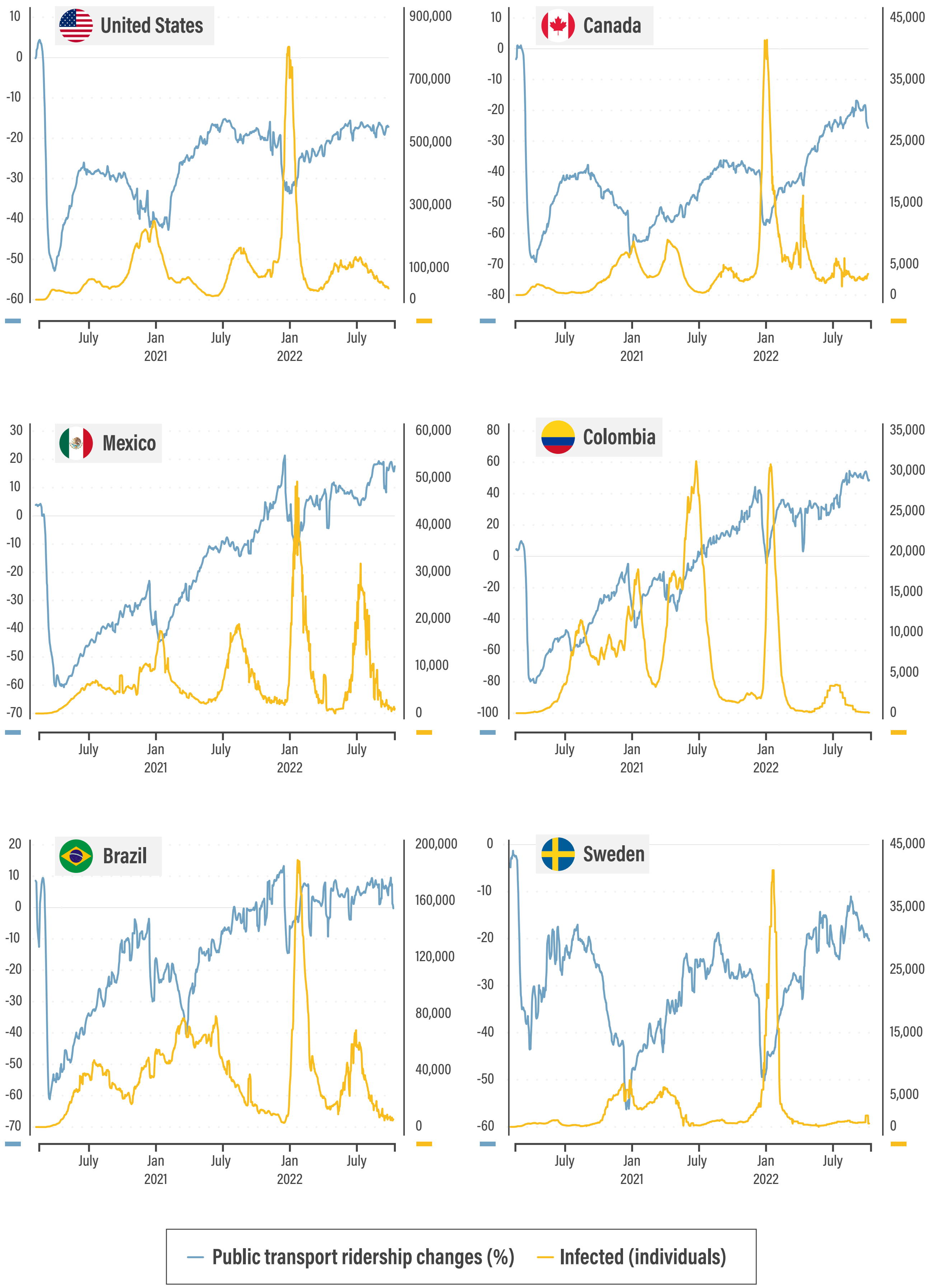
These trends contribute to lower levels of public transport use, particularly during rush hours, compared to pre-pandemic values.[23] The resulting reduced revenue from fares, complemented with reduced government subsidies and a lack of proper funding, can lead to budget deficits and quality of service deterioration, making public transport services less attractive and leading to greater private car use.[24]

In February 2022, the Russian Federation's invasion of Ukraine sparked new travel restrictions and economic sanctions.[25] A subsequent US ban on imports of Russian oil, natural gas, and coal, as well as the European Union's pledge to cut imports of Russian oil by two-thirds, led to a surge in energy prices globally.[26] The price of crude oil increased 45% between January and March 2022, raising the cost of global commerce and travel.[27] The energy crisis led many countries, mainly in Europe, to introduce energy-saving policies.

- In 2021, Austria introduced the KlimaTicket, which offers almost unlimited use of public transport country-wide for an adult fare of EUR 1,095 (USD 1,169) annually or EUR 3 (USD 3-20) per day.[28]
- Between June and August 2022, Germany introduced the EUR 9 (USD 9.61) public transport ticket – covering all rides on a public bus, rail, tram or metro during the month of purchase – to maintain affordability and save fuel by encouraging a shift from cars to public transport.[29] In August 2022, the government announced the successor EUR 49 (USD 52.31) Deutschlandticket to start in 2023.[30]
- In April 2022, Chile's president announced Chile Apoya, an economic recovery package of 21 measures that included freezing public transport fares for the year in response to rising global oil prices.[31]
- In the Philippines, the rise in transport costs has contributed greatly to inflation. Transport inflation in the country averaged 3.84% annually between 2013 and 2022 but hit 9.7% in 2021 and 12.9% in 2022.[32] Without government intervention, collective transport in the Philippines (and several other countries) could collapse in the face of rising oil prices related to the Russian invasion of Ukraine.[33].
- In December 2022, the United Kingdom announced a GBP 60 million (USD 72 million) investment to cap single bus fares at GBP 2 (USD 2.4) from January to March 2023 (later extended through June 2023), allowing passengers to save nearly a third of the ticket price on average.[34] As part of the government's Help for Households campaign, the scheme was adopted by 130 bus operators nationwide and aimed to alleviate the rising costs of living, reduce emissions and congestion, and help the bus industry recover from the pandemic.[35]

FIGURE 1. Public transport ridership in selected countries as a percentage of pre-COVID-19 levels, and the number of infected individuals from February 15, 2020 to October 15, 2022

Source: See endnote 5 for this section.



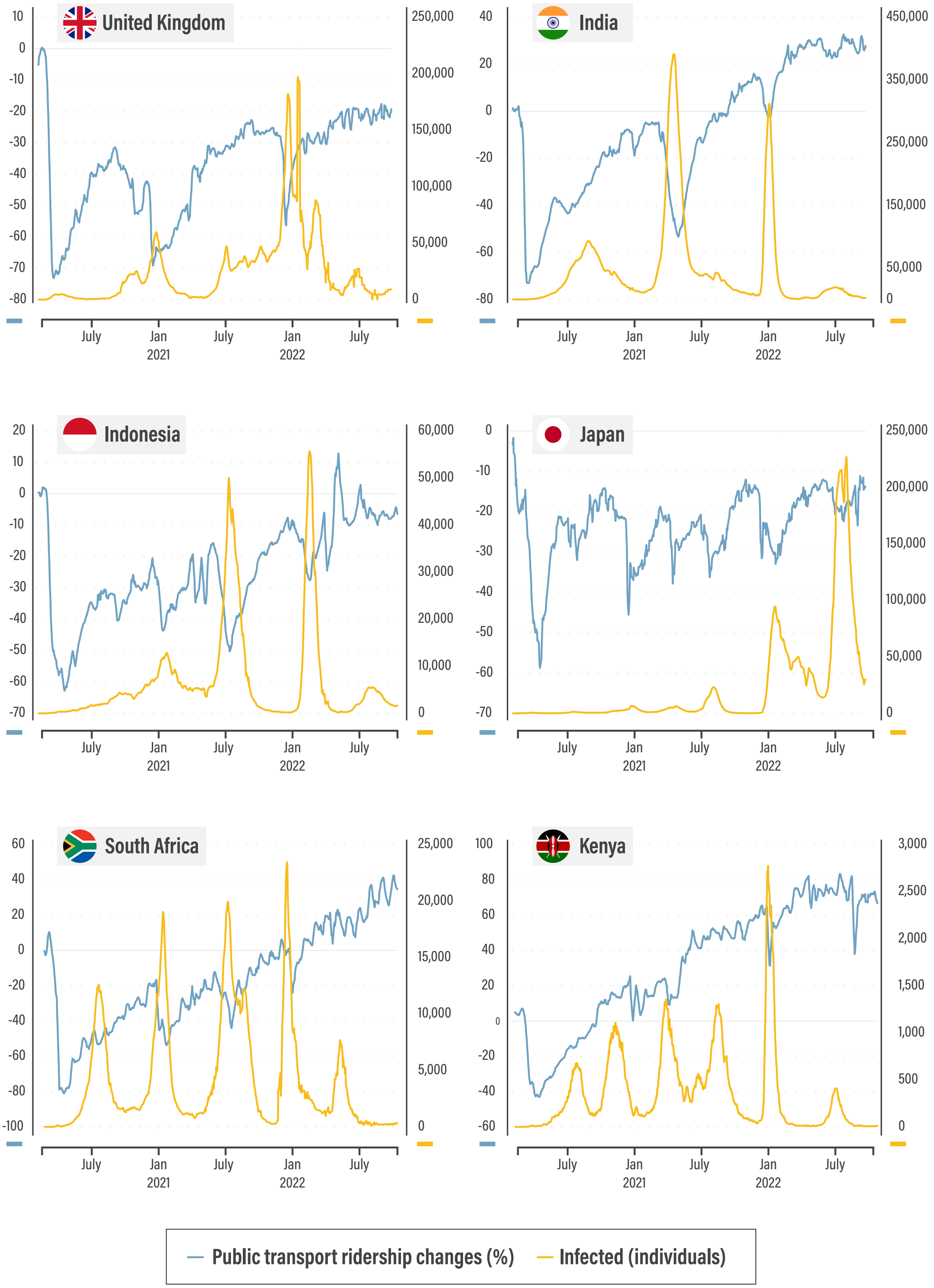
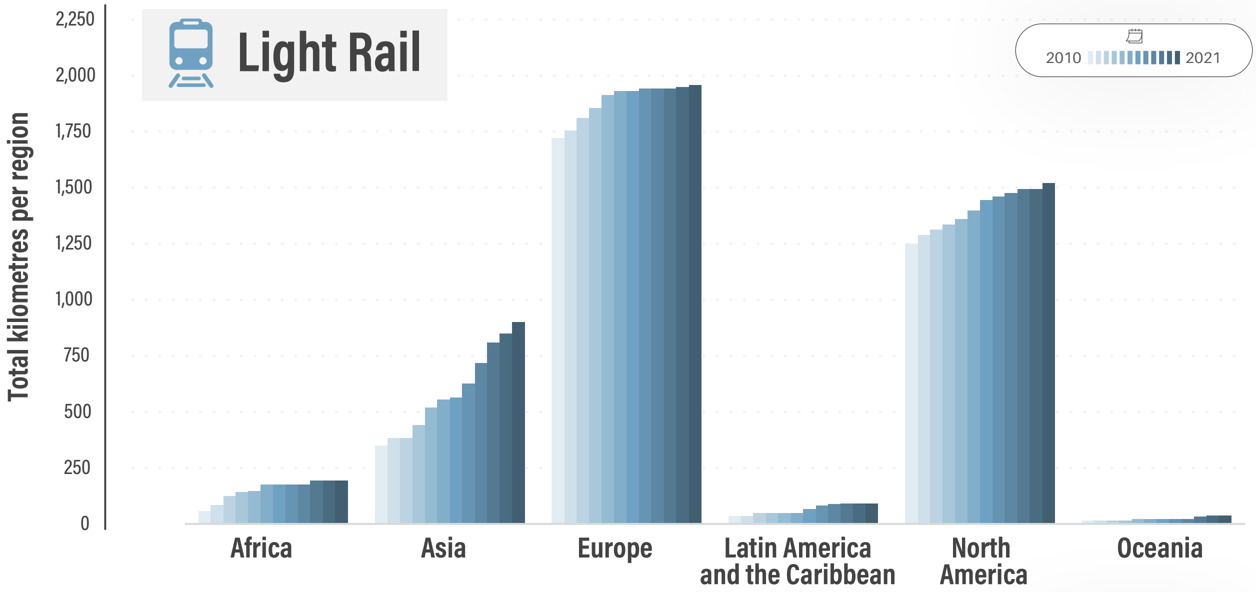
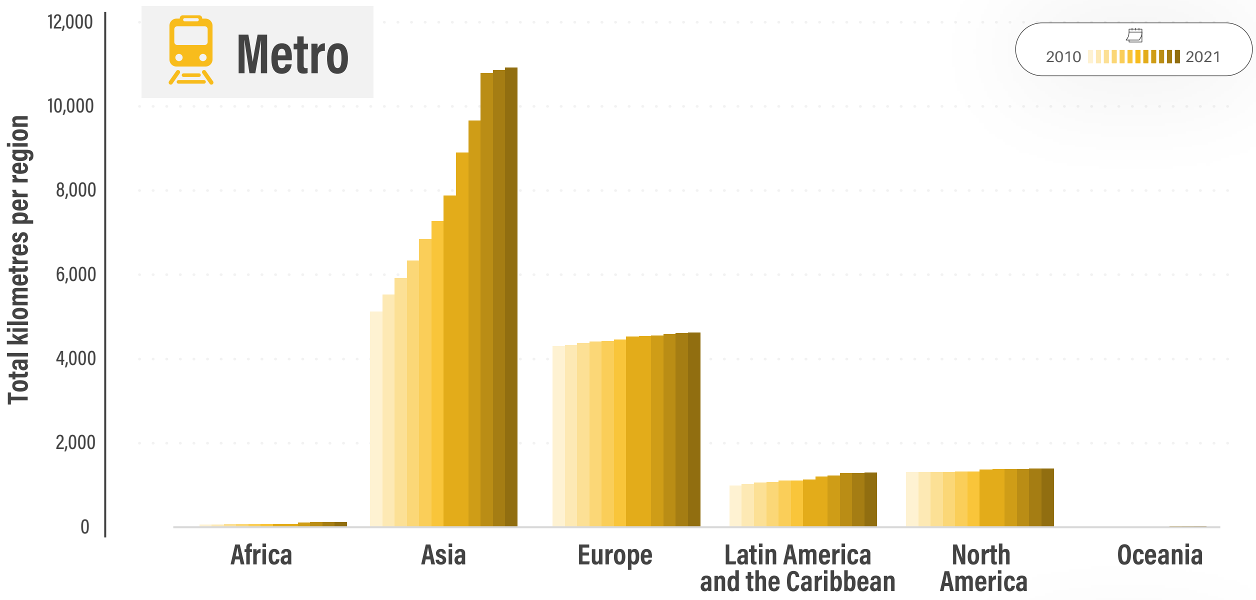
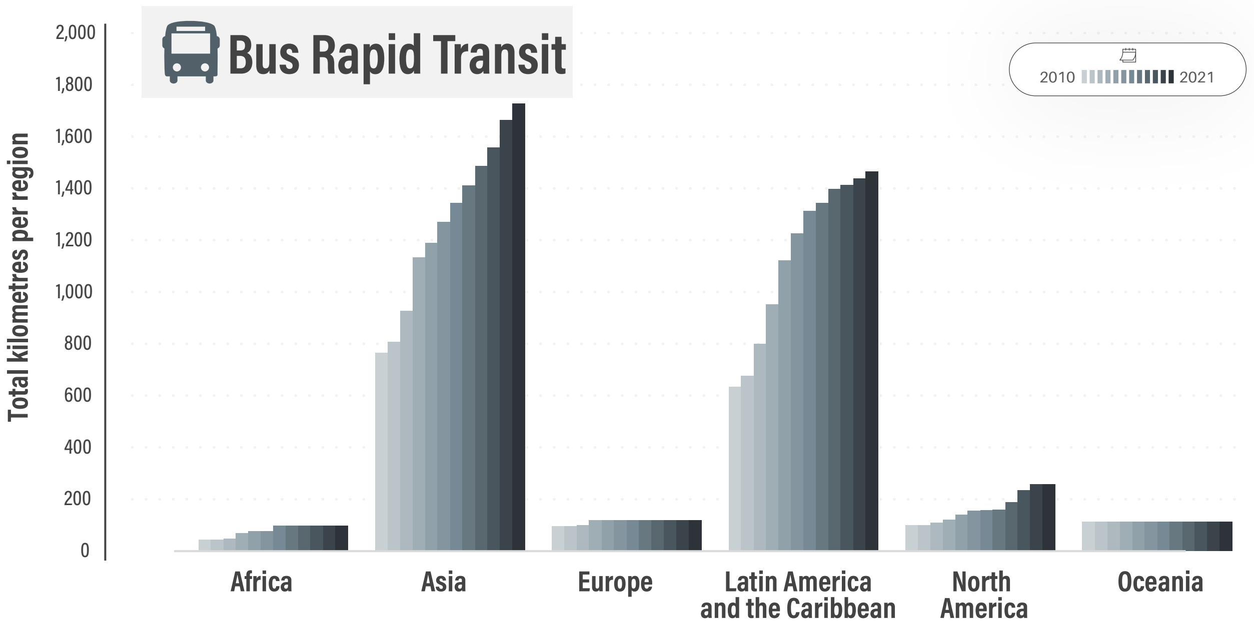

United Kingdom
10
0
-10
-20
-30
-40
-50
-60
-70
-80
250,000
200,000
150,000
100,000
50,000
0
July
Jan
2021
July
Jan
2022
July
India
40
20
0
-20
-40
-60
-80
450,000
350,000
250,000
150,000
50,000
0
July
Jan
2021
July
Jan
2022
July
Indonesia
20
10
0
-10
-20
-30
-40
-50
-60
-70
60,000
50,000
40,000
30,000
20,000
10,000
0
July
Jan
2021
July
Jan
2022
July
Japan
0
-10
-20
-30
-40
-50
-60
-70
250,000
200,000
150,000
100,000
50,000
0
July
Jan
2021
July
Jan
2022
July
South Africa
60
40
20
0
-20
-40
-60
-80
-100
25,000
20,000
15,000
10,000
5,000
0
July
Jan
2021
July
Jan
2022
July
Kenya
100
80
60
40
20
0
-20
-40
-60
3,000
2,500
2,000
1,500
1,000
500
0
July
Jan
2021
July
Jan
2022
July
Public transport ridership changes (%)
Infected (individuals)

FIGURE 2. Growth of major public transport systems by region, 2010-2021

Source: See endnote 44 for this section.







BOX 1. Perception of safety on public transport

A key factor shaping demand for public transport is passengers' perceptions of safety regarding public health and crime rates. The COVID-19 pandemic initially instilled fear and anxiety about increased risk of exposure to pathogens while on board, but extensive studies revealed that, with the right sanitation and safety measures in place, the risk of infection was low. Despite this, popular media contributed to people's fears and reluctance to return to public transport. A study from China found that anxious passengers tend to focus on sensational information and rumours, resulting in heightened anxiety about health safety. Access and exposure to reliable information can reduce anxiety, but this is dependent on timely information and details on the effective measures put in place to keep passengers safe.

Along with concerns about public health, in 2021 a rise in violent crime on public transport systems was noted in multiple US cities including Charlotte, Chicago, Seattle and New York, potentially deterring riders from returning to public transport. Women tend to be more impacted by personal safety concerns and use public transport for different purposes than men.

Estimates suggest that public transport is the second most common location where sexual harassment occurs, after public streets, although reliable data are lacking due to underreporting. Existing studies offer mixed and even contradictory information about conditions in which harassment is more likely to occur, as it can take place during any hour, during the day or at night, on crowded vehicles or in isolated locations, on board or waiting at stations. Globally, women represent the majority of public transport riders, and safety is a key factor influencing women's mobility decisions, but most existing infrastructure has not considered these needs.

Measures to improve accessibility and safety include providing stations with lifts, ensuring bright lighting at stations, minimising the gap between the ground or platform and vehicle, reserving seats for women near the driver, ensuring access to public restrooms with child-changing areas, and having an option for fixed-rate day passes to keep fares low for those who make multiple stops.

- Several countries – including Brazil, Egypt, Indonesia and Mexico – have addressed women's concerns for safety on board by reserving the front of buses or metro carriages for women and children, with the police responsible for enforcement.
- Studies show that men typically travel more directly from point A to point B than women do and are willing to travel farther (having on average a 14% longer commute than women). Women's travel patterns are more complex, as they are typically responsible for family care and are more likely to travel with small children or elderly individuals. Public transport stations and vehicles can address these challenges by accommodating wheelchairs and strollers and providing well-marked and accessible seating for diverse populations.
- Women are twice as likely as men to drop off or pick up children, which restricts the flexibility of their departure time. Having a child is correlated with a 23% increase in the number of women's trips, and mothers are also more likely to make multiple stops along their commute, or to "trip chain" for non-work-related purposes. Consequently, women are more impacted by environmental issues (weather and pollution) than men, particularly when waiting at unprotected or unsheltered stops.
- In Colombia, reductions in public transport services during the pandemic disproportionally affected women, who take more frequent and shorter trips than men. In terms of overall security, emptier streets with fewer bystanders increased concerns about safety.

Source: See endnote 12 for this section.

Photo: Ashden

Among the major public transport modes (bus rapid transit, metro and light rail), metro systems showed the strongest growth between 2015 and 2021.[36] **Despite budget cuts, delays, and low ridership, public transport expansion projects continued during 2020-2021 in all major regions, with the opening of dozens of new train, bus, light rail and tram lines** (see Figure 2).[37] Additional projects were completed in 2022 as economies recovered and as ridership returned to near pre-pandemic levels.

- The few expansion projects completed in 2021 included the opening of a regional commuter train in Dakar (Senegal); the launch of Tramway 9 in Paris (France) to link the city and suburbs; and the extension of the Northern Line in London (UK) to Battersea – London's first metro extension this century.[38]
- In China, metro expansions – including maglev trains – were completed in Beijing (56 kilometres), Guangzhou (90 kilometres), Shanghai (102 kilometres) and Shenzhen (107 kilometres) during 2020-2022.[39]
- In 2022, the extension of the 18.3-kilometre Silver Line metro in Washington, D.C. (USA) to Dulles Airport was completed, and four commuter rails opened in the US states of California, Florida and New York.[40]
- In Africa, metro lines were expanded in Algiers (Algeria), Cairo (Egypt) and Lagos (Nigeria) during 2022.[41]
- In Latin America, a new metro system started operating in Quito (Ecuador) in December 2022, the first in the country.[42]

Global bus rapid transit networks expanded modestly between 2020 and 2022, with operations starting in six new cities in Brazil, India, Kenya, and the United States, adding nearly 90 kilometres of corridors.[43] During 2020-2021, no apparent expansion of bus rapid transit occurred in Africa, Europe, North America or Oceania, whereas slight expansion occurred in Latin America and noticeable growth took place in Asia (see Figure 2).[44] As of March 2023, 186 cities had bus rapid transit systems in operation, 30 cities were expanding existing networks, and 52 cities were planning or starting construction.[45]

Emission trends

Passenger emissions from both public transport and private motorised transport (automobiles and motorcycles) decreased dramatically in 2020 due to COVID-19-related lockdowns.[46] **Commuting and the use of transport fell sharply and urban air quality improved, although essential workers continued to rely on both public and private transport to commute to work.** Research from this period found a positive correlation between public transport ridership and reduced pollution in selected countries.[47]

Overall, however, emissions continue to correlate with a country's per capita gross domestic product, meaning that high-income countries have higher transport-related carbon dioxide (CO_2) emissions (*see Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).[48] In 2021, transport CO_2 emissions increased but did not yet return to pre-pandemic levels, with most of the increase originating from private vehicles (see Figures 3 and 4).[49]

- A report on air quality found that 9 of 10 major cities observed lower levels of particulate matter ($PM_{2.5}$) pollution in 2020 compared to the same period in 2019.[50]
- With its first major lockdown in 2020, Los Angeles (USA), which historically has had very poor air quality, experienced clean air and blue skies.[51]
- Many cities that typically struggle with dangerously high levels of $PM_{2.5}$ pollution saw the greatest improvements during the early pandemic lockdowns – including Delhi (India), with reductions of 60%; Seoul (Republic of Korea) with reductions of 54%; and Wuhan (China) with reductions of 44%.[52]
- In some cities, CO_2 emissions from public transport continued to decline in 2021 – including in Sydney (Australia), Guadalajara (Mexico), Houston and San Francisco (USA), Montreal and Toronto (Canada), Osaka (Japan) and Porto Alegre (Brazil) (see Figure 3).[53]

To reduce emissions, many cities have introduced electric buses to their transport fleets. However, the largest emission reductions will occur only if the e-buses are charged using renewable rather than fossil fuel-based electricity. In 2021, electric bus sales grew 40% and an estimated 670,000 e-buses were in circulation worldwide, representing around 4% of the global bus fleet.[54] With multiple manufacturers and different design needs for various regions (for example, smaller buses to navigate narrow streets in Europe and Japan compared to China and the United States), the availability of electric models continues to expand across leading markets.[55]

China has dominated the e-bus market, hosting around 99% of the global stock in 2017 and expanding its fleet by nearly 100,000 e-buses annually.[56] **As of 2021, China remained home to more than 90% of the global fleet and accounted for 91.6% of global electric heavy-duty vehicle sales.**[57] The Chinese government has provided significant subsidies for the rapid electrification of buses, although much of this support was set to expire in 2022. However, it has enabled Chinese manufacturers to

FIGURE 3. Emissions from public transport (including buses, rails, subways and trams) versus other modes (automobiles and motorcycles) in selected cities, 2018-2021

Source: See endnote 49 for this section.

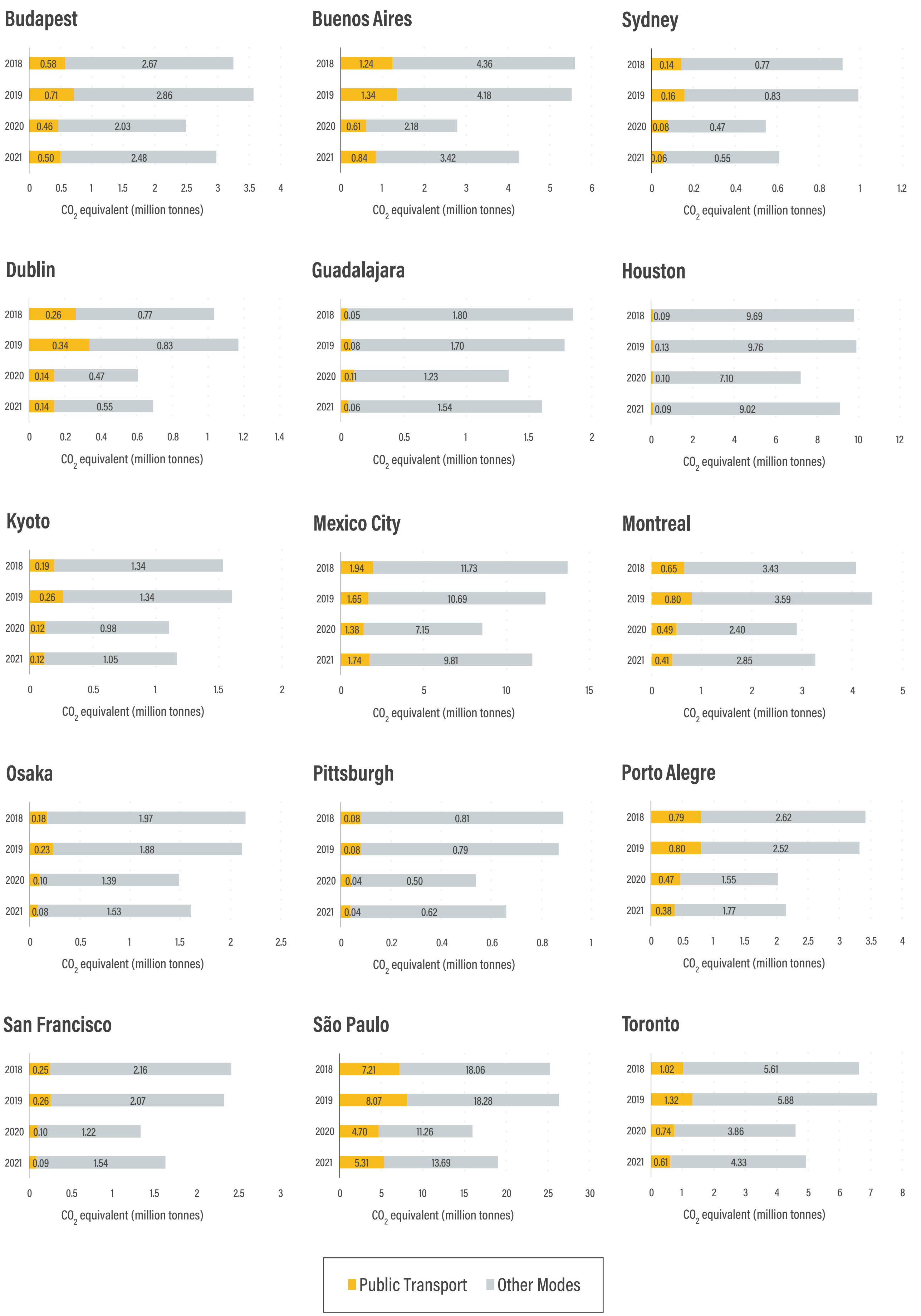
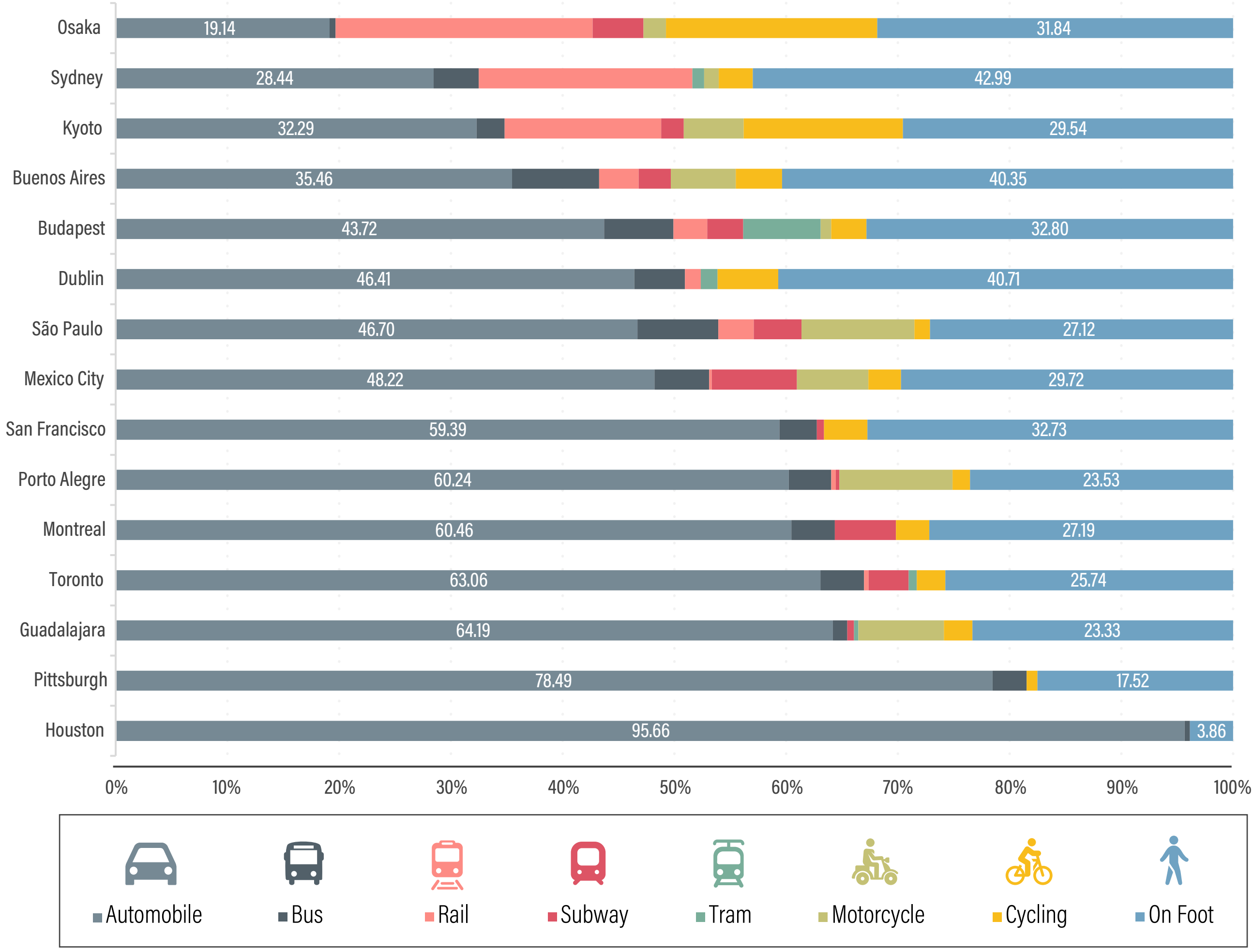


FIGURE 4. Modal share of selected cities, by total number of trips, 2021

Source: See endnote 49 for this section.



expand into other markets, such as the Asia-Pacific region and Europe.[58] China's BYD, the largest electric vehicle manufacturer globally, has an advantage in both operating costs and technology, as its models have the longest ranges (up to 350 kilometres) and are customisable in size and range to different countries' needs.[59]

In many markets, the lower total cost of ownership of electric buses has made them more favourable economically.[60] Once the high purchase costs can be overcome, the operation and maintenance of electric buses is considerably lower than for diesel buses.

- In Indonesia, an electric bus travelling 80,000 kilometres a year will save an estimated 79% in fuel costs compared to a diesel bus covering the same distance.[61]
- Electric buses in India show a lower total cost of ownership, even without any subsidy schemes.[62]
- In 2022, Bogotá (Colombia) expanded its e-bus fleet and built the largest bus depot outside of China.[63] With all 1,485 of the city's e-buses in service, annual avoided CO_2 emissions are projected to reach 94,300 tonnes.[64] Elsewhere in Latin America, Chile had 1,223 e-buses, and Mexico had 606, as of 2022.[65]
- India's Grand Challenge, developed under the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) II scheme, introduced 5,450 e-buses across five cities in 2020.[66] Following the success of the initial project, the government plans to expand fleets by 50,000 e-buses through 2030, with 64 selected cities receiving at least 25 buses each.[67]
- For the 2022 FIFA World Cup, Qatar deployed 900 e-buses, the majority of which (741) were manufactured by China's Yutong.[68] The Swedish-Swiss company ABB provided more than 125 megawatts of charging capacity.[69] Although e-buses comprise 30% of Qatar's Mowasalat public transport fleet, 99%

of the country's energy comes from fossil gas (with a target for 20% solar by 2030), resulting in only limited emission reductions from the uptake of electric transport.[70]

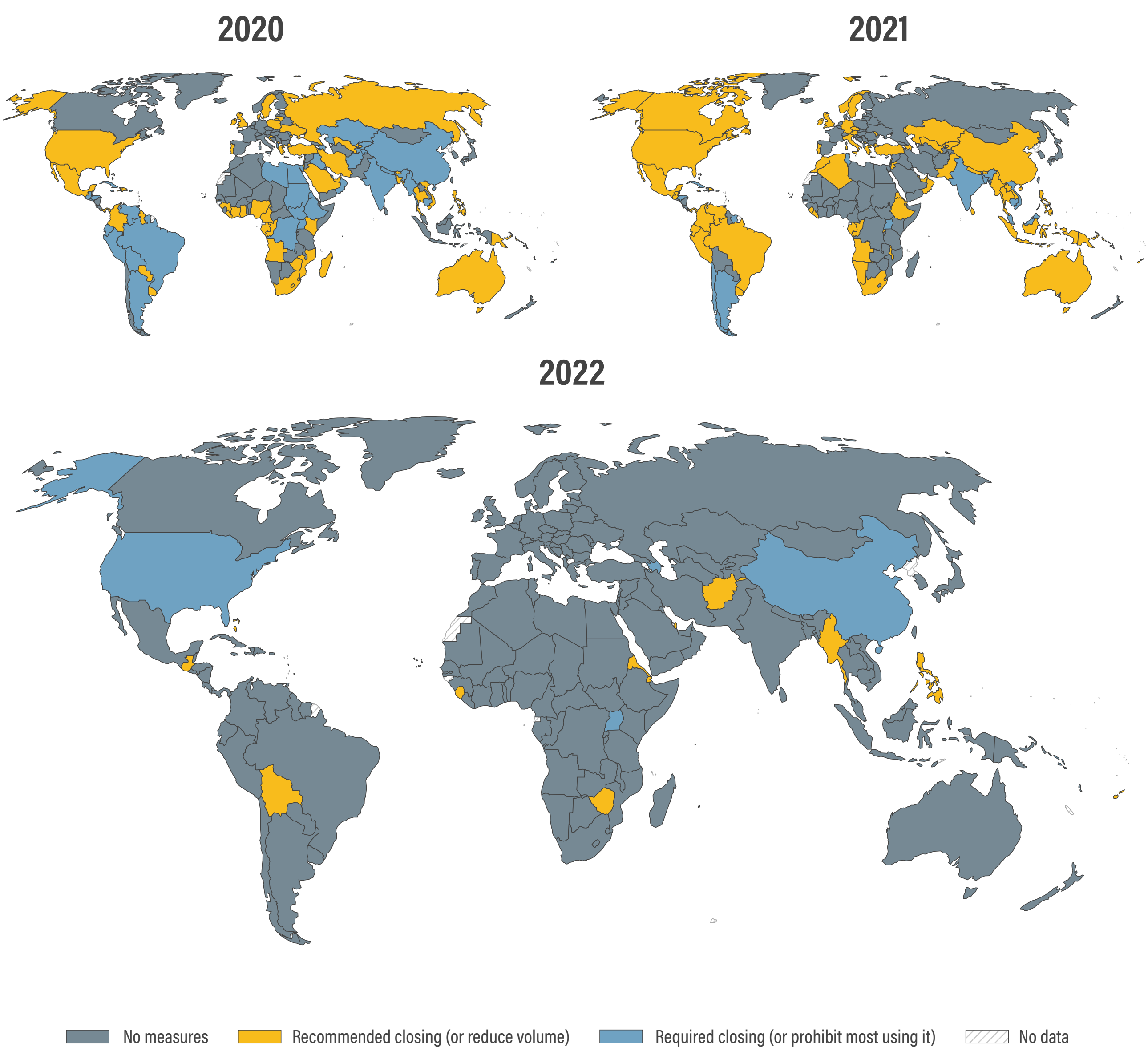
- In Europe, the increase in e-bus sales is attributed to national and city-level electrification targets, as well as the EU Clean Vehicles Directive, which mandates the procurement of zero-emission buses.[71] (*See Section 4.2 Vehicle Technologies.*)
- In 2021, three European countries registered more than 500 e-buses each: Germany (555), the United Kingdom (540) and France (512).[72] The United Kingdom's largest bus and coach operator, Stagecoach, planned to expand its e-bus fleet 80% in 2023 as part of its commitment to becoming a net zero business.[73]

Policy developments

Early in the COVID-19 pandemic, concerns about high transmission rates on public transport led to strict closures, severe policies, reduced services and social distancing protocols; however, as experts studied the mechanisms of transmission, and as public transport was considered safe, most countries loosened restrictions (see Figure 5).[74] Table 1 provides a summary of city-level public transport policy actions in response to the pandemic.[75]

FIGURE 5. Snapshots of public transport closure policies on June 30 of 2020, 2021 and 2022

Source: See endnote 74 for this section.



Note: The response level of the strictest sub-national level is shown if policies vary within a country.

TABLE 1. Transport policy responses to COVID-19 in selected cities, 2020

Source: See endnote 75 for this section.

Location	Initiative	Date	Description
Newport, UK	On-demand services (bus, ridehailing)	May 2020	Transport for Wales introduced the pilot programme fflecsi, run by local bus operators, to provide a safe and sustainable on-demand bus service for essential workers. As of 2022, it was still operating in addition to regular scheduled bus services.
Île-de-France, France	Alternative work sites to smooth transport demand	June 2020	The *Lissage des Heures de pointe @SmartWork* (Smoothing of Peak Hours @SmartWork) service provides educational materials and videos to inform residents about teleworking, alternative work sites away from home and active mobility options for commuting. The goal is to encourage citizens to rethink their transport habits and find collaborative teleworking space closer to home.
Singra, Bangladesh	Expanded e-rickshaw fleets for emergency services	April 2020	Singra Municipality, with support from TUMI, implemented 10 e-rickshaws for public transport and 2 emergency vehicles; constructed an e-rickshaw garage; and provided safety training for drivers. The vehicles are used for the "home delivery system" of food to the public, to collect samples for COVID-19 testing, and to extend emergency services to rural areas.
Kinshasa, Republic of the Congo	Contact tracing system for public transport users (bus)	April 2020	The programme uses an SMS system to trace the chain of contamination by identifying anyone who took the same public transport vehicle as a sick patient. This makes it possible to find potentially exposed people and to test them quickly, then to disinfect the vehicle in question. The system is completely accessible to all strata of the population.

As travel restrictions eased and as countries enacted economic recovery policies, many governments provided strong subsidies for public transport. Between March 2020 and February 2021, USD 130 billion in stimulus funding was leveraged globally to support green transport, with 30% going towards stabilising public transport and 26% towards rail construction and services (see Figure 6).[76]

Some governments reduced transport fares to combat low ridership rates and to assist low-income populations and those most reliant on public transport. Although free access to public transport addresses equity concerns by eliminating the cost barrier, it may not be enough to encourage private vehicle users to shift towards more sustainable urban mobility options.

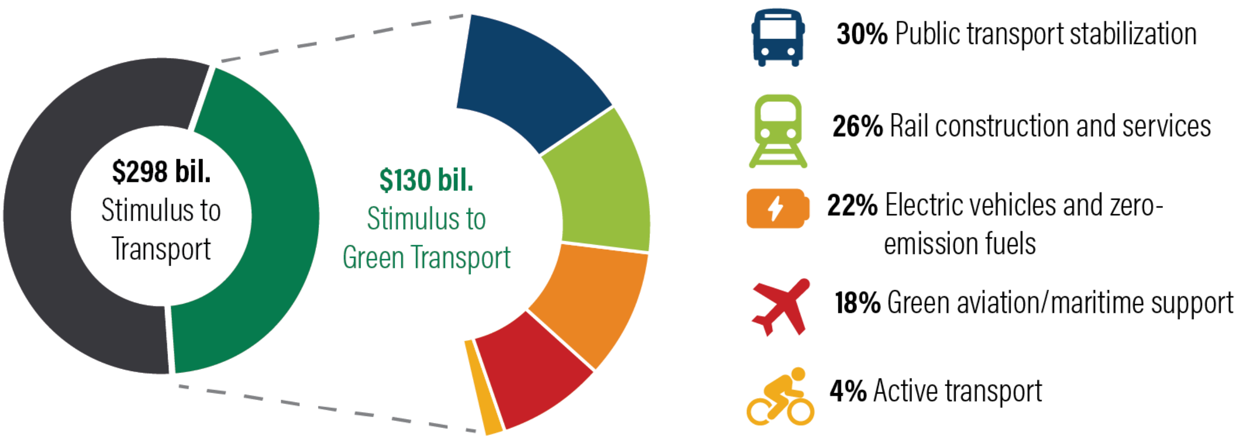
- In Brazil, where pandemic-related restrictions contributed to an estimated USD 188 million loss in daily fare revenues for bus operators, the government allocated 22% of subsidies to cover fare costs and to make public transport more accessible in over 150 cities as of June 2022.[77]
- Ireland, Italy, New Zealand and the US state of Utah were among the places that introduced reduced fares during 2021-2022.[78]
- Some cities, as well as the country of Luxembourg, have trialled and/or fully implemented free ticketing and fares for public transport.[79] All public transport is free in Morungaba (Brazil); in the United States, Albuquerque has implemented free buses, and both Washington, D.C. and Worcester intended to do so in 2023.[80]

In addition to municipal-level action, national governments have provided critical funding and policy support to increase the use of public transport. **As countries recognise the benefits of leveraging public transport as a climate tool, many have included public transport improvement plans in their Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement.** One analysis found that 100 of the 142 first- and second-round NDC submissions as of the end of 2021 included measures pertaining to public transport.[81] However, only 26 of the NDCs established quantitative targets for measures such as electrification, shifting from private motor vehicles to public transport and expanding public transport infrastructure.[82]

Further analysis explored the increased ambition between the initial NDC submissions (2015) and the more recent (updated) submissions.[83] Overall, measures pertaining to

FIGURE 6. Allocation of green stimulus funding, March 2020 to February 2021

Source: See endnote 76 for this section.



public transport increased from 63 in the initial round to 65 in the updated NDCs.[84] However, these are net numbers: 25 initial NDC submissions that had included public transport removed the measures in the updated round, and 27 new NDCs included it in their updates, for a total of 90 NDCs that featured public transport measures in at least one edition of the document.[85] As electrification has gained attention, the number of NDCs including electrification (of both private and public transport) rose from 27 in the initial round (21 measures and 6 targets) to 68 in the updated round (44 measures and 24 targets) (see Figure 7).[86]

The NDCs mention various tools to harness public transport to positively impact the health, equity and economic development of cities. They include measures to improve affordable public transport, curtail motorised travel demand, decarbonise and electrify vehicles, improve the safety of road infrastructure, and promote more active lifestyles through cycling and walking the final leg of public transport journeys.

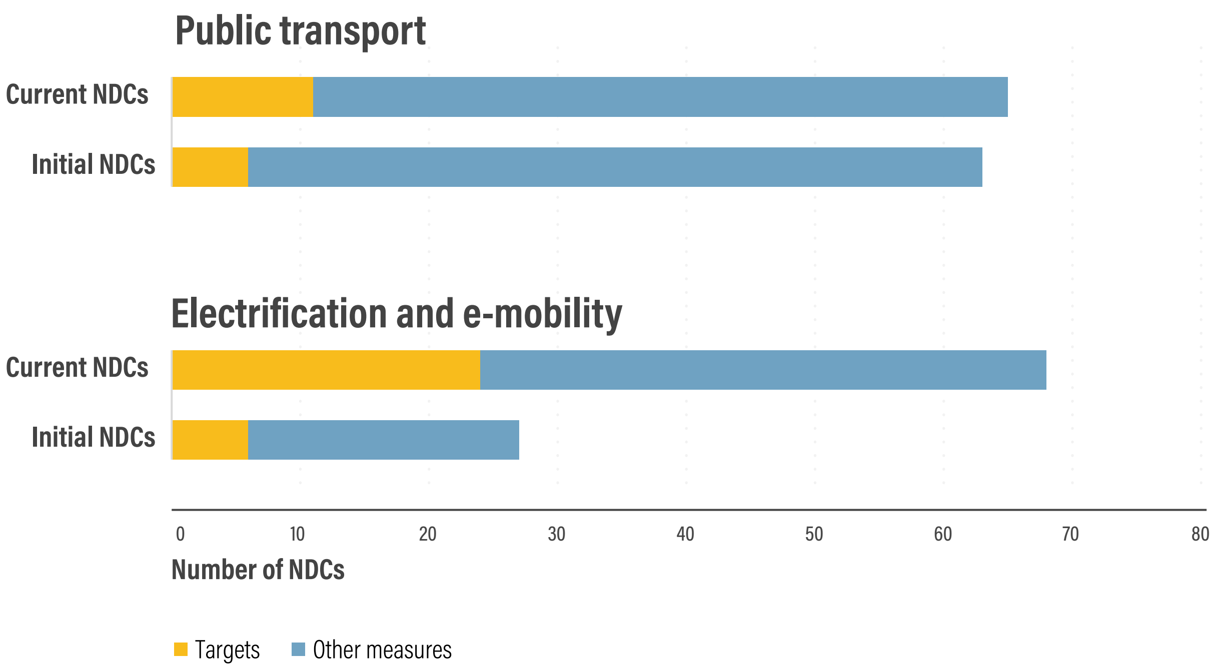
In addition, national governments and private enterprises have continued to invest in transport and public infrastructure. In the United States, the 2022 Inflation Reduction Act, coupled with investments provided through the bipartisan Infrastructure Investment and Jobs Act, allocate an unprecedented USD 3 trillion in funding for infrastructure, with a focus on justice and equity.[87] Over five years, public transport will receive nearly USD 40 billion to fund the backlog of system repairs and deficiencies, including adding around 24,000 buses and 5,000 rail cars, as well as expanding public transport networks and improving accessibility.[88] A further USD 66 billion will go to the repair and improvement of passenger and freight rail.[89]

In low- to middle-income countries, where most people do not own private vehicles, enhancing public transport is crucial for economic growth and improving living standards, although funding is challenging. Between 2007 and 2020, China's Belt and Road Initiative provided more than USD 19 billion to fund transport projects across Africa.[90] However, some countries – including the Democratic Republic of the Congo, Ghana and Kenya – have cancelled contracts over lack of transparency and inability to pay back loans.[91]

In Africa and other growing economies, it is critical that infrastructure expansion is guided by the United Nations Sustainable Development Goals to guarantee progress towards equity and justice, resulting in a sustainable system that considers the mobility needs of all residents, not just those who own private vehicles (see Box 2).[92]

FIGURE 7. Number of initial and updated Nationally Determined Contributions that included public transport, as of end-2022

Source: See endnote 86 for this section.



BOX 2. Public transport connects closely to the Sustainable Development Goals

Safe, convenient, reliable and affordable public transport is key to successful and thriving cities. It also enables progress towards many of the UN Sustainable Development Goals (SDGs). For example, access to public transport:

- provides access to education and economic opportunities, thereby reducing poverty (SDG 1);
- improves people's health (SDG 3) through better road safety, improved air quality, increased physical activity getting to and from fixed stations, and improved access to health centres; and
- empowers women and girls (SDG 5) and improves gender equity by providing safe and independent mobility to reach education and job opportunities.

In September 2020, the UN General Assembly passed a resolution on "Improving global road safety", which declared 2021-2030 the Decade of Action for Road Safety, striving to reduce injuries and fatalities from road accidents by at least 50%. This resolution acknowledges that ensuring safety on the roads involves addressing the larger issue of equal access to transport and that promoting modes of transport that are sustainable, such as safe public transport and safe walking and cycling, is essential.

Additional SDGs can be supported by connecting public transport development with climate goals through electrification, particularly rail and bus routes. For example, electrification of public transport fleets will not only increase overall efficiency but also create demand for clean and sustainable electricity (SDG 7).

Public transport creates jobs and connects people to opportunities, contributing to economic growth (SDG 8). Public transport also allows optimisation of investments in resilient infrastructure (SDG 9) as cities plan for a future with more extreme weather events and more dense populations residing in urban areas. As of the end of 2022, however, only 16 NDCs included adaptation and resilience measures for public transport.

Source: See endnote 92 for this section.

Partnership in action

A variety of international efforts have sought to accelerate both funding and policy support for public transport efforts globally.

- The **International Association of Public Transport (UITP)** is the only worldwide network to bring together all public transport stakeholders and all sustainable transport modes. UITP has over 1,900 members from more than 100 countries.[93] The Barcelona Declaration, which serves as a testament to the undeniable and indispensable role of public transport, was launched at the UITP Global Public Transport Summit 2023 and signed by 43 leaders of the global public transport sector.[94]
- The **International Union of Railways (UIC)** is an international rail transport industry body developing the overall coherence of the rail system at the world level.[95] In 2020, UIC launched RAILISA (RAIL Information System and Analyses), an online tool allowing users to visualise and download data provided by railway companies worldwide. Data indicators (length of lines and tracks on the infrastructure network, passenger and freight traffic) are available for more than 100 railway companies.[96]
- In 2022, the Egyptian Presidency of the UN Climate Conference in Sharm El-Sheikh, Egypt (COP 27) partnered with the global transport community to launch the **Low Carbon Transport for Urban Sustainability (LOTUS)** initiative to improve urban transport and mobility in the Global South.[97] The multi-stakeholder consultation process identified five systematic challenges in the urban mobility landscape, including financing gaps, weak policy making and implementation capacity, lack of clear targets, difficulty integrating informal transport and siloed thinking around an operator-centric approach to decarbonisation. LOTUS prioritises three areas of action: scaling up investment in electric vehicles, empowering and investing in informal transport to mobilise a just transition, and assisting the development of integrated policy for low- and middle-income countries.
- The **TUMI E-Bus Mission** aims to accelerate the dispersion of electric buses in the Global South and was funded by the German Ministry for Economic Cooperation and Development (BMZ), with a core group of organisations including C40 Cities, Germany's Agency for International Co-operation (GIZ), the International Council on Clean Transportation, the Institute for Transportation and Development Policy, ICLEI – Local Governments for Sustainability, UITP and the World Resources Institute.[98] By ensuring readiness for fleet electrification, the TUMI E-bus Mission works towards reducing air and noise pollution, as well as slashing urban CO_2 emissions from transport systems and serving as a model for successful e-bus implementation in cities around the world.[99]
- The **Zero-Emission Bus Resource Alliance** is a professional association that began in 2015 for transit agencies to come together and share lessons learned about zero-emission technologies.[100] Through the Alliance, more than 50 transit leaders share experiences and organise without manufacturers or outside groups.


Photo: Marc A. Hermann/MTA

MODULE 3 3.4.2

AUTHORS:
Andrea San Gil León and Adriana Quesada Valverde,
Global Network for Popular Transportation

Informal Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability
Global Status Report - 3rd edition

Note: The previous section *3.4.1 Public Transport* covers any collective transport services in cities operated and regulated by public authorities; any other shared, technology-focused services run by companies through apps are covered in *3.4.3 App-Driven Shared Transport*.

Key findings

- Informal transport services are among the most common urban mobility systems globally. They are present in nearly every city and town in low- and middle-income countries and even in the underserved fringes of cities in high-income countries.
- Informal transport refers to services that are offered with some measure of informality in their operations, not planned or operated by governments. These services tend to be demand-driven, unscheduled, and flexible, reflecting varying degrees of organisation among drivers and operators.
- If integrated into policy and planning, informal transport could help to accelerate the transition towards more sustainable transport systems worldwide.
- A tendency to ignore or eliminate informal transport, despite its immense contributions, has generated large gaps in policy, knowledge and data.

Demand trends

- Global data on the size, reach and ridership of informal transport fleets are lacking, although research is attempting to close this knowledge gap. Overall, the market share for these services is high, especially in Sub-Saharan Africa and in some Latin American cities, while it is lower in Asian cities.
- Electrification efforts for two- and three-wheelers, which are major modes for informal transport, are accelerating rapidly. However, there is little information on how much of the informal fleet is electrified. Most sales of electric two- and three-wheelers are in Asia (especially in China, India and Viet Nam), and the vehicles are projected to continue to be the largest electrified road transport fleet globally.
- During the COVID-19 pandemic, informal transport experienced up to 50-70% losses in demand and income between 2020 and 2022, depending on the region, with little to no support from government. These services also were essential to ensure that riders had access to transport, particularly in vehicles that allowed for greater ventilation and lower capacity, such as bike taxis, two- and three-wheelers, and pick-up trucks.
- In some African cities, up to 95% of all motorised trips are made using informal transport.
- The vehicles (and names) used for informal transport services typically vary by region. Minibuses appear to be the most-used mode in Africa and in Latin America and the Caribbean, whereas two- and three-wheelers are most common in Asia.
- By 2022, Africa was home to 27 million registered two- and three-wheelers, of which 80% were used for passenger transport and/or delivery services; this was up from less than 5 million in 2010.
- In certain Latin American cities, fleets of minibuses and collective taxis are similar in size to or even larger than government-provided bus fleets.
- Informal transport can also be found in high-income countries, although to a far lesser extent. When such services are linked to the use of technology or digital platforms, they either are part of government-supported pilots or services, or are quickly regulated under categories such as app-based mobility, demand-responsive transport, ride-hailing or mobility-as-a-service.

Emission trends

- In general, data on emission trends for informal transport are lacking, and few countries collect disaggregated data for the sector. However, this does not mean that there is no progress towards decarbonisation.
- Angola is the only country in the world to acknowledge the emissions caused by informal vans in its Nationally Determined Contribution (NDC) towards reducing emissions under the Paris Agreement.
- A study found that the fuel economy of vehicles used for informal transport in Africa is two to three times worse than in the countries the vehicles are imported from.

- The potential to electrify informal transport is enormous: in South Africa, each electric minibus in operation could reduce tailpipe emissions by 13 tonnes of carbon dioxide (CO_2) equivalent annually.
- The available information on emissions from informal transport in Asia focuses mainly on specific vehicle types. Across the region, initial steps are being made towards electrifying informal transport.
- In Latin America, efforts to calculate emissions from informal transport or to electrify these modes remain scarce, although some examples exist.

Policy developments

- The most common policy measures and innovations are mapping, digitalisation and the introduction of technological platforms to improve the experience of users and service providers. Less common, but very relevant efforts include organisational and financial support to reform the sector in certain cities.
- As of early 2023, no countries worldwide had included measures to reduce emissions from informal transport in their NDCs under the Paris Agreement.
- Attempts to adequately incorporate the informal transport sector into global and local decarbonisation efforts have been hampered by the lack of consolidated and robust information.

Overview

Informal transport services are among the most common urban mobility systems globally. They are present in nearly every city and town in low- and middle-income countries and even in the underserved fringes of cities in high-income countries. The widely used labels for these services – which include "informal" and "unregulated systems" – define them by what they *are not* rather than by what they *are*: homegrown, emergent, widespread, self-organising and self-sustaining modes of mobility. Other terms affirming these transport forms include "popular", "entrepreneurial", "neighbourhood" and "indigenous".

Informal transport refers to services that are offered with some measure of informality in their operations, not planned or operated by governments. These services tend to be demand-driven, unscheduled, and flexible, reflecting varying degrees of organisation among drivers and operators. Typically, informal transport systems are not planned by municipal authorities but instead represent private, often unscheduled and flexible services that "spring up to meet demand".[1] They tend to be provided by small operators using small to medium-sized vehicles (with or without motors), generally in the absence of an effective regulatory framework.[2] In many cases, these services operate in a grey area between formal and informal systems (often termed semi-formal), depending on the local operating context, the type of service and the level of regulation required by government authorities.

Informal transport also can be understood as any transport service that is offered with some measure of informality in its operations.[3] Despite operating largely outside of government-provided or -regulated public transport systems, these systems move millions of people, employ hundreds of thousands and support urban economies. **If integrated into policy and planning, informal transport could help to accelerate the transition towards more sustainable transport systems worldwide.**

In low- and middle-income countries, informal transport often intersects with "app-based shared mobility", or the use of mobile applications and software to enable users to access and use transport services. This is the case with car-based ride-hailing (e.g., Careem, DiDi, Grab, Lyft, Uber), three-wheeler-based ride-hailing (e.g., Ola, Uber), motorcycle taxis (e.g., Gojek, Gokada, Safeboda) and on-demand microtransit (e.g., GrabShuttle, SWVL, Via). These digital technology platforms are often grafted onto existing informal transport systems that pre-date the rise of the platforms, and platform companies recruit drivers and operators of informal transport as service providers.[4] In high-income countries, the technology platforms are integral to the shared mobility service. (*See Section 3.4.3 App-Driven Shared Transport.*)

A tendency to ignore or eliminate informal transport, despite its immense contributions, has generated large gaps in policy, knowledge and data. Attempts to adequately incorporate this sector into global and local decarbonisation efforts have been hampered by a lack of consolidated and robust information. Better documentation of trends, policy measures, and mobility and emission data for the sector can help guide decision making and next steps, enabling informal transport to play a more prominent role in climate action, funding, and strategies, particularly for low- and middle-income countries.

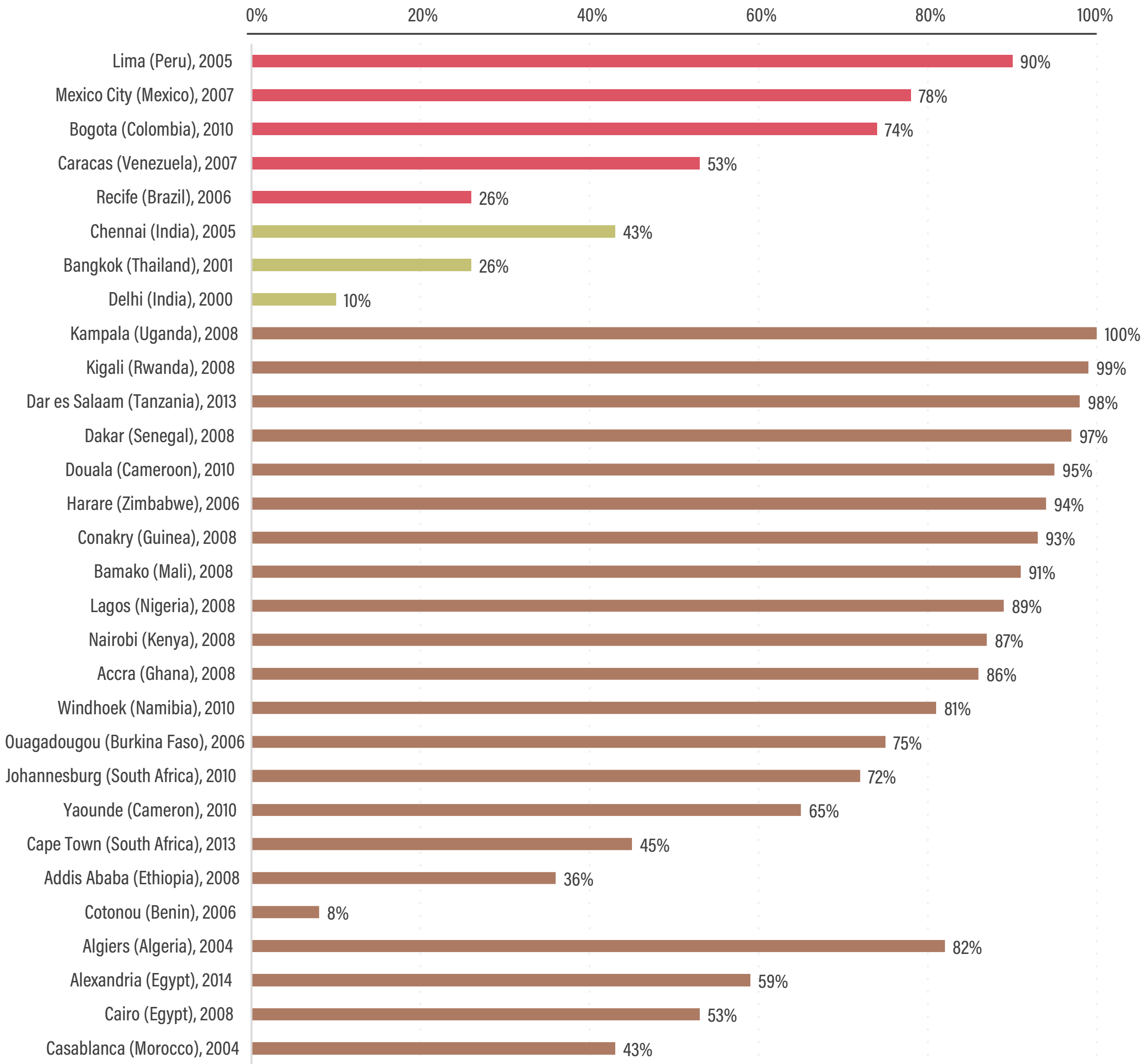
Demand trends

Global data on the size, reach and ridership of informal transport fleets are lacking, although research is attempting to close this knowledge gap. Overall, the market share for these services is high, especially in Sub-Saharan Africa and in some Latin American cities, while it is lower in Asian cities (see Figure 1).[5] Even in cities with government-provided transport services, informal transport persists and often dominates over government-provided services.

Electrification efforts for two- and three-wheelers, which are major modes for informal transport, are accelerating rapidly. However, there is little information on how much of the informal fleet is electrified. As of 2021, around 25% of the global two- and three-wheeler fleet (both formal and informal), and 44% of worldwide sales, were electric, helping to reduce more than 1 million barrels of oil use per day.[6] **Most sales of electric two- and three-wheelers are in Asia (especially in**

FIGURE 1. Market shares of informal transport among motorised trips in 30 cities, selected years

Source: See endnote 5 for this section.



China, India and Viet Nam), and the vehicles are projected to continue to be the largest electrified road transport fleet globally.[7]

During the COVID-19 pandemic, informal transport experienced up to 50-70% losses in demand and income between 2020 and 2022, depending on the region, with little to no support from government.[8] **These services also were essential to ensure that riders had access to transport, particularly in vehicles that allowed for greater ventilation and lower capacity, such as bike taxis, two- and three-wheelers, and pick-up trucks.**

- In 2020, informal transport service levels in Africa dropped 30-40%, with effects including reduced service quality, higher wait times, mismatched supply and demand, and lower revenues.[9] Estimated losses neared 50-70% in some African cities.[10]
- In Asia, one of the few studies on the pandemic's impact on informal transport reported a negative effect on the operations of remork drivers (who use a motorcycle and cart rickshaw to carry passengers) – including a 57% decline in ridership, up to a 55% drop in frequency and up to a 62% decline in monthly income (with no government support).[11]
- The only available study for Latin America identified an overall decline in informal transport use during the pandemic but highlighted the continued use of services such as pick-up trucks and two- and three-wheelers, as well as the increased use of bicycle taxis – suggesting that riders preferred more ventilated and lower-capacity vehicles.[12]

Africa

In some African cities, up to more than 95% of all motorised trips are made using informal transport (see Figure 2).[13] These services – which range from minibuses and two- and three-wheelers to boats, bikes and motorcycles – enable residents to access transport offerings in locations where government-provided services either are unavailable or do not satisfy user needs and demand.[14]

- In Accra (Ghana), informal transport accounted for more than 90% of the total public transport supply in 2018.[15]
- In 2018, informal transport met more than 60% of the mobility demand in Dar es Salaam (Tanzania), half in Abidjan (Côte d'Ivoire); nearly 40% in Lagos (Nigeria) and 35% in Addis Ababa (Ethiopia).[16]
- In Gauteng (South Africa), 82% of the public transport network in 2022 was made up of informal minibus taxi routes.[17]

The vehicles (and names) used for informal transport services typically vary by region. Minibuses appear to be the most-used mode in Africa and in Latin America and the Caribbean, whereas two- and three-wheelers are most common in Asia (see Figure 3).[18]

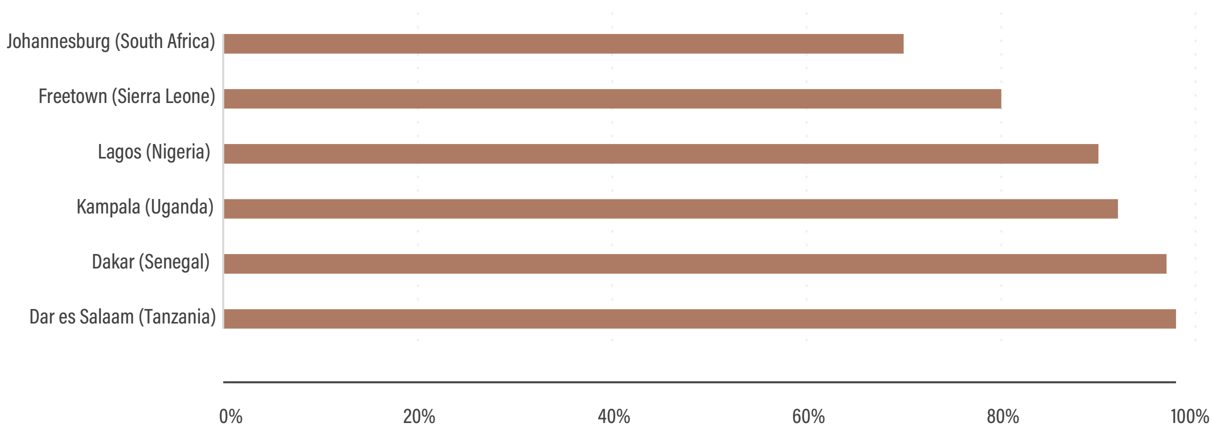
Minibuses are one of the highest-demand modes of informal transport in Africa.

- In Dar es Salaam (Tanzania), Johannesburg (South Africa), Kampala (Uganda) and Lagos (Nigeria), 83% of trips by informal transport in 2018 used minibuses.[19]
- In 2020, 70% of public transport commuters in Nairobi (Kenya) relied on matatu minibuses or buses.[20]
- Minibus taxis accounted for 73% of the transport choices in Addis Ababa (Ethiopia) in 2005.[21]
- In Kumasi (Ghana), minibuses are one of the two main informal transport services, along with shared sedans; together, these modes served around half of all motorised transport users in 2010.[22]

Two- and three-wheelers are also an important mode of informal transport in Africa, and fleets have grown sharply in the past two decades, especially in Sub-Saharan Africa. **By 2022, Africa was home to 27 million registered two- and three-wheelers, of which 80% were used for passenger transport and/or delivery services; this was up from less than 5 million in 2010.**[23] The largest fleets are in West and East Africa.[24]

FIGURE 2. Share of road-based motorised trips made by informal transport services in six African cities, selected years

Source: See endnote 13 for this section.



Note: Data for Dakar reflect the percentage of daily trips made using informal transport, and data for Freetown refer to the percentage of passenger transport trips using informal transport. Data for Dar es Salaam and Johannesburg are from 2013; for Dakar, Kampala and Lagos are from 2008; and for Freetown are from 2019.

FIGURE 3. Common informal transport modes and local names for these services in Africa

Source: See endnote 18 for this section.

Minibuses or buses	Candongueiros (Angola), Car Rapide (Senegal), Chapa (Maputo, Mozambique), Dala Dala (Tanzania), Danfos (Nigeria), Esprit de Mort (Democratic Republic of the Congo), Gbaka (Côte d'Ivoire), Kombi (Harare, Zimbabwe; South Africa), Minibus-Taxi (Cape Town, South Africa), Sotramas (Mali), Trotro (Accra and Kumasi, Ghana)
Bikes	Cyclo-Pousse (Madagascar)
Boats	Akro or Piroue (Togo)
Motorcycles	Boda boda (East Africa), Okada (West Africa)
Three wheelers	Bajaji (Tanzania), Hende moto (Nigeria), Kekeh (Freetown), Pragia (Kumasi)
Automobiles	Amaphela (Cape Town), Mshikashika (Harare), Taxi (Freetown), Woro-woro (Côte d'Ivoire)

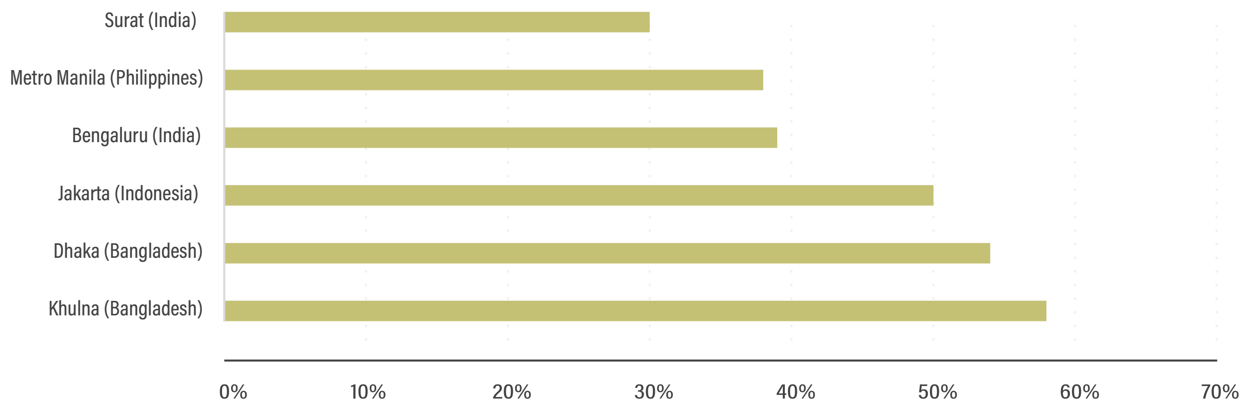
Asia

People in Asian cities rely heavily on informal transport, with the modal share for these services reaching up to 58% in selected cities (see Figure 4).[25] The services typically operate in organised ways, such as route associations, driver unions, and location- or area-based drivers' associations.[26] As in Africa, the modes and names for informal transport vary by city or region (see Figure 5).[27] Efforts to understand the scope and demand for informal transport in Asia are still in the early stages.

- Researchers in Japan have termed informal transport services in Asia as "LAMAT" (Locally Adapted Modified and Advanced Transport), and in Phnom Penh (Cambodia) they reported a fleet size in 2018 of 29,288 auto-rickshaws, 14,338 Bajaj and 10,091 remorks.[28]
- In China, the Local Traffic Management Bureau and the National Bureau of Statistics gather information on informal transport such as vehicle registrations and transaction data in the informal economy.[29]
- In Medan (Indonesia), an estimated 7,000 angkot minibuses provide the majority of all trips made by shared transport; the minibuses are operated by 42 for-profit co-operatives, and more than 3,500 workers are directly and indirectly tied with the operation of this system.[30] Meanwhile, ojeks (motorbike taxis) and tuk tuks (motorised three-wheelers) have a modal share of 7% in the city.[31]

FIGURE 4. Estimated modal shares of informal transport in commuting trips in six Asian cities

Source: See endnote 25 for this section.



Note: Data for Bengaluru are specifically for two-wheelers and auto-rickshaws. Data for Metro Manila are from 2021, for Khulna are from 2019, for Dhaka and Surat are from 2018, and for Bengaluru and Jakarta are from 2017.

FIGURE 5 . Common informal transport modes and local names for these services in Asia

Source: See endnote 27 for this section.

Automobiles	Services (Lebanon)
Motorcycles	Lemorque/ Motodop/Remork/Remorque (Cambodia), Motosai (Thailand), Ojek (Indonesia)
Minibuses or buses	Angkot/pete-pete/sudako (Indonesia), Jeepney (Philippines)
Three wheelers	Baby Taxi or Mahindra (Bangladesh), Bajaj (Cambodia and Indonesia), Chang Gari or Chingchi (Pakistan), Sān Lún Chē (China), Tuk-tuk / Auto-rickshaw (various countries)

Latin America and the Caribbean

More than half of all trips taken via shared transport in many Latin American and Caribbean cities are provided by informal transport services, which have varying names and modes (see Figure 6).[32] However, data on the use or modal share for these services are limited. Existing studies for the region tend to focus on the specific vehicle types (such as three-wheelers or minibuses) used in certain cities (see Figures 7 and 8) or on the fleet numbers available to meet existing demand.[33] **In certain Latin American cities, fleets of minibuses and collective taxis are similar in size to or even larger than government-provided bus fleets** (see Figure 8).[34]

- Minibuses are the most widely used informal transport mode throughout the islands of Barbados, Guyana, Jamaica, St. Lucia, and Trinidad and Tobago.[35]
- Mexico City depends heavily on its informal transport system, with over 1,000 minibus routes that cover 28,000 kilometres and provide 11.5 million passenger trips daily.[36]
- In Central America, one analysis estimated that more than 85,000 vehicles provide informal transport services, although this is likely well below the actual number due to a lack of data.[37]
- Existing data suggest that the share of informal trips among total passenger journeys taken is 30-40% in Guadalajara (Mexico), Mexico City and Panama City; 40% in Bogotá (Colombia) and 50% in Lima (Peru).[38]

Other studies have explored the motivations behind the use of informal transport in the region.

- A study in Central America found that the main reasons that users prefer informal transport modes for travel are ease of access, price and velocity.[39]
- In Guatemala, three-wheelers have an advantage over other forms of transport due to their ability to manoeuvre narrow, winding streets. Pick-ups and other cargo vehicles provide passenger transport in rural areas where road access is limited.[40]
- In the Caribbean, the unreliability and lack of coverage of government-run buses in less-populated locations drives travellers to use informal transport services.[41]
- In Guyana, Jamaica, and Trinidad and Tobago, the elderly and disabled tend to prefer shared taxi services, as these typically provide greater convenience and comfort.[42]

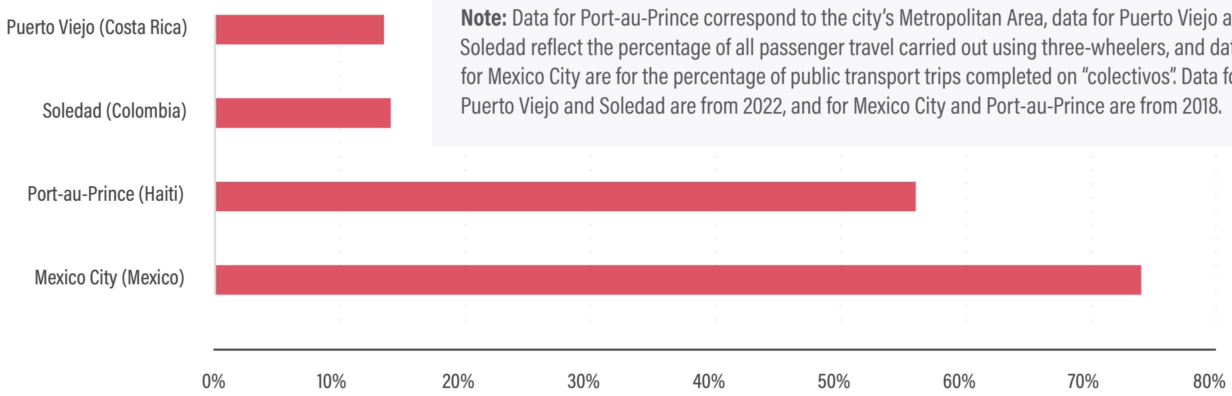
FIGURE 6. Common informal transport modes and local names for these services in Latin America and the Caribbean

Source: See endnote 32 for this section.

Automobiles	Concho (Dominican Republic), Ferry (Panama), Guala (Cali, Colombia), Porcoico (Nicaragua), Robot (Jamaica), Taxi Pirata/Colectivo (Central America, Ecuador), Trufi (Bolivia)
Bikes	Bicitaxi (Colombia and Guatemala), Bicitaxi/Ciclotaxi (Mexico)
Boats	Lancha (Costa Rica and Guatemala)
Minibuses or buses	Busito/Minibus/Ruletero/Chicken Bus (Guatemala), Chiva/Chivero (Colombia), Camioneta (Caracas, Venezuela), Diablo Rojo (Panama), Maxi taxi (Trinidad and Tobago), Surubíe/Mini (Bolivia), ZR Van/Mini bus (Barbados)
Three wheelers	Coco Taxi (Cuba), Motocarro/Mototaxi (various countries), Torito / Tuk Tuk (various countries), moto taxi (Ecuador)
Pick-up/Trucks	Pick-up (Guatemala), Tap-tap (Haiti)

FIGURE 7. Estimated modal shares of informal transport in cities in Latin America and the Caribbean

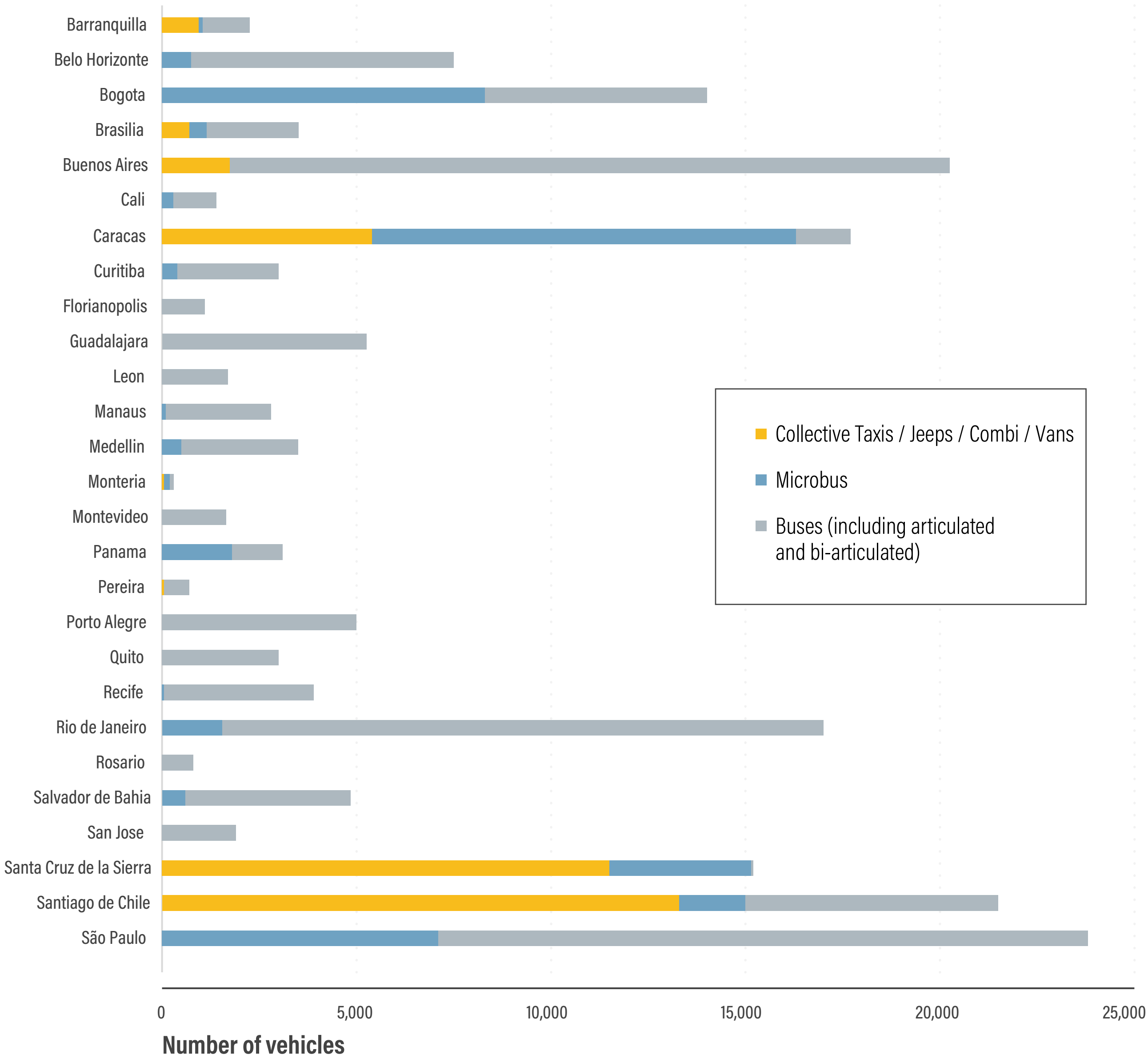
Source: See endnote 33 for this section.



Note: Data for Port-au-Prince correspond to the city's Metropolitan Area, data for Puerto Viejo and Soledad reflect the percentage of all passenger travel carried out using three-wheelers, and data for Mexico City are for the percentage of public transport trips completed on "colectivos". Data for Puerto Viejo and Soledad are from 2022, and for Mexico City and Port-au-Prince are from 2018.

FIGURE 8. Motorised collective transport vehicle fleets in different cities in Latin America and the Caribbean, 2020

Source: See endnote 34 for this section.



Informal transport in high-income countries

Informal transport can also be found in high-income countries, although to a far lesser extent. When such services are linked to the use of technology or digital platforms, they either are part of government-supported pilots or services, or are quickly regulated under categories such as app-based mobility, demand-responsive transport, ride-hailing or mobility-as-a-service. However, examples do exist of more informal transport services.

- In New York City (USA), the commuter transit network Dollaride comprises 500 drivers who make more than 120,000 van trips daily in underserved areas; the vans complement the city's subway system and meet the needs of people who live in "transit gaps", including residents located farther from the city centre who have longer and more expensive daily commutes.[43]
- In Brussels (Belgium), Bruxelles Mobilité licenses "navette" taxi services (usually shared through an agreement between the driver and passengers); they operate informally given that sharing a taxi is banned by formal regulations and that drivers cannot officially offer a shared service.[44]

Emission trends

In general, data on emission trends for informal transport are lacking, and few countries collect disaggregated data for the sector. However, this does not mean that there is no progress towards decarbonisation.

Significant efforts have been made to collect information, conduct research and implement actions to reduce emissions from informal transport around the world. In New York City (USA), Dollarides estimates that its commuting vans emit more than 27,000 tonnes of carbon dioxide (CO_2) equivalent annually and has devised a plan to fund both vehicle electrification and related charging infrastructure, with the first electric fleets and charging stations planned in Brooklyn and Queens in late 2023.[45]

Africa

Angola is the only country in the world to acknowledge the greenhouse gas emissions caused by informal vans in its Nationally Determined Contribution (NDC) towards reducing emissions under the Paris Agreement (although it does not provide numerical data).[46] Beyond this, no data were found on emission trends from the informal transport sector in Africa. Most efforts to decarbonise informal transport in the region focus on gathering data to better understand these systems on the path towards greater efficiency and electrification.

A study found that the fuel economy of vehicles used for informal transport in Africa (boda-bodas, tuk-tuks, passenger cars and matatus) is two to three times worse than in the countries the vehicles are imported from.[47]

- In South Africa, the entire fleet of minibus taxis consumes 10% of the daily national energy production, which is enough to cover 70% of all commuter trips.[48]
- Research on the electrification of minibus taxis in Sub-Saharan Africa has used GPS data to identify which mobility patterns have a significant impact on energy consumption.[49]
- Solar photovoltaics is suggested as a viable renewable energy source for electric informal transport in Sub-Saharan Africa.[50]
- GoMetro, an initiative to electrify informal transport in South Africa, tested various electric vehicles suitable for minibus and minivan operations and built the country's first public

charging station for minibus taxis.[51] **The potential to electrify informal transport is enormous: the country's minibus taxi industry emits 34 million tonnes of CO_2 equivalent per year, and each electric minibus in operation could reduce tailpipe emissions by 13 tonnes of CO_2 equivalent annually.**[52]

- In El Kelaa des Sraghna (Morocco), 25 electric tricycles, charged using local solar panels, were introduced in 2021 as part of a pilot to transport people and goods in the town and nearby rural municipalities.[53]

Asia

The available information on emissions from informal transport in Asia focuses mainly on specific vehicle types. Across the region, initial steps are being made towards electrifying informal transport.

- In Bengaluru (India), a study found that the city's 120,000 auto-rickshaws emitted an estimated 0.45 million tonnes of CO_2 equivalent, 1,445 tonnes of nitrogen oxides and 164 tonnes of particulate matter (PM_{10}) in 2017.[54]
- A study of motorcycle taxis (ojeks) in Bandung (Indonesia) found that the vehicles have poor fuel efficiency and release a total of 11,199 tonnes of CO_2 equivalent annually.[55]
- The Transformative Urban Mobility Initiative (TUMI) helped introduce 10 electric rickshaws in Singra (Bangladesh) to provide public transport and emergency health services (including during the COVID-19 pandemic); as of 2021, the e-rickshaws accounted for 6% of all trips.[56]
- China was home to 9.5 million electric two- and three-wheelers in 2021, accounting for the bulk of the global fleet and for 95% of new registrations; most of the vehicles are used for delivery purposes rather than passenger transport.[57] The electrification of two- and three-wheelers has contributed nearly half (45%) of China's total emission reductions from vehicle electrification.[58]
- In 2021, sales of electric two- and three-wheelers reached 230,000 in Viet Nam and nearly 300,000 in India.[59] By 2018, almost 40% of India's three-wheeler fleet was electric.[60]

Latin America and the Caribbean

In Latin America, efforts to calculate emissions from informal transport or to electrify these modes remain scarce, although some examples exist.

- A study in Puerto Viejo (Costa Rica) estimated that if the three-wheeler trips providing informal transport were instead taken using government-regulated taxis, the total emissions would more than double.[61]
- In Guatemala, an initiative to retrofit a tuk-tuk to run on solar power was undertaken to generate experience and know-how for replication in other cities in Latin America and the Caribbean.[62]

Policy developments

Governments and other stakeholders can take wide-ranging actions to enhance the quality of informal transport services, facilitate their integration into wider transport networks, improve working conditions, and contribute to emission reductions and climate resilience and adaptation.[63] **The most common policy measures and innovations are mapping, digitalisation, and the introduction of technological platforms to improve the experience of users and service providers** (see Table 1)**.**[64] **Less common but very relevant efforts include organisational and financial support to reform the sector in certain cities.**

As of early 2023, no countries worldwide had included measures to reduce emissions from informal transport in their NDCs under the Paris Agreement. By viewing existing informal transport services as an asset, stakeholders can work with these systems as a baseline for action, contributing to emission reductions through efforts to "Avoid" private vehicle travel, "Shift" towards shared mobility and "Improve" fleets through both electrification and efficiency.[65]

Attempts to adequately incorporate the informal transport sector into global and local decarbonisation efforts have been hampered by the lack of consolidated and robust information (see Box 1)**.**[66] Better documentation of the trends, policy measures, and mobility and emissions data associated with the sector can help guide decision making and next steps, enabling informal transport to play a more prominent role in climate action, funding and strategies, particularly for low- and middle-income countries.

TABLE 1. Example policy measures and strategies to improve informal transport and include it in climate action

Source: See endnote 64 for this section.

Area	Measures/Strategies	Examples
Data and information	■ Build a dashboard or observatory of informal transport. ■ Carry out recurrent surveys to understand demand and modal share for these modes. ■ Map local informal transport offerings.	In 2021, the World Bank shared how it collected **mobility data on tap-tap operations** in Cap-Haïtien, Haiti with the support of companies such as DataFromSky, Mobile Market Monitor and WhereIsMyTransport. GoAscendal, a South Africa-based technology company, mapped 528 minibus routes in Cape Town during 2020-2022 and established the **African Urban Mobility Observatory**.
Regulatory recognition and integration	■ Recognise and establish the function of informal transport in the public transport system. ■ Define specifications for the quality of service for these modes. ■ Define the authorities responsible for regulating the sector. ■ Define the regulatory framework for carrying out the activity.	In 2020, Mexico City's Mobility Secretariat (SEMOVI) used a participatory process to develop a regulation for **bike taxi operations** in the city. The regulation requires operators to organise in co-operatives and to define the number of vehicles in operation and the tariff. The regulation also provided training to co-operatives to attain operating permits and defined an operation area for bike taxis. It was accompanied by a vehicle substitution programme that provides government funding to support the shift to electric pedal-assisted vehicles. **Angkots** (minibuses) have been integrated in the public transport system of Indonesia, as feeders for the Teman Bus service, through a government-funded programme launched in 2020 and the support of the Institute for Transportation and Development Policy (ITDP).
Business development	■ Engage in business consolidation and co-operatives. ■ Establish transport workers' unions.	The **Boda Boda Safety Association of Kenya (BAK)** maps its members across the country's 47 counties, with a mandate that includes training, advocating for the sector's needs, and working with governments and communities to develop projects and policy. In Cochabamba (Bolivia), three-wheeler drivers have organised in **associations or unions to support each other** and have gained a minimum legal coverage against persecution by authorities. In South Africa, in 2021, the World Bank and the Development Bank of Southern Africa launched an initiative to better understand how to support and improve the minibus taxi industry in South Africa. After an **assessment of their business models, finances and operations**, the initiative has supported taxi associations in migrating into companies, rationalising their vehicle fleet, and implementing more effective operational processes as well as improving the working conditions for drivers and personnel.
Fleet improvement and electrification	■ Provide vehicle renewal or recapitalisation incentives for upgrading to cleaner and safer vehicles. ■ Offer co-operative loans.	The Indian government has enacted a **subsidy scheme** called FAME II (Faster Adoption and Manufacturing of Hybrid and EV) until 2024, while increasing by 50% the credit ceiling for two-wheelers to support this transition. In northern India, the Rejuvenation of Auto-Rickshaw in Amritsar through Holistic Intervention (RAAHI) project was launched in 2019 to switch the city's three-wheeler transport system to electric vehicles. The project provides vehicle owners with **subsidies for the electric vehicle cost and low-interest loans** to those replacing diesel three-wheelers that do not meet the Bharat Stage (BS) III emission standard. Three Wheels United, based in Bangalore, India, promotes the use of electric vehicles and works with stakeholders to provide **loan options, savings accounts and recurring deposit accounts** to improve the quality of life of drivers, making them more financially secure and increasing their sense of ownership.
Operations	■ Offer safe driver training and improve labour conditions. ■ Provide salaries to drivers and improve workers' rights. ■ Consolidate driver recruitment and management. ■ Support vehicle management and route rationalisation. ■ Offer cashless and integrated ticketing. ■ Support mapping and digitalisation of transport routes and improved data on operations. ■ Implement passenger information systems. ■ Provide open public transport data. ■ Support first-/last-mile connectivity.	The **Trufi** app is a journey planner that covers both government and informal transport services in different cities around the world. In 2020, Maha Metro in India launched a mobile app to enable passengers to **book auto-rickshaw trips**, helping the company improve its feeder service and to integrate informal transport services with the public transport service. In the Philippines, Sakay.ph has mapped routes for road-based informal transport modes, such as jeepney and UV Express services, as part of a **journey planner app** used by around 500,000 commuters in Metro Manila. In 2021, the Philippines' Land Transportation Franchising and Regulatory Board and the Department of Transportation launched a technology to optimise jeepney services and provide drivers with a **daily payment contingent on their kilometres travelled**, rather than drivers only earning what is left over after paying rent to operators. Earnings for drivers could increase further based on service quality, commuter feedback and performance.

BOX 1. Key indicators for informal transport

Data regarding informal transport are often non-existent or are not disaggregated from public transport data. Gathering data on these systems could allow for countries to improve electrification and decarbonisation targets based on a clear baseline, understanding the current state of their systems, using the current assets (informal transport providers and vehicles), improving transparency, and preventing potential emissions leakages that can affect countries' NDCs and global decarbonisation goals.

Data could help entrepreneurs, governments and banks build new (and locally appropriate) financial products, subsidies, and market incentives that encourage asset owners to convert to electric vehicles, allowing the aggregation of demand to increase supply and production of these vehicles. It could also facilitate the integration of informal transport into planning transport systems that are not only zero emissions, but demand-oriented, agile and flexible to users' needs. It sets the foundations to engage and recruit informal transport's labour, associations, owners, firms, and investors in decarbonisation efforts, contributing to a more just transition. Finally, it can help in gauging progress towards the United Nations Sustainable Development Goal 11 (SDG 11.2), taking into consideration existing urban mobility systems.

This box suggests key data and indicators that can be used to guide different stakeholders in gathering information on informal transport in a standardised, comparable way, and explains why these are important.

1. **Characteristics of the informal transport vehicle fleet:** Activity data are essential to estimate the sector's greenhouse gas emissions. These emission estimates will provide a baseline for climate action and decarbonisation strategies for the sector. Key information to collect includes:
   a. Number of vehicles
   b. Type of vehicles
   c. Average age of vehicles
   d. Average operational lifespan of vehicles
   e. Type of fuel used
   f. Fuel efficiency (miles/gallon or kilometres/gallon)
   g. Number of electric units (if any)
   h. Average kilometres travelled (daily or annual) per vehicle type

2. **Modal share and/or number of daily trips taken in informal transport:** Understanding the scale of use of the mode, adequately reflecting the importance of the sector in providing transport access (SDG 11.2) and understanding the potential impact of decarbonisation strategies in terms of social and economic components, not only emission reductions.

3. **Operational characteristics:** These are essential to understand the service coverage (geographic and territorial) of these systems, ascertain how they interact with government-run systems and how they provide access to employment, public services, and community amenities. This is necessary to move towards greater systemic integration and optimisation to reduce emissions, improve transport services for users and operators, and improve user experience with available information for better trip planning, potentially leading to increased ridership of shared mobility services, reducing or preventing private vehicle trips. Key information to collect includes:
   a. Routes
   b. Stops
   c. How operators connect to clients

4. **Characteristics of the workforce:** Adequately understanding the scale of the market, as well as the size and needs of the labour sector that is directly and indirectly employed by informal transport will create the space for innovative approaches to labour policy and social support systems for workers in the sector, translating into a more just transition. Key information that should be collected includes:
   a. Number of people working in the sector
   b. Gender
   c. Age
   d. Nationality
   e. Race
   f. Average income

5. **Organisation dynamics:** There is a need to better understand how these systems are organised, including how associations facilitate (or block) benefits for labourers and owners and how they wield (or lack) political power; and to understand the dimensions and operations of the micro-, small-, and medium-sized enterprises that serve informal transport, their economic impact, and the motivations and dynamics of the small investors. Doing so is foundational to creating policy and regulatory frameworks that bring these enterprises on board and guarantee their involvement in the road to zero, as well as business and technology innovations that can help improve the businesses, the quality of services, and safety of informal transport. Key information to collect includes:
   a. Type(s) of organisation(s) (if any)
   b. Number of organisations and members
   c. Business model and key details of operations
   d. Political influence or lack thereof.
   e. Main causes, motivations or agendas for which they fight.

Source: See endnote 66 for this section.

Partnership in action

- The **Asian Development Bank's Asian Transport Outlook Database** is an open resource that provides national-level data on the transport sector in 51 economies in the Asia-Pacific region, including data on modal share and motorisation for informal transport modes such as two- and three-wheelers, intermediate public transport and non-motorised two-wheelers (pedicabs and bike rickshaws).[67]
- Two joint initiatives – **Digital Transport for Africa (DT4A)** and **Datos Abiertos de Transporte Urbano y Movilidad (DATUM)** in Latin America – use open data and peer-to-peer knowledge sharing to scale up and support urban mobility projects. The initiatives collect GTFS (General Transit Feed Specification) data on informal transport systems and are supported by global partners such as France's AFD, the World Resources Institute, the Institute for Transportation and Development Policy, the Mastercard Foundation, multilateral banks and several universities worldwide.[68]
- The **Global Labour Institute** and the **International Transport Workers Federation's Informal Transport Programme** support the representation, livelihoods and organisation of informal transport workers, undertake research on the potential impact of bus rapid transit projects in cities, and provide practical steps towards the formalisation of informal transport based on the inclusion of democratic workers' organisations in policy development, planning and implementation.[69]
- The **Global Network for Popular Transportation** – a project of the Shared-Use Mobility Center initiated by Agile City Partners and supported by CoMotion Inc. – aims to transform the global narrative on popular transport, highlight successful efforts and advocate approaches to improve the sector. It does this by creating networks and communities of practice, bringing popular transport into global discussions and events, fostering conversations and collaborations across sectors involved with popular transport, disseminating knowledge, conducting research and providing technical advice and support to initiatives on popular transport.[70]
- The **International Association of Public Transport's (UITP) Informal Transport Working Group** aims to reconcile the interests of operators, passengers and employees and to tackle informal transport by transforming services and enabling regulatory and structural reforms.[71]
- The **International Transport Forum's (ITF) Transportation Outlook** provides an overview of trends and prospects for the global transport sector and includes databases on modes often used for informal transport, such as three-wheelers and minibuses.[72] ITF's **Decarbonisation Transport Initiative** promotes carbon-neutral mobility to fight climate change and helps decision makers select mitigation measures that they can use to act on their climate commitments.[73] The initiative has supported projects such as the 2022 award-winning "Transition to Electric Boda Boda in the Nairobi City County, Kenya".[74]

- **Low Carbon Transport for Urban Sustainability (LOTUS)** is an initiative by the Egyptian Presidency of the 2022 UN Climate Change Conference (COP 27) aiming to activate systemic change to improve and decarbonise the urban mobility landscape. Among its three strategic aims are to "Empower and invest in informal transportation to decarbonise, and mobilise towards SDG 11".

- **MobiliseYourCity Partnership** has developed an Informal transport Toolkit to guide the development of the informal transport sector, as well as a catalogue of 50 practical measures to help local and national governments drive reforms in the sector. This initiative supports the development of sustainable urban mobility plans (SUMPs), which helps local governments identify measures to support informal transport and integrate it in the local mobility systems. MobiliseYourCity has also organised and supported webinars, workshops and events linked to the digitalisation, mapping and integration of informal transport services.[75]

- The **Transformative Urban Mobility Initiative (TUMI)** of the **German Agency for International Cooperation (GIZ)** has supported projects such as rickshaw electrification in Singra (Bangladesh), the development of a trip planning app that integrates informal transport service information in Nagpur (India), and the introduction of electric three-wheelers for shared transport and delivery services in El Kelaa des Sraghna (Morocco).[76] TUMI also initiated a global **Mobility Data Hub** – which covers both government and informal transport – alongside partners such as CAF, ETH Zurich, the New Urban Mobility Alliance, Trufi Association and WhereIsMyTransport.[77]

- The **United Nations Environment Programme's Global Working Group on Electric 2&3 Wheelers** seeks to advance the transition to electric and non-motorised two- and three-wheelers in 17 countries (Bangladesh, Burundi, Ethiopia, India, Kenya, Madagascar, Maldives, Morocco, Nepal, the Philippines, Rwanda, Sierra Leone, Tanzania, Thailand, Togo, Uganda and Viet Nam). It supports the development of global and regional targets for the shift to electric mobility, facilitates discussions around the global harmonisation of e-mobility standards and regulations, and develops tools to support e-mobility projects worldwide.[78]

- The **Volvo Research and Educational Foundations' Informal and Shared Mobility in Low- and Middle-Income Countries (ISM)** initiative will support an International Research Program from 2023-2026, and contributes to strengthening equity and sustainability in urban transport by supporting research that creates new knowledge to better inform stakeholders in the target countries to govern, design and develop informal and shared mobility, thereby contributing to better access to goods and services for all.[79]

MODULE 3 3.4.3

AUTHOR:
Sebastian Castellanos, *NUMO*

SUPPORTING AUTHOR:
Agustina Krapp, *SLOCAT Secretariat*

App-Driven Shared Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Note: This section *3.4.3 App-Driven Shared Transport* covers any technology-driven, app-based shared mobility services, while section *3.4.1 Public Transport* covers any collective transport services in cities operated and regulated by public authorities, and *Section 3.4.2 Informal Transport* focuses on informal, unregulated shared services.

Key findings

- While there is no broadly accepted definition of app-driven shared mobility, the term generally encompasses a set of business models in which mobility assets are shared among multiple users, facilitated by smartphone apps.
- Some of the most visible deployments of app-driven shared mobility have been led by private sector companies. However, public and non-profit organisations also play an important role in regulating, contracting and/or directly operating these services.

Demand trends

- Carsharing had an estimated 86 million users worldwide as of 2021, and the market is expected to reach 224 million users by 2026. The number of cities offering carsharing services increased from 3,128 in 2019 to 4,100 in 2021.
- In 2022, transport network companies – or companies that provide on-demand transport services, often through apps – had an estimated 1.28 billion users worldwide, and this number is projected to reach 1.45 billion by 2027. Although the market is dominated by cars, around a quarter of the revenues of transport network companies worldwide come from motorcycles.
- After a small lull due to the COVID-19 pandemic, the market for shared micromobility (the use of smaller vehicles such as bikes, scooters and mopeds) experienced an uptick, with these services operating in more than 1,000 cities worldwide.
- Due to the diversity of business models, it is difficult to identify the market size of mobility-as-a-service (MaaS); however, some analysts expect continued growth in this space through 2030.

Emission trends

- Because of the diverse nature of the assets and services within app-driven shared mobility, assessing their impact on sustainability, and specifically on carbon dioxide (CO_2) emissions, is difficult. Estimating the overall emission-reduction potential of app-driven shared mobility is challenging, as analyses often focus only on individual services and fail to account for a combined effect.
- Carsharing can reduce CO_2 emissions 3-18%, according to the latest modelling. Interest in pairing electric vehicles with carsharing programmes is rising. As more programmes offer electrified options, the potential to mitigate CO_2 emissions will likely increase.
- Ride-hailing is similarly marketed as an alternative to car ownership, and here too the evidence regarding the emission impacts is varied.
- The impacts on CO_2 emissions of shared micromobility are highly dependent on the transport modes being substituted, as well as on vehicle durability and operational procedures.
- While mobility-as-a-service can in theory reduce CO_2 emissions, pollution, and congestion, empirical evidence is very limited, and comprehensive studies are needed.

Policy developments

- The deployment of peer-to-peer carsharing services has introduced regulatory challenges for governments.
- Ride-hailing operations are now common throughout the world, including in places with diverse regulatory environments – from welcoming to hostile.
- Many European cities have started to deploy stricter regulations for shared e-scooters.
- Commercial deployments of mobility-as-a-service remain limited, but developments in Europe, China and the United States might provide insights into new forms of public-private collaboration.

Overview

While there is no broadly accepted definition of app-driven shared mobility, the term generally encompasses a set of business models in which mobility assets are shared among multiple users, facilitated by smartphone apps. Some of the most visible deployments of app-driven shared mobility have been led by private sector companies. These include so-called transport network companies, or companies that provide on-demand transport services through apps, such as DiDI, Ola, and Uber, as well as bike- and scooter-sharing services such as DiDIi, Lime, Meituan Bike, Tier and Voi. **However, public and non-profit organisations also play an important role in regulating, contracting and/or directly operating these services.**

Consensus also is lacking on the scope of services or vehicle types that fall under the term app-driven shared mobility, although attempts have been made at developing a taxonomy.[1] The term can refer to the temporary use of an asset – such as a car, bike, scooter or boat – owned by a third party (whether a company or a peer), or to a ride service (ride-hailing or carpooling) provided by a third party in a car, airplane or bus (e.g., demand-responsive transit).[2] Due to the difficulty in categorising these services, this section reflects a deep-dive into some of the most prominent types: 1) carsharing, 2) ride-hailing, 3) bike-, scooter- and moped-sharing (shared micromobility) and 4) mobility-as-a-service.

Since 2020, the app-driven shared transport sector has experienced mixed responses. Although private venture capital dominated the space early on, some of the larger players – such as Bird, Helbiz and Uber – have since gone public.[3] The market for transport network companies has continued to consolidate among fewer, bigger players, and this trend also is occurring in the shared micromobility space, with mergers and acquisitions of multiple players.[4] Overall, the demand for shared mobility services is trending upwards after a generalised reduction during the lockdowns of the COVID-19 pandemic.

Shared mobility often is promoted as a more sustainable alternative to car ownership that can increase the number of mobility options, alleviate congestion, reduce pollution, provide equitable access to opportunities and improve efficiency.[5] However, the evidence is not conclusive, and it is not yet affirmed whether shared mobility can support the United Nations Sustainable Development Goals (SDGs), especially SDGs 3, 7 and 11.

- In the case of SDG 3 (good health and well-being), shared mobility may either reduce or exacerbate road deaths. Evidence from Madrid (Spain) suggests that ride-hailing could reduce traffic fatalities.[6] For shared micromobility services, assessing the impacts on road safety has proven difficult due to the novelty of these services, although greater attention has been paid to safety aspects recently.[7]
- Regarding SDG 7 (affordable and clean energy), many shared mobility services promote the sharing of assets, which in theory could be seen as an improvement in energy efficiency; however, the true impact of these services depends mainly on the modes they are replacing. For example, an electric scooter is inherently more energy efficient than a car, so replacing a car trip with a scooter trip could improve overall efficiency (even when considering operational needs). However, if an electric scooter replaces a walking trip, the reverse may be true.
- With respect to SDG 11 (sustainable cities and communities), in theory an increase in the overall availability of new transport services could improve access to necessities; however, the evidence is not yet conclusive. A forthcoming study shows that, paired with frequent public transport, shared bike and scooter services improve access to job opportunities.[8] At the same time, studies have revealed racial discrimination towards users of ride-hailing apps, which can lead to the worsening of access for vulnerable populations.[9]

On the policy front, changes since 2020 are related to the advance of autonomous vehicle technologies, which present regulatory challenges for the ride-hailing market, and to increased targets for the electrification of fleets. Regarding shared micromobility, after a few years of a "wild west" approach to regulation, some major cities have moved towards a more tightly regulated market, with fewer operators working under stricter contracts.

Although the Russian invasion of Ukraine has upended many aspects of the energy sector, it appears to have had only minor impacts on the shared mobility space, most notably Uber's accelerated exit from the Russian market.[10]

Demand trends

Carsharing

Carsharing or car clubs are a form of asset sharing in which cars are made available for short-term rentals. Unlike traditional car rental companies, carsharing services typically require a membership, and the vehicles can be accessed at decentralised locations, mostly within cities. The locations can be fixed (station-based), whereby the vehicles must be picked up at or returned to specific locations, or free-floating.[11] The car fleets can either be owned by a company or owned by individuals who make them available to others (peer-to-peer).

- **Carsharing had an estimated 86 million users worldwide as of 2021, and the market is expected to reach 224 million users by 2026.**[12]
- **The number of cities offering carsharing services increased from 3,128 in 2019 to 4,100 in 2021.**[13]
- The global carsharing fleet is estimated at 539,000 vehicles – a majority of which are station-based systems – and this value is projected to grow to 973,000 vehicles by 2026[i].[14]

The market is dominated by a mix of traditional car manufacturing companies, such as BMW and Renault, and other private sector entities, as well as a few non-profit companies, such as Colorado CarShare.[15] The majority of carsharing operations are in Europe, North America, and the Asia-Pacific region, with leading markets in China, France, Germany, Italy, Japan, the Republic of Korea and the Russian Federation.[16] As of 2018, an estimated 70% of registered carsharing members were in Asia.[17]

- In China, DiDi had more than 550 million users as of 2019, with its service offerings covering carsharing among other types of shared mobility.[18]
- In 2022, Turo, one of the world's largest peer-to-peer carsharing services, expanded its operations to all 50 US states as well as to Australia and Europe (through its acquisition of OuiCar).[19]
- India's leading carsharing company, Zoomcar, had 25,000 registered vehicles on its platform as of September 2022.[20]
- In 2022, HourCar launched an all-electric carsharing service in the Twin Cities area (Minneapolis–Saint Paul) of Minnesota (USA) that is entirely owned by the municipality; the service relies on stations located mainly in communities of colour and along public transport corridors.[21]
- Zity, present in Madrid (Spain) and Paris (France), expanded its service in 2022 to Lyon (France) and Milan (Italy), increasing its customer base 22% to reach 600,000 users.[22] The company's fleet grew 44% in 2022, adding nearly 600 new vehicles to reach a total of 1,875 all-electric cars.[23]

Transport network companies

Transport network companies provide a form of app-driven shared mobility service in which users can access point-to-point ride service, similar to a taxi. Also known as ride-hailing, these services are typically provided by individuals who own their vehicles; however, examples of corporate-owned fleets do exist, and this organisational type might grow in the future with the advent of autonomous vehicles (*see Policy Developments section*). Among the factors that can influence ride-hailing choice are convenient travel times, reduced waiting times (compared to unavailable or inconvenient public transport), ease of requesting the service, ease of payment, and comfort and safety.[24]

In 2022, transport network companies had an estimated 1.28 billion users worldwide, and this number is projected to reach 1.45 billion by 2027.[25] **Although the market is dominated by cars, around a quarter of the revenues of transport network companies worldwide come from motorcycles.**[26] The most prominent global operators include DiDi, Grab, Ola and Uber.

- In early 2023, Bolt announced plans to expand its operations across Africa, with expected investments of nearly EUR 500 million (USD 533 million) over a two-year period, and 300,000 new drivers.[27]
- DiDi, the largest transport network company in China, was allowed to resume normal operations in January 2023 following an 18-month ban on signing up new users due to cybersecurity concerns.[28] At the same time, China announced the launch of its public ride-sharing platform, Qiang Guo Jiao Tong.[29]
- Cabify, a leading ride-sharing operator in Latin America and Spain, announced that it would cease operations in Ecuador in 2023.[30] The company Beat closed operations in Latin America in 2022.[31]
- Following the Russian Federation's invasion of Ukraine, Uber divested from the Russian ride-hailing operator Yandex Taxi.[32]

Shared micromobility

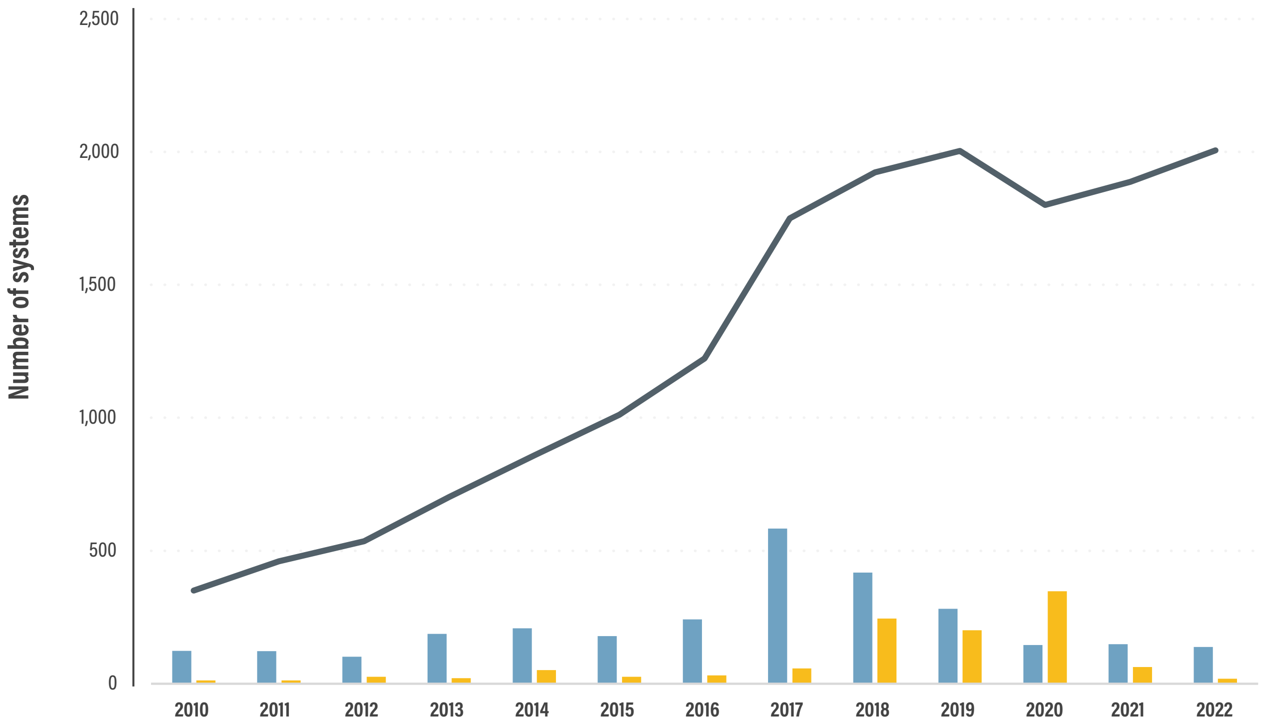
Micromobility refers to the use of smaller vehicles such as bikes, scooters and mopeds. In its shared form, it works similarly to carsharing, with users accessing the vehicles mostly in cities using an app. Besides increased mobility, this mode can foster greater use of active transport such as walking and cycling.

After a small lull due to the COVID-19 pandemic, the market for shared micromobility experienced an uptick. As of 2022, a total of 2,006 docked or hybrid (i.e. combination of docked and dockless) bike-sharing systems were operating in 92 countries (see Figure 1).[33] In addition, 1,478 scooter services and more than 200 moped-sharing services were operating

i The sources used for this third edition differ from the sources used in the second edition, possibly resulting in discrepancies in numbers.

FIGURE 1. Number of bike-sharing systems worldwide, 2010-2022

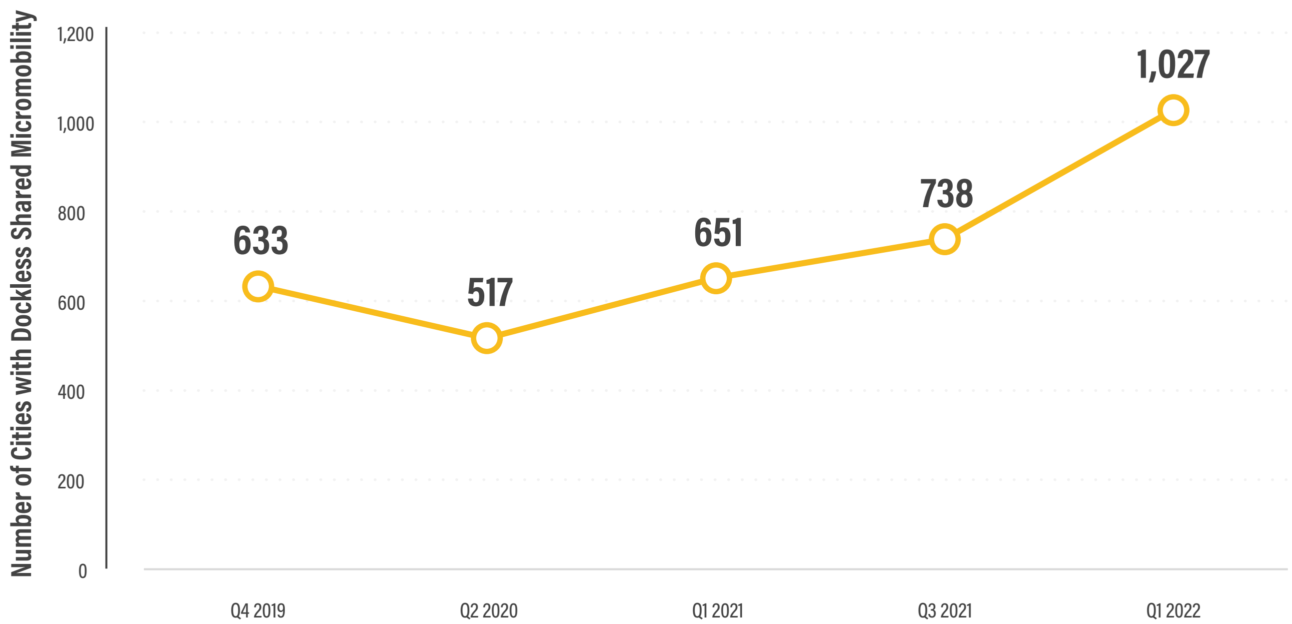
Source: See endnote 33 for this section.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Openings	123	122	102	187	208	179	242	584	418	282	145	149	138
Closures	12	12	26	21	51	26	31	57	245	201	348	63	19
Operating	350	460	536	702	859	1,012	1,223	1,750	1,923	2,004	1,801	1,887	2,006

FIGURE 2. Number of cities with dockless shared micromobility operations, 2019-2022

Source: See endnote 34 for this section.



by year's end, resulting in shared micromobility services of all types **operating in more than 1,000 cities worldwide** (see Figure 2).[34] For bike sharing, the biggest increase has been in dockless operations, perhaps because these are private and do not require a public contract (*see Policy Developments section*).[35] Europe, China and the United States lead in the number of operations.[36]

In China, 360 cities had dockless bike sharing systems as of 2020, with a combined total of more than 287 million users.[37] A 2022 study on shared mobility in China revealed knowledge gaps on topics such as the health impacts, life-cycle greenhouse gas emissions and equity implications of such systems.[38]

Mobility-as-a-service (MaaS)

Mobility-as-a-service is a loosely defined concept in which multiple mobility services are bundled together and accessed via a single interface, typically a phone app. Business models differ but can include planning, booking and paying for services such as carsharing, ride-hailing, public transport, bike sharing and others. Some forms include a "mobility wallet" or a suite of bundled services available to users for a monthly fee.

The market includes both public and private initiatives. Large players include Jelbi and Whim in Europe; more traditional asset-sharing operators such as DiDi and Uber; and mapping apps such as Baidu Maps, Citymapper, Google Maps and Moovit.[39] Multiple shared scooter companies are now integrated into the Google Maps platform, enabling users of the app to locate available vehicles nearby.[40]

Due to the diversity of business models, it is difficult to identify the market size of mobility-as-a-service (MaaS); however, some analysts expect continued growth in this space through 2030.[41]

- By 2021, the global MaaS market was worth an estimated USD 3.27 billion, with projections to grow as much as seven-fold by 2028.[42] The MaaS market generated an estimated USD 20 billion in revenue in 2022 and is expected to generate USD 92 billion by 2027, most of it through paid subscriptions.[43]
- In Europe, multi-modal trips increased 221% in 2022, and the number of people taking such trips increased 27%.[44] A study found that 60% of Europeans would like a single app that integrates all mobility options.[45]
- In the United Kingdom, Wales announced plans in 2022 to develop a national MaaS solution, projecting investment of GBP 2.3 million (USD 2.8 million) over five years.[46]
- Tampa (USA) launched a MaaS app in 2022.[47]

Emission trends

Because of the diverse nature of the assets and services within app-driven shared mobility, assessing their impact on sustainability, and specifically on carbon dioxide (CO_2) emissions, is difficult. In general, these services are marketed as an alternative to car ownership, although some recent life-cycle emissions analyses reveal that the services may increase CO_2 emissions on a per passenger-kilometre basis, depending on the transport modes they substitute.[48]

Estimating the overall emission-reduction potential of app-driven shared mobility is challenging, as analyses often focus only on individual services and fail to account for a combined effect. The growing availability of alternatives to car ownership could make it more feasible to live a car-free or car-light life, such that the impact of multiple services could be greater than that of individual ones.

Carsharing

Because carsharing is marketed as an alternative to car ownership, it is generally assumed that the reduction in car ownership will lead to a decline in vehicle-kilometres travelled and thus a reduction in CO_2 emissions. **Carsharing can reduce CO_2 emissions 3-18%, according to a 2020 analysis that modelled three different markets.**[49] However, operational demands from carsharing programmes can result in increases in CO_2 emissions, indicating that more sophisticated analyses of life-cycle emissions are required to identify the overall effect.[50]

Interest in pairing electric vehicles with carsharing programmes is rising. As more programmes offer electrified options, the potential to mitigate CO_2 emissions will likely increase.

- Zity in Spain (660 electric cars) and MILES Mobility in Germany (2,000 electric cars) are among the largest carsharing programmes that include electric vehicles in their fleets.[51]
- Zipcar in the United States joined the White House EV Acceleration Challenge and announced plans to expand its electric vehicle fleet throughout 2023 and to allocate 25% of its electric fleet to disadvantaged communities.[52]

Transport network companies

Ride-hailing is similarly marketed as an alternative to car ownership, and here too the evidence regarding the emission impacts is varied.[53] Again, context plays an important role. In cities with good public transport and non-motorised infrastructure, ride-hailing tends to mostly replace walking, cycling and public transport trips. Elsewhere, it mostly replaces car trips, including taxis. The operational component of transport network companies also plays a key role in potential increases in CO_2 emissions, as drivers ride "dead miles" in search of passengers, leading to higher vehicle-kilometres travelled and thus greater emissions.[54]

Since ride-hailing vehicles tend to drive more kilometres, research has shown that electrifying these fleets can lead to greater CO_2 reductions.[55] Some companies have moved towards electric vehicles to increase the overall efficiency and lower the emissions of ride-hailing fleets. Power utilities also have joined this space.

- Uber offers incentives to nudge drivers to transition to electric vehicles, in an attempt to become a zero-emission platform.[56]
- In 2022, BGE, a utility in the US state of Maryland, partnered with Lyft to rent electric vehicles to ride-hailing drivers.[57]
- Cabify received a loan of EUR 40 million (USD 42 million) from the European Investment Bank in 2022 to acquire 1,400 electric vehicles and deploy charging infrastructure in Spain, contributing to the company's larger effort to invest EUR 82 million (USD 87 million) in fleet decarbonisation.[58] Cabify aims to provide all trips in zero-emission vehicles in Spain by 2025 and in Latin America by 2030.[59]
- In January 2023, Uber and the car rental company Hertz announced a partnership through which Hertz will offer 25,000 electric vehicles for rent to Uber drivers in European capital cities by 2025.[60]

Shared micromobility

Attempts to quantify the emissions impacts of shared micromobility, using life-cycle analyses, also point to the importance of context. **The impacts on CO_2 emissions are highly dependent on the transport modes being substituted, as well as on vehicle durability and operational procedures.**[61]

- A modelling exercise from the International Transport Forum found that shared micromobility devices could generate as much CO_2 emissions as a battery electric private car (see Figure 3).[62]
- A study in Zurich (Switzerland) showed that shared micromobility was mostly replacing trips by public transport, walking, and biking, resulting in a net increase in CO_2 emissions.[63]
- A US analysis found that under a scenario of high adoption of shared micromobility, energy consumption from passenger travel could be reduced 1% at the national level and 2.6% at the city level.[64] Micromobility-induced public transport trips were identified as the largest contributors for these reductions.[65]
- A study in Germany revealed that e-scooters could potentially substitute 13% of daily car trips in the country, with potential savings of 1.2% of transport emissions if the scooters replaced petrol cars.[66]

A promising area of study is the potential of shared micromobility to fill the gaps in first- and last-mile connectivity, therefore expanding the reach and impact of public transport. A survey of nearly 7,000 dockless bike-sharing users across 12 Chinese cities found that the majority of these users (54%) used the bikes to make convenient connections to other transport modes, and more than a third (36%) used them to commute to work.[67] However, this is a nascent area of study, and context likely also plays an important role.

Mobility-as-a-service

As with other shared mobility services, the promise of mobility-as-a-service is its potential to reduce private car ownership and use, while improving access to necessities. It is a major element of digitalisation and enabling integrated transport planning (see *Section 3.1 Integrated Transport Planning*). **While MaaS can in theory reduce CO_2 emissions, pollution, and congestion, empirical evidence is very limited, and comprehensive studies are needed.**[68]

- MaaS resulted in fuel cost savings globally of an estimated USD 2.8 billion in 2022, with projections to reach USD 10.8 billion by 2027.[69]
- A MaaS pilot carried out in Sydney (Australia) during 2019 and 2020 showed promising outcomes in terms of reduced private car use and emissions, but results cannot be easily scaled over a large population.[70]
- A 2022 simulation for Amsterdam (Netherlands) compared different MaaS scenarios (based on service characteristics, interest in using MaaS and shares of population using it) and found that emissions decreased 3-4% in a conservative scenario, 14-19% in a balanced scenario and 43-54% in an optimistic scenario.[71]
- A 2022 literature review suggested that the positive impacts of MaaS on CO_2 reductions might be lower than previously thought.[72]

Policy developments

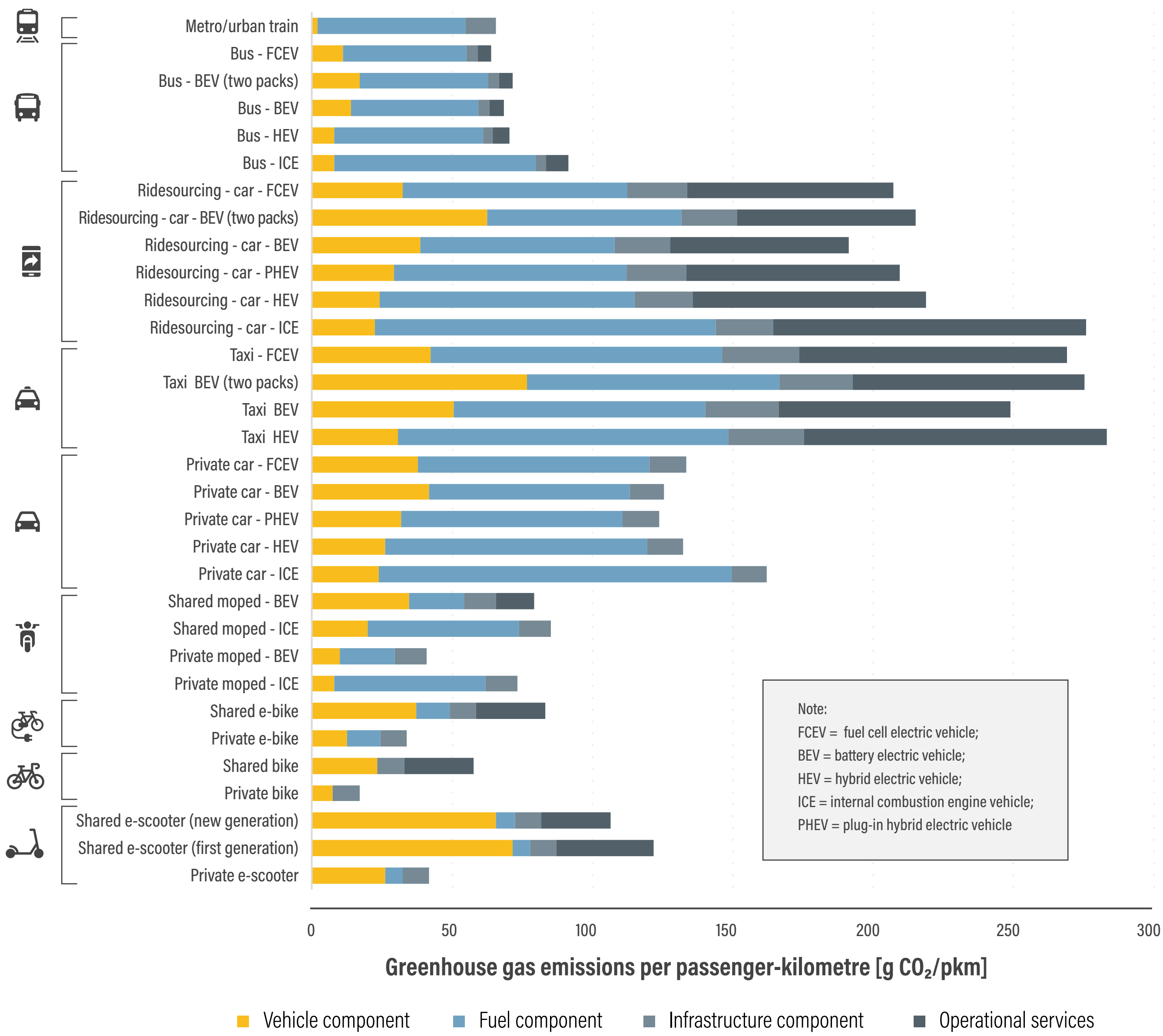
Policy making in the shared mobility space remains complicated. Cities have taken diverse approaches to regulation, with little evidence to conclude that one regulatory approach is better than another.[73]

Carsharing

Corporate-owned carsharing is a well-established service that has been around for at least 20 years. More recently, **the deployment of peer-to-peer carsharing services has introduced regulatory challenges for governments.** In the United States, the state governments of Arizona, Florida, Hawaii, Maryland and Oklahoma adopted regulations in 2021 governing peer-to-peer carsharing by defining standards for consumer protection, insurance and taxation.[74]

FIGURE 3. Estimated life-cycle greenhouse gas emissions per passenger-kilometre, by urban transport mode

Source: See endnote 62 for this section.



A key aspect of carsharing services that requires active government involvement is the definition of parking locations. In some cities in Finland, for example, carsharing vehicles have access to a different parking charge than regular vehicles, and in other cities the government actively decides parking locations, making sure that they are close to public transport or pedestrian zones.[75]

Transport network companies

In some geographies, the policy space for transport network companies has neared a steady state after a decade of being in the front news, while in other locations policy action is still happening. **Ride-hailing operations are now common throughout the world, including in places with diverse regulatory environments – from welcoming to hostile.** At the same time, taxi companies have evolved their business models to include phone apps, thereby blurring the factor that differentiated the services of transport network companies a few years back.[76]

- In 2022, Uber partnered with two taxi companies in New York City (USA) to start featuring taxis in its app, allowing nearly 14,000 taxi drivers to gain access to Uber's customer base.[77]

A more recent development in this space has been the advent of commercial ride-hailing operations using autonomous vehicles. These services create novel regulatory challenges for policy makers, including related to safety, data sharing and form factor (e.g., do these services require a steering wheel?).[78]

- In 2021, Baidu received a permit to operate the first driverless taxi service in two Chinese cities, Chongqing and Wuhan.[79] In early 2023, the company was granted the first licence to pilot the service in Beijing.[80]
- Hyundai launched a driverless ride-hailing service in Seoul (Republic of Korea) in 2022, although a safety driver is always on board.[81]
- In 2022, Cruise received a permit to provide driverless rides in San Francisco (USA).[82]

Governments are implementing policies to curb CO_2 emissions from transport network companies, especially in urban environments.

- The deployment of low-emission zones (so far mainly in Europe) can pressure the fleets of transport network companies to transition towards electric vehicles to be able to access broader areas of a city.[83]
- In 2021, the California Air Resources Board (CARB) approved the Clean Miles Standard, the first US programme requiring ride-hailing companies to transition towards electric vehicles by 2030.[84]

Another potential area for policy development is the link between public transport and transport network companies. Some agencies have either tapped into private transport network companies to serve areas that are underserved by public transport. or deployed their own ride-hailing services to serve the same purpose.

- In 2021, the Los Angeles metro (USA) expanded its Metro Micro pilot of on-demand vans for residents underserved by transport network companies to serve new areas of the city, as part of its current bus plan.[85]

Shared micromobility

After an initial period in which policy makers were caught off guard by the private deployment of shared micromobility services, **many European cities have started to deploy stricter regulations for shared e-scooters.** These developments have been aided by national-level regulations that provide the tools for local governments to act.[86]

- Paris (France) led the way, shifting from an open market that allowed any operator to deploy vehicles, to a more controlled procurement process that limits the number of vehicles and operators and establishes stricter, binding rules.[87] To accommodate these new services, the city has repurposed some on-street car parking spaces as micromobility parking areas.[88] In 2021, Paris set a maximum speed limit of 10 kilometres per hour in areas with a high pedestrian volume.[89]
- In April 2023, after public consultation, Paris decided to ban shared e-scooters as of September of that year. The referendum, motivated by safety and ecological concerns, was criticised for the low voter turnout, with only 8% of registered Parisians going to the polls.[90] The measure does not affect e-scooters owned by individuals.[91]
- In August 2021, Oslo (Norway) established a ban on e-scooter rentals between 11 p.m. and 5 a.m. to reduce night-time accidents.[92] The following month, the city reduced the number of shared e-scooters from 25,000 to 8,000.[93]
- In February 2022, Stockholm (Sweden), in response to residents' complaints about blocked sidewalks, decided to reduce the number of e-scooters by nearly 50% (from 23,000 to around 12,000) and to split them equally among the eight companies operating in the city.[94] In September 2022, the city banned the scooters from sidewalks and established dedicated parking spaces.[95]
- Spain's Traffic Law, updated in March 2022, establishes general requirements for the use of e-scooters and requires municipalities to adopt specific criteria to regulate the use in each city.[96]

Micromobility operators also have realised that their long-term financial sustainability is tied to more regulated markets and limits on the supply of service providers.

- In 2022, the company Bird decided to stop operating in Germany, Sweden, and Norway, and to reduce operations in several cities across the United States, Europe, the Middle East, and Africa, due to an oversupply of vehicles in these markets and to a lack of adequate regulatory frameworks.[97]

Some cities have taken a pro-active approach to the deployment of e-scooters by running pilots to understand their functioning.

- In 2021, after New York City (USA) launched an e-scooter pilot together with three companies in the Bronx district, a survey revealed that the vehicles were mostly replacing walking or public transport trips, and that some of the highest ridership corridors connected riders to public transport and commercial activities.[98] After a year of safe operations, the city decided to extend the programme for five more years, expanding it to communities underserved by existing public transport and micromobility services.[99]
- In 2022, the state government of Victoria (Australia)

announced a trial, in partnership with Lime and Neuron Mobility, to deploy 1,500 e-scooters in the cities of Melbourne, Port Phillip and Yarra for one year to understand how to incorporate e-scooters as a safe mobility option.[100]

Bike sharing systems also continued to expand in different regions.

- Quebec (Canada) launched a pedal-assist electric bike sharing system in 2021, with the goal of providing 1,000 bicycles and 100 smart stations by 2026.[101]
- In 2022, London (UK) expanded its bike sharing service Santander Cycles by adding the first 500 e-bikes across key locations in the city centre.[102]
- Cairo (Egypt) launched a downtown bike sharing programme in 2022, which includes 250 GPS-tracked bicycles distributed across 26 solar-powered docking stations, with the goal of eventually operating 500 bicycles and 45 stations.[103]
- In 2022, Hanoi (Viet Nam) approved an e-bike sharing pilot to serve bus rapid transit passengers travelling between two specific destinations for free.[104]
- The first shared bicycle system of Bogotá (Colombia) began operating in 2022, with 1,500 mechanical bikes, 1,500 e-bikes, 150 hand-pedal bikes for wheelchair users, and 150 cargo bikes to transport goods distributed across 300 stations.[105]
- In 2022, Mexico City began expanding its shared bicycle system, Ecobici, with the goal of extending coverage from three to six city zones and adding 2,980 bikes for a total of 9,480.[106]

Another area of innovation in the micromobility policy space is the use of data to aid in regulations. Los Angeles (USA), in its scooter sharing pilot programme, pioneered the development of the Mobility Data Specification (MDS), a data standard that defines data requests by public sector agencies.[107] Multiple agencies in the United States and beyond have since adopted the MDS.[108]

Mobility-as-a-service

Commercial deployments of MaaS remain limited, but developments in Europe, China and the United States might provide insights into new forms of public-private collaboration.

- An important recent development in MaaS was the launch of Jelbi in Berlin (Germany) in 2019. The service, operated by the public transport operator, encompasses most mobility services in the city, and it includes payments and real-time navigation. Furthermore, the operator created mobility hubs that allow a user to access multiple services at a single location around rail stations.[109]
- Other pilot projects have been implemented in Pittsburgh and Tampa (USA) and in Beijing and Guangzhou (China).[110]
- In addition, some commercial services have been operational for multiple years, such as Whim in Helsinki (Finland).[111] The space is still nascent, and existing examples could provide insights into good policy practices to replicate.

Partnership in action

- The **Better Bike Share Partnership** is a collaboration of the City of Philadelphia, the National Association of City Transportation Officials (NACTO) and PeopleForBikes to increase access to and use of shared micromobility systems in low-income areas and communities of colour.[112] In 2020, the partnership launched the Living Lab programme in five US cities to undertake best practices studies, provide technical assistance and measure changes over time.
- The **MaaS Alliance** is a public-private partnership dedicated to creating and advancing the foundations for a common approach to mobility-as-a-service by unlocking the economies of scale needed for successful implementation and uptake of MaaS in Europe and beyond.[113] Its three working groups address issues related to user needs, regulatory challenges, governance and business models, technology and standardisation.[114]
- The **NUMO New Mobility Atlas** is an extensive, data-driven platform mapping the rapid proliferation of new mobility, including micromobility, in cities around the world. Developed in partnership with organisations from the public and private sectors, the Atlas uses open data to track shared transport options (e.g., dockless scooters, bicycles and mopeds) by 127 mobility service operators in 53 countries and 626 cities.[115]
- The **Open Mobility Foundation** developed the Mobility Data Specification (MDS), an open source tool to help manage dockless micro-mobility programmes (including shared dockless e-scooters).[116] MDS is a set of Application Programming Interfaces that create standardised two-way communications for cities and private companies to share information about their operations, and that allow more than 130 cities across the United States and around the globe to collect data and publish regulations that can inform efficient traffic management and policy making.
- The **Polis Network's Working Groups on Active Travel and Traffic Efficiency** address the broad subject of multimodal network management from both a strategic and technical perspective, focusing on supporting city and regional authorities in the management and regulation of carsharing, ride-sharing, bike sharing services and MaaS.[117]

MODULE 3 3.5

AUTHORS:
Joo Hyun Ha and Lucie Anderton, *International Union of Railways (UIC)*

CONTRIBUTORS:
Agustina Krapp, *SLOCAT Secretariat*

Rail

Key findings

- A modal shift to rail, stimulated by policy initiatives based on ambitious targets, can play a decisive role in cutting carbon emissions from the transport sector, according to the International Energy Agency's scenario for net zero emissions by 2050.
- Despite growth in passenger and freight rail activity during 2010-2020, only 6-7% of passenger journeys were made by rail, on average. Freight logistics flows will need to exploit rail's potential to achieve higher volumes and efficiency.

Demand trends

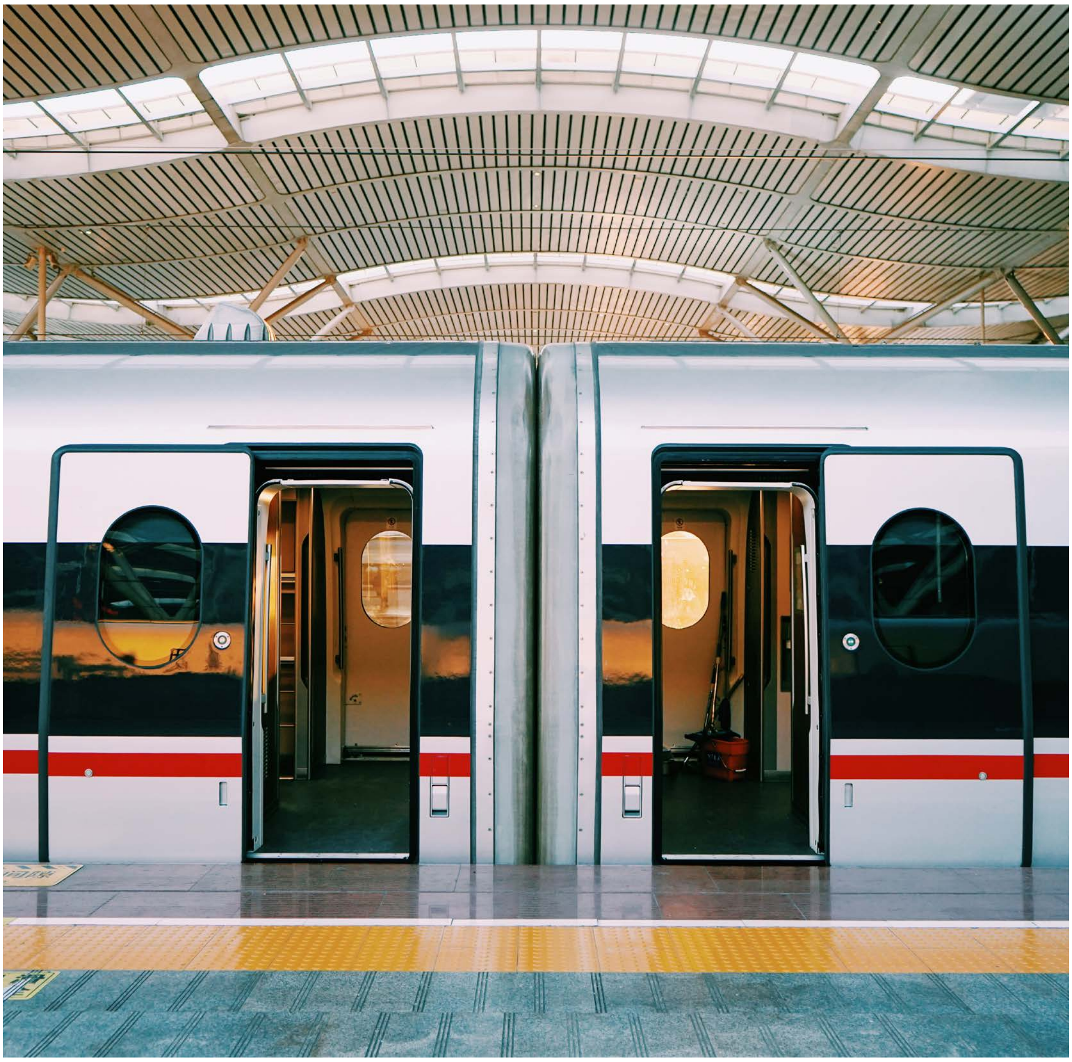
- Global passenger rail activity grew 29% between 2010 and 2019, from 3.22 trillion to 4.16 trillion passenger-kilometres.
- Due to mobility restrictions related to the COVID-19 pandemic, global passenger demand for rail services fell 37.7% in 2020 to 2.59 trillion passenger-kilometres.
- Rail use trends in the first half of 2022 varied widely by region and rail mode (passenger versus freight transport).
- Global rail freight activity increased 12.5% between 2010 and 2019, to 11.3 trillion tonne-kilometres, then fell 4% in 2020 to 10.9 trillion tonne-kilometres. By region, Asia and Oceania accounted for 41% of all rail freight activity in 2020, followed by the Americas (28%).
- The Russian Federation's invasion of Ukraine had strong impacts on passenger and freight rail activity, as rail freight between Asia and Europe dropped by a quarter in 2022.
- Between 2010 and 2020, rail lines globally were extended by nearly 50,000 kilometres to reach 1.1 million kilometres, although very little growth occurred outside of Asia
- High-speed rail activity dropped sharply in 2020, falling 50% on average across countries. However, the pandemic did not stop the development of infrastructure, as the global high-speed rail network expanded by more than one-third from 44,000 kilometres in 2017 to nearly 59,000 kilometres in 2022.
- High-speed rail can increase the modal share of rail by replacing car trips and shorter flights.
- Operators around the world are upgrading their rail fleets, with investments in rail rolling stock projected to increase 6% a year between 2019 and 2024 across all geographies.

Emission trends

- Rail has the lowest greenhouse gas and energy intensity of all transport modes, emitting on average 19 grams of carbon dioxide (CO_2) equivalent per passenger-kilometre in 2021, one-tenth the emissions of a medium-sized passenger car.
- Greater use of rail could reduce global transport emissions 11-16% in 2050 compared to a business-as-usual pathway, saving up to 300 million tonnes of emissions annually in China, India and North America.
- Rail is the most electrified mode of transport, with around 45% of its energy use coming from electricity in 2021. This share is projected to reach two-thirds by 2030 (particularly in freight), and growth in hydrogen use is also anticipated. In 2021, freight rail consumed four times more energy than passenger rail.
- Because trains are large energy consumers, decarbonising the electricity grid through the use of renewable energy is an important step to delivering net zero railways.
- When trains are powered by renewable hydrogen, they provide an almost silent ride and emit only steam and condensed water, avoiding up to 700 tonnes of CO_2 emissions annually compared to the equivalent regional diesel train.

Policy developments

- As part of national plans for pandemic recovery, between 2020 and 2022 governments launched plans to upgrade and develop rail lines and to decarbonise transport, although public spending for road transport remains higher than for rail.
- Shifting transport activity to rail is key to decarbonising the global transport sector. To meet global climate targets for 2050, an estimated 15% of flights and more than 2% of private vehicle road travel need to be moved to high-speed rail.
- Railway expansions (conventional and high-speed rail) are planned in all regions to improve the connectivity and convenience of rail travel. The global high-speed rail network is projected to grow from around 59,000 kilometres in 2022 to 78,000 kilometres in the next years.
- As of 2022, 9 out of the 30 countries that submitted updated Nationally Determined Contributions towards reducing emissions under the Paris Agreement mentioned solutions in the rail sector, mostly as a mitigation action.



Overview

Rail transport is considered to be the cleanest mode of collective passenger transport, as it has the lowest greenhouse gas and energy intensities. High rates of electrification and energy efficiency in operations make rail the least carbon-intensive transport mode per passenger- or tonne-kilometre. The COVID-19 pandemic and related restrictions greatly impacted rail operations worldwide, especially for passenger services. As countries and economies recover, rail demand has gradually returned to near pre-pandemic levels.

A modal shift to rail, stimulated by policy initiatives based on ambitious targets, can play a decisive role in cutting carbon emissions from the transport sector, according to the International Energy Agency's scenario for net zero emissions by 2050. [1] As countries seek to transition to more sustainable transport systems, several economic recovery packages have included efforts to increase the modal share of rail. However, these measures remain insufficient to achieve the emission reductions needed in the transport sector to keep global temperature rise within 1.5 degrees Celsius.

Despite growth in passenger and freight rail activity during 2010-2020, only 6-7% of passenger journeys were made by rail, on average.[2] Studies suggest that this needs to grow more than 40% by 2030 to decarbonise mobility in line with the Paris Agreement goals.[3] **Freight logistics flows will also need to exploit rail's potential to achieve higher volumes and efficiency.**[4]

Demand trends

Global passenger rail activity grew 29% between 2010 and 2019, from 3.22 trillion to 4.16 trillion passenger-kilometres.[5] **Due to mobility restrictions related to the COVID-19 pandemic, global passenger demand for rail services fell 37.7% in 2020 to 2.59 trillion passenger-kilometres.**[6] Despite the restrictions, many rail companies maintained the same level of service to ensure transport for essential workers and equipment across countries.[7] Rail accounted for the lowest share of overall transport demand in 2021, at 3%, followed by aviation (8%).[8]

- By region, the greatest declines in rail passenger traffic in 2020 were in Africa (59.2%) and the Americas (63.4%), whereas passenger traffic was less affected in Asia and Oceania (see Figure 1).[9]
- In 2020, the rail operator SNCF in France used high-speed trains to transport COVID-19 patients and medical staff around the country, adapting double-decker passenger trains to offer medical services and adding extra cars for safety in case of collision.[10]

Rail use trends in the first half of 2022 varied widely by region and rail mode (passenger versus freight transport). Although passenger traffic improved overall compared to 2021, for many companies the total number of passenger-kilometres travelled remained below 2019 levels despite encouraging growth.[11] By 2022, rail ridership returned to near pre-pandemic levels in most developed countries as demand for leisure travel surged.[12] However, business travel by rail has recovered more gradually and may eventually find a new equilibrium below that of 2019 due to more remote working and teleconferencing.[13]

- To boost ridership, the Southeastern Pennsylvania Transportation Authority (SEPTA) in the United States announced various initiatives under its 2023 budget, including a USD 10 Neighborhood FleX DayPass targeting riders travelling shorter distances, which can be used for up to 10 rides in a single day across various transport modes (including buses, subways, trolleys and regional rail).[14]
- In Japan, JR East expanded its in-station and in-train services to retain business travellers by providing shared offices and tools to improve concentration for work in trains, such as augmented-reality glasses and separation screens.[15] It also created new services to encourage "workation" (work and vacation trips) by combining railway, hotel, car rentals and remote-work offerings.[16]
- In Switzerland, rail projects planned for 2025 and 2035 could help raise public transport's share of total traffic by 3% to 24%.[17]

Global rail freight activity increased 12.5% between 2010 and 2019, to 11.3 trillion tonne-kilometres, then fell 4% in 2020 to 10.9 trillion tonne-kilometres.[18] **By region, Asia and Oceania accounted for 41% of all rail freight activity in 2020, followed by the Americas (28%)** (see Figure 2).[19]

- As of 2021, around 10% of cargo in South Africa – a total of 6.7 million tonnes – had been shifted from road to rail through the Transnet Road to Rail Migration Plan.[20]

FIGURE 1. Passenger rail activity by region, 2010-2020

Source: See endnote 9 for this section.

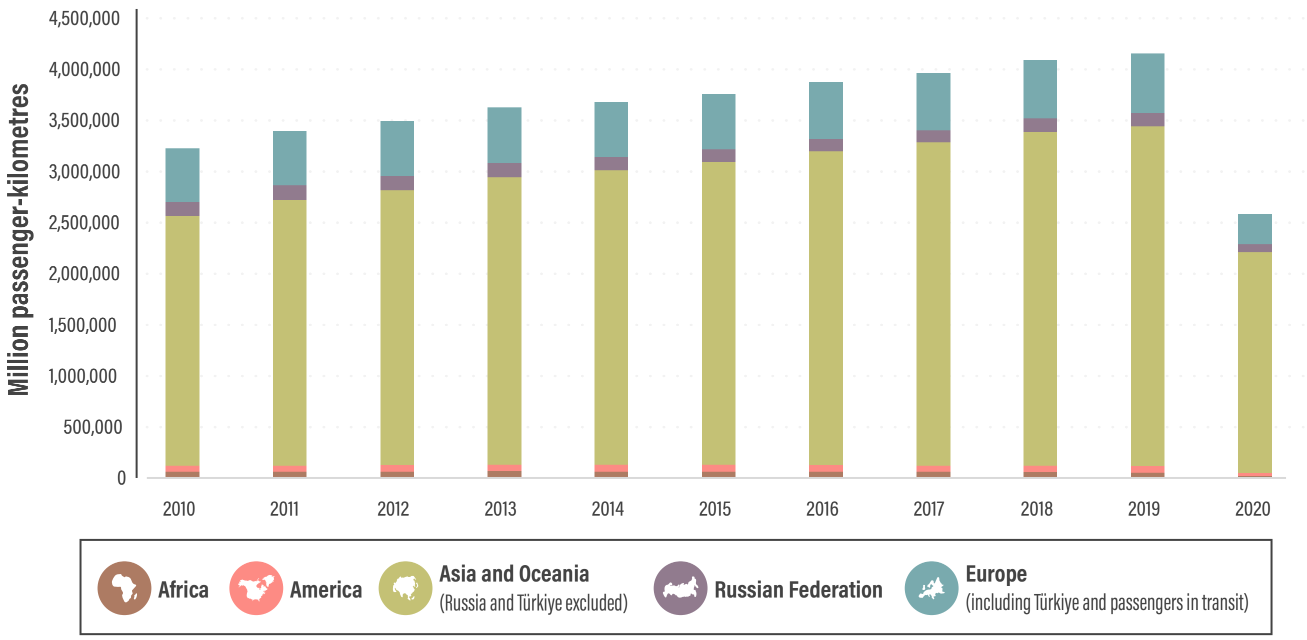


FIGURE 2. Freight rail activity by region, 2004-2020

Source: See endnote 19 for this section.

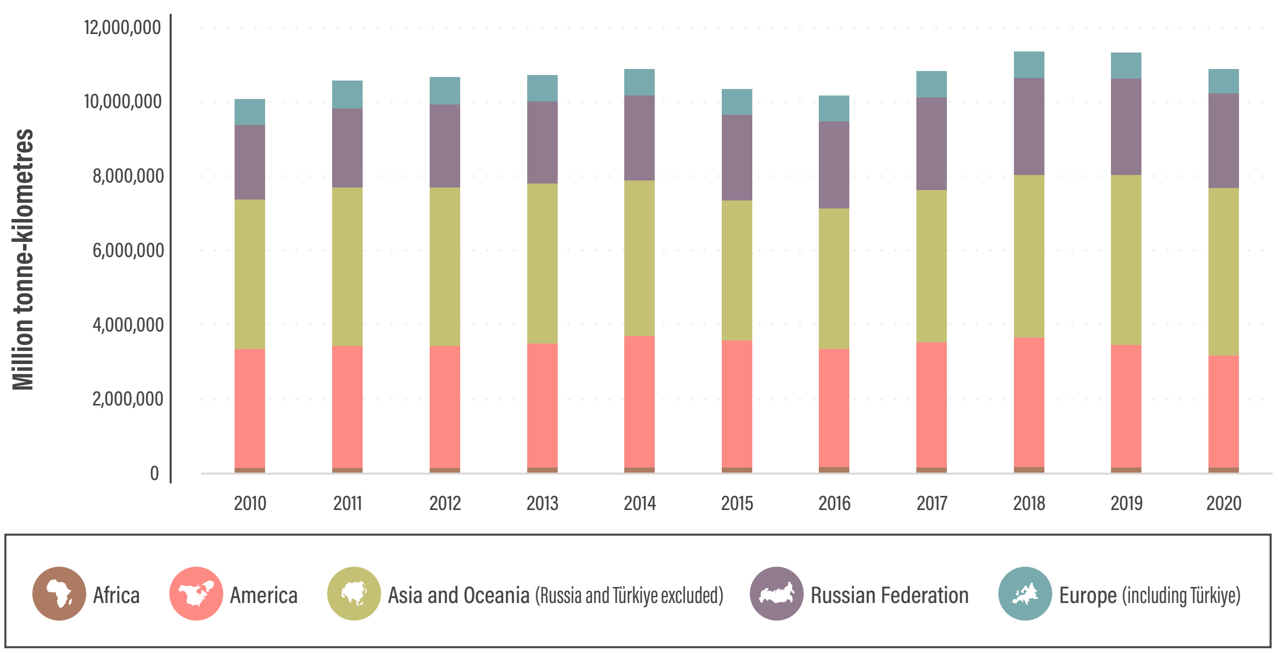


TABLE 1. Status of high-speed rail lines, by region, as of 2021 (in kilometres)

Source: See endnote 31 for this section.

Region	In operation	Under construction	Planned	Long-term planning
Africa	186	0	2,210	4,195
Asia-Pacific	44,428	14,367	6,893	18,320
Europe	11,990	3,062	5,913	3,316
Latin America	0	0	0	638
Middle East	1,501	2,006	3,139	1,831
North America	735	274	1,488	5,307
Total	**58,840**	**19,709**	**19,643**	**33,607**

The Russian Federation's invasion of Ukraine had strong impacts on passenger and freight rail activity, as rail freight between Asia and Europe dropped by a quarter in 2022.[21] Rail-based container-traffic between Europe and China fell 22% in 2022.[22] Rail freight activity along the Middle and Southern Silk Roads, which do not go through the Russian Federation, is expected to grow from 6,900 twenty-foot equivalent in 2021 to 760,000 twenty-foot equivalent in 2030.[23]

- In 2022, Germany implemented the "9 Euro" ticket in response to the energy crisis spurred by the Russian invasion of Ukraine. For a reduced monthly fare of EUR 9 (USD 9.6), users were able to use local and regional public transport from June to August 2022, leading to a 3% decline in car traffic compared to the same period in 2019.[24] A survey found that 35% of 1,000 respondents used public transport more often and 22% shifted their trips from private to public transport.[25] In January 2023, Germany introduced the successor Deutschlandticket, a EUR 49 (USD 52) monthly ticket for public and regional transport.[26]
- In 2022, German rail freight operator DB Cargo implemented measures to alleviate supply chain constraints following the Russian invasion of Ukraine, particularly in delivering grain across the region (see Box 1).[27]

Between 2010 and 2020, rail lines globally were extended by nearly 50,000 kilometres to reach 1.1 million kilometres, although very little growth occurred outside of Asia (see Figure 3).[28]

High-speed rail activity dropped sharply in 2020, falling 50% on average across countries.[29] **However, the pandemic did not stop the development of infrastructure, as the global high-speed rail network expanded by more than one-third from 44,000 kilometres in 2017 to nearly 59,000 kilometres in 2022** (see Figure 4).[30] The network is expected to grow another one-third in length in the coming years, with 19,709 kilometres of high-speed lines under construction as of 2022 and a further 19,643 kilometres planned (see Figure 5 and Table 1).[31] **High-speed rail can increase the modal share of rail by replacing car trips and shorter flights** (see Figure 6).[32]

BOX 1. Support from the international railway community following the Russian invasion of Ukraine

Following the Russian Federation's invasion of Ukraine in February 2022, the International Union of Railways (UIC) launched the Refugee Task Force in March to support companies, partner associations and organisations to tackle the challenges arising from this humanitarian crisis. The Task Force exchanged best practices and know-how on the management of migration flows, establishing information exchange in real time between train operators and infrastructure managers to accommodate Ukrainian refugees in railway stations, preparing communication plans and addressing any security issues.

- Ukrainian railways reported that the number of passengers leaving and entering Ukraine by train had evened out by mid-2022. Of 30,800 rail passengers on international routes in the week of 4 July, 15,500 left Ukraine and 15,300 entered the country.

In 2022, Germany's rail freight operator DB Cargo announced a "grain bridge" for Ukrainian exports to German ports in Rostock, Hamburg and Brake (near Bremerhaven). The network created for the transport of relief goods to Ukraine would be "rotated" for this purpose, according to the company, with several trains running per week. Much of the transport would go through Romania, but DB Cargo's subsidiaries in Poland and other countries were also involved.

Source: See endnote 27 for this section.

FIGURE 3. Length of rail lines by region, 2010-2020

Source: See endnote 28 for this section.

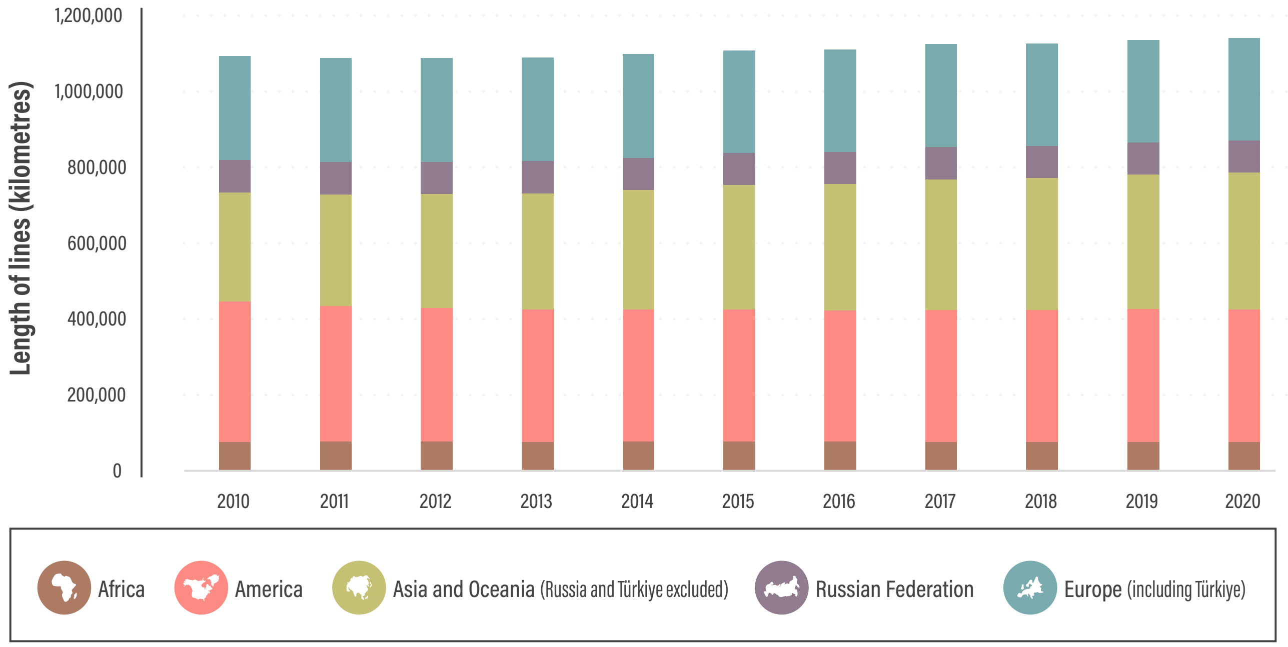


FIGURE 4. High-speed rail development in selected countries/regions, 2010-2021

Source: See endnote 30 for this section.

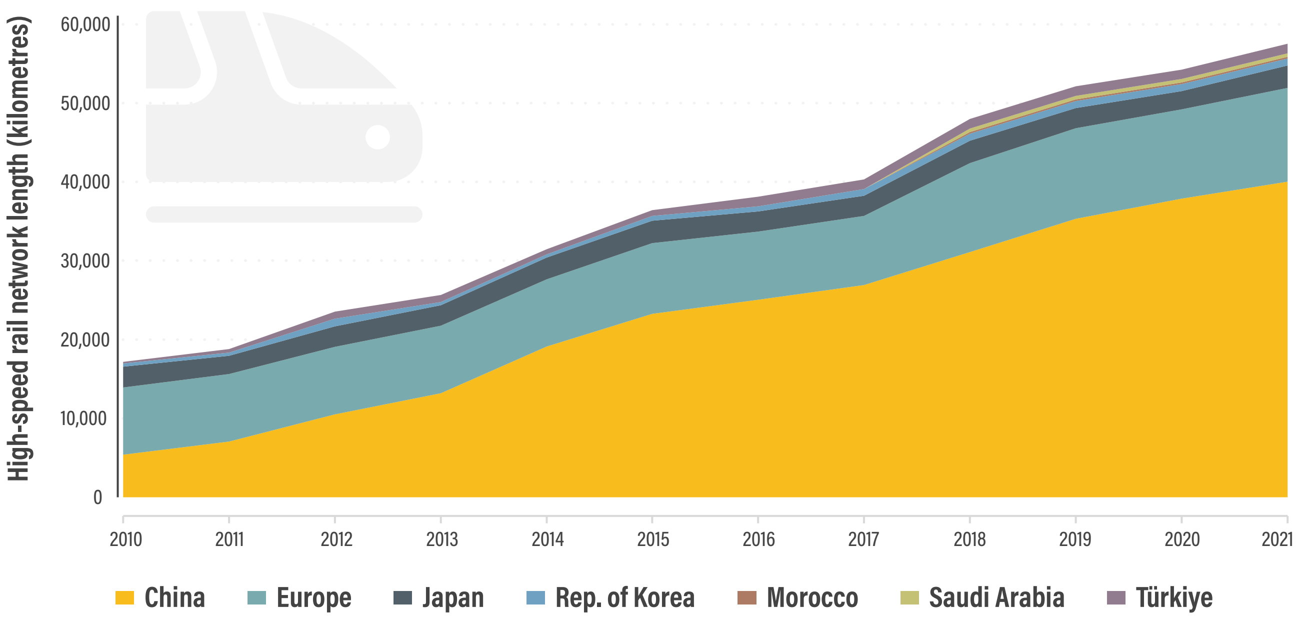


FIGURE 5. Status of global high-speed rail network by country/region, as of 2021

Source: See endnote 31 for this section.

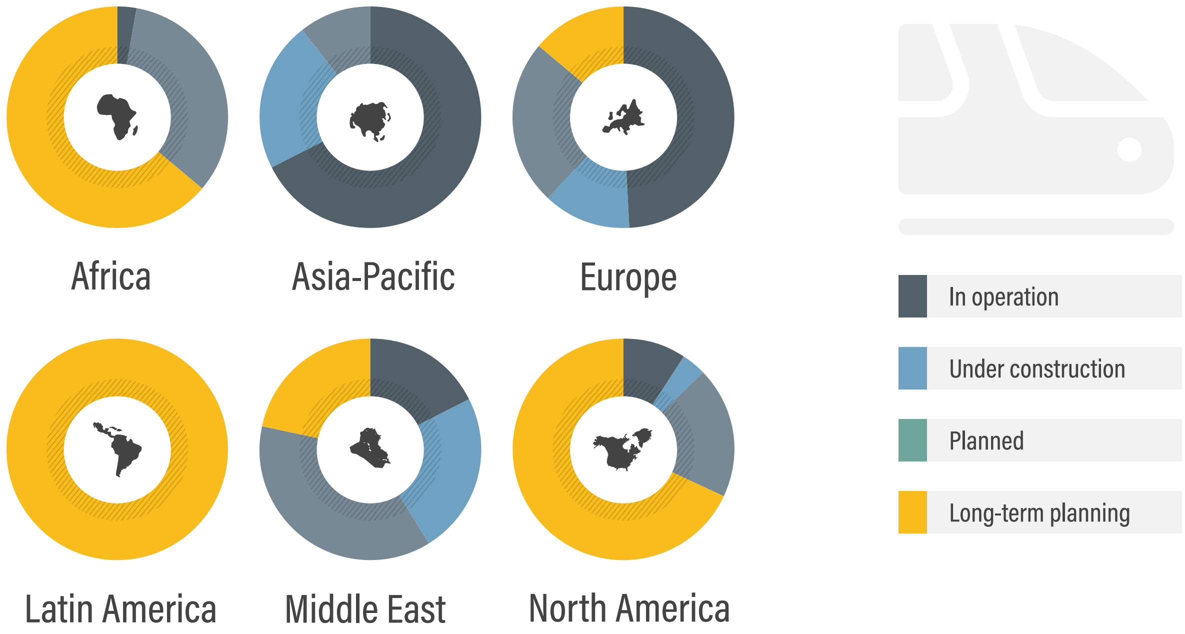
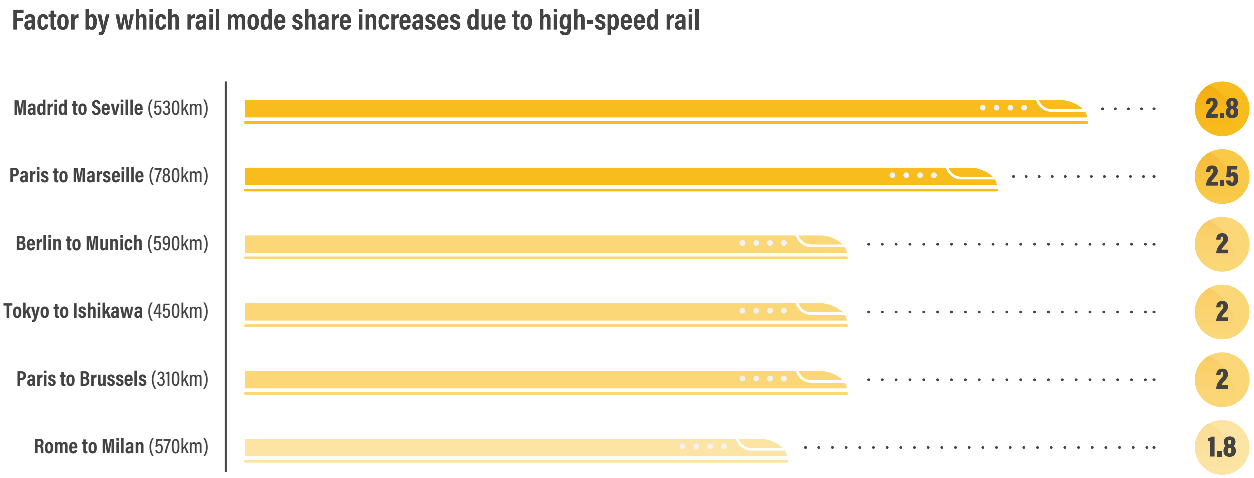


FIGURE 6. Increases in rail modal share due to high-speed rail

Source: See endnote 32 for this section.



- China has led the high-speed rail expansion, adding around 80% of the new infrastructure between 2017 and 2022.[33] China's high-speed rail network grew from 33,330 kilometres in 2020 (already the world's largest network), to 40,040 kilometres in 2021, to around 42,000 kilometres by the end of 2022 (see Figure 4).[34]
- Europe boasts the second largest high-speed rail network and aims to double its ridership by 2030 compared to 2015, with a vision of replacing short-haul flights with convenient and sustainable high-speed rail service.[35]
- Latin America does not have existing high-speed rail, but projects are planned in Brazil, Chile and Mexico.[36]
- In Africa, where existing railways are mostly single lines connecting larger cities to ports (except in northern Africa and South Africa), numerous high-speed projects have been proposed or started but have faced delays due to political conflict, funding and the pandemic. Morocco opened Africa's first high-speed rail service (323 kilometres) in 2018 and aims to expand it by 492 kilometres in the coming years.[37] Egypt is developing the Electric Express Train project, a 660 kilometre high-speed rail that will connect the port cities of Ain Sokhna, Marsa Matrouh and Alexandria.[38]

Operators around the world are upgrading their rail fleets, with investments in rail rolling stock projected to increase 6% a year between 2019 and 2024 across all geographies.[39] Countries have added new high-speed rail as well as standard-speed services.

- Brazil has plans for 10 new rail lines totalling 3,300 kilometres and USD 10.1 billion, under its new regulatory framework for railways, approved in 2021.[40]
- Romania plans to construct a high-speed railway from Bucharest to Budapest (Hungary).[41]
- Overnight trains have experienced a revival in Western Europe in recent years. In 2021, SNCF in France re-established night train connections between Paris and Nice and launched the Paris-Munich-Vienna service in partnership with Austria's ÖBB.
- Other operators in Europe, such as FlixTrain in Germany, revived slower long-distance trains with intermediate stops at smaller cities.[42]

Emission trends

Rail has the lowest greenhouse gas and energy intensity of all transport modes, emitting on average 19 grams of carbon dioxide (CO_2) equivalent per passenger-kilometre in 2021, one-tenth the emissions of a medium-sized passenger car.[43] Overall, energy use and emissions from rail have fallen since 2000 due to rising energy efficiency and the phasing out of diesel fuel (see Figure 7).[44] However, emissions increased in 2020 because trains continued to run to ensure transport for essential workers and equipment, but were operating with fewer people, leading to an increase in the carbon intensity of operations per passenger-kilometre.[45]

FIGURE 7. CO_2 emissions intensity of global rail, 2000-2020

Source: See endnote 44 for this section.

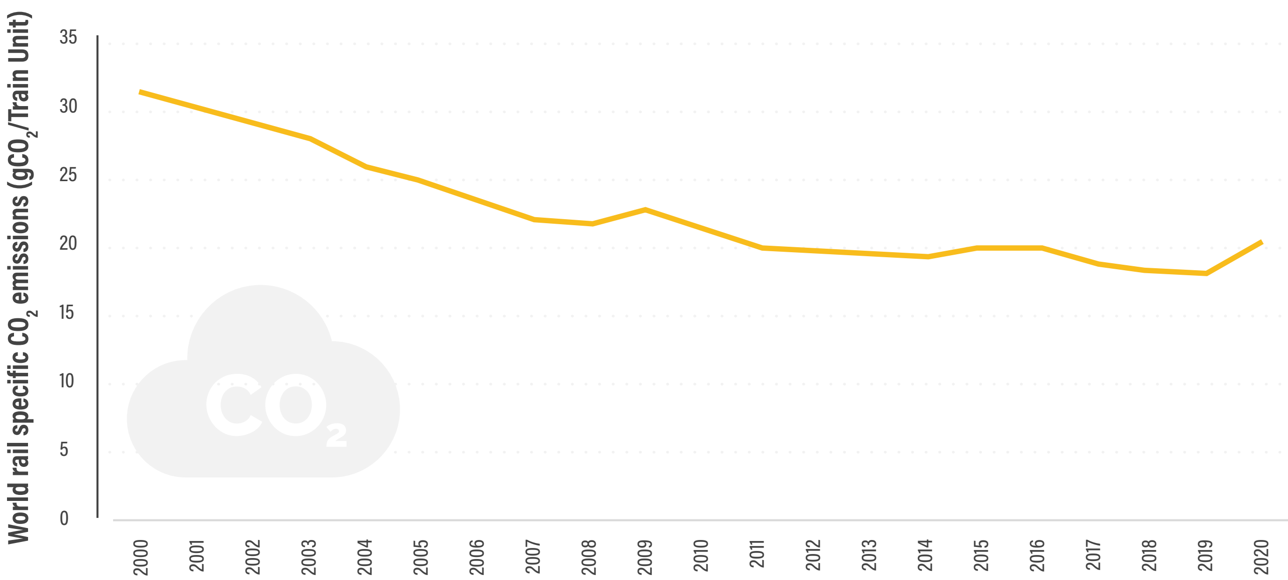
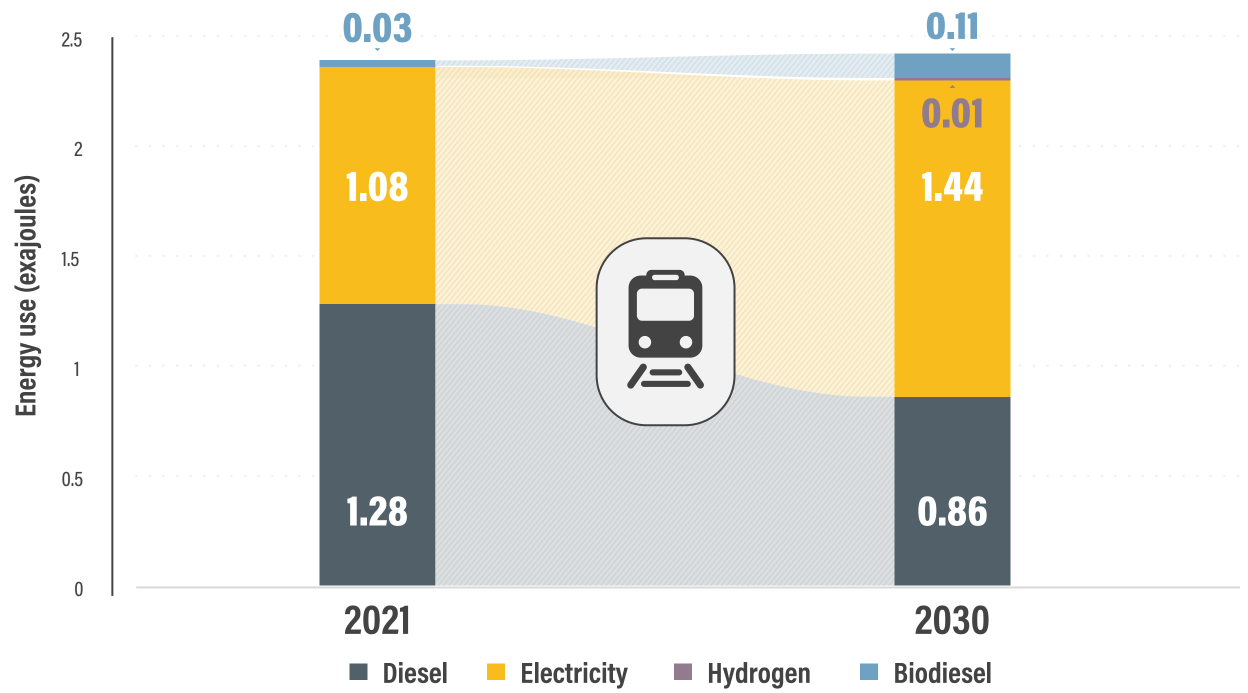


FIGURE 8. Energy use in the rail sector by source, 2021 and projections for 2030

Source: See endnote 51 for this section.



- For European rail networks, CO_2-equivalent emissions from passenger rail fell by around one-third between 2005 and 2021 (34.3% market based or 26.6% location-based).[46]
- The carbon intensity of rail freight continued to improve in 2021, showing a 4.3% reduction in grams of CO_2-equivalent per tonne-kilometre.[47]

Greater use of rail could reduce global transport emissions 11-16% in 2050 compared to a business-as-usual pathway, saving up to 300 million tonnes of emissions annually in China, India and North America.[48] To achieve these reductions, key trends include a modal shift towards rail in combination with electrification, the integration of renewable power, digitalisation and energy efficiency. Reducing and shifting personal vehicle use and aviation to rail (urban and inter-city rail), as well shifting freight activity from road transport to rail, could reduce around 2 gigatonnes of CO_2-equivalent well-to-wheel emissions.[49]

Rail is the most electrified mode of transport, with around 45% of its energy use coming from electricity in 2021.[50] In 2021, global energy use for rail was spilt roughly evenly between diesel fuel (1.28 exajoules) and electricity (1.08 exajoules), with a small contribution from biodiesel (see Figure 8).[51] With the modal shift from aviation and road transport to rail, energy use in rail will continue to grow. **Globally, the share of electricity use in rail is projected to reach two-thirds by 2030 (particularly in freight), and growth in hydrogen use is also anticipated.**[52]

In Europe, the electricity share was already close to 60% as of 2021.[53] **In 2021, freight rail consumed four times more energy than passenger rail.**[54]

The share of electrified lines globally increased steadily between 2011 and 2020, although growth was minimal in Africa and has fallen slightly in the Americas (see Figure 9).[55]

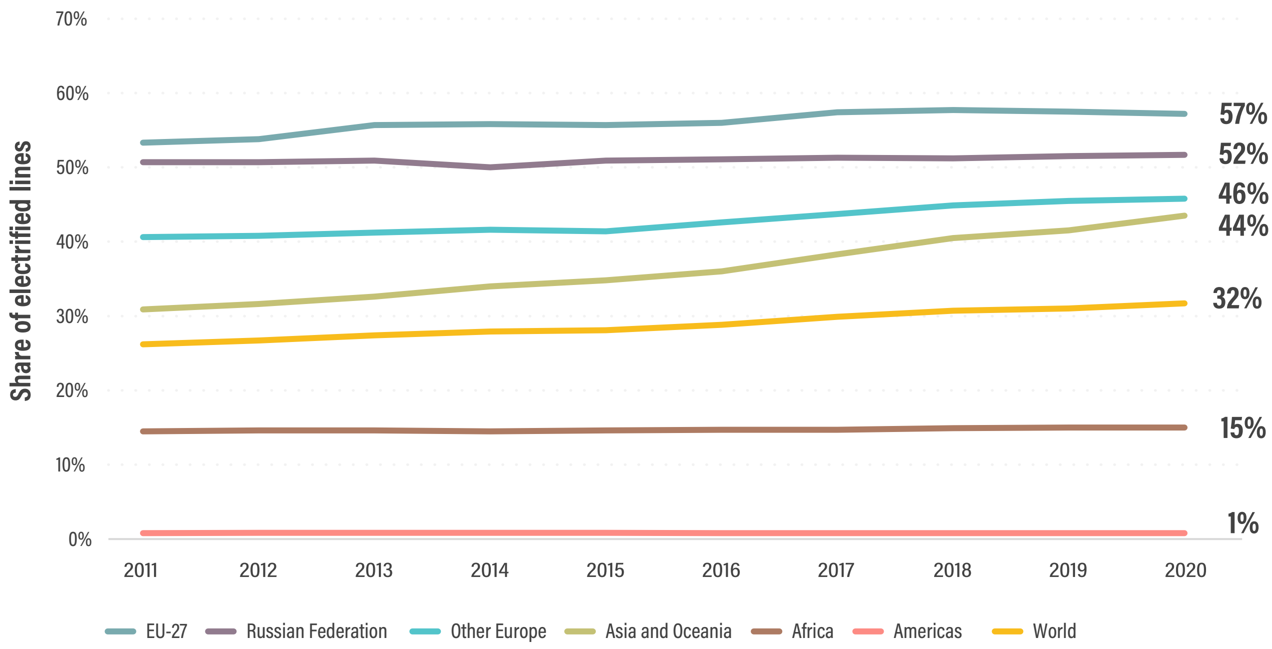
- In 2020, Indian Railways set an ambitious target to electrify all rail routes by December 2023 and to add more than 500 megawatts of renewable power (solar and wind).[56]
- Romania has allocated EUR 3.9 billion (USD 4.2 billion) from European Union (EU) recovery funds for rail modernisation – including electric and other locomotives with zero emissions – as part of the government commitment to abolish coal use for electricity generation by 2032.[57]
- Scotland's Rail Services Decarbonisation Action Plan aims to decarbonise passenger rail by 2035 through significant rail electrification, a large-scale modal shift to rail, and some battery or hybrid trains.[58]

Because trains are large energy consumers, decarbonising the electricity grid through the use of renewable energy is an important step to delivering net zero railways.

- The Italian railway company FS is investing EUR 1.6 billion (USD 1.7 billion) in a plan to install 2 gigawatts of solar

FIGURE 9. Share of electrified rail lines by region, 2011-2020

Source: See endnote 55 for this section.



photovoltaic plants across its real estate assets (stations, railway workshops, warehouses, industrial areas, offices); the plants will produce 2.6 terawatt-hours of electricity per year, covering at least 40% of the FS Group's power needs and saving 800,000 tonnes of CO_2 emissions.[59]

- Indian Railways is working with partners to install and connect new renewable power generation facilities, including solar farms that directly feed rail traction power.[60]

When trains are powered by renewable hydrogen, they provide an almost silent ride and emit only steam and condensed water, avoiding up to 700 tonnes of CO_2 emissions annually compared to the equivalent regional diesel train.[61]

- The world's first hydrogen-powered train, the Coradia iLint developed by Alstom, began serving passengers in 2018.[62]
- In 2022, the first hydrogen train route went into service in north-west Germany, with other fleets of Alstom hydrogen trains to be launched in Frankfurt, Italy's Lombardy region and across France.[63]
- Romania plans to modernise its rail with the acquisition of 12 hydrogen-powered electric trainsets and 55 upgraded electric locomotives.[64] In addition, 20 shunting locomotives will be upgraded from diesel to electric and plug-in, and all purchases of new rolling stock will have the European signalling system ETCS on board.[65]

Policy developments

As part of national plans for pandemic recovery, between 2020 and 2022 governments launched plans to upgrade and develop rail lines and to decarbonise transport, although public spending for road transport remains higher than for rail.

- The European Green Deal, a major stimulus package focused on sustainability released in 2020, included an estimated EUR 87.5 billion (USD 93.4 billion) in investment related to rail infrastructure.[66] The European Commission aims to double high-speed rail traffic by 2030 and to triple it by 2050; it also aims for all scheduled collective travel of under 500 kilometres to be carbon neutral within the EU by 2030.[67]
- In the United States, the 2022 Infrastructure Investment and Jobs Act allocated USD 66 billion in funding and grants for rail corridor development, track upgrades and safety improvements.[68]
- The 2021 US Bipartisan Infrastructure Bill includes USD 66 billion in new rail infrastructure funding from 2022 to 2026, the biggest investment in passenger rail transport in the history of rail provider Amtrak.[69]
- A rail company in Saudi Arabia received 28,000 applications for a job posting to recruit 30 female train drivers, who would drive high-speed trains between the holy cities of Mecca and Medina following a year of training.[70]

Shifting transport activity to rail is key to decarbonising the global transport sector. To meet global climate targets for 2050, an estimated 15% of flights and more than 2% of private vehicle road travel need to be moved to high-speed rail.[71]

- The African Union Commission is promoting and facilitating rail transport under its Programme for Infrastructure Development in Africa, which focuses on developing an integrated transport network for the continent; railways have been considered as the backbone of transport networks at all levels.[72]
- In 2022, the European Commission approved France's proposal to prohibit short-haul flights between cities that are linked by a train journey of less than 2.5 hours when a reliable rail alternative exists.[73] The measure, enacted in May 2023, applied initially for three routes from Paris-Orly to Bordeaux, Lyon and Nantes.[74]
- Switzerland has revised its long-term rail strategy, Rail 2050, in favour of improving short- and medium-distance rail services; this is expected to result in a 10% increase in both domestic and import/export rail freight by 2050.[75]

Railway expansions (conventional and high-speed rail) are planned in all regions to improve the connectivity and convenience of rail travel. The global high-speed rail network is projected to grow from around 59,000 kilometres in 2022 to 78,000 kilometres in the next years.[76]

- In 2023, 4,500 kilometres of high-speed rails were announced to connect the Three Seas Region (including Austria, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia), for planned completion in 2028.[77]
- Efforts to improve rail connectivity and convenience are ongoing in Asia, where more than 70% of the growth in the global high-speed rail network is expected to occur. High-speed rail expansions are expected in India, Indonesia, Iran, Thailand, Türkiye and Viet Nam.[78]
- Regional collaboration in Africa continued to advance efforts to build rail infrastructure to ensure reliable, efficient and sustainable transport service for the future. An integrated African high-speed rail network is at the heart of the region's Agenda 2063.[79] The Integrated High Speed Train Network project aims to connect all African capitals and commercial centres through an African high-speed train network, thereby facilitating the movement of goods, services and people; reducing transport costs and relieving congestion of systems.[80]
- In 2022, Egypt signed an EUR 8 billion (USD 8.5 billion) deal with Siemens for a high-speed rail system, contributing to the building of the world's sixth-largest rail network, which will connect cities along the Nile with the Red and Mediterranean seas.[81]
- Tanzania and Burundi agreed in 2022 to jointly build a 282-kilometre-long standard gauge railway to connect the countries.[82]
- In 2022, Senegal announced the launch of the operating phase for the Regional Express Train (TER), which is expected to carry some 115,000 passengers daily and will connect Dakar to the new city of Diamniadio, around 40 kilometres to the east.[83]
- Oman and the United Arab Emirates agreed in 2023 to build a USD 3 billion rail link between the two countries.[84]

As of 2022, 9 out of the 30 countries that submitted updated Nationally Determined Contributions towards reducing emissions under the Paris Agreement mentioned solutions in the rail sector, mostly as a mitigation action.[85] The shift from road transport to rail or inland waterways was the most popular freight-related mitigation action in the second generation of NDCs (14 NDCs) as of the end of 2022.[86] In total, rail-focused mitigation actions were covered by 37 second-generation NDCs.[87]

- India's NDC commits to raising the share of rail traffic for freight from 35% in 2022 to 45% by 2030.[88]
- Egypt is promoting green finance (green bonds) for clean transport – introducing high-speed rail and expanding metro, monorail and light rail – and has also set specific transport emission targets.[89]
- Thailand is promoting a road-to-rail modal shift for both freight and passenger traffic, as part of the Environmentally Sustainable Transport System Plan.[90]
- The United Arab Emirates is promoting greater use of public transport (such as the urban metro in Dubai) and building new freight lines that will greatly reduce emissions, as part of a road-to-rail modal shift.[91]

Partnership in action

- The **UIC International Union of Railways** is the worldwide professional association representing the railway sector and promoting rail transport.[92] In 2022, the UIC released a manifesto for the UIC Centenary setting the scene for the main deliveries from the global railway community over the next decade, and describing how the global railway community will help bring to life the 2030 Vision.[93]
- The **UIC and the International Union of Public Transport** issued a joint statement for the Transport thematic day of the 2021 United Nations Climate Change Conference in Glasgow, United Kingdom (COP 26) on the need for a greater focus on rail and public transport on the climate agenda.[94]

MODULE 3 3.6

LEAD AUTHOR:
Hannah E. Murdock, *Imperial College London*

SUPPORTING AUTHOR:
Tokam Cabrel, *SLOCAT Secretariat*

CONTRIBUTORS:
Mark Major, *SLOCAT Secretariat*
Todd Litman, *Victoria Transport Policy Institute*

Road Transport

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Note: This section on road transport covers trends in motorised individual road transport as well as road vehicle activity, vehicle sales, self-driving road vehicles, parking, traffic congestion and road safety. Road-based public transport is covered in *Section 3.4.1 Public Transport*.

Key findings

- Road transport contributes the largest greenhouse gas emissions among all transport modes.
- Some governments have taken strong action to encourage the shift towards sustainable modes of transport as well as to reduce vehicle travel, promote low-emission vehicles, improve fuel efficiency and increase the use of renewable fuels.

Demand trends

- Global demand for passenger transport (of all forms) grew 6% between 2018 and 2022, reaching 26.4 trillion kilometres. Nearly two-thirds of passenger transport globally was in passenger cars, although the modal split varies highly by location.
- Global freight activity increased an estimated 7% between 2019 and 2022, to surpass 179 trillion tonne-kilometres. In 2019, road transport accounted for 22% of freight activity globally, on average, although the modal split varies highly by location. Cargo bikes are increasingly being viewed as a more sustainable substitute for delivery vans.
- Since 2020, a rise in the global average price of oil has led to higher fuel prices, affecting overall transport costs. Because the transport sector relies on fossil fuels for 96% of its energy consumption, fluctuating oil prices can greatly impact the cost of operating motorised vehicles, highlighting the need to shift to more sustainable energy sources and modes of transport.
- Motorisation rates vary greatly by region, with the highest rate in North America – at four times the global average of 196 vehicles per 1,000 people – and the lowest rate in Africa, at a quarter of the global average, as of 2020.
- The number of cars per household varies greatly by income group and region; in the United Kingdom, for example, a quarter of higher-income households own three or more cars.
- Global automobile sales (for both passenger and commercial four-wheeled vehicles) dropped 13.7% in 2020, grew 5% in 2021 (to total 82.7 million units), then fell 1.4% in 2022 to 81.6 million units.
- Electric car sales grew 55% in 2022 to exceed a record 10 million units. More than 26 million electric cars were on the world's roads that year, a five-fold increase from 2018.
- Global shares of electric heavy-duty vehicles remain relatively low, with electric buses accounting for around 3.1% of the total bus stock, and heavy-duty trucks comprising just 0.4% of the total truck stock in 2022.
- The electrification of vehicles will not resolve several critical transport issues, such as traffic congestion, urban sprawl and the amount of public space devoted to vehicles. Studies have shown a correlation between higher prices for parking and greater use of public transport and active mobility, and in many places parking prices have increased sharply in recent years.
- Rising demand for road transport can lead to increased traffic congestion, with significant economic and public health costs. By 2021, congestion had returned to pre-pandemic levels in many cities, and in some places it worsened.
- High demand for private road transport can lead to declines in road safety, with a greater likelihood of road crashes. During 2010-2019, the number of road deaths fell only 2% annually on average, well below the targeted 50% by 2020 set under the United Nations Decade of Action for Road Safety.

Emission trends

- In 2021, fossil fuels supplied 96% of the total energy demand in transport – a share that has barely changed over the past decade even as biofuels and electric vehicles have increased – due mainly to rising overall demand.
- Road transport accounted for nearly 78% of transport energy consumption in 2021, and for 40% of oil demand globally.
- Road transport is the largest emitter of carbon dioxide (CO_2) among all transport modes, contributing 78% of transport emissions in 2020.
- Passenger transport accounted for more than two-thirds of the emissions from road transport, while road freight contributed the remaining nearly one-third. CO_2 emissions from road transport have continued to increase over the past two decades.
- Countries in Europe, North America and Oceania had the highest per capita road transport CO_2 emissions in 2021. The United States contributed the highest road transport emissions in both absolute and per capita terms.

- As larger vehicle sizes have gained in popularity, their rising energy consumption is posing a growing risk to decarbonisation. Larger vehicles take up greater public and private space, consume far greater amounts of fuel than small- and medium-sized vehicles, and result in far greater emissions.
- It is important to evaluate vehicle impacts using life-cycle analysis, which accounts for resource consumption and emissions that occur not only during vehicle operation, but also during manufacturing and infrastructure production. Measured this way, hybrid and electric vehicles typically reduce emissions by one-third to two-thirds, depending on the fuel source.
- While safety on highways and urban roads can facilitate the use of multiple transport modes, road safety and climate change are interrelated and can impact each other in various ways. Effective speed management can help reduce congestion, leading to shorter travel times and reduced emissions from idling and stop-and-go traffic.
- Self-driving vehicles, automated vehicles and autonomous vehicles have the potential to decrease emissions if shared and regulated. However, there is also the risk of higher transport emissions by increasing the vehicle size and total vehicle travel, but these impacts are uncertain.
- To reach the global goal of net zero greenhouse gas emissions by 2050, road transport must also be net zero. CO_2 emissions intensity must be reduced by more than 94% for trucks and 98% for cars compared to 2020 levels, according to the International Energy Agency's Net Zero scenario.

Policy developments

- Successful strategies to reduce emissions from road transport include a mix of "Avoid", "Shift" and "Improve" policies and measures. The most successful combine carbon or fuel taxes with incentives for cleaner vehicles, but prioritising measures that incentivise active travel and public transport can maximise emission reductions and co-benefits.
- By 2022, at least 23 countries and 17 sub-national jurisdictions had targets for 100% bans on sales of internal combustion engine vehicles, while several other jurisdictions had lower targeted shares.
- Some governments have discouraged new roads, such as Austria, the United Kingdom and the United States.
- Government financial support for electric vehicles nearly doubled in 2021, and support for electric two- and three-wheelers also advanced, including in many cities and in low- and middle-income countries. Governments also have enacted diverse policies and measures to support the deployment of electric vehicle charging infrastructure.
- Biofuel blending mandates continue to be the most common policy for incentivising renewable energy in road transport.
- Congestion pricing has been shown to reduce both emissions and fuel consumption and can lead to more liveable environments; however, this policy has only been implemented in a few cities around the world.
- A comprehensive and integrated approach to decarbonising freight transport could provide significant environmental and social benefits. In general, policies for decarbonising heavy-duty vehicles have tended to lag behind those for light-duty vehicles.
- Several policies at the regional, national and sub-national levels have been adopted in recent years to address road safety, particularly aimed at speed management and sometimes also specifically linked to improving the sustainability of transport systems.

Overview

Road transport contributes the largest greenhouse gas emissions among all transport modes. Achieving an economy with net zero emissions requires road transport to also be net zero, so policies aimed at reducing these emissions are essential to achieve decarbonisation and meet climate targets.[1] **Some governments have taken strong action to encourage the shift towards sustainable modes of road transport as well as to reduce vehicle travel, promote low-emission vehicles, improve fuel efficiency and increase the use of renewable fuels.**

In low- and middle-income countries, motorisation has grown rapidly in recent years, driven by factors such as economic growth, urbanisation, automobile-orientated planning and, in some cases, fuel subsidies and low fuel taxes. Meanwhile, new car sales have declined in many high-income countries, due in part to the COVID-19 pandemic but also because of measures that some countries have put in place to reduce dependency on personal vehicles. However, most high-income countries remain automobile-centric, and in some places this dependency has increased in recent years due to investment and planning decisions.

Fossil fuels continue to account for nearly all of the energy used in road transport, despite the increased adoption of ambitious targets to phase out petrol and diesel vehicles and to shift towards sustainable fuels. Achieving emission reduction targets as well as additional co-benefits will require prioritising a shift towards active travel (walking and cycling) and public transport to reduce total vehicle travel, alongside policies to improve vehicle technologies and fuels.[2]

Demand trends

In recent years, factors such as population growth, economic development, and concerns about air pollution and climate change have led to shifts in the demand for passenger and freight road transport. This has led to shifts in modal shares and in vehicle-kilometres travelled, and to rising interest in and adoption of new technologies such as electric and autonomous vehicles[i].

Global demand for passenger transport (of all forms) grew 6% between 2018 and 2022, reaching 26.4 trillion kilometres.[3] Nearly two-thirds of passenger transport globally was in passenger cars, although the modal split varies highly by location.[4] For example, in Cape Town (South Africa) and Auckland (New Zealand) more than 80% of trips in 2022 were by automobile and just over 10% were by walking; in contrast, walking comprised well over 40% of trips in London (UK), Paris (France) and Sydney (Australia), with automobile use as low as 14% in the case of Paris.[5] (*See Section 3.1 Integrated Transport Planning.*)

Global freight activity increased an estimated 7% between 2019 and 2022, to surpass 179 trillion tonne-kilometres.[6] In 2019, road transport accounted for 22% of freight activity globally, on average, although the modal split varies highly by location.[7]

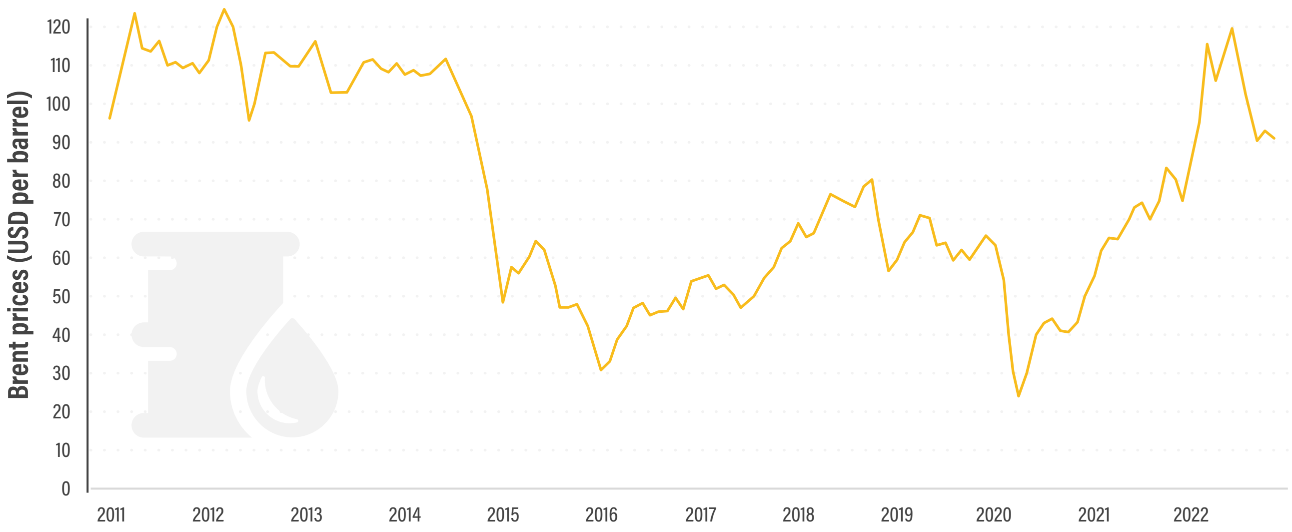
- In the European Union (EU), road freight continued to rank a distant second after maritime freight in 2021, representing around 24% of total freight transport (compared to 68% for maritime).[8]
- However, road transport dominated the freight sector in Germany, Japan and the United States in 2020.[9] (*See Spotlight 4 The Role of Companies in Decarbonising Global Freight and Logistics.*)
- **Cargo bikes are increasingly being viewed as a more sustainable substitute for delivery vans** (*see Section 3.3 Cycling*).

Since 2020, a rise in the global average price of oil has led to higher fuel prices, affecting overall transport costs (see Figure 1).[10] Because the transport sector relies on fossil fuels for 96% of its energy consumption, fluctuating oil prices can greatly impact the cost of operating motorised vehicles, highlighting the need to shift to more sustainable energy sources and modes of transport.[11] Factors influencing fuel prices have included the COVID-19 pandemic, geopolitical tensions (particularly the Russian Federation's invasion of Ukraine) and regulations aimed at reducing emissions.[12] Although rising fuel prices have not appeared to affect distances travelled in many locations, they have placed a higher financial burden on drivers and freight operators (*see Section 3.1 Integrated Transport Planning*).[13]

i While these demand indicators are important for understanding the road transport sector, they are mostly motorised vehicle-centric and do not reflect the emerging more people-centred paradigm that also takes into account social and environmental concerns. For additional indicators, see Table 1 in Section 3.1 Integrated Transport Planning.

FIGURE 1. Average crude oil price globally, 2011-2022

Source: See endnote 10 for this section.



The price of crude oil increased 415% between April 2020 and June 2022 – rising from USD 23.34 per barrel to USD 120.08 per barrel – and stood at around USD 80 per barrel by March 2023.[14]

- Average annual oil prices were predicted to fall from USD 100 per barrel in 2022 to USD 92 per barrel in 2023, and USD 80 per barrel in 2024.[15] However, industry analysts expect prices to remain well above their recent five-year average of USD 60 per barrel.[16]

Trends in vehicle-kilometres travelled have varied greatly by country since the lows seen during the pandemic.[17]

- In the United States, vehicle-kilometres travelled grew less than 1% in 2022 and remained 9% lower than pre-pandemic levels; this was due in part to the increase in teleworking, as nearly 18% of US employees continued to work fully or partially from home.[18] (*For more on teleworking, see Section 3.1 Integrated Transport Planning.*)
- In the United Kingdom, vehicle-kilometres travelled increased 4% in 2022 but were still 13% below pre-pandemic levels.[19]
- In contrast, vehicle-kilometres travelled in Germany grew 21% in 2022 and were 8% higher than pre-pandemic levels.[20]
- A 2021 study in California (USA) concluded that subsidies for public transport were the most effective tool for reducing vehicle-kilometres travelled.[21]

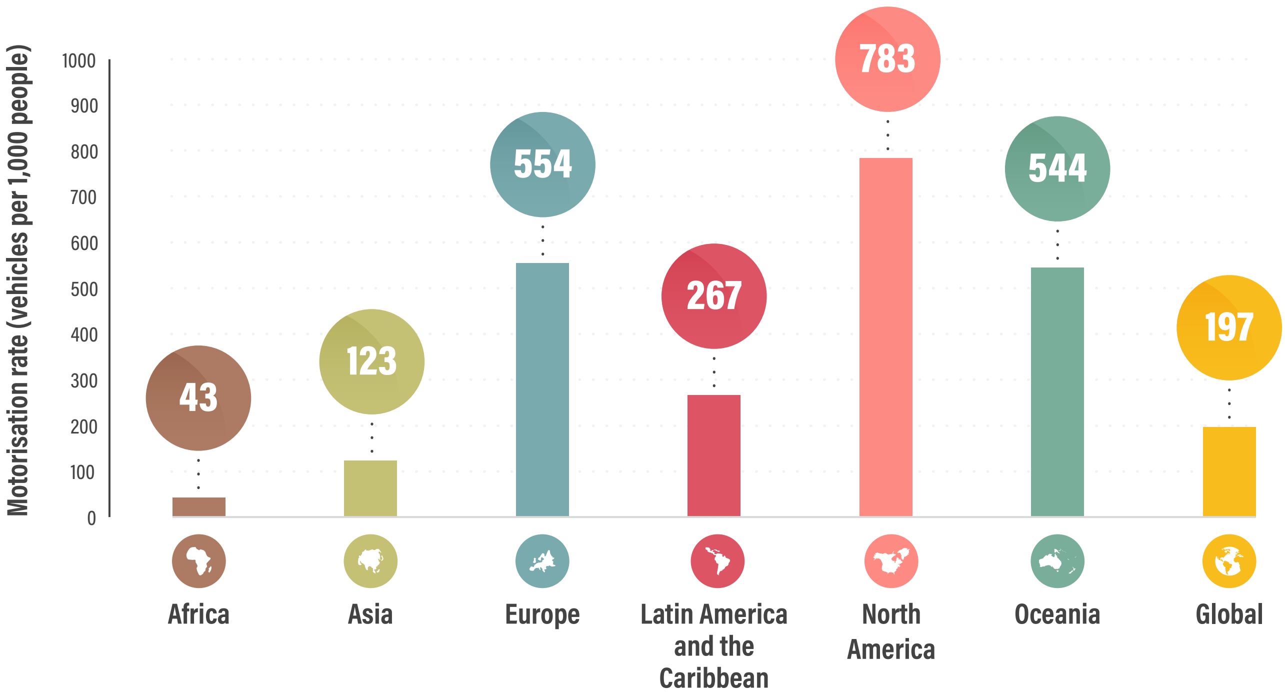
Motorisation rates, or the number of motor vehicles per 1,000 people, vary greatly by region, with the highest rate in North America – at four times the global average of 196 vehicles per 1,000 people – and the lowest rate in Africa, at a quarter of the global average, as of 2020 (see Figure 2).[22] However, motorisation in Africa is increasing, driven by factors including economic growth, urbanisation, expansion of the middle class, improvements in road infrastructure and the greater availability of financing options.[23] The number of motorcycles on Africa's roads surged from just 5 million in 2010 to an estimated 27 million in 2022, with most of them used for taxi or delivery services.[24] (*See Section 2.1 Africa Regional Overview.*)

Car ownership has historically been a symbol of status and mobility and is often associated with greater freedom and flexibility. However, automobiles are costly to own and operate and therefore are not affordable for many households, in addition to imposing significant external costs[i]. Many major cities, mostly in high-income countries, have low rates of car ownership, due in part to strong public transport services that support large flows of passengers, and/or to growing support for active travel modes such as walking and cycling, particularly since the pandemic.[25]

i External costs could include congestion, road and parking infrastructure costs, crash risk, fuel import costs (and sometimes subsidies), and local and global pollution.

FIGURE 2. Motorisation rates by region, 2020

Source: See endnote 37 for this section.



The number of cars per household varies greatly by income group and region; in the United Kingdom, for example, a quarter of higher-income households own three or more cars.[26] Car ownership has increased in low- and middle-income countries, particularly as incomes rise.[27] Conversely, in many high-income countries, per capita vehicle ownership and travel rates began to peak early in the 21st century, after growing steadily in the 20th century.[28] Still, most high-income countries have tended to support a automobile-centric paradigm. In parts of the United States and elsewhere, there is a risk of a rise in multi-vehicle households as locations become locked-in to automobile-dependence, due to limited public transport and active travel options as well as automobile-centric planning and investment.[29]

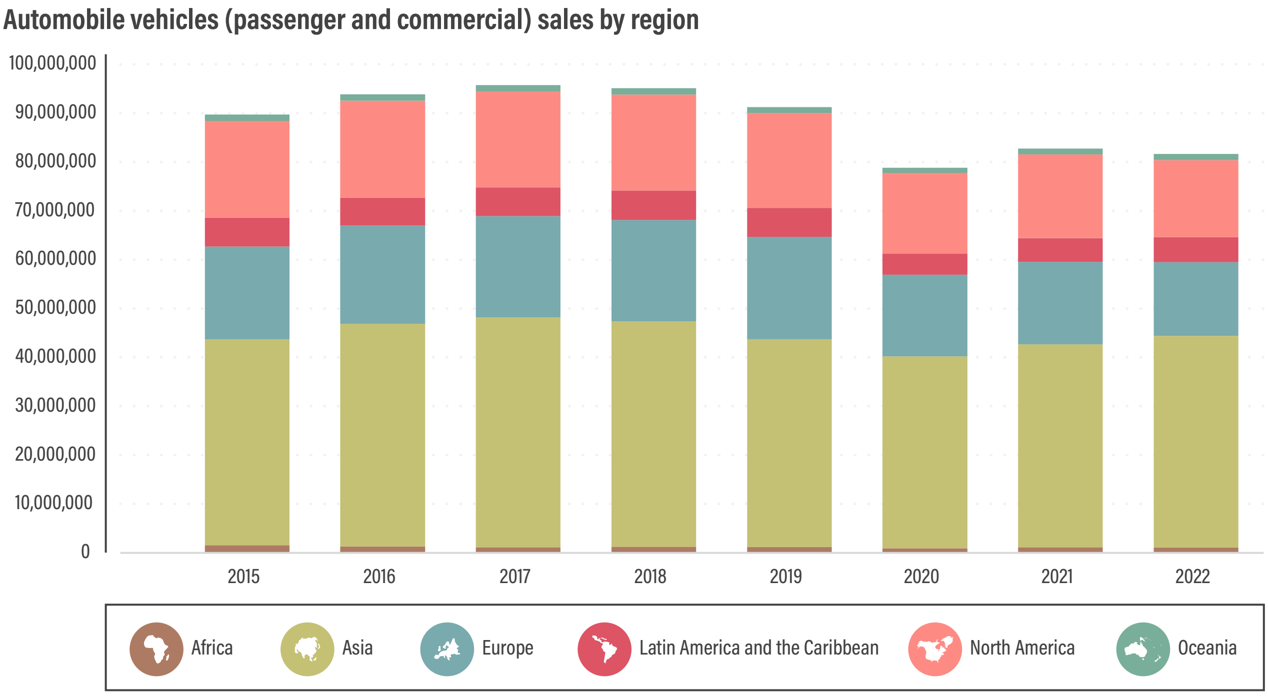
The relationship between income and car ownership is complex, and a wide range of factors influence whether someone chooses to own a car. Many current demographic and economic trends have the potential to reduce per capita vehicle travel and to increase the demand for affordable, healthy and resource-efficient transport; these trends include an ageing population, increasing poverty, rising fuel prices, increasing health and environmental concerns, new work and travel options (such as telework and e-bikes), changing consumer preferences, and transport and land planning that supports other modes.[30]

- In the United States, both the share of households with cars and the number of households with multiple cars have increased sharply in recent decades.[31] The share of US households with two or more cars grew from 22% in 1960 to 59% in 2020, whereas the share of car-less households fell from 22% to only 8.5% during this period.[32] Contributing factors include rising incomes, easier access to car loans, improved road infrastructure, and automobile-centric planning that prioritises individual car ownership.
- The five fastest growing US cities (in terms of population, income, GDP, businesses, housing and changes in unemployment) in 2022 were heavily automobile-dependent, with walkability ratings of less than 35 points (out of potential 100 points).[33]
- In the United Kingdom, a 2018 survey revealed that 43% of households owned a single car, 27% owned two cars, and 8% owned three or more cars, while the remaining 22% did not own a car.[34] In rural areas of the country, 83% of surveyed households owned at least one car, compared to 63% in urban areas, due likely to the greater distances and lower public transport availability in rural areas.[35]
- In Latin America and the Caribbean, a 2023 assessment of 300 cities found that higher car ownership rates, especially in Brazil and Mexico, are associated with the complexity of urban forms, street network circuity and (in part) urban fragmentation.[36]

Global automobile sales (for both passenger and commercial four-wheeled vehicles) dropped 13.7% in

FIGURE 3. Automobile vehicle sales (passenger and commercial) by region, 2015-2022

Source: OICA. See endnote 38 for this section.



2020, grew 5% in 2021 (to total 82.7 million units), then fell 1.4% in 2022 to 81.6 million units (see Figure 3).[37] Car sales alone dropped 16% in 2020 with the onset of the COVID-19 pandemic and the global economic slowdown.[38] The weakening of sales was exacerbated by a shortage of automotive semiconductor chips, which resulted in around 11.3 million fewer passenger cars and 2.5 million fewer commercial vehicles sold in 2020.[39] Pre-pandemic, automobile sales hit an all-time high of 97 million units in 2017 and have generally decreased since then, reflecting lower sales in Asia and in Latin America and the Caribbean.[40]

Electric car sales grew 55% in 2022 to exceed a record 10 million units.[41] More than 26 million electric cars were on the world's roads that year, a five-fold increase from 2018.[42] Larger vehicles such as sport utility vehicles (SUVs) and trucks – both electric and conventional models – have continued to rise in popularity as manufacturers have marketed these vehicles to consumers (in part because of greater profit margins than for smaller vehicles).[43] Numbers of self-driving, automated and autonomous vehicles also have increased, with companies such as Audi, Ford, General Motors, Honda and Mercedes-Benz all releasing road vehicles with some type of advanced driving assistance technology in 2022 and early 2023.[44] Although these innovations are not yet in use in most places, they could have an impact on emissions from road transport (*see Emission Trends section below and Section 4.2 Vehicle Technologies*).

The rapid growth in electric vehicles is noteworthy given the recent disruptions to the global vehicle market in light of the COVID-19 pandemic and the Russian Federation's invasion of Ukraine. However, trends vary greatly by location. Electric passenger car sales have been slower in low- and middle-income countries (except China and India), with fewer models available and high prices making the vehicles unaffordable for widespread uptake.[45] (*See Section 4.2 Vehicle Technologies.*)

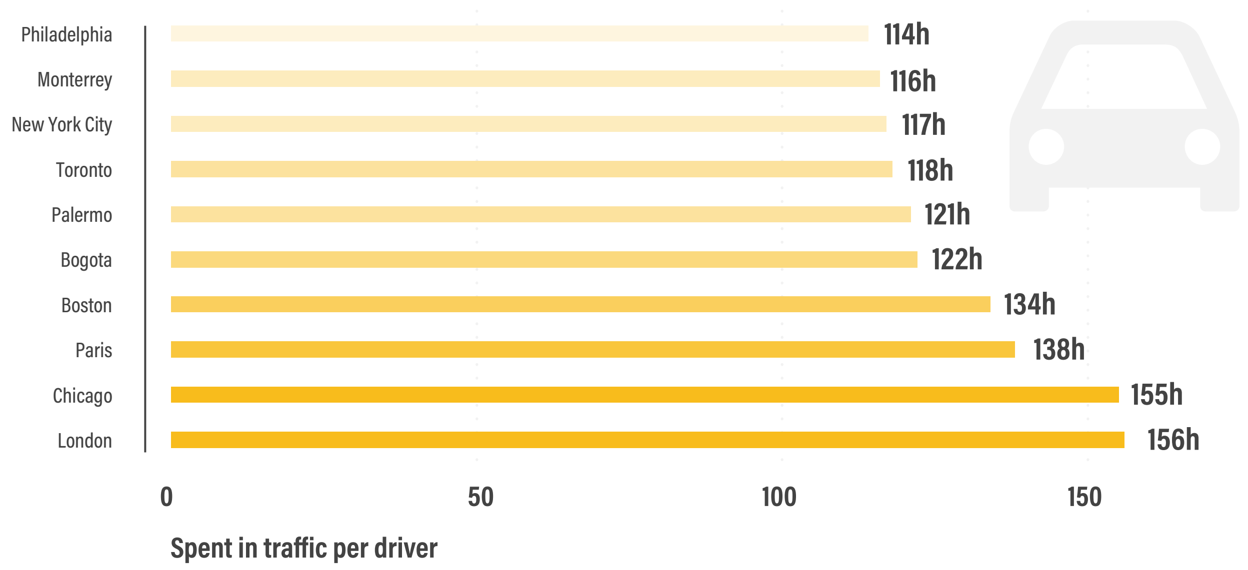
Global shares of electric heavy-duty vehicles remain relatively low, with electric buses accounting for around 3.1% of the total bus stock, and heavy-duty trucks comprising just 0.4% of the total truck stock in 2022.[46] However, as interest has grown, sales of new electric buses increased 15% in 2022 to reach 65,000 units, and sales of electric trucks rose 45% to reach 59,000 units.[47]

Between 2019 and 2022, an additional 900,000 public charging points[i] were installed worldwide (primarily in China, with a third of them fast chargers), to reach a global total of nearly 2.7 million.[48] This was a resumption of the average growth rate from

i Chargers and charging points refer to the socket that can charge a vehicle. A single charging location can have several individual charging stations, which in turn can have several chargers/charging points.

FIGURE 4. Top 10 cities where people spent the most time in traffic, 2022

Source: INRIX. See endnote 65 for this section.



2015 to 2019, before the COVID-19 pandemic.[49] Fast charger installations grew more rapidly than slow chargers.[50] Much of the growth in charging point installations has been in China, the EU, and the United States, driven by a combination of public and private investments and regulatory mandates.[51] (*See Section 4.2 Vehicle Technologies*.)

The electrification of vehicles will not resolve several critical transport issues, such as traffic congestion, urban sprawl and the amount of public space devoted to vehicles.[52] Parking in particular occupies a great deal of public space, sometimes far outnumbering the number of vehicles.[53] **Studies have shown a correlation between higher prices for parking and greater use of public transport and active mobility, and in many places parking prices have increased sharply in recent years.**[54]

- New York City (USA) continued to have the most expensive off-street two-hour parking globally, at USD 43.10 in 2022, with prices climbing 23% since 2019.[55] Australia and the United States remained the most expensive countries for this type of parking and were home to all of the top ten most expensive locations.[56] On average, off-street two-hour parking costs in Australia rose 2.6% between 2019 and 2022 (reaching USD 32.65 in Sydney), while US costs increased 4.3%.[57]

- Moscow (Russian Federation) overtook Amsterdam (Netherlands) to become the city with the most expensive on-street two-hour parking, at USD 28.50, and average on-street short-term parking costs in the city increased 77.7% between 2019 and 2022.[58]

- In 2022, the cities with the most expensive off-street daily parking were mostly in Europe (64.2% of the total, with Amsterdam ranking highest among European countries at USD 47.22), followed by the United States (24.8%) and countries in Asia (12.1%).[59]

Rising demand for road transport can lead to increased traffic congestion, with significant economic and public health costs.[60] **By 2021, congestion had returned to pre-pandemic levels in many cities, and in some places it worsened.**[61] According to one index, the congestion levels in 17% of cities in 2021 surpassed 2019 levels.[62] Overall, however, global congestion levels remained 10% lower in 2021 than before the pandemic, and peak-hour traffic also had decreased.[63] By 2022, traffic delays exceeded pre-pandemic levels in 39% of US urban areas and 42% of European urban areas.[64] These two regions also were home to the world's five most congested cities, with London (UK) topping the list for the second year in a row in both congestion impact and hours lost in traffic per driver (see Figure 4).[65]

- In 2021, Cairo (Egypt) remained the most congested city in Africa – with 80 hours lost in traffic per driver – followed by four cities in South Africa (East London, Cape Town, Johannesburg and Pretoria); however, Cairo traffic in 2021 was still down 3% compared to 2020 and 12% compared to 2019.[66]

- The five most congested cities in Europe in 2022 were London (UK; 156 hours lost), Paris (France; 138), Palermo (Italy; 121), Dublin (Ireland; 114) and Rome (Italy; 107).[67] However, London and Paris continue to rank among the top cities in the availability of transport options and have made great strides in supporting active travel, public transit and accessibility (*see Section 3.1 Integrated Transport Planning*).[68]

- In some European cities, car use and congestion have fallen in response to the implementation of specific measures, such as Germany's EUR 9 (USD 9.61) monthly pass for unlimited travel on public transport, which led to congestion declines and improved driving times in 23 of 26 cities examined.[69]
- Bogotá (Colombia; 122 hours lost) topped the congestion list in Latin America in 2022 and was also the sixth most congested city globally, followed by Medellin (Colombia; 91) and Mexico City (74).[70]
- In North America, the top five cities for congestion impact in 2022 were the US cities of Chicago (155 hours lost), Boston (134) and New York (117), followed by Toronto (Canada; 118) and Miami (USA; 105).[71] Chicago and Miami experienced more congestion and delays than before the pandemic, while Boston, New York and Los Angeles remained below 2019 levels.[72]
- The estimated cost of traffic congestion in the United States rose from USD 53 billion in 2021 to USD 81 billion in 2022.[73]

High demand for private road transport can lead to declines in road safety, with a greater likelihood of road crashes. During 2010-2019, the number of road deaths fell only 2% annually on average, well below the targeted 50% by 2020 set under the United Nations Decade of Action for Road Safety.[74] Contributing factors included increased congestion, higher speeds, and driver distraction and fatigue from longer commute times.[75] The Vision Zero strategy for road safety aims to eliminate all traffic fatalities and injuries.[76]

- Globally, road deaths increased 10% in the first half of 2022 compared to the first half of 2021 but remained below pre-pandemic levels in most countries.[77]
- In 2021, traffic fatalities In the United States reached their highest level since 2005.[78] In 2022, the fatality rate was 18% higher than in 2019, due in part to reduced traffic enforcement.[79]

Emission trends

Increases in vehicle ownership, distance travelled, urbanisation, and demand for goods have led to more vehicles on the road and to a corresponding rise in energy use in road transport, as well as increased air pollution and emissions. Rising numbers of mostly fossil fuel-powered road vehicles – coupled with sprawl, longer supply chains, and demand for larger, less fuel-efficient vehicles – have worsened the problem.

In 2021, fossil fuels supplied 96% of the total energy demand in transport – a share that has barely changed over the past decade even as biofuels and electric vehicles have increased – due mainly to rising overall demand.[80] Oil products supplied around 90% of the energy mix for road transport, with biofuels and natural gas accounting for most of the remainder, while the share of electricity was less than 1% (*see Section 4.1 Transport Energy Sources*).[81] **Road transport accounted for nearly 78% of transport energy consumption in 2021, and for 40% of oil demand globally.**[82]

Road transport is the largest emitter of carbon dioxide (CO_2) among all transport modes, contributing 78% of total transport emissions in 2020.[83] **Passenger transport accounted for more than two-thirds of the emissions from road transport, while road freight contributed the remaining nearly one-third.**[84] **CO_2 emissions from road transport have continued to increase over the past two decades** (see Figure 5).[85] In 2021, road transport CO_2 emissions grew a further 7% (from 5.5 gigatonnes to 5.9 gigatonnes), more than the total energy-related CO_2 emissions of North America.[86]

Countries in Europe, North America and Oceania had the highest per capita road transport CO_2 emissions in 2021.[87] **The United States contributed the highest road transport emissions in both absolute and per capita terms** (see Figure 6).[88] Despite vehicle emission standards in these regions, the high levels of motorisation and motorised vehicle activity lead to high per capita emissions. In Europe, where emission standards for road transport are increasingly strict, the average CO_2 emissions of new cars sold dropped to 115 grams per kilometre in 2021, down 16 grams from the previous year.[89]

As larger vehicle sizes have gained in popularity, their rising energy consumption is posing a growing risk to decarbonisation. Larger vehicles take up greater public and private space, consume far greater amounts of fuel than small- and medium-sized vehicles, and result in far greater emissions.[90] The CO_2 emissions intensity of passenger cars depends on factors such as the vehicle size and weight, the type of fuel used and the level of fuel efficiency. Generally, smaller, more fuel-efficient cars have lower emissions intensity than larger, less-efficient cars.[91]

- In 2023, the International Energy Agency (IEA) recommended that the auto industry decrease vehicle size, as SUVs consume around 20% more fuel than a medium-sized car.[92]
- Between 2021 and 2022, SUVs were responsible for a third of the total growth in oil consumption globally.[93] During that time, oil demand from SUVs increased by 500,000 barrels a day, while that of conventional cars stayed the same.[94]
- SUVs were the only major area across all sectors (even beyond transport) where emissions increased during the pandemic.[95]

FIGURE 5. CO_2 emissions from road transport, by vehicle type, 2000, 2010 and 2020

Source: IEA. See endnote 85 for this section.

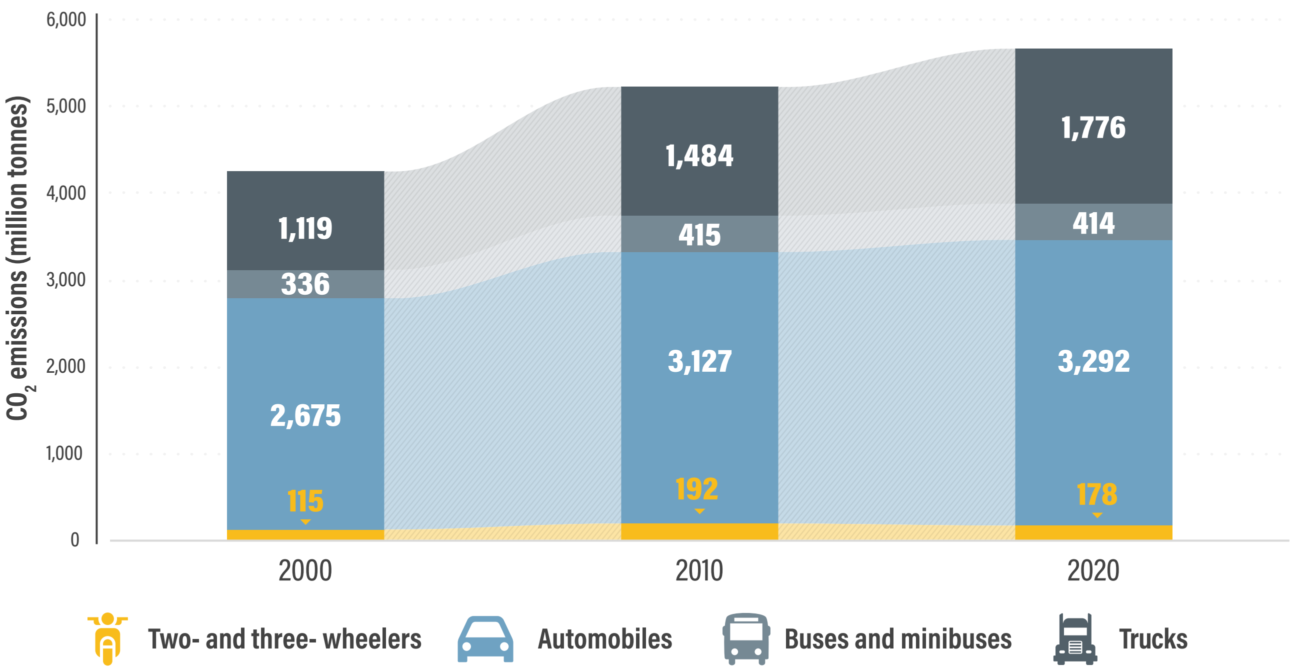


FIGURE 6. Per capita CO_2 emissions from road transport in countries globally, 2021 (in kilograms)

Source: See endnote 88 for this section.

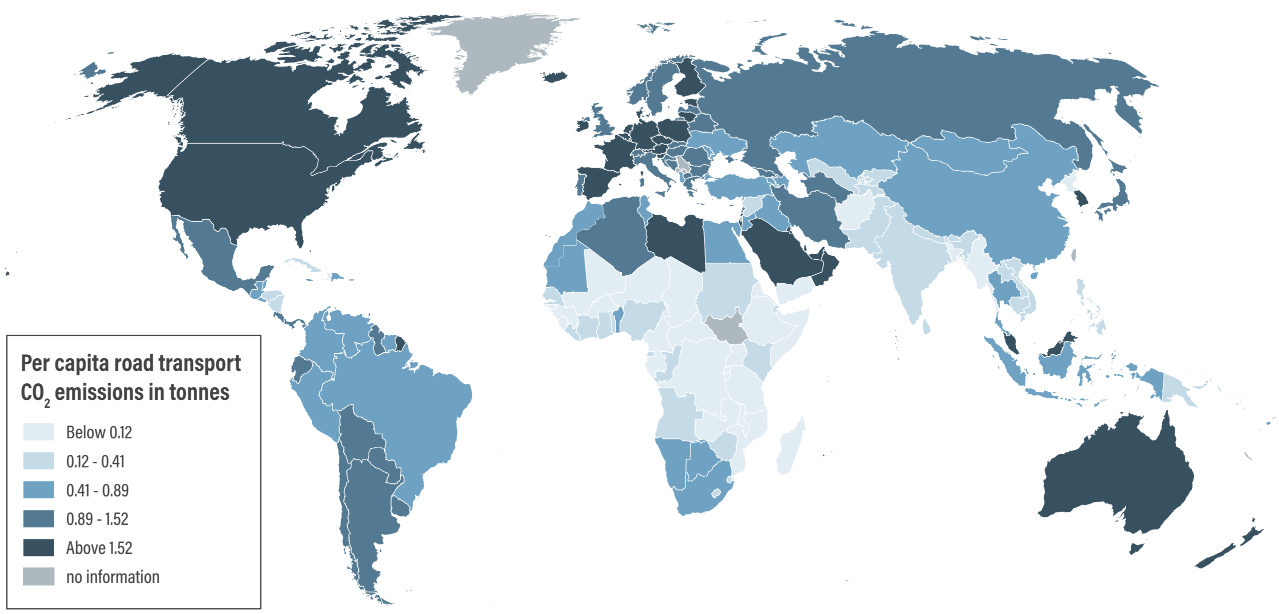
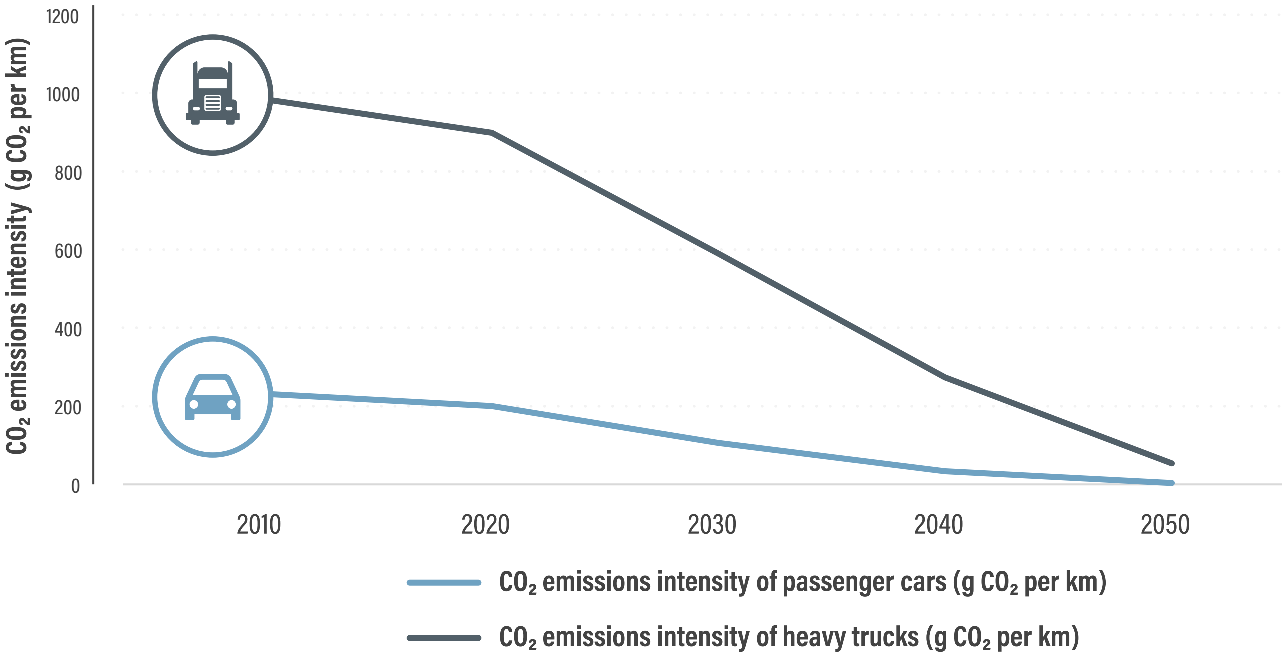


FIGURE 7. Required emissions intensity pathway to 2050 according to the International Energy Agency's Net Zero scenario

Source: IEA. See endnote 102 for this section.



It is important to evaluate vehicle impacts using life-cycle analysis, which accounts for resource consumption and emissions that occur not only during vehicle operation, but also during manufacturing and infrastructure production. Measured this way, hybrid and electric vehicles typically reduce emissions by one-third to two-thirds, depending on the fuel source.[96] (*See Section 4.2 Vehicle Technologies.*)

While safety on highways and urban roads can facilitate the use of multiple transport modes, road safety and climate change are interrelated and can impact each other in various ways. Speed management in particular has a direct impact on emissions and energy efficiency.[97] Higher speeds not only increase the risk of traffic crashes and fatalities, but also result in higher fuel consumption, emissions and air pollution.[98] **Effective speed management can help reduce congestion, leading to shorter travel times and reduced emissions from idling and stop-and-go traffic.**[99]

Self-driving vehicles, automated vehicles and autonomous vehicles have the potential to decrease emissions if shared and regulated. However, there is also the risk of higher transport emissions by increasing the vehicle size and total vehicle travel, but these impacts are uncertain.[100] If autonomous vehicles are used mainly for ride-hailing, carpooling, and/or public transport, they could help reduce the number of single-occupancy vehicles on the road and the overall vehicle-kilometres travelled. However, if they are privately owned and encourage more sprawled development, they are likely to increase total vehicle-kilometres travelled and worsen congestion.[101]

To reach the global goal of net zero greenhouse gas emissions by 2050, road transport must also be net zero. CO_2 emissions intensity must be reduced by more than 94% for trucks and 98% for cars compared to 2020 levels, according to the IEA's Net Zero scenario (see Figure 7).[102] Achieving the necessary reductions from road transport is essential for mitigating climate change but will require a concerted effort from governments, businesses and individuals.

Photo: Dennis Schroeder / NREL

Policy developments

Successful strategies to reduce emissions from road transport include a mix of "Avoid", "Shift" and "Improve" policies and measures[i]. The most successful combine carbon or fuel taxes with incentives for cleaner vehicles, but prioritising measures that incentivise active travel and public transport can maximise emission reductions and co-benefits.[103] Following the Avoid-Shift-Improve framework can help in prioritising planning and investment decisions to support a shift away from the automobile-centric model to create more liveable environments.[104] (*See Section 3.1 Integrated Transport Planning.*)

By 2022, at least 23 countries and 17 sub-national jurisdictions had targets for 100% bans on sales of internal combustion engine vehicles, while several other jurisdictions had lower targeted shares.[105]

- Five of the countries with targets for 100% bans on internal combustion engine vehicles (Chile, Denmark, New Zealand, Sweden and the United Kingdom) also had targets for 100% renewable power, effectively mandating the use of clean power for the vehicles.[106]
- In 2022, the EU's Fit for 55 package called for an effective ban on the sale of internal combustion engine cars by 2035.[107] The package mandates a 100% CO_2 emission reduction target for new cars and vans by 2035, with interim reduction targets of 55% for new cars and 50% for new vans by 2030.[108]
- In 2021, Canada announced a regulation to ban the sale of petrol and diesel cars and light-duty trucks by 2035, with plans for interim targets for 2025 and 2030.[109]

Going one step beyond targeted bans on internal combustion engine vehicles, an increasing number of jurisdictions adopted targets to reduce vehicle travel in general.

- In 2022, California (USA) set a target to reduce per capita light-duty vehicle miles travelled 25% per capita by 2030 and 30% by 2045, compared with 1990; the state aims to reach carbon neutrality by 2045, in one of the most comprehensive climate action roadmaps globally.[110]
- New Zealand set a target to reduce light-duty vehicle travel 20% by 2035, as part of a wider target to cut transport emissions 41% by 2035, set out in the country's Emissions Reduction Plan of 2022.[111]
- In 2020, Scotland (UK) set a target in its National Transport Strategy (NTS2) to reduce vehicle travel 20% by 2030 and established a sustainable travel hierarchy that privileges active travel.[112]

Some governments have discouraged new roads. While historically, the traditional solution to many transport issues in much of the world has been to build more roads and to widen existing roads, this is now known to paradoxically lead to increased traffic.[113] A new paradigm would see policies and measures that support shifting towards a more sustainable, less automobile-centric transport system.

- Austria cancelled eight highway projects as of 2021 due to considerations for climate action.[114]
- In 2021, a US government memo recommended repairing existing roads before building new ones, while at the same time encouraging cycling and walking infrastructure that requires less environmental review than building new roads and bridges.[115]
- The United Kingdom's National Highways adopted a Strategic Road Network programme in 2021 that aligns with the global goal of keeping global temperature rise below 1.5 degrees Celsius.[116]

Government financial support for electric vehicles nearly doubled in 2021, and support for electric two- and three-wheelers also advanced, including in many cities and in low- and middle-income countries.[117] (*See Section 4.2 Vehicle Technologies.*) Although "Avoid" and "Shift" measures have great benefits and contribute greatly to emission reductions, the adoption of electric vehicles is the most common measure for reducing emissions from road transport.[118] Many governments have enacted policies to support and encourage purchases of electric vehicles, and several governments also have adopted targets banning the sale of internal combustion engine vehicles (although in some places policy support was removed) (*see Policy Developments section below*).

- China extended its subsidy scheme for electric vehicles in 2022 but reduced the amount by 30%.[119]
- The UK government removed its last remaining subsidies for electric cars in 2022 – due in part to relatively high uptake of the vehicles in the country – and opted to redirect the funds to other electric vehicle types and to expanding the charging network.[120]

Governments also have enacted diverse policies and measures to support the deployment of electric vehicle charging infrastructure. Without the availability of robust and reliable charging infrastructure, consumers may be reluctant to purchase electric vehicles for fear of running out of power on the road, leading to so-called range anxiety.[121] (*See Section 4.2 Vehicle Technologies.*)

- Europe has greatly advanced its support for charging, including through mandates for installations in new buildings and an EU-wide requirement to provide charging points every 60 kilometres by 2026.[122]

i See the Avoid-Shift-Improve framework, https://slocat.net/asi.

- In some cases, legislation requires direct linkages to renewable power for charging, such as in France, where parking lots with 80 or more spaces must have solar photovoltaic systems by 2026-2028.[123]

Despite the increased uptake in electric vehicles and related support measures, **biofuel blending mandates continue to be the most common policy for incentivising renewable energy in road transport.**[124] As of the end of 2022, 56 countries and 30 sub-national jurisdictions had such mandates, down from 65 countries in 2021 following temporary suspensions, in some cases due to rising prices for vegetable oil.[125] Conversely, some countries further strengthened their mandates during 2022. (*See Section 4.1 Transport Energy Sources.*)

- Argentina, India, Indonesia, and the Republic of Korea increased their biofuel mandates or targets in 2022.[126]
- The United States proposed updating its national policy to mandate higher volumes of biofuels.[127]

Congestion pricing has been shown to reduce both emissions and fuel consumption and can lead to more liveable environments; however, this policy has only been implemented in a few cities around the world.[128] Congestion pricing leads to reductions in vehicle-kilometres travelled, to less stop-and-go traffic (hence fewer accelerations and decelerations), and to declines in urban traffic, creating a more pedestrian-friendly environment and reducing noise pollution.[129] Although there is typically support for such fee-based systems, implementation can be highly contested, and overall progress remains slow.[130]

- By 2022, congestion pricing was in place in London (UK), Milan (Italy), Singapore, and Stockholm (Sweden), with plans under way or in discussion in a handful of other cities.[131]
- New York City (USA) planned to implement congestion pricing by the end of 2023.[132]
- Los Angeles (USA) aimed to pilot congestion pricing by early 2023, with full implementation in 2025, after studies demonstrated that the measure would reduce time stuck in traffic and increase people's use of public transport, ridesharing, and active travel, thereby reducing emissions.[133]
- Cambridge (UK) developed plans in 2022 to implement a congestion charge of GBP 5 (USD 6) by 2026-2027.[134]
- In 2023, London (UK) marked the 20th anniversary of its congestion charge, which had reduced congestion 30% and emissions 16% since 2003, limiting traffic and contributing to a shift to active travel and public transport.[135] The city plans to remove its congestion pricing exemption for electric vehicles by 2025.[136]
- Between 2000 and 2022, London's congestion charge resulted in 1 billion fewer vehicle-miles driven by cars; however, the number of vehicle-miles driven by light commercial vehicles increased by the same amount, and taxis also filled the space left by cars.[137]

A comprehensive and integrated approach to decarbonising freight transport could provide significant environmental and social benefits. In general, policies for decarbonising heavy-duty vehicles have tended to lag behind those for light-duty vehicles. Incentivising low-carbon freight transport options would include strategies such as the adoption of fuel-efficient technologies and alternative fuels, implementation of carbon pricing mechanisms, promotion of multimodality, cargo consolidation centres, last-mile sustainable urban logistics, and autonomous deliveries, among others.[138]

- As of 2022, just five countries – Canada, China, India, Japan and the United States – had fuel economy standards that apply to heavy-duty vehicles.[139] No additional countries have adopted such standards since 2017.[140]
- In 2022, the United States finalised its strongest ever national standards to reduce emissions from heavy-duty trucks, starting with the 2027 model year.[141] The updated air quality standards are the first in the country for heavy-duty trucks in more than 20 years and are over 80% more stringent than the previous ones.[142]
- An "ecologistics community" has been set up by ICLEI–Local Governments for Sustainability to encourage sustainable urban freight in cities around the world, including the development of indicators to serve as a guide for local governments.[143]

Several policies at the regional, national and sub-national levels have been adopted in recent years to address road safety, particularly aimed at speed management and sometimes also specifically linked to improving the sustainability of transport systems.

- In 2022, the EU made anti-speeding technology mandatory for all new cars sold in the region by 2024, with the intelligent speed assistance technology meant to alert and slow drivers when they speed.[144]
- Mexico adopted a new law for mobility and road safety in 2021, in an attempt to reduce road deaths while also increasing equitable access to sustainable transport services.[145]
- Morocco planned to improve the flow of traffic, increase road safety, and decrease air pollution using electronic tolls, digital payments, and real-time traffic monitoring, with support from a EUR 85 million (USD 85 million) finance contract from the European Investment Bank in 2021.[146]
- In response to the recent rise in road fatalities and injuries, in 2022 the US Department of Transportation announced a comprehensive National Roadway Safety Strategy, which includes using new technology but also working with sub-national actors to build and maintain safer roads.[147]

- In Wales (UK), speed limits in built-up areas were reduced from 30 to 20 miles per hour starting in 2023, despite opposition from some drivers.[148]

Beyond these policies, other measures that help support a more sustainable transport system include those aimed at incentivising active travel and public transit, complete streets, transit-oriented development, sustainable urban mobility and logistics plans, and low-emission zones, among others (*see Section 3.1 Integrated Transport Planning*).

Partnership in action

- The **Accelerating to Zero Coalition,** announced at the 2021 United Nations Climate Conference in Glasgow, United Kingdom (COP 26), aims to accelerate the transition to 100% zero-emission cars and vans. By the end of 2022, the declaration had 221 signatories (40 of them countries) pledging to work towards having all sales of new cars and vans be zero emission globally by 2040, and by at latest 2035 in leading markets.[149]
- The **Breakthrough Agenda on Transport**, launched at COP 26 in 2021, aims to shift to a more sustainable and diverse range of modes and vehicle technologies, with 2030 targets for battery electric vehicles and fuel cell electric vehicles to comprise 60% of global bus sales and 35-40% of global heavy goods vehicles sales, and for zero-emission vehicles to make up 100% of total global passenger vehicle and van sales by 2030.[150]
- Released in 2021, the **International Road Assessment Programme (iRAP)**'s Plan for the Second Decade of Action for Road Safety aims to save 2 million people from death or injury, make 200,000 kilometres of roads safer and influence USD 200 billion in road infrastructure investment to save lives in the coming decade.[151] iRAP's Plan is aligned to the Global Plan for the Decade of Action launched in October 2021, under which achieving "3-star" or better journeys is one of five key action areas.[152]
- The **International Road Federation's (IRF) Data Warehouse**, released in 2022, is a web-based global road data platform that support analysis, capacity building and advocacy activities on the national and regional levels.[153]
- In 2022, 27 countries signed the **Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles** to enable 100% zero-emission new truck and bus sales by 2040, with an interim goal of 30% zero-emission vehicle sales by 2030, to facilitate the achievement of net zero carbon emissions by 2050.[154]

MODULE 3 3.7

AUTHOR:
Karl Peet, SLOCAT Secretariat

Aviation

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- Passenger activity contributed more than 70% of aviation-related carbon dioxide (CO_2) emissions in 2019.
- Aviation accounted for less than 1% of global freight activity in 2019 but was responsible for 7% of the CO_2 emissions from freight transport that year.
- The number of air passengers carried globally grew an estimated 47% in 2022, due to the rapid recovery of international routes following sharp declines early in the COVID-19 pandemic. Air passenger demand was expected to return to pre-pandemic levels in the first quarter of 2023 and to rise 3% above 2019 levels by the end of 2023.
- In March 2022, 36 countries closed their airspace to Russian airlines in reaction to the country's invasion of Ukraine, with the Russian Federation responding reciprocally. This gave airlines in China, India and the Middle East market advantages over airlines based in Europe and the United States. Aviation emissions are likely to increase significantly as a result.
- Out of an estimated 98.3 million global aviation jobs as of 2020, roughly 40% were lost during the COVID-19 pandemic.
- With the rebound in air travel demand, airlines and airports have experienced inefficiencies that can greatly increase aviation emissions yet are largely avoidable. Inefficiencies include carrying additional fuel on planes to reduce the cost of refuelling at certain airports and increasing flight speeds to compensate for airport delays due to short staffing.
- Jet fuel prices rose to USD 150 per barrel in March 2022, up 39% from the previous month (February 2022) and 121% from the previous year (March 2021).

Emission trends

- As countries emerged from pandemic-related lockdowns, aviation emissions reached around 720 million tonnes in 2021, regaining nearly one-third of the drop that occurred in 2020. Aviation contributed more than 2% of global energy-related emissions in 2021, showing faster emission growth than road, rail or maritime transport.
- Aviation has contributed around 4% to human-induced climate change to date, despite being responsible for only 2.4% of annual global CO_2 emissions.
- An estimated 1% of the world's population accounts for more than half of the total emissions from passenger air travel, and private jet travel has a disproportionate impact on the climate, contributing 4% of global aviation emissions.
- If pre-pandemic growth trends continue, aviation will contribute 6-17% of all greenhouse gas emissions within the carbon budget of scenarios aimed at keeping global temperature rise below 1.5 degrees Celsius (°C) to 2°C. The sector could reduce emissions to meet the targets of the Paris Agreement through 1) a decrease in air travel demand of 2.5% annually with the current fuel composition or 2) a shift to 90% carbon-neutral fuels by 2050.
- Incremental improvements in aircraft fuel efficiency have slowed over time. Even though new aircraft are up to 20% more efficient than models they replace, such improvements have been insufficient to compensate for rising demand.
- Aviation's CO_2 emissions could fall 9% to 94% below 2019 levels by 2050 by scaling up sustainable aviation fuels (SAF), improving operational efficiency and powering aircraft with liquid hydrogen.
- Reductions in air passenger demand due to fuel price increases, a shift from aviation to high-speed rail, reduced business travel and levies on frequent flyers could provide modest emission reductions in certain contexts.

Policy developments

- In October 2022, the member states of the International Civil Aviation Organization adopted a long-term global goal of net zero carbon emissions by 2050, but the goal remains aspirational and is insufficient to meet the targets of the Paris Agreement.
- To align efforts to decarbonise the sector, the International Aviation Climate Ambition Coalition was established at the 2021 United Nations (UN) Climate Change Conference in Glasgow, United Kingdom (COP 26).
- Aviation was identified as of one of the "hard-to-abate" sectors targeted for decarbonisation under the Mitigation Work Programme of the UN Framework Convention on Climate Change, agreed to at the 2022 UN Climate Change Conference in Sharm el-Sheikh, Egypt (COP 27).
- Sustainable aviation fuel accounted for less than 1% of aircraft fuel as of 2023, but scaling up its production to meet global demand is possible by 2040.
- As of 2021, SAF was an estimated two to eight times more expensive to produce than conventional jet fuel, although public and private sector efforts are aligning to make SAF more economical.
- Europe's largest airlines have lobbied policy makers to weaken the European Union's ambition on decarbonising aviation, despite companies' public commitments towards net zero emissions.
- Electric aircraft development has accelerated in numerous countries, spawning new partnerships among established passenger and freight transport providers and emerging technology companies.
- Several emerging companies are developing small and medium-sized aircraft powered by hydrogen fuels.

Overview

Between mid-2020 and mid-2023, the demand for air travel gradually rebounded as the world emerged from the worst of the COVID-19 pandemic.[1] However, the global disruption caused by the Russian Federation's invasion of Ukraine in February 2022 stalled the recovery and drove up jet fuel prices.[2] Air travel restrictions early in the pandemic had severe impacts on tourism, impeding efforts to achieve several of the United Nations Sustainable Development Goals (SDGs), including SDG 1 (no poverty) and SDG 10 (reduced inequalities). By 2022, international tourism had recovered to nearly two-thirds of pre-pandemic levels in Africa and the Americas, but less than one-quarter in Asia, due to a slower emergence from lockdowns in the region.[3]

Key emission trends continue to reveal that a small share of the global population (1%) accounts for a disproportionately high share of aviation carbon emissions, even as inequities in access to air travel prevail globally.[4] Meanwhile, efforts to rein in emissions, including with sustainable aviation fuels, hydrogen, and electrification, show early promise but remain far from the required speed and scale.

Among policy developments, the International Aviation Climate Ambition Coalition emerged at the 2021 UN Climate Change Conference in Glasgow, United Kingdom (COP 26), and aviation was identified as one of the "hard-to-abate" sectors targeted for decarbonisation under the Mitigation Work Programme of the UN Framework Convention on Climate Change (UNFCCC), agreed to at the 2022 UN Climate Change Conference in Sharm el-Sheikh, Egypt (COP 27).[5] In 2022, the International Civil Aviation Organization (ICAO) adopted a long-term aspirational goal of net zero carbon emissions for international aviation by 2050, which has been criticised for its lack of binding commitments and interim targets, and thus for its failure to create incentives for urgent climate action.[6]

Demand trends

Passenger activity contributed more than 70% of aviation-related carbon dioxide (CO_2) emissions in 2019.[7] Aviation accounted for less than 1% of global freight activity in 2019 but was responsible for 7% of the CO_2 emissions from freight transport that year.[8] During the COVID-19 pandemic in 2020, one-third of the revenue of airlines came from air cargo.[9] Air cargo traffic reached an all-time high in 2021 and gradually returned to 2019 levels by the end of 2022.[10]

The number of air passengers carried globally grew an estimated 47% in 2022, due to the rapid recovery of international routes following sharp declines early in the COVID-19 pandemic.[11] The number of passenger aircraft in service in 2022 paralleled overall demand, which rose to around 75% of pre-pandemic levels (see Figure 1).[12] Estimated air cargo demand in 2022 was similar to 2021 levels and was only marginally higher than pre-pandemic levels.[13]

Air passenger demand was expected to return to pre-pandemic levels in the first quarter of 2023 and to rise 3% above 2019 levels by the end of 2023.[14] Air passenger demand in 2024 is expected to be even stronger (around 4% above 2019 levels).[15] The ICAO lowered its projection for annual growth in aviation demand to 2050 from 4.2% to 3.6%.[16] Strategies to reduce demand under a scenario of net zero emissions include a shift to high-speed rail, reduced business flights and levies on frequent flyers.[17]

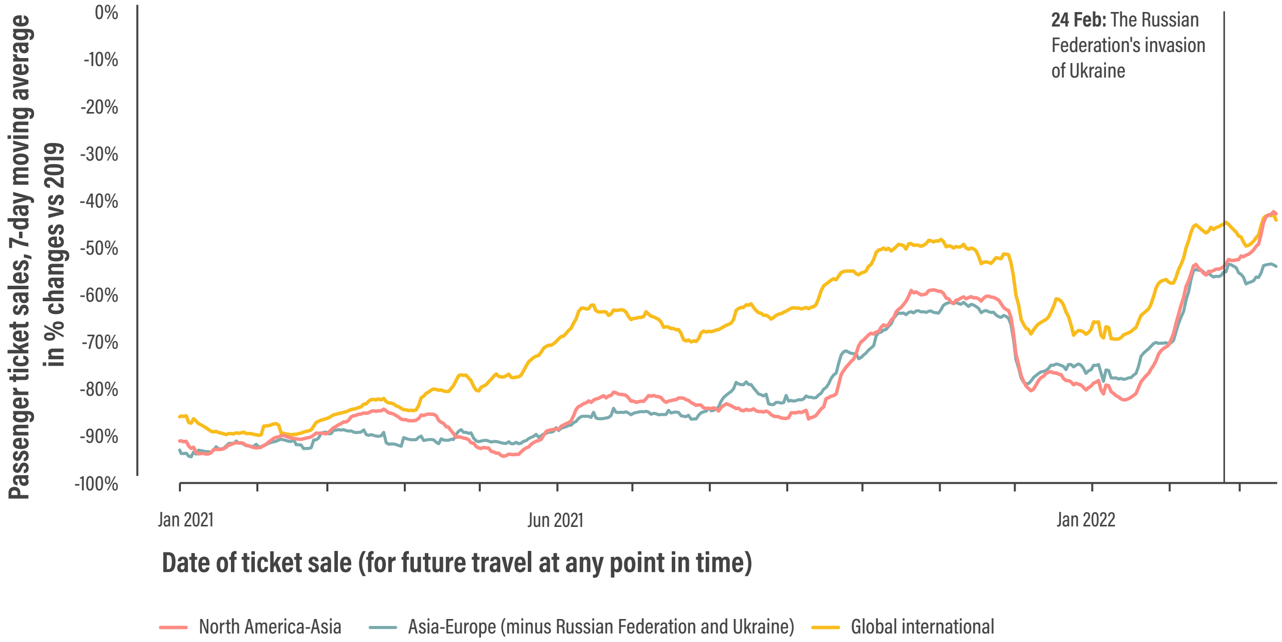
In March 2022, 36 countries closed their airspace to Russian airlines in reaction to the country's invasion of Ukraine, with the Russian Federation responding reciprocally.[18] This gave airlines in China, India and the Middle East market advantages over airlines based in Europe and the United States. Aviation emissions are likely to increase significantly as a result.[19] For example, Finnair had 40% longer flights to China, British Airways had a 20% longer diversion to China, and other European airlines were adding 15-40% flight times for the same routes.[20] Many US-based airlines lost access to polar flight paths, adding flight time and fuel expense to existing routes and causing the cancellation of some planned route expansions, resulting in an estimated annual loss of USD 2 billion.[21]

Out of an estimated 98.3 million global aviation jobs as of 2020, roughly 40% were lost during the COVID-19 pandemic.[22] With the rebound in air travel demand, airlines and airports have experienced inefficiencies that can greatly increase aviation emissions yet are largely avoidable.[23] Inefficiencies include carrying additional fuel on planes to reduce the cost of refuelling at certain airports and increasing flight speeds to compensate for airport delays due to short staffing.[24]

Jet fuel prices rose to USD 150 per barrel in March 2022, up 39% from the previous month (February 2022) and 121% from the previous year (March 2021).[25] Before the

FIGURE 1. Demand trends for international air travel, January 2021 to March 2022

Source: See endnote 12 for this section.



pandemic, fuel costs accounted for around 25% of airlines' operating expenses.[26] In 2020 and 2021, airlines' variable costs fell, causing the fuel cost share to decline, but by early 2022 it had returned to pre-pandemic levels.[27] Airlines can absorb fuel costs or pass them on to passengers as higher fares, which may reduce demand in a time of high inflation.

Emission trends

As countries emerged from pandemic-related lockdowns, aviation emissions reached around 720 million tonnes in 2021, regaining nearly one-third of the drop that occurred in 2020.[28] Aviation contributed more than 2% of global energy-related emissions in 2021, showing faster emission growth than road, rail or maritime transport.[29] By late 2022, aviation emissions rose slightly to recover roughly a third of the drop attributed to the pandemic in 2020.[30]

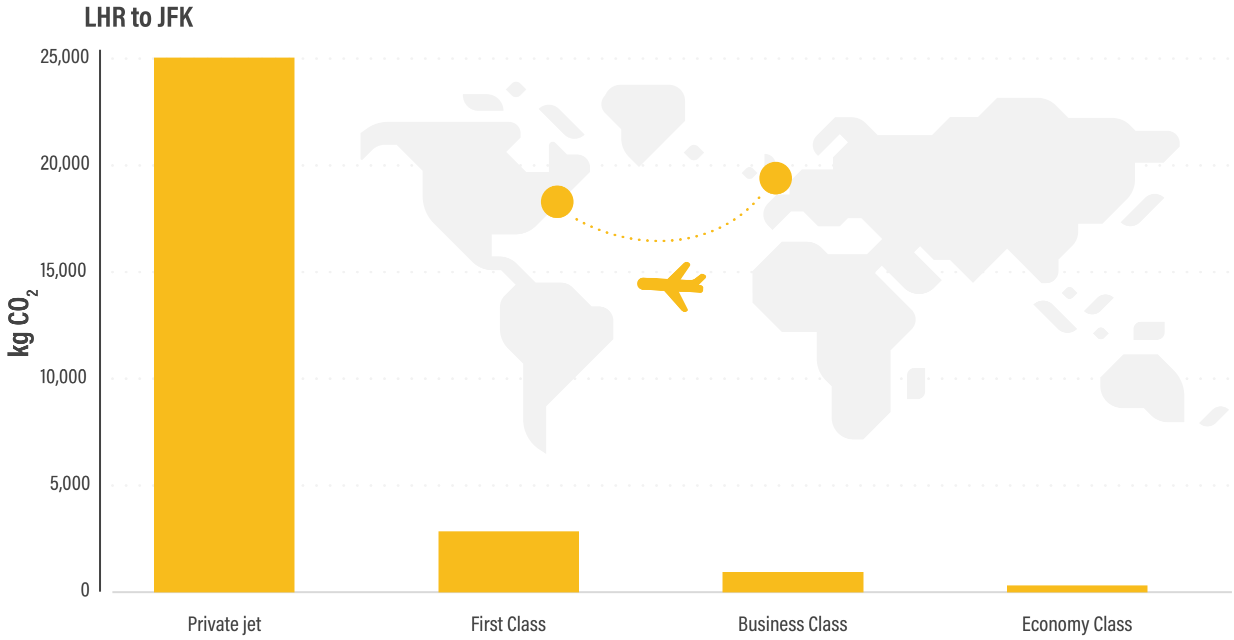
Aviation has contributed around 4% to human-caused climate change to date, despite being responsible for only 2.4% of annual global CO_2 emissions.[31] In 2018, commercial aviation contributed the vast majority of aviation CO_2 emissions (an estimated 88%), followed by military operations (8%) and private flights (4%).[32] In addition to the CO_2 emitted through combustion of jet fuel, aircraft release water vapour that leads to formulation of cirrus clouds, trapping additional heat in the atmosphere.

An estimated 1% of the world's population accounts for more than half of the total emissions from passenger air travel, and private jet travel has a disproportionate impact on the climate, contributing 4% of global aviation emissions.[33] As of 2018, only 11% of all people worldwide travelled by air, with at most 4% of the population taking international flights.[34]

- Carbon emissions from a passenger flying from London (UK) to New York (USA) in a commercial jet are equivalent to 4 weeks of emissions from a typical European household (if flying in economy class) or as much as 38 weeks of emissions (if flying in first class).[35]
- Passengers travelling from London to New York in a private jet produce around 25 tonnes of CO_2, equivalent to six years of emissions from a typical European household (see Figure 2).[36]
- An analysis of the activity of private jets owned by US celebrities shows that the planes emit 482 times more CO_2 emissions than the average person globally does annually.[37]

FIGURE 2. Relative emissions of different classes of airline services from London to New York

Source: See endnote 36 for this section.



- Employee travel accounts for an estimated five-sixths of the emissions of McKinsey & Co., leading the company to target a 30% reduction in greenhouse gas emissions from business travel per employee by 2025.[38]

If pre-pandemic growth trends continue, aviation will contribute 6-17% of all greenhouse gas emissions within the carbon budget of scenarios aimed at keeping global temperature rise below 1.5 degrees Celsius (°C) to 2°C.[39] The sector could reduce emissions to meet the targets of the Paris Agreement through 1) a decrease in air travel demand of 2.5% annually with the current fuel composition or 2) a shift to 90% carbon-neutral fuels by 2050.[40] The drop in emissions during 2020 and 2021 is expected to delay aviation's contribution to climate change by only around five years, if demand growth recovers to pre-pandemic levels.[41]

Incremental improvements in aircraft fuel efficiency have slowed over time. Even though new aircraft are up to 20% more efficient than models they replace, such improvements have been insufficient to compensate for rising demand.[42] The energy intensity of passenger aviation fell 2.4% annually from 2000 to 2010 then dropped to 1.9% annually from 2010 to 2019, reflecting a slowdown in efficiency gains (see Figure 3).[43]

Aviation's CO_2 emissions could fall 9% to 94% below 2019 levels by 2050 by scaling up sustainable aviation fuel (SAF), improving operational efficiency and powering aircraft with liquid hydrogen.[44] SAF offers the largest mitigation potential, contributing around 60% of the emission reductions under various decarbonisation scenarios (see Figure 4).[45] Improvements in the operational and technical efficiency of aircraft represent 33% of the reduction potential, while the use of hydrogen accounts for 4-5%.[46]

Reductions in air passenger demand due to fuel price increases, a shift from aviation to high-speed rail, reduced business travel and levies on frequent flyers could provide modest emission reductions in certain contexts.[47] One hypothesis suggests that higher fuel costs could lead to a slight reduction in air travel demand and encourage a greater shift to high-speed rail through 2050 (*see Section 3.5 Inter-city Rail*).[48] However, at present, such "Avoid" and "Shift" strategies towards decarbonising aviation are likely to be outweighed by "Improve" strategies at the required scale and pace.

- Through its 2021 Climate Law, France banned domestic flights where rail alternatives of less than 2.5 hours are available.[49] However, France opted not use its EU presidency term (January to June 2022) to urge other governments to adopt similar policies.[50]

FIGURE 3. Energy intensity of domestic (top) and international (bottom) passenger aviation, 2000-2021 and projections to 2030 under a net zero scenario

Source: See endnote 43 for this section.

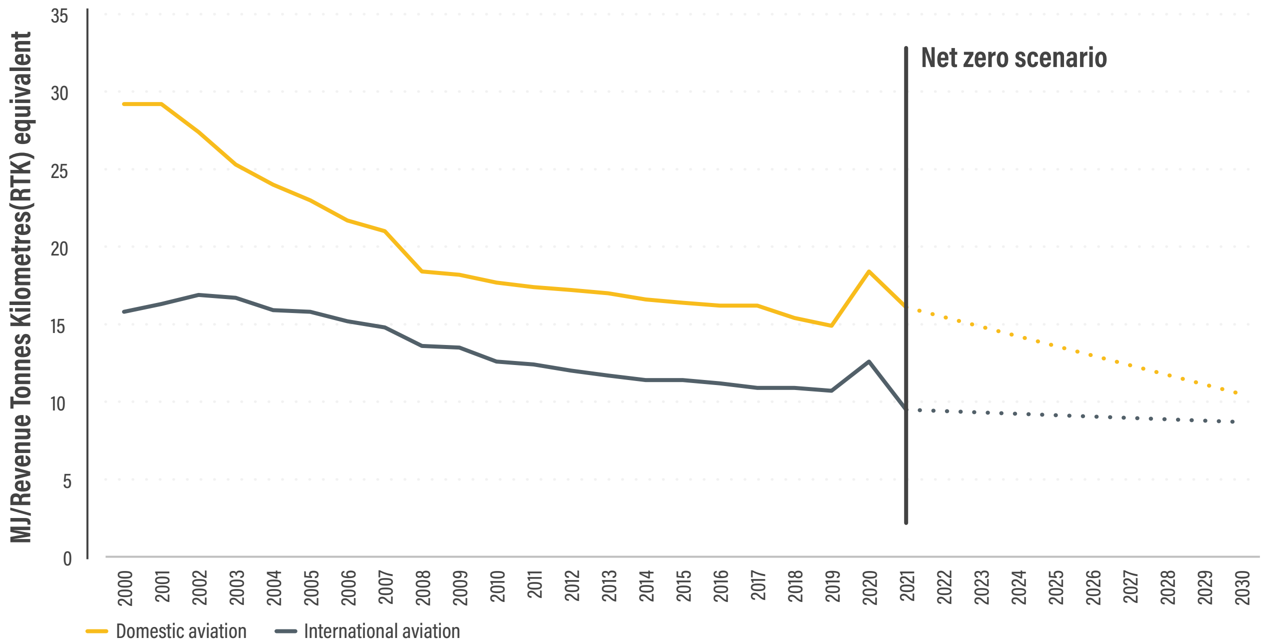
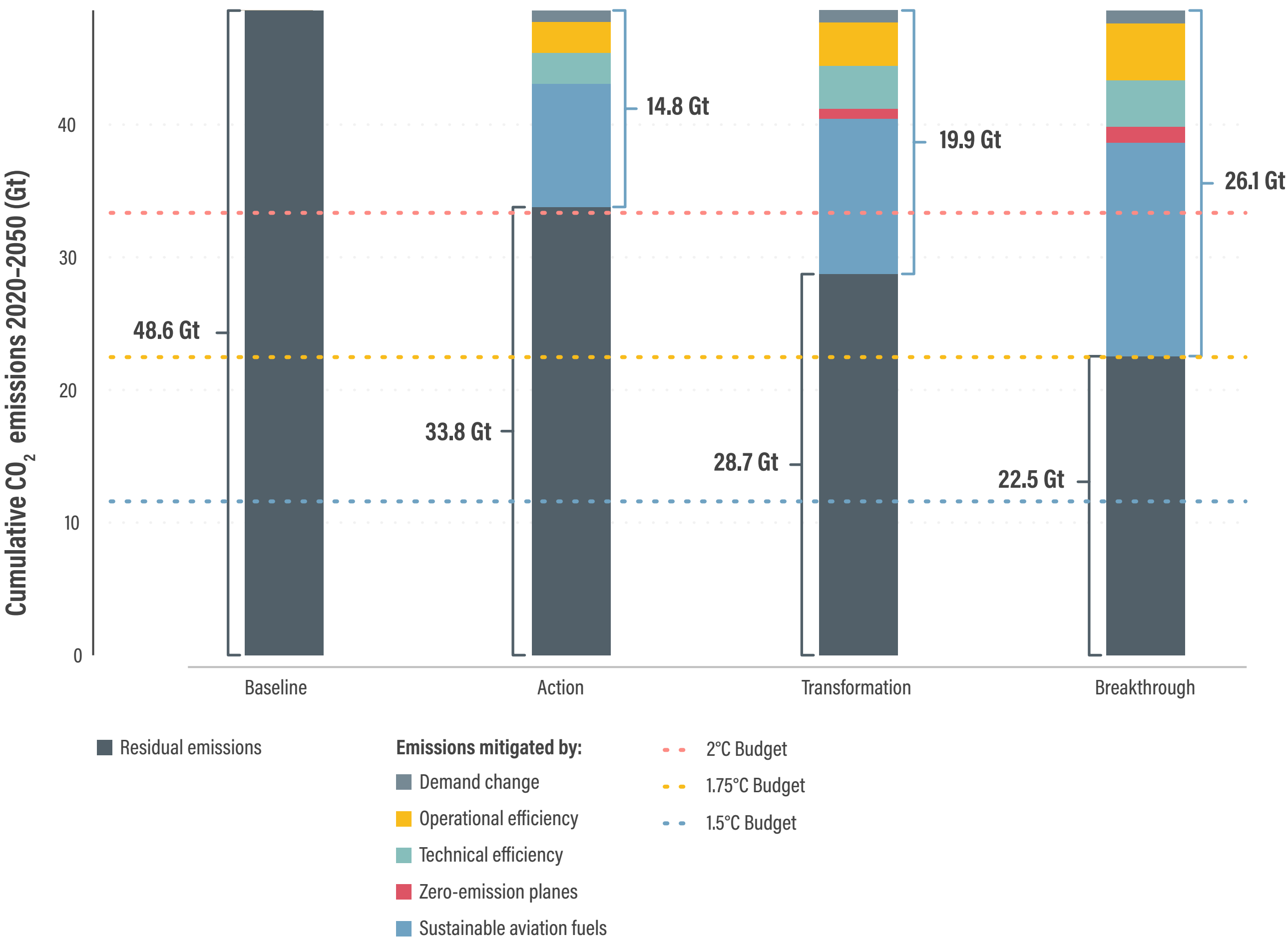


FIGURE 4. Scenarios for CO_2 emission mitigation from aviation, 2020-2050

Source: See endnote 45 for this section.



- Changing work patterns and remote work have reduced demand for domestic business travel but have expanded demand for summer air travel in the northern hemisphere.[51]
- A 2022 report projects that a levy on frequent flyers (i.e., an escalating price based on the number of flights taken) could earn 98% of its revenues from the wealthiest 20% of air travellers.[52]

Policy developments

In October 2022, the member states of the International Civil Aviation Organization adopted a long-term global goal of net zero carbon emissions by 2050, but the goal remains aspirational and is insufficient to meet the targets of the Paris Agreement (see Figure 5).[53] The goal has been criticised for its lack of interim targets and binding commitments for countries – and thus for its failure to create any incentives to take meaningful action towards achieving it.[54]

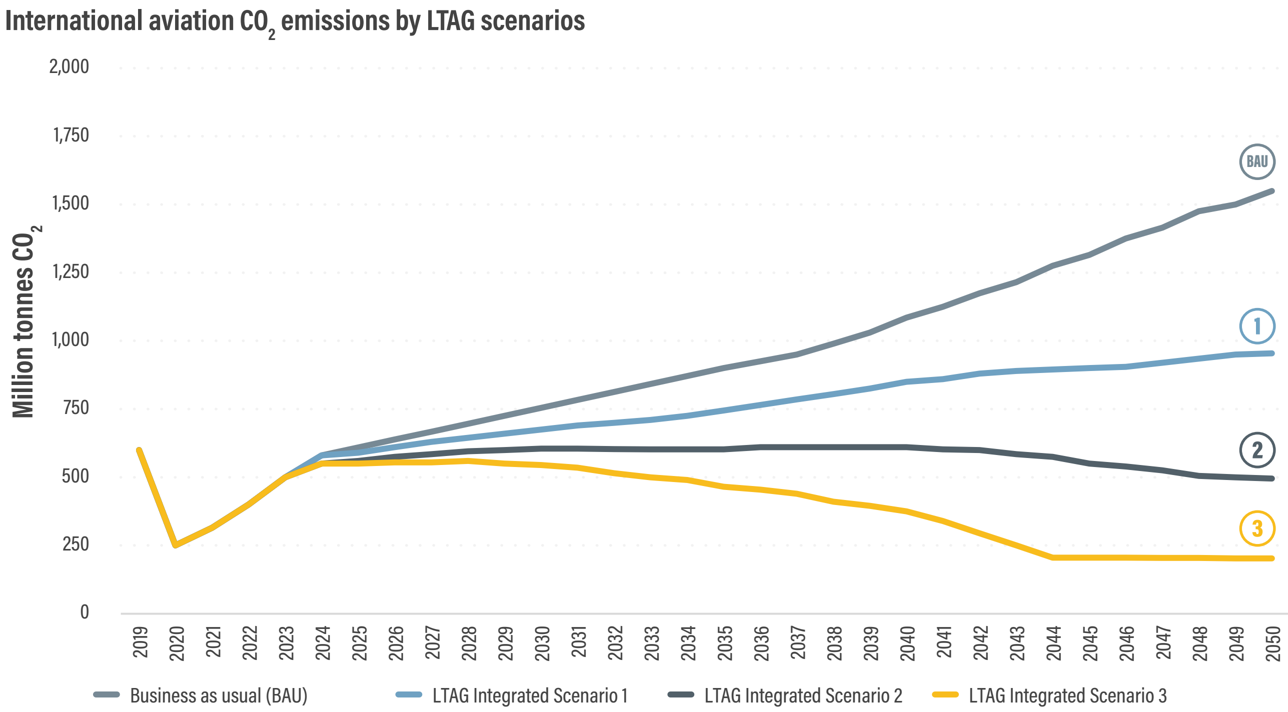
To align efforts to decarbonise the sector, the International Aviation Climate Ambition Coalition was established at the 2021 United Nations Climate Change Conference in Glasgow, United Kingdom (COP 26).[55] The Glasgow Climate Pact adopted at COP 26 states that "limiting warming to 1.5°C requires a 45% reduction in global CO_2 emissions by 2030 relative to 2010 levels".[56]

- The Netherlands is considering establishing a ceiling on CO_2 emissions from international flights originating in the country.[57]
- Of the 144 second-generation Nationally Determined Contributions (NDCs) submitted by countries under the Paris Agreement as of March 2023, 15 NDCs mention aviation, or 10% of the total.[58] For example, the EU's updated NDC mentions the region's intention to expand the scope of aviation emissions covered under the EU Emission Trading Scheme.[59]

Aviation was identified as one of the "hard-to-abate" sectors targeted for decarbonisation under the UNFCCC Mitigation Work Programme agreed to at the 2022 UN Climate Change Conference in Sharm el-Sheikh, Egypt (COP 27).[60] The Pact

FIGURE 5. Decarbonisation scenarios under the International Civil Aviation Organization's long-term aspirational goal of 2022

Source: See endnote 53 for this section.



Note: LTAG = long-term aspirational goal

Photo: dsleeter_2000

agreed to establish mechanisms to rapidly scale up ambition and implementation to close the 1.5°C gap in the current decade.[61] The first global dialogue of the UNFCCC Mitigation Work Programme was convened in June 2023, focused on the topic of a just energy transition.[62]

Sustainable aviation fuel (SAF) accounted for less than 1% of aircraft fuel as of 2023, but scaling up its production to meet global demand is possible by 2040.[63] SAF, which includes biofuels and e-fuels, can provide significant emission reductions compared to conventional fuels if it can be produced sustainably at the required scale.[64] Because the volume of biofuels from waste and residues will not be sufficient to meet demand, energy crops will also be required.[65] E-fuels are relatively inefficient due to energy losses in the production and transport of hydrogen and the combustion of the fuel.[66]

- The United States has created a roadmap to expand annual SAF production to 3 billion gallons (11.4 million litres) by 2030 and 35 billion gallons (13.3 million litres) by 2050, with the aim of meeting 100% of jet fuel demand with SAF and reducing the life-cycle emissions of aircraft 50% by that year.[67]
- Fuels such as hydrogen, e-fuels and biofuels offer advantages that are particularly important for long-distance shipping and aviation; however, they require much more space, and fuels such as e-kerosene are 3-5 times more energy intensive than electricity, on a well-to-tank basis.[68]

As of 2021, SAF was an estimated two to eight times more expensive to produce than conventional jet fuel, although public and private sector efforts are aligning to make SAF more economical.[69]

- In 2022, Airbus successfully tested the use of 100% SAF on a flight of the first A380 plane the company ever made, and it aims to introduce the world's first zero-emission jet by 2035, based on SAF tests on other aircraft.[70]
- Chevron USA and Gevo (a US-based advanced biofuels company) announced plans in 2021 to jointly invest in facilities to scale up production of SAF from non-food sources.[71]
- The EU struck a deal to require the use of SAF for all flights in the region, starting at 2% in 2025 and scaling up to 70% by 2050.[72] The compromise agreement was less ambitious than the original proposal but sets a tangible baseline to allow for increasing ambition over time.[73]
- The United Kingdom set a target in 2021 to use 10% SAF by 2030 and has engaged private sector partners to help reach this target with grants totalling GBP 165 million (USD 205 million) through the country's Advanced Fuel Fund.[74]

Europe's largest airlines have lobbied policy makers to weaken the EU's ambition on decarbonising aviation, despite companies' public commitments towards net zero

emissions.[75] Proposed policies from front groups representing European airlines would limit the EU's SAF plan (ReFuelEU) only to flights within the region.[76] Such a policy would reduce the projected 2050 emission savings from ReFuelEU by nearly 40%.[77]

Electric aircraft development has accelerated in numerous countries, spawning new partnerships among established passenger and freight transport providers and emerging technology companies.[78] As of October 2022, efforts to develop electric aircraft were in process in Australia, Brazil, China, France, Germany, India, Indonesia, Japan, the Republic of Korea, the Russian Federation, the United Kingdom and the United States.[79] However, electric aircraft have relatively low potential to reduce total aviation emissions and have a long development timeline, and thus may have little real impact before 2050.[80]

- Air Canada announced in 2022 that it would order 30 hybrid-electric aircraft from Sweden's Heart Aerospace to replace turbo-prop aircraft on regional routes.[81]
- In 2021, DHL Express announced an order of 12 all-electric cargo planes from Eviation, an emerging US-based manufacturer.[82]
- Norway set a target in 2018 for all short-haul flights to be electric by 2040.[83] The first electric plane prototypes were announced in 2022 and were expected to begin commercial operation by 2028.[84]

Several emerging companies are developing small and medium-sized aircraft powered by hydrogen fuels.[85] Hydrogen-powered aircraft pose numerous technical challenges, including needs for innovative fuel storage methods, lightweight cryogenic tanks and redesigned aircraft frames. Investments are under way to scale up fuel production and to support next-generation aircraft.

- Airbus has invested in the world's largest clean hydrogen infrastructure fund.[86]
- In 2022, American Airlines announced an equity investment in Universal Hydrogen, which is building a green hydrogen distribution network for use in aviation.[87]
- A consortium including Dutch aircraft manufacturer Fokker and the Delft University of Technology plans to launch the world's first hydrogen-fuelled flight of a 40-80-seat passenger plane from Rotterdam (Netherlands) to London (UK) by 2028.[88]
- The United Kingdom is backing the development of an aircraft that would allow a zero-carbon, non-stop flight from London to San Francisco (USA) for nearly 300 passengers.[89]

MODULE 3 3.7

AUTHOR:
Karl Peet, *SLOCAT Secretariat*

Shipping

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

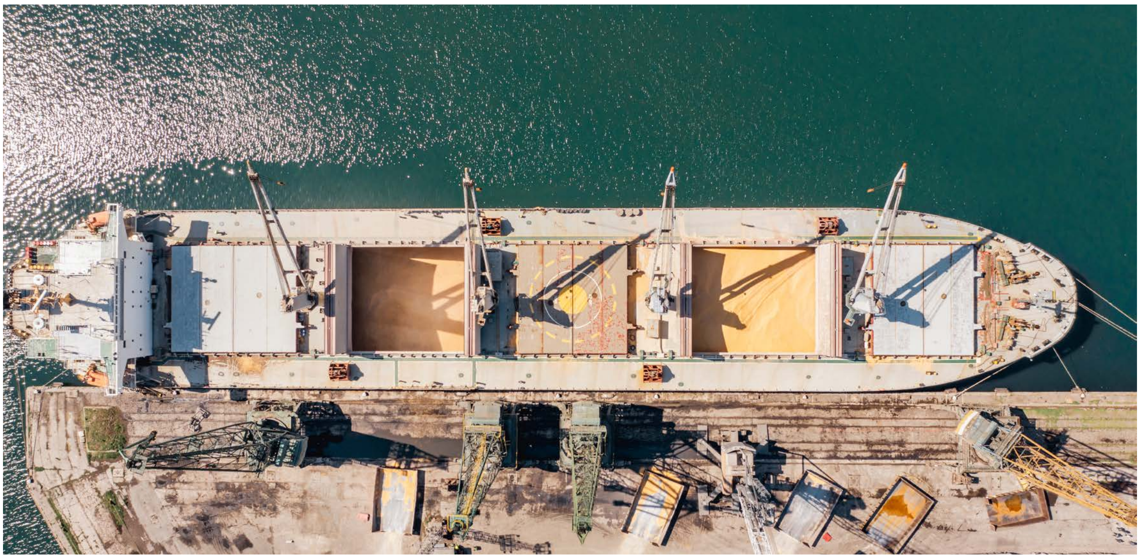
- Maritime trade volumes have increased four-fold in the last four decades, leading to more competitive shipping rates through economies of scale. The maritime shipping industry moves around 11 billion tonnes of goods annually, roughly 300 times more than is moved by aircraft.
- At the beginning of 2023, global container shipping rates were almost back to pre-pandemic levels, defying predictions of the pandemic driving a paradigm shift in container shipping.
- Following the Russian invasion of Ukraine in February 2022, the capacity of container shipping fleets was reduced in the Russian Federation, and operations at Ukrainian ports were suspended until July 2022, when grain exports resumed.
- As much as 40% of maritime trade consists of transporting fossil fuels (such as oil, coal and liquefied natural gas, LNG) from points of fuel production to points of fuel consumption. By 2050, global fossil fuel demand is projected to decline 80% for coal, 50% for oil, and 25% for natural gas, which could lead to stranded assets for fossil fuel transport in the shipping industry.
- The average age of the world's container shipping vessels increased from 10.3 years in 2011 to 13.7 years in 2022. This ageing global fleet is leading to increasing pollution per unit of volume.
- Since mid-2020, higher shipping costs have been driven by events such as the COVID-19 pandemic and the Russian invasion of Ukraine.
- As of 2021, advanced biofuels for shipping cost two to three times as much as conventional fuel and thus were not yet widely commercially viable.
- Inland waterway freight activity in the European Union (EU) increased 3.3% in 2021, with container ship demand rebounding after several years of volatility.

Emission trends

- Carbon dioxide (CO_2) emissions from the international shipping sector grew 5% in 2021, reversing a decline in 2020 and returning to 2017 levels. CO_2 emissions from the world's maritime shipping fleet grew an estimated 4.7% in 2022 and increased 23.8% overall between 2012 and 2022.
- Although international shipping has the lowest CO_2 emissions per tonne-kilometre among transport modes, the sector emitted around 700 million tonnes of CO_2 in 2021, a total exceeded by only five countries: China, the United States, India, the Russian Federation and Japan.
- Even in a scenario in which measures taken by the International Maritime Organization (IMO) contribute to lowering emissions, a 15% decline in emissions between 2021 and 2030 is needed to enable the sector to achieve net zero emissions by 2050.
- In 2019, inland waterway transport produced far fewer CO_2 emissions than road or rail transport while contributing to several of the United Nations Sustainable Development Goals. Inland waterway transport is responsible for 2% of the global greenhouse gas emissions from transport.
- Roughly 5% of maritime fuels must be zero carbon by 2030 to achieve the targets of the Paris Agreement. As of 2021, however, biofuels accounted for less than 1% of total shipping energy use.
- Sails are making a comeback in decarbonisation pledges, with more than 20 commercial ships using "wind-assist" technologies retrofitted to existing vessels as of 2023. Battery-electric propulsion is emerging as a low-emission option for the marine shipping sector, due to its considerable potential for emission reduction.
- A global carbon price on maritime shipping would create further incentives to accelerate development of biofuels, wind propulsion and battery-electric vessels.

Policy developments

- An IMO submission in 2022 suggests increased ambition towards mitigating emissions, with the Energy Efficiency Existing Ship Index and the Carbon Intensity Indicator entering into force in 2023.
- In June 2023, the IMO adopted a revised strategy to reduce greenhouse gas emissions from international shipping to at least 70% below 2008 levels by 2040, and striving for 80%. This is a major improvement from the IMO's initial 2018 strategy, which aimed at a 50% reduction by 2050.
- Overall, the revised IMO strategy raises the level of ambition for emission mitigation and is estimated to place the international shipping sector well within the carbon budget required to align with a scenario of keeping global temperature rise below 2 degrees Celsius (°C) compared to pre-industrial levels. However, the strategy remains insufficient to support the carbon budget in a scenario of keeping global temperature rise within 1.5°C.
- The revised IMO strategy does not directly enforce a carbon price for maritime shipping despite earlier IMO working group meetings giving hope for such an economic levy, which was seen as a breakthrough by many Parties to the Paris Agreement.
- As of 2022, only 35% of major maritime shipping companies had set a target for net zero emissions by 2050 and/or had committed to the 2018 IMO target of a 50% emission reduction by 2050. A third of commitments by firms had identified a fuel strategy, with LNG being the most common conventional fuel and ammonia the most common alternative fuel.
- During 2021 and 2022, a varied group of ports, cities, cargo owners, and shipping companies and manufacturers issued commitments and calls for decarbonising the sector by 2050 and making zero-emission vessels widespread by 2030.
- For domestic maritime transport (coastal and inland shipping), very few efforts are in place to support a shift from road freight to inland waterways.
- The Maritime Just Transition Task Force of the UN Framework Convention on Climate Change was established in 2021 to facilitate a decarbonised shipping industry, followed by the launch of the Just Transition Work Programme in 2022. Maritime shipping has been identified as one of the "hard-to-abate" sectors targeted under the Mitigation Work Programme adopted in 2022.
- Emissions from international shipping continue to be outside the scope of countries' Nationally Determined Contributions (NDCs) towards reducing emissions, due to a lack of clarity in the Paris Agreement.
- With additional cost pressures deriving from the Russian Federation's invasion of Ukraine, and despite the new IMO targets, there is a strong risk that shipping decarbonisation will slip further down the policy agenda.



Overview

Maritime shipping was much less affected by the COVID-19 pandemic than other forms of transport, and by early 2023 global container shipping rates had nearly returned to 2019 levels. Containers were moving rapidly in and out of China, whereas container activity in Europe and the United States was slower to recover due to ongoing port congestion.

Due to trade restrictions with the Russian Federation – a leading oil and gas exporter – energy costs and thus shipping costs increased in 2022. Many ships had to be rerouted, as transport to and from the Russian Federation and Ukraine was at least temporarily halted, leading to additional delays, higher port charges and increased pressure on storage capacity.

In 2023, a key policy development in the maritime shipping sector was the International Maritime Organization's (IMO) adoption of a revised strategy to address greenhouse gas emissions from international shipping, including ambitious targets to reduce emissions up to 80% by 2040, compared to 2008 levels.[1] Under the new strategy, the international shipping sector would be able stay within the carbon budget required to keep global temperature rise below 2 degrees Celsius (°C) (although not below 1.5°C).[2]

Additional policy steps during 2021 and 2022 included the establishment of the Maritime Just Transition Task Force and the launch of the Just Transition Work Programme, which support a safe, equitable and human-centred transition towards a decarbonised shipping industry; these initiatives also help to advance progress on the United Nations Sustainable Development Goals (SDGs), including SDG 3 (health and well-being), SDG 8 (decent work and economic growth) and SDG 10 (reduced inequalities).[3]

Demand trends

Maritime trade volumes have increased four-fold in the last four decades, leading to more competitive shipping rates through economies of scale.[4] **The maritime shipping industry moves around 11 billion tonnes of goods annually, roughly 300 times more than is moved by aircraft.**[5] In the European Union (EU), maritime shipping accounts for around 80% of total exports and imports by volume (and around 50% by value).[6]

At the beginning of 2023, global container shipping rates were almost back to pre-pandemic levels, defying predictions of the pandemic driving a paradigm shift in container shipping.[7] Trends for 2022 showed containers moving in and out of China faster than ever, while ongoing congestion in Europe and the United States continued to slow the recovery of global maritime shipping.[8]

Following the Russian invasion of Ukraine in February 2022, the capacity of container shipping fleets was reduced in the Russian Federation, and operations at Ukrainian ports were suspended until July 2022, when grain exports resumed.[9] Reduced grain exports resulted in higher food prices, as the Russian Federation and Ukraine had been responsible for 53% of global trade in sunflower oil and 27% of trade in wheat (as of early 2022).[10] Sourcing of grains and other food imports has since shifted to Australia and Brazil, among other countries.[11]

In vulnerable regions that depend highly on maritime transport, such as small-island developing states, consumer prices could increase up to 8.1% between 2021 and 2022, according to the UN Conference on Trade and Development (UNCTAD).[12] As a result of the conflict-related disruptions, container shipping demand has shifted towards other European countries such as Denmark, Estonia, Latvia, Lithuania, Romania and Sweden (see Figure 1).[13]

As much as 40% of maritime trade consists of transporting fossil fuels (such as oil, coal and liquefied natural gas, LNG) from points of fuel production to points of fuel consumption.[14] In 2021, the shipping industry transported nearly 2 billion tonnes of crude oil, in addition to more than 1 billion tonnes of coal and 500 million tonnes of LNG.[15] In turn, nearly 100% of maritime shipping vessels relied on fossil fuels for propulsion as of March 2023 (see Figure 2).[16]

By 2050, global fossil fuel demand is projected to decline 80% for coal, 50% for oil, and 25% for natural gas, which could lead to stranded assets for fossil fuel transport in the shipping industry.[17] With a minimum lifespan of 20 years for most vessels, there is a risk that the continued procurement of ships that transport fossil fuels will lead to inefficiencies in shipping fleets.[18]

The average age of the world's container shipping vessels has increased from 10.3 years in 2011 to 13.7 years in 2022; the ageing global fleet is increasing pollution per unit volume.[19] Commercial fleets are ageing as many ship owners are delaying orders for new vessels due to uncertainty about technology trajectories, cost-efficient fuels and carbon pricing.[20]

FIGURE 1. Container shipping fleet deployment of selected countries, by capacity, 2018 to mid-2022

Source: See endnote 13 for this section.

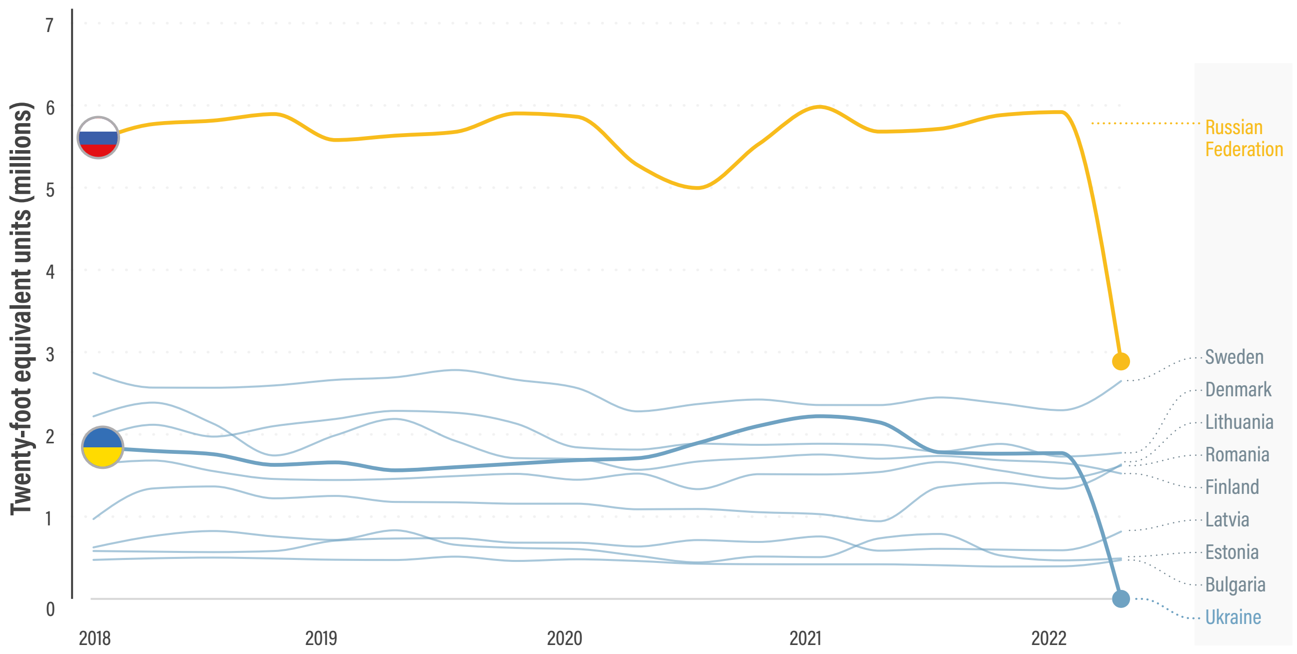


FIGURE 2. Shares of fossil fuels in international shipping and shipping vessel propulsion, as of March 2023

Source: See endnote 16 for this section.

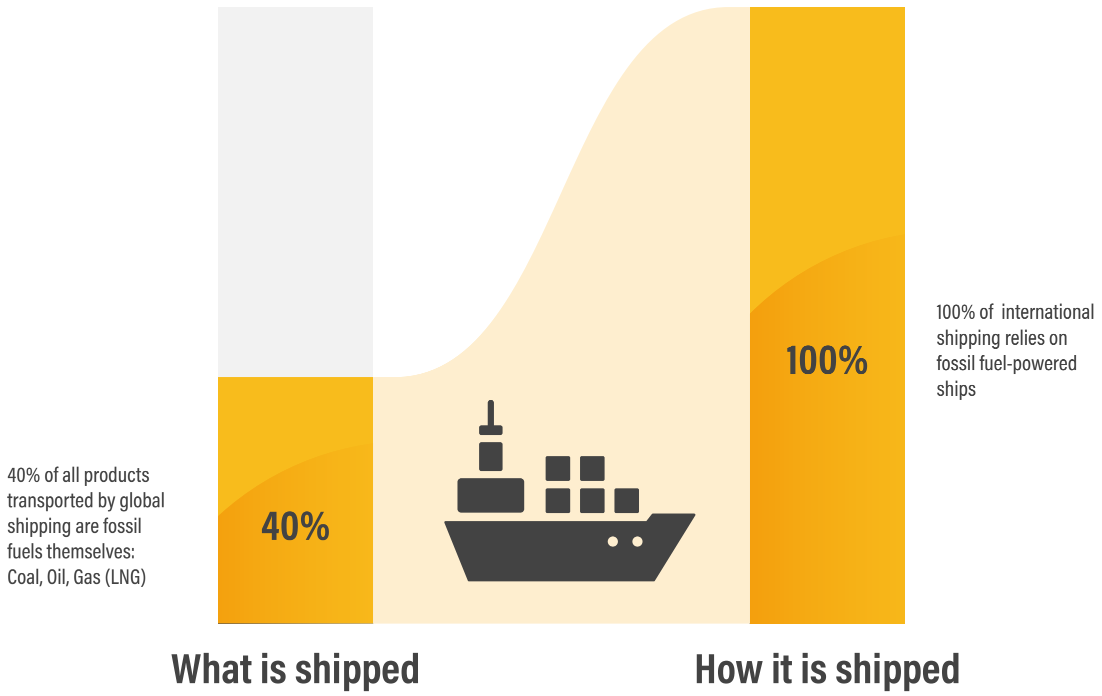
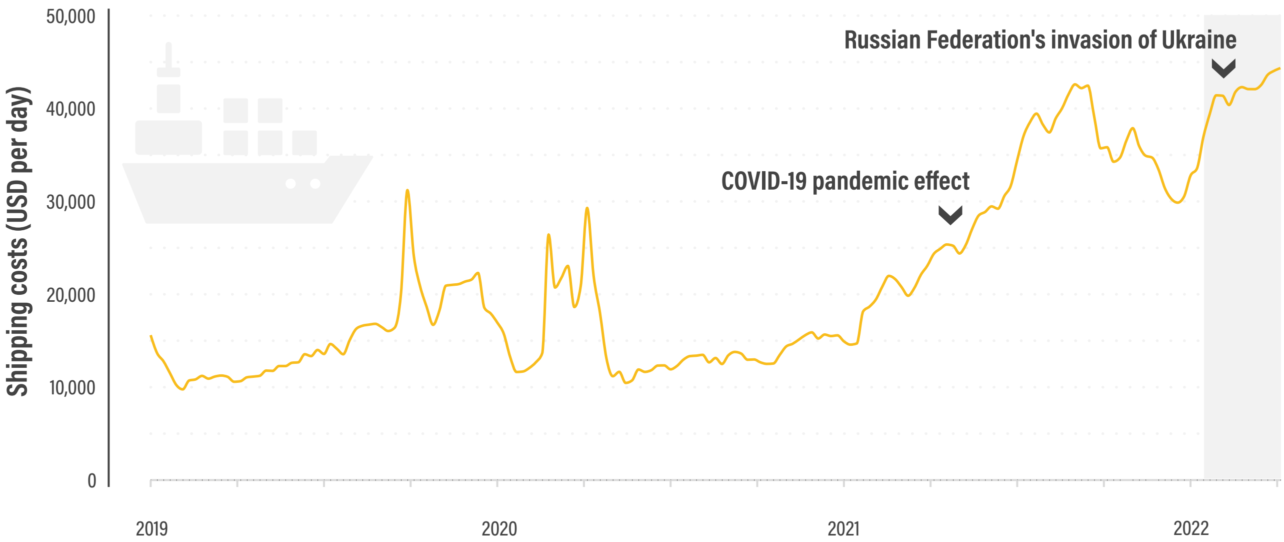


FIGURE 3. Rising costs of shipping, 2019 to mid-2022

Source: See endnote 23 for this section.



In 2021, the global commercial fleet grew less than 3%, the second lowest growth rate since 2005.[21]

Since mid-2020, higher shipping costs have been driven by events such as the COVID-19 pandemic and the Russian invasion of Ukraine. High energy prices are a key contributor to increased maritime shipping costs. The average price of fuel oil increased nearly two-thirds from January to May 2022.[22] The average fuel surcharge by container shipping lines rose nearly 50% during this period (see Figure 3).[23]

As of 2021, advanced biofuels for shipping cost two to three times as much as conventional fuel and thus were not yet widely commercially viable.[24] The annual consumption of diesel fuel in maritime shipping in 2020 was 240 million tonnes oil equivalent (mtoe), whereas the amount of biofuels needed for sector decarbonisation is 220 mtoe.[25]

Inland waterway freight activity in the EU increased 3.3% in 2021, with container ship demand rebounding after several years of volatility.[26] After a period of relative stability from 2011 to 2017, freight transport demand in EU inland waterways has fluctuated since 2017 due to factors including the pandemic and slow economic growth (see Figure 4).[27]

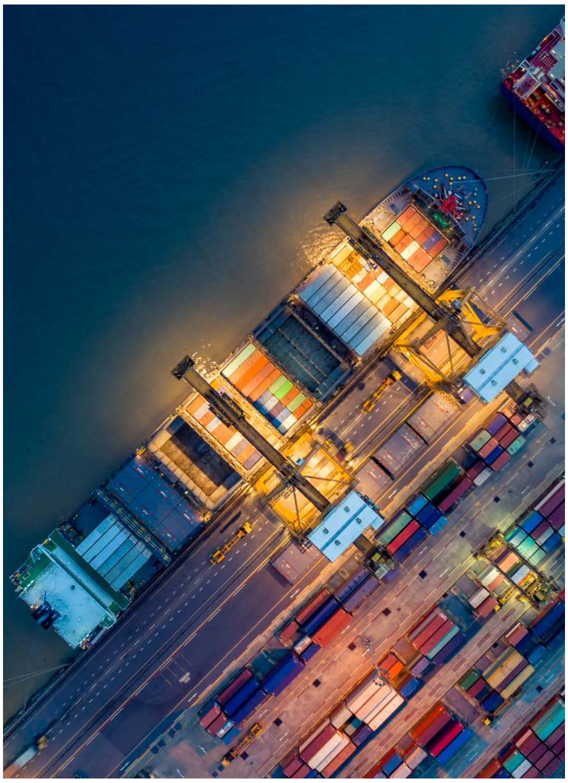
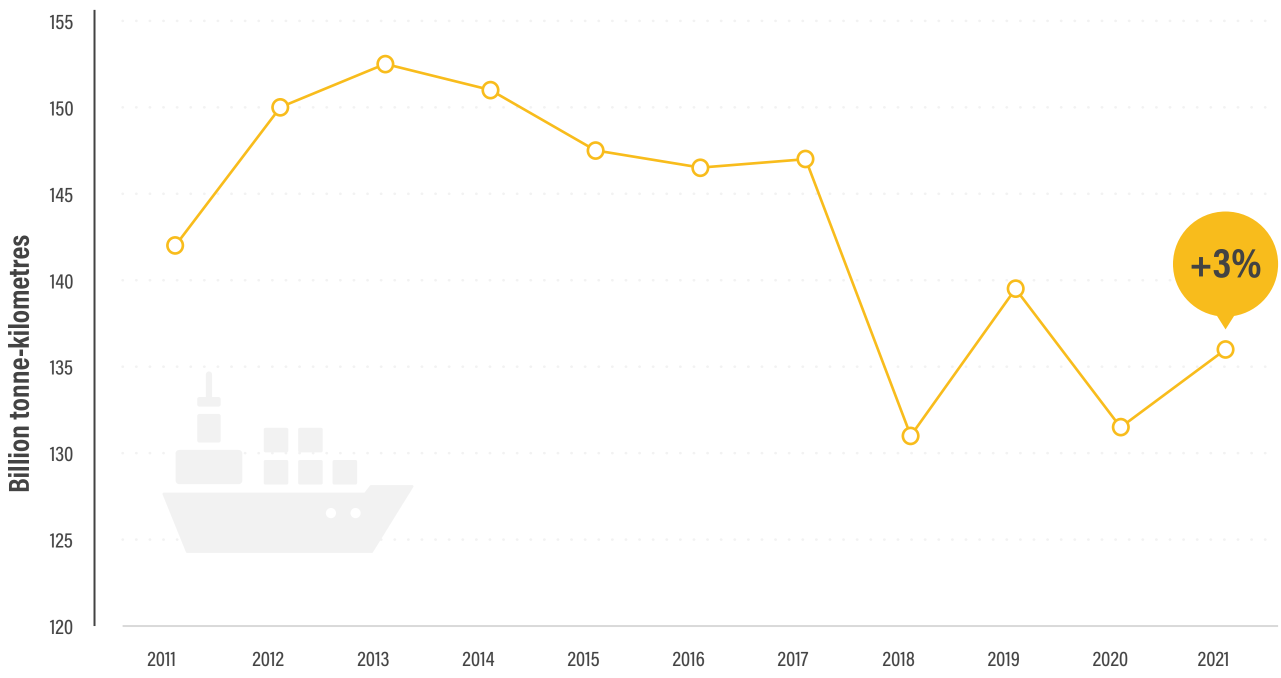


FIGURE 4. Inland waterway freight transport activity in the European Union, 2011-2021

Source: See endnote 27 for this section.



Emission trends

Carbon dioxide (CO_2) emissions from the international shipping sector grew 5% in 2021, reversing a decline in 2020 and returning to 2017 levels.[28] International shipping emissions accounted for around 3% of total energy-related CO_2 emissions in 2021 and were poised to grow further in 2022 (see Figure 5).[29] **CO_2 emissions from the world's maritime shipping fleet grew an estimated 4.7% in 2022 and increased 23.8% overall between 2012 and 2022** (see Figure 6).[30]

Although international shipping has the lowest CO_2 emissions per tonne-kilometre among transport modes, the sector emitted around 700 million tonnes of CO_2 in 2021, a total exceeded by only five countries: China, the United States, India, the Russian Federation and Japan.[31] Global maritime shipping released more emissions than all of Germany in 2021; nevertheless, emissions from international shipping are not included in countries' national emission inventories (*see Policy Developments section*).

Even in a scenario in which measures taken by the International Maritime Organization contribute to lowering emissions, a 15% decline in emissions between 2021 and 2030 is needed to enable the sector to achieve net zero emissions by 2050.[32] Meeting this target would require CO_2 emissions from maritime shipping to remain steady until 2025 (rather than rising, as they are currently) and then to decrease 3% annually until 2030.[33] In 2019, China's coastal shipping sector alone released around 45 million tonnes of CO_2, roughly 4.5% of the country's total transport emissions.[34] Mandatory energy efficiency standards for ships, as well as low-carbon fuel regulations, could support a peaking of emissions from China's domestic coastal shipping by 2040 and a decline by 2060.[35]

In 2019, inland waterway transport produced far fewer CO_2 emissions than road or rail transport while contributing to several of the UN Sustainable Development Goals (SDGs).[36] **Inland waterway transport is responsible for 2% of the global greenhouse gas emissions from transport.**[37] Inland waterway freight transport (or "inland towing") produced 30% fewer emissions than rail freight and nearly 90% fewer emissions than road freight (per tonne-kilometre) in 2019 (see Figure 7).[38] By reducing energy use and shifting freight transport away from agglomerations, inland waterway transport contributes to SDG 3 (health and well-being), SDG 7 (energy), SDG 9 (industry, innovation and infrastructure) and SDG 13 (climate action).[39]

FIGURE 5. Monthly emissions from international shipping, 2019-2022

Source: See endnote 29 for this section.

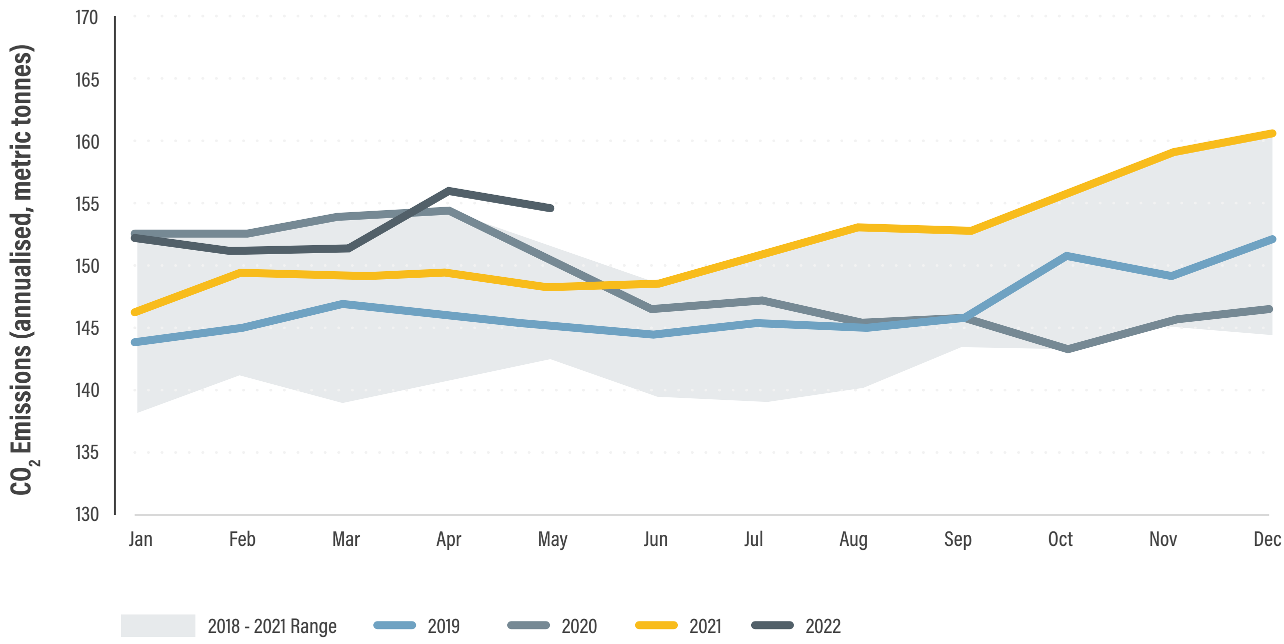


FIGURE 6. CO_2 emissions from the world's commercial shipping fleet, 2012-2022

Source: See endnote 30 for this section.

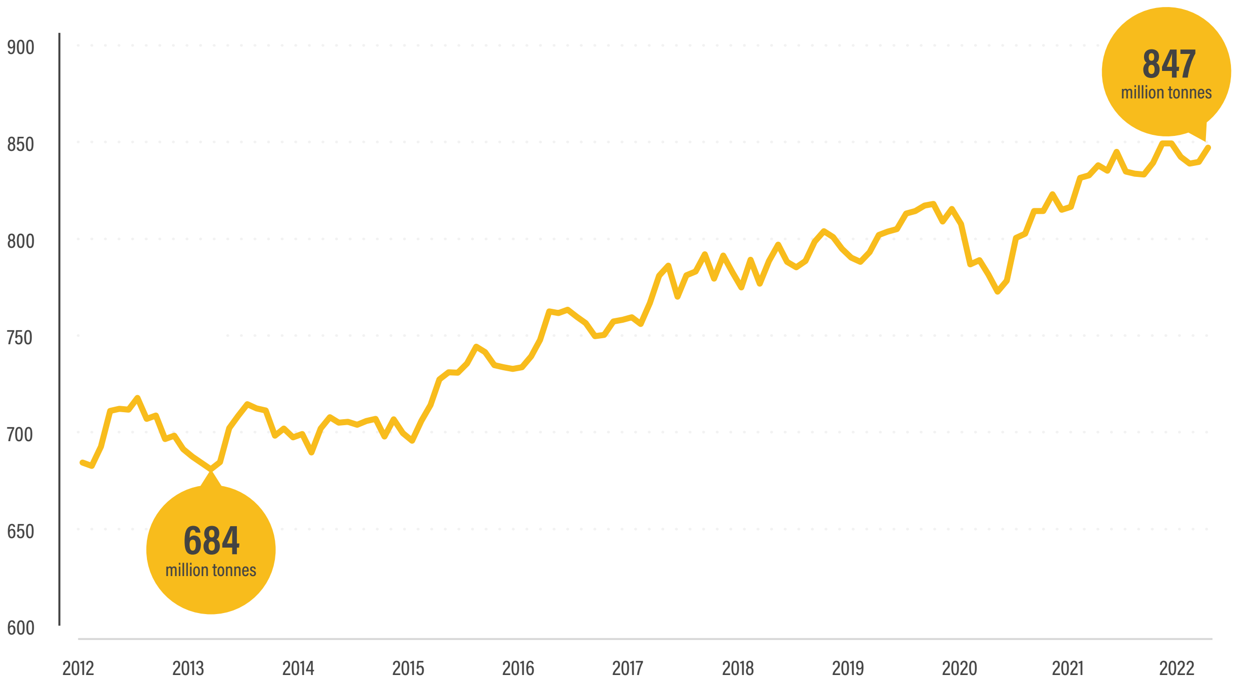
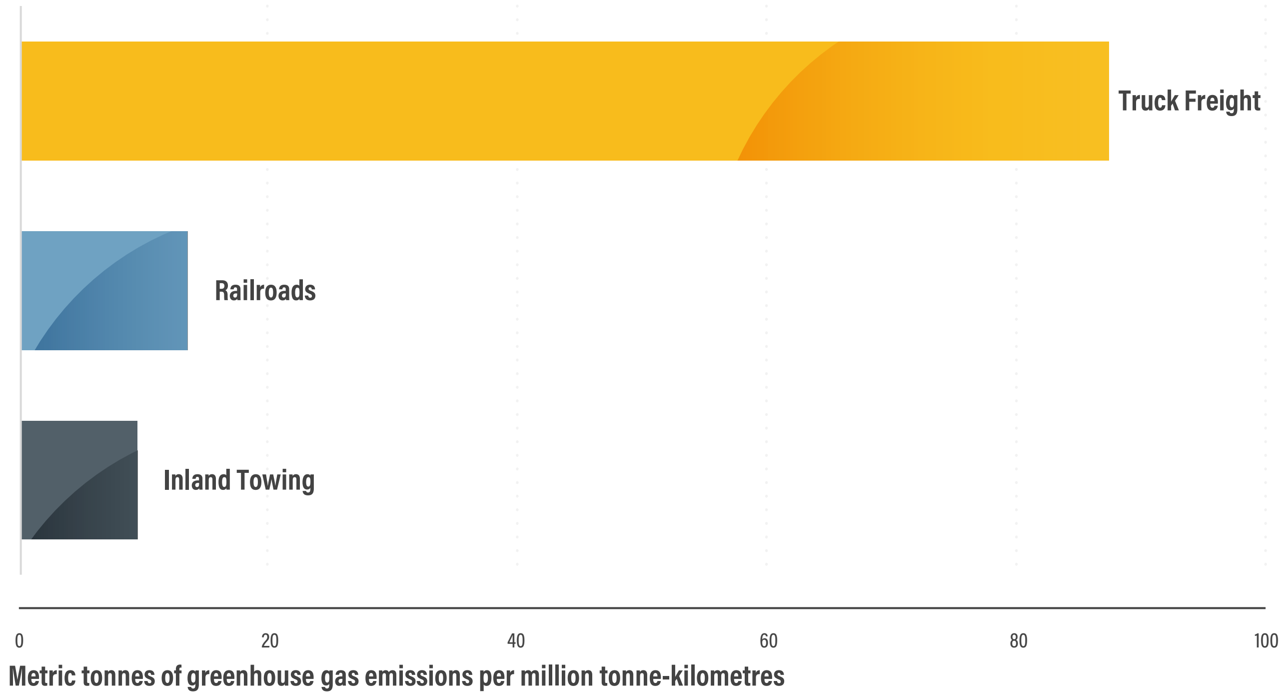


FIGURE 7. Greenhouse gas emissions per million tonne-kilometres, by transport mode, 2019

Source: See endnote 38 for this section.



Roughly 5% of maritime fuels must be zero carbon by 2030 to achieve the targets of the Paris Agreement.[40] As of 2021, however, biofuels accounted for less than 1% of total shipping energy use.[41] Oil products supplied more than 99% of the total energy for international shipping in 2021.[42]

- As of March 2022, almost 40% of new vessel procurements worldwide were for ships capable of running on multiple fuels including **LNG, methanol, ammonia** and **electricity**.[43] Scaling up these fuels further will require ports providing adequate fuelling infrastructure.[44]
- Around 50 methanol dual-fuelled vessels were ordered worldwide in 2022, as shipowners anticipate the need to replace ageing fleets.[45] Orders for **methanol**-powered ships are expected to surge.
- **Ammonia** is being developed as a low-carbon shipping fuel, but the threat of unintended consequences is high. Ammonia fuels have low life-cycle energy efficiency and are not easy to transport and use due to their toxicity. If nitrogen releases from ammonia fuels are not well controlled, maritime transport could emit potent nitrous oxide emissions at a micro scale and substantially alter the global nitrogen cycle at a macro scale.[46]

Sails are making a comeback in decarbonisation pledges, with more than 20 commercial ships using "wind-assist" technologies retrofitted to existing vessels as of 2023.[47] Wind propulsion has been a niche solution as shipping companies have failed to bear the full environmental and societal costs of burning fossil fuels.[48]

- The China Merchant Energy Shipping company is operating a super tanker with four large sails that will reduce the ship's average fuel consumption nearly 10%.[49]
- Japanese bulk carrier MOL is operating a wind-assisted ship, and Swedish shipping company Wallenius is building a wind-assisted vessel to cut emissions up to 90%.[50]
- The French start-up Zephyr & Borée has built a wind-assisted vessel that will be used to transport parts of the European Space Agency's Ariane 6 rocket.[51]

Battery-electric propulsion is emerging as a low-emission option for the marine shipping sector, due to its considerable potential for emission reduction.[52] Advantages of battery-electric vessels include improvements in battery energy storage, increasing availability of renewable electricity, and efficiency advantages over green hydrogen and ammonia. It is imperative to undertake a systematic analysis of the potential of battery-electric ships.

- In 2022, California (USA) imposed new air quality rules on small boats, which can be replaced by battery-operated vessels that are technically and commercially feasible.[53]
- Maersk, the world's largest shipping company by volume, is piloting battery-hybrid propulsion on a container ship operating between East Asia and West Africa.[54]
- An electric 80-metre container ship was expected to begin operation in Norway in the early 2020s, and similar projects were under way in Denmark, Japan and Sweden.[55]

A global carbon price on maritime shipping would create further incentives to accelerate development of biofuels, wind propulsion and battery-electric vessels.[56] A global carbon pricing regime could build on lessons learned from the EU's Emissions Trading Scheme, which includes international shipping emissions.

Policy developments

An IMO submission at the 2022 UN Climate Change Conference in Sharm el-Sheikh, Egypt (COP 27) suggests increased ambition towards mitigating emissions, with the Energy Efficiency Existing Ship Index and the Carbon Intensity Indicator entering into force in 2023.[57] The Carbon Intensity Indicator looks at the CO_2 emissions of a ship per unit of nominal transport work, while the Energy Efficiency Existing Ship Index examines the CO_2 emissions per cargo tonne and kilometre compared to a baseline, which is decided by ship design.[58] These indicators will allow the shipping industry to assess progress towards a target to reduce carbon intensity (measured as CO_2 emissions per transport work) 40% by 2030, although this falls short of demonstrating aggregate reductions.[59]

In June 2023, the IMO adopted a revised strategy to reduce greenhouse gas emissions from international shipping to at least 70% below 2008 levels by 2040, and striving for 80%.[60] **This is a major improvement from the IMO's initial 2018 strategy, which aimed at a 50% reduction by 2050.**[61] The 2023 IMO greenhouse gas strategy aims to:

- review and strengthen the energy efficiency of ships, to reduce their carbon intensity;
- reduce CO_2 emissions at least 40% by 2030, compared to 2008 levels;
- increase the uptake of zero or near-zero greenhouse gas emission technologies, fuels and/or energy sources by at least 5% and striving for 10% of international shipping's energy use by 2030;
- peak greenhouse gas emissions from international shipping as soon as possible and reach net zero emissions by or close to 2050.[62]

Indicative checkpoints towards net zero emissions include reducing total annual greenhouse gas emissions from international shipping 20-30% by 2030 and 70-80% by 2040, compared to 2008 levels.[63] **Overall, the revised IMO strategy raises the level of ambition for emission mitigation and is estimated to place the international shipping sector well within the carbon budget required to align with a scenario of keeping global temperature rise below 2°C compared to pre-industrial levels. However, the strategy remains insufficient to support the carbon budget in a scenario of keeping global temperature rise below 1.5°C.**[64]

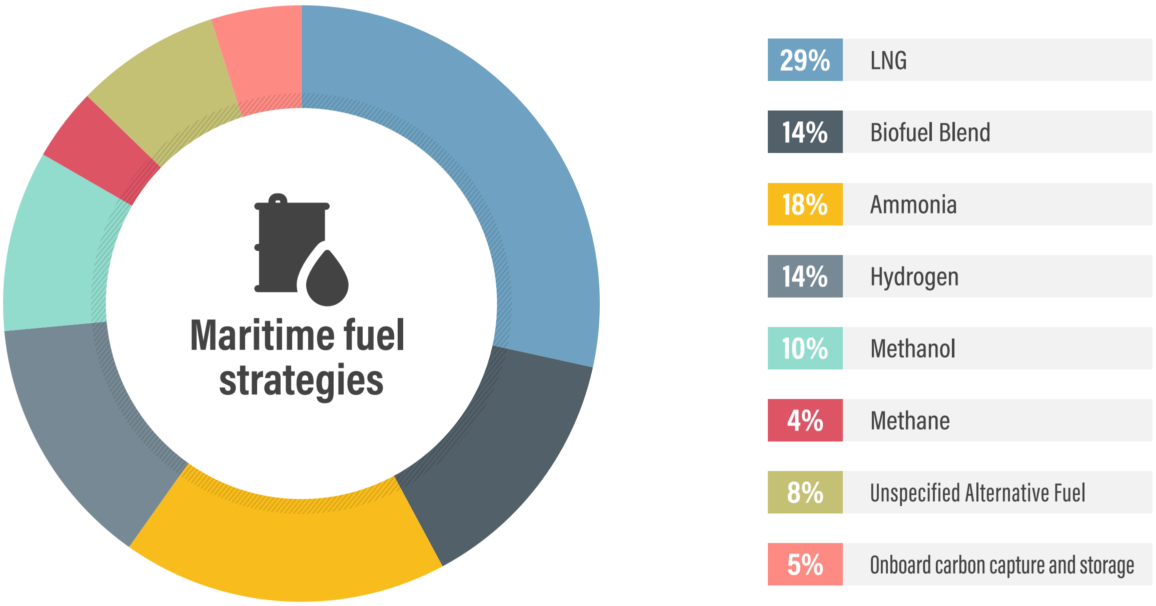
The revised IMO strategy does not directly enforce a carbon price for maritime shipping despite earlier IMO working group meetings giving hope for such an economic levy, which was seen as a breakthrough by many Parties to the Paris Agreement.[65] After more than a decade of contention, countries seemed to have agreed on the need to put a price on maritime shipping emissions at the IMO working group meeting in May 2022. The industry's trade association had previously supported a levy of USD 2 per tonne of fuel to fund research on clean shipping technology, translating to a carbon price of just USD 0.64.[66] The revised strategy features the possibility of a carbon price as a potential mid-term measure for reducing greenhouse gas emissions.[67]

- Major economies have previously resisted carbon tax proposals. At the 2022 meeting, however, EU countries and the United States shifted to support carbon pricing, with first-time backing for the measure by the Bahamas, New Zealand and the United Kingdom.[68]
- The Marshall Islands and Solomon Islands have proposed a carbon price of USD 100 per tonne on shipping fuels.[69]
- Maersk, the world's largest container shipping company, has proposed a price of USD 150 per tonne to accelerate use of low-carbon fuels.[70]

As of 2022, only 35% of major maritime shipping companies had set a target for net zero emissions by 2050 and/or had committed to the 2018 IMO target of a 50% emission reduction by 2050.[71] **A third of commitments by firms had identified a fuel strategy, with LNG being the most common conventional fuel and ammonia the most common alternative fuel.**[72] Companies with pledges have higher levels of reported emissions disclosure and related decarbonisation actions (see Figure 8).[73]

FIGURE 8. Proportion of fuel strategies in industry commitments on maritime shipping decarbonisation, as of 2022

Source: See endnote 73 for this section.



During 2021 and 2022, a varied group of ports, cities, cargo owners, and shipping companies and manufacturers issued commitments and calls for decarbonising the sector by 2050 and making zero-emission vessels widespread by 2030.[74]

- Cargo Owners for Zero Emission Vessels, a group of retailers including Amazon, Ikea, and Unilever, have committed to shipping products solely on zero-emission vessels by 2040 and have urged policy makers to fully decarbonise shipping by 2050.[75]
- The ports of Los Angeles and Shanghai, along with C40 Cities, announced a partnership in January 2022 to create the first "green shipping corridor" between China and the United States.[76]

For domestic maritime transport (coastal and inland shipping), very few efforts are in place to support a shift from road freight to inland waterways. As part of the European Green Deal, there is a proposal to cut transport emissions 90% by 2050, with plans to increase connectivity and to shift more passengers and freight away from road transport to rail and inland waterways (*see Section 2.3 Europe Regional Overview*).[77] This proposal should help boost the share of inland waterways in total freight transport, which declined between 2011 and 2021 in 11 of the 17 EU Member States for which this transport mode is applicable.[78]

The Maritime Just Transition Task Force of the UN Framework Convention on Climate Change was established at COP 26 in 2021 to facilitate a decarbonised shipping industry, followed by the launch of the Just Transition Work Programme at COP 27 in 2022.[79] At COP 26, more than 20 nations signed on to the **Clydebank Declaration**, publicly pledging to demonstrate the viability of green shipping corridors by 2025.[80] **Maritime shipping has been identified as one of the "hard-to-abate" sectors targeted under the Mitigation Work Programme adopted in 2022.**[81]

Emissions from international shipping continue to be outside the scope of countries' Nationally Determined Contributions (NDCs) towards reducing emissions, due to a lack of clarity in the Paris Agreement.[82] Some experts call for a two-tiered approach to tackling emissions in the maritime transport sector that merges collective action through the IMO and individual commitments in countries' NDCs.[83] Nevertheless, 22 of the second-generation NDCs submitted by countries as of the end of 2022 featured mitigation actions related to maritime transport, mostly the NDCs of island countries such as Cabo Verde, Kiribati, Maldives, Micronesia, Samoa, Solomon Islands and Sri Lanka.[84]

- Cabo Verde intends to support a shift to low-carbon international maritime trade, with ships being powered by sails or solar or other low-carbon fuels.[85]
- China aims to increase the share of railways and waterways in freight activity and to expand its use of zero-emission vessels.[86]
- Micronesia intends to update vessels to increase ship efficiency, embed renewable energy as a power source and add more vessels for response operations.[87]
- The updated NDC of Kiribati includes a comprehensive package of activities, such as the development of a national maritime action plan, low-carbon container ships and biofuel blending.[88]

With additional cost pressures deriving from the Russian Federation's invasion of Ukraine, and despite the new IMO targets, there is a strong risk that shipping decarbonisation will slip further down the policy agenda. The Russian invasion poses novel challenges to decarbonisation of the shipping industry, which requires additional financial, technical and policy support for widespread implementation of low-carbon measures.[89]

4

Transport and Energy

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Contents

4.1 Transport Energy Sources 338

4.2 Vehicle Technologies 352

List of Figures

Transport Energy Sources

Figure 1. Energy consumption in transport, by energy source, 2015, 2019 to 2021 . . . . **342**
Figure 2. Specific fuel consumption of cars and vans versus sales shares of electric cars and sport utility vehicles, 2015-2021 . . . . **343**
Figure 3. Shares of oil products used in road transport, by fuel type, 2000-2020 . . . . **344**
Figure 4. Biofuel production, by type, 2015-2021. . . . . **345**
Figure 5. Electricity demand from electric vehicles in selected countries/regions, by vehicle type, 2015, 2020 and 2021 . . . . **345**
Figure 6. Evolution of CO_2eq emissions from passenger cars in the EU-27, by contributing factor, 2000-2019 . . . . **347**
Figure 7. Baseline emissions from transport in 2020, and the mitigation potentials from different sectoral activities to 2050 . . . . **348**
Figure 8. Equivalent passenger car CO_2 emissions and fuel consumption in countries with mandatory vehicle efficiency or emissions standards, 2000-2035. . . . . **349**

Vehicle Technologies

Figure 1. Electric passenger car stock (left) and sales (right), 2015-2022 . . . . **356**
Figure 2. Battery price development, 2010-2022 . . . . **358**
Figure 3. Annual fuel cost for vehicle types in the United States, based on 2021-2023 models **359**
Figure 4. Oil displacement through electric vehicles, 2020-2022 . . . . **360**

List of Tables

Transport Energy Sources

Table 1. Electricity requirements of different vehicle propulsion technologies **343**

MODULE 4 4.1

AUTHOR:
Marion Vieweg, *Current Future*
Hannah E. Murdock, *Imperial College London*

Transport Energy Sources

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

Demand trends

- An analysis of 810 scenarios developed by the Intergovernmental Panel on Climate Change concluded that to limit global warming even to 2 degrees Celsius (°C), transport energy consumption would need to peak between 2030 and 2035 and then decrease. Scenarios compatible with a 1.5°C scenario would require earlier peaking and steeper reductions in energy use from the sector.
- In 2021, the growth in transport energy consumption rebounded somewhat (although it did not yet return to 2019 levels), indicating that the decline in 2020 was related to the COVID-19 pandemic and not to policy action in the sector.
- The Russian Federation's invasion of Ukraine in February 2022 led to fuel price spikes in the transport sector, underscoring the need to decouple transport from fossil fuel dependency. Towards the end of 2022, global cost inflation settled in the range of 5-10%.
- Improvements in engine technologies, the introduction of hybrid powertrains, and greater use of electric vehicles led to an 8.2% increase in the energy efficiency of cars and vans between 2015 and 2021. However, the increased popularity of sport utility vehicles (SUVs) and trucks poses a huge challenge to reducing energy consumption and emissions in the sector.
- In road transport, direct use of electricity is most efficient from an energy perspective, where this is technically and logistically feasible.
- The share of diesel among all oil products used in road transport increased from 39.1% to 45.5% between 2000 and 2020. This trend is driven largely by rising demand for freight transport, which is mostly diesel-powered.
- Biofuels are the largest renewable energy source in transport, accounting for 3.7% of the sector's energy consumption in 2021, up 0.8 percentage points since 2015. The main policies supporting biofuels are blending mandates set by countries.
- Hydrogen can play a role whenever direct electrification is impossible. Hydrogen is considered plausible for road transport (for use in heavy-duty vehicles for long distances) and for aviation and shipping.
- Despite the immense growth in electric vehicles over the last decade, electricity demand in road transport is still low, with electric vehicles accounting for around 1% of vehicles globally in 2022. Electric vehicles represented only 0.14% of total global electricity consumption in 2020.
- Electrification is most prominent in rail transport, accounting for 45% of the energy consumed by rail in 2021.
- Fossil fuels continue to account for the majority of electricity generation in the power sector, and thus for the majority of the electricity supplied for electric vehicles.
- More than 450,000 commercial flights used sustainable aviation fuel (SAF) in 2022, with SAF production increasing 200% compared to 2021. However, SAF still accounted for only 0.1% of all consumed aviation fuel as of 2022.

Emission trends

- Carbon dioxide (CO_2) emissions from road transport increased steadily between 2000 and 2020.
- Energy efficiency improvements and the use of renewable energy sources, mostly biofuels, helped reduce emissions from the transport sector. However, these savings continued to be outweighed by rising emissions from the overall growth in transport demand and from the modal shift towards higher-emitting forms of transport, leading to a net increase in emissions from the sector.
- The required shift to renewable energy in transport will have negative effects on employment in regions that are highly dependent on fossil fuels. Policies aimed at fostering the decarbonisation of transport will need to ensure an equitable and just transition towards more sustainable jobs. Globally, this shift is expected to result in a net gain in jobs.
- An "ambitious yet feasible" scenario from the International Council on Clean Transportation (ICCT) projects that the energy efficiency of light-duty vehicles will improve 0.75% annually between 2030 and 2050. Energy efficiency plays a major role in decarbonising the maritime and aviation sectors under this scenario.

Policy developments

- Mandatory standards for energy efficiency and for greenhouse gas emissions have proven to be effective instruments to drive efficiency and the shift to zero-emission vehicles.
- An increasing number of countries – mostly with limited or no domestic vehicle manufacturing – have established vehicle standards or other instruments to enhance the efficiency of imported vehicles.
- Fuel economy and greenhouse gas emission standards for heavy-duty vehicles are an important instrument to decarbonise the freight sector. In 2022, more than 70% of trucks sold were covered by fuel economy or vehicle efficiency regulations, although only seven countries or regions had such standards.
- Many countries have adopted vehicle labelling schemes to help consumers make informed choices by better understanding the life-cycle costs of vehicles.
- Biofuel blending mandates remain the most popular measure for increasing renewable energy in transport, with at least 56 countries and the European Union having established some form of obligation by the end of 2022.
- As of the end of 2022, at least six countries mentioned biofuel blending in their updated Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement, with policy implementation yet to come.
- In aviation, some countries are considering biofuel blending mandates for sustainable aviation fuel.

Photo credits: Marc A. Hermann/MTA

Overview

Fossil fuels continue to be the dominant energy source in the transport sector, determining trends for the sector's overall contributions to carbon dioxide (CO_2) emissions and air pollution. Solutions that aim to "Avoid" transport activity and to "Shift" to more efficient modes will help reduce overall energy demand, while at the same time providing broader sustainability benefits. However, for full decarbonisation, additional "Improve" measures are required to increase the energy efficiency of vehicles and reduce overall energy demand, and to replace fossil fuels with renewable energy alternatives to reduce the carbon intensity of energy use.

The fossil fuels used in transport emit large amounts of fine particulate matter, black carbon and other pollutants. In 2019, outdoor air pollution related in part to transport activity contributed to an estimated 4.2 million premature deaths.[1] This has motivated many countries to introduce fuel quality and emission standards for air pollutants and to increasingly supplement these with policies such as fuel economy and CO_2 emission standards, energy labelling schemes and differentiated taxation.

Energy use in transport must rapidly transition to renewable energy sources, including biofuels, biogas, hydrogen, synthetic fuels and renewable electricity.[2] Policies to scale up renewable fuels include biofuel blending mandates and incentives for alternative powertrains that would support the use of renewable electricity and fuels. Some renewable fuels – such as liquid biofuels, synthetic fuels and upgraded biomethane – can be used in conventional internal combustion engines with small adjustments. Railways are already significantly electrified, allowing for a quick uptake of renewables. Other sub-sectors require changes in vehicle technology, such as battery electric and fuel cell electric vehicles (*see Section 4.2 Vehicle Technologies*).

Despite the rapid increase in electric vehicles and renewable power globally, as well as steady increases in biofuels, fossil fuels continued to account for nearly all (96%) of the energy used in transport in 2021 – a share that has barely changed over the past decade, due mainly to rising transport demand.[3] Electric vehicle targets do not automatically lead to the uptake of renewable energy, unless they are coupled with specific mandates. Electric vehicles accounted for around 1% of vehicles globally in 2022, while renewable energy supplied just over one-quarter of global electricity demand.[4] Sustainable aviation fuel (SAF) accounted for less than 0.1% of all aviation fuels consumed in 2022.[5]

These trends underscore the importance of prioritising measures to reduce overall transport demand and to shift to more sustainable modes, which can lead to greater emission reduction and broader sustainability benefits; it is also critical that the electricity used for electric vehicles is generated from renewable sources.[6]

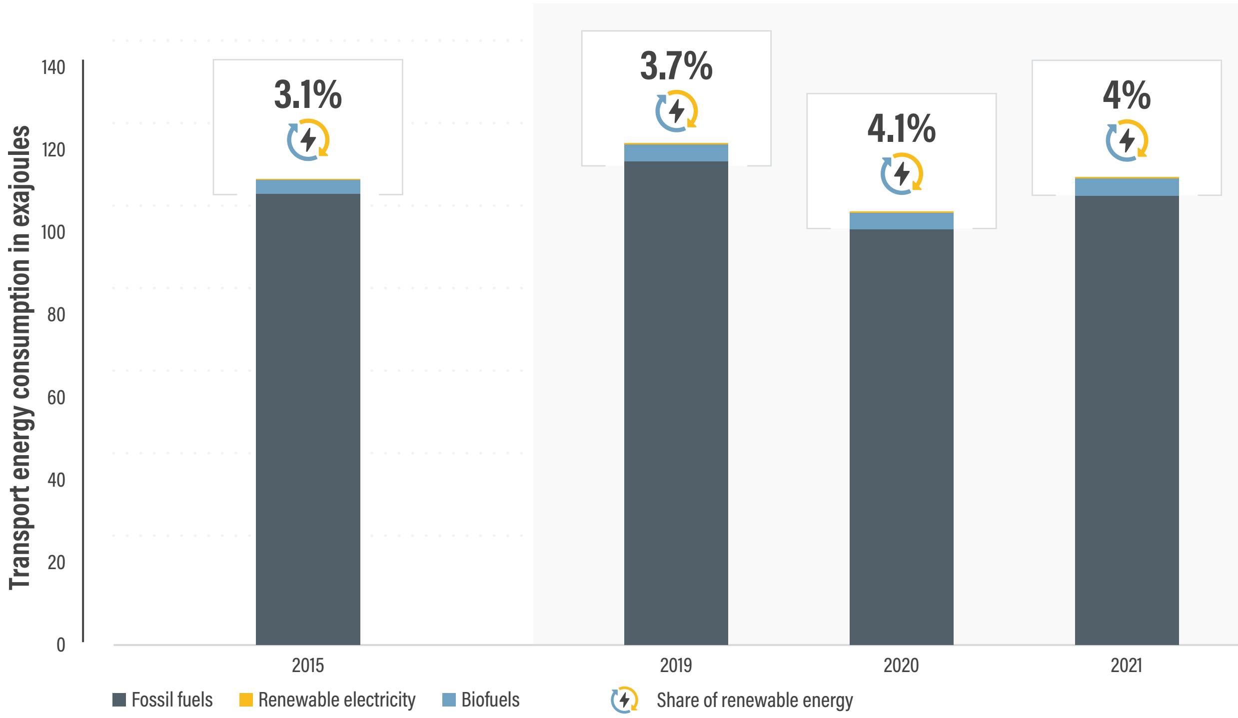
Demand trends

Several key trends, some of them contradictory, are driving greater energy consumption in transport. On the one hand, energy demand has declined due to the continuous increase in motor and vehicle efficiency and to greater use of electric vehicles (*see Section 4.2 Vehicle Technologies*). At the same time, however, energy demand has increased as both vehicle size and mass have grown (especially with the rising popularity of sport utility vehicles, SUVs), and as passenger and freight transport activity has risen overall (*see Section 1.1 Transport in Support of 1.5°C and the SDGs*).

The net growth in energy demand highlights the need to enhance efforts to rapidly improve vehicle efficiency, including by reducing vehicle weight and shifting to renewable energy sources to decarbonise the transport sector. In line with the Paris Agreement, energy demand must peak soon and then decrease rapidly. **An analysis of 810 scenarios developed by the Intergovernmental Panel on Climate Change concluded that to limit global warming even to 2 degrees Celsius (°C), transport energy consumption would need to peak between 2030 and 2035 and then decrease.**[7] **Scenarios compatible with a 1.5°C scenario would require earlier peaking and steeper reductions in energy use from the sector.**[8]

FIGURE 1. Energy consumption in transport, by energy source, 2015, 2019 to 2021

Source: See endnote 11 for this section.



In 2021, the growth in transport energy use rebounded somewhat (although it did not yet return to 2019 levels), indicating that the decline in 2020 was related to the COVID-19 pandemic and not to policy action in the sector.[9] Fossil fuels continued to dominate the sector, supplying 96% of transport energy consumption in 2020 and 2021, whereas biofuels supplied 3.7% and renewable electricity 0.35%.[10] Due mainly to the overall increase in transport demand, the share of renewables in transport remained low at 4% in 2021, up just 0.9 percentage points from 2015 (see Figure 1).[11]

The Russian Federation's invasion of Ukraine in February 2022 led to fuel price spikes in the transport sector, underscoring the need to decouple transport from fossil fuel dependency.[12] **Towards the end of 2022, global cost inflation settled in the range of 5-10%.**[13] Global oil demand and production remained relatively stable during the year, and the price of oil and subsequently transport fuels returned to mid-2021 levels by the end of 2022.[14] In some countries, pre-tax fuel prices for end users were twice as high in June 2022 as in July 2021.[15] The conflict also shifted trade for Russian oil from Europe and North America to India, China, and Türkiye, leading to a drop in container activity; however, lower trade volumes in bunker fuels were partly offset by longer transport routes (*see Section 3.8 Shipping*).[16]

Improvements in engine technologies, the introduction of hybrid powertrains and greater use of electric vehicles led to an 8.2% increase in the energy efficiency of cars and vans between 2015 and 2021.[17] The average specific fuel consumption (fuel use per 100 kilometres) has been declining (see Figure 2).[18] These improvements have been slowed by a trend towards increasing vehicle size and weight.[19] **In particular, the increased popularity of SUVs and trucks poses a huge challenge to reducing energy consumption and emissions in the sector.**[20] (*See Section 3.6 Road Transport and Section 4.2 Vehicle Technologies.*)

In road transport, direct use of electricity is most efficient from an energy perspective, where this is technically and logistically feasible. For road vehicles, the future renewable electricity demand will depend greatly on the vehicle propulsion technology used (see Table 1).[21] Battery electric vehicles are at least twice as efficient in terms of energy needed than fuel cell electric vehicles.[22] (*See also Section 4.2 Vehicle Technologies.*)

The share of diesel among all oil products used in road transport increased from 39.1% to 45.5% between 2000 and 2020 (see Figure 3).[23] **This trend is driven largely by rising demand for freight transport, which is mostly diesel-powered.** If fossil fuel-powered road freight continued, this

FIGURE 2. Specific fuel consumption of cars and vans versus sales shares of electric cars and sport utility vehicles, 2015-2021

Source: See endnote 18 for this section.

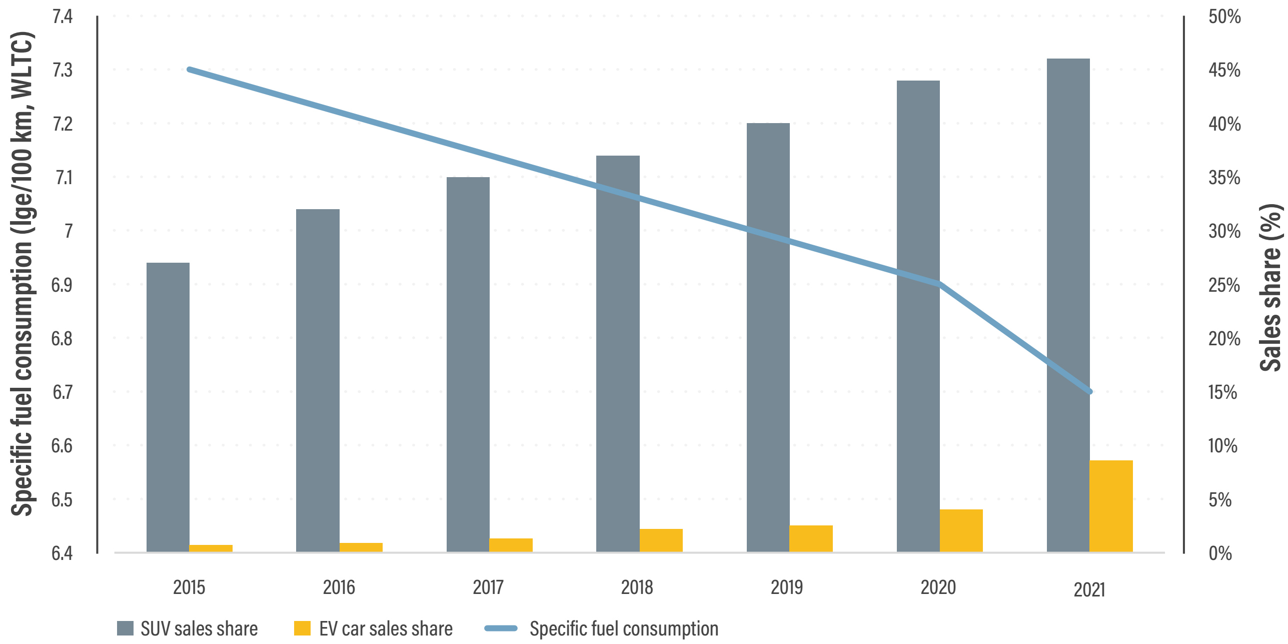


TABLE 1. Electricity requirements of different vehicle propulsion technologies

Source: See endnote 21 for this section.

Propulsion technology	Energy to generate 1 megajoule (MJ) of traction power
Battery electric vehicles	1.7 MJ
Fuel cell electric vehicles using liquid hydrogen	4.6 MJ
Synthetic fuels based on renewable electricity	7.7 MJ

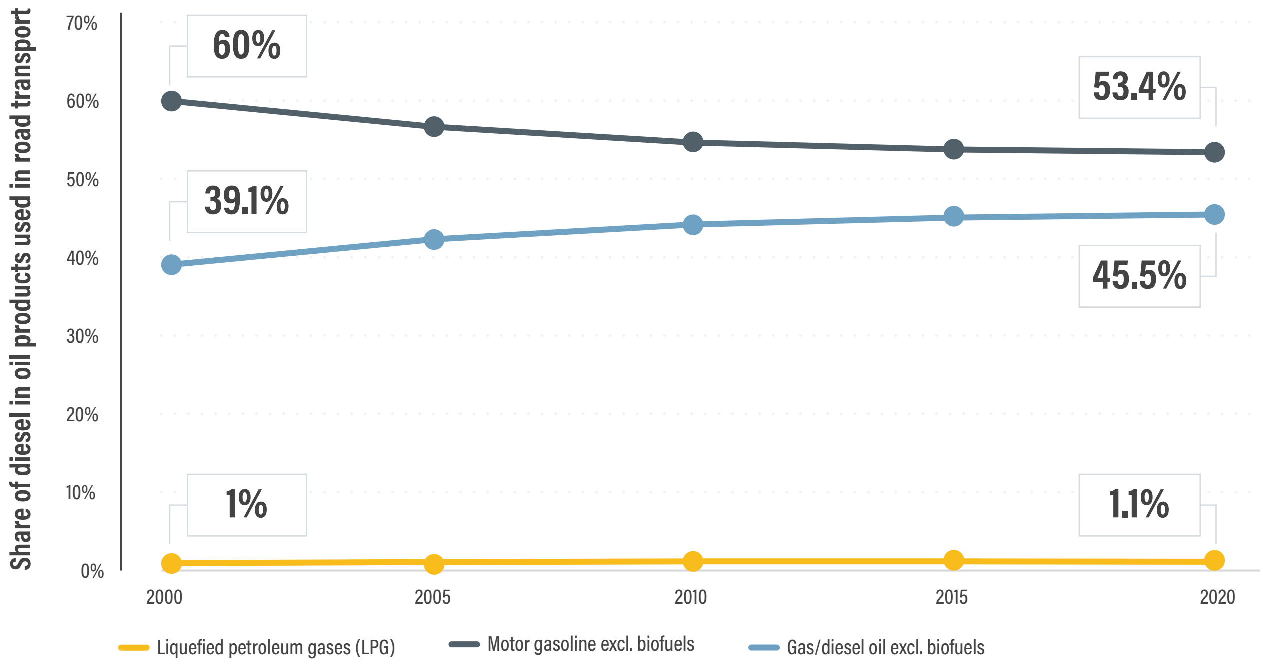
will influence the future demand for biofuels. Meanwhile, in the European Union (EU), the share of new passenger cars that run on diesel fell from 27.9% in 2020 to 19.6% in 2021.[24]

The share of natural gas used in transport increased from 3.6% to 4.5% between 2015 and 2021.[25] Natural gas consumption for trucks and buses remained stable over this period.[26] However, the number of passenger vehicle fleets running on compressed natural gas (CNG) has increased (especially in India, which has the world's largest CNG vehicle fleet), due to the rapid expansion of fuelling infrastructure and to incentive programmes for CNG vehicle purchases and retrofits.[27]

Biofuels are the largest renewable energy source in transport, accounting for 3.7% of the sector's energy consumption in 2021, up 0.8 percentage points since 2015.[28] The main policies supporting biofuels are blending mandates set by countries.[29] Biofuel growth is driven mainly

FIGURE 3. Shares of oil products used in road transport, by fuel type, 2000-2020

Source: See endnote 23 for this section.



by increased use of biodiesel, particularly fatty acid methyl ester (FAME), the dominant biodiesel type, which grew 52% between 2015 and 2021.[30] Production volumes of advanced renewable diesel in the form of hydrogenated vegetable oil (HVO) and hydroprocessed esters and fatty acids (HEFA) remain low but have grown the fastest among all biofuels, up 160% between 2015 and 2021 (see Figure 4).[31]

Whereas ethanol production fell during the COVID-19 pandemic as overall passenger transport declined, biodiesel growth continued almost unhampered, since freight activity was much less affected, with activity levels (in tonne-kilometres) remaining almost constant. In addition, an increasing number of companies (for example, in the United Kingdom), relied on **biogas** for road freight, although at a much smaller scale.[32]

Hydrogen can play a role whenever direct electrification is impossible.[33] **Hydrogen is considered plausible for road transport (for use in heavy-duty vehicles for long distances) and for aviation and shipping.**[34] Although fuel cell electric vehicles are less efficient than battery electric vehicles, they could be an option for reducing emissions from heavy-duty vehicles in the medium term.[35] However, most fuel cell vehicles (82%) were light-duty vehicles as of 2021.[36] In addition, less than 1% of global hydrogen production that year was low emission (so-called green or renewable hydrogen), while the majority was sourced from fossil fuels (grey hydrogen).[37] As of 2020, green hydrogen was at least three times more expensive to produce than grey hydrogen.[38]

Despite the immense growth in electric vehicles over the last decade, electricity demand in road transport is still low, with electric vehicles accounting for around 1% of vehicles globally in 2022 (*see Section 4.2 Vehicle Technologies*).[39] **Electric vehicles represented only 0.14% of total global electricity consumption in 2020** (see Figure 5).[40] However, demand for electricity for road vehicles increased 730% between 2015 and 2021, with most of this growth in China.[41]

Electrification is most prominent in rail transport, accounting for 45% of the energy consumed by rail in 2021.[42] Together with the small share of biodiesel used in rail transport, this resulted in a renewable energy share for rail in 2021 of 12.2%, the highest in the transport sector.[43] In aviation, the use of direct electric propulsion is so far limited to smaller aircraft and shorter distances.[44] In shipping, electrification is used only for shorter distances (such as in ferries and small vessels) or in diesel-electricity hybrid systems (*see Section 3.8 Shipping*).[45]

Fossil fuels continue to account for the majority of electricity generation in the power sector, and thus for the majority of the electricity supplied for electric vehicles.[46] The share

FIGURE 4. Biofuel production, by type, 2015-2021

Source: See endnote 31 for this section.

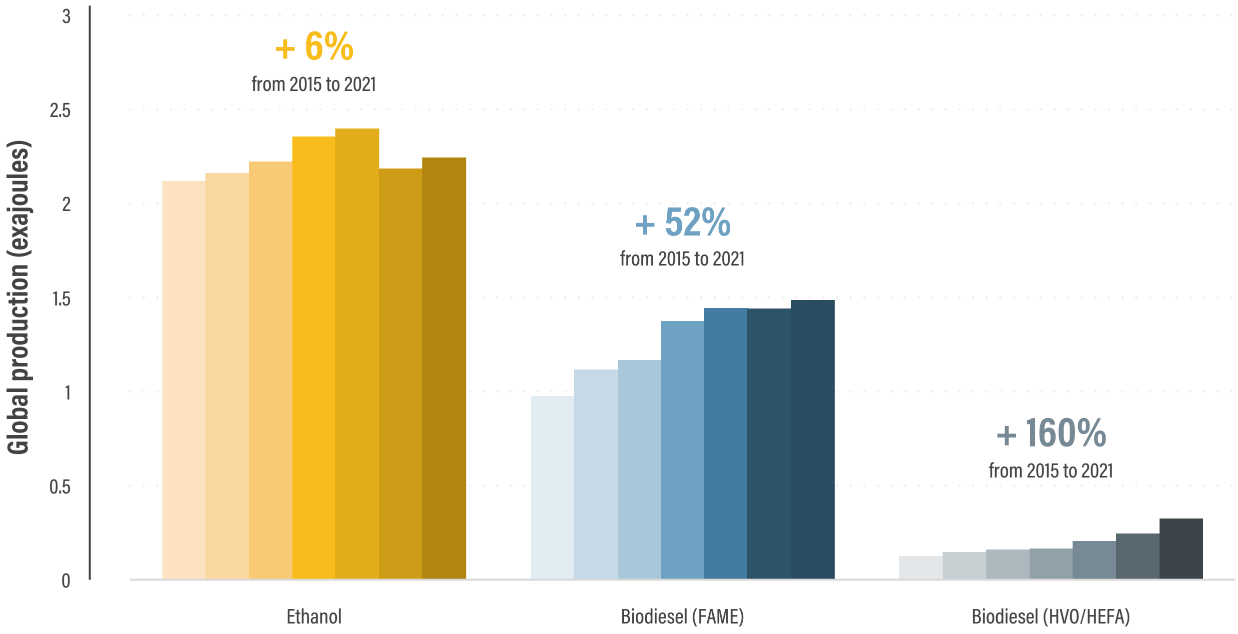
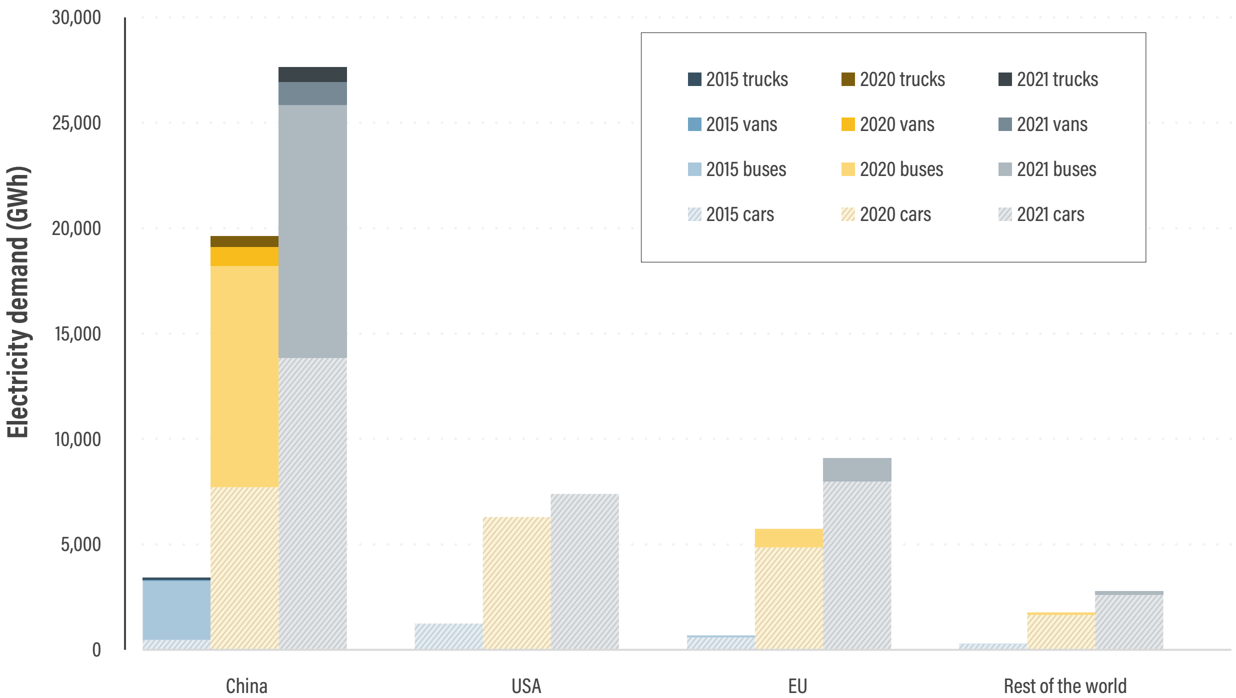


FIGURE 5. Electricity demand from electric vehicles in selected countries/regions, by vehicle type, 2015, 2020 and 2021

Source: See endnote 40 for this section.



of renewables in total global electricity generation was an estimated 28% in 2021, up just 5 percentage points from 2015.[47] However, the share of renewables in global power generation capacity *additions* has increased rapidly since 2010, reaching 83% by 2020.[48] Despite such rapid increases in capacity, the overall growth in electricity demand globally has slowed potential gains in the share of renewables.

More than 450,000 commercial flights used sustainable aviation fuel[i] (SAF) in 2022, with SAF production increasing 200% compared to 2021.[49] However, SAF still accounted for only 0.1% of all consumed aviation fuel as of 2022.[50] SAF is currently blended with fossil fuel at rates of between 5% and 50%, but the first flight using 100% SAF took off in January 2023, raising hopes of increasing use rates in the future.[51] By the end of 2022, 60 airports, mainly in Europe and the United States, provided continuous supply of SAF blends, up from 46 in 2020, and 30 more airports provided batch deliveries, up from 23 in 2020.[52] (*See Section 3.7 Aviation.*)

i Produced from bioenergy, municipal waste, or synthetically through carbon captured from the air.

Emission trends

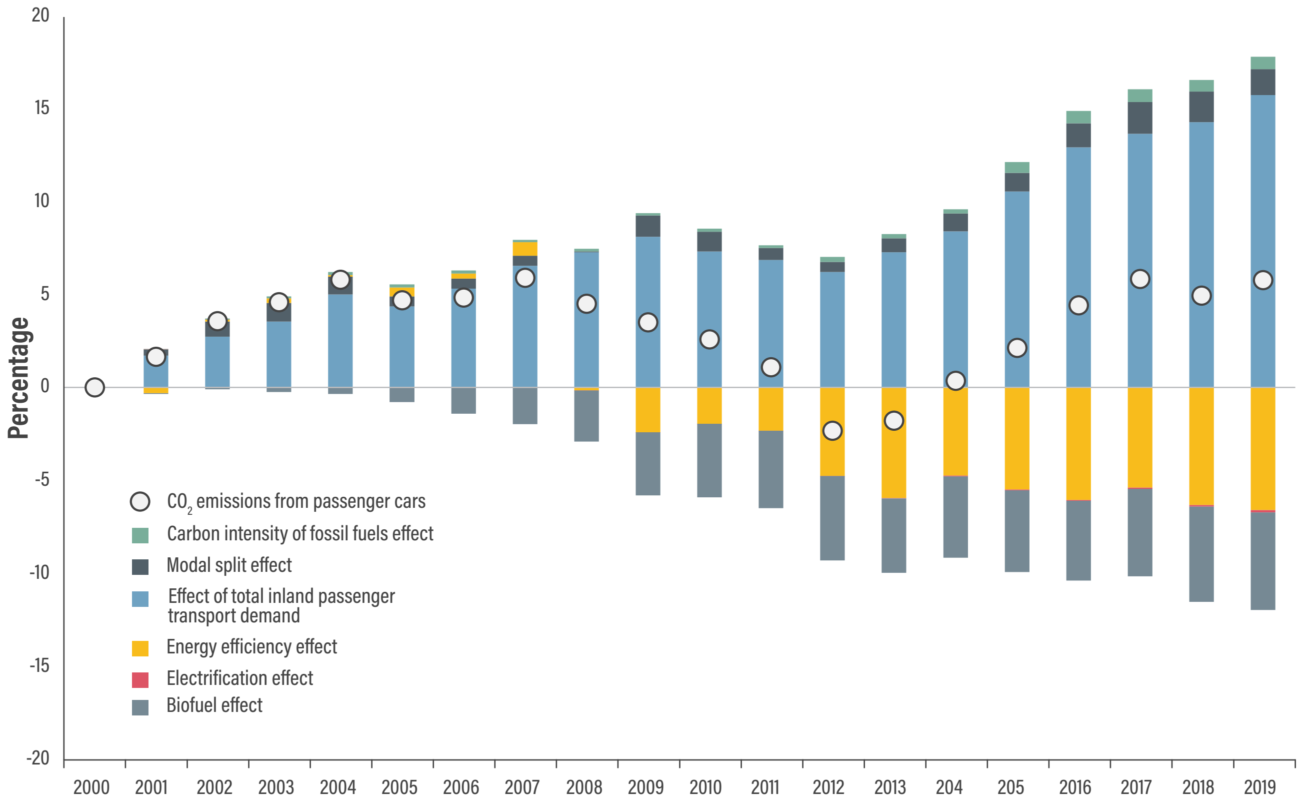
Carbon dioxide (CO_2) emissions from road transport increased steadily between 2000 and 2020 (*see Section 3.6 Road Transport*).[53] Even regions where emission standards were increasingly strict saw growth due to rising transport demand. In the EU, emissions from passenger cars increased 5.8% between 2000 and 2019, despite a 6% decline in energy consumption per passenger-kilometre.[54] The use of biofuels dampened emission increases during this period, as did energy efficiency standards, but electrification did not play a significant role in decarbonising passenger cars in the EU up to 2019 (see Figure 6).[55]

Energy efficiency improvements and the use of renewable energy sources, mostly biofuels, helped reduce emissions from the transport sector. However, these savings continued to be outweighed by rising emissions from the overall growth in transport demand and from the modal shift towards higher-emitting forms of transport, leading to a net increase in emissions from the sector.

The required shift to renewable energy in transport will have negative effects on employment in regions that are highly dependent on fossil fuels. Policies aimed at fostering the decarbonisation of transport will need to ensure an equitable just transition towards more sustainable jobs.[56]

FIGURE 6. Evolution of CO_2eq emissions from passenger cars in the EU-27, by contributing factor, 2000-2019

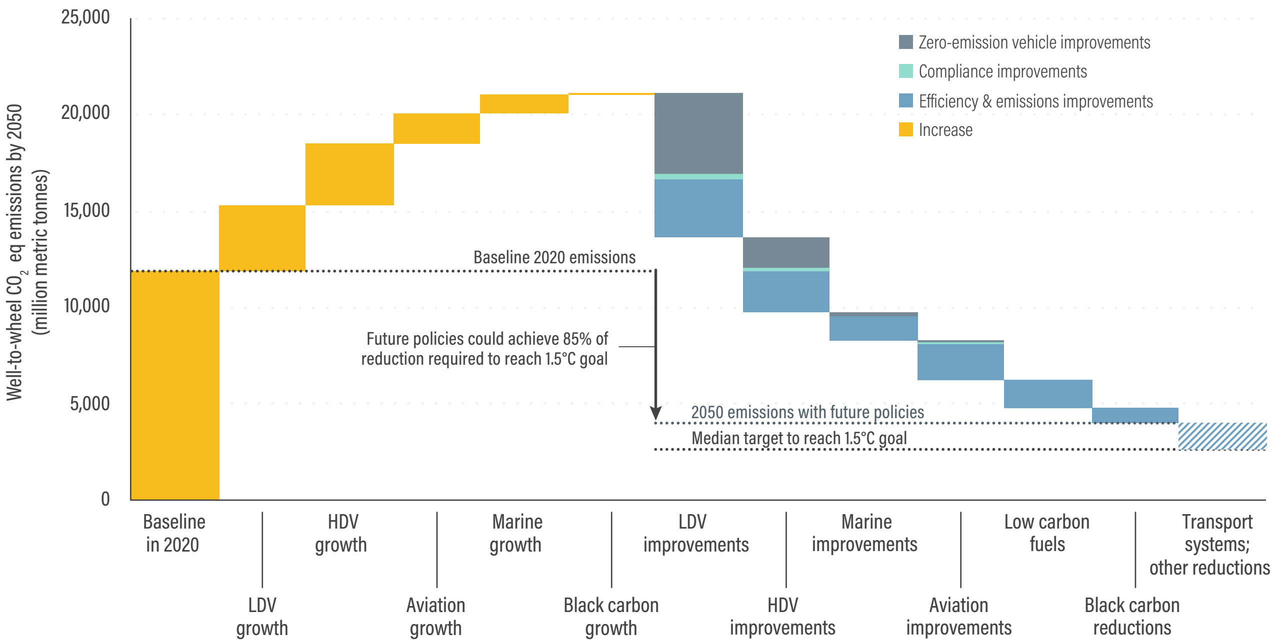
Source: See endnote 56 for this section.



Note: Emission data are measured in CO_2 equivalent emissions and shown as a percentage change compared to the year 2000.

FIGURE 7. Baseline emissions from transport in 2020, and the mitigation potentials from different sectoral activities to 2050

Source: See endnote 62 for this section.



Note: Figure does not show potential reductions from "Avoid" and "Shift" measures.
HDV = heavy-duty vehicle; LDV = light-duty vehicle.

Globally, this shift is expected to result in a net gain in jobs.[57] It is crucial to find tailored solutions that mitigate negative developments and create a more equitable and sustainable system for all stakeholders.[58] According to a 2022 report, the top five countries leading the way on measures to achieve a just transition were Costa Rica, Portugal, Sweden, Argentina, and Spain, while China, Brazil, India, the United States and Europe (as a region) led in renewable energy jobs.[59]

An "ambitious yet feasible" scenario from the International Council on Clean Transportation (ICCT) projects that the energy efficiency of light-duty vehicles will improve 0.75% annually between 2030 and 2050.[60] In the future, zero-emission vehicles are projected to play a major role in emission reductions, especially for road transport. Widespread electrification with renewable sources also offers high potential for emission reductions, and must counteract the expected growth in emissions from rising transport activity and the use of heavier vehicles (see Figure 7).[61]

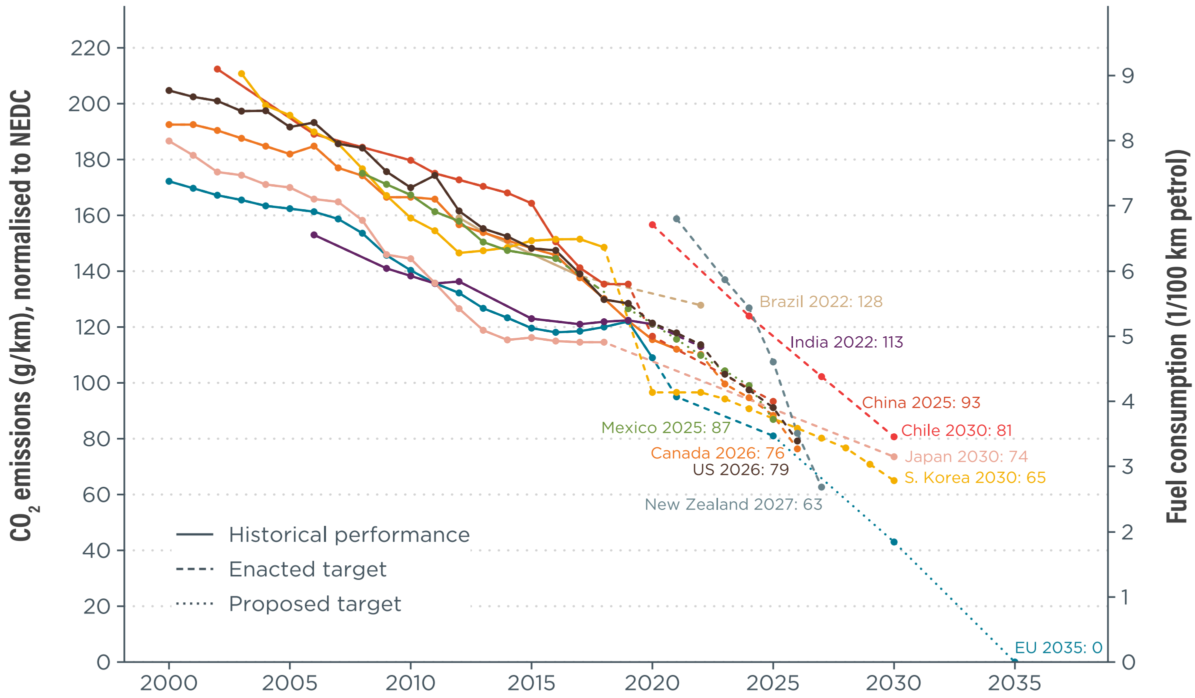
Energy efficiency plays a major role in decarbonising the maritime and aviation sectors under the ICCT's "ambitious yet feasible" scenario. The scenario assumes an improvement in ship efficiency of 70% by 2040, with only 17% of energy demand being met by zero-emission vessels.[62] In aviation, emissions are projected to decrease 40% between 2020 and 2050, with only 10% of liquid fuels being replaced by electrification.[63]

Policy developments

Mandatory standards for energy efficiency and for greenhouse gas emissions have proven to be effective instruments to drive efficiency and the shift to zero-emission vehicles. At least 11 countries plus the EU-27 – covering more than 80% of global passenger car sales – have established or enacted fuel efficiency or greenhouse gas emission standards for passenger cars and light trucks; some countries have proposed strengthening their standards, and at least one new country (Malaysia) has proposed enacting

FIGURE 8. Equivalent passenger car CO_2 emissions and fuel consumption in countries with mandatory vehicle efficiency or emissions standards, 2000-2035

Source: See endnote 66 for this section.



Note: Differences in the test procedures across standards are converted to the New European Driving Cycle (NEDC), a testing method to check fuel economy and emissions. Switzerland and the United Kingdom have adopted EU greenhouse gas emission standards and are included under "EU" in the graph.

mandatory standards.[64] Countries where such standards have been implemented have seen significant reductions in both emissions and fuel consumption (see Figure 8).[65]

- Chile adopted new vehicle efficiency standards under its energy efficiency law, which will come into effect in 2024 for light-duty vehicles and 2026 for medium-duty vehicles, progressing from 18.8 kilometres per litre in 2024 to 28.9 kilometres per litre by 2030 for light-duty vehicles.[66]
- The United States revised its fuel economy standards in 2022, with the new standards aimed at increasing fuel efficiency 8% annually for model years 2024-2025 and 10% annually for model year 2026.[67]
- As part of its Fit for 55 package, the EU adopted higher fleet-wide CO_2 emission reduction targets for new passenger cars and vans, raising reductions to 55% for cars and 50% for vans by 2030, and 100% for both by 2035, effectively banning fossil fuels.[68]
- Malaysia issued a voluntary standard in 2021 for energy-efficient vehicle certificates – including vehicle labelling – and started a public consultation process in 2022 for mandatory greenhouse gas emission standards.[69]

An increasing number of countries – mostly with limited or no domestic vehicle manufacturing – have established vehicle standards or other instruments to enhance the efficiency of imported vehicles. By mid-2020, 67 countries had age restrictions on the import of used vehicles, which influence the fuel efficiency.[70]

- In 2023, New Zealand began operating a Clean Car Standard system that grants importers CO_2 credits for vehicles that have fewer emissions than the individual vehicle target, and imposes charges for vehicles that have higher emissions.[71] The scheme applies to new and used cars and light commercial vehicles; targets are set annually up to 2027, and rates for exceeding the target will increase in 2025.[72]
- In 2020, the 15 member states of the Economic Commission of West African States (ECOWAS) adopted age limits of 5 years for imports of light-duty vehicles and 10 years for heavy-duty

vehicles; members have 10 years to implement the restrictions under the region's new fuel economy roadmap.[73]

- In January 2023, Kenya started enforcing its import bans for motor vehicles older than eight years and for trucks up to 30 tonnes that are older than three years.[74]
- Uganda imposed a ban on the import of motor vehicles older than nine years as of 1 July 2022.[75]
- After the end of Brazil's Invar Auto programme in 2017, which provided tax credits for meeting corporate average vehicle efficiency targets, the country set an efficiency improvement target of 11% over 2017 levels starting in 2022 under its Rota 2030 scheme.[76]

Fuel economy and greenhouse gas emission standards for heavy-duty vehicles are an important instrument to decarbonise the freight sector, particularly given the challenges in finding alternative fuels and propulsion systems for heavy-duty trucks. **In 2022, more than 70% of trucks sold were covered by fuel economy or vehicle efficiency regulations, although only seven countries or regions had such standards** (Canada, China, the EU, India, Japan, the United Kingdom and the United States).[77]

- In 2023, the EU proposed enhanced standards for 2030 that would raise the efficiency improvement target to 45% up from the current 30% and reduce emissions 90% by 2040.[78]
- Chile's Energy Efficiency Law introduces the first standards for medium- and heavy-duty vehicles, which for medium-duty vehicles would be defined in 2024 and take effect in 2026 (and for heavy-duty vehicles in 2026 and 2028, respectively).[79]
- New Zealand adopted a new procurement requirement in 2022 that requires all public transport buses purchased starting in January 2025 to be zero emissions.[80]
- In 2021, 15 countries and regions endorsed the Global Memorandum of Understanding on Zero-Emission Medium and Heavy-Duty Vehicles, committing to 100% zero-emission new truck and bus sales by 2040; as of February 2023, the measure had a total of 27 endorsees including manufacturers, fleet owners, utilities and sub-national entities.[81]
- California (USA) enacted in 2020 the Advanced Clean Trucks regulation, the first regulation worldwide requiring manufacturers to increase the sales share of zero-emission trucks. By 2035, the rule requires a zero-emission share of 40% for tractor trucks (class 7-8), 75% for rigid trucks (class 4-8) and 55% for pick-up trucks and vans (class 2b-3).[82]

Many countries have adopted vehicle labelling schemes to help consumers make informed choices by better understanding the life-cycle costs of vehicles. Several other policies influence the energy efficiency of vehicles, with vehicle taxation often used to steer consumers towards more efficient vehicles.

- In 2022, Viet Nam extended its vehicle labelling scheme to include externally charged hybrid and fully electric vehicles.[83]
- Thailand is adapting its labelling to include watts-per-kilometre for electric vehicles; labelling is particularly relevant in the country because the information is directly linked to vehicle excise tax.[84]
- New Zealand launched an updated vehicle labelling scheme in April 2022 that includes CO_2 emissions and Clean Car Discount eligibility.[85]
- In 2021, Indonesia reformed its vehicle tax structure to include fuel consumption and emission levels.[86]

Biofuel blending mandates remain the most popular measure for increasing renewable energy in transport, with at least 56 countries and the EU having established some form of obligation by the end of 2022.[87] Biofuels policies are driven and restricted by the availability of feedstocks, cost and resulting demand. Countries with abundant feedstocks are more likely to implement blending mandates and generally support biofuel production infrastructure. Requirements regarding the sustainability of biofuels and life-cycle greenhouse gas emissions including land use vary across countries. Several changes to existing mandates emerged in 2021, many in direct response to rising fuel prices:

- Canada replaced its Renewable Fuels Regulations with Clean Fuels Regulations, which take a life-cycle approach and require suppliers to reduce the carbon intensity of diesel and petrol sold in the country, starting in 2023.[88]
- The United Kingdom introduced the mandatory provision of E10 (10% ethanol blend) petrol as the standard in petrol stations, although E5 blends will remain available.[89]
- India released its 2025 ethanol roadmap, which would move up by five years the country's blending mandate for 20% ethanol, to 2025. The roadmap places a renewed focus on food-based feedstocks, despite past challenges in meeting ethanol blend rates, in a departure from the Ethanol Blended Program laid out under the National Policy on Biofuels, which prioritised second-generation feedstocks.[90]
- Argentina lowered its biodiesel blending mandate from 10% to 5% in June 2021 to control rising fuel prices and split its 12% ethanol blending requirement to 6% from sugar cane and 6% from corn.[91] In June 2022, the mandate was raised to 7.5% to increase supply, and in October the government launched a Biofuel Commission, which calls for a 15% ethanol blend mandate and a 1% blend mandate for SAF.[92]
- In 2021, Brazil cut its biodiesel blending mandate from 13% to 10% to counter rising costs; however, government data suggest that blending could return to 15% in March 2023.[93] Still, the country's RenovaBio programme remains the world's largest programme supporting biofuels.[94] In 2023, the

programme updated its mandatory emission reduction targets, while the federal government published guidelines for the implementation of a carbon credit market among biofuels producers and importers.[95]

- Finland temporarily reduced its biofuel blending obligations from 19.5% to 12% for 2022 and from 21% to 13.5% for 2023, in an effort to reduce end-user fuel prices.[96] To compensate for the additional emissions, the government plans to increase its blending obligation for 2030 from 30% to 34%.[97]
- Malaysia pushed the roll-out of its biodiesel blend mandate from 2020 (when it was delayed by the pandemic) to early 2022.[98]

Changes to existing biofuel mandates in 2022 included the following:

- Colombia reduced its ethanol blending mandate from 10% to 6%, while Thailand reduced its biodiesel mandate from 7% to 5%.[99]
- The Czech Republic, Latvia, Peru and Zimbabwe temporarily suspended their biofuel blending mandates.[100] At the sub-national level, New Mexico (USA) also suspended its mandate.[101]
- The Republic of Korea increased its biofuels mandate from 3% to 3.5%, with further increases to occur in 2024 (4%) and 2030 (8%).[102]
- Poland increased its biofuels mandate from 4.95% to 6.2%.[103]

New biofuel policies under development as of 2022 included:

- New Zealand is set to introduce targets to reduce the emission intensity of fuels 2.4% by 2024 (and 9% by 2035) through its Sustainable Biofuels Obligation Bill, which had its first reading in Parliament in November 2022.[104]
- Indonesia was road-testing a 40% biodiesel blend that could lead to a higher ethanol blending mandate by 2025.[105]

As of the end of 2022, at least six countries mentioned biofuel blending in their updated Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement, with policy implementation yet to come.

- Blends mentioned in countries' NDCs include Eswatini (E10 by 2030), Guatemala (B10 by 2032), Lao People's Democratic Republic (10% of transport fuels by 2030), Malawi (E20 by 2040), Mali (5.4% biodiesel and 11% ethanol by 2030) and Vanuatu (B20 by 2030).[106]
- Other countries have set renewable energy targets for the sector in their NDCs, such as Dominica (100% by 2030) and the Republic of North Macedonia (10% by 2030).[107]

In aviation, some countries are considering biofuel blending mandates for sustainable aviation fuels. Additionally, the EU is revising its Emission Trading System (ETS) to apply the polluter pays principle by phasing out free allowances for the aviation sector by 2026.[108] As part of the Fit for 55 package agreed to in December 2022, the EU would include emissions from maritime transport in its ETS starting in 2024, and would create a separate ETS for buildings, road transport and fuels.[109]

- The EU's Fit for 55 package aims to establish an SAF blending mandate starting in 2025, with shares increasing up to 2050.[110]
- In 2022, the United Kingdom confirmed a SAF blending mandate from 2025 requiring at least 10% of jet fuel to be made from sustainable feedstocks by 2030.[111]

MODULE 4 4.2

AUTHORS:
Oliver Lah, Alvin Mejia and Kanya Pranawengkapti,
Urban Electric Mobility Initiative, Wuppertal Institute

CONTRIBUTOR:
Nikola Medimorec, *SLOCAT secretariat*

Vehicle Technologies

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Note: This section is focused on the electrification of transport, covering all transport modes. Major trends for specific modes are captured in other sections, including 3.3 Cycling, 3.5 Intercity Rail Transport, 3.7 National and International Aviation, 3.8 Shipping – Maritime and Inland Waterways, and 4.1 Transport Energy Sources.

Key findings

Demand trends

- Electric four-wheeled vehicles are the fastest growing sector of the clean energy industry. In 2022, global sales of electric cars (including battery electric vehicles and plug-in hybrid electric vehicles) increased 55% – exceeding 10 million units – and nearly every seventh car sold was electric.
- The global electric car fleet increased 154% between 2020 and 2022, maintaining five-year average growth of 53%. The global electric car stock totalled 26 million units in 2022, more than five times the number in 2018. However, electric vehicles still accounted for only around 1% of vehicles globally. In 2022, an estimated 70% of the fleet was battery electric vehicles, and 30% was plug-in hybrids.
- As of 2022, at least 209,000 electric vehicles were deployed in company fleets, around 40,000 more than at the end of 2020.
- Electric two-wheeled vehicles (i.e., electric-assist bikes, mopeds and non-speed-limited motorcycles) dwarf numbers of other electric vehicles, with a total of 275 million units globally in 2022. However, global sales of electric two- and three-wheeled vehicles fell 18% in 2022, from more than 11 million units in 2021 to 9.2 million units. Most sales were in Asia, with China accounting for around 84% of new electric two-wheeled vehicle registrations in 2022.
- The number of electric medium- and heavy-duty trucks increased 19% in 2022 to 322,000 vehicles. Sales of electric trucks increased from 40,000 units in 2021 to around 60,000 units in 2022, although this reflected just 1.2% of total truck sales.
- The global electric van stock grew 45% in 2022, to an estimated 948,000 vehicles, and the electric bus fleet grew 8% to 800,000 vehicles. Electric bus sales represent 4.5% of total new bus sales in 2022.
- Global sales of used electric vehicles have increased, with the European Union (EU), Japan and the Republic of Korea exporting more than 760,000 units between 2017 and 2020.
- Electric vehicle charging infrastructure grew 55% in 2022. An estimated 900,000 new publicly available chargers were installed worldwide during the year, bringing the cumulative total to 2.7 million.
- In 2022 – and for the first time since 2013 – average global prices for electric vehicle batteries rose 7% due to higher material and energy costs during production, a trend that could slow the global uptake of e-mobility solutions.
- Electric vehicle battery swapping systems have continued to grow globally. In 2021, the market was dominated by services catering to passenger electric vehicles, accounting for an estimated 57.5% of the total revenue and led by the increase in electric micro-mobility, such as e-scooters.
- A major driver of future demand for electric vehicles is lower fuel costs, which were at least a third those of diesel and petrol in 2022.

Emission trends

- Global energy consumption for electric mobility increased 22% in 2022, with more than half (59%) of the demand coming from electric cars, followed by electric buses (21%), motorcycles (12%) and trucks (8%). In total, these electric vehicle fleets consumed around 110 terawatt-hours of electricity in 2022.
- Fossil fuel dependency is a major issue in transport and needs to change quickly. Electricity is projected to become the dominant fuel in transport by the early 2040s.
- Aggressive emission reduction pathways aligned with the goal of keeping global warming below 1.5 degrees Celsius (°C) by 2050 feature a significant uptake of electric vehicles, with at least 80% of cars and small commercial vehicles being electric by 2050.
- Although the Russian Federation's invasion of Ukraine led to surging natural gas prices and greater demand for coal, the increased carbon dioxide (CO_2) emissions from coal have been curtailed by the more aggressive deployment of renewable energy technologies (such as solar photovoltaics and wind) and of electric vehicles.
- Overall, battery electric vehicles emit fewer life-cycle greenhouse gas emissions than fossil fuel-powered vehicles, especially when the vehicles are charged using low-carbon electricity.

Policy developments

- Electric vehicles are only one part of the broader transformation needed in transport and mobility systems worldwide to achieve both decarbonisation and sustainability goals, such as access to transport for all, safer roads, cleaner air and livable cities. This transformative change requires an integrated multi-modal, multi-level approach that addresses all aspects of the transport and mobility system.
- Electric vehicle uptake should be framed in a circular economy approach, including the end-of life recycling of batteries as well as the re-use and recovery of other materials (e.g., electronics, metals, minerals).
- More jurisdictions are setting targets for phasing out fossil-fuelled vehicles. As of April 2023, at least 41 countries or sub-national jurisdictions had set phase-out targets for vehicles with internal combustion engines, twice as many as in 2020.
- Many policies related to transport and climate change have highlighted the electrification of buses and/or the procurement of new e-buses, with at least 20 countries announcing such measures during 2020-2022.
- Some governments and other stakeholders have set concrete targets for electric vehicle charging infrastructure.
- Government subsidies for electric vehicles nearly doubled in 2021, approaching USD 30 billion globally. Other economic instruments used to support uptake include tax rebates, feebates and bonus-malus schemes, in which governments incentivise zero- and low-emission vehicles while discouraging high-emission vehicles.
- By the end of 2022, countries' climate strategies were highly favouring electric mobility over other types of actions to mitigate transport emissions.
- In 2021 and 2022, significant global initiatives were focused on the electrification of light-duty as well as medium- to heavy-duty vehicles, covering all major automobile markets and regions.
- Leading automakers are projected to spend an estimated USD 1.2 trillion to 2030 to deliver up to 54 million electric vehicles (and the necessary batteries), accounting for 50% of total vehicle production.
- There is a risk of an electric mobility divide between high-income countries and low- and middle-income countries, in the absence of electrification policies tailored at the economic and regional context.

Overview

Replacing the current fossil-fuelled road transport fleet with low-emission vehicles – powered by electrification, hydrogen, biofuels and e-fuels – is a key strategy towards decarbonisation of transport. Actively supporting the adoption of electric and other low-emission vehicles, along with the necessary enabling infrastructure, is a crucial step towards achieving a sustainable transport system. Managing the overall size and shape of the vehicle fleet goes hand in hand with efforts to manage mobility demand through shifts to sustainable, low carbon transport modes.

Minimising the carbon emissions from vehicle technologies is a key systemic change that is required in the mobility transition. Electric vehicles have zero emissions at the tailpipe and produce far fewer greenhouse gas emissions over their lifetimes than conventional petrol- or diesel-powered vehicles. The carbon footprint of electric vehicles will continue to shrink as they are increasingly powered by renewable electricity sources. In addition to reducing emissions, shifting to low-emission vehicles can improve local air quality, reduce dependence on fossil fuels and lower transport costs. These technologies also hold significant potential for economic development, especially in markets beyond traditional auto manufacturing countries.

However, the overall contribution of low-emission vehicles to climate change mitigation and sustainable development depends critically on their integration with other pillars of the system. Low-emission vehicles need to be fit-for-purpose, meaning that they must be both resource- and energy-efficient. This strengthens the case for electric micro-mobility (two- and three-wheelers and a more diverse set of four-wheelers, including two-seaters, small vans and trucks, and light electric freight vehicles) and points to the cost-effectiveness of more systemic approaches to transforming transport.[1] In recent years, many countries have shifted their approach from encouraging the uptake of electric vehicles towards setting phase-out targets for conventionally fuelled vehicles.

Vehicle electrification strategies should be seen in light of other options for reducing emissions from transport, such as “avoid, shift and improve” strategies. For passenger transport, a high-shift scenario to either electric vehicles or public transport alone would be insufficient to reduce emissions to levels required to avoid climate change.[2] Achieving a net zero emission pathway requires considering all available options to provide access to sustainable mobility for all, including vehicle technologies, modal choice and compact urban design. It is critical to adopt an integrated, multi-modal approach that addresses all aspects of the mobility system, that aligns with national and local policies, and that involves both public and private sector action.

Although low-emission vehicles are a crucial aspect of decarbonising the land transport sector, they are not a sufficient solution. A world with 2 billion low-emission cars would still be unsustainable due to increased traffic congestion, displacement of land for highways and parking, and destruction of ecosystems for mineral extraction.

As an energy end-use sector, transport is directly linked to Sustainable Development Goal (SDG) 7 (affordable and clean energy). Stakeholders can contribute to SDG 7 by increasing the share of renewables in the energy mix and by implementing measures to improve passenger/freight output per unit of energy input. Transport systems also impact SDG 9 (industry, innovation and infrastructure) and SDG 12 (responsible consumption and production), and they are impacted in part by measures taken by governments and industry to achieve these goals.[3]

Demand trends

Electric four-wheeled vehicles are the fastest growing sector of the clean energy industry.[4] **In 2022, global sales of electric cars (including battery electric vehicles and plug-in hybrid electric vehicles) increased 55% – exceeding 10 million units – and nearly every seventh car sold was electric.**[5] The share of electric cars in all car sales globally increased from 9% in 2021 to 14% in 2022.[6] Around 60% (6.2 million) of the electric cars sold in 2022 were in Asia, followed by 26% in Europe and 11% in North America (see Figure 1).[7]

- China accounted for 60% of the growth in electric car sales in 2021 and 2022, with the number of electric cars sold in the country in 2021 (3.2 million) exceeding the total number sold worldwide in 2020.[8]
- Electric vehicle sales in Europe grew more than 15% in 2022 (total sales of 2.3 million), while North America sold an additional 300,000 electric vehicles that year (total sales of 726,000).[9]
- Low-emission vehicle trends in other regions can be found in the respective regional overviews (*see Section 2.1 Africa, Section 2.4 Latin America and Caribbean*, and *Section 2.6 Oceania*).
- Overall, vehicle sales (of all types) slowed between 2020 and 2022, due in part to disruptions caused by the pandemic and by the Russian Federation's invasion of Ukraine.[10] The pandemic led to the disruption of supply chains, affecting the production and distribution of vehicles.[11] At the same time, visible improvements in urban air quality early in the pandemic paralleled greater demand for cleaner electric mobility.[12]

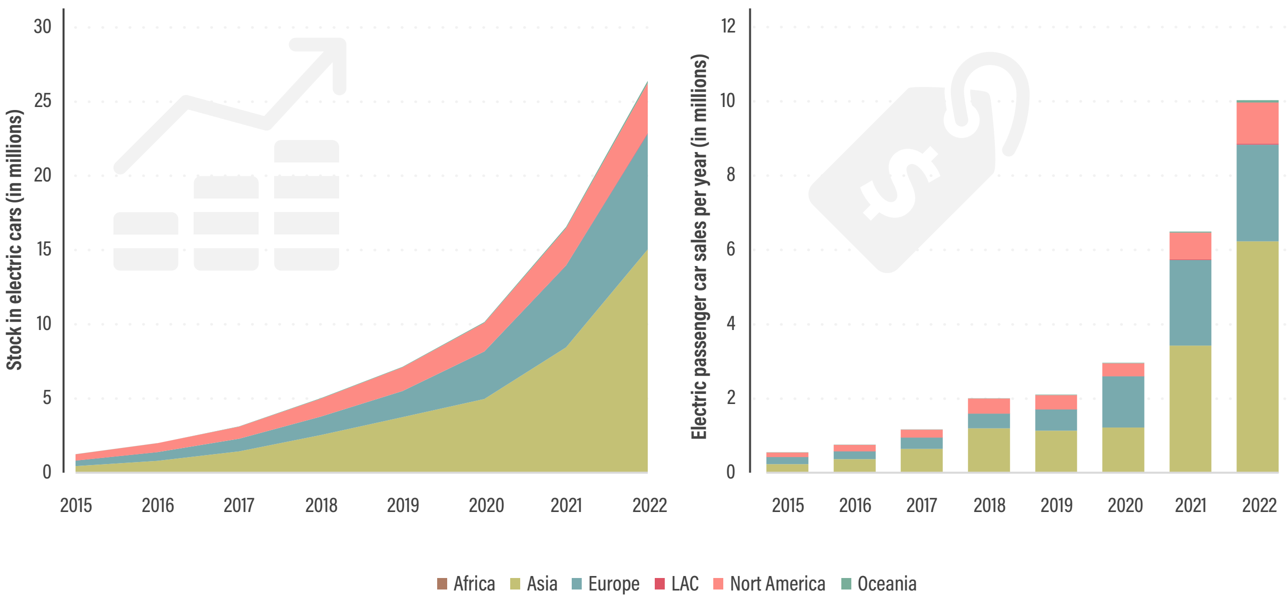
The global electric car fleet increased 154% between 2020 and 2022, maintaining five-year average growth of 53%.[13] **The global electric car stock totalled 26 million units in 2022, more than five times the number in 2018** (see Figure 1).[14] **However, electric vehicles still accounted for only around 1% of vehicles globally.**[15] **In 2022, an estimated 70% of the fleet was battery electric vehicles, and 30% was plug-in hybrids.**[16]

As of 2022, at least 209,000 electric cars were deployed in company fleets, around 40,000 more than at the end of 2020.[17] The company EV fleet is supported by nearly 21,000 charging units installed in more than 3,000 locations worldwide.[18] In Europe, six out of ten cars sold in 2020 were company vehicles, but 87% of them were fossil fuel-powered vehicles, pointing to the need to prioritize electrification of company fleets.[19]

Electric two-wheeled vehicles (i.e., electric-assist bikes, mopeds and non-speed-limited motorcycles) dwarf numbers of other electric vehicles, with a total of 275 million units globally in 2022.[20] **However, global sales of electric two- and three-wheeled vehicles fell 18% in 2022, from more than 11 million units in 2021 to 9.2 million units.**[21] The main reason for the drop was supply chain challenges in China related to the COVID-19 pandemic, which led to lower sales in the country's domestic market.[22]

FIGURE 1. Electric passenger car stock (left) and sales (right), 2015-2022

Source: See endnote 7 for this section.



- **Most sales were in Asia, with China accounting for around 84% of new electric two-wheeled vehicle registrations in 2022.**[23] Almost every second electric vehicle sold in China was an electric two-wheeler in 2022.[24]
- India added 300,000 electric two- and three-wheelers in 2021, Viet Nam added 230,000 units, and Europe added 87,000 units.[25] (*For more on electric-assist bikes, see Section 3.3 Cycling.)*

The number of electric medium- and heavy-duty trucks increased 19% in 2022 to 322,000 vehicles.[26] **Sales of electric trucks increased from 40,000 units in 2021 to around 60,000 units in 2022, although this reflected just 1.2% of total truck sales.**[27]

- In 2022, 95% of electric truck sales were in China, with most of the electric trucks having a gross vehicle weight of under 4.5 tonnes.[28]
- The number of electric truck models increased significantly as 220 new models were released in 2022, showing that truck electrification has become increasingly popular among vehicle manufacturers.[29]

The global electric van stock grew 45% in 2022, to an estimated 948,000 vehicles, and the electric bus fleet grew 8% to 800,000 vehicles.[30] **Electric bus sales represent 4.5% of total new bus sales in 2022.**[31]

- In 2021, the strongest growth in electric vans and light commercial vehicles was in the Republic of Korea, representing 12% of all van sales and increasing from 1,500 vehicles in 2019 to 28,000 vehicles in 2021.[32] China was home to 60% of the global van fleet in 2022.[33]
- China continues to dominate the electric bus and truck market, accounting for about 96% of the estimated global electric bus as well as the electric truck stock in 2022.[34]
- Battery-electric buses became the dominant type of bus sales in the EU in 2019. In Europe, more than 3,400 e-buses were delivered in 2022 – bringing the total operational stock to more than 11,600.[35] As of 2022, more than two thirds of new bus registrations in the EU were electric and a third of the total bus stock was electric.[36]
- In 2021, for the first time, at least three countries in Europe (France, Germany and the United Kingdom) registered more than 500 e-buses each.[37] The European Automobile Manufacturers' Association estimated that e-buses account for more than 6% of bus registrations in the EU as of 2021.[38]

Global sales of used electric vehicles have increased, with the European Union (EU), Japan and the Republic of Korea exporting more than 760,000 units between 2017 and 2020.[39] Although uptake of electric vehicles in many low- and middle-income countries has lagged, opportunities to transfer cleaner vehicle technologies have arisen through used vehicle markets.[40]

Electric vehicle charging infrastructure grew 55% in 2022.[41] **An estimated 900,000 new publicly available chargers were installed worldwide during the year, bringing the cumulative total to 2.7 million.**[42] Annual growth in charging infrastructure in 2022 exceeded pre-COVID-19 levels for 2015-2019, which were around 50%.[43] Most public chargers – just over two-thirds (67%) – were slow chargers in 2022.[44]

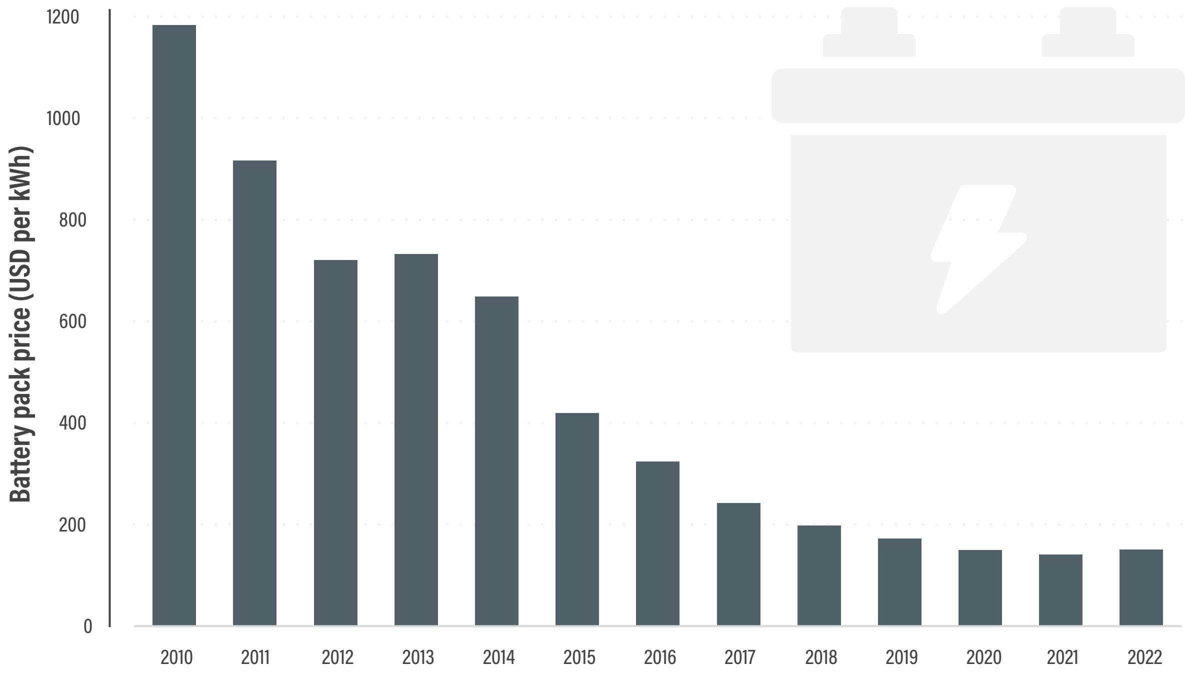
- China was home to roughly two-thirds (62%) of the world's public chargers in 2022, or more than 1.7 million.[45] The Republic of Korea – with 201,000 public chargers, or 7% of the global total – overtook the United States (with 130,000, or 5%) during the year.[46]
- By the end of 2022, Europe had 430,000 electric vehicle chargers, of which 73% were medium-speed alternating current chargers.[47]
- The Republic of Korea boasts the highest density of charging locations, with 75 locations per 100 kilometres of roadway in 2022, followed by the Netherlands with 22 locations and Norway with 13.[48]
- Fast-charger installations in China grew more than 61% in 2022 – reaching a total of 760,000 – driven by government subsidies and by rapid deployment by public utilities.[49]
- The ratio of electric vehicles to charging points remained relatively constant between 2015 and 2022, at fewer than 10 vehicles per charging point in China, the Republic of Korea and the Netherlands.[50]
- In the United States, where growth in the electric vehicle fleet has outpaced the installation of public charging stations, the ratio of electric vehicles to charge points was 24 to 1 in 2022.[51] In Europe, the ratio was around 12 to 1 by year's end.[52]

In 2022 – and for the first time since 2013 – average global prices for electric vehicle batteries rose 7% due to higher material and energy costs during production (see Figure 2)**, a trend that could slow the global uptake of e-mobility solutions.**[53] Battery price increases are expected to translate to overall increases in the price of electric vehicles, a deviation from the trajectory outlined in the previous edition of this report.

- The Russian Federation's invasion of Ukraine impacted the production and price of electric vehicles, particularly in Europe.[54] Both countries are primary sources of elements needed in electric vehicle production, such as high-grade nickel, palladium and neon.[55] The effects of the war – including economic sanctions, damage to infrastructure and displacement of workers in Ukraine's electric vehicle industry – have all impacted the industry.[56]
- Prices of lithium-ion battery packs increased 7% in 2022, due mainly to the rising costs for input metals such as lithium, nickel, cobalt and manganese.[57] This was a reversal of the

FIGURE 2. Battery price development, 2010-2022

Source: See endnote 53 for this section.



long-term trend from 2010 to 2021, when battery prices fell 88% as the industry adopted lower-cost chemistries such as lithium iron phosphate (LFP), which were 30% cheaper than nickel manganese cobalt (NMC) cells.[58]

- Some predict that battery pack prices will continue to rise until 2026, while others suggest a sustained price of around USD 151 per kilowatt-hour (kWh) to 2024, when more lithium production is expected to come online.[59] However, a meta-analysis predicts a decrease to USD 132 per kWh by 2030 and USD 71 per kWh by 2050.[60]
- For the electric vehicles sold in 2018, the estimated material demand was 11 kilotonnes of lithium, 11 kilotonnes of manganese, 15 kilotonnes of cobalt and 34 kilotonnes of nickel.[61] The demand for these materials could increase 25- to 30-fold until 2030.[62]

Electric vehicle battery swapping systems have continued to grow globally. In 2021, the market was dominated by services catering to passenger electric vehicles, accounting for an estimated 57.5% of the total revenue and led by the increase in electric micro-mobility, such as e-scooters.[63]

- As of 2023, the Chinese manufacturer Nio had installed 10 battery swapping stations across Europe, and it aims to have 120 stations in the region by the end of 2023.[64]
- Gogoro, which introduced a Smartscooter that integrates battery swapping systems, reported more than 450,000 users across some 2,200 swapping stations; in Chinese Taipei, the stations are estimated to be available every 500 metres.[65]
- In 2022, North America accounted for a quarter of the total revenue from the electric vehicle battery swapping market.[66]

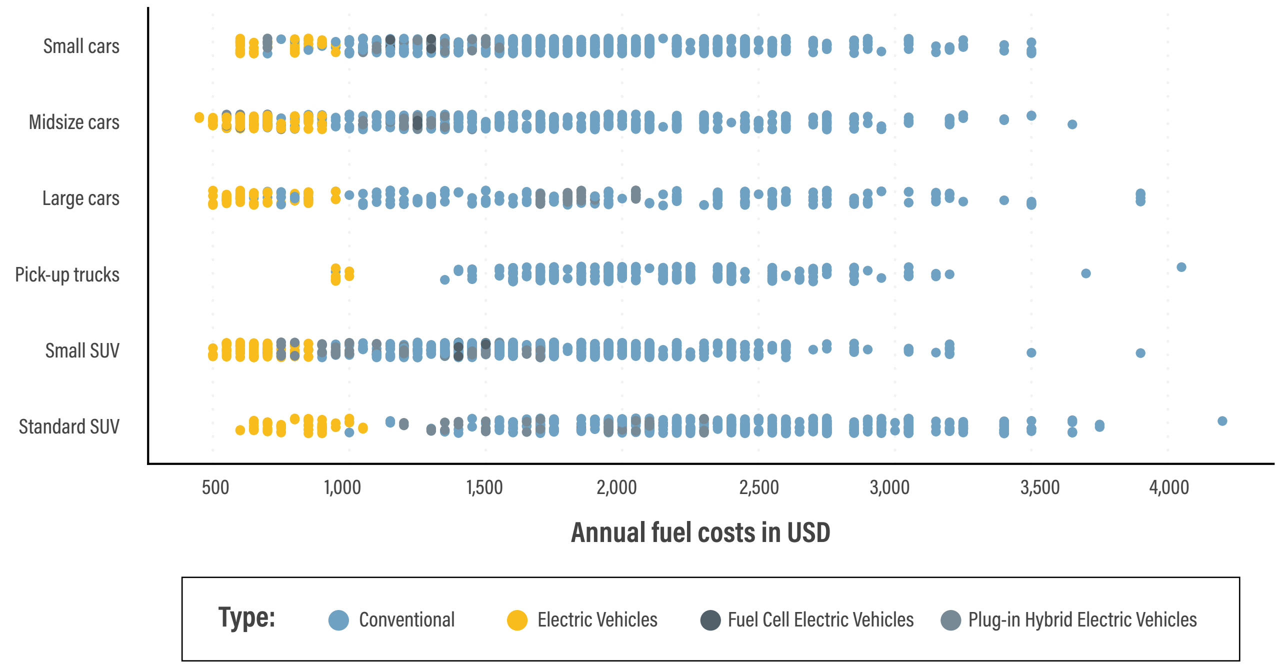
A major driver of future demand for electric vehicles is lower fuel costs, which were at least a third those of diesel and petrol in 2022.[67] Electric passenger cars released between 2021 to 2023 in the United States showed the lowest annual fuel costs per household among all fuel types (see Figure 3).[68] The average annual expenses for a conventional mid-size car were three times higher than for an electric car of the same size.[69]

Emission trends

Global energy consumption for electric mobility increased 22% in 2022, with more than half (59%) of the demand coming from electric cars, followed by electric buses (21%), motorcycles (12%) and trucks (8%).[70] **In total, these electric vehicle fleets consumed around 110 terawatt-hours of electricity in 2022.**[71] The emission benefits of electric vehicles can be maximised by charging the vehicles using renewable-

FIGURE 3. Annual fuel cost for vehicle types in the United States, based on 2021-2023 models

Source: See endnote 68 for this section.



based electricity.[72] This highlights the urgent need to integrate higher shares of renewable energy in the overall electricity mix.[73]

Fossil fuel dependency is a major issue in transport and needs to change quickly. Electricity is projected to become the dominant fuel in transport by the early 2040s.[74] Compared to other strategies to decarbonise transport, electrification of passenger vehicles (two- and four-wheelers) is "well underway" and is expected to advance exponentially.[75]

- In 2021, emissions from oil remained below pre-pandemic levels because global transport activity was limited.[76] As COVID-19 travel restrictions eased substantially in 2022, oil-related CO_2 emissions rose an estimated 180 million tonnes.[77]
- Among 13 transport targets – such as the development of public transport, cycling infrastructure, sustainable aviation fuels, etc. – only the two electrification targets (for electric light-duty vehicle sales and electric bus sales) are going in a promising direction, while all others are well off track.[78]

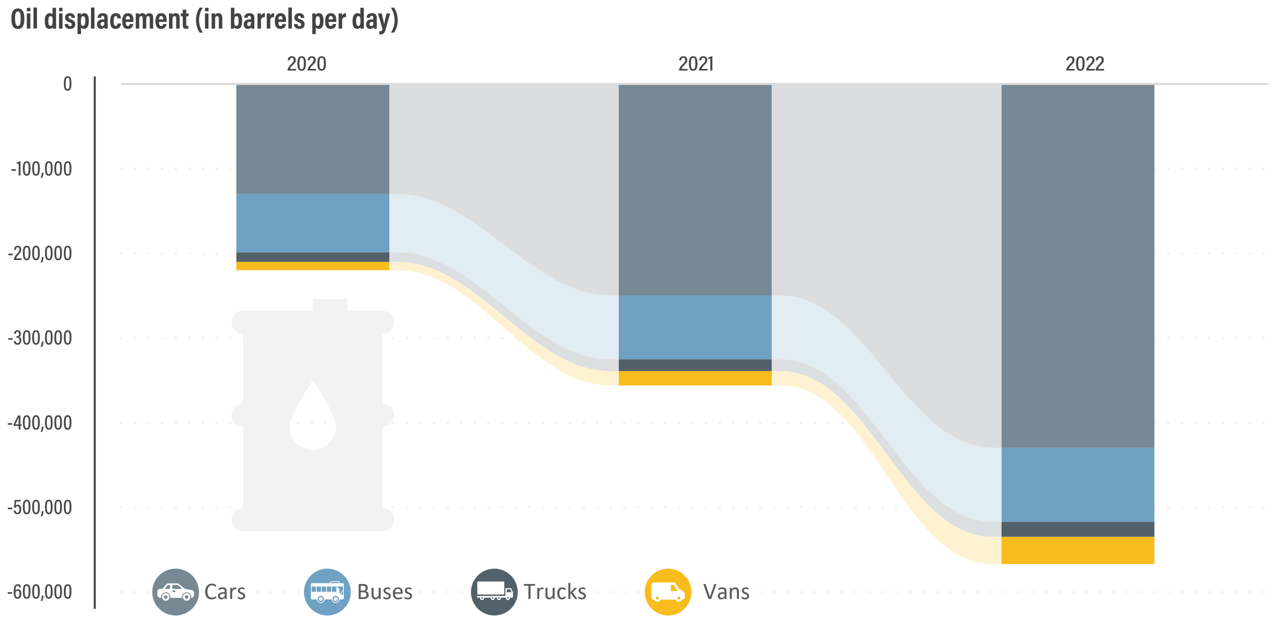
Aggressive emission reduction pathways aligned with the goal of keeping global warming below 1.5°C by 2050 feature a significant uptake of electric vehicles, with at least 80% of cars and small commercial vehicles being electric by 2050.[79]

- Under current policies, electric vehicles will avoid 700 million tonnes of greenhouse gas emissions annually by 2030.[80] However, to reach net zero emissions by 2050, the emission savings need to surpass 1,100 million tonnes annually by 2030, with electric heavy-duty vehicles (buses and trucks) contributing 25% of the avoided emissions.[81]
- A 2022 study shows that to keep global warming below 1.5°C, automobile manufacturers have to halve their future sales of internal combustion engine vehicles (from a range of 546 to 778 million vehicles between 2020 and 2050, to 330 to 463 million).[82]
- The previous edition of this report suggested that envisioned electric vehicle production levels would not supply enough vehicles to meet government-set targets.[83] Although auto manufacturers have since increased their electric vehicle ambitions, the current estimate is that electric vehicles need to represent 52% of total vehicle production by 2029 to support the 1.5°C target (*see Section 1.3.3 The Role of Business in Decarbonising Transport*).[84]

Although the Russian Federation's invasion of Ukraine led to surging natural gas prices and greater demand for coal, the increased CO_2 emissions from coal have been curtailed by the more aggressive deployment of renewable energy technologies (such as solar photovoltaics and wind) and of electric vehicles.[85] Electric vehicles were also able to displace 567,000 barrels oil per day in 2022, a 59% increase compared to 2021 (see Figure 4).[86]

FIGURE 4. Oil displacement through electric vehicles, 2020-2022

Source: See endnote 86 for this section.



- Electric vehicles alone enabled a net reduction of an estimated 80 million tonnes of greenhouse gas emissions (well-to-wheel emissions) in 2022, double the amount reduced in 2021.[87] Electric vehicles in China provided the biggest emission savings (30% of the total savings) in 2022.[88]
- A 2022 study found that in Germany, light-electric vehicles (such as scooters, e-bikes, motorcycles and small cars) could replace half of all kilometres driven by medium-sized fossil fuel cars, avoiding a total of 57 million tonnes of greenhouse gas emissions annually by 2030.[89]
- The electric bus fleet in Latin America saved 129,070 tonnes of CO_2 annually in 2021.[90] Two years later, in 2023, the savings had more than tripled, to 404,190 tonnes of CO_2 annually.[91]

Overall, battery electric vehicles emit fewer life-cycle greenhouse gas emissions than fossil fuel-powered vehicles, especially when the vehicles are charged with low-carbon electricity.[92] However, critics have raised concerns about emissions released during the production and recycling of electric vehicles and their components, notably the batteries.[93]

- A 2020 study found that, on average, even very inefficient electric vehicles release fewer life-cycle emissions than very efficient new petrol vehicles, if the average emission intensity of electricity is below 700 grams of CO_2 equivalent per kilowatt-hour.[94] A passenger electric vehicles would result in a 29% reduction in greenhouse gas emissions on average (up to 1.5 gigatonnes of CO_2 annually).[95]
- These findings are consistent with a 2019 study showing that electric vehicles are poised to result in significant emission savings – even if these vehicles are assumed to have lower lifespans, which in turn reduces the operational emission savings (which in themselves are much lower than for fossil-based vehicles).[96]
- Electric vehicles, in combination with low-emission electricity, offer the largest potential for decarbonising land transport on a life-cycle basis, according to the Intergovernmental Panel on Climate Change.[97] To address growing concerns about the impacts of batteries and the critical minerals needed to produce them, manufacturers can seek to diversify materials and supply, improve energy and material efficiency, and support greater circularity.[98]
- Researchers found that putting a price on indirect emissions (i.e., from electricity grids) can lead to an increase, rather than a decrease, in electric vehicle sales, which would bring additional opportunities to reduce both cumulative tailpipe and indirect emissions.[99]
- A 2022 study found that circular strategies could cut the emissions from materials used in vehicles (of all types) as much as 60% by 2040; currently, 78% of a vehicle is recyclable, but this share could be increased to 97% by 2040.[100]

Policy developments

Electric vehicles are only one part of the broader transformation needed in transport and mobility systems worldwide to achieve both decarbonisation and sustainability goals, such as access to transport for all, safer roads, cleaner air and livable cities. This transformative change requires an integrated multi-modal, multi-level approach that addresses all aspects of the transport and mobility system.

- Providing high-quality public transport services and walking and cycling infrastructure is a core part of achieving access to transport for all. To enable this, densification characterised by compact city development can help with mixed-use, poly-centric structures, and short travel distances.
- Sharing should include pooling and public transport feeder systems as well as access to shared cars and ride-hailing services. Pricing systems should be harmonised across these services and encourage the use of the most efficient options.
- For greater efficiency, drastically downsizing both the size and power of vehicles is vital – making electrification of the entire vehicle fleet both cost-effective and feasible. This is counter to the ongoing trend towards bigger, faster and more powerful cars, which has eradicated almost all efficiency gains in powertrain technologies. Electric vehicle concepts should focus on the most viable and resource-efficient solutions.

Electric vehicle uptake should be framed in a circular economy approach, including the end-of life recycling of batteries as well as the re-use and recovery of other materials (e.g., electronics, metals, minerals).[101] However, there are very few efforts in this direction.

In 2023, the EU approved new rules ensuring that the increased demand for electric vehicle batteries will be met by more environmentally sustainable batteries, with lower emissions and sourced from recycled materials.[102]

More jurisdictions are setting targets for phasing out fossil-fuelled vehicles. As of April 2023, at least 41 countries or sub-national jurisdictions had set phase-out targets for vehicles with internal combustion engines, twice as many as in 2020.[103] As of 2020, only 19 countries or sub-national jurisdictions had set targets to phase out diesel and petrol passenger vehicles.[104]

- Previously, many individual EU member countries (Austria, Denmark, France, Ireland, Italy, the Netherlands, Portugal, Slovenia, Spain, Sweden) had set targets for phasing out internal combustion engine vehicles. In early 2023, the EU passed regionwide legislation to ban sales of new fossil fuel-powered cars and vans by 2035; Germany opposed the ban until the legislation allowed for the continued sale of combustion-engine cars running on synthetic e-fuels, which might still produce CO_2 emissions.[105]
- In 2023, the EU proposed that only zero-emission buses could be sold in the region starting in 2030, and that by 2040 new trucks would need to produce at least 90% fewer CO_2 emissions compared to 2019 levels.[106]
- Chile in 2021 announced a target for 100% sales of zero-emission light-duty vehicles by 2035.[107]
- In 2023, the US Environmental Protection Agency proposed strengthening fuel economy standards 2% per year for passenger cars and 4% per year for light trucks from 2027 to 2032, in order to reduce CO_2 emissions 56% below 2026 levels by 2032.[108]
- In 2022, Canada moved its target for banning internal combustion engine cars forward by five years, from 2040 to 2035, including a medium-term zero-emission sales target of 20% by 2026; in addition, medium- and heavy-duty vehicles should be 35% electric by 2030 and 100% electric for certain categories by 2040.[109]
- California (USA) is one of the world's largest economies with a phase-out policy, targeting a phase-out of internal combustion engine passenger cars by 2035.[110] In 2023, California also set a target for half of all heavy-duty trucks sold in the state to be electric by 2035.[111]

Many policies related to transport and climate change have highlighted the electrification of buses and/or the procurement of new e-buses, with at least 20 countries announcing such measures during 2020-2022.[112]

- Most e-bus schemes target general public transport uses, as in Bogotá (Colombia), Hamburg (Germany) and Nepal; however, Canada and the United States have also targeted the electrification of school buses.[113]
- Several cities, such as Bogotá (Colombia) and São Paulo (Brazil) have banned the purchase of new diesel buses.[114]
- Berlin (Germany) and Santiago (Chile) are among the cities targeting 100% zero-emission bus fleets within the coming decades.[115] Other municipal targets for zero-emission bus fleets range from 20% to 80%.[116]
- India's FAME-II scheme aggregates demand for e-buses.[117] It enabled one of the largest tenders for electric buses in the world with 5,450 electric buses for five cities in 2022.[118] The Indian state of Tamil Nadu is targeting a 30% electric bus fleet by 2030.[119] In 2023, India launched the National Electric Bus Programme aiming to deploy 50,000 electric buses by 2027.[120]
- As of 2022, 37 cities had signed the C40 Green and Healthy Streets Declaration, pledging to only procure zero-emission buses starting in 2025.[121]
- Cambodia reduced its import duties on electric vehicles in 2021 and aims to electrify 40% of its urban buses by 2050.[122]

- Kenya is partnering with the EU to develop a network of five electric bus rapid transit lines – the first in East Africa – which are expected to enter service in 2030.[123]
- Viet Nam's transport sector action plan mentions that all new buses procured from 2025 will be zero-emission.[124]

Policies related to the electrification of two- and three-wheelers are also increasing in all major regions.

- Various cities, including Mumbai (India) and Stockholm (Sweden), support the procurement of e-bikes for bike sharing purposes.[125]
- France offers incentives of up to EUR 4,000 (USD 4,310) to swap out an old polluting car with an e-bike.[126]
- Various countries, such as Guatemala, India, and Sudan, have enacted measures to convert diesel and petrol-powered three-wheelers to electric.[127]
- To alleviate air pollution, Delhi (India) banned new registrations of diesel auto-rickshaws starting in 2023, and it plans to only allow natural gas-powered or electric rickshaws starting in 2027.[128]
- Uganda is partnering with SPIRO, a vehicle and battery design company, to roll out 140,000 electric motorbikes and up to 3,000 battery charging and swapping stations across the country.[129]

Some governments and other stakeholders have set concrete targets for electric vehicle charging infrastructure. In addition to expanding and funding national charging networks, several countries have encouraged charging infrastructure in homes and on other private property.

- England is reportedly incorporating mandatory electric vehicle charger requirements for new homes and buildings in its new building codes by 2023.[130] The United Kingdom aims to have 300,000 charging stations by 2030.[131]
- In October 2022, the European Parliament adopted minimum requirements for charging infrastructure as part of the Alternative Fuels Infrastructure Regulation; EU Member States are now required to build charging points along at least every 60 kilometres of motorways by 2026.[132]

Government subsidies for electric vehicles nearly doubled in 2021, approaching USD 30 billion globally.[133] Other economic instruments used to support uptake include tax rebates, feebates and bonus-malus schemes, in which governments incentivise zero- and low-emission vehicles while discouraging high-emission vehicles.[134]

- China extended its subsidy scheme for new energy vehicles, including electric vehicles, through 2022.[135] However, it reportedly cut these subsidies 30% that year.[136]
- The Republic of Korea introduced a subsidy scheme that applied to low-emission cars priced under KRW 90 million (USD 78,671) in 2021, and KRW 55 million (USD 48,077) in 2022.[137]
- In 2022, New Zealand started a feebate programme for battery electric vehicles and plug-in hybrid electric vehicles, which contributed to a large increase in electric vehicle sales following implementation.[138]

By the end of 2022, countries' climate strategies were highly favouring electric mobility over other types of actions to mitigate transport emissions.

- An estimated 55% of the second-generation Nationally Determined Contributions (NDCs) (79 NDCs) submitted by countries under the Paris Agreement feature e-mobility-related transport mitigation actions.[139]
- In the second-generation NDCs, the attention moved away from public transport actions and towards e-mobility actions, such that for every public transport action there are now two electric mobility actions mentioned.[140]
- The e-mobility actions feature a diversity of road transport modes, with buses and cars each representing 20% of all e-mobility actions mentioned (*see Section 1.3.1 National Climate and Sustainability Strategies to Achieve the Targets of the Paris Agreement and the SDGs on Transport*).[141]

In 2021 and 2022, significant global initiatives were focused on the electrification of light-duty as well as medium- to heavy-duty vehicles, covering all major automobile markets and regions.

- At the 2021 United Nations (UN) Climate Change Conference in Glasgow, United Kingdom (COP 26), a declaration emerged on accelerating the transition to 100% zero-emission cars and vans; this action was later renamed the Accelerating to Zero Coalition at the 2022 UN Climate Change Conference in Sharm-el Sheikh, Egypt (COP 27).[142] The declaration, which had received well over 200 signatories by 2023, aims for all sales of new cars and vans to be zero emission by 2040.[143]
- Also at COP 26, a Memorandum of Understanding on Zero Emissions Medium- and Heavy-Duty Vehicles was launched, with the goal of achieving 100% zero-emission new truck and bus sales by 2040.[144]

Leading automakers are projected to spend an estimated USD 1.2 trillion to 2030 to deliver up to 54 million electric vehicles (and the necessary batteries), accounting for 50% of total vehicle production.[145] As of 2023, however, only two auto manufacturers (Tesla and BYD) were seen as leaders in the zero-emission vehicle transition.[146] In addition, virtual power grids, which allow for aggregation of decentralised energy sources such as electric vehicles, are gaining traction.

- Volkswagen has announced that it will produce only electric vehicles in Europe as of 2033, and Mitsubishi aims to only sell electric vehicles by 2035; new vehicles manufactured by Jaguar will be all-electric by 2025, and by Land Rover by 2036.[147]
- In 2022, BMW announced an aim to sell more than 2 million electric vehicles in 2025 and to have 50% of its vehicles be electric by 2030.[148]
- In early 2023, Google, Ford, and General Motors, along with solar energy producers in the United States, announced a partnership to develop virtual power grids.[149]

There is a risk of an electric mobility divide between high-income countries and low- and middle-income countries, in the absence of electrification policies tailored at the economic and regional context. Historically, high-income countries have been responsible for the majority of greenhouse gas emissions, and they therefore have a responsibility to help low- and middle-income countries with vehicle electrification and overall transport decarbonisation.[150]

- The priority of low- and middle-income countries should be on accessible, affordable, inclusive, secure and safe transport options – with a focus on formal transport, e-bikes, and two- and three-wheelers.
- In 2022, Angola passed a law to half the import duty and vehicle tax for electric vehicles.[151] Many other countries have set tight import regulations (*see Section 3.6 Road Transport*).
- Chinese Taipei donated 10 electric buses to Paraguay in 2023 to kickstart that country's electric public transport fleet.[152]
- Sudan is actively working on retrofitting tuk-tuks to be solar-powered electric vehicles.[153]

Partnership in action

- Through the **Accelerating to Zero Coalition**, established at COP 26 in 2021, more than 200 stakeholders – including governments, auto manufacturers, investors, financial institutions and fleet operators – committed to transition to 100% zero-emission cars and vans globally by 2040, and no later than 2035 in key markets.[154] Signatories also pledged to support emerging economies through technical assistance, finance and capacity building.[155]
- **EV100** – a global group of businesses committed to fleet electrification – has committed to deploying more than 5.5 million electric vehicles by 2030.[156]
- The **Electric Vehicle Initiative's EV30@30 campaign**, launched in 2017, set a goal of achieving 30% electric vehicle sales (including cars, buses and trucks) by 2030, with the support of 15 countries and more than 20 companies and organisations.[157]
- In 2021, 15 countries announced support for the **Global Drive to Zero Campaign**, committing to the first global Memorandum of Understanding on Zero Emissions Medium- and Heavy-Duty Vehicles, with the goal of achieving 2030 and 2040 targets for new electric truck and bus sales.[158] The signatories, representing around 5% of global medium- and heavy-duty vehicle sales, must report progress annually and develop plans to support their ambitions.[159]
- The **TUMI E-Bus Mission** assists 20 cities in creating world-leading electric bus fleets and scaling e-bus adoption to hundreds more through city-to-city mentorship.[160]
- The **Zero Emission Bus Rapid- deployment Accelerator (ZEBRA) Partnership** was established by C40 and International Council on Clean Transportation to accelerate the deployment of zero emission buses in major Latin American cities.[161]
- The **Zero Emission Vehicles Transition Council** was established by the UK COP26 Presidency as the world's first political forum to discuss how to accelerate the pace of the global transition to zero emission vehicles.[162] The forum consisted ministers and government representatives from the world's largest and most progressive automotive markets, collectively accounting for more than half of all new car sales globally.

5

Enabling Climate and Sustainability Action in Transport: Finance, Capacity and Institutional Support

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Contents

5.1 Financing Sustainable Transport in Times of Limited Budgets 367

SPOTLIGHT 5 Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport 383

Section Spotlight

List of Figures

Financing Sustainable Transport in Times of Limited Budgets

Figure 1. Potential jobs created through transport investments, 2020 . . . 371
Figure 2. Investment in transport from the COVID-19 stimulus in G20 countries, by volume and share of GDP . . . 372
Figure 3. Estimated public investment in transport (a) as a share of total public investment in infrastructure and (b) by transport sub-sector, in the G20 countries, 2022 . . . 373
Figure 4. Transport infrastructure investments in OECD countries, 2018-2021 . . . 374
Figure 5. Global climate finance in the transport sector, by source, 2017/18 and 2019/20 . . . 375
Figure 6. Financing for transport mitigation and adaptation, by type of financier, 2017-2020 . . . 375
Figure 7. Use of proceeds from global green bonds issuances, 2014-2022 . . . 376
Figure 8. Fossil fuel support by sector in 51 OECD, G20 and Eastern Partnership countries, 2010-2021 . . . 378
Figure 9. Corporate venture capital investment in clean energy start-ups, 2015-2021 . . . 379
Figure 10. Public transport coverage and share of the population with convenient access in urban areas, by region, 2022 . . . 380

Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport

Figure 1. Share of cities with planned areas, pre-1900 to 2015 . . . 385

List of Tables

Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport

Table 1. Overview of different forms of capacity development in the transport sector . . . 386
Table 2. Capacity needs and impacts of different stakeholders . . . 387
Table 3. List of e-learning courses of Transforming Urban Mobility: Introduction to Transport Planning for Sustainable Cities . . . 388

MODULE 5 5.1

AUTHOR:
Jyoti Bisbey, *World Association of PPP Units & Professionals*

Financing Sustainable Transport in Times of Limited Budgets

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Key findings

- Effective financing is crucial for the development of modern transport networks that facilitate economic growth, improve connectivity and enhance quality of life for residents. It involves a combination of public and private resources, strategic planning and careful allocation of funds to ensure the efficient operation and expansion of transport infrastructure and services.

Current investment and financing for transport infrastructure

- Transport is the largest recipient of infrastructure investment among sectors globally, attracting an estimated USD 79 trillion from 2015 to 2040; of this, USD 26 trillion (one-third) goes to roads and USD 10 trillion to rail.
- The global market for transport services reached USD 7.3 trillion in 2022 and is projected to more than double to USD 15.9 trillion by 2032.
- Many countries have placed an emphasis on expanding the capital stock in the transport sector, and in particular on expanding highway networks, with the aim of improving connectivity and supporting economic development.
- The employment benefits of sustainable transport investments exceed those of other sectors (including building retrofits and solar/wind power conversion) and can be especially high in low- and middle-income regions. Globally, the transport investments with the highest potential to multiply employment opportunities are in walking and cycling infrastructure and in electric vehicle charging infrastructure.
- Transport was a major recipient of COVID-19 recovery investment. In the G20 countries, the majority of the stimulus funding for transport went to the rail and road sectors, with almost no funding for active transport; this is in line with overall G20 transport investment in recent years.

Impacts of the Russian invasion of Ukraine

- The Russian Federation's invasion of Ukraine pushed up energy prices for many consumers and businesses around the world, hurting households, industries and entire economies – most severely in low- and middle-income countries where people can least afford it.
- The war has had far reaching economic impacts and has halted the fiscal consolidation process of many low- and middle-income countries that started in the aftermath of the pandemic.
- Europe's quest for alternatives to Russian energy could supercharge investment in hydrogen, potentially leading to USD 1 trillion of new projects globally by 2030.

Major trends in transport financing

- The transport sector has dominated infrastructure investments in both the G20 countries and in the member countries of the Organisation for Economic Co-operation and Development (OECD). However, much of this investment has been for road construction and highway expansion, supporting rising motorisation rates while not necessarily enhancing travel opportunities and conditions.
- In 2022, around 42% of public funding in the G20 countries went to transport sector investments, of which nearly half (46%) were in road transport, followed by rail and public transport.
- The transport sector also represented a large share of spending in China and in some low- and middle-income countries. China spent 5.6% of its gross domestic product (GDP) on transport in 2022, compared with shares of only around 0.7% to 0.9% each in Denmark, France, Germany, Mexico, the Russian Federation and the United Kingdom.

Finance for transport decarbonisation

- Achieving the needed reductions in greenhouse gas emissions from transport will require strong regulations and fiscal incentives as well as large investments in infrastructure to enable low- and zero-emission transport.
- Climate finance totalled USD 653 billion in 2019/20, with around a quarter of it (USD 169 billion) going to the transport sector. This was more than in previous years – spurred by investment in rail and transit projects and by rising household purchases of electric vehicles – but represents only a fraction of the total estimated need.

- Despite significant pledges to increase multilateral financing through various low-carbon mechanisms, only a small share of these funds cover transport decarbonisation projects. Addressing this gap requires reassessing public sector funding priorities and exploring new opportunities to mobilise large-scale private investment towards development objectives.
- Public money was consistently the main source of financing for climate change mitigation and adaptation actions in the transport sector from 2017 to 2020.
- Of the green bond volume in 2022, two-thirds (67%) originated in developed markets, with the rest coming from emerging markets (23%) and from supranational issuers such as the World Bank and Asian Development Bank (9%).
- The EU's extensive green bond programme has driven much of the growth in green bonds, issuing a cumulative USD 39.9 billion over four deals since its debut in October 2021.
- Collectively, green bonds for energy, buildings and transport accounted for 77% of the total green debt volume in 2022 (down from 81% in 2021 and a high of 85% in 2021), with transport contributing just under USD 100 billion.
- Countries raised a record USD 95 billion in 2022 through carbon pricing schemes that charge firms for emitting carbon dioxide, covering around 23% of global greenhouse gas emissions.
- In the transport sector, progress in carbon financing is mixed. Most carbon markets have focused on aviation and maritime emissions and less on emissions from land-based transport. In road transport, 99% of the carbon price signal resulted from fuel taxes, not carbon pricing initiatives.
- Consumer and government spending on electric cars increased 50% in 2022 to reach USD 425 billion globally.
- As the electric car market matures, reliance on direct subsidies is expected to phase out over time. The focus of government policy incentives is gradually shifting from consumers to charging infrastructure and battery manufacturing, leading to announcements of record investments in new battery manufacturing capacity in 2022.
- The transport sector relied on fossil fuels for nearly 96% of its energy consumption in 2020 and 2021. In the transport sector alone, subsidies and other support for fossil fuels jumped 31% in 2021 due to the surge in fuel use following the lifting of COVID-related mobility restrictions.
- Despite a slump in revenues, auto companies maintained strong spending on research and development in 2020 and 2021, in a push to gain a technological edge in the fast-changing mobility sector. In 2021, low carbon mobility and battery start-ups accounted for a combined 35% of the spending growth and for 40% of the early-stage finance.

Projected transport investment needs

- Investment needs can change over time due to factors such as technological advancements, shifts in transport patterns, economic developments and policy changes. For transport sector decarbonisation, more focus is needed on addressing the service gap rather than the investment gap, as ensuring improved services often requires more than capital investment.
- An estimated USD 2.7 trillion in annual investment (USD 40.5 trillion in total) will be needed globally between 2016 and 2030 to achieve low carbon transport pathways, with 60-70% of the investment occurring in emerging economies. However, regional investment gaps for transport infrastructure by 2040 are significant, estimated at USD 0.8 trillion for Africa, USD 1.6 trillion for Asia and USD 6.0 trillion for the Americas.
- Global investment needs for transport infrastructure through 2050 are an estimated USD 50 trillion. Reducing emissions through low carbon urban mobility would require investments totalling USD 1.83 trillion (around 2% of global GDP), which would result in estimated savings of USD 2.8 trillion in 2030 and nearly USD 7.0 trillion in 2050.

Overview

Financing in transport refers to the various methods and sources of money that are used to support the development, operation and maintenance of transport infrastructure and mobility services. Infrastructure and services such as roads, bridges, airports, railways and public transport networks require significant investments to be built and maintained effectively. Financing in transport involves obtaining the necessary resources to cover the costs associated with these projects and operations. It includes the following:

- **Capital investment** – financing for the construction, expansion, or renovation of transport infrastructure, which includes building new roads, bridges, airports and other facilities.
- **Operations and maintenance** – funding to operate and maintain transport systems, covering expenses such as staff salaries, maintenance of vehicles and infrastructure, and other operational costs.
- **Public funding** – funds provided by various levels of government to support transport projects, which can come from taxes, tolls, fees and other revenue sources dedicated to transport.
- **Private investment –** financing from private companies and investors, whether through direct investments or in the form of public-private partnerships (whereby private entities might handle the construction, operation or maintenance of infrastructure in exchange for certain revenue-sharing arrangements).
- **Borrowing and loans** – money that governments and transport agencies borrow – either through issuing bonds or taking out loans from financial institutions – and then repay over time, often using revenue generated from transport-related activities.
- **User fees and tolls** – funds that users of transport infrastructure pay to help finance the construction and maintenance of facilities, such as tolls that are used to fund highway upkeep.
- **Grants and subsidies** – funds that governments provide to transport projects, particularly projects that serve a public interest but that may not be financially self-sustainable.
- **Fuel taxes** – taxes collected from motorists that are generally earmarked for transport-related purposes, such as funding road construction and maintenance projects.
- **Environmental and impact fees** – payments or mitigation efforts that transport projects might require to offset the environmental impacts caused by construction or operation.
- **Innovative financing** – new resource mobilisation mechanisms that are being explored to help finance transport projects sustainably and efficiently, such as congestion pricing, carbon credits and value capture strategies.
- **Climate finance** – financing that is critical to reaching the scale of climate change mitigation and adaptation that is required in the transport sector to achieve Paris Agreement targets.

Effective financing is crucial for the development of modern transport networks that facilitate economic growth, improve connectivity and enhance quality of life for residents. It involves a combination of public and private resources, strategic planning and careful allocation of funds to ensure the efficient operation and expansion of transport infrastructure and services.

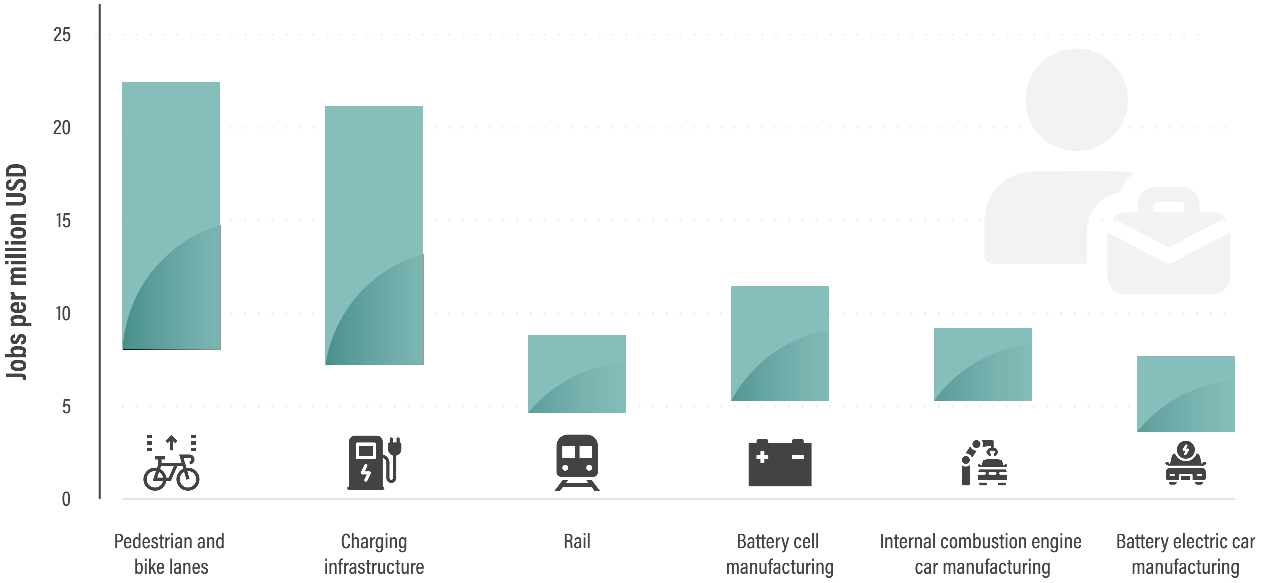
Current investment and financing for transport infrastructure

Transport is the largest recipient of infrastructure investment among sectors globally, attracting an estimated USD 79 trillion from 2015 to 2040; of this, USD 26 trillion (one-third) goes to roads and USD 10 trillion to rail.[1] The global market for transport services reached USD 7.3 trillion in 2022 and is projected to more than double to USD 15.9 trillion by 2032.[2]

Investments in the transport sector can be distinguished between investments in infrastructure and related facilities, and investments in mobility services. In general, the public sector supports investments in large infrastructure, such as airports and highways, whereas both the public and private sectors provide investments in mobility services, with the public sector focusing more on supplying public transport. Decisions on transport and mobility are highly influenced by access to infrastructure, which is more limited in low- and middle-income countries in terms of coverage and quality.

FIGURE 1. Potential jobs created through transport investments, 2020

Source: See endnote 7 for this section.



Many countries have placed an emphasis on expanding the capital stock in the transport sector, and in particular on expanding highway networks, with the aim of improving connectivity and supporting economic development.

- In Africa, transport has typically accounted for more than half of the total budget for infrastructure investment, ranging between 52% and 59% for the years 2016-2018.[3] Most of this investment is targeted at road transport, followed by rail, airports and ports.[4]
- Road transport represented around three-quarters of all transport infrastructure investment in Africa and the Americas in 2022.[5]

For investment in mobility services, the private sector plays a strong role. Private transport operators are typically the main providers of innovative urban transport services (for example, Uber, Bikeshare, Bird scooters and commuter buses) and of operations and maintenance services for public transport. In contrast, the public sector has invested mainly in rail and public bus/metro services. However, this varies by country, depending on the degree of decentralisation, the financial capacity and the set-up of transport systems. In some countries, public companies also provide freight transport (through rail and trucking services) and to a lesser extent air and maritime services.

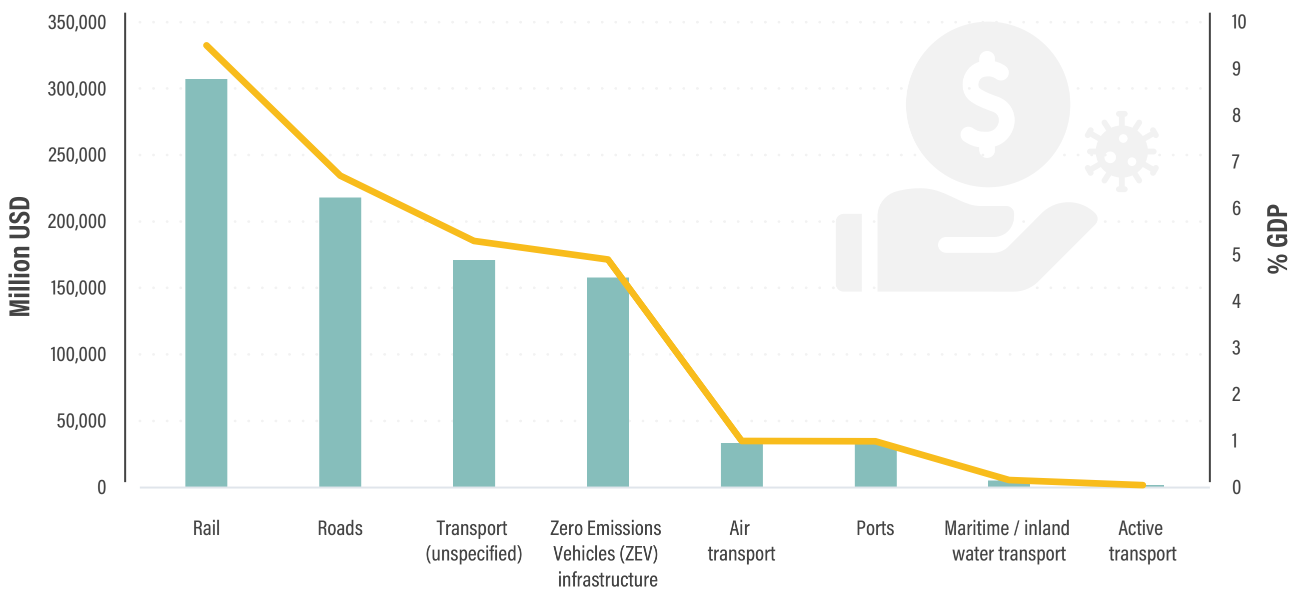
The employment benefits of sustainable transport investments exceed those of other sectors (including building retrofits and solar/wind power conversion) and can be especially high in low- and middle-income regions.[6] Globally, the transport investments with the highest potential to multiply employment opportunities are in walking and cycling infrastructure and in electric vehicle charging infrastructure (see Figure 1)**.**[7]

- Across 21 countries in low- and middle-income regions of Africa, Asia, Eastern Europe, and Latin America, investments in public transport and vehicle electrification could lead to the creation of more than 50 million jobs by 2030.[8]
- A green recovery strategy (as compared to a business-as-usual strategy) could have generated at least an estimated 10 million additional new jobs in low carbon transport from 2020 to 2030.[9]

Transport was a major recipient of COVID-19 recovery investment. In the G20 countries, the majority of the stimulus funding for transport went to the rail and road sectors (see Figure 2)**, with almost no funding for active transport; this is in line with overall G20 transport investment in recent years.**[10]

FIGURE 2. Investment in transport from the COVID-19 stimulus in G20 countries, by volume and share of GDP

Source: See endnote 10 for this section.



- Between February 2020 and August 2021, the G20 countries allocated USD 3.2 trillion (4.6% of the G20's gross domestic product, GDP) in stimulus funding to transport infrastructure, mainly to drive economic recovery and to achieve long-term transformative outcomes.[11] If this amount were spent over the following two years, it would represent a 45% increase in the average annual investment in infrastructure across the G20.[12]

Impact of the Russian invasion of Ukraine

The Russian Federation's invasion of Ukraine pushed up energy prices for many consumers and businesses around the world, hurting households, industries and entire economies – most severely in low- and middle-income countries where people can least afford it. The need to make up for immediate shortfalls in natural gas and other energy exports from the Russian Federation led to increased production elsewhere, and new infrastructure for liquefied natural gas was pursued globally to diversify the supply. Oil and gas investment increased 10% in 2022 but remained well below 2019 levels.[13]

The war has had far-reaching economic impacts and has halted the fiscal consolidation process of many low- and middle-income countries that started in the aftermath of the pandemic. In Sub-Saharan Africa, public debt more than tripled between 2010 and 2022.[14] In response to the reductions in food supplies from Ukraine and to the rise in food and fuel prices, countries in Sub-Saharan Africa have resorted to subsidies, temporary waivers of tariffs and levies, and income support for the most vulnerable groups – increasing the region's fiscal deficit from an estimated 4.8% of GDP in 2021 to 5.2% in 2022.[15]

Europe's quest for alternatives to Russian energy could supercharge investment in hydrogen, potentially leading to USD 1 trillion of new projects globally by 2030.[16] As of 2021, the hydrogen sector was already converting more of its bulging project pipeline into investment decisions, and companies were raising growing amounts of money. With the European Union's (EU) goal under the REPowerEU plan to use low carbon hydrogen, as well as higher hydrogen targets in the United Kingdom and elsewhere, it is increasingly likely that major projects will enter construction soon. If the hydrogen is produced mainly using new, dedicated wind and solar plants, these facilities would represent around 40% of total costs, whereas infrastructure for hydrogen transport – including port facilities, ships and storage – would represent 25% of costs (*see Section 4.1 Transport Energy Sources*).[17]

Major trends in transport financing

The transport sector has dominated infrastructure investments in both the G20 countries and in the member countries of the Organisation for Economic Co-operation and Development (OECD). However, much of this investment has been for road construction and highway expansion, supporting rising motorisation rates while not necessarily enhancing travel opportunities and conditions.

- **In 2022, around 42% of public funding in the G20 countries went to transport sector investments, of which nearly half (46%) were in road transport, followed by rail and public transport** (see Figure 3).[18]
- OECD countries greatly increased their investments in transport infrastructure between 2010 and 2021. Transport infrastructure spending grew 7% annually on average between 2010 and 2017 before falling nearly 5% in 2018, driven by reduced investment in rail and water transport.[19]
- Most of the OECD investment in transport infrastructure has been for road transport. In 2018, OECD countries spent on average 1.2% of their GDP on transport infrastructure, with roughly 0.9% going to road infrastructure and only 0.2% to rail infrastructure (see Figure 4).[20]

The transport sector also represented a large share of spending in China and in some low- and middle-income countries.

- **China spent 5.6% of its GDP on transport in 2022, compared with shares of only around 0.7% to 0.9% each in Denmark, France, Germany, Mexico, the Russian Federation and the United Kingdom.**[21]
- In Africa, 41.7% of infrastructure finance commitments in 2017 went towards transport.[22]
- Latin America and the Caribbean, which has a similar density of paved roads as Africa, spent around 44% of its total infrastructure investments on transport between 2008 and 2015.[23] During 2015-2019, around 1.2% of public spending in the region on average went to transport infrastructure, with higher shares in countries such as Belize (5.4%), Bolivia (5.3%) and Nicaragua (3.9%).[24]

FIGURE 3. Estimated public investment in transport (a) as a share of total public investment in infrastructure and (b) by transport sub-sector, in the G20 countries, 2022

Source: See endnote 18 for this section.

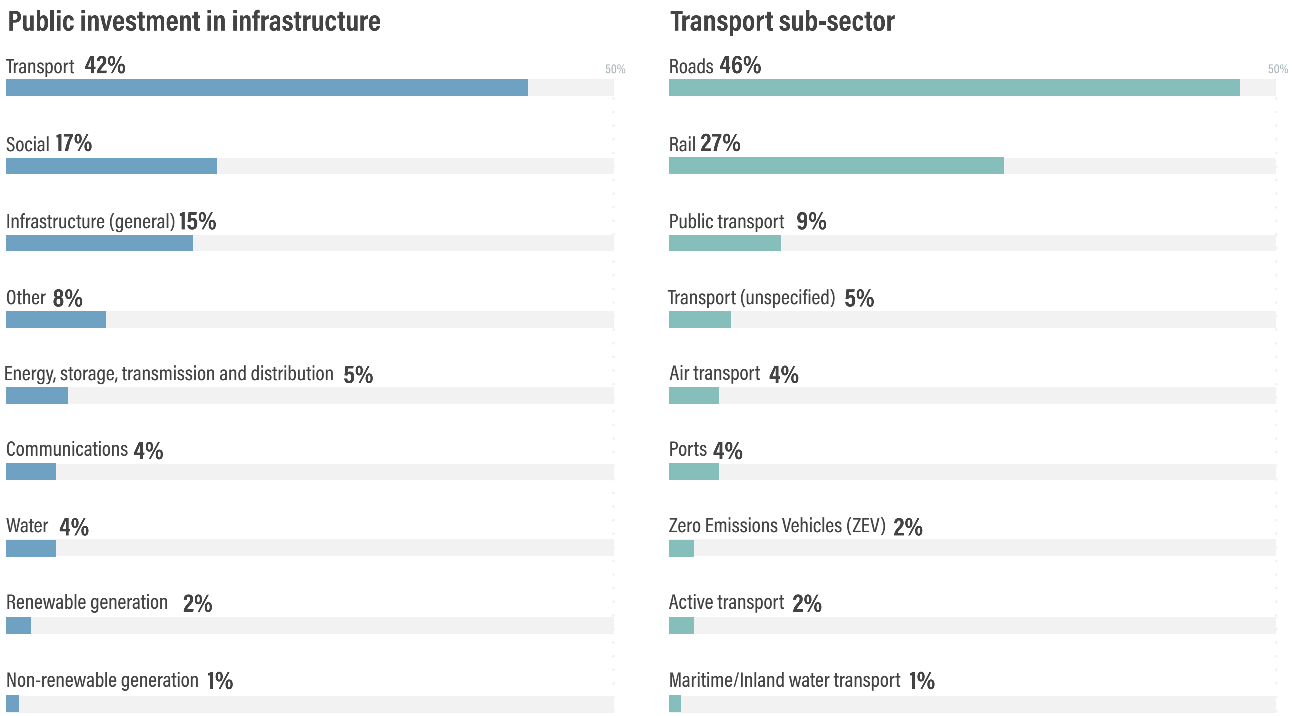
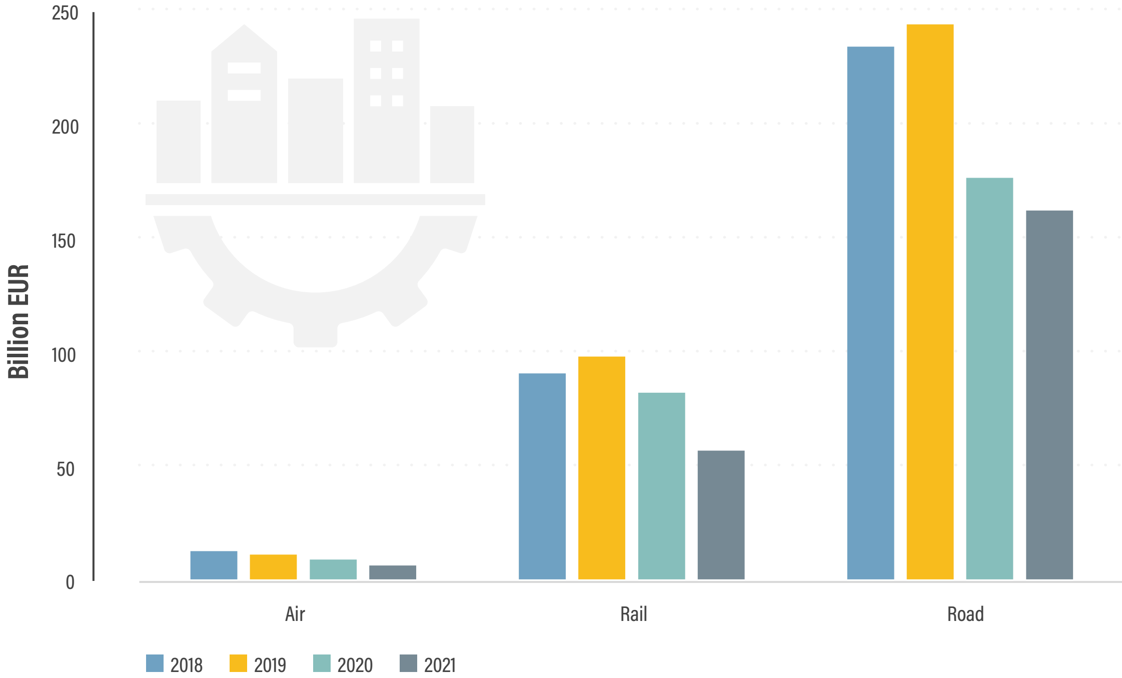


FIGURE 4. Transport infrastructure investments in OECD countries, 2018-2021

Source: See endnote 20 for this section.



Finance for transport decarbonisation

Achieving the needed reductions in greenhouse gas emissions from transport will require strong regulations and fiscal incentives as well as large investments in infrastructure to enable low- and zero-emission transport (see *Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).

Climate finance totalled USD 653 billion in 2019/20, with around a quarter of it (USD 169 billion) going to the transport sector (see Figure 5)**.**[25] **This was more than in previous years – spurred by investment in rail and transit projects and by rising household purchases of electric vehicles – but represents only a fraction of the total estimated need.**[26] Estimates suggest that fully decarbonising the shipping industry alone would cost USD 1.4 trillion to 1.9 trillion; achieving net zero CO_2 emissions in aviation by 2050 would cost at least USD 5 trillion; and improving the efficiency of road transport in order to achieve the goal of keeping global temperature rise within 1.5 degrees Celsius by 2050 would cost USD 3 trillion.[27]

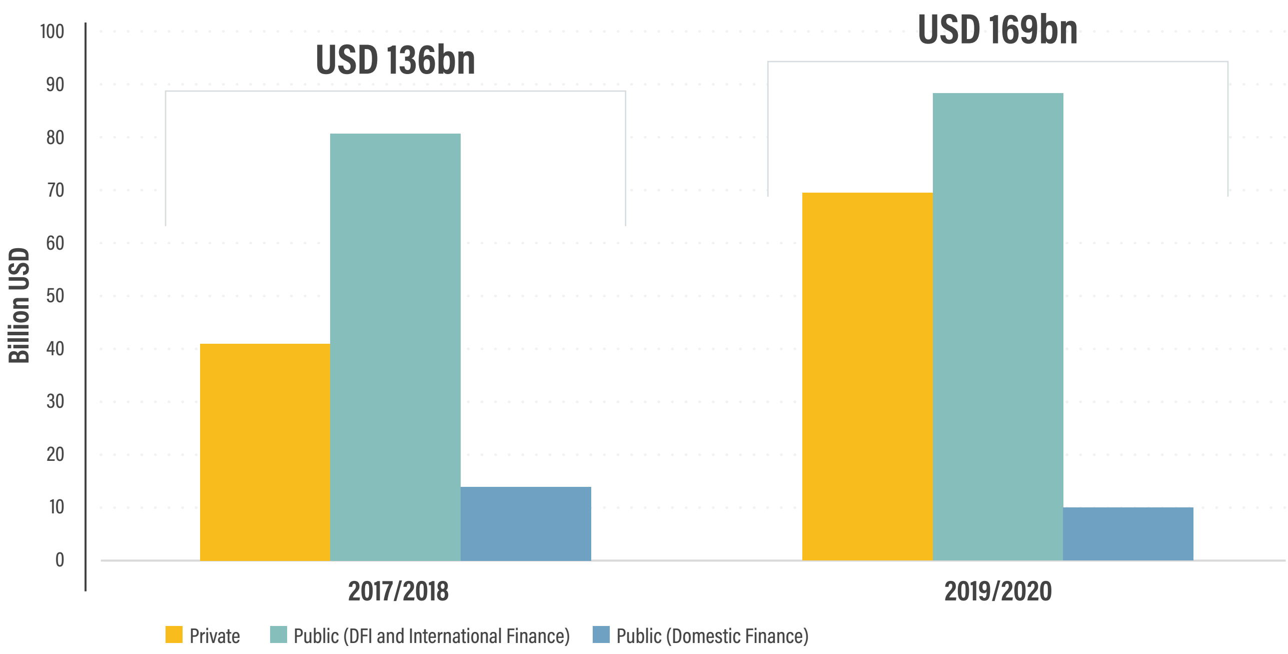
Despite significant pledges to increase multilateral climate financing through various low-carbon mechanisms, only a small share of these funds cover transport decarbonisation projects.[28] **Addressing this gap requires reassessing public sector funding priorities and exploring new opportunities to mobilise large-scale private investment towards development objectives.** Although greater spending on climate action is needed, public budgets – traditionally an important source of financing for green infrastructure and transport – are strained, and existing resources are often directed towards vehicle electrification and not necessarily to the areas covered under the Avoid-Shift-Improve framework for transport decarbonisation (*see Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).

Public money was consistently the main source of financing for climate change mitigation and adaptation actions in the transport sector from 2017 to 2020.[29] National development finance institutions were the leading funder of transport climate investments (see Figure 6), with the monies originating from international development finance institutions, capital market issuances and central government transfers.[30]

Of the green bond volume in 2022, two-thirds (67%) originated in developed markets, with the rest coming from emerging markets (23%) and from supranational issuers such as the World Bank and Asian Development Bank (9%).[31] A green bond

FIGURE 5. Global climate finance in the transport sector, by source, 2017/18 and 2019/20

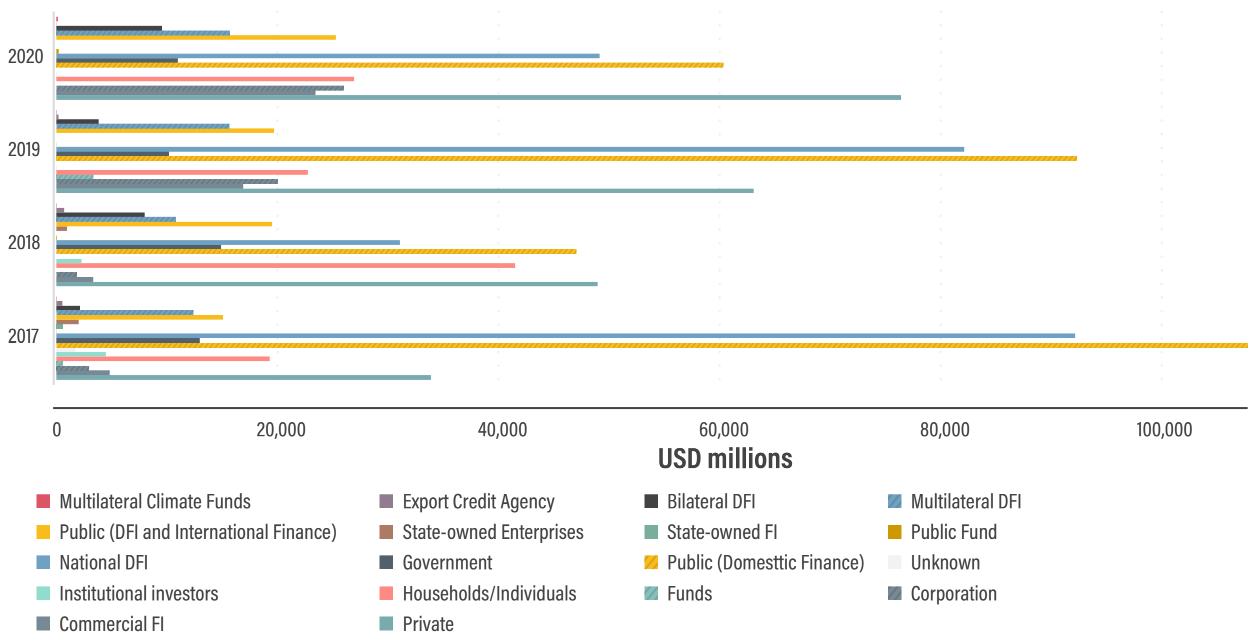
Source: See endnote 25 for this section.



Note: DFI = development finance institution

FIGURE 6. Financing for transport mitigation and adaptation, by type of financier, 2017-2020

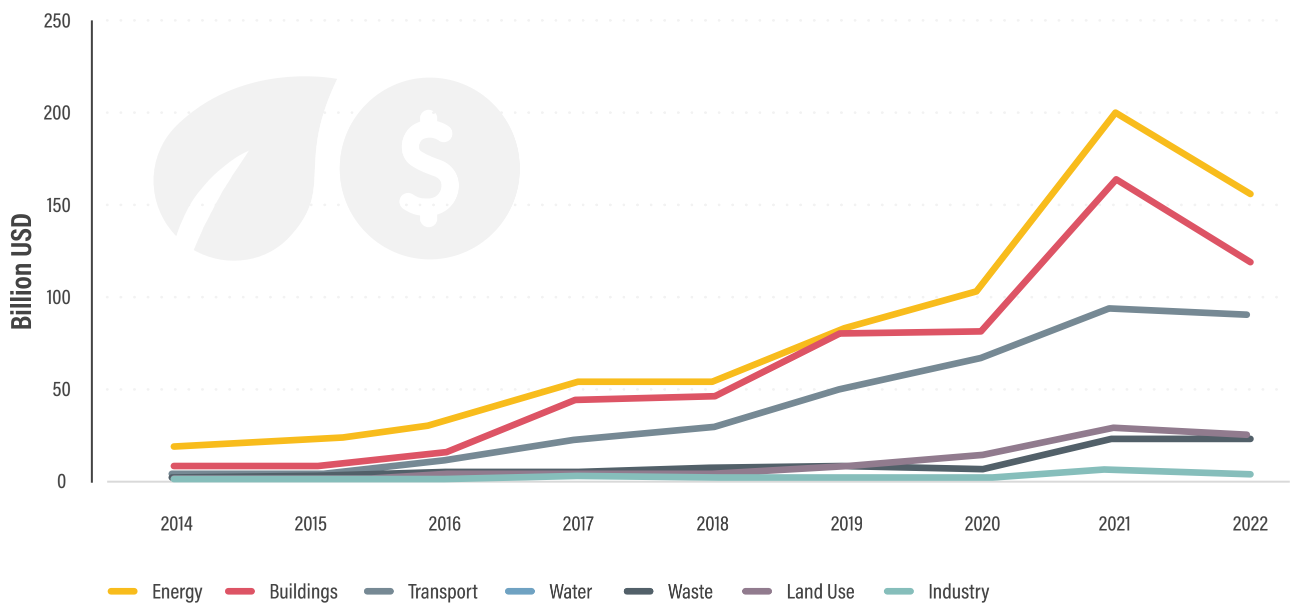
Source: See endnote 30 for this section.



Note: DFI = development finance institution FI = finance institution

FIGURE 7. Use of proceeds from global green bonds issuances, by sector, 2014-2022

Source: See endnote 38 for this section.



is differentiated from a regular bond by its label, which signifies a commitment to use the funds raised to exclusively finance (or re-finance) "green" projects, assets or business activities. Green bond volumes fell in 2022 from all sources except supranational, which increased 43% to USD 45.1 billion.[32]

The EU's extensive green bond programme has driven much of the growth in green bonds, issuing a cumulative USD 39.9 billion over four deals since its debut in October 2021.[33] Supranationals dominated the top ten sources of thematic debt in 2022, issuing USD 116 billion across the three categories of green, social and sustainability.[34]

- The United States was the largest country source and priced the highest share of sustainability deals (USD 21.5 billion).[35]
- China produced the largest volume of green bonds (USD 85.4 billion), while France dominated social bonds (USD 54.5 billion).[36]
- The Dominican Republic was the only country to join the green bond market in 2022, issuing a green bond to raise cash for the energy company EGE Haina to expand its Larimar I wind farm.[37]

Collectively, green bonds for energy, buildings and transport accounted for 77% of the total green debt volume in 2022 (down from 81% in 2021 and a high of 85% in 2020), with transport contributing just under USD 100 billion (see Figure 7)**.**[38] Smaller use of proceeds categories (such as waste, land use, industry and ICT) are gaining share as more issuers (including large sovereigns) finance a broader range of projects. Adaptation-related investments gained the most share, although they still represent only a tiny portion of the market.

The Russian Federation's invasion of Ukraine affected capital market activity globally in 2022, triggering energy price spikes, inflation and rising interest rates. It also affected bonds bearing thematic labels, which represented 5% of total debt volumes (the same as in 2021) and fell 24% in value in 2022.[39]

Countries raised a record USD 95 billion in 2022 through carbon pricing schemes that charge firms for emitting carbon dioxide (CO_2), covering around 23% of global greenhouse gas emissions.[40] Several countries are using a price on carbon emissions to help meet their climate goals in the form of a tax, or under an emissions trading scheme (ETS) or cap-and-trade system. As of 2023, a total of 73 global carbon pricing instruments were in operation.[41] Carbon markets are evolving faster in high-income markets that have access to capital markets, while growth is slower in emerging markets where access to capital markets and integration of greenhouse gas emissions into a trading system are in development.

In the transport sector, progress in carbon financing is mixed. Most carbon markets have focused on aviation and maritime emissions and less on emissions from land-based transport.[42] **In road transport, 99% of the carbon price signal resulted from fuel taxes, not carbon pricing initiatives.**[43] Faced with declining tax revenues from fuel excise duty, countries face a shrinking tax revenue base as vehicles become more fuel efficient and as the penetration of electric vehicles increases. Addressing this evolution with a change in approach to carbon taxation of vehicle usage is increasingly important.

The largest carbon market globally is the EU Emissions Trading Scheme (EU ETS), the world's first, most extensive and longest-running international system for trading emission allowances. Since reforms to the scheme in 2018, the average annual price of carbon permits in the EU has increased significantly, and in February 2023, the carbon price reached a then-record high of EUR 100.34 (USD 108.93) per metric tonne of CO_2.[44] The EU ETS covers around 40% of EU greenhouse gas emissions and will include maritime transport emissions starting in 2024.[45] As maritime emissions come under growing scrutiny, the risk of "carbon leakage" and revenue loss for the EU ETS could grow, if ships opt to avoid ports that participate in the scheme.

On a global level, members of the International Maritime Organization are considering carbon pricing as a mid-term measure, with recent vigorous debate on this policy option *(see Section 3.8 Shipping)*.[46] Proposals by governments and industry range from a carbon levy on bunker fuel to an emission trading system coupled with a fuel emissions standard or a revenue-neutral feebate scheme.[47]

In the aviation sector, the International Civil Aviation Organization (ICAO) agreed on key parameters for its Carbon Offsetting and Reduction Scheme for International Aviation.[48] In 2022, the ICAO Assembly decided that the baseline above which airlines must offset emissions should be 85% of 2019 emissions, for both the voluntary and mandatory phases of the scheme. The ICAO also adopted a long-term and non-binding aspirational goal to reach net zero carbon emissions by 2050 (see *Section 3.7 Aviation*).[49]

Public policy support for electric vehicles

Government support to the transport sector takes a variety of forms, including setting up programmes and regulations, fiscal and public finance management support (such as grants, subsidies and taxation for infrastructure development) and climate action financing. Major economies have adopted important policies to support the uptake of electric vehicles and to promote transport decarbonisation across multiple modes. In Norway, where the share of electric car sales neared 90% in 2022, a comprehensive policy levies higher taxes on high-emission cars than on low- and zero-emission cars, helping to make the latter more affordable and enabling the country to offer incentives for zero-emission cars without any loss in revenue.[50]

Consumer and government spending on electric cars increased 50% in 2022 to reach USD 425 billion globally.[51] Most of this was spent by private or corporate consumers, while the government share of electric car spending remained at 10%, having fallen from more than 20% in 2017.[52] Maintaining strong growth in electric vehicle sales will depend on factors including the deployment of charging infrastructure, the availability of car models and battery costs – all of which require continuous support from government policies and private sector investment (see *Section 4.2 Vehicle Technologies*).

As the electric car market matures, reliance on direct subsidies is expected to phase out over time. The focus of government policy incentives is gradually shifting from consumers to charging infrastructure and battery manufacturing, leading to announcements of record investments in new battery manufacturing capacity in 2022. Budget-neutral feebate programmes – which tax inefficient internal combustion engine vehicles to finance subsidies for low-emission or electric vehicle purchases – can be a useful transition policy tool. Fuel taxation that reflects the societal and environmental impacts of driving more polluting vehicles, together with stringent vehicle efficiency or CO_2 standards, have helped leading markets increase electric vehicle adoption and are key to hastening the transition to electric mobility.

- The US Inflation Reduction Act of 2022 contains a suite of policies designed to accelerate electric vehicle adoption and the production of biofuels, synthetic fuels and hydrogen.[53]
- In 2022, the US Departments of Energy and Transport articulated a bold framework for transport decarbonisation, and the US Environmental Protection Agency has proposed multi-pollutant emission standards for light- and heavy-duty vehicles, aimed at helping to meet national targets for net zero emissions by 2050.[54]
- In February 2023, the EU advanced its transition to electric vehicles through the launch of the Green Deal Industrial Plan.[55] It also reached agreement on the Alternative Fuels Infrastructure Regulation, which will mandate Member States to roll out public charging infrastructure for light- and heavy-duty electric vehicles.[56]
- The EU reached agreement in 2022 on a law that will mandate the adoption of low-emission alternatives to fossil jet kerosene in aviation, as well as low-emission fuels in maritime transport.[57]

A proposal is being formulated to revise the EU ETS to cover maritime emissions in 2024 and to create a separate new ETS that also includes road transport emissions.[58]

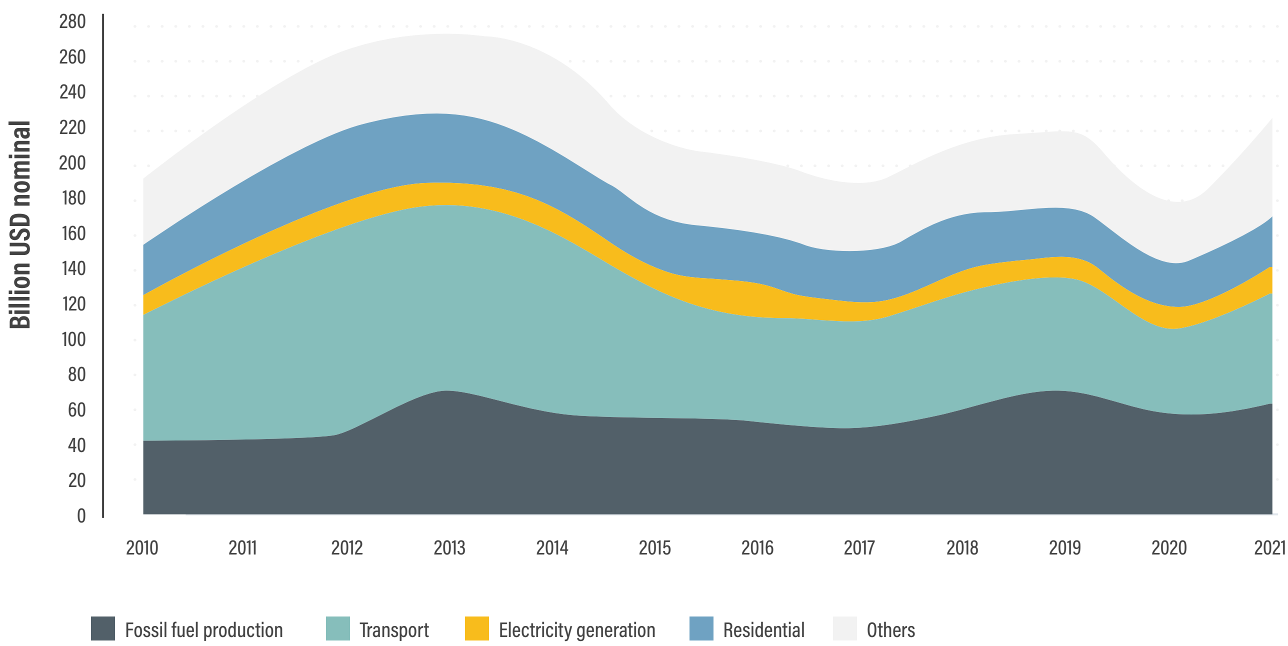
- In 2022, India adopted the Production Linked Incentives (PLI) scheme, which includes a programme to boost domestic battery manufacturing, with a budget of INR 181 billion (USD 2.2 billion).[59] India also adopted the Automobile and Auto Component PLI scheme, which grants incentives for sales of advanced automotive components and vehicles, including battery electric and hydrogen fuel cell vehicles.[60]
- In early 2023, Australia committed to putting in place a fuel efficiency standard for light-duty vehicles and formulated a National Electric Vehicle Strategy to accelerate the adoption of electric vehicles.[61]

Fossil fuel dependency of the transport sector

The transport sector relied on fossil fuels for nearly 96% of its energy consumption in 2020 and 2021 (*see Section 4.1 Transport Energy Sources*).[62] **In the transport sector alone, subsidies and other support for fossil fuels jumped 31% in 2021 due to the surge in fuel use following the lifting of COVID-related mobility restrictions** (see Figure 8).[63] Direct support for fossil-based fuels and electricity generation rose 23%, reflecting in part government interventions to shield households and firms from the impacts of high energy prices following the strong recovery in demand.[64] Support for fossil fuels had been trending downward since its peak in 2013, but it increased 27% in 2021 (to USD 227 billion) as energy prices rose with the rebound of the global economy.[65]

FIGURE 8. Fossil fuel support by sector in 51 OECD, G20 and Eastern Partnership countries, 2010-2021

Source: See endnote 63 for this section.



Major shift in venture capital for mobility technology

Despite a slump in revenues, auto companies maintained strong spending on research and development (R&D) in 2020 and 2021, in a push to gain a technological edge in the fast-changing mobility sector. In 2021, low-carbon mobility and battery start-ups accounted for a combined 35% of the spending growth and for 40% of the early-stage finance.[66] However, these shares are lower than in 2017-2019, as the growth in spending in 2021 was more evenly distributed among technology areas. Notably, early-stage mobility investment has been shifting away from companies developing electric vehicles and associated technologies. Overall, start-ups in the United States and Europe raised record funds despite the pandemic, boosted by energy storage, hydrogen and renewable energy technologies.

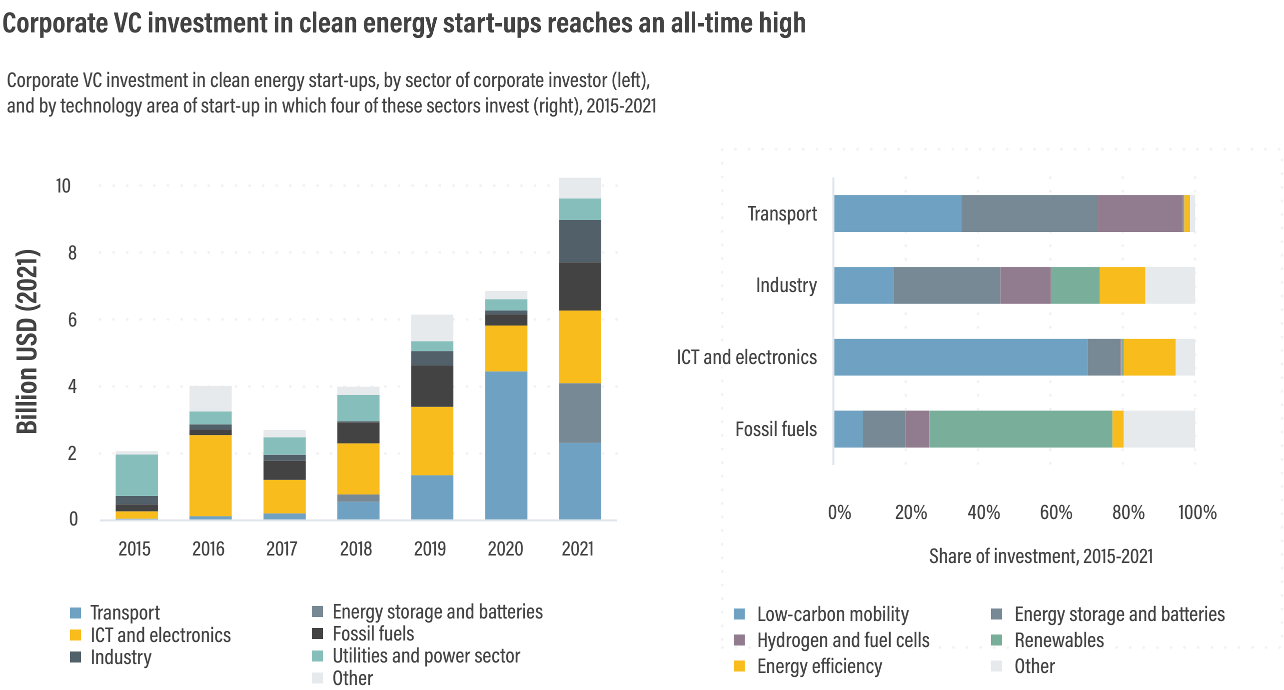
Electric vehicle start-ups have progressed rapidly through early-stage funding rounds (see Figure 9).[67] As the market consolidates around a smaller number of major players, their presence in later-stage funding has risen. In 2021, around USD 24 billion in late-stage venture capital – or more than half of all capital raised by clean energy start-ups – was channelled into electric mobility and batteries.[68] In China, new electric vehicle manufacturers have moved quickly from early to later stages, including Leap Motor, Zeekr, and Hozon, which together have raised more than USD 2.5 billion since 2021.[69] As near-term market expectations for electric vehicles are revised upwards, boosted by concerns about high oil prices and energy security, batteries remain an area of technology uncertainty and competition.

Meanwhile, funding for battery manufacturers has boomed, providing crucial capital to alternative chemistries and to emerging concepts for the extraction, processing and recycling of critical minerals.[70]

- Late-stage venture capital for energy storage and batteries surged to more than USD 12 billion in 2021, accounting for 45% of total year-on-year growth.[71]

FIGURE 9. Corporate venture capital investment in clean energy start-ups, 2015-2021

Source: See endnote 67 for this section.



Notes: Includes early- and late-stage deals. Includes only investment by private sector investors. Where there are several investors, deal value is evenly split across them. ICT = information and communications technology. Left graph: Industry = chemicals, cement, commodities, construction (excluding real estate), iron and steel, and other equipment suppliers; Utilities and power sector = independent power producers, and electricity and renewables equipment and services.

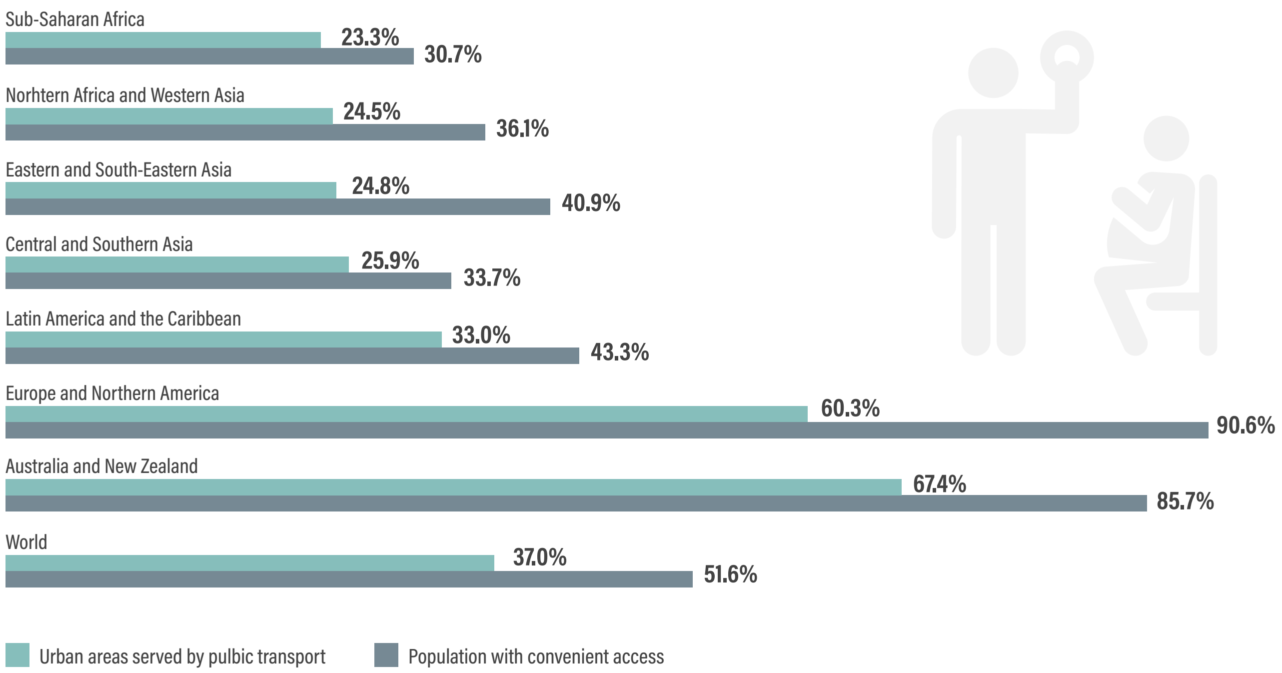
- In China, the battery developer Svolt raised more than USD 3 billion, and in Chinese Taipei the solid-state electric vehicle battery maker ProLogium Technology secured USD 326 million to expand production overseas.[72]
- In the United States, after raising USD 160 million from investors including BMW, Ford, and SK Group, the solid-state battery manufacturer Solid Power listed through a merger with a special-purpose acquisition company, raising more than USD 500 million.[73] Form Energy raised USD 240 million to develop long-duration iron-air battery storage, including via funds from ArcelorMittal.[74]
- In 2021, the French battery developer Verkor raised USD 118 million – including from the French government, Renault, Schneider Electric and Arkema – to build an R&D and pilot production facility.[75] In 2020, Verkor secured USD 1.4 billion in project finance for a 50 gigawatt-hour per year factory by 2030, as Europe expands public financing for the rapid scale-up of manufacturing by start-ups.[76]

Projected transport investment needs

Investment needs can change over time due to factors such as technological advancements, shifts in transport patterns, economic developments and policy changes. For transport sector decarbonisation, more focus is needed on addressing the service gap rather than the investment gap (see Figure 10)**, as ensuring improved services often requires more than capital investment** (for example, to cover the cost of maintenance over the life cycle of the asset).[77] In many countries, improving the provision of sustainable transport services requires not just improved infrastructure and fleet modernisation, but also institutional change and capacity development.

FIGURE 10. Public transport coverage and share of the population with convenient access in urban areas, by region, 2022

Source: See endnote 77 for this section.



Note: Based on data from 1,507 cities in 126 countries.

BOX 1. Investment needs for the transport sector

Investment needs for the transport sector can vary greatly depending on the region, country, type of transport and specific projects being considered. Transport infrastructure includes roads, highways, railways, ports, airports, public transport systems and more. The investment needs typically cover various aspects such as construction, maintenance, upgrades and expansion of transport networks.

- **Low- and middle-income countries:** Many of these countries require substantial investments in basic transport infrastructure to improve connectivity, facilitate trade and support economic growth (see Box 2).[78]
- **Urban transport:** Urban areas often require investments in public transport systems such as buses, metros and light rail to alleviate traffic congestion and reduce pollution.
- **Rural connectivity:** In rural and remote areas, investments in road networks can improve access to essential services and markets for agricultural products.
- **Sustainable transport:** There is a growing emphasis on investing in sustainable transport modes such as electric vehicles, bike lanes, pedestrian-friendly infrastructure and integrated mobility solutions.
- **Maintenance and upgrades:** Existing transport infrastructure requires regular maintenance and occasional upgrades to ensure safety and efficiency.
- **Multi-modal connectivity:** Investment in seamless connectivity among different modes of transport (e.g., integrating roads, railways, ports and airports) can improve efficiency and reduce logistical costs.
- **Digital infrastructure:** Modern transport systems often require investments in digital infrastructure for smart traffic management, real-time information and efficient operations.

An estimated USD 2.7 trillion in annual investment (USD 40.5 trillion in total) will be needed globally between 2016 and 2030 to achieve low carbon transport pathways, with 60-70% of this investment occurring in emerging economies.[79] However, regional investment gaps for transport infrastructure by 2040 are significant, estimated at USD 0.8 trillion for Africa, USD 1.6 trillion for Asia and USD 6.0 trillion for the Americas.[80] Low carbon transport pathways entail an integrated approach of "Avoid", "Shift" and "Improve" measures that must be implemented quickly to avoid lock-in effects of carbon-intensive and cost-intensive infrastructure and behavior.[81]

Global investment needs for transport infrastructure through 2050 are an estimated USD 50 trillion.[82] Reducing emissions through low carbon urban mobility would require investments totalling USD 1.83 trillion (around 2% of global GDP), which would result in estimated savings of USD 2.8 trillion in 2030 and nearly USD 7.0 trillion in 2050.[83]

- In Africa and in the Americas, 95% and 88% respectively of the investment gap is associated with road transport, whereas in Oceania the gap for road infrastructure is much smaller.[84] Globally, 88% of roadways do not meet minimum walking safety requirements, and 86% do not meet minimum cycling safety requirements.[85]
- More than 9 out of 10 streets in Africa do not meet minimum walking and cycling safety requirements (*see Section 3.2 Walking*). The Rural Access Index, measuring the share of people with access to an all-season road within a walking distance of 2 kilometres, shows that African countries have the lowest access, with shares reaching only 11.4% in Malawi and 22.3% in Mali in 2017.[86]

BOX 2. Projections of transport investment needs for low- and middle-income countries

- In 2019, the **World Bank** estimated that to pursue a decarbonisation pathway, low- and middle-income countries would need to increase their investment in transport infrastructure by 1.3% of GDP, with overall investment of USD 417 billion annually between 2015 and 2030. Ongoing spending on maintenance would require increasing spending by 2.6% of GDP.
- The **Inter-American Development Bank** estimates that closing gaps in road infrastructure, airports and public transport requires an annual investment of 1.37% of the regional GDP of Latin America and the Caribbean from 2019 to 2030.
- The **Asian Development Bank** estimates that developing Asia will need to invest USD 26 trillion from 2016 to 2030, or USD 1.7 trillion annually, to maintain its growth momentum, eradicate poverty and respond to climate change. Without climate change mitigation and adaptation costs, USD 22.6 trillion will be needed, or USD 1.5 trillion annually (baseline estimate). Of the total climate-adjusted investment needs over 2016-2030, USD 8.4 trillion is for transport.

Source: See endnote 78 for this section.

Partnership in Action

SLOCAT partners engaged in dozens of actions during 2020-2022, including:

- **Climate Bond Initiative** released version 2 of the Low Carbon Transport Criteria certifying low carbon transport green bonds.[87] Bonds certified under these Criteria will also automatically meet the green definitions for transport in the EU taxonomy on sustainable finance.
- **Financing Fundamentals For the Decarbonization of the Transport Sector** was developed in 2021 to facilitate an understanding of the power of innovative financing, guide policymakers and practitioners through best practices and case studies, and incentivise and advocate for political leadership and buy-in.[88] This activity has been developed with the leadership of the Transformative Urban Mobility Initiative (TUMI), the German Federal Ministry for Economic Cooperation and Development (BMZ), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the World Resources Institute (WRI), in collaboration with the SLOCAT Partnership on Sustainable, Low Carbon Transport.
- The **Global Facility to Decarbonize Transport (GFDT)** at the World Bank was established in fiscal year 2021 as a multi-donor trust fund. The GFDT supports the deployment of low carbon mobility and resilient transport solutions through: 1) project design and implementation (targeting pilot projects with measurable climate benefits that use innovative technology); 2) research and data (understanding that robust analytics are essential in identifying specific challenges and identifying the right solutions); and 3) capacity building (helping clients modernise policies, regulations and institutions to catalyse more resources for low carbon transport).
- **Towards a Gold Standard for Transport Investment – A blog series by SLOCAT** features a range of experts and change makers who are powering the sustainable, low carbon transport revolution by advancing adequate financing to reach the scale of decarbonisation of the transport sector necessary to achieve Paris Agreement targets.[89]
- **World Resources Institute's Reimagining Public Transport programme** provides sustainable financing for cities in Brazil, China, India and Mexico to enable funding for high-quality infrastructure and operations that can provide reliable and frequent service, affordable to the public, from government, the private sector and new forms of finance such as demand management.[90]

AUTHORS: Armin Wagner and Viviane Weinmann, *GIZ*

Capacity and Institutional Support to Achieve Sustainable, Low Carbon Transport

The demand for both passenger and freight transport continues to grow, driven by global and regional integration and urbanisation. Capacity development plays a critical role in addressing the many challenges facing the transport sector, from ensuring integrated planning to fostering inclusive and equitable human development in harmony with nature. However, to achieve meaningful and lasting impact, it is imperative to better understand the strengths and weaknesses of existing capacity development programmes, identify gaps and tailor interventions to meet the evolving needs of transport professionals, city authorities and other stakeholders.

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability Global Status Report - 3rd edition

Note: This spotlight explores the state of play of capacity development programmes in the transport sector. We invite feedback, advice and suggestions from practitioners, policy makers, researchers and all those invested in advancing capacity development in the sector. We also encourage international engagement and collaboration to foster knowledge sharing, best practices and the exchange of experiences across different regions and contexts.

Contexts and Challenges

Urban sprawl

A study by the International Transport Forum shows that despite global uncertainties, the world's urban population is expected to grow more than 40% by 2050, while urban passenger travel demand will almost double. Without sound regulatory frameworks, this will lead to significant urban sprawl.[1]

Investment gaps

As a result of the high growth in demand for passenger and freight transport, there are significant investment needs that can only be partially met. If investments do occur, they are often made in unsustainable infrastructure, with a road-centric focus that disregards integrated approaches to sustainable transport and mobility. Moreover, public administrations are frequently unable to adequately plan urban development (and with it urban transport), in particular using long-term perspectives.

City planning and management

According to the World Cities Report 2022, cities are facing a decrease in the share of planned areas **(see Figure 1)**.[2] Without sound planning and management capacities, urban areas are unable to achieve compact integrated and connected development.[3]

Administrative and institutional capacities

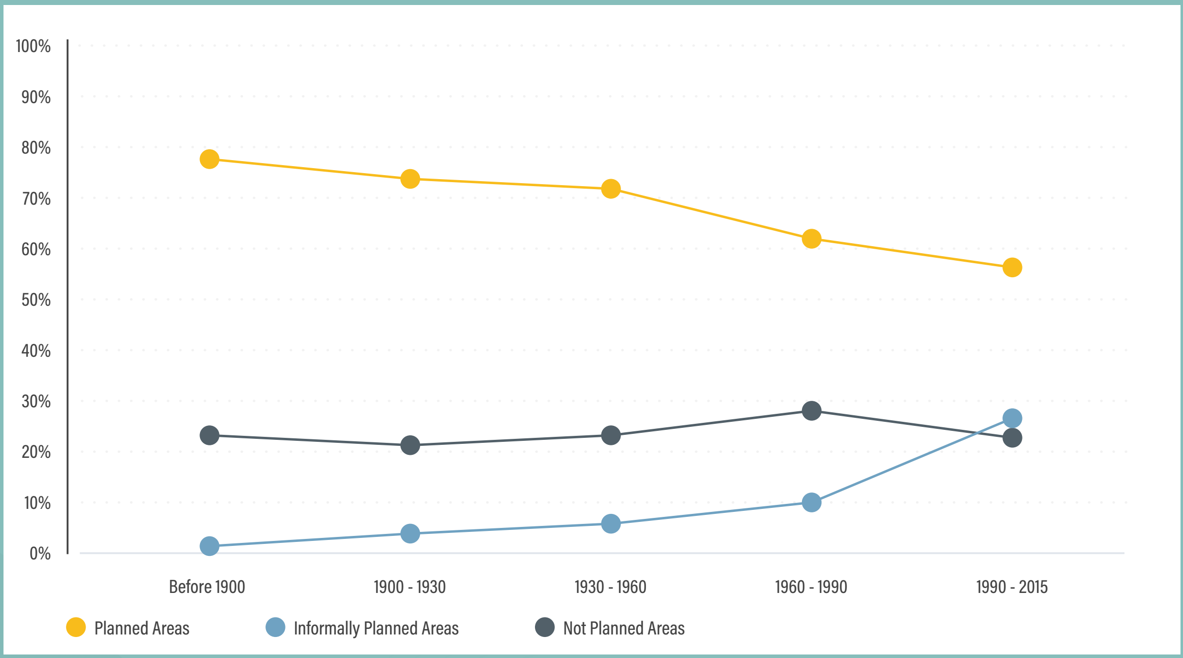
In addition to conflicting political directives or lack of investments at scale, deficiencies in administrative structures and limitations in personnel and institutional capacities are essential and frequent challenges that hinder integrated transport and mobility planning efforts.

Expectations for capacity building needs:

- **At the individual level**, transport experts are required to possess not only technical and economic skills but also abilities in areas such as reform support, negotiation management and financing to solve everyday transport issues while ensuring long-term sustainable mobility. The concept of lifelong learning is already being actively embraced, particularly in dynamic fields such as mobility, where innovation cycles are becoming shorter.
- **At the city level**, urban areas must manage the financing of transport infrastructure, establish reliable governance structures and consider a broad spectrum of environmental and societal requirements.
- **At the state level**, governments – particularly finance, transport, planning, and local self-government ministries – have the responsibility to establish appropriate regulatory frameworks for sustainable urban mobility.

FIGURE 1. Share of cities with planned areas, pre-1900 to 2015

Source: See endnote 2 for this section.



A stocktake on capacity development needs shows that only very limited, often sporadic information is available on the concrete needs for enhancing professional skills and strengthening institutions. There is no known regional or international quantified stocktaking.

As a first step, action is needed to conduct a comprehensive stocktake on capacity development in the transport sector, addressing the requirements and challenges facing transport experts, cities, states and the global community. This assessment should involve evaluating current training programmes, identifying gaps, sharing best practices and fostering international co-operation to accelerate the implementation of sustainable transport concepts worldwide.

Scale of challenge

Around 57% of the global population lived in urban areas in 2022.[4] By mid-century, the urban population is expected to near 68%, much of it in low- and middle-income countries.[5] The 20 largest cities in the fastest-growing nations – India, Nigeria, Pakistan, Ethiopia, Tanzania, Indonesia, Egypt and Congo – had an estimated combined population of 250 million people in 2018, which is projected to exceed 650 million by 2050.[6]

If we assume that 100 skilled personnel are needed to manage and plan urban mobility in cities with a population of under 1 million, and that 250 such personnel are required for cities with more than 1 million people, then around 25,000 skilled individuals would be required just for 160 cities. Considering the projected population increase, this number would increase to around 33,100 skilled personnel by 2050. The estimate does not account for the high turnover rate in public administration jobs or for the increasing complexity of these tasks in the future.

Since this calculation covers only less than 10% of the total urban population in low- and middle-income countries, a target number of at least 250,000 skilled staff across these countries would be a reasonable initial estimate. Notably, these figures do not account for the significant needs at the national and local levels for skilled planners in non-urban transport planning or in related areas such as urban planning and land management.

To refine the above calculations and provide a solid basis for decision making, the following questions need to be thoroughly assessed:

- How do the staffing requirements for urban mobility management differ based on city size and population?
- What are the potential consequences of not accounting for the high turnover rate in public administration jobs, and for the increasing complexity of urban mobility planning tasks in the future?
- What strategies can be implemented to attract and retain skilled personnel in urban mobility management positions?
- How does the estimated number of skilled personnel required for managing urban mobility in low- and middle-income countries compare to the current availability of such professionals?
- What are the potential impacts of a shortage of skilled staff in urban mobility management on the quality of urban infrastructure and services?
- How can the estimate of 250,000 skilled urban mobility planners across low- and middle-income countries be validated and refined based on the specific needs and characteristics of different cities and regions?

Approaches for capacity development

Various forms of capacity development are available in the transport sector. These vary by target group, size, methods, and content, reflecting the diversity of approaches used to enhance skills, knowledge and expertise in the field (see Table 1). By examining different methods such as webinars, e-learning, expert training, and on-the-job training, stakeholders can identify appropriate strategies to meet their specific capacity development needs (see Table 2). Gaining a better understanding of the range of approaches can lead to informed decision making and facilitate the adoption of effective capacity development practices in the transport sector.

What evidence exists regarding the impact and effectiveness of each form of capacity development mentioned above? The following questions include some of the aspects that must be thoroughly considered to get to such assessment:

- Are there any studies or evaluations that provide insights into the scalability and replicability of these capacity development approaches?

TABLE 1. Overview of different forms of capacity development in the transport sector

Form/Type of capacity development	Target group	Size	Methods	Content
Webinar	Transport experts, city officials, stakeholders	Variable	Online presentations, interactive discussions	Introduction to specific topics, knowledge sharing, case studies
E-learning	Transport professionals, city authorities, technicians	Variable	Online courses, modules, quizzes	Technical skills, policy frameworks, best practices
Dive-in training	City planners, engineers, project managers	Small to medium groups	On-site visits, field exercises, workshops	Hands-on experience, project-specific skills, problem solving
Expert training	Transport professionals, policy makers, government officials	Small to medium groups	Workshops, seminars, expert-led sessions	In-depth knowledge, policy development, strategic planning
On-the-job training	Transport operators, technicians, new hires	Individual or small groups	Mentoring, shadowing, hands-on practice	Practical skills, operational procedures, safety protocols
Formal education	Students, aspiring professionals	Large groups	Classroom lectures, coursework, examinations	Theoretical knowledge, technical skills, research methods

TABLE 2. Capacity needs and impacts of different stakeholders

Stakeholders	Needs	Impact
Political decision makers/ management in city administrations/transport companies – alignment of initiatives, programmes and projects towards sustainable mobility/e-mobility	■ Planning of initiatives, programmes and projects towards sustainable mobility/e-mobility ■ Initiation of reform steps ■ Innovation	■ Active on-the-job training/mentoring ■ Long-term: sustainable mobility in academic curricula and/or links to government career programmes
Employees in city/regional administrations in transport departments, etc.	■ Planning and implementation of projects in the field of sustainable mobility (infrastructure/ vehicles)	■ (Academic) training ■ Further education through training ■ On-the-job training
Employees in transport companies (bus drivers, mechanics, electronics technicians, etc.)	■ Education and training for the operation of sustainable infrastructure and (electric) vehicles	■ Training (dual vocational education and training) ■ Continuing education ■ On-the-job training

- How can we measure and assess the long-term impact of different capacity development methods on the skills, knowledge and performance of individuals and organisations?
- What are the potential barriers and challenges in scaling up these capacity development approaches across different contexts and regions?
- Have there been any successful examples of scaling up specific forms of capacity development? If so, what were the key factors that contributed to their scalability?
- What strategies and resources are needed to expand the reach and impact of webinars, e-learning and other technology-enabled capacity development methods?
- How can we ensure that expert training and on-the-job training programmes are accessible to a larger number of participants without compromising the quality of learning?
- What collaborative efforts and partnerships can be established to promote the scaling up of effective capacity development models, such as sharing best practices and lessons learned?
- How can data-driven approaches, including monitoring and evaluation, help inform the scaling up of capacity development initiatives in the transport sector?
- Are there specific policies, funding mechanisms or regulatory frameworks that need to be in place to support the scaling up of different forms of capacity development?
- What capacity development programmes and initiatives are in place at the individual, city, state and global levels?
- How effective have these programmes been in addressing the skills and knowledge gaps in the transport sector?
- What are the strengths and weaknesses of the existing capacity development initiatives?
- Are there any gaps or areas that require further attention?

In recent years, the global transport community has built up a substantial range of capacity developments offers. The following is a non-exhaustive list of example efforts and offerings funded by Germany's Agency for International Cooperation (GIZ):

- The **Leaders in Urban Transport Planning (LUTP)** programme empowers policy makers with the skills needed to identify, prepare and implement holistic strategies that address complex urban transport challenges.[7]
- The **Master 2 en Transport et Mobilité Durable dans les Villes Africaines programme** – created in 2014 by CODATU, Senghor University, the African School of Architecture and Urban Planning (EAMAU) and the National Conservatory of Arts and Crafts of Paris (CNAM) – supports the development professional sectors in the field of transport and urban mobility and contributes to the strengthening of expertise in African countries.[8]
- To scale and facilitate the capacity building process, **MobiliseYourCity** developed a full catalogue of training materials, summarising the most important knowledge on Sustainable Urban Mobility Planning.[9]

- The **Transformative Urban Mobility Initiative (TUMI)** is the leading global implementation initiative on sustainable mobility, formed through the union of 11 globally recognised partners. The TUMI Training Catalogue offers a range of tailor-made sessions to dive deep into the topic of accessibility in public transport modes (e.g., cycling, electric buses, gender, leadership, planning).[10]
- The e-learning course **Transforming Urban Mobility: Introduction to Transport Planning for Sustainable Cities** covers the different dimensions of sustainable urban mobility, including the "Avoid-Shift-Improve" framework, which strives to achieve significant reductions in greenhouse gas emissions, energy consumption, and congestion, with the ultimate objective of creating more liveable cities (see Table 3).[11]

Further questions for consideration:

- What capacity development programmes and initiatives are in place at the individual, city, state and global levels?
- How effective have these programmes been in addressing the skills and knowledge gaps in the transport sector?
- What are the strengths and weaknesses of the existing capacity development initiatives?
- Are there any gaps or areas that require further attention?

TABLE 3. List of e-learning courses of Transforming Urban Mobility: Introduction to Transport Planning for Sustainable Cities

Thematic field	Country	Target group	Contact	Web link
Transforming Urban Mobility: Introduction to Transport Planning for Sustainable Cities	Global	All stakeholders / Online	TUMI	https://www.futurelearn.com/courses/introducing-sustainable-urban-mobility
Transforming Urban Mobility: Components of Transport Planning for Sustainable Cities	Global	All stakeholders / Online	TUMI	https://www.futurelearn.com/courses/components-of-sustainable-urban-mobility
Achieving Transitions to Zero Carbon Emissions and Sustainable Urban Mobility	Global	All stakeholders / Online	Funded by EIT Implemented by UCL, TUMI, ICLEI	https://www.futurelearn.com/courses/achieving-zero-carbon-sustainable-urban-mobility
MRV – Emission Monitoring, Reporting & Verification (MRV)	Global	All stakeholders / Online	TraCs	Launch planned for 2023
Gender & Inclusive Mobility Course 1	Global	All stakeholders / Online	WMW (by TUMI)	Launch planned for 2023
Gender & Inclusive Mobility Course 2	Global	Advanced experts / Online	WMW (by TUMI)	Launch planned for 2023
Digitisation, E-Mobility	Global	All stakeholders / Public Transit Agencies / Operators	TUMI E-Bus Mission	https://www.mobility-academy.eu/enrol

Better data and capacity development

Data on capacity development in all its dimensions are crucial for effective planning, implementation and evaluation of interventions in the transport sector. Collecting and analysing relevant data can provide valuable insights into the effectiveness, impact and gaps in capacity development efforts. A comprehensive overview is lacking on the current offers, as well as on demand, quality of staff and institutions, etc. To fully assess the state of capacity development, the following data could be needed:

- **Demographic data:** Information on the target audience, such as transport experts, city officials, and stakeholders, including their profiles, qualifications and areas of expertise (capacity needs assessment).
- **Skill assessment data:** Assessments or evaluations of the skills and knowledge levels of participants before and after the capacity development programmes to measure the impact and effectiveness of the interventions.
- **Resource allocation data:** Data on the financial resources allocated to capacity development initiatives, including budgetary allocations for training programmes, infrastructure development and support systems like mentorship or coaching.
- **Stakeholder engagement data:** Information on the level of engagement and collaboration with stakeholders – such as transport agencies, academic institutions, private sector entities and civil society organisations – to understand the extent of partnerships and knowledge sharing.
- **Monitoring and evaluation data:** Data collected during the monitoring and evaluation process, including feedback from participants, surveys, and qualitative or quantitative assessments of program outcomes and impacts.
- **Performance data:** Data on the performance of trained individuals or teams, such as project outputs, achievements and improvements in their respective roles within the transport sector.
- **Sustainability data:** Data on the long-term effects and sustainability of capacity development efforts, including the retention of trained professionals, the integration of new skills and practices into policies or processes, and the establishment of knowledge sharing networks.
- **Training data:** Data related to the various forms of capacity development, including the number of participants, duration of training and types of training methods employed (e.g., webinars, e-learning, on-the-job training).

Collecting and analysing these types of data can provide valuable insights into the strengths and weaknesses of capacity development initiatives, facilitate evidence-based decision making, inform resource allocation and support continuous improvement in the field of transport capacity development. This should also reflect the current and potential role of national governments and institutions as well as international partners.

To institutionalise data collection and facilitate the provision of information, the establishment of a global transport and capacity development observatory (or similar format) could be encouraged. This should bring together stakeholders both from the transport arena and from education and skills backgrounds. Further, there is a need to better understand the financial implications (costs and benefits) of enhanced training and education in the field of transport.

Sustainability of capacity development efforts

Ensuring the sustainability of capacity development efforts requires continuously integrating the sustainability approach into global efforts for capacity development. To achieve lasting engagement from participants, simple measures such as establishing an alumni network and setting up a helpdesk should be implemented on the local, regional and international levels. Such resources enable participants to continue benefiting from ongoing communication and support even after completing the training.

To incorporate additional knowledge partners in the long run, a franchise-like approach with quality-assured individual products can be considered. By forming strategic partnerships, collaborating with experts in specific domains, and leveraging their knowledge, the training efforts can expand and address a wider range of topics.

Additional questions based on the given items include:

- How can we ensure the long-term sustainability of international capacity development approaches?
- What measures can be taken to continuously monitor and ensure the quality of the covered topics?
- What strategies can be implemented to foster lasting engagement and involvement from participants, such as alumni networks or helpdesk services?
- How can we effectively support participants and international partners in applying the knowledge gained during the training in real-life situations?

- What approaches can be adopted to involve additional knowledge partners and expand the training offerings while maintaining quality assurance?
- How can we develop sustainable approaches to finance training and education in the field of transport?

With a broader perspective, we should continue analysing the role of international co-operation and knowledge exchange:

- How are countries and cities collaborating and sharing knowledge in the field of sustainable transport?
- What mechanisms are in place for international co-operation and knowledge exchange, within and beyond the activities related to official development assistance?
- How can existing networks and platforms be strengthened or expanded to facilitate knowledge sharing and collaboration?

Way forward

To really make a difference in the area of capacity development for transport and mobility, a comprehensive approach is needed that ambitiously drives the transformation of transport and mobility systems worldwide. Concerted action is required that 1) develops new narratives, 2) penetrates the identified areas of public administration management, and 3) initiates the corresponding transformation course. Action areas comprise the following:

Standards and guidelines:

- Renew all construction standards, guidelines, related documents, etc. in the next 10 years and align them with the topics of climate and sustainable development (i.e., international promotion of "comprehensive renewal").
- Identify the best standards and regulations worldwide, extract the technical core and make it available internationally, and introduce it into dialogue formats.
- Ensure accessibility to sustainable infrastructure for populations, and set targets to build implementation capacity.

Professional associations:

- Provide broad support for (new) professional associations in the transport sector that meet ambitious objectives.
- Create wider impact through connection to neighbouring fields such as urban development, etc.
- Link to career development.

Education (among others):

- Modernise the curricula, teaching materials and supporting materials and underpin them with comprehensive audiovisual communication.
- Create and expand sustainability clusters (bubbles) and penetrate and transform existing bubbles (architects, investors).
- Use existing social platforms to democratise education, through the creation of bottom-up content (memes, infographics, local examples).
- Use a data point system similar to that used by architects and link it to the career process.

Together, it is possible to work towards enhancing the effectiveness and impact of capacity development efforts for more inclusive, sustainable, and efficient transport and mobility systems.

Methodological Note

Data Usage

Time Period for data

The report strives to utilise the most recent publicly available data and information just prior to the time of publication (as of 30 May 2023). The majority of figures in the report were developed between September and December 2022 using the most recent data available at that time.

Secondary data

SLOCAT relies on secondary data and information collected and provided by SLOCAT partners and other entities and does not make use of any internal modelling tools.

Data on sustainable mobility: A call to action

The report benefits directly from data collected by a wide range of stakeholders working in different areas of transport.

Data are important for providing a comprehensive picture of the status of sustainable, low carbon transport and are essential for both policy and investment decision making. In these times of change, it is critical to upgrade data and policy collection and interpretation capacities to better understand progress and the hurdles that must be addressed.

The data limitations mentioned below are not new. Obtaining regular, reliable and public data across regions and transport modes remains an outstanding issue. When an increasing number of stakeholders are collecting data and policy information, more and better open-access data and capacity building efforts for data interpretation are supported by many multi-stakeholder partnerships in the sustainable, low carbon movement.

If you share our passion for open-access data and knowledge towards greater impact on policy and investment decision making worldwide and/or would like to contribute data or knowledge to our collective efforts on this report, **please reach out to the research team in the SLOCAT Secretariat at tcc-gsr@slocatpartnership.org**.

Specific data used in this report

Data on emissions

The data in this edition of the report point to the direct carbon emissions from transport activity; they do not cover the indirect emissions and land-use impacts associated with certain modes of transport. The report primarily utilises CO_2 emission data compiled in the Emissions Database for Global Atmospheric Research (EDGAR) from the Joint Research Centre of the European Commission, as this represents the most recent, comprehensive dataset on transport CO_2 emissions. However, this global dataset does not convey in full detail the unique situations of individual countries. EDGAR provides estimates for fossil CO_2 emissions from all anthropogenic activities with the exception of land use, land-use change, forestry and the large-scale burning of biomass. The main activities covered are CO_2 emissions emitted by the power sector (i.e., power and heat generation plants), by other industrial combustion (i.e., combustion for industrial manufacturing and fuel production) and by buildings and other activities such as industrial process emissions, agricultural soils and waste. Transport activities covered within EDGAR include road transport, non-road transport, domestic aviation, and inland waterways on a country level, as well as international aviation and shipping.

For the world, regions and countries, the CO_2 emission data (provided by EDGAR) span through 2021. In a few places in the report, CO_2 data for 2022 are shown to illustrate the impact of the COVID-19 pandemic; however, these data are based on a different methodology than the EDGAR dataset and should not be compared directly with the data from previous years. The latest CO_2 emission data for individual transport modes as well as passenger and freight transport are for 2019 and have been compiled only at the global level. Data on passenger activity (passenger-kilometres) and freight activity (tonne-kilometres) – provided mainly in the country fact sheets – are based on the latest available year, as indicated in the report analysis.

Information on greenhouse gas emissions – provided in CO_2 equivalent (CO_2eq) – include not only CO_2 but also methane, nitrous oxide, and industrial gases such as hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride. These data are less up-to-date. As of 31 May 2021, data on greenhouse gas emissions were not readily available for the period 2019-2020. In some cases, additional data sources were used to provide detailed information about other climate pollutants besides CO_2.

All data on CO_2 and other greenhouse gas emissions, as well as CO_2eq, are provided in metric tonnes.

Data on vehicle fleets

The motorisation rate (as reflected in vehicles per 1,000 people) is based on information by the International Road Federation (IRF)'s World Road Statistics 2022. The indicator "Total Vehicles In Use Rate by Population" by IRF covers all road motor vehicles except motorcycles. The most recent data point between the years 2016 and 2020 have been used to allow global comparisons to a certain degree.

Policy landscape data

Policy-related information presented in this report is mainly focused on 2021 and 2022, with a few exceptional cases and significant developments until May 2023. This information is not intended to be comprehensive. The data for the policy landscape indicators provided in Section 3 were gathered through desk research unless otherwise indicated. Barriers to accessing such information include language and limited availability of information through online media (e.g., websites, press releases and news articles).

Data in country fact sheets

Information in the fact sheets is based on desk research and on contributions from the national focal points. The data were collected to the best of the authors' knowledge and based on data availability, and thus may not be complete or show the most recent status. When no information is available for a given indicator, the term "Not available" is used.

Data gaps

Major data gaps exist in areas where there is no globally accepted data collection methodology. For example, the mapping of cycling and walking infrastructure is not currently done in all regions. Also, the modal share can be surveyed through different methods, leading to inconsistencies in available data. In addition, data on paratransit (informal transport), a predominant form of transport in many parts of the world, are largely lacking. This results in an incomplete picture of the impact of transport on climate change and sustainable development.

Methodological approach

Countries and regions

The report follows the M49 Standard of the United Nations Statistics Division. In total, 196 countries have official United Nations membership and are also party to the United Nations Framework Convention on Climate Change. The available data have been put in a common structure for the United Nations member countries, regions and income groups to enable a consistent assessment. Income groups are based on the World Bank's classification of 2022.

Economic calculations

The per capita and gross domestic product (GDP) calculations are based on the United Nations World Population Prospects 2022 and on World Bank GDP data using constant 2015 USD.

Spatial and temporal scales

The geographic scale (global, national, city-level, etc.) as well as time scale (annual, monthly, daily) used in this report depends largely on the available dataset, as noted in the relevant figures and text. The detailed data forming the basis of the calculations and analysis are provided in the SLOCAT Transport Knowledge Base.

Criteria for selection

The report covers policies, targets, emission reductions (achieved or envisioned) and market measures. To merit inclusion in the analysis, the policies, projects and trends must have been announced or completed between 2021 and 2022. Significant developments from January through May 2023 were included when deemed relevant, with the understanding that the next edition of the *SLOCAT Transport, Climate and Sustainability Global Status Report* will cover a period starting from mid-2023.

Pre- and post-COVID-19 pandemic trends

The year 2020 was pivotal for the world, and the COVID-19 pandemic has had substantial impacts on many of the transport trends monitored in this report. This edition attempts to differentiate between long-term trends and impacts due to the pandemic. To the extent possible, the analysis notes "pre-pandemic" (up to the end of 2019 or latest by February 2020) and "during pandemic" trends (starting in March 2020 until the end of 2020), as in some cases the pandemic led to reversals in long-term trends, at least for a specific period of time. In each section, a box describes the impacts that the pandemic has had on specific regions and sub-sectors.

Assembling the report

Advisory Team

This edition of the report was guided by a global advisory team consisting of 23 experts in the field who provided inputs over the span of six meetings between April 2022 and September 2023; with ad-hoc support in the months following release to nourish the report's broader dissemination strategy.

Authors and contributors

The report was collaboratively drafted by over 60 authors and contributors from 33 organisations, led by the SLOCAT Secretariat. This includes additions and high-level inputs from the chief advisor and copyeditor of the report. Authors researched and compiled relevant facts and figures for the five sections of the report, including the Spotlights, with supporting review and inputs from several contributing organisations.

Peer review: A peer review was carried out in April and May 2023 with 650+ comments received from 40+ reviewers. Each comment was individually reviewed by the SLOCAT Secretariat and considered in finalising the report.

List of Abbreviations

°C . . . . . . Celsius
A-S-I . . . . Avoid-Shift-Improve
A2Z . . . . . Accelerating to Zero Coalition
A4E . . . . . Airlines For Europe
AAAM . . . . African Association of Automotive Manufacturers
ACEA . . . . European Automobile Manufacturers Association
ACI . . . . . Airports Council International Europe
ADA . . . . . Americans with Disabilities
ADB . . . . . Asian Development Bank
AFD . . . . . Agence Française de Développement
AfDB . . . . African Development Bank
ALP . . . . . Asia LEDS Partnership
ANWAC . . African Network for Walking and Cycling
ARENA . . . Australian Renewable Energy Agency
ARTC . . . . Australian Rail Track Corporation
ASEAN . . . Association of Southeast Asian Nations
AVERE . . . European Association for Electromobility
B10 . . . . . 10% biodiesel blend in diesel
B30 . . . . . 30% biodiesel blend in diesel
B100 . . . . . 100% biodiesel blend in diesel
BAK . . . . . Boda Boda Safety Association of Kenya
BAU . . . . . Business as usual
BDI . . . . . Federation of German Industries
BMZ . . . . . German Ministry for Economic Cooperation and Development
BRT . . . . . Bus rapid transit
BS . . . . . . Bharat Stage
CAF . . . . . Development Bank of Latin America
CBI . . . . . Confederation of British Industry
CDRI . . . . Coalition for Disaster Resilient Infrastructure
CEOE . . . . Spanish Confederation of Business Organizations
CEVA . . . . Corporate Electric Vehicle alliance
CLEPA . . . European Association of Automotive Suppliers
CLG . . . . . Corporate Leaders Group
CNAM . . . . National Conservatory of Art and Crafts of Paris
CNG . . . . . Compressed natural gas
CO2 . . . . . Carbon dioxide
COP26 . . . United Nations Climate Change Conference in Glasgow, UK
COP27 . . . United Nations Climate Change Conference in Egypt
DATUM . . . Datos Abiertos de Transporte Urbano y Movilidad
DT4A . . . . Digital Transport for Africa
e-mobility Electric mobility
e-bike . . . Electric bike
e-scooter . Electric scooter
e.g. . . . . . For example
EAMAU . . African School of Architecture and Urban Planning
ECF . . . . . European Cyclists' Federation
ECOWAS . . Economic Community of West African States
ECSA . . . . European Community Shipowners' Associations
EDGAR . . . Emissions Database for Global Atmospheric Research
EIE . . . . . Environmental Insights Explorer
ERA . . . . . European Regions Airline Association
ERPS . . . . European Parliamentary Research Service
ERRAC . . . European Rail Research Advisory Council
ERT . . . . . European Round Table for Industry
ESCAP . . . Economic and Social Commission for Asia and the Pacific
ETS . . . . . Emission Trading System
ETS . . . . . Emission trading scheme
EU . . . . . . European Union
EV . . . . . . Electric vehicle
FAME . . . . Faster Adoptions and Manufacturing of Hybrid and Electric Vehicles
FDI . . . . . Foreign direct investment
g . . . . gram
GBP . . . . . British pound sterling
GDP . . . . . Gross domestic product
GEF . . . . . Global Environment Facility
GFDT . . . . Global Facility to Decarbonize Transport
GFEI . . . . . Global Fuel Economy Initiative
Gg . . . . . . Gigagrams
GIZ . . . . . Deutsche Gesellschaft für Internationale Zusammenarbeit
GLEC . . . . Global Logistics Emission Council
GVCs . . . . Global value chains
GW . . . . . Gigawatts
HCN . . . . Health and Climate Network
HDM . . . . . Highway Development and Management Model
HEAT . . . . Health Economic Assessment Tool
ICAO . . . . International Civil Aviation Organization
ICCT . . . . . International Council on Clean Transportation
ICLEI . . . . Local Governments for Sustainability
IDB . . . . . Inter-American Development Bank
IEA . . . . . International Energy Agency
IFIEC . . . . International Federation of Industrial Energy Consumers
IISD . . . . . International Institute for Sustainable Development
ILO . . . . . . Internation Labour Organization
IKI . . . . . . International Climate Initiative
IMF . . . . . International Monetary Fund
IMO . . . . . International Maritime Organization
IPCC . . . . . Intergovernmental Panel on Climate Change
IRAP . . . . International Road Assessment Programme
IRENA . . . International Renewable Energy Agency
IRF . . . . . . International Road Federation
ISM . . . . . Informal and Shared Mobility in Low- and Middle-Income Countries
ISO . . . . . International Organization for Standardization
ISSB . . . . International Sustainability Standards Board
ITDP . . . . . Institute for Transportation and Development Policy
ITDP . . . . . Institute for Transport and Development Policy
ITF . . . . . . International Transport Forum
ITS . . . . . . Institute of Transport Studies
JETPs . . . . Just Energy Transition Partnerships
km . . . . . . kilometre
kWh . . . . . kilowatt-hour
LAMAT . . . Locally Adapted Modified and Advanced Transport
LEDS . . . . Low-emission development strategy
LEZs . . . . Low-emission zones
LFP . . . . . Lithium iron phosphate
LG-CTA . . . Leadership Group for Clean Transport in Asia
LNG . . . . . Liquified natural gas
LOTUS . . . Low Carbon Transport for Urban Sustainability Initiative
LPG . . . . . Liquefied petroleum gas
LT-LEDS . . Long-Term Low Emission Development Strategies
LTS . . . . . Long Term Strategies
LUTP . . . . Leaders in Urban Transport Planning
MaaS . . . . Mobility-as-a-service
MAC . . . . . Mobility and access
MDB . . . . . Multilateral development bank
MDS . . . . . Mobility Data Specification
MEDEF . . . Mouvement des Enterprises de France
MGPCA . . Marrakech Partnership for Global Climate Action
Mj . . . . . . Megajoule
MNEs . . . . Multi-national enterprises
MRV . . . . . Emission monitoring, reporting and verification
MTCC . . . . Maritime Technology Cooperation Centre
Mtoe . . . . Million tonnes oil equivalent
NACTO . . . National Association of City Transportation Officials
NAMAs . . . Nationally appropriate mitigation actions
NAPAs . . . National adaptation programmes of action
NAPs . . . . National Adaptation Plans
NDC-TIA . . NDC Transport Initiative for Asia
NDCs . . . . Nationally Determined Contributions
NEDC . . . . New European Driving Cycle
NEM . . . . . National electricity market
NO2 . . . . . Nitrogen dioxide
NTS2 . . . . Scotland's National Transport Strategy
NUMO . . . New Urban Mobility Alliance
NUMPs . . . Sustainable urban mobility plans
NZ . . . . . . Net Zero
OECD . . . . Organisation for Economic Co-operation and Development
PAAPAM . . Pan-African Action Plan for Active Mobility
PATH . . . . Partnership for Active Travel and Health
PCREEE . . Pacific Centre for Renewable Energy and Energy Efficiency
PDR . . . . . People's Democratic Republic
PGK . . . . . Papua New Guinean Kina
PIARC . . . World Road Association
PIDF . . . . Pacific Islands Development Forum
PLAMOBI Latin American Bicycle Mobility Platform
PLI . . . . . Production Linked Incentive
PM . . . . . . Particulate matter
PPPs . . . . Public-private partnerships
R&D . . . . . Research and development
RAAHI . . . Auto-Rickshaw in Amritsar through

Holistic Intervention
REN21. . . . Renewable Energy Policy Network for the 21st Century
SAF . . . . . Sustainable aviation fuels
SBT . . . . . Science Based Targets Initiative
SDGs . . . . Sustainable Development Goals
SEMOVI . . Mexico City's Mobility Secretariat
SIDS . . . . Small island developing states
SLOCAT . . SLOCAT Partnership on Sustainable, Low Carbon Transport
SMMT . . . Society of Motor Manufacturers and Traders
SULPs . . . Sustainable urban logistics plans
SUMPs . . . Sustainable urban mobility plans
SUV . . . . . Sport utility vehicles
TCFD . . . . Task Force on Climate-related Financial Disclosures
TEN-T . . . . Trans-European Transport Network
THE PEP . . Transport, Health and Environment Pan-European Programme
TUMI . . . . Transformative Urban Mobility Initiative
UC . . . . . University of California
UCI . . . . . Union Cycliste Internationale
UCL . . . . . University Colleague London
UIC . . . . . International Union of Railways
UITP . . . . International Association of Public Transport
UK . . . . . . United Kingdom
ULEZs . . . Ultra-low-emission zones
UN . . . . . . United Nations
UNCTAD . . United Nations Conference on Trade and Development
UNDP . . . . United Nations Development Program
UNDRR . . . United Nations Office for Disaster Risk Reduction
UNECE . . . United Nations Economic Commission for Europe
UNEP . . . . United Nations Environment Programme
UNFCCC . . United Nations Framework Convention on Climate Change
UNIDO . . . United Nations Industrial Development Organization
US . . . . . . United States
US . . . . . . United States
USA . . . . . United States of America
USD . . . . . United States Dollar
VDA . . . . . German Association of the Automotive Industry
VNO-NCW Dutch Employers' Federation
VNRs . . . . Voluntary national reviews
VREF . . . . Volvo Research and Education Foundations
WBCSD . . World Business Council for Sustainable Development
WHO . . . . World Health Organization
WRI . . . . . World Resources Institute
WSC . . . . World Shipping Council
ZEBRA . . . Zero Emission Bus Rapid-deployment Accelerator
ZEZ-Fs . . . Zero-emission zones for freight
ZEZs . . . . Zero-emission zones

Endnotes

1.1
TRANSFORMING TRANSPORT AND MOBILITY TO ACHIEVE THE TARGETS OF THE PARIS AGREEMENT AND THE SUSTAINABLE DEVELOPMENT GOALS

1 Analysis from the SLOCAT Partnership for Sustainable, Low Carbon Transport (SLOCAT), based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

2 Intergovernmental Panel on Climate Change (IPCC) (2022), "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/sixth-assessment-report-working-group-3.

3 IPCC (2022), "Synthesis Report of the IPCC Sixth Assessment Report (AR6): Summary for Policymakers", https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf.

4 Ibid.

5 SLOCAT (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd Edition", www.tcc-gsr.com.

6 Global Monitoring Laboratory (2023), "Trends in Atmospheric Carbon Dioxide", https://gml.noaa.gov/ccgg/trends/global.html, accessed 7 February 2023.

7 IPCC (2022), "Climate Change 2022: Mitigation of Climate Change. Summary for Policymakers", https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf.

8 **Figure 1** from US National Aeronautics and Space Administration (NASA) (2022), "GISS Surface Temperature Analysis (v4)", https://data.giss.nasa.gov/gistemp/graphs_v4, accessed 20 August 2022.

9 IPCC, op. cit. note 7.

10 Ibid.

11 P. Friedlingstein et al. (2022), "Global carbon budget 2022", *Earth System Science Data*, Vol. 14, pp. 4811-4900, https://doi.org/10.5194/essd-14-4811-2022.

12 SLOCAT analysis based on Crippa et al., op. cit. note 1.

13 Z. Hausfather and P. Friedlingstein (2022), "Analysis: Global CO2 Emissions from Fossil Fuels Hit Record High in 2022", Carbon Brief, https://www.carbonbrief.org/analysis-global-co2-emissions-from-fossil-fuels-hit-record-high-in-2022.

14 Ibid.

15 L. de Klerk et al. (2022), "Climate Damage Caused by Russia's War in Ukraine", https://climatefocus.com/wp-content/uploads/2022/11/ClimateDamageinUkraine.pdf.

16 Ibid.

17 Ibid.

18 IPCC, op. cit. note 7.

19 Renewable Energy Policy Network for the 21st Century (REN21) (2023), "Renewables 2023 Global Status Report: Transport in Focus", https://www.ren21.net/gsr-2023/modules/energy_demand/03_transport_in_focus.

20 SLOCAT analysis based on Crippa et al., op. cit. note 1.

21 **Figure 2** from Ibid.

22 Ibid.

23 Ibid.

24 **Figure 3** from Ibid.

25 **Figure 4** from Carbon Monitor (2023), "CO_2 Emissions Variation", https://carbonmonitor.org/variation, accessed 7 February 2023.

26 International Energy Agency (IEA) (2022), "Transport: Sectoral Overview", https://www.iea.org/reports/transport.

27 **Figure 5** from SLOCAT analysis based on Crippa et al., op. cit. note 1.

28 Ibid.; World Bank (2022), "GDP (constant 2015 US$)", http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

29 SLOCAT analysis based on Crippa et al., op. cit. note 1.

30 L. Cozzi, O. Chen and H. Kim, (2023), "The world's top 1% of emitters produce over 1 000 times more CO2 than the bottom 1%," IEA, https://www.iea.org/commentaries/the-world-s-top-1-of-emitters-produce-over-1-000-times-more-co2-than-the-bottom-1.

31 Ibid.

32 SLOCAT analysis based on Crippa et al., op. cit. note 1.

33 **Figure 6** from Ibid.

34 Ibid.

35 Ibid.

36 Shell (2020), "The Energy Transformation Scenarios", https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html, accessed 20 August 2022.

37 **Figure 7** from Ibid.

38 IEA (2023), "CO2 Emissions from Trucks and Buses, 2000-2021, and 2030 in the Net Zero Scenario", https://www.iea.org/data-and-statistics/charts/co2-emissions-from-trucks-and-buses-2000-2021-and-2030-in-the-net-zero-scenario, accessed 9 February 2023.

39 US International Trade Commission (2020), "The Impact of the COVID-19 Pandemic on Freight Transportation Services and U.S. Merchandise Imports", https://www.usitc.gov/research_and_analysis/tradeshifts/2020/special_topic.html.

40 Shell, op. cit. note 36.

41 Ibid.

42 International Transport Forum (ITF) (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

43 M. Klöwer et al. (2021), "Quantifying aviation's contribution to global warming", *Environmental Research Letters*, Vol. 16, p. 10402, https://iopscience.iop.org/article/10.1088/1748-9326/ac286e.

44 SLOCAT analysis based on Crippa et al., op. cit. note 1.

45 S. Gössling and A. Humpe (2020), "The global scale, distribution and growth of aviation: Implications for climate change", *Global Environmental Change*, Vol. 65, https://doi.org/10.1016/j.gloenvcha.2020.102194.

46 SLOCAT analysis based on Crippa et al., op. cit. note 1.

47 Ibid.

48 IEA (2022), "Aviation Tracking Report", https://www.iea.org/reports/aviation.

49 Gössling and Humpe, op. cit. note 45.

50 Ibid.

51 Cozzi, Chen and Kim, op. cit. note 30.

52 Yard Digital PR Team (2022), "Just Plane Wrong: Celebs with the Worst Private Jet CO2 Emissions", https://weareyard.com/insights/worst-celebrity-private-jet-co2-emission-offenders.

53 International Air Transport Association (IATA) (2022), "The Impact of the War in Ukraine on the Aviation Industry", https://www.iata.org/en/iata-repository/publications/economic-reports/the-impact-of-the-conflict-between-russia-and-ukraine-on-aviation.

54 J. Bailey (2023), "One Year of War: How Russia's War in Ukraine Is Affecting Aviation", Simple Flying, 24 February, https://simpleflying.com/one-year-of-war-how-russias-war-in-ukraine-is-affecting-aviation

55 Ibid.

56 SLOCAT analysis based on Crippa et al., op. cit. note 1.

57 N. Degnarain (2020), "Calls for Global Shipping to Ditch Fossil Fuels and Meet Climate Goals", Forbes, 25 September, https://www.forbes.com/sites/nishandegnarain/2020/09/25/loud-calls-for-global-shipping-to-ditch-fossil-fuels-and-meet-climate-goals.

58 SLOCAT analysis based on Crippa et al., op. cit. note 1.

59 **Figure 8** from Ibid.

60 United Nations Conference on Trade and Development (UNCTAD) (2022), "Maritime Trade Disrupted: The War in Ukraine and Its Effects on Maritime Trade Logistics", https://unctad.org/system/files/official-document/osginf2022d2_en.pdf.

61 ITF, op. cit. note 42.

62 IPCC (2022), "Climate Change 2022: Mitigation of Climate Change", https://www.ipcc.ch/report/sixth-assessment-report-working-group-3.

63 ITF, op. cit. note 42.

64 IPCC, op. cit. note 62.

65 ITF, op. cit. note 42.

66 SLOCAT analysis based on Crippa et al., op. cit. note 1; International Civil Aviation Organization (ICAO) (2022), "Report on the Feasibility of a Long-Term Aspirational Goal", https://www.icao.int/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixR2.pdf.

67 International Maritime Organization (IMO) (2020), "Fourth Greenhouse Gas Study 2020", https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx.

68 ITF, op. cit. note 42.

69 S. Gota and C. Huizenga (2022), "Asian Transport 2030 Outlook", https://asiantransportoutlook.com/analytical-outputs/asian-transport-2030-outlook.

70 World Resources Institute (2022), "Transport, Systems Change Lab", https://systemschangelab.org/transport.

71 Ibid.

72 IEA (2023), "Analysis: Transport", https://www.iea.org/analysis/all?topic=transport.

73 IEA (2023), "Energy Technology Perspectives 2023", https://www.iea.org/reports/energy-technology-perspectives-2023.

74 IEA (2023), "ETP Clean Energy Technology Guide", https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide?selectedSector=Transport, accessed 11 April 2023.

75 SLOCAT (2022), "Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies, October 2022 Update", www.slocat.net/ndcs.

76 United Nations Environment Programme (UNEP) (2022), "Emissions Gap Report 2022: The Closing Window – Climate Crisis Calls for Rapid Transformation of Societies", https://www.unep.org/emissions-gap-report-2022.

77 Ibid.

78 Ibid.

79 SLOCAT, op. cit. note 75.

80 Ibid.

81 P. Jaramillo et al. (2022), "Transport", in IPCC, op. cit. note 62.

82 Ibid.

83 Ibid.

84 SLOCAT, op. cit. note 5.

85 S. Gota et al. (2019), "Decarbonising transport to achieve Paris Agreement targets", *Energy Efficiency*, Vol. 12, pp. 363-386, https://doi.org/10.1007/s12053-018-9671-3.

86 International Renewable Energy Agency (IRENA) (2022), "World Energy Transitions Outlook 2022", https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022

87 **Figure 9** from IEA (2021), "Net Zero by 2050", https://www.iea.org/reports/net-zero-by-2050.

88 Ibid.

89 IPCC, op. cit. note 62. **Table 1** based on the following sources: IEA, op. cit. note 87; IEA (2022), "World Energy Outlook 2022", https://www.iea.org/reports/world-energy-outlook-2022.

90 C. Briceno-Garmendia, W. Qiao and V. Foster (2023), "The Economics of Electric Vehicles for Passenger Transportation", World Bank, https://www.worldbank.org/en/topic/transport/publication/the-economics-of-e-mobility-for-passenger-transportation.

91 IPCC, op. cit. note 62.

92 Ibid.

93 IEA, op. cit. note 89.

94 IPCC, op. cit. note 62.

95 Jaramillo et al., op. cit. note 81.

96 Ibid.

97 Ibid.

98 Ibid.

99 ITF, op. cit. note 42.

100 Ibid.

101 IEA, op. cit. note 87.

102 IPCC, op. cit. note 62.

103 IEA, op. cit. note 87.

104 Ibid.

105 Ibid.

106 Ibid.

107 Ibid.

108 IEA, op. cit. note 89.

109 IEA, op. cit. note 87.

110 Ibid.

111 Ibid.

112 Ibid.

113 IATA (2021), "Net-Zero Carbon Emissions by 2050", https://www.iata.org/en/pressroom/pressroom-archive/2021-releases/2021-10-04-03.

114 ICAO (2022), "Long Term Global Aspirational Goal (LTAG) for International Aviation", https://www.icao.int/environmental-protection/Pages/LTAG.aspx, accessed 13 February 2023.

115 ICAO, op. cit. note 66.

116 Ibid.

117 Ibid.

118 International Council on Clean Transportation (2023), "ICAO's 2050 Net-zero CO2 Goal for International Aviation", https://theicct.org/publication/global-aviation-ICAO-net-zero-goal-jan23.

119 Ibid.

120 IEA (2021), op. cit. note 87.

121 IMO (2023), "Initial IMO GHG Strategy", https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx, accessed 14 February 2023.

122 Ibid.

123 UNCTAD (2022), "Review of Maritime Transport 2022", https://unctad.org/rmt2022, accessed 20 January 2023.

124 **Figure 10** from Jaramillo et al., op. cit. note 81.

125 Ibid.

126 Ibid.

127 Ibid.

128 Ibid.

129 Ibid.

130 Ibid.

131 **Box 2** from SLOCAT (2022), "Transport and Voluntary National Reviews 2022", www.slocat.net/vnr.

132 **Table 2** from Ibid.

133 F. Denton et al. (2022), "Accelerating the transition in the context of sustainable development", in IPCC, op. cit. note 62.

134 Ibid.

135 H. Lee et al. (2023), "AR6 Synthesis Report, Climate Change 2023", IPCC, https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf.

136 J.D. Sachs et al. (2022), "Sustainable Development Report 2022: From Crisis to Sustainable Development: The SDGs as Roadmap to 2030 and Beyond", https://bit.ly/3qtgdQT.

137 Ibid.

138 For the spillover performance of all 193 UN Member States, see Sustainable Development Report (2022), "Spillover Rankings", https://dashboards.sdgindex.org/rankings/spillovers.

139 Ibid.

140 F. Creutzig et al. (2022), "Demand-side solutions to climate change mitigation consistent with high levels of well-being", *Nature Climate Change*, Vol. 12, pp. 36-46, https://doi.org/10.1038/s41558-021-01219-y.

141 Ibid.

142 Ibid.

143 **Figure 15** from IEA (2022), "A 10-Point Plan to Cut Oil Use", https://www.iea.org/reports/a-10-point-plan-to-cut-oil-use.

144 European Commission, "REPowerEU Affordable, Secure and Sustainable Energy for Europe", https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en, accessed March 2023.

1.2
TRANSPORT ADAPTATION AND RESILIENCE

1 World Bank (2021), "Resilience Rating System", https://documents1.worldbank.org/curated/en/701011613082635276/pdf/Summary.pdf.

2 United Nations Office for Disaster Risk Reduction (UNDRR) (2023), "The Handbook for Implementation. Principles for Resilient Infrastructure: How to Make Infrastructure Resilient", https://www.undrr.org/publication/handbook-implementing-principles-resilient-infrastructure.

3 United Nations Conference on Trade and Development (UNCTAD) (2018), "SIDSport-ClimateAdapt", https://sidsport-climateadapt.unctad.org.

4 US Bureau of Transportation Statistics (2021), "Transportation Statistics Annual Report 2021", https://www.bts.gov/sites/bts.dot.gov/files/2022-01/TSAR_FULL BOOK-12-31-2021.pdf.

5 Associação Nacional das Empresas de Transportes Urbanos (NTU) (2023), "Transporte público por ônibus: Impactos da pandemia de Covid-19", https://www.ntu.org.br/novo/upload/Publicacao/Pub638168022171830458.pdf; NTU (2023), "Setor de ônibus coletivo urbano acumula prejuízo de R$ 36 bi e tem desafio de atrair novos passageiros", https://ntu.org.br/novo/NoticiaCompleta.aspx?idArea=10&idNoticia=1632.

6 R. Rochabrun (2022), "Peru Indigenous groups block river in the Amazon after oil spill", Reuters, 29 September, https://www.reuters.com/world/americas/peru-indigenous-groups-block-river-amazon-after-oil-spill-2022-09-28; BBC (2023), "Train strikes: When are they and why are they taking place?" https://www.bbc.com/news/business-61634959.

7 European Parliamentary Research Service (2022), "Russia's War on Ukraine: Implications for Transport", https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733536/EPRS_BRI(2022)733536_EN.pdf.

8 UNCTAD (2023), "Global crisis", https://unctad.org/global-crisis, accessed 29 May 2023.

9 Organisation for Economic Co-operation and Development (OECD) (2022), "How vulnerable is European manufacturing to gas supply conditions? A regional approach", https://www.oecd.org/ukraine-hub/policy-responses/how-vulnerable-is-european-manufacturing-to-gas-supply-conditions-01278ba3.

10 UN-Habitat (2022), "World Cities Report 2022", https://unhabitat.org/wcr.

11 Ibid.

12 The White House (2021), "Report on the Impact of Climate Change on Migration", https://www.whitehouse.gov/wp-content/uploads/2021/10/Report-on-the-Impact-of-Climate-Change-on-Migration.pdf.

13 European Institute of Innovation & Technology (2020), "Activity Deliverable. D01 WP 1 – Report that summarises disruptive technologies, use cases of new mobility services and regulations by city/region", https://eit.europa.eu/sites/default/files/disruptive_technologies_use_cases_of_new_mobility_services_and_regulations_1.pdf.

14 Nordic Policy Centre (2022), "Finland's Mobility as a Service Legislation", https://www.nordicpolicycentre.org.au/mobility_as_a_service_legislation_in_finland.

15 International Transport Forum (2018), "Policies to Extend the Life of Road Assets", https://www.itf-oecd.org/policies-extend-life-road-assets.

16 D. Paddeu (2022), "The Future of Last-mile Deliveries: Understanding the Local Perspective", Local Government Association, https://www.local.gov.uk/publications/future-last-mile-deliveries-understanding-local-perspective.

17 World Bank (2020), "World Development Report 2020: Trading for Development in the Age of Global Value Chains", https://www.worldbank.org/en/publication/wdr2020; World Bank (2022), "Global Value Chains in Light of COVID-19: Trade, Development & Climate Change", https://www.worldbank.org/en/topic/trade/publication/global-value-chains-in-light-of-covid-19-trade-development-climate-change.

18 UNCTAD (2022), "Building resilient maritime logistics in challenging times", 11 August, https://unctad.org/news/building-resilient-maritime-logistics-challenging-times.

19 Intergovernmental Panel on Climate Change (IPCC) (2022), "Summary for Policymakers. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", pp. 3-33, https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.

20 J.O. Ebinger and N. Vandycke (2015), "Moving Toward Climate-Resilient Transport: The World Bank's Experience from Building Adaptation into Programs", World Bank, https://openknowledge.worldbank.org/bitstreams/e8973a62-f62e-53b7-b0fb-ff6173592155/download.

21 Ibid.

22 National Research Council (2008), "Potential Impacts of Climate Change on U.S. Transportation", Committee on Climate Change and US Transportation, Transportation Research Board Division on Earth and Life Studies, https://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf.

23 Ebinger and Vandycke, op. cit. note 20.

24 Ibid.

25 Ibid.

26 Ibid.

27 Deloitte (2017), "New Technologies Case Study: Data Sharing in Infrastructure – A Final Report for the National Infrastructure Commission", p. 37, https://nic.org.uk/app/uploads/Data-sharing-in-infrastructure.pdf; A. Busby et al. (2020), "Motivations for and Barriers to Data Sharing. Identifying Cultural and Legal Barriers to Data Sharing Across Government", UK Department for Digital, Culture, Media & Sport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/895505/_Kantar_research_publication.pdf.

28 Centre for Public Impact (2016), "Rio de Janeiro's centre of operations: COR", 25 March, https://www.centreforpublicimpact.org/case-study/ioe-based-rio-operations-center.

29 A. Tall et al. (2021), "Enabling Private Investment in Climate Adaptation & Resilience. Current Status, Barriers to Investment and Blueprint for Action", World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR), https://openknowledge.worldbank.org/server/api/core/bitstreams/127de8c7-d367-59ac-9e54-27ee52c744aa/content.

30 A. Kannan et al. (2021), "Governance of Infrastructure for Resilience", Coalition for Disaster Resilient Infrastructure (CDRI) and The Resilience Shift, https://www.resilienceshift.org/wp-content/uploads/2021/11/WhitePaperonGovernanceofInfrastructureforResilience.pdf.

31 New York City Department of Environmental Protection (2022), "NYC Green Infrastructure 2021 Annual Report", https://www.nyc.gov/assets/dep/downloads/pdf/water/stormwater/green-infrastructure/gi-annual-report-2020.pdf.

32 S. Hallegatte, J. Rentschler and J. Rozenberg (2019), "Lifelines: The Resilient Infrastructure Opportunity", World Bank, https://openknowledge.worldbank.org/handle/10986/31805.

33 E.E. Koks et al. (2019), "A global multi-hazard risk analysis of road and railway infrastructure assets", *Nature Communications*, Vol. 10, No. 2677, https://www.nature.com/articles/s41467-019-10442-3.

34 J. Verschuur et al. (2022), "Multi-Hazard Risk to Global Port Infrastructure and Resulting Trade and Logistics Losses", https://www.researchgate.net/publication/367089437_Multi-hazard_risk_to_global_port_infrastructure_and_resulting_trade_and_logistics_losses.

35 Koks et al., op. cit. note 33.

36 Ministry of Planning Development & Special Initiatives (2022), "Pakistan Floods 2022 Post-disaster Needs Assessment: Main Report", https://www.ilo.org/global/topics/employment-promotion/recovery-and-reconstruction/WCMS_862500/lang--en/index.htm.

37 A. Christodoulou and H. Demirel (2018), "Impacts of climate change on transport A focus on airports, seaports and inland waterways", https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108865/jrc108865_final.pdf.

38 Bureau of Transportation Statistics (2022), "Understanding the Reporting of Causes of Flight Delays and Cancellations", https://www.bts.gov/topics/airlines-and-airports/understanding-reporting-causes-flight-delays-and-cancellations.

39 G. Pescaroli et al. (2019), "Cascading Effects of Global Positioning and Navigation Satellite Service Failures: A Review for Improving Organisational Resilience", University College London Institute for Disaster and Risk Reduction and Mullard Space Science Laboratory, https://discovery.ucl.ac.uk/id/eprint/10076568/7/Pescaroli_cascading_effects_of_GNSS_failures%20ISO.pdf.

40 BBC (2019), "Indonesia blackout: Huge outage hits Jakarta and surrounding area", 5 August, https://www.bbc.com/news/world-asia-49227033.

41 Al Jazeera (2022), "Why Indonesia is abandoning its capital city to save it," https://www.aljazeera.com/news/2022/11/9/hldwhyindonesia-is-abandoning-its-capital-jakarta-to-save-ithld.

42 World Bank Group and Asian Development Bank (2021), "Climate Risk Country Profile: Maldives", https://www.adb.org/sites/default/files/publication/672361/climate-risk-country-profile-maldives.pdf.

43 B. Lefevre et al. (2016), "The Trillion Dollar Question II: Tracking Investment Needs in Transport", World Resources Institute, https://policycommons.net/artifacts/1360264/the-trillion-dollar-question-ii/1973621.

44 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), "SLOCAT Transport and Climate Change Global Status Report, 2nd Edition. Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation", https://tcc-gsr.com/home.

45 Ebinger and Vandycke, op. cit. note 20.

46 Hallegatte, Rentschler and Rozenberg, op. cit. note 32.

47 Ebinger and Vandycke, op. cit. note 20.

48 T. Floriano et al. (2020), "Resilience and Vulnerability of Public Transportation Fare Systems: The Case of the City of Rio De Janeiro, Brazil", https://www.mdpi.com/2071-1050/12/2/647, https://www.researchgate.net/publication/338622203_Resilience_and_Vulnerability_of_Public_Transportation_Fare_Systems_The_Case_of_the_City_of_Rio_De_Janeiro_Brazil.

49 Hallegatte, Rentschler and Rozenberg, op. cit. note 32.

50 J.F. Fung and J.F. Helgeson (2017), "Defining the Resilience Dividend: Accounting for Co-benefits of Resilience Planning", US Department of Commerce, https://www.nist.gov/publications/defining-resilience-dividend-accounting-co-benefits-resilience-planning.

51 G. Lyons, (2021), "Discovering 'the sweet spot'", https://www.tapforuncertainty.eu/author/lyons; Mott MacDonald (2023). Vision-led strategic plan-

ning for an uncertain world", https://www.mottmac.com/article/59966/futures-vision-led-planning-for-an-uncertain-world.

52 **Box 1** from the following sources: Transportation Research Board (2008), "The Role of Transit in Emergency Evacuation", Special Report 294, Committee on the Role of Public Transportation in Emergency Evacuation, Transportation Research Board of the National Academies, https://nap.nationalacademies.org/catalog/12445/the-role-of-transit-in-emergency-evacuation-special-report-294; J. Dash and N. Dasgupta (2019), "India plans to evacuate 800,000 as cyclone nears east coast", Reuters, 1 May, https://www.reuters.com/article/india-cyclone-idINL3N22E0KZ; Al Jazeera (2019), "Cyclone Fani: UN praises India's response to devastating storm", 5 May, https://www.aljazeera.com/news/2019/5/5/cyclone-fani-un-praises-indias-response-to-devastating-storm.

53 A. Ahmad (2023). personal communication with SLOCAT, 5 May 2023.

54 C.E. Schlumberger (2015), "Air transportation – the critical infrastructure when disaster strikes", World Bank, Transport for Development, 6 May, https://blogs.worldbank.org/transport/air-transportation-critical-infrastructure-when-disaster-strikes.

55 UNICEF (2022), "Drone technology can save lives and create jobs for thousands of young people", 20 October, https://www.unicef.org/southafrica/press-releases/drone-technology-can-save-lives-and-create-jobs-thousands-young-people.

56 Fung and Helgeson, op. cit. note 50.

57 S. Hallegatte et al. (2020), "From poverty to disaster and back: A review of the literature", *Economics of Disasters and Climate Change*, Vol. 4, pp. 223-247, https://doi.org/10.1007/s41885-020-00060-5.

58 J. Hine et al. (2019), "Evidence on impact of rural roads on poverty and economic development", K4D Helpdesk Report, Institute of Development Studies, https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14656.

59 S. Aggarwal (2018), "Do rural roads create pathways out of poverty? Evidence from India", *Journal of Development Economics*, Vol. 133, pp. 375-395, https://www.sciencedirect.com/science/article/abs/pii/S0304387818300063.

60 N. Kaiser and C.K. Barstow (2022), "Rural Transportation Infrastructure in Low- and Middle-Income Countries: A Review of Impacts, Implications and Interventions", *Sustainability*, Vol. 14, No. 4, p. 2149, https://doi.org/10.3390/su14042149.

61 Ibid.

62 Hine et al., op. cit. note 58.

63 J. Rentschler et al. (2019), "Three Feet Under: The Impact of Floods on Urban Jobs, Connectivity, and Infrastructure", World Bank, https://openknowledge.worldbank.org/bitstreams/e28bfeac-7102-56b0-bc34-53b173926a5c/download.

64 M. Heller (2021), "Why the next step for antiracism is transportation", World Economic Forum, 22 April, https://www.weforum.org/agenda/2021/04/transport-us-antiracism.

65 B. Carter (2021), "Impact of Social Inequalities and Discrimination on Vulnerability to Crises", K4D Helpdesk Report, Institute of Development Studies, https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/16541.

66 E. Neumayer and T. Plümper (2007), "The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1982-2002", *Annals of the Association of American Geographers*, Vol. 97, No. 3, pp. 551-566, https://doi.org/10.1111/j.1467-8306.2007.00563.x.

67 **Box 2** from M.C. Diazgranadoz and E. Corwin (2022), "Green-Gray Solution to Protect the Ciénaga Grande de Santa Marta (CGSM) in Colombia", https://www.greengrowthknowledge.org/sites/default/files/downloads/best-practices/CGSM-Case-Study-Sustainable-Infrastructure-Putting-Principle-into-Practice-Colombia.pdf.

68 US Environmental Protection Agency (2022), "Using trees and vegetation to reduce heat islands", https://www.epa.gov/heatislands/using-trees-and-vegetation-reduce-heat-islands.

69 Partnership for Active Travel and Health (2022), "Make way for walking and cycling", https://pathforwalkingcycling.com.

70 C. Moreno et al. (2021), "Introducing the '15-minute city': Sustainability, resilience and place identity in future post-pandemic cities", *Smart Cities*, Vol. 4, No. 1, pp. 93-111, https://doi.org/10.3390/smartcities4010006.

71 United Nations Framework Convention on Climate Change (UNFCCC) (2022), "Yearbook of Global Climate Action 2022", https://unfccc.int/documents/614385; UNFCCC (2023), "Key aspects of the Paris Agreement", https://unfccc.int/most-requested/key-aspects-of-the-paris-agreement, accessed 31 January 2023.

72 Paris Process on Mobility and Climate (2017), "Marrakech Partnership for Global Climate Action (MPGCA) Transport Initiatives: Stock-take on action toward implementation of the Paris Agreement and the 2030 Agenda on Sustainable Development. Overview of Progress", November, https://slocat.net/wp-content/uploads/2022/04/2017-MPGCA-Transport-Initiatives-Report_Final.pdf.

73 UN Climate Change High-Level Champions (2022), "A Climate-Smart, Sustainable and Resilient Maritime Sector", https://climatechampions.unfccc.int/wp-content/uploads/2022/11/Joint-Statement-FINAL.pdf.

74 CDRI (2023), "Overview", https://www.cdri.world, accessed 31 January 2023; CDRI (2023), "What we do: Programmes", https://www.cdri.world/whatwedo#programmes, accessed 31 January 2023; Global Resilience Partnership (2023), "What we do", https://www.globalresiliencepartnership.org/what-we-do, accessed 31 January 2023; Global Infrastructure Hub (2023), "About the GI Hub", https://www.gihub.org/about/about, accessed 31 January 2023.

75 International Coalition for Sustainable Infrastructure (2022), "Implementation Lab at COP27: Engineering the vision for climate-resilient transport", https://unfccc.int/sites/default/files/resource/MPGCA_COP27_IL_%20Resiliient_Transport_Infrastructure_1611_411.pdf.

76 IPCC (2023), "IPCC data", https://www.ipcc.ch/data, accessed 18 January 2023.

77 IPCC (2022), "Climate Change 2022: Impacts, Adaptation and Vulnerability", Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, https://www.ipcc.ch/report/ar6/wg2.

78 Task Force on Climate-related Financial Disclosures (TCFD) (2017), "Recommendations of the Task Force on Climate-related Financial Disclosures", https://www.fsb-tcfd.org/recommendations.

79 TCFD (2022), "Task Force on Climate-related Financial Disclosures. 2022 Status Report", https://www.fsb.org/2022/10/2022-tcfd-status-report-task-force-on-climate-related-financial-disclosures.

80 International Organization for Standardization (2021), "ISO 14091:2021: Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment", https://www.iso.org/standard/68508.html.

81 World Bank (2022), "Highway Development and Management Model", https://www.worldbank.org/en/topic/transport/brief/highway-development-and-management-model.

82 United Nations Environment Programme (UNEP) (2022), "Adaptation Gap Report 2022: Too Little, Too Slow – Climate adaptation failure puts world at risk", https://www.unep.org/adaptation-gap-report-2022.

83 UNFCCC (2021), "Adaptation at the forefront of COP26 outcomes in Glasgow", https://www4.unfccc.int/sites/NWPStaging/News/Pages/Adaptation-at-the-forefront-of-COP-26-outcomes-in-Glasgow.aspx.

84 Ibid.

85 Green Climate Fund (2023), "Project portfolio. Portfolio dashboard", https://www.greenclimate.fund/projects/dashboard, accessed 24 February 2023.

86 UNEP (2022), "What you need to know about the COP27 Loss and Damage Fund", https://www.unep.org/news-and-stories/story/what-you-need-know-about-cop27-loss-and-damage-fund.

87 Islamic Development Bank (2022), "Joint Methodology for Tracking Climate Change Adaptation Finance", https://www.isdb.org/sites/default/files/media/documents/2022-11/Joint%20methodology%20for%20tracking%20climate%20change%20adaptation%20finance.pdf.

88 Federal Transit Administration (2022), "Bipartisan Infrastructure Law", https://www.transit.dot.gov/BIL.

89 Centre for Environmental Excellence (2022), "FHWA issues 'Climate Challenge' funds to 25 state DOTs", 27 October, https://environment.transportation.org/news/fhwa-issues-climate-challenge-funds-to-25-state-dots.

90 GFDRR (2020), "Making Transportation Climate Resilient in Freetown", Resilience Series, https://www.gfdrr.org/en/feature-story/results-resilience-making-transportation-climate-resilient-freetown.

91 C40 Cities (2019), "Inclusive Community Engagement Playbook", https://www.c40knowledgehub.org/s/article/Inclusive-Community-Engagement-Playbook.

92 Resilient Cities Network, https://resilientcitiesnetwork.org, accessed 24 February 2023.

93 R.J. Lempert, M. Miro and D. Prosdocimi (2021), "A DMDU Guidebook for Transportation Planning Under a Changing Climate", Inter-American Development Bank, https://publications.iadb.org/en/dmdu-guidebook-transportation-planning-under-changing-climate.

94 R. Lempert et al (2021), "A DMDU Guidebook for Transportation Planning Under a Changing Climate", https://publications.iadb.org/en/dmdu-guidebook-transportation-planning-under-changing-climate.

95 UNFCCC (2023), "Submitted NAPs", 9 January, https://napcentral.org/submitted-naps.

96 Ibid.; SLOCAT, op. cit. note 44.

97 Ibid.

98 Republic of Niger (2022), "Plan national d'adaptation aux changements climatiques", Conseil National de L'environnement pour un Developpement Durable Secrateriat Executive, https://unfccc.int/sites/default/files/resource/Plan-National-d%27Adaptation_Niger_Version-Finale.pdf.

99 Government of Tonga (2018), "Joint National Action Plan 2 on Climate Change and Disaster Risk Management", https://policy.asiapacificenergy.org/node/4358.

100 World Bank (2023), "Tonga Climate Resilient Transport Project", https://projects.worldbank.org/en/projects-operations/project-detail/P161539, accessed 19 January 2023; World Bank (2022), "Project Appraisal Document: Federated States of Micronesia Strategic Climate-Oriented Road Enhancements", https://documents1.worldbank.org/curated/en/453251648600227981/pdf/Micronesia-Strategic-Climate-Oriented-Road-Enhancements-Project-SCORE.pdf.

101 Arcadis (2020), "Arcadis helps Hong Kong ensure security of service for extreme weather events using InfoWorks ICM", https://www.autodesk.com/customer-stories/arcadis-hong-kong.

102 Gerència d'Àrea d'Ecologia Urbana (2021), "Barcelona Nature Plan 2030", https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/123630.

103 Intendencia de Montevideo and 100 Resilient Cities (2018), "Montevideo Resilience Strategy", https://resilientcitiesnetwork.org/downloadable_resources/Network/Montevideo-Resilience-Strategy-English.pdf.

104 K. Mutombo, A.I. Olçer and L. Kuroshi (2020), "A System Inter-dependent Approach in Addressing Climate Change in Ports. A Case Study of the Port of Durban, South Africa", in R.C. Brears, ed., *The Palgrave Handbook of Climate Resilient Societies*, pp. 1-66, https://www.researchgate.net/publication/344841504_A_System_Inter-dependent_Approach_in_Addressing_Climate_Change_in_Ports_A_Case_Study_of_the_Port_of_Durban_South_Africa.

105 World Bank (2022), "Private Participation in Infrastructure (PPI). 2021 Annual Report", https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099920006212228192/p1616740725f490c0090db0b25cd05ad7ea.

106 World Bank (2017), "Resilient Infrastructure Public-Private Partnerships (PPPs): Contracts and Procurement. The Case of Japan", https://documents.worldbank.org/en/publication/documents-reports/documentdetail/479931516124878843/resilient-infrastructure-public-private-partnerships-ppps-contracts-and-procurement-the-case-of-japan.

107 Ibid.

108 European Standards (2021), "Adaptation to climate change – using adaptation pathways for decision making – guide", https://www.en-standard.eu/bs-8631-2021-adaptation-to-climate-change-using-adaptation-pathways-for-decision-making-guide.

109 Committee on Adaptation to a Changing Climate (2018), "Climate-Resilient Infrastructure: Adaptive Design and Risk Management", https://ascelibrary.org/doi/book/10.1061/9780784415191.

110 Austroads (2023), "Guide to Road Design Part 5. Drainage – General and Hydrology Considerations", https://austroads.com.au/publications/road-design/agrd05.

111 Cerema (2015), "National climate change adaptation plan: transportation infrastructures and systems, action 1. Potential impacts of climate change on transportation infrastructures and systems, on their design, maintenance and operation standards, and the need for detailed climate projections", https://doc.cerema.fr/Default/doc/SYRACUSE/20503/national-climate-change-adaptation-plan-transportation-infrastructures-and-systems-action-1-potentia?_lg=fr-FR.

112 CDRI, "What we do: Programmes", op. cit. note 74, accessed 8 February 2023.

113 UN Climate Change High-Level Champions (2022), "2030 Adaptation Outcomes for Resilient Transport Systems. Sharm El-Sheikh Adaptation Agenda", https://climatechampions.unfccc.int/wp-content/uploads/2022/11/SeS-Adaptation-Agenda_Complete-Report-COP27_FINAL-1.pdf.

114 United Nations (2015), "Sendai Framework for Disaster Risk Reduction 2015-2030", https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030.

115 UNDRR (2022), "2021 Progress Report on the Implementation of the UN Plan of Action on DRR for Resilience", https://www.undrr.org/publication/2021-progress-report-implementation-un-plan-action-disaster-risk-reduction-resilience.

116 UNCTAD (2022), "Building resilient maritime logistics in challenging times", 11 August, https://unctad.org/news/building-resilient-maritime-logistics-challenging-times.

117 Islamic Development Bank (2019), "A Framework and Principles for Climate Resilience Metrics in Financing Operations", https://www.isdb.org/climate-change/publications/a-framework-and-principles-for-climate-resilience-metrics-in-financing-operations.

118 **Table 1** based on the following sources: M. Kurth et al. (2020), "Lack of resilience in transportation networks: Economic implications", *Transportation Research Part D: Transport and Environment*, Vol. 86, https://www.sciencedirect.com/science/article/abs/pii/S1361920920306064; Highways England (2019), "Operational Metrics Manual", https://nationalhighways.co.uk/media/5isknpuq/ris2-operational-metrics-manual-july-2021-1.pdf; A. Thaduri, A.H. Garmabaki and U. Kumar (2021), "Impact of climate change on railway operation and maintenance in Sweden: A state-of-the-art review", *Maintenance, Reliability and Condition Monitoring*, https://doi.org/10.21595/mrcm.2021.22136; UNDRR (2023), "The Handbook for Implementation: Principles for Resilient Infrastructure (draft)", https://www.preventionweb.net/news/consultation-handbook-implementation-principles-resilience-infrastructure; Hallegatte, Rentschler and Rozenberg, op. cit. note 32; GFDRR (2014), "Bosnia & Herzegovina Floods", https://www.gfdrr.org/sites/default/files/publication/pda-2014-bosnia.pdf; Peru from OECD (2020), "Common Ground Between the Paris Agreement and the Sendai Framework: Climate Change Adaptation and Disaster Risk Reduction", https://doi.org/10.1787/3edc8d09-en; Connect SF (2018), "A vision for moving San Francisco into the future", https://connectsf.org/about/components/vision.

119 European Parliament and Council (2022), "Directive of the European Parliament and of the Council on the resilience of critical entities and repealing Council Directive 2008/114/EC", https://data.consilium.europa.eu/doc/document/PE-51-2022-INIT/en/pdf.

120 N. Carhart et al. (2016), "A conceptual approach to strategic performance indicators", *Infrastructure Asset Management*, Vol. 3, No. 4, pp. 132-142, https://doi.org/10.1680/jinam.16.00015.

SPOTLIGHT 1 TRANSPORT - HEALTH NEXUS

1 World Health Organization (WHO) (2021), "Urban Health", https://www.who.int/news-room/fact-sheets/detail/urban-health.

2 United Nations (UN) (2023), "The Sustainable Development Agenda", https://www.un.org/sustainabledevelopment/development-agenda, accessed 29 May 2023.

3 P.F. Rodrigues et al. (2020), "Health economic assessment of a shift to active transport", *Environmental Pollution*, Vol. 258, https://doi.org/10.1016/j.envpol.2019.113745.

4 O. Mark (2014), "Shipping Emissions in Ports", International Transport Forum, https://www.itf-oecd.org/sites/default/files/docs/dp201420.pdf.

5 P.R. Shukla et al., eds. (2022), "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg3.

6 **Table 1** adapted from idem, table 10.1.

7 Ibid.

8 Ibid.

9 WHO (2023), "Disability", https://www.who.int/news-room/fact-sheets/detail/disability-and-health, accessed 29 May 2023.

10 WHO (2015), "Health 2020: Transport and Health", https://apps.who.int/iris/bitstream/handle/10665/363314/WHO-EURO-2015-6166-45931-66211-eng.pdf; E. Cooper et al. (2019), "Transport, Health and Wellbeing: An Evidence Review for the Department of Transport", NatCen, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/847884/Transport__health_and_wellbeing.pdf; WHO, op. cit. note 9.

11 WHO (2022), "Ambient (Outdoor) Air Pollution", https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

12 T. Goforth and D. Nock (2022), "Air pollution disparities and equality assessments of US national decarbonization strategies", *Nature Communications*, Vol. 13, p. 7488, https://doi.org/10.1038/s41467-022-35098-4.

13 S.C. Anenberg et al. (2019), "The global burden of transportation tailpipe emissions on air pollution-related mortality in 2010 and 2015", *Environmental Research Letters*, Vol. 14, p. 094012, https://iopscience.iop.org/article/10.1088/1748-9326/ab35fc/pdf.

14 N. Mueller et al. (2023), "Health impact assessments of shipping and port-sourced air pollution on a global scale: A scoping literature review", *Environmental Research*, Vol. 216, Part 1, p. 114460, https://www.sciencedirect.com/science/article/pii/S001393512201787X.

15 International Maritime Organization (IMO) (2023), "Clean air in shipping", https://www.imo.org/en/OurWork/Environment/Pages/Clean%20air%20in%20shipping.aspx, accessed 29 May 2023.

16 P. Neil (2021), "90% of the world suffers from harmful levels of air pollution", Air Quality News, 1 February, https://airqualitynews.com/2021/02/01/90-of-the-world-suffers-from-harmful-levels-of-air-pollution.

17 Ibid.

18 P. Giani et al. (2020), "Short-term and long-term health impacts of air pollution reductions from COVID-19 lockdowns in China and Europe: A modelling study", *The Lancet Planetary Health*, Vol. 4, No. 10, pp. e474-e482, https://www.sciencedirect.com/science/article/pii/S2542519620302242.

19 **Box 1** from D. Appiah (2022), "Cost of air pollution in Africa's cities to increase 600% by 2040, without urgent action", Clean Air Fund, 26 October, https://www.cleanairfund.org/news-item/african-cities.

20 WHO (2019), "New WHO-led study says majority of adolescents worldwide are not sufficiently physically active, putting their current and future health at risk", 22 November, https://www.who.int/news/item/22-11-2019-new-who-led-study-says-majority-of-adolescents-worldwide-are-not-sufficiently-physically-active-putting-their-current-and-future-health-at-risk.

21 WHO (2022), "Cycling and walking can help reduce physical inactivity and air pollution, save lives and mitigate climate change", 7 June, https://www.who.int/europe/news/item/07-06-2022-cycling-and-walking-can-help-reduce-physical-inactivity-and-air-pollution--save-lives-and-mitigate-climate-change.

22 I. Hamilton et al. (2021), "The public health implications of the Paris Agreement: A modelling study", *The Lancet*, February, https://doi.org/10.1016/S2542-5196(20)30249-7.

23 **Box 2** from A. Sudmant et al. (2020), "Towards Sustainable Mobility and Improved Public Health: Lessons from Bike Sharing in Shanghai, China", Coalition for Urban Transitions, https://urbantransitions.global/wp-content/uploads/2020/03/Towards-Sustainable-Mobility-and-Improved-Public-Health-Lessons-from-bike-sharing-in-Shanghai-China-final.pdf.

24 WHO (2022), "Road Traffic Injuries", https://www.who.int/news-room/fact-sheets/detail/road-traffic injuries.

25 A. Hawes (2022), "Six reasons why road safety is an equality and social justice issue", BrightMile, 1 September, https://www.brightmile.io/blog/six-reasons-why-road-safety-is-an-equality-and-social-justice-issue.

26 WHO (2022), "Powered two-and three-wheeler safety: A road safety manual for decision-makers and practitioners, 2nd edition", https://apps.who.int/iris/bitstream/handle/10665/363455/9789240060562-eng.pdf.

27 Hawes, op. cit. note 25.

28 Ibid.

29 International Transport Forum (2022), "Road Safety Annual Report 2022", https://www.itf-oecd.org/sites/default/files/docs/irtad-road-safety-annual-report-2022.pdf (based on preliminary data).

30 T. Satiennam et al. (2016), "Potential for modal shift by passenger car and motorcycle users towards Bus Rapid Transit (BRT) in an Asian developing city", *IATSS Research*, Vol. 39, No. 2, p. 121-129, ISSN 0386-1112, https://doi.org/10.1016/j.iatssr.2015.03.002; FIA Foundation (2022), "The Wheels of Change: Safe and Sustainable Motorcycles in Sub-Saharan Africa", https://www.fiafoundation.org/resources/the-wheels-of-change-safe-and-sustainable-motorcycles-in-sub-saharan-africa.

31 WHO, op. cit. note 24.

32 WHO, op. cit. note 26.

33 World Resources Institute (WRI) (2022), "Brazil commits to reduce traffic deaths 50% by 2030", 19 September, https://www.wri.org/outcomes/brazil-commits-reduce-traffic-deaths-50-2030.

34 Ministry of Health of Brazil (2019), "Surveillance of Violence and Accidents in Urgency and Emergency Sentinel Services – Capitals and Municipalities / Ministry of Health, Secretariat of Health Surveillance, Department of Health Analysis and Noncommunicable Disease Surveillance", https://sanare.emnuvens.com.br/sanare/article/view/51.

35 Y. Martynov (2023), "Why transportation becomes a barrier to healthcare access", Route Genie, 23 February, https://routegenie.com/why-transportation-becomes-a-barrier-to-healthcare-access.

36 T. Guimarães, K. Lucas and P. Timms (2019), "Understanding how low-income communities gain access to healthcare services: A qualitative study in São Paulo, Brazil", *Journal of Transport & Health*, Vol. 15, p. 100658, https://www.sciencedirect.com/science/article/abs/pii/S2214140519301379; R. Dahab and D. Sakellariou (2020), "Barriers to accessing maternal care in low income countries in Africa: A systematic review", *International Journal of Environmental Research and Public Health*, Vol. 17, No. 12, p. 4292, https://www.mdpi.com/1660-4601/17/12/4292.

37 C. Varela et al. (2019), "Transportation barriers to access health care for surgical conditions in Malawi: A cross sectional nationwide household survey", *BMC Public Health*, Vol. 19, No. 264, https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-6577-8.

38 E.T. Remillard et al. (2022), "Transportation challenges for persons aging with mobility disability: Qualitative insights and policy implications", *Disability and Health Journal*, Vol. 15, No. 1, Supplement, p. 101209, https://doi.org/10.1016/j.dhjo.2021.101209.

39 V. Sunio et al. (2023), "Impact of public transport disruption on access to healthcare facility and well-being during the COVID-19 pandemic: A qualitative case study in Metro Manila, Philippines", *Case Studies on Transport Policy*, March, No. 11, pp. 100948, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9810551.

40 R. Wallace, S. Green and G. Agarwal (2016), "Promoting the health benefits of walking and bicycling to work: A qualitative exploration of the role of healthcare providers in addressing barriers to active commuting", *Sports and Exercise Medicine Open Journal*, Vol. 2, No. 2, pp. 24-32, https://www.openventio.org/Volume2-Issue2/Promoting-the-Health-Benefits-of-Walking-and-Bicycling-to-Work-A-Qualitative-Exploration-of-the-Role-of-Healthcare-Providers-in-Addressing-Barriers-to-Active-Commuting-SEMOJ-2-135.pdf.

41 Cooper et al., op. cit. note 10.

42 Y. Du, G. Sun and M. Kwan (2022), "Transit-oriented development for older people: Does using multiple public transport options improve their physical and mental health?" *Journal of Transport and Land Use*, Vol. 15, No. 1, pp. 729-753, https://doi.org/10.5198/jtlu.2022.2152.

43 K. Wild et al. (2021), "The Relationship Between Transport and Mental Health in Aotearoa New Zealand", Waka Kotahi NZ Transport Agency, https://www.nzta.govt.nz/assets/resources/research/reports/675/675-the-relationship-between-transport-and-mental-health-in-aotearoa.pdf.

44 H. Nadrian et al. (2019), "'I am sick and tired of this congestion': Perceptions of Sanandaj inhabitants on the family mental health impacts of urban traffic jam", *Journal of Transport & Health*, Vol. 14, p. 100587, https://doi.org/10.1016/j.jth.2019.100587.

45 SLOCAT Partnership on Sustainable, Low Carbon Transport (2018), "Transport and Climate Change Global Status Report", https://www.slocat.net/wp-content/uploads/legacy/slocat_transport-and-climate-change-2018-web.pdf.

46 Energy Sector Management Assistance Program (ESMAP) (2019), "Maximizing Finance for Development in Egypt's Energy Sector", https://documents1.worldbank.org/curated/en/780061567532224696/pdf/Maximizing-Finance-for-Development-in-Egypts-Energy-Sector.pdf.

47 International Institute for Sustainable Development (2012), "Fossil-Fuel Subsidy Reform in India: Cash Transfers for PDS Kerosene and Domestic LPG", https://www.iisd.org/gsi/sites/default/files/ffs_india_teri_rev.pdf.

48 United Nations Framework Convention on Climate Change (2021), "Glasgow Climate Pact", https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf.

49 Global Climate and Health Alliance (2022), "International health organizations call for Fossil Fuel

Non-Proliferation Treaty to protect lives of current and future generations", 13 September, https://climateandhealthalliance.org/press-releases/international-health-organizations-call-for-fossil-fuel-non-proliferation-treaty-to-protect-lives-of-current-and-future-generations.

50 WHO (2022), "WHO Director-General's opening remarks at the dialogue on climate and health", 5 September, https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-dialogue-on-climate-and-health---5-september-2022.

51 Directorate-General for Environment (2018), "Concerted EU action reduces air pollution from shipping in European coastlines and ports", 16 April, https://commission.europa.eu/news/concerted-eu-action-reduces-air-pollution-shipping-european-coastlines-and-ports-2018-04-16_en; C40 Cities Climate Leadership Group (2023), "Why Port Cities Should Include Ports and Shipping in Climate Action Plans", https://www.c40knowledgehub.org/s/article/Why-port-cities-should-include-ports-and-shipping-in-climate-action-plans.

52 Health and Climate Network (HCN) (2022), "A Just Energy Transition for a healthy fossil free world", https://healthandclimatenetwork.org/a-just-energy-transition-for-a-healthy-fossil-free-world.

53 HCN (2023), "HCN Activity B: Knowledge base on HCT policy objectives", https://onedrive.live.com/view.aspx?resid=7EEF07C9A973C4CF!1939&cid=7eef07c9a973c4cf&authkey=!AFXHxc7zY5b5z1U&CT=1679313963200&OR=ItemsView, accessed 29 May 2023; HCN and SLOCAT (2022), "Knowledge Base on Health-Climate-Transport Objectives: User Guide", http://slocat.net/wp-content/uploads/2022/05/HCN Knowledge-Base-on-Health-Climate-Transport-Objectives_User-guide.pdf.

54 WHO (2021), "Health Economic Assessment Tool (HEAT) for Walking and for Cycling", https://www.who.int/publications/i/item/health-economic-assessment-tool-(heat)-for-walking-and-for-cycling.

55 Ibid.

56 Global Climate and Health Alliance (2023), "2023 Healthy NDC Scorecard", https://climateandhealthalliance.org/initiatives/healthy-ndcs/ndc-scorecards.

57 UK Department of Transport (2021), "Zero Emission Vehicles Transition Council: 2022 Action Plan", https://www.gov.uk/government/publications/zero-emission-vehicles-transition-council-2022-action-plan/zero-emission-vehicles-transition-council-2022-action-plan.

58 Ministry of Mines and Energy of Brazil (2020), "Portaria No 122, de 23 de Marco de 2020", http://antigo.mme.gov.br//web/guest/acesso-a-informacao/legislacao/portarias/-/document_library_display/mhGvQg5HAvT2/view_file/1119182.

59 Sustainable Bus (2022), "Israel sets target for zero emission bus purchases for public transport. 100% ZE buses mandatory in 2026", 3 February, https://www.sustainable-bus.com/news/israel-target-zero-emissions-buses-public-transport.

60 J. Dow (2022), "EPA finalizes first clean trucks rule in 21 years, but it could be better", Electrek, 20 December, https://electrek.co/2022/12/20/epa-finalizes-first-clean-trucks-rule-in-21-years-but-it-could-be-better.

61 L. Pineda, C. Jimenez and O. Delgado (2022), "Estrategia para el Despliegue de Flota Eléctrica en el Sistema de Corredores de Transporte Público de Pasajeros de la Ciudad de México 'Metrobús': Líneas 3 Y 4", International Council on Clean Transportation, https://theicct.org/publication/mexico-latam-hdv-zebra-mar22.

62 BNamericas (2021), "Ecuador plans achieving mass electromobility by 2040", 4 November, https://www.bnamericas.com/en/interviews/ecuador-plans-mass-electromobility-by-2040.

63 L. Gaucher and M. Gawlik (2022), "Barcelone capitalise sur son expérience tactique pour transformer ses espaces publics", L'institut Paris Region, 21 April, https://www.institutparisregion.fr/amenagement-et-territoires/les-chroniques-de-lurbanisme-tactique/barcelone-capitalise-sur-son-experience-tactique-pour-transformer-ses-espaces-publics.

64 A. Soni and K. Dubash (2023), "The Dawn of India's Walking and Cycling Revolution", Institute for Transportation and Development Policy, 5 January, https://www.itdp.org/2023/01/05/india-walking-cycling-revolution-stmag-34.

65 Government of Canada (2022), "National Active Transportation Strategy", https://www.infrastructure.gc.ca/trans/active-strat-actif-eng.html.

66 Global Alliance of NGOs for Road Safety (2021), "30 km/h for cyclists in Argentina", 23 April, https://www.roadsafetyngos.org/events/30-km-h-for-cyclists-in-argentina; Global Alliance of NGOs for Road Safety (2021), "Moldova: Toward a national default 30 km/h limit on local urban streets", 27 July, https://www.roadsafetyngos.org/events/131398; Welsh Government (2023), "20mph as Wales prepares to lower default speed limit", 17 March, https://www.gov.wales/new-data-shows-benefits-driving-20mph-wales-prepares-lower-default-speed-limit.

67 Ministry of Climate Action and Energy (BMK) (2021), "Austria's 2030 Mobility Master Plan", https://www.bmk.gv.at/en/topics/mobility/mobility-masterplan2030.html.

68 WHO (2023), "Decade of Action for Road Safety 2021-2030", https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/decade-of-action-for-road-safety-2021-2030, accessed 29 May 2023.

69 Ibid.

70 WHO (2023), "Decade of Action for Road Safety 2011-2020", https://www.who.int/groups/united-nations-road-safety-collaboration/decade-of-action-for-road-safety-2011-2020, accessed 29 May 2023.

71 WRI (2022), "Brazil commits to reduce traffic deaths 50% by 2030", 19 September, https://www.wri.org/outcomes/brazil-commits-reduce-traffic-deaths-50-2030.

72 S. Zsiros (2023), "Brussels wants to roll out EU-wide driving ban as it seeks to improve European road safety", Euronews, 3 January, https://www.euronews.com/my-europe/2023/03/01/brussels-wants-to-roll-out-eu-wide-driving-ban-as-it-seeks-to-improve-european-road-safety.

73 Global Health Advocacy Incubator (2022), "New Julián Esteban Law mandates safe system approach for Colombia", 16 August, https://www.advocacyincubator.org/featured-stories/2022-08-16-new-julian-esteban-law-mandates-safe-system-approach-for-colombia.

74 **Box 3** from UNEP (2023), "Pan-African Action Plan for Active Mobility", https://www.unep.org/explore-topics/transport/what-we-do/share-road/pan-african-action-plan-active-mobility, accessed 29 May 2023; Africa Check (2021), "Do 'over a million' Africans die in road accidents each year? No, global figure", 3 June, https://africacheck.org/fact-checks/reports/do-over-million-africans-die-road-accidents-each-year-no-global-figure.

75 Bloomberg Philanthropies (2023), "The Bloomberg Philanthropies Initiative for Global Road Safety", https://www.bloomberg.org/public-health/improving-road-safety/initiative-for-global-road-safety, accessed 29 May 2023.

76 Climate & Clean Air Coalition (2023), "BreatheLife Campaign: A global campaign to mobilise governments and individuals to take action on air pollution", https://www.ccacoalition.org/en/activity/breathelife-campaign, accessed 29 May 2023.

77 WHO (2023), "'Dakar Declaration' to strengthen data on road crash deaths in Africa", 6 April, https://www.who.int/news/item/06-04-2023-dakar-declaration--to-strengthen-data-on-road-crash-deaths-in-africa.

78 Global Road Safety Partnership (2023), "Programmes", https://www.grsproadsafety.org, accessed 29 May 2023.

79 VisionZeroNetwork (2023), "What is Vision Zero?" https://visionzeronetwork.org/about/what-is-vision-zero, accessed 29 May 2023.

80 WHO (2021), "WHO kicks off a Decade of Action for Road Safety", 28 October, https://www.who.int/news/item/28-10-2021-who-kicks-off-a-decade-of-action-for-road-safety.

SPOTLIGHT 2 TRANSPORT ADAPTATION, RESILIENCE AND DECARBONISATION IN SMALL ISLAND DEVELOPING STATES

1 N. Baker and A. Campbell (2021), "Navigating Island Futures in Transport: A Guide to Developing National Transport Strategies for Small Island Developing States", Ministry of Foreign Affairs and Trade, New Zealand Government, p. 4, https://www.theprif.org/sites/default/files/documents/NIFT_Part_I_21stCentury_Approach_FINAL_1.pdf.

2 United Nations Environment Programme (UNEP), "Small island developing states", https://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/small-island-developing-states, accessed 4 April 2023.

3 Baker and Campbell, op. cit. note 1; N. Baker, personal communication with SLOCAT Partnership on Sustainable, Low Carbon Transport, 2 May 2023.

4 M. Mycoo et al. (2022), "Small Islands", in H.-O. Pörtner et al., "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter15.pdf.

5 World Meteorological Organization (2020), "State of Climate Services 2020 Report: Move from Early Warnings to Early Action", https://public.wmo.int/en/media/press-release/state-of-climate-services-2020-report-move-from-early-warnings-early-action.

6 Ibid.

7 World Bank (2020), "Infrastructure in Asia and the Pacific: Road Transport, Electricity, and Water & Sanitation Services in East Asia, South Asia, & the Pacific Islands", pp. 27-28, https://openknowledge.worldbank.org/server/api/core/bitstreams/7851a3b6-077c-5f9a-9db5-6d184752cae4/content.

8 Despite poor data availability, land transport was identified in a 2021 study as most likely the largest user of imported fuel in many SIDS, from Baker and Campbell, op. cit. note 1, p. 11.

9 Pacific Coastal and Marine Science Center (2022), "Low-lying areas of tropical Pacific islands", US Geological Survey, 27 June, https://www.usgs.gov/centers/pcmsc/science/low-lying-areas-tropical-pacific-islands; United Nations in the Caribbean (2022), "Small islands are increasingly affected by climate change: IPCC report", 28 February, https://caribbean.un.org/en/173533-small-islands-are-increasingly-affected-climate-change-ipcc-report; K. Butler (2021), "14 Islands Threatened by Climate Change", Treehugger, 29 June, https://www.treehugger.com/island-nations-threatened-by-climate-change-4869275.

10 P. Akiwumi (2022), "Climate finance for SIDS is shockingly low: Why this needs to change", United Nations Conference on Trade and Development (UNCTAD), 24 May, https://unctad.org/news/blog-climate-finance-sids-shockingly-low-why-needs-change.

11 Ibid.

12 Ibid.

13 World Bank (2006), "The Pacific Infrastructure Challenge: A review of obstacles and opportunities for improving performance in the Pacific Islands", https://openknowledge.worldbank.org/server/api/core/bitstreams/0acb4643-3951-5297-bc83-07110c50ea33/content.

14 M. Senthilingam (2015), "How paradise became the fattest place in the world", CNN, 1 May, https://edition.cnn.com/2015/05/01/health/pacific-islands-obesity/index.html.

15 UN Department of Economic and Social Affairs (2023), "Small Island Developing States", https://sdgs.un.org/topics/small-island-developing-states, accessed 3 May 2023.

16 UNCTAD (2022), "Development and Globalization: Facts and Figures 2021", https://unctad.org/system/files/official-document/dgff2021_en.pdf; Baker and Campbell, op. cit. note 1; Baker, op. cit. note 3.

17 According to the World Travel and Tourism Council (WTTC), direct and indirect contributions to the Maldives economy amount to 78% of GDP and 62% of total employment; see Organisation for Economic Co-operation and Development (OECD) (2018), "Making Development Co-operation Work in Small Island Developing States", Figure 1.8, http://dx.doi.org/10.1787/888933645649; H. Khor, R. Kronenberg and P. Tumbarello, eds. (2016), "Resilience and Growth in the Small States of the Pacific", International Monetary Fund, www.elibrary.imf.org/staticfiles/misc/excerpts/small_states_pacific_excerpt.pdf.

18 WTTC (2016), "Economic Impact Reports", www.wttc.org/research/economic-research/economic-impact-analysis.

19 Pacific Region Infrastructure Facility (PRIF) (2013), "Infrastructure Maintenance in the Pacific: Challenging the Build-Neglect-Rebuild Paradigm", https://www.theprif.org/sites/default/files/documents/Final%20Maintenance%20Summary%20Paper.pdf; Baker, and Campbell, op. cit. note 1; Baker, op. cit. note 3.

20 UNEP (2014), "Small Island Developing States", p. 19, https://sustainabledevelopment.un.org/content/documents/1693UNEP.pdf.

21 UNCTAD, op. cit. note 16, p. 80.

22 H. Mata-Lima et al. (2021), "Waste-to-energy: An opportunity to increase renewable energy share and reduce ecological footprint in Small Island Developing States (SIDS)", *Energies*, Vol. 14, p. 7586, https://doi.org/10.3390/en14227586.

23 Registrations from UNCTAD, op. cit. note 16, p. 53; connectivity from United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States 2021 report, cited in idem, p. 55; P. Niérat and D. Guerrero, "UNCTAD maritime connectivity indicators: review, critique and proposal", UNCTAD, 10 December 2019, https://unctad.org/news/unctad-maritime-connectivity-indicators-review-critique-and-proposal.

24 Motorisation rate based on available countries in International Road Federation (IRF) (2022), "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

25 Ibid.

26 European Automobile Manufacturers' Association (ACEA) (2022), "Motorisation rates in the EU, by country and vehicle type", 2 April, https://www.acea.auto/figure/motorisation-rates-in-the-eu-by-country-and-vehicle-type.

27 Not Just Bikes (2022), "This Tiny Island Has Insane Traffic", https://www.youtube.com/watch?v=k-dz6FeQLuHQ; S. Johnson, personal communication with SLOCAT, 19 April 2023.

28 S. Johnson (2022), "Could there be a 'Parisian Revolution' in the Pacific? How could international donors help Pacific cities become cycling cities", World Bank, https://micromobilityconference.com/wp-content/uploads/2022/12/12_Johnson_Sam_Could-there-be-a-Parisian-Revolution-in-the-Pacific.pdf.

29 K. Hymel (2019), "If you build it, they will drive: Measuring induced demand for vehicle travel in urban areas", *Transport Policy*, Vol. 76, April, pp. 57-66, https://www.sciencedirect.com/science/article/abs/pii/S0967070X18301720;

30 M. Goh (2002), "Congestion management and electronic road pricing in Singapore", *Journal of Transport Geography*, Vol. 10, No. 1, pp. 29-38, https://www.sciencedirect.com/science/article/pii/S0966692301000369; Singapore Land Transport Authority (LTA) (2023), "The LTA Story", https://www.lta.gov.sg/content/ltagov/en/who_we_are/our_organisation/the_lta_story.html, accessed 19 May 2023; Singapore Urban Redevelopment Authority (URA) (2019), "Walking and Cycling Plan", 5 July, https://www.ura.gov.sg/Corporate/Guidelines/Development-Control/Non-Residential/Commercial/WCP.

31 Johnson, op. cit. note 28.

32 World Bank (2022), "Design Regional E-mobility Policy Framework and Technical Guidelines in the Pacific Island Countries", 10 October, unpublished.

33 M.C. Attard et al. (2021), "Long-term strategies in SIDS: Blueprints for decarbonised and resilient 1.5° C compatible economies," IMPACT, https://climateanalytics.org/media/lts-briefing-impact.pdf; World Bank, op. cit. note 32.

34 World Bank, op. cit. note 32; RMI (2023), "Bermuda's Road to Clean Mobility and Energy", https://rmi.org/our-work/islands-energy-program/bermuda-road-to-clean-mobility-and-energy, accessed 24 May 2023.

35 RMI (2022), "Bermuda Electrifies 1/3 of Its Public Bus Fleet", CleanTechnica, 14 April, https://cleantechnica.com/2022/04/14/bermuda-electrifies-a-third-of-its-public-bus-fleet.

36 RMI, op. cit. note 34.

37 L. Viscidi et al. (2020), "Electrified Islands: The Road to E-Mobility in the Caribbean", p. 8, https://ecpamericas.org/wp-content/uploads/2020/12/Electrified-Islands-Final-2.pdf.

38 NewEnergyEvents (2020), "E-Mobility Roadmap Workshop", https://newenergyevents.com/cref2020/e-mobility-roadmapping-workshop.

39 Johnson, op. cit. note 28.

40 S. Johnson, personal communication with SLOCAT, 19 April 2023.

41 K.U. Shah (2022), "Renewables and Energy Transitions in Small Island States", International Institute for Sustainable Development, 8 June, https://sdg.iisd.org/commentary/guest-articles/renewables-and-energy-transitions-in-small-island-states.

42 International Renewable Energy Agency (IRENA), "SIDS Lighthouses Initiative", https://islands.irena.org, accessed 24 May 2023.

43 BBC News (2021), "Tesla partners with nickel mine amid shortage fears", 5 March, https://www.bbc.co.uk/news/business-56288781.

44 C. Wilson (2022), "Bougainville starts process to reopen controversial Panguna mine", Al Jazeera, 6 May, https://www.aljazeera.com/news/2022/5/6/holdbougainvillestartsprocessto-reopen-controversial-panguna-mine.

45 Thunderstruck (2022), "Exploring for Fiji's Zinc, Copper, Silver and Gold", https://www.thunderstruck.ca/images/pdf/presentations/2022/Thunderstruck_Resources_presentation_11-April.pdf.

46 Akiwumi, op. cit. note 10.

47 SLOCAT analysis based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

48 Ibid.

49 Ibid.

50 **Figure 2** from Ibid.

51 Despite poor data availability, land transport was identified in a 2021 study as most likely the largest user of imported fuel in many SIDS, from Baker and Campbell, op. cit. note 1, p. 11.

52 Ibid., pp. 7-8.

53 Ibid., pp. 7-8.

54 World Bank (2017), "Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action", https://openknowledge.worldbank.org/entities/publication/7d71d8de-a47d-53c5-901d-3c01d81b0f74.

55 World Bank (2012), "Samoa Post Tsunami Reconstruction Project", 16 April, https://www.worldbank.org/en/results/2012/04/16/samoa-post-tsunami-reconstruction-project.

56 Y.Y. Kesete (2017), "The Road to Recovery in Dominica: Rebuilding and Resilience after Cyclone Erika", United Nations Office for Disaster Risk Reduction, 24 May, https://www.preventionweb.net/blog/road-recovery-dominica-rebuilding-and-resilience-after-cyclone-erika.

57 International Monetary Fund (2021), "Dominica Disaster Resilience Strategy", p. 18, https://www.imf.org/-/media/Files/Publications/CR/2021/English/1DMAEA2021001.ashx.

58 Ibid.

59 Ibid.

60 Singapore LTA, op. cit. note 30; Singapore URA, op. cit. note 30.

61 Ibid.; RMI, op. cit. note 34.

62 Ministry of Health, Wellness and Environment of Antigua and Barbuda (2020), "Electric Bus Pilot Project", 25 August, https://health.gov.ag/electric-bus-pilot-project.

63 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (2022), "Transitioning to Low Carbon Sea Transport in the Marshall Islands, Bonn", https://www.giz.de/en/downloads/giz2022-en-transitioning-to-low-carbon-sea-transport-2.pdf.

64 C.N. Nemra (2021), "Global shipping is a big emitter, the industry must commit to drastic action before it is too late", The Guardian, 19 September, https://www.theguardian.com/world/2021/sep/20/global-shipping-is-a-big-emitter-the-industry-must-commit-to-drastic-action-before-it-is-too-late.

65 **Box 1** from the following sources: Barbados Ministry of Foreign Affairs and Foreign Trade (2022), "The 2022 Bridgetown Initiative", 23 September, https://www.foreign.gov.bb/the-2022-barbados-agenda; R. Palmer and F. Schroeder (2022), "The Bridgetown Initiative, A climate and development plan for COP27", E3G, 14 November, https://www.e3g.org/news/the-bridgetown-initiative-a-climate-and-development-plan-for-cop27; UNCTAD (2023), "Global Supply Chain Forum 2024", https://unctad.org/meeting/global-supply-chain-forum-2024, accessed 24 May 2023.

66 Vanuatu ICJ Initiative (2023), "Port Vila Call for a Just Transition to a Fossil Fuel Free Pacific", https://www.vanuatuicj.com/call, accessed 24 May 2023.

67 Regional Pacific NDC Hub (2022), "Mandate, Vision and Objectives", https://pacificndc.org/our-work/vision-values, accessed 24 May 2023.

68 GIZ (2021), "Transitioning to Low Carbon Sea Transport", https://www.giz.de/en/worldwide/59626.html.

69 Global Green Growth Institute (2023), "Powering Pacific Green Growth", https://storiesofchange.gggi.org/pacific/index.html, accessed 24 May 2023.

70 Maritime Technology Cooperatio Centre (2016), "About the MTCC-Pacific Project", https://mtccpacific.spc.int/about-the-project.

71 Pacific Community (2022), "Charging up regulations to support electric transportation in the Pacific", 23 February 2022, https://spc.int/updates/blog/2022/02/charging-up-regulations-to-support-electric-transportation-in-the-pacific; Pacific Centre for Renewable Energy and Energy Efficiency (2020), "Options for Integrated Electric Mobility and Renewable Power Markets in the Pacific Island Countries and Territories (PICT)", https://www.pcreee.org/sites/default/files/documents/files/200729%20PCREEE%20E-Mobility%20Program%20-%20Technical%20Paper%20-%20Final%20clean.pdf.

72 IRENA, op. cit. note 43.

73 Ibid.

74 US Department of State (2019), "Pacific Islands Forum – U.S. Engagement in the Pacific Islands Fact Sheet", 17 August, https://2017-2021.state.gov/pacific-islands-forum-u-s-engagement-in-the-pacific-islands/index.html.

75 US Department of State (2022), "U.S. – Pacific Island Country Summit", Bureau of East Asian and Pacific Affairs, https://www.state.gov/u-s-pacific-islands-country-summit; The White House (2022), "FACT SHEET: President Biden Unveils First-Ever Pacific Partnership Strategy", 29 September, https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/29/fact-sheet-president-biden-unveils-first-ever-pacific-partnership-strategy.

1.3.1
TRANSPORT IN NATIONAL CLIMATE AND SUSTAINABILITY STRATEGIES TO ACHIEVE THE TARGETS OF THE PARIS AGREEMENT AND SDGS

1 United Nations Framework Convention on Climate Change (UNFCCC) (2021), "NDC Synthesis Report", https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs/ndc-synthesis-report.

2 SLOCAT Partnership on Sustainable, Low Carbon Transport (SLOCAT) (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", www.tcc-gsr.com.

3 UNFCCC (2023), "Marrakech Partnership for Global Climate Action", https://unfccc.int/climate-action/marrakech-partnership-for-global-climate-action.

4 Ibid.

5 R. Grynspan (2022), "Weathering a 'Perfect Storm' of Cascading Crises", SDG Action, 20 May, https://sdg-action.org/weathering-a-perfect-storm-of-cascading-crises.

6 A. Guterres (2023), "Secretary-General's Briefing to the General Assembly on Priorities for 2023", United Nations, 6 February, https://www.un.org/sg/en/content/sg/speeches/2023-02-06/secretary-generals-briefing-the-general-assembly-priorities-for-2023.

7 UNFCCC, op. cit. note 1.

8 SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

9 Ibid.

10 Ibid.

11 Ibid.

12 Ibid.

13 Ibid.

14 Ibid.

15 Ibid.

16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.

20 **Figure 1** from SLOCAT (2022), "Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies", www.slocat.net/ndcs. **Table 1** from SLOCAT analysis based on GIZ and SLOCAT, op. cit. note 8.

21 **Table 2** from SLOCAT analysis based on GIZ and SLOCAT, op. cit. note 8.

22 Ibid.

23 Ibid.

24 Ibid.

25 Ibid.

26 Ibid.

27 Ibid.

28 UNFCCC, op. cit. note 1.

29 **Figure 2** from SLOCAT analysis based on GIZ and SLOCAT, op. cit. note 8.

30 Ibid.

31 Ibid.

32 Ibid.

33 Ibid.

34 **Table 3** from Ibid.

35 Ibid.

36 Ibid.

37 Ibid.

38 **Table 4** from the following sources: SLOCAT (2022), "Are Nationally Determined Contributions Aligned with the Commitments and Initiatives on Transport Announced on the Occasion of COP26? A Comparative Analysis by SLOCAT", https://slocat.net/cop26-commitments-ndc-alignment-2022; Accelerating to Zero Coalition Steering Committee (2022), "Signatories", https://acceleratingtozero.org/signatories-views, accessed 14 December 2022; UNFCCC (2022), "Breakthroughs", https://racetozero.unfccc.int/system/breakthroughs, accessed 14 December 2022; Department for Transport (2022), "COP 26: Clydebank Declaration for green shipping corridors", https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors; CALSTART (2023), "Global Memorandum of Understanding on Zero-emission Medium- and Heavy-duty Vehicles", Global Commercial Vehicle Drive to Zero, https://globaldrivetozero.org/mou-nations, accessed 14 December 2022; CALSTART (2023), "Global MOU Policy Tracker Dashboard", Global Commercial Vehicle Drive to Zero, https://globaldrivetozero.org/progress-dashboard, accessed 14 December 2022; UK Department for Transport (2022), "COP 26 declaration: International Aviation Climate Ambition Coalition", https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition/cop-26-declaration-international-aviation-climate-ambition-coalition.

39 SLOCAT, op. cit. note 38.

40 COP27 Presidency (2022), "Low Carbon Transport for Urban Sustainability (LOTUS) Initiative", https://cop27.eg/#/presidency/initiative/lotus.

41 Ibid.

42 Green Shipping (2022), "Green Shipping Challenge at COP27", https://greenshippingchallenge.org/cop27.

43 PATH (2022), "COP27: PATH's Letter to Governments and Cities", https://pathforwalkingcycling.com/cop27.

44 Transport Decarbonisation Alliance (2021), "Call to Support Active Mobility Capacity Building", https://tda-mobility.org/call-to-support-active-mobility-capacity-building.

45 SLOCAT analysis based on GIZ and SLOCAT, op. cit. note 8.

46 SLOCAT (2023), "Paris Process on Mobility and Climate", https://slocat.net/ppmc, accessed 15 March 2023.

47 SLOCAT analysis based on GIZ and SLOCAT, op. cit. note 8.

48 SLOCAT (2022), "¿Hay coherencia entre las estrategias climáticas y las políticas de transporte? El caso de América Latina y el Caribe para los niveles nacional y subnacional", https://slocat.net/hay-coherencia-entre-las-estrategias-climaticas-y-las-politicas-de-transporte.

49 Ibid.

50 Ibid.

51 World Bank (2022), "Global Facility to Decarbonize Transport (GFDT)", https://www.worldbank.org/en/programs/global-facility-to-decarbonize-transport/grantees, accessed 20 May 2023.

52 UK Department for Transport (2021), "Government Publishes World's First 'Greenprint' to Decarbonise All Modes of Domestic Transport by 2050", 14 July, https://www.gov.uk/government/news/government-publishes-worlds-first-greenprint-to-decarbonise-all-modes-of-domestic-transport-by-2050.

53 Department of the Taoiseach (2022), "Government Launches Updated Climate Action Plan Accelerating Ambition in Reaching Climate Goals", 21 December, https://www.gov.ie/en/press-release/c2114-government-launches-updated-climate-action-plan-accelerating-ambition-in-reaching-climate-goals.

54 Auckland Council (2022), "The Pathway to Lower Transport Emissions in Auckland", 15 August, https://ourauckland.aucklandcouncil.govt.nz/news/2022/08/transport-emissions-reduction-pathway.

55 Freetown City Council (2023), "Freetown's First Climate Action Strategy 2022-2030", https://fcc.gov.sl/freetowns-first-climate-action-strategy.

56 C40 Cities (2022), "Mumbai Climate Action Plan", https://www.c40.org/news/mumbai-climate-action-plan.

57 Brihanmumbai Municipal Corporation (2021), "Action Areas", https://mcap.mcgm.gov.in/key-action-area.

58 City of Vancouver (2022), "Climate Action Through Transportation", https://vancouver.ca/green-vancouver/transportation.aspx.

59 SLOCAT (2023), "SLOCAT Key Transformations for Sustainable, Low Carbon Land Transport", https://slocat.net/key-transformations.

60 **Box 1** from SLOCAT and Islamic Development Bank (2020), "Transport, Climate Action and Sustainable Development: Synergies Across Nationally Determined Contributions (NDCs) and Voluntary National Reviews (VNRs)", https://slocat.net/wp-content/uploads/2020/04/SLOCAT-ISDB_2020_Transport-Climate-Action-Sustainable-Development.pdf.

61 SLOCAT (2022), "Transport and Voluntary National Reviews 2022", www.slocat.net/vnr.

62 Ibid.

63 SLOCAT (2019), "Sustainable Transport: A Critical Driver to Achieve the Sustainable Development Goals", www.slocat.net/vnr.

64 SLOCAT, op. cit. note 61.

65 Ibid.

66 SLOCAT (2021), "Transport and Voluntary National Reviews 2021: Achieving the Sustainable Development Goals in Times of Change", https://slocat.net/wp-content/uploads/2021/10/SLOCAT-2021-VNR-Analysis_Final-Report.pdf. **Figure 3** from SLOCAT, op. cit. note 61.

67 **Table 5** from SLOCAT, op. cit. note 61.

68 Ibid.

69 Ibid.

70 Ibid.

71 Ibid.

72 Grynspan, op. cit. note 5.

73 United Nations Sustainable Development Group (2022), "Global Impact of War in Ukraine on Food, Energy and Finance Systems – Brief No. 1", https://unsdg.un.org/resources/global-impact-war-ukraine-food-energy-and-finance-systems-brief-no1; United Nations Sustainable Development Group (2022), "Global Impact of War in Ukraine on Food, Energy and Finance Systems – Brief No. 2", https://unsdg.un.org/resources/global-impact-war-ukraine-food-energy-and-finance-systems-brief-no2; United Nations Sustainable Development Group (2022), "Global Impact of War in Ukraine: Energy Crisis – Brief No. 3", https://unsdg.un.org/resources/global-impact-war-ukraine-energy-crisis-brief-no3.

74 P. Pereira et al. (2022), "The Russian-Ukrainian armed conflict will push back the sustainable development goals", *Geography and Sustainability*, Vol. 3, No. 3, pp. 277-287, https://www.sciencedirect.com/science/article/pii/S2666683922000591.

75 United Nations (2023), "United Nations Secretary-General's SDG Stimulus to Deliver Agenda 2030", https://www.un.org/sustainabledevelopment/wp-content/uploads/2023/02/SDG-Stimulus-to-Deliver-Agenda-2030.pdf.

76 J.D. Sachs et al. (2022), "Sustainable Development Report 2022: From Crisis to Sustainable Development: The SDGs as Roadmap to 2030 and Beyond", https://bit.ly/3qtgdQT.

1.3.2
SUB-NATIONAL ACTIONS FOR SUSTAINABLE, LOW CARBON TRANSPORT

1 International Energy Agency (IEA) (2022), "Transport", https://www.iea.org/reports/transport; electricity use was split into fossil fuel-based and renewables using the global share of renewables in electricity and heat generation, from IEA (2022), "Energy Statistics Data Browser", https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser.

2 Renewable Energy Policy Network for the 21st Century (REN21) (2023), "Renewables 2023 Global Status Report: Energy Demand Modules", p. 40, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

3 Climate Action Tracker (2022), "2100 Warming Projections: Emissions and expected warming based on pledges and current policies", https://climateactiontracker.org/global/temperatures/, accessed 25 August 2023.

4 **Figure 1** from SLOCAT Partnership on Sustainable, Low Carbon Transport (2022), "Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies", www.slocat.net/ndcs.

5 Ibid.

6 Ibid.

7 **Figure 2** from SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

8 United Nations Framework Convention on Climate Change (2023), "Sharm el-Sheikh mitigation ambition and implementation work programme", https://unfccc.int/topics/mitigation/workstreams/mitigation-work-programme, accessed 10 August 2023.

9 International Institute for Sustainable Development (2018), "38 countries, 1,200 companies join e-mobility partnership, COP Presidency announces Just Transition Declaration", 11 December, https://sdg.iisd.org/news/38-countries-1200-companies-join-e-mobility-partnership-cop-presidency-announces-just-transition-declaration.

10 Ibid.

1 Organisation for Economic Co-operation and Development (OECD) and United Cities and Local Governments (2016), "Subnational Governments Around the World: Structure and Finance", https://www.oecd.org/regional/regional-policy/Subnational-Governments-Around-the-World-%20Part-I.pdf.

2 International Energy Agency (IEA) (2021), "Empowering Cities for a Net Zero Future", https://www.iea.org/reports/empowering-cities-for-a-net-zero-future; T. Cyrs and C. Elliott (2018), "INSIDER: Expand the Role of Subnational Actors in Climate Policy", World Resources Institute (WRI), https://www.wri.org/technical-perspectives/insider-expand-role-subnational-actors-climate-policy; J. Duggan (2019), "The Role of Sub-state and Non-state Actors in International Climate Processes: Subnational Governments", Chatham House, https://www.chathamhouse.org/2019/01/role-sub-state-and-non-state-actors-international-climate-processes-subnational-governments.

3 Duggan, op. cit. note 2.

4 IEA, op. cit. note 2.

5 International Transport Forum (2023), "ITF Transport Outlook 2023", https://doi.org/10.1787/b6cc9ad5-en; IEA, op. cit. note 2; https://www.itf-oecd.org/sites/default/files/transport-outlook-2021-presentation-key-findings.pdf.

6 B. Venditti (2022), "This chart shows the impact rising urbanization will have on the world", World Economic Forum, 26 April, https://www.weforum.org/agenda/2022/04/global-urbanization-material-consumption.

7 IEA, op. cit. note 2.

8 D. Pojani and D. Stead (2018), "Policy design for sustainable urban transport in the global south", Policy Design and Practice, 1:2, 90-102, DOI: 10.1080/25741292.2018.1454291.

9 United Nations, "UN Population Division Data Portal", https://population.un.org/dataportal/home, accessed 31 May 2023.

10 Ibid.

11 Destatis (2023), "International Statistics: The largest cities worldwide 2023", https://www.destatis.de/EN/Themes/Countries-Regions/International-Statistics/Data-Topic/Population-Labour-Social-Issues/DemographyMigration/UrbanPopulation.html, accessed 15 August 2023.

12 IEA, op. cit. note 2.

13 Duggan, op. cit. note 2.

14 D.A. Benitez and J. Bisbey (2021), "Financing Low Carbon Transport Solutions in Developing Countries. Transport Decarbonization Investment Series", World Bank, https://openknowledge.worldbank.org/entities/publication/e9bafdd7-91ab-5e8a-811e-7a207fb75a3b.

15 Greater London Authority (2023), "Green Transport", https://www.london.gov.uk/programmes-strategies/transport/green-transport, accessed 15 August 2023; City of New York (2023), "1.5°C: Aligning New York City with the Paris Climate Agreement", https://www.nyc.gov/site/sustainability/codes/1.5-climate-action-plan.page, accessed 15 August 2023; City of Paris (2020), "Paris Climate Action Plan", https://cdn.paris.fr/paris/2020/11/23/a10afc931be2124e21e39a1624132724.pdf, accessed 15 August 2023; Our Auckland (2022), "The pathway to lower transport emissions in Auckland", https://ourauckland.aucklandcouncil.govt.nz/news/2022/08/transport-emissions-reduction-pathway, accessed 15 August 2023; D. Pojani and D. Stead (2018), "Policy design for sustainable urban transport in the global south", Policy Design and Practice, 1:2, 90-102, DOI: 10.1080/25741292.2018.1454291.

16 Google (2023), "Environmental Insights Explorer", https://insights.sustainability.google, accessed 17 May 2023.

17 Ibid.

18 C.S. Okoro and K. Lawani (2022), "Optimising sustainable mobility: A performance assessment of non-motorised transport infrastructure in Johannesburg, South Africa", *Journal of the South African Institution of Civil Engineering*, Vol. 64, No. 2 (June), pp. 67-76, http://www.scielo.org.za/pdf/jsaice/v64n2/06.pdf.

19 Google, op. cit. note 16.

20 WRI (forthcoming), "Connecting Informal Transport to Climate Action: A Briefing Note for COP27"; C.J. Abraham et al. (2021), "Ray of hope for sub-Saharan Africa's Informal transport: Solar charging of urban electric minibus taxis in South Africa", *Energy for Sustainable Development*, Vol. 64, pp. 118-127, https://doi.org/10.1016/j.esd.2021.08.003; R. Behrens et al. (2021), "Transitions – Informal Transport Compendium Report".

21 J. Fenston (2022), "Some streets closed during the pandemic to allow pedestrians will remain car-free", https://www.npr.org/2022/12/06/1139751600/some-streets-closed-during-the-pandemic-to-allow-pedestrians-will-remain-car-fre, accessed 15 August 2023; Bloomberg (2021), "Can 'Open Streets' Outlast the Pandemic?", https://www.bloomberg.com/news/articles/2021-04-29/what-s-next-for-the-open-streets-of-the-pandemic, accessed 15 August 2023.

22 Statista (2018), "Cost for public transport in cities worldwide", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/275438/public-transport-cost-cities.

23 Ibid.

24 Statista (2023), "Public transport monthly ticket cost: Key cities globally 2023", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1154432/public-transport-monthly-ticket-cost-selected-cities-worldwide.

25 H. Chandler-Wilde (2023), "These Are the World's Most Congested Cities", https://www.bloomberg.com/news/articles/2023-01-10/these-are-the-world-s-most-congested-cities, accessed 15 August 2023.

26 International Association of Public Transport (2022), "World Metro Figures 2021", chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cms.uitp.org/wp/wp-content/uploads/2022/05/Statistics-Brief-Metro-Figures-2021-web.pdf, accessed 15 August 2023.

27 Traffic delays exceeded pre-COVID levels in 116 out of 295 cities tracked in the United States and in 249 out of 593 cities tracked in Europe. INRIX (2023), "2022 INRIX Traffic Scorecard Report", https://inrix.com/scorecard.

28 MCC Berlin (2021), "Corona crisis lesson: Additional bike lanes induce large increases in cycling", 30 March, https://www.mcc-berlin.net/en/news/information/information-detail/article/corona-crisis-lesson-additional-bike-lanes-induce-large-increases-in-cycling.html.

29 Intergovernmental Panel on Climate Change (2022), "Climate Change 2022: Mitigation of Climate Change", https://www.ipcc.ch/report/ar6/wg3; IEA, op. cit. note 2.

30 International Transport Forum (2023), "ITF Transport Outlook 2023", https://doi.org/10.1787/b6cc9ad5-en; IEA, op. cit. note 2; https://www.itf-oecd.org/sites/default/files/transport-outlook-2021-presentation-key-findings.pdf.

31 Analysis from the SLOCAT Partnership for Sustainable, Low Carbon Transport (SLOCAT), based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

32 Ibid.

33 Google Earth (2023), "EIE's 2022 transportation data release reveals a need for public transit solutions and low-emission zones", https://medium.com/google-earth/eies-2022-transportation-data-release-reveals-a-need-for-public-transit-solutions-and-low-emission-8b3df2828f76.

34 W. Li et al. (2022), "Assessing the transition to low-carbon urban transport: A global comparison", *Resources, Conservation and Recycling*, Vol. 180 (May), p. 106179, https://doi.org/10.1016/j.resconrec.2022.106179; C40 (2023), "Greenhouse gas emissions interactive dashboard", https://www.c40knowledgehub.org/s/article/C40-cities-greenhouse-gas-emissions-interactive-dashboard.

35 Ibid.

36 C40 (2023), "Transport", https://www.c40.org/what-we-do/scaling-up-climate-action/transportation, accessed 15 August 2023.

37 Li et al., op. cit. note 36; C40, op. cit. note 36.

38 Ibid., both references.

39 Li et al., op. cit. note 36.

40 Ibid.

41 Alliance for Logistics Innovation through Collaboration in Europe (Alice) (2022), "Urban Freight Roadmap", https://www.etp-logistics.eu/wp-content/uploads/2022/08/Urban-Freight-Roadmap.pdf, accessed 15 August 2023.

42 United Nations Framework Convention on Climate Change (2022), "Race To Zero Campaign", https://unfccc.int/climate-action/race-to-zero-campaign, accessed 15 June 2023.

43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 **Figures 1 and 2** from Net Zero Tracker (2023), "Data Explorer", https://zerotracker.net, accessed 16 June 2023.

48 **Figure 3** from Ibid.

49 **Figure 4** from Ibid.

50 OECD (No date), "Achieving the SDGs in cities and regions", https://www.oecd.org/about/impact/achieving-sdgs-in-cities-and-regions.htm, accessed 15 August 2023.

51 UN-Habitat (2020), "Guidelines for Voluntary Local Reviews Volume 1: A Comparative Analysis of Existing VLRs", https://unhabitat.org/guidelines-for-voluntary-local-reviews-volume-1-a-comparative-analysis-of-existing-vlrs, accessed 15 August 2023.

52 UN Department of Economic and Social Affairs (2023), "Voluntary Local Reviews", https://sdgs.un.org/topics/voluntary-local-reviews, accessed 15 August 2023.

53 Ibid.

54 City of Amsterdam (2022), "Voluntary Local Review 2022: Impact of the Sustainable Development Goals on the City of Amsterdam", https://sdgs.un.org/sites/default/files/vlrs/2022-12/vlr_amsterdam.pdf, accessed 15 August 2023.

55 City Helsinki (2023), "From Agenda to Action – Implementation of the UN Sustainable Development Goals in Helsinki 2023", https://www.hel.fi/static/kanslia/Julkaisut/2023/from-agenda-to-action-2023.pdf, accessed 15 August 2023.

56 G. Marsden et al. (2014), "Muddling through with climate change targets: a multi-level governance perspective on the transport sector", *Climate Policy*, Vol. 14, No. 5, pp. 617-636, https://doi.org/10.1080/14693062.2014.905823.

57 M. Rabbia, Á. Zopatti (2021), "Subnational Governance of Climate Change", In: Luetz, J.M., Ayal, D. (eds) Handbook of Climate Change Management. Springer, Cham. https://doi.org/10.1007/978-3-030-57281-5_52.

58 H. Fuhr, T. Hickmann and K. Kern (2018), "The role of cities in multi-level climate governance: Local climate policies and the 1.5 °C target", *Current Opinion in Environmental Sustainability*, Vol. 30 (February), pp. 1-6, https://doi.org/10.1016/j.cosust.2017.10.006.

59 MobiliseYourCity (No date), "Supporting mobility planning with technical assistance", https://www.mobiliseyourcity.net/planning-sustainable-mobility-sumps-and-numps, accessed 15 August 2023; SLOCAT (2022), "National Urban Mobility Policies and Investments Programmes in Support of Climate Commitments in Latin America and the Caribbean", https://slocat.net/wp-content/uploads/2022/12/Global-Stocktake-Submission_2022.12.13_EN.pdf.

60 European Commission (2021), "Questions and Answers: European Urban Mobility Framework", https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_6729.

61 European Commission (2023), "Commission guides Member States on sustainable urban mobility planning", https://transport.ec.europa.eu/news-events/news/commission-guides-member-states-sustainable-urban-mobility-planning-2023-03-09_en.

62 Arup (2022), "Türkiye's first Sustainable Urban Mobility Plan launched in Istanbul", https://www.arup.com/news-and-events/first-sustainable-urban-mobility-plan-for-turkey-announced-in-istanbul , accessed 10 August 2023.

63 A. Pharande (2022), "Transit-oriented development – Making Indian cities liveable again" for Construction Week, https://www.constructionweekonline.in/people/transit-oriented-development-making-indian-cities-liveable-again, accessed 15 August 2023.

64 N. Medimorec et al. (2022), "Sustainable Transport in African Cities: Challenges and Opportunities Through the 15-minute City Planning Approach", SLOCAT, https://slocat.net/15-minute-city-planning-african-cities.

65 R.M. Nugraha and P.G. Bhwana (2022), "309 KM of Jakarta bike lanes established before 2022 ends", Tempo, 31 August, https://en.tempo.co/read/1628899/309-km-of-jakarta-bike-lanes-established-before-2022-ends.

66 Eltis (2022), "SUMP for the city of Utrecht ", https://www.eltis.org/resources/case-studies/sump-city-utrecht, accessed 15 August 2023.

67 Institute for Transportation and Development Policy (ITDP) (2020), "Ethiopia Non-Motorised Transport Strategy 2020-2029", https://africa.itdp.org/publication/ethiopia-non-motorized-strategy-2020-2029; World Economic Forum, op. cit. note 6; International Climate Initiative (2021), "Growing Smarter – Sustainable Mobility in East Africa", https://www.international-climate-initiative.com/en/project/growing-smarter-sustainable-mobility-in-east-africa-18-i-356-africa-a-sustainable-mobility-in-east-africa.

68 Fare Free Public Transport (2022), "Information about cities with fare free public transport", https://freepublictransport.info, accessed 15 December 2022; Mobilité gratuite au Luxembourg (2020), "Free Mobility", https://mobilitegratuite.lu/en/free-mobility.

69 Ibid.

70 CNBC (2023), "Washington D.C.'s free bus bill becomes law as zero-fare transit systems take off", https://www.cnbc.com/2023/01/30/dc-free-bus-bill-becomes-law-zero-fare-transit.html#:~:text=Washington%2C%20D.C.%2C%20has%20enacted%20a,of%20a%20growing%20movement%20nationwide, accessed 15 August 2023.

71 C. Blanchar (2023), "La 'tasa Amazon' de Barcelona entra en vigor sin saber si repercutirá en los comercios o en los consumidores", El Pais, https://elpais.com/espana/catalunya/2023-03-02/la-tasa-amazon-de-barcelona-entra-en-vigor-sin-saber-si-repercutira-en-los-comercios-o-en-los-consumidores.html; C. Blanchar (2022), "Barcelona comenzará a cobrar en marzo la 'tasa Amazon': la pagarán los grandes operadores de reparto por aparcar al entregar a domicilio", El Pais, https://elpais.com/espana/catalunya/2022-12-02/barcelona-comenzara-a-cobrar-en-marzo-la-tasa-amazon-la-pagaran-los-grandes-operadores-de-reparto-por-aparcar-al-entregar-a-domicilio.html.

72 C. Blanchar (2023), "La 'tasa Amazon' de Barcelona entra en vigor sin saber si repercutirá en los comercios o en los consumidores", El Pais, https://elpais.com/espana/catalunya/2023-03-02/la-tasa-amazon-de-barcelona-entra-en-vigor-sin-saber-si-repercutira-en-los-comercios-o-en-los-consumidores.html; C. Blanchar (2022), "Barcelona comenzará a cobrar en marzo la 'tasa Amazon': la pagarán los grandes operadores de reparto por aparcar al entregar a domicilio", El Pais, https://elpais.com/espana/catalunya/2022-12-02/barcelona-comenzara-a-cobrar-en-marzo-la-tasa-amazon-la-pagaran-los-grandes-operadores-de-reparto-por-aparcar-al-entregar-a-domicilio.html.

73 H. Ouellette-Vezina (2023), "Des véhicules dorénavant facturés selon leur poids", La Presse, https://www.lapresse.ca/actualites/grand-montreal/2023-05-02/stationnement-dans-rosemont-la-petite-patrie/des-vehicules-dorenavant-factures-selon-leur-poids.php.

74 H. Thompson (2023), "French first as city brings in parking charges linked to car's weight", Connexion, https://www.connexionfrance.com/article/French-news/French-first-as-city-brings-in-parking-charges-linked-to-car-s-weight.

75 BBC (2022), "Mothers in Cambridge start campaign to support congestion charge ", https://www.bbc.co.uk/news/uk-england-cambridgeshire-63919087, accessed 14 August 2023; Intelligent Transport (2023), "London's Congestion Charge celebrates 20 years of success ", https://www.intelligenttransport.com/transport-news/143883/londons-congestion-charge-celebrates-20-years-of-success, accessed 14 August 2023; Politico (2022), "It's a global phenomenon — now New York is poised to lead the nation in congestion pricing", https://www.politico.com/news/2022/09/03/as-new-york-moves-forward-on-congestion-pricing-00054379, accessed 14 August 2023.

76 Politico (2023), "It's a global phenomenon — now New York is poised to lead the nation in congestion pricing", https://www.politico.com/news/2022/09/03/as-new-york-moves-forward-on-congestion-pricing-00054379, accessed 14 August 2023.

77 OECD (2022), "London's congestion charge and its low emission zones", https://www.oecd.org/climate-action/ipac/practices/london-s-congestion-charge-and-its-low-emission-zones-c6cd48e9, accessed 14 August 2023.

78 ICCT (2021), "A global overview of zero-emission zones in cities and their development progress", https://theicct.org/sites/default/files/publications/global-cities-zez-dev-EN-aug21.pdf, accessed 14 August 2023.

79 World Resources Institute (no date), "Scaling Up Low Emission Zone (LEZ) Implementation in Jakarta to Improve Air Quality", https://wri-indonesia.org/en/initiatives/scaling-low-emission-zone-lez-implementation-jakarta-improve-air-quality, accessed 14 August 2023; M. Rizki, M.Z. Irawan, P. Dirgahayani, P.F. Belgiawan, R. Wihanesta (2022), "Low Emission Zone (LEZ) Expansion in Jakarta: Acceptability and Restriction Preference", *Sustainability*. 2022; 14(19):12334. https://doi.org/10.3390/su141912334.

80 ICCT (2021), "A global overview of zero-emission zones in cities and their development progress", https://theicct.org/sites/default/files/publications/global-cities-zez-dev-EN-aug21.pdf, accessed 14 August 2023; Shenzhen Public Security Bureau (2022), "Announcement of Shenzhen Municipal Public Security Bureau Traffic Police Bureau on Setting up Green Logistics Zones to Prohibit the Passage of Light Diesel Trucks", 20 July, http://www.sz.gov.cn/cn/xxgk/zfxxgj/tzgg/content/post_9969657.html (using Google Translate).

81 Luoyang Public Security Bureau (2021), "Notice on Further Normalizing and Optimizing Road Access Management of Urban Delivery Trucks", 21 April, http://zw.lyd.com.cn/system/2021/04/21/032019328.shtml (using Google Translate).

82 Los Angeles Cleantech Incubator (no date), "Santa Monica Zero Emissions Delivery Zone Pilot", https://laincubator.org/zedz, accessed 10 August 2023.

83 POLIS (2021), "Absolute Zero: Introducing Zero Emission Zones", https://www.polisnetwork.eu/article/absolute-zero-introducing-zero-emission-zones, accessed 16 August 2023.

84 Netherlands Enterprise Agency, RVO (no date), "Zero-emission zones to be introduced in many cities from 2025", https://business.gov.nl/running-your-business/environmental-impact/making-your-business-sustainable/zero-emission-zones-to-be-introduced-in-many-cities-from-2025, accessed 10 August 2023.

85 Accelerating to Zero Coalition (2022), "Accelerating to Zero (A2Z) Coalition launches at COP27 to drive global transition to zero-emission vehicles", https://acceleratingtozero.org/accelerating-to-zero-a2z-coalition-launches-at-cop27-to-drive-global-transition-to-zero-emission-vehicles.

86 Autocar Professional (2021), "Mumbai to get 1,900 new electric buses by mid-2023, BEST floats tender", https://www.autocarpro.in/news-national/mumbai-to-get-1-900-new-electric-buses-by-mid2023-best-floats-tender-80079, accessed 10 August 2023.

87 HT Auto (2021), "Mumbai's BEST adds 60 more electric buses, target 200 double decker buses too", Hindustan Times, https://auto.hindustantimes.com/auto/news/mumbais-best-adds-60-more-electric-buses-target-200-double-decker-buses-too-41634018382726.html.

88 California Air Resources Board (2023), "Clean Miles Standards", https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard, accessed 31 January 2023.

89 Electrive (2022), "Sao Paulo forbids the purchase of diesel buses", https://www.electrive.com/2022/12/06/sao-paulo-forbids-the-purchase-of-diesel-buses, accessed 10 August 2023.

90 R. Magisson-Javaux (2022), "Transdev Group deploys 406 new 100% electric buses in Bogotá", Transdev, 6 April, https://www.transdev.com/en/sustainable-mobility/406-electric-buses-in-bogota.

91 Ibid.

92 International Council on Clean Transportation (2022), "Update on zero-emission zone development progress in cities", https://theicct.org/wp-content/uploads/2022/08/Global-ZEZs-update-FINAL.pdf.

93 ICLEI–Local Governments for Sustainability (2023), "Local and regional governments and ICLEI", https://iclei.org/our_network, accessed 23 June 2023.

94 Despacio (2023), "Prácticas de Bicilogistica en América Latina", https://www.despacio.org/portfolio/practicas-de-bicilogistica-en-america-latina; La Capital (2022), "Rosario lanzó el nuevo sistema de bicis para el traslado de paquetería en el centro", https://www.lacapital.com.ar/la-ciudad/rosario-lanzo-el-nuevo-sistema-bicis-el-traslado-paqueteria-el-centro-n10031849.html.

95 Convergence Energy Services Limited (2022), "The 'Grand Challenge' for Electric Bus Deployment: Outcomes and Lessons for the Future", https://www.convergence.co.in/public/images/electric_bus/Grand-Challenge-Case-Study-Final-Web-Version.pdf; M. Dawra, M.D. Pandey and S. Bhatia (2022), "Expanding the footprint of the Grand Challenge across Tier-II India", WRI India, https://wri-india.org/blog/expanding-footprint-grand-challenge-across-tier-ii-india; A. Vijaykumar and P. Mulukutla (2022), "Key lessons for India's bus electrification drive", WRI India, https://wri-india.org/blog/key-lessons-indias-bus-electrification-drive.

96 Ibid.

97 ITDP (2021), "Rwanda", https://africa.itdp.org/where-we-work/rwanda; C. Mimano, M. Kinyua and C. Kost (2022), "Transit-oriented development as an anchor to compact, equitable, and accessible African cities", SLOCAT, https://slocat.net/transit-oriented-development-as-an-anchor-to-compact-equitable-and-accessible-african-cities.

98 M. Cleuet and A. Jehanno (2019), "Developing Sustainable Urban Mobility Plans – Guidelines for MobiliseYourCity Geographies", https://changing-transport.org/wp-content/uploads/2023_developin-sustainable-urban-mobility-plans.pdf.

99 S. Vemuri et al. (2023), "MobiliseYourCity Global Monitor 2023", https://www.mobiliseyourcity.net/sites/default/files/2023-05/Global%20Monitor%20 2023_final.pdf.

100 World Bank (2022), "With bus rapid transit, African cities are riding toward a better future", https://www.worldbank.org/en/news/feature/2022/11/28/with-bus-rapid-transit-african-cities-are-riding-toward-a-better-future.

101 Green Climate Fund (2021), "Dakar Bus Rapid Transit Pilot Project", https://www.greenclimate.fund/sites/default/files/document/14160-dakar-bus-rapid-transit-pilot-project.pdf.

1.3.3
THE ROLE OF BUSINESS IN DECARBONISING TRANSPORT

1 Sustainability for All (2023), "100 Companies are responsible for 71% of GHG emissions", https://www.activesustainability.com/climate-change/100-companies-responsible-71-ghg-emissions, accessed 25 February 2023.

2 Science Based Targets (2023), "Companies taking action", https://sciencebasedtargets.org/companies-taking-action#dashboard, accessed 3 March 2023.

3 We Mean Business Coalition (2023), "The 4 A's of Climate Leadership", https://www.wemeanbusinesscoalition.org/business, accessed 25 February 2023.

4 Ibid.

5 World Benchmarking Alliance (WBA) (2021), "2021 Automotive Benchmark", Climate and Energy Benchmark, https://www.worldbenchmarkingalliance.org/publication/automotive.

6 Science Based Targets, op. cit. note 2; Science Based Targets (2023), "Transport", https://sciencebasedtargets.org/sectors/transport#our-updated-oems-policy, accessed 25 February 2023.

7 WBA, op. cit. note 5.

8 L. Paoli, A. Dasgupta and S. McBain (2022), "Electric Vehicles", International Energy Agency (IEA), https://www.iea.org/reports/electric-vehicles.

9 WBA, op. cit. note 5.

10 **Figure 3** from Y. Qiu, S. Song and R. McLane (2022), "Zero-emission truck real-world performance in US and Europe and implications for China", Calstart, https://globaldrivetozero.org/publication/zero-emission-truck-real-world-performance-in-us-and-europe-and-implications-for-china.

11 Air Transport Action Group (2021), "Commitment to Fly Net Zero 2050", https://aviationbenefits.org/flynetzero.

12 Global Maritime Forum (2021), "Ambition Statement", Getting to Zero Coalition, https://www.globalmaritimeforum.org/getting-to-zero-coalition/ambition-statement.

13 International Maritime Organization (2021), "Initial IMO GHG Strategy", https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx; Global Maritime Forum (2023), "Critical window of opportunity for shipping at IMO", https://www.globalmaritimeforum.org/news/critical-window-of-opportunity-for-shipping-at-imo.

14 S. Bullock, J. Mason and A. Larkin (2022), "The urgent case for stronger climate targets for international shipping", *Climate Policy*, Vol. 22, No. 3, pp. 301-309, https://www.tandfonline.com/doi/full/10.1080/14693062.2021.1991876.

15 WBA, op. cit. note 5.

16 **Figures 4 and 5** from InfluenceMap (2023), "Automotive Climate Tool", https://automotive.influencemap.org, updated January 2023.

17 IEA (2023), "Global Electric Vehicles Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

18 S. Shivji (2022), "How India's electric rickshaw revolution is forging a low-carbon future", CBC, https://www.cbc.ca/news/world/india-electric-rickshaw-revolution-low-carbon-future-1.6642423.

19 InfluenceMap, op. cit. note 16.

20 Ibid.

21 R. Irle and EV-Volumes (2022), "Global EV Sales for 2022", https://www.ev-volumes.com; D. Bleakley (2023), "Legacy auto faces disaster in China with unsellable cars as pollution crunch looms", The Driven, 30 March, https://thedriven.io/2023/03/30/legacy-auto-faces-disaster-in-china-with-unsellable-cars-as-pollution-crunch-looms.

22 Shivji, op. cit. note 18.

23 A. Pelaez-Fernandez (2023), "Mexico makes lots of electric cars, but few Mexicans drive them", Yahoo Finance, 21 March, https://finance.yahoo.com/news/mexico-makes-lots-electric-cars-120226420.html.

24 Global Market Insights (2022), "5 Major Battery Leasing Service Companies Riding the EV Wave", 6 May, https://www.gminsights.com/blogs/battery-leasing-service-contenders-taking-steps-to-consolidate-presence.

25 **Figure 6** from Calstart, "Zeti Analytics", Drive to Zero, https://globaldrivetozero.org/zeti-analytics, accessed March 2023.

26 IEA (2023), "Global EV Data Explorer", https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

27 IEA (2023), "Trends in electric heavy-duty vehicles", *Global EV Outlook 2023*, https://www.iea.org/reports/global-ev-outlook-2023/trends-in-electric-heavy-duty-vehicles.

28 IEA (2023), "Prospects for electric vehicle deployment", *Global EV Outlook 2023*, https://www.iea.org/reports/global-ev-outlook-2023/prospects-for-electric-vehicle-deployment.

29 BYD Brazil (n.d.), "Pioneira em soluções de energia limpa", https://www.byd.com.br/sobre, accessed 10 March 2023; City of São Paulo (2022), "Prefeitura passa a aceitar somente ônibus elétricos no transporte público", 17 October, https://www.capital.sp.gov.br/noticia/prefeitura-passa-a-aceitar-somente-onibus-eletricos-no-transporte-publico.

30 Renault Brasil (2023), "Renault Kwid", https://www.renault.com.br, accessed 10 March 2023; Mobilize (2023), "Mobilize en el seno del Renault Group: obtención de mayores beneficios", https://www.mobilize.com/es/te-presentamos-mobilize/mobilize-x-renault-group, accessed 10 March 2023.

31 IEA (2023), op. cit. note 26; IEA, op. cit. note 28.

32 **Table 1** based on the following sources: L. Stuyck (2023), "AB InBev investeert in 10 nieuwe E-Trucks voor stadsbelevering", https://ab-inbev.be/nl_BE/news/ab-inbev-investeert-in-10-nieuwe-e-trucks-voor-stadsbelevering; J. Strandhede (2021), "DFDS extends its record order with another 25 electric trucks from Volvo", Volvo, 22 December, https://www.volvotrucks.com/en-en/news-stories/press-releases/2021/dec/dfds-extends-its-record-order-with-another-25-electric-trucks-from-volvo.html; Tevva (n.d.), https://www.tevva.com, accessed 10 March 2023; Auto Desk (2021), "Tata Steel Deploys 27 Electric Trucks for Transportation of Finished Steel Rolls in India", News18, 1 August, https://www.news18.com/news/auto/tata-steel-deploys-27-electric-trucks-for-transportation-of-finished-steel-rolls-in-india-4031936.html; Maersk (2022), "Maersk to deploy 300 electric trucks in partnership with Einride", 24 March, https://www.maersk.com/news/articles/2022/03/24/maersk-to-deploy-300-electric-trucks-in-partnership-with-einride; J.S. Hill (2023), "Volta Trucks receives €40 million boost to electric truck as a service model", The Driven, 30 March, https://thedriven.io/2023/03/30/volta-trucks-receives-e40-million-boost-to-electric-truck-as-a-service-model; L. Kihlström (2021), "Sweden and Germany are leading the development for electric roads", Vattenfall, 21 January, https://group.vattenfall.com/press-and-media/newsroom/2021/sweden-and-germany-are-leading-the-development-for-electric-roads; Financial Times (2022), "South Korean shipbuilder bets on methanol-powered vessels in decarbonisation push", 27 August, https://www.ft.com/content/7ae78b8d-58e2-40e0-8ec3-0d874febfece; Marine Insight (2019), "Top 5 Zero Emission Ship Concepts of the Shipping World", https://www.marineinsight.com/green-shipping/top-5-zero-emission-ship-concepts; The Maritime Executive (2021), "World's First Zero-Emission Wind and Hydrogen Power Cargo Ship", 26 March, https://maritime-executive.com/article/world-s-first-zero-emission-wind-and-hydrogen-power-cargo-ship; A. Korn (2022), "Alice, the first all-electric passenger airplane, takes flight", CNN Business, 27 September, https://edition.cnn.com/2022/09/27/tech/eviation-alice-first-flight/index.html; T. Banse (2023), "Hydrogen-powered airliner makes first flight at Moses Lake", KNKX, 3 March, https://www.knkx.org/transportation/2023-03-03/hydrogen-powered-airliner-makes-first-flight-at-moses-lake; P. Johnson (2023), "World's largest electric cargo plane unveiled, here's how far it can fly on its own", Electrek, 30 January, https://electrek.co/2023/01/30/worlds-largest-electric-cargo-plane-unveiled.

33 H. Basma and F. Rodríguez (2021), "Race to Zero: Zero-emission Commercial Trucks and Buses in Europe", International Council on Clean Transportation, https://theicct.org/publication/race-to-zero-ze-hdv-eu-dec21.

34 International Air Transport Association (IATA) (2022), "Net zero 2050: Sustainable aviation fuels", https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels.

35 T. Kjølberg (2022), "World's First Zero-Emissions Cruise Ship Designed for Norwegian Fjords", Daily Scandinavian, 13 October, https://www.dailyscandinavian.com/world-first-zero-emission.

36 US Congress (2022), "Inflation Reduction Act of 2022", https://www.congress.gov/bill/117th-congress/house-bill/5376; Council of the European Union (2023), "Alternative fuel infrastructure: Provisional agreement for more recharging and refuelling stations across Europe", 28 March, https://www.consilium.europa.eu/en/press/press-releases/2023/03/28/alternative-fuel-infrastructure-provisional-agreement-for-more-recharging-and-refuelling-stations-across-europe.

37 IATA (2022), "Incentives needed to boost SAF production", 22 June, https://airlines.iata.org/analysis/incentives-needed-to-boost-saf-production.

38 Ibid.

39 **Figure 7** from InfluenceMap (n.d.), "Policy trackers", https://europe.influencemap.org/policy, accessed 10 March 2023.

40 WBA, op. cit. note 5.

41 **Figure 8** from InfluenceMap, op. cit. note 15.

42 InfluenceMap (2022), "The Automotive Sector and Climate Change", https://influencemap.org/report/The-Automotive-Sector-and-Climate-Change-18218; InfluenceMap (2022), "Europe Automotive Suppliers & EU Climate Policy", https://influencemap.org/report/European-Automotive-Suppliers-EU-Climate-Policy-17388; InfluenceMap (2022), "US Heavy-Duty Transport & Climate Change", https://influencemap.org/report/US-Heavy-Duty-Transport-Climate-Change-20434; InfluenceMap (2021), "Aviation Industry Lobbying & European Climate Policy", https://influencemap.org/report/Aviation-Industry-Lobbying-European-Climate-Policy-131378131d9503b4d32b365e54756351.

43 **Table 2** from InfluenceMap (2023), "Industry Associations", https://europe.influencemap.org/industry-associations, accessed 10 March 2023.

44 N. Carey (2022), "Volvo Cars to leave ACEA car lobby group over climate goals", Reuters, 8 July, https://www.reuters.com/business/autos-transportation/volvo-cars-leave-acea-car-lobby-group-over-climate-goals-2022-07-08.

45 industriAll European Trade Union et al. (2021), "Urgent need for a Just Transition framework for Europe's automotive workforce", 7 July, https://www.transportenvironment.org/wp-content/uploads/2021/08/Letter-to-Mr-F.-Timmermans-Urgent-need-for-a-Just-Transition-framework-for-Europes-automotive-workforce.pdf.

46 Just Transition in the European Car Industry (2023), “About the Project”, https://justtransition.eu/about-project, accessed 10 March 2023.

47 CDP (2022), “CDP Climate Change 2022 Questionnaire”, https://guidance.cdp.net/zh/guidance?cid=30&ctype=theme&idtype=ThemeID&incchild=1&microsite=0&otype=Questionnaire&page=1&tags=TAG-646,TAG-605,TAG-600.

48 UNFCCC (2023), "Long-term strategies portal", https://unfccc.int/process/the-paris-agreement/long-term-strategies, accessed 2 February 2023; R. Black et al. (2021), “Taking Stock: A global assessment of net zero targets”, Energy & Climate Intelligence Unit and Oxford Net Zero, https://eciu.net/analysis/reports/2021/taking-stock-assessment-net-zero-targets.

49 **Figure 9** from Science Based Targets, op. cit. note 2.

50 WBA (2022), “2022 Transport Benchmark”, https://www.worldbenchmarkingalliance.org/publication/transport; A. Mckinnon, M. Petersen and P. Evans (2021), “Decarbonising European logistics: A progress report”, *FOCUS*, Vol. 23, pp. 38-40, https://www.researchgate.net/publication/351329246_Decarbonising_European_logistics_a_progress_report_FOCUS.

51 International Transport Federation (2022), “Keeping 1.5ºC alive: Transport at COP26”, https://www.itf-oecd.org/sites/default/files/docs/cop26-transport-policy-brief.pdf.

52 WBA, op. cit. note 50.

53 D. Klasen (2022), “Science Based Target Initiative confirms climate targets of Deutsche Post DHL Group”, Deutsche Post DHL Group, 17 November, https://www.dpdhl.com/en/media-relations/press-releases/2022/science-based-target-initiative-confirms-climate-targets-of-deutsche-post-dhl-group.html.

54 WBA, op. cit. note 50.

55 ComfortDelGro Corporation Limited (2022), “Comfortdelgro’s decarbonisation targets get nod from global Science Based Targets Initiative (SBTi)”, https://www.comfortdelgro.com/documents/38822/423903/Media+Release+-+ComfortDelGro%E2%80%99s+Decarbonisation+Targets+Get+Nod+From+Global+Science+Based+Targets+Initiative+%28SBTi%29_Grp.pdf.

56 WBA (2023), “Royal Mail plc”, https://www.worldbenchmarkingalliance.org/publication/transport/companies/royal-mail-group, accessed 10 March 2023.

57 ÖBB, (2019), “Climate Protection Strategy 2030”, https://presse.oebb.at/dam/jcr:54307abe-7093-4ec3-8202-2db1dab3aeae/OEBB_KSB2019_EN_web.pdf; Global Railway Review (2021), “ÖBB RCG now operates green traction current in the Czech Republic”, https://www.globalrailwayreview.com/news/129010/obb-rcg-green-traction-czech-republic.

58 **Figure 10** from CDP (2023), “Are companies developing credible climate transition plans?” 16 February, https://www.cdp.net/en/articles/climate/new-cdp-data-shows-companies-are-recognizing-the-need-for-climate-transition-plans-but-are-not-moving-fast-enough-amidst-incoming-mandatory-disclosure.

59 **Figure 11** from WBA, op. cit. note 50.

60 EcoVadis (2022), “EcoVadis Business Sustainability Risk and Performance Index 7th edition”, https://index.ecovadis.com/industry.

61 WBA, op. cit. note 50.

62 Ibid.

63 J.B. Hunt (2022), “How J.B. Hunt is making sustainability a priority”, 28 December, https://www.jbhunt.com/blog/2022/12/making-sustainability-priority.

64 WBA, op. cit. note 50.

65 Euronews (2022), “Amazon to invest over €1 billion to boost electric vehicle fleet and ‘micromobility hubs’ in Europe”, 10 October, https://www.euronews.com/next/2022/10/10/amazon-to-invest-over-1-billion-to-boost-electric-vehicle-fleet-and-micromobility-hubs-in-.

66 WBA, op. cit. note 50.

67 World Benchmarking Alliance evaluates both the climate and social performance of companies. For climate, WBA assesses, through the ACT methodology, how companies’ emission reduction commitments, targets, and transition plans align with a 1.5C scenario. For social, WBA further assesses these companies on their human rights, decent work and just transition commitments. **Figure 11** from WBA, op. cit. note 50.

68 Ibid.

69 Ibid.

70 Maersk (2021), “Sustainability Report 2021”, https://www.maersk.com/~/media_sc9/maersk/corporate/sustainability/files/resources/2021/maersk-sustainability-report_2021.pdf.

71 First Group (2021), “First Group Plc Annual Report and Accounts 2021”, https://www.firstgroupplc.com/~/media/Files/F/Firstgroup-Plc/reports-and-presentations/reports/first-group-ara-2021.pdf.

72 WBA, op. cit. note 50.

73 United Nations Global Compact (n.d.), “About the Just Transition Maritime Task Force”, https://unglobalcompact.org/take-action/think-labs/just-transition/about, accessed 13 March 2023.

74 WBA, op. cit. note 50.

75 Ibid.

76 Ibid.

77 Ibid.

78 Ibid.

79 **Table 3** from InfluenceMap, op. cit. note 42, accessed 5 March 2023.

80 WBA, op. cit. note 50.

81 Ibid.

82 CDP (2023), “New CDP data shows companies are recognizing the need for climate transition plans but are not moving fast enough amidst incoming mandatory disclosure”, 16 February, https://www.cdp.net/en/articles/climate/new-cdp-data-shows-companies-are-recognizing-the-need-for-climate-transition-plans-but-are-not-moving-fast-enough-amidst-incoming-mandatory-disclosure.

83 WBA, op. cit. note 50.

84 Ibid.

85 Smart Freight Centre (2019), “What is the GLEC Framework”, https://www.smartfreightcentre.org/en/how-to-implement-items/what-is-glec-framework/58.

86 ISO 14083 (2023), “Greenhouse gases – Quantification and reporting of greenhouse gas emissions arising from transport chain operations”, https://www.iso.org/standard/78864.html.

87 Science Based Targets, op. cit. note 2.

88 Climate Group (2022), “EV100 Progress and Insights Report 2022”, https://www.theclimategroup.org/our-work/press/ev100-progress-and-insights-report-2022.

89 Ibid.

90 Ceres (n.d.), “Corporate Electric Vehicle Alliance”, https://www.ceres.org/climate/transportation/corporate-electric-vehicle-alliance, accessed 5 April 2023.

91 Ibid.

92 First Movers Coalition (2023), “Sectors”, https://www.weforum.org/first-movers-coalition/sectors, accessed 15 March 2023.

93 Climate Group, op. cit. note 88.

94 Climate Group and SystemiQ (2021), “Fleets First – How accelerating fleet electrification can unlock the shift to clean road transport”, https://www.theclimategroup.org/media/11251/download.

95 Bikes Make Life Better (2023), “Corporate Bike Programs: A Guide to Best Practices”, https://bikesmakelifebetter.com/corporate-bike-programs-a-guide-to-best-practices, accessed March 2023; Finances Online (2023), “List of 20 Biggest Remote Work from Home Companies”, https://financesonline.com/list-of-biggest-remote-work-from-home-companies.

96 **Table 4** from the following sources: Interface (2023), “Reuse and Recycling”, https://www.interface.com/US/en-US/sustainability/recycling.html, accessed 5 March 2023; Patagonia (2023), “Take-Back Program”, https://www.patagonia.com/our-footprint/take-back-program.html, accessed 5 March 2023; M. Griswold (2022), “The Gartner Supply Chain Top 25 for 2022”, Gartner, https://www.gartner.com/en/articles/the-gartner-supply-chain-top-25-for-2022; H. Yang and J. Lee (2022), “S. Korea’s LGES plans new EV battery plant in Europe”, Reuters, 27 July, https://www.reuters.com/technology/lg-energy-solution-q2-profit-plunges-73-misses-estimates-2022-07-27; R. Wiles (2023), “Korean battery giant LG announces huge expansion of plans for battery factory in Queen Creek”, Yahoo News, 27 March, https://news.yahoo.com/korean-electronics-giant-lg-announces-165556547; IKEA (2022), “The IKEA road to decarbonising transports and logistics”, 7 July, https://about.ikea.com/en/behind-scenes/commitments/2022/07/07/decarbonising-transports-and-logistics-to-create-a-sustainable-future.

97 Aberdeen Standard Investments and Transport Intelligence (2022), “European Logistics Survey: The trends shaping the future of logistics property”, https://cdn.e-fundresearch.com/files/asi_ti_european_logistics_survey_final.pdf.

98 Climate Group (2023), “EU Policy Engagement”, https://www.theclimategroup.org/eu-policy-engagement, accessed 2 March 2023.

99 World Business Council for Sustainable Development (2022), “WBCSD recommendations align with new policy guidelines on EV charging in India”, https://www.wbcsd.org/Programs/Cities-and-Mobility/Transforming-Urban-Mobility/Mobility-Decarbonization/News/WBCSD-recommendations-align-with-new-policy-guidelines-on-EV-charging-in-India.

100 We Mean Business (2021), “G20 2021”, https://www.wemeanbusinesscoalition.org/g20-2021.

101 Transport and Environment (2023), “Open-letter to accelerate the electrification of fleets in Europe”, https://www.transportenvironment.org/wp-content/uploads/2023/02/Open-letter_-Accelerate-the-electrification-of-fleets-in-Europe1-3.pdf.

102 **Table 5** from InfluenceMap, op. cit. note 42, accessed 2 March 2023.

103 CDP, op. cit. note 47.

104 Smart Freight Centre (2020), “Closing the Logistics Emissions Disclosure Gap: An analysis of emissions disclosure to CDP by corporations worldwide”, https://www.smartfreightcentre.org/en/news/closing-the-logistics-emissions-disclosure-gap-an-analysis-of-carbon-disclosure-to-cdp-by-multinationals-worldwide/29464.

105 UN High Level Expert Group (HLEG) on the Net Zero Emissions Commitments of Non-State Entities (2022), “Integrity Matters: Net zero commitments by businesses, financial institutions, cities and regions”, https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf.

106 ACT (2021), “Assessing Low-Carbon Transition – ACT Step-by-Step: Methodology”, https://actinitiative.org/act-methodologies; CDP (2021), “Climate Transition Plans”, https://www.cdp.net/en/guidance/guidance-for-companies/climate-transition-plans.

107 We Mean Business Coalition et al. (2022), “Climate Transition Action Plans – Activate your journey to climate leadership”, https://www.wemeanbusinesscoalition.org/blog/climate-transition-action-plans-activate-your-journey-to-climate-leadership.

108 We Mean Business Coalition (2022), “The 4 A’s of Climate Leadership”, https://www.wemeanbusinesscoalition.org/business.

109 International Financial Reporting Standards Foundation (2023), "About the International Sustainability Standards Board", https://www.ifrs.org/groups/international-sustainability-standards-board, accessed 20 February 2023.

110 Energy & Climate Intelligence Unit (2021), "Taking stock: A global assessment of net zero targets", https://www.consilium.europa.eu/en/press/press-releases/2022/11/28/council-gives-final-green-light-to-corporate-sustainability-reporting-directive

111 SLOCAT (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", https://tcc-gsr.com/

112 Intergovernmental Panel on Climate Change (2022), "Sixth Assessment Report (AR6) – Mitigation of Climate Change", https://www.ipcc.ch/report/ar6/wg3.

113 S. Punte (2020), "Supply Chains in the Time of Corona", Smart Freight Centre, https://www.smartfreightcentre.org/en/news/supply-chains-in-the-time-of-corona/13050.

114 ALICE (2019), "Roadmap Towards Zero Emissions Logistics 2050", https://www.etp-logistics.eu/alice-launches-the-roadmap-towards-zero-emissions-logistics-2050.

115 National Business Initiative (2023), https://www.nbi.org.za, accessed 20 February 2023.

116 J. Ambrose (2023), "Invasion of Ukraine has fuelled funding boom for clean energy", The Guardian (UK), https://www.theguardian.com/environment/2023/may/25/invasion-of-ukraine-has-fuelled-funding-boom-for-clean-energy.

BOX 1

1 International Transport Forum (ITF) (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

2 **Figure 13** from Smart Freight Centre, "2019 Emissions Council Framework for Logistics Emissions Accounting and Reporting. Version 2.0", https://www.feport.eu/images/downloads/glec-framework-20.pdf, accessed 30 June 2023.

3 International Energy Agency (IEA) (2021), "Net Zero by 2050", https://www.iea.org/reports/net-zero-by-2050.

4 ITF (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

5 IEA (2023), "Rail", https://www.iea.org/reports/rail.

6 ITF, op. cit. note 1.

7 IKEA (2023), "IKEA collaborates with partners to lower carbon emissions on one of the longest non-stop rail distances in Europe", 7 March, https://about.ikea.com/en/newsroom/2023/03/07/ikea-collaborates-with-partners-to-lower-carbon-emissions-on-non-stop-rail.

8 IEA (2023), "Global EV Outlook 2023: Trends in electric heavy-duty vehicles", https://www.iea.org/reports/global-ev-outlook-2023/trends-in-electric-heavy-duty-vehicles#abstract , accessed 25 July 2023

9 R. Irle (2023), "Global EV Sales for 2021", EV-Volumes, https://www.ev-volumes.com/news/ev-sales-for-2021, accessed 7 August 2023.

10 Global Commercial Drive to Zero (2023), "Global Agreement on Zero-Emission Trucks and Buses", https://globaldrivetozero.org, accessed 30 June 2023.

11 Climate Group (2022), "EV100 Progress and Insights Report 2022", https://www.theclimategroup.org/our-work/press/ev100-progress-and-insights-report-2022.

12 Holcim (2023), "Holcim to deploy 1,000 Volvo electric trucks", 22 May, https://www.holcim.com/media/media-releases/holcim-deploys-volvo-electric-trucks.

13 Maersk (2023), "A.P. Moller – Maersk accelerates fleet decarbonisation with 8 large ocean-going vessels to operate on carbon neutral methanol", 24 August, https://www.maersk.com/news/articles/2021/08/24/maersk-accelerates-fleet-decarbonisation.

14 International Air Transport Association (IATA) (2021), "Resolution on the industry's commitment to reach net-zero carbon emissions by 2050", 4 October, https://www.iata.org/en/pressroom/pressroom-archive/2021-releases/2021-10-04-03.

15 International Civil Aviation Organization (ICAO) (2022), "States adopt net-zero 2050 global aspirational goal for international flight operations", 7 October, https://www.icao.int/Newsroom/Pages/States-adopts-netzero-2050-aspirational-goal-for-international-flight-operations.aspx.

16 IATA, "Net zero 2050: Sustainable aviation fuels factsheet", https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels, accessed 7 August 2023.

17 Boeing (2023), "Boeing launches SAF Dashboard to track and project sustainable aviation fuel production", 20 June, https://investors.boeing.com/investors/news/press-release-details/2023/Boeing-Launches-SAF-Dashboard-to-Track-and-Project-Sustainable-Aviation-Fuel-Production/default.aspx.

18 L.M. Ellram et al. (2022), "A legitimacy theory perspective on Scope 3 freight transportation emissions", *Journal of Business Logistics*, Vol. 43, pp. 472-498, https://doi.org/10.1111/jbl.12299.

19 Smart Freight Centre, "The GLEC Framework", https://www.smartfreightcentre.org/en/how-to-implement-items/what-is-glec-framework/58, accessed 25 July 2023.

20 European Commission, "Corporate sustainability reporting", https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en, accessed 25 July 2023

21 Science Based Targets initiative (SBTi) (2023), "Ambitious Corporate Climate Action", https://sciencebasedtargets.org, accessed 25 July 2023; SBTi (2023), "How it works", https://sciencebasedtargets.org/how-it-works.

22 Eurostat (2022), "Road freight transport by journey characteristics", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_journey_characteristics, accessed 7 August 2023.

23 Smart Freight Centre (2023), "Clean Cargo", https://www.smartfreightcentre.org/en/our-programs/clean-cargo-1, accessed 7 August 2023.

24 ICLEI–Local Governments for Sustainability (2023), "Ecologistics", https://sustainablemobility.iclei.org/ecologistics, accessed 30 June 2023.

25 Polis Network (2023), "Urban freight", https://www.polisnetwork.eu/what-we-do/working-groups/urban-freight, accessed 10 August 2023.

26 Smart Freight Centre, "Sustainable Freight Buyers Alliance", https://smartfreightcentre.org/en/our-programs/sfba, accessed 7 August 2023.

SPOTLIGHT 4 SHORTENING GLOBAL SUPPLY CHAINS AS A KEY TO DECARBONISING TRANSPORT

1 SLOCAT (2018), *Transport and Climate Change Global Status Report 2018,* https://www.slocat.net/wp-content/uploads/legacy/slocat_transport-and-climate-change-2018-web.pdf; ITF (2023), *ITF Transport Outlook 2023*, Paris, https://www.itf-oecd.org/itf-transport-outlook-202

2 A.C. McKinnon (2018), *Decarbonizing Logistics: Distributing Goods in a Low Carbon World,* 1 Edition, Kogan Page Ltd, New York, https://cmc.marmot.org/Record/.b58234214; ITF(2019), *Transport Outlook 2019*, Paris, https://www.oecd-ilibrary.org/transport/itf-transport-outlook-2019_transp_outlook-en-2019-en

3 Intergovernmental Panel on Climate Change (IPCC) (2022), *Climate Change 2022: Mitigation of Climate Change Summary for Policymakers,* Geneva, https://www.ipcc.ch/report/sixth-assessment-report-working-group-3.

4 S. Yeh et al. (2017), Detailed assessment of global transport-energy models' structures and projections, *Transportation Research Part D: Transport and Environment*, Volume 55, Pages 294–309, https://doi.org/10.1016/j.trd.2016.11.001; A.C. McKinnon (2018), *Decarbonizing Logistics: Distributing Goods in a Low Carbon World,* 1 Edition, Kogan Page Ltd, New York, https://cmc.marmot.org/Record/.b58234214; W.F. Lamb et al. (2021), A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018, *Environmental Research Letters,*,Volume 16, 073005, doi:10.1088/1748-9326/abee4e

5 **Box 1** Author's analysis based on World Investment Report, UNCTAD (2020); The Geography of Transport Systems, fifth edition, Jean-Paul Rodrigue (2020); Assessing the opportunities and limits of a regionalization of economic activity, Raza et al. (2021)

6 H. Waisman et al. (2021), *Climate ambition beyond emission numbers : Taking stock of progress by looking inside countries and sectors,* Deep Decarbonisation Pathways (DDP) Initiative –IDDRI, Paris, https://www.iddri.org/en/publications-and-events/report/climate-ambition-beyond-emission-numbers-taking-stock-progress

7 **Box 2** from the following sources: OECD (n.d), "Global Value Chains", https://www.oecd.org/industry/global-value-chains/#:~:text=International%20production%2C%20trade%20and%20investments,are%20located%20across%20different%20countries. (accessed 15 June 2023); S. Ganapati and W.F. Wong (2023), How far goods travel: global transport and supply chains from 1965-2020, CESifo Working Paper No. 10398, http://dx.doi.org/10.2139/ssrn.4442431

8 OECD(n.d), "Global Value Chains", https://www.oecd.org/industry/global-value-chains/#:~:text=International%20production%2C%20trade%20and%20investments,are%20located%20across%20different%20countries. (accessed 15 June 2023)

9 OECD (n.d), "The trade policy implications of global value chains", https://www.oecd.org/trade/topics/global-value-chains-and-trade (accessed 15 June 2023)

10 UNCTAD (2020), *World Investment Report 2020: International production beyond the pandemic,* Geneva, https://unctad.org/publication/world-investment-report-2020

11 S. Ponte, G. Gereffi and G. Raj-Reichert (2019), *Handbook on global value chains,* Edward Elgar Publishing, Northampton; UNCTAD (2020), *World Investment Report 2020: International production beyond the pandemic,* Geneva, https://unctad.org/publication/world-investment-report-2020

12 UNCTAD (2022), *Review of Maritime Transport 2022: Navigating Stormy Waters,* New York and Geneva, https://unctad.org/rmt2022

13 C. Majaski (2023)," What is the General Agreement on Tariffs and Trade (GATT)", Investopedia, 30 April, https://www.investopedia.com/terms/g/gatt.asp.

14 UNCTAD (2020), *World Investment Report 2020: International production beyond the pandemic,* Geneva, https://unctad.org/publication/world-investment-report-2020

15 Federal Reserve Bank of New York (2023), "Global Supply Chain Pressure Index", https://www.newyorkfed.org/research/policy/gscpi#/interactive, (accessed 14 June)

16 OECD (2020), " The face mask global value chain in the COVID-19 outbreak: Evidence and policy lessons", OECD Policy Responses to Coronavirus (COVID-19) , 4 May, https://www.oecd.org/coronavirus/policy-responses/the-face-mask-global-value-chain-in-the-covid-19-outbreak-evidence-and-policy-lessons-a4df866d

17 S. Saxon (2022), " How Shanghai's lockdowns are affecting global supply chains", McKinsey & Company, 27 May, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/how-shanghais-lockdowns-are-affecting-global-supply-chains; The Maritime Executive (2022), " Shanghai's Port is Nearing Normal Operations After Two-Month Lockdown", 6 June, https://maritime-executive.com/article/shanghai-s-port-is-nearing-normal-operations-after-two-month-lockdown

18 H. Strubenhoff (2022), " The war in Ukraine triggered a global food shortage", Brookings, 14 June, https://www.brookings.edu/blog/future-development/2022/06/14/the-war-in-ukraine-triggered-a-global-food-shortage

19 R. Meade (2021), " Suez blockage extends as salvors fail to free Ever Given", Lloyd's List, 25 March, https://lloydslist.maritimeintelligence.informa.com/LL1136246/Suez-blockage-extends-as-salvors-fail-to-free-Ever-Given

20 J. Masters (2021), " Suez Canal shutdown shows the vulnerability of the global economy to extreme events", Yale Climate Connections, 29 March, https://yaleclimateconnections.org/2021/03/suez-canal-shutdown-shows-vulnerability-of-global-economy-to-extreme-events

21 L. Harry-Villain et al. (2021), *Companies and carbon neutrality, a story of systemic transformations and cooperation: Illustration on the freight transport sector*, IDDRI, https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/Autre%20Publication/202111-Note%20transport.pdf; C. Knizek et al. (2022)," Why global industrial supply chains are decoupling", EY, 13 June, ; The White House (2022), Economic Report of the President, "https://www.whitehouse.gov/wp-content/uploads/2022/04/ERP_2022_.pdf"https://www.whitehouse.gov/wp-content/uploads/2022/04/ERP_2022_.pdf..

22 S. Kinkel and S. Maloca (2009), Drivers and antecedents of manufacturing offshoring and backshoring : A German perspective, *Journal of Purchasing and Supply Management*, Volume 15, No. 3, pp. 154-165. doi: 10.1016/j.pursup.2009.05.007; W. Raza et al. (2021), "Assessing the opportunities and limits of a regionalization of economic activity," Austrian Foundation for Development Research (ÖFSE), https://www.researchgate.net/publication/351051391_Assessing_the_opportunities_and_limits_of_a_regionalization_of_economic_activity (accessed 14 June)

23 S. Miroudot and H. Nordström (2019), *Made in the world revisited*, European University Institute, https://cadmus.eui.eu/handle/1814/64724

24 S.J. Evenett, (2019), Protectionism, state discrimination and international business since the onset of the Global Financial Crisis, *Journal of International Business Policy*, Volume 2, No. 1, pp. 9-36, DOI: 10.1057/s42214-019-00021-0; M.A. Crowley (2019), Trade War: The Clash of Economic Systems Threatening Global Prosperity, CEPR Press, London; UNCTAD (2020), *World Investment Report 2020: International production beyond the pandemic,* Geneva, https://unctad.org/publication/world-investment-report-2020

25 UNCTAD (2020), *World Investment Report 2020: International production beyond the pandemic,* Geneva, https://unctad.org/publication/world-investment-report-2020

26 U.S Department of Energy () (), " Federal Tax Credits for Solar Manufacturers", Solar Energies Technologies Office , W; https://www.forbes.com/sites/willyshih/2023/02/22/the-inflation-reduction-act-will-bring-some-manufacturing-back-to-the-us/?sh=347e1e8ab544 https://www.energy.gov/eere/solar/federal-tax-credits-solar-manufacturers; W. Shih (2023), " The Inflation Reduction Act Will Bring Some Manufacturing Back To The U.S.", Forbes, 22 February, https://www.forbes.com/sites/willyshih/2023/02/22/the-inflation-reduction-act-will-bring-some-manufacturing-back-to-the-us/?sh=347e1e8ab544

27 J. Hsu et al. (2022), Keeping Your Friends Closer: Friend-shoring in Response to Regional Value Content Requirements, SSRN, https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=4246225 (accessed 14 June)

28 EurWORK(2020), " Directive on cross-border mobility of companies", 25 March, https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/directive-on-cross-border-mobility-of-companies

29 European Commission (n.d), " European Battery Alliance", https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-battery-alliance_en (accessed 14 June)

30 J. Cottineau (2023), " In Isère, how Seqens is preparing to relaunch European production of paracetamol", L'UsineNouvelle, 12 April, https://www.usinenouvelle.com/article/en-isere-comment-seqens-se-prepare-a-relancer-la-production-europeenne-de-paracetamol.N2114386

31 United Nations Framework Convention on Climate Change (UNFCCC) (2023), "Long-term strategies portal", Bonn, https://unfccc.int/process/the-paris-agreement/long-term-strategies (accessed 14 June); R. Black et al. (2021), Taking Stock: A global assessment of net zero targets, Energy & Climate Intelligence Unit and Oxford Net Zero, https://eciu.net/analysis/reports/2021/taking-stock-assessment-net-zero-targets

32 European Commission (n.d), " Carbon Border Adjustment Mechanism", https://taxation-customs.ec.europa.eu/green-taxation-0/carbon-border-adjustment-mechanism_en)

33 European Commission (2022)," Green Deal: EU agrees law to fight global deforestation and forest degradation driven by EU production and consumption", Brussels, 6 December, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_7444

34 Smart Freight Centre (n.d)," What is the GLEC Framework", Amsterdam, https://www.smartfreightcentre.org/en/how-to-implement-items/what-is-glec-framework/58 (accessed 14 June)

35 W. Raza et al. (2021), "Assessing the opportunities and limits of a regionalization of economic activity," Austrian Foundation for Development Research (ÖFSE), https://www.researchgate.net/publication/351051391_Assessing_the_opportunities_and_limits_of_a_regionalization_of_economic_activity (accessed 14 June 2023).

36 IPCC (2022), *Climate Change 2022: Transport Chapter 10*New York and Geneva,https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter10.pdf

37 Shell Global (2020)," The Energy Transformation Scenarios", https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html, (accessed 14 June 2023)

38 International Maritime Organization (2022), Note by the International Maritime Organization to the fifty-seventh session of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA 57),

Sharm El Sheikh, Egypt, 6 to 12 November 2022, available at https://unfccc.int/sites/default/files/resource/IMO%20submission%20to%20SBSTA%2057.pdf

39 IMO (2023), Intersessional Working Group on Reduction of GHG Emissions from Ships (ISWG-GHG 14), 20-24 March 2023, https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/Intersessional-Working-Group-on-Reduction-of-GHG-Emissions-from-Ships-(ISWG-GHG-14),-20-24-March-2023.aspx

40 Green Shipping Challenge, " Green Shipping Challenge at COP27: Participants and Announcements", https://greenshippingchallenge.org/cop27/ (accessed 15 June 2023); UK Department of Transport (2022)," COP 26: Clydebank Declaration for green shipping corridors", 13 April, https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors; Global Maritime Forum (n.d), *Call to Action for Shipping Decarbonization*, https://www.globalmaritimeforum.org/content/2021/09/Call-to-Action-for-Shipping-Decarbonization.pdf

41

42 SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

43 SLOCAT (2022), Actions to Reduce Emissions and Boost the Resilience of Freight Transport and Global Supply Chains: SLOCAT Guidelines for NDCs, http://bit.ly/NDCFreightguidelines

2.1
AFRICA REGIONAL OVERVIEW

1 Calculations by the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats, 2018, "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

2 African Union, "Agenda 2063: The Africa We Want", https://au.int/en/agenda2063/overview, accessed 10 July 2023.

3 J. Teye, 2018, "Urbanisation and Migration in Africa", Centre for Migration Studies, University of Ghana, https://www.un.org/en/development/desa/population/events/pdf/expert/28/EGM_Joseph_Teye_ppt.pdf; African Development Bank (AfDB), 2012, "Urbanisation in Africa", https://blogs.afdb.org/inclusive-growth/urbanization-africa-191.

4 International Energy Agency (IEA), 2022, "Africa Energy Outlook 2022", https://iea.blob.core.windows.net/assets/27f568cc-1f9e-4c5b-9b09-b18a55fc850b/AfricaEnergyOutlook2022.pdf; United Nations Development Programme (UNDP), 2022, "The Impact of the War in Ukraine on Sustainable Development in Africa", https://www.undp.org/sites/g/files/zskgke326/files/2022-05/UNDP%20RBA%20-%20IMpact%20of%20the%20war%20in%20Ukraine%20on%20Africa%20-%2024%20May%202022_0.pdf.

5 MobiliseYourCity, 2022, "About MobiliseYourCity Africa", https://www.mobiliseyourcity.net/node/294.

6 African Policy Circle, 2020, "Addressing the Challenges of Urbanization in Africa", https://www.kas.de/documents/252038/7995358/Addressing+the+Challenges+of+Urbanization+in+Africa.pdf/df4e7f62-c130-e702-9669-0a746596028e.

7 African Transport Policy Program (SSATP), 2022, "Changing the Pace of Urban Mobility in Africa", https://www.ssatp.org/topics/urban-mobility.

8 Ibid.

9 Automotive Industry Export Council (AIEC), 2020, "Automotive Export Manual 2020", https://www.aiec.co.za/downloads/AutomotiveExportManual2020.pdf.

10 FIA Foundation, 2022, "The Wheels of Change: Safe and Sustainable Motorcycles in Sub-Saharan Africa", https://www.fiafoundation.org/resources/the-wheels-of-change-safe-and-sustainable-motorcycles-in-sub-saharan-africa.

11 Ibid.

12 International Road Federation (IRF), 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

13 T. Schiller and K. Pillay, 2016, "Navigating the African Automotive Sector: Ethiopia, Kenya and Nigeria", Deloitte, https://www2.deloitte.com/content/dam/Deloitte/za/Documents/deloitteafrica/ZA_Deloitte-Africa-automotive-insights-Ethiopia-Kenya-Nigeria-Apr16-2017.pdf; T.T. Mtembu, 2020, "Vehicle Ownership for South Africa: Developing a Forecasting Model and Assessing Household Vehicle Ownership", https://scholar.sun.ac.za/handle/10019.1/108158.

14 H.O. Wamwayi, 2021, "Advancing Electric Mobility in Africa", United Nations Framework Convention on Climate Change, https://unfccc.int/news/advancing-electric-mobility-in-africa.

15 I. Diouf et al., 2020, "Urban Mobility and Covid-19 in Africa", Transport Global Practice, World Bank Africa Transport Policy Program, https://www.ssatp.org/sites/ssatp/files/publication/COVID19%20and%20Public%20Transport%20in%20Africa%20-%20FINAL%20-%20Aug2020%20-%20ENGLISH.pdf.

16 J. Harper, 2021, "Africa Emerges as Car Industry Hub", DW, https://www.dw.com/en/africa-begins-to-emerge-as-car-industry-hub/a-59500532.

17 A. Black, 2022, "Can the African Continental Free Trade Area Drive Africa's Automotive Industry?" Development Matters, https://oecd-development-matters.org/2022/02/28/can-the-african-continental-free-trade-area-afcfta-drive-africas-automotive-industry.

18 Harper, op. cit. note 16.

19 African Association of Automotive Manufacturers (AAAM), 2022, "African New Vehicle Sales Increase by 32%", https://aaamafrica.com/f/african-new-vehicle-sales-increase-by-32%25, accessed 23 January 2023.

20 Ibid

21 Ibid.

22 Ibid.

23 SLOCAT Partnership, 2021, "Transport and Climate Change Global Status Report, 2nd Edition", African Regional Overview, https://tcc-gsr.com/global-overview/africa; Statista, 2022, "Commercial Vehicle Sales in Africa", https://www.statista.com/statistics/473661/commercial-vehicle-sales-in-africa.

24 G.K. Ayetor et al., 2021, "Vehicle Regulations in Africa: Impact on Used Vehicle Import and New Vehicle Sales", *Transportation Research Interdisciplinary Perspectives*, Vol. 10 (June), p. 100384, https://doi.org/10.1016/j.trip.2021.100384.

25 AAAM, 2020, "Africa Automotive Forum: Summary Report", https://www2.deloitte.com/content/dam/Deloitte/za/Documents/AAAM_Africa_Automotive_Forum_2020_Summary.pdf; United Nations Environment Programme (UNEP), 2019, "Addressing the Used Vehicles Market: Potential Strategies for Importing and Exporting Countries to Improve Safety, Fuel Economy and Emissions Impact", https://wedocs.unep.org/bitstream/handle/20.500.11822/27789/used_vehicles.pdf.

26 UNEP, 2020, "Used Vehicles and the Environment: A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation", https://wedocs.unep.org/handle/20.500.11822/34175.

27 United Nations Economic Commission for Europe (UNECE), 2022, "Safer and Cleaner Used Vehicles for Africa", https://unece.org/sites/default/files/2022-06/WP.29-187-17e.pdf

28 UNEP, op. cit. note 26

29 UNECE, op. cit. note 27.

30 Ibid.

31 Ibid.

32 East African Community, 2022, "EAS 1047:2022 Standards on Air Quality – Vehicular Exhaust Emission Limits", https://www.tbs.go.tz/uploads/publications/en-1658900195-EAC%20GAZETTE%20No.%2015%20of%201st%20July%202022.pdf.

33 B. Fabian, 2020, "New UNEP Report Highlights Importance of Used Vehicle Flows for Fuel Economy, Emissions, and Vehicle Safety in Developing Countries", Global Fuel Economy Initiative, https://www.globalfueleconomy.org/blog/2020/november/new-unep-report-highlights-importance-of-used-vehicle-flows-for-fuel-economy-emissions-and-vehicle-safety-in-developing-countries.

34 UN-Habitat et al., 2022, "Walking and Cycling in Africa: Evidence and Good Practice to Inspire Action", https://unhabitat.org/sites/default/files/2022/07/executive_summary.pdf.

35 Ibid.

36 M. Vanderschuren, 2012, "Non Motorised Transport in Africa", https://www.researchgate.net/publication/282764517_Non_Motorised_Transport_in_Africa.

37 C.S. Okoro and K. Lawani, 2022, "Optimising Sustainable Mobility: A Performance Assessment of Non-motorised Transport Infrastructure in Johannesburg, South Africa", *Journal of the South African Institution of Civil Engineering*, Vol. 64, No. 2 (June), pp. 67-76, http://www.scielo.org.za/pdf/jsaice/v64n2/06.pdf.

38 Climate and Development Knowledge Network, 2021, "Non-Motorized Transport Peer Learning Nairobi-Kisumu and Mombasa Reports", www.cdkn.org/nmt.

39 C. Koinange, 2004, "NMT Strategy for Kenya", http://airqualityandmobility.org/STR/NMTStrategy_Kenya_200402.pdf.

40 Ibid.

41 Ibid.

42 M. Segui-Gomez et al., 2021,"Road Safety Data in Africa: A Proposed Minimum Set of Road Safety Indicators for Data Collection, Analysis and Reporting", SSATP, https://www.ssatp.org/publication/road-safety-data-africa-proposed-minimum-set-road-safety-indicators-data-collection.

43 World Health Organization (WHO), 2018, "Global Status Report on Road Safety", https://www.who.int/publications-detail-redirect/9789241565684.

44 Ibid.

45 Ibid.; UN-Habitat et al., op. cit. note 34; Segui-Gomez et al., op. cit. note 42.

46 UN-Habitat et al., op. cit. note 34.

47 WHO, op. cit. note 43.

48 World Bank, 2019, "Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles", https://elibrary.worldbank.org/doi/pdf/10.1596/33363.

49 Segui-Gomez et al., op. cit. note 42.

50 Ibid.

51 International Transport Forum (ITF), 2020, "Road Safety Annual Report 2020", https://www.itf-oecd.org/sites/default/files/docs/irtad-road-safety-annual-report-2020_0.pdf; M. Rasmeni, 2020, "Average Road Crashes, Fatalities Decline Due to Covid-19 Restrictions – MVA", The Namibia Economist, https://economist.com.na/55137/extra/average-road-crashes-fatalities-drop-due-to-covid-19-restrictions-mva.

52 UN-Habitat, 2021, "11 2 1 Percentage Access to Public Transport", https://data.unhabitat.org/datasets/GUO-UN-Habitat::11-2-1-percentage-access-to-public-transport/about; UN-Habitat et al., op. cit. note 34.

53 R. Behrens, D. Mfinanga and D. Mccormick, eds., 2016, "Paratransit in African Cities: Operations, Regulation and Reform", https://www.routledge.com/Paratransit-in-African-Cities-Operations-Regulation-and-Reform/Behrens-McCormick-Mfinanga/p/book/9780415870337; C. Venter, 2013, "The Lurch Towards Formalisation: Lessons from the Implementation of BRT in Johannesburg, South Africa", *Journal of Transport Geography*,
Vol. 88, p. 102476, https://doi.org/10.1016/j.retrec.2012.06.003.

54 Digital Transport for Africa, 2021, "DT4A Innovation Challenge", https://digitaltransport4africa.org/innovation-challenge.

55 UN-Habitat and International Association of Public Transport (UITP), 2021, "A Progress Report on SDG 11.2", https://unhabitat.org/sites/default/files/2021/10/a_progress_report_on_sdg_11.2.pdf.

56 AfDB, 2022, "Transport: Toward a More Inclusive, Safer and Cleaner Mobility in African Cities", https://www.afdb.org/sites/default/files/2023/01/18/transport-toward_a_more_inclusive_safer_and_cleaner_mobility_in_african_cities_-_sudap_paper_-_addb_umdf_-_2022.pdf.

57 Ibid.

58 S. Woolf and J.W. Joubert, 2013, "A People-centred View on Paratransit in South Africa", *Cities*, **Vol.** 35

(December), pp. 284-293, https://doi.org/10.1016/j.cities.2013.04.005.

59 FIA Foundation, op. cit. note 10.

60 L. Diaz Olvera, D. Plat and P. Pochet, 2020, "Looking for the Obvious: Motorcycle Taxi Services in Sub-Saharan African Cities", *Journal of Transport Geography*, Vol. 88, p. 102476, https://doi.org/10.1016/j.jtrangeo.2019.102476.

61 WHO, op. cit. note 43.

62 M. Kiruga, 2019, "African Cities Grapple with Two-wheeled Transport Conundrum", The Africa Report, https://www.theafricareport.com/15049/african-cities-grapple-with-two-wheeled-transport-conundrum.

63 Diouf et al., op. cit. note 15.

64 Ibid.

65 Ibid.

66 R. Behrens and A. Newlands, 2022, "Revealed and Future Travel Impacts of COVID-19 in Sub-Saharan Africa: Results of Big Data Analysis and a Delphi Panel Survey", *Journal of Transport and Supply Chain Management*, Vol. 16, https://doi.org/10.4102/jtscm.v16i0.758.

67 J. Rosenberg, I. Strauss and G. Isaacs, 2021, "COVID-19 Impact on SADC Labour Markets: Evidence from High Frequency Data and Other Sources", *African Development Review*, Vol. 33, Supplement 1, pp. S177-S193, https://doi.org/10.1111/1467-8268.12528.

68 The Namibia Economist, 2020, "Public Transport Operators Feel Lockdown Damage, Temporarily Increase Fares by 15%", https://economist.com.na/52811/retail/public-transport-operators-feel-covid-19-pinch-temporarily-increases-fares-by-15; M. Bruwer, S.J. Andersen and M. Mokonyama, 2021, Chapter 6.4. Transport, "South Africa Covid-19 Country Report", Department of Planning, Monitoring and Evaluation, Government Technical Advisory Centre and National Research Foundation, https://www.gov.za/sites/default/files/gcis_document/202206/sa-covid-19-reporta.pdf; Diouf et al., op. cit. note 15; R. Luke, 2020, "The Impact of COVID-2019 on Transport in South Africa", *Journal of Transport and Supply Chain Management*, Vol. 14, https://doi.org/10.4102/jtscm.v14i0.545; Namibia Broadcasting Cooperation, 2020, "Government Approves 15 % Bus and Taxi Fare Increase", https://nbcnews.na/news/government-approves-15-bus-and-taxi-fare-increase.30871.

69 World Economic Forum, 2023, "AfCFTA: A New Era for Global Business and Investment in Africa", https://www3.weforum.org/docs/WEF_Friends_of_the_Africa_Continental_Free_Trade_Area_2023.pdf.

70 D. Kuteyi and H. Winkler, 2022, "Logistics Challenges in Sub-Saharan Africa and Opportunities for Digitization", *Sustainability*, Vol. 14, No. 4, p. 2399, https://doi.org/10.3390/su14042399.

71 FEAFFA and Shippers Council of East Africa, 2021, "Impact of COVID-19 on Transport and Logistics Sector in East Africa", African Economic Research Consortium, https://africaportal.org/wp-content/uploads/2023/06/AERC-Policy-Brief-COVID-19_015.pdf.

72 Ibid.

73 World Bank, 2018, "International LPI Global Rankings", https://lpi.worldbank.org/international/global, accessed 25 January 2023.

74 SLOCAT analysis based on United Nations Conference on Trade and Development (UNCTAD) and World Bank, 2023, "Liner Shipping Connectivity Index (Maximum Value in 2004 = 100)", https://data.worldbank.org/indicator/IS.SHP.GCNW.XQ.

75 AfDB, 2020, "Infrastructure Development", https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Tracking_Africa%E2%80%99s_Progress_in_Figures_-_Infrastructure_Development.pdf.

76 A. Faajir and Z.H. Zidan, 2016, "An Analysis of the Issues and Challenges of Transportation in Nigeria and Egypt". The *Business and Management Review*, Vol. 7, No. 5, https://cberuk.com/cdn/conference_proceedings/conference_35916.pdf.

77 World Bank, op. cit. note 73; AfDB, op. cit. note 75.

78 A.A. Obiri-Yeboah, J.F.X. Ribeiro and B. Pappoe, 2020, "Travel Time Variability Analysis: The Case of Kumasi, Ghana", http://ijtte.com/study/409/download/TRAVEL_TIME_VARIABILITY_ANALYSIS__THE_CASE_OF_KUMASI__GHANA.html.

79 A. Ait Ali et al., 2022, "The Economic Implications of the War in Ukraine for Africa and Morocco", Policy Center for the New South, https://www.policycenter.ma/publications/economic-implications-war-ukraine-africa-and-morocco.

80 E. Mwepya Shitima, 2022, "Towards COP27: Views from Africa's Chief Climate Negotiator", United Nations, https://www.un.org/osaa/news/towards-cop27-views-africa%E2%80%99s-chief-climate-negotiator; C. Heitzig, A. Ordu and L. Senbet, 2021, "Sub- Saharan Africa's Debt Problem: Mapping the Pandemic's Effect and the Way Forward", Africa Growth Initiative, Brookings Institution, https://www.brookings.edu/research/sub- saharan-africas- debt- problem- mapping- the- pandemics-effect-and- the- way- forward.

81 UNCTAD, 2022, "UNCTAD's Review of Maritime Transport 2022: Facts and Figures on Africa", https://unctad.org/press-material/unctads-review-maritime-transport-2022-facts-and-figures-africa.

82 IEA, 2022, "Africa Energy Outlook 2022", https://iea.blob.core.windows.net/assets/27f568cc-1f9e-4c5b-9b09-b18a55fc850b/AfricaEnergyOutlook2022.pdf; J. Kefas Sheehama, 2022, "Catastrophic Increase in Oil Process Pushes Up Namibian Inflation", The Namibia Economist, https://economist.com.na/68642/columns/catastrophic-increase-in-oil-prices-pushes-up-namibian-inflation; South African Government, 2022, "Mineral Resources and Energy Announces Adjustment of Fuel Prices", https://www.gov.za/speeches/mineral-resources-and-energy-announces-adjustment-fuel-prices-6-dec-2022-0000.

83 SLOCAT calculations based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

84 CDP, 2020, "CDP Africa Report: Benchmarking Progress Towards Climate Safe Cities, States and Regions", https://cdn.cdp.net/cdp-production/cms/reports/documents/000/005/023/original/CDP_Africa_Report_2020.pdf?1583855467.

85 G.K. Ayetor et al., 2021, "Investigating the State of Road Vehicle Emissions in Africa: A Case Study of Ghana and Rwanda", *Transportation Research Interdisciplinary Perspectives*, Vol. 11 (September), p. 100409, https://doi.org/10.1016/j.trip.2021.100409.

86 SLOCAT calculations based on M. Crippa et al., op. cit. note 83

87 Ibid.

88 Ibid.

89 Ibid.

90 Ibid.

91 **Figure 2** from SLOCAT calculations based on M. Crippa et al., op. cit. note 83.

92 **Figure 3** and **Figure 4** from SLOCAT calculations based on M. Crippa et al., op. cit. note 83.

93 Ibid.

94 ENATIS, 2020, "Electronic National Traffic Information System", South Africa National Department of Transport, https://online.natis.gov.za; National Bureau of Statistics, 2019, "Nigeria Road Transport Data", Federal Road Safety Corps, https://nigerianstat.gov.ng/elibrary; F. Atsu, S. Adams and J. Adjei, 2021, "ICT, Energy Consumption, Financial Development, and Environmental Degradation in South Africa", *Journal of Computer Information Systems*, Vol. 63, No. 3, pp. 1-14, http://dx.doi.org/10.1080/08874417.2022.2049017.

95 H. Orkor, 2015, "Policy Reforms to Promote Energy Efficiency in the Transportation Sector", Economic and Social Commission for Western Asia, https://www.unece.org/fileadmin/DAM/energy/se/pdfs/gee21/projects/others/Egypt.pdf; A. El-Dorghamy, 2018, "Mainstreaming Electric Mobility in Egypt: Policy Brief", Friedrich Ebert Stiftung Egypt Office, https://books.google.com.gh/books?id=wgLYxQEACAAJ.

96 H. Ritchie, 2019, "Where in the World Do People Emit the Most CO2", Our World in Data, https://ourworldindata.org/per-capita-co2.

97 African Union, 2019, "Road Safety: African Action Plan for the Global Decade of Action for Road Safety", https://au.int/sites/default/files/documents/32186-doc-road_safety_african_action_plan_for_the_global_decade_of_action_for_road_safety-e.pdf.

98 A. Olivier, 2020, "Decade of Action Strategy for Road Safety, 2021-2030", Windhoek, Namibia; M. Peden et al., eds., 2017, "World Report on Road Traffic Injury Prevention", WHO, https://apps.who.int/iris/bitstream/handle/10665/42871/9241562609.pdf.

99 Kampala Capital City Authority, 2021, "Kampala Capital City Road Safety Strategy, 2021-2030", https://www.kcca.go.ug/media/docs/Kampala%20Road%20Safety%20Strategy%202021-2030.pdf.

100 C. Tolga Imamoglu et al., 2021, "African Cities Taking on Road Safety", The City Fix, https://thecityfix.com/blog/african-cities-taking-on-road-safety.

101 Vision Zero for Youth, 2021, "Addis Ababa, Ethiopia, and Bogotá, Colombia, Receive 2021 Vision Zero for Youth Leadership Awards", https://www.visionzeroforyouth.org/wp-content/uploads/2021/05/Intl-VZY-Award-Announcement_2021_final.pdf.

102 UN-Habitat et al., op. cit. note 34; J. Okaima Piette and Y. Lee, 2021, "In the Wake of COVID, Rebuilding Transport Is Not Good Enough. We Must Bounce Forward", World Bank, https://blogs.worldbank.org/transport/wake-covid-rebuilding-transport-not-good-enough-we-must-bounce-forward.

103 UN-Habitat et al., op. cit. note 34.

104 Ibid.

105 UN-Habitat et al., op. cit. note 34.

106 Ibid.

107 Ibid.

108 World Economic Forum, op. cit. note 69.

109 City of Windhoek, 2018, "Non-Motorised Transport Strategy – Final Report", https://www.windhoekcc.org.na/documents/3857%20NMT%20Windhoek-Strategy%20Report%20FINAL-lp-20180719.pdf; Transformative Urban Mobility Initiative (TUMI), 2022, Ebikes4Windhoek, https://transformative-mobility.org/focus-area/tumi-challenges/tumi-challenge-windhoeck-namibia/.

110 Institute for Transportation and Development Policy (ITDP), 2020, "Ethiopia Non-Motorised Transport Strategy 2020-2029", https://africa.itdp.org/publication/ethiopia-non-motorized-strategy-2020-2029; World Economic Forum, op. cit. note 69; International Climate Initiative, 2021, "Growing Smarter – Sustainable Mobility in East Africa", https://www.international-climate-initiative.com/en/project/growing-smarter-sustainable-mobility-in-east-africa-18-i-356-africa-a-sustainable-mobility-in-east-africa.

111 ITDP, 2020, op. cit. note 110.

112 N. Medimorec et al., 2022, "Sustainable Transport in African Cities: Challenges and Opportunities Through the 15-minute City Planning Approach", SLOCAT, https://slocat.net/15-minute-city-planning-african-cities.

113 ITDP, 2020, "Quick Guide to Bus Sector Modernisation", https://africa.itdp.org/publication/quick-guide-to-bus-sector-modernisation.

114 W.V. Mitullah and S. Siro Onsafe, 2013, "Formalising the Matatu Industry in Kenya: Policy Twists and Turns" Institute of Development Studies, University of Nairobi, http://erepository.uonbi.ac.ke/bitstream/handle/11295/98621/Winnie_Formalising%20the%20Matatu%20Industry%20in%20Ken-

ya%2C%20Policy%20Twists%20and%20Turns.pdf; C.G. Macharia, 2017, "Regulation in the Transport Industry: A Case of Matatu Sector in Kenya", United States International University – Africa, https://erepo.usiu.ac.ke/bitstream/handle/11732/3539/CAROL%20G.%20MACHARIA%20MBA%202017.pdf; R. Behrens et al., 2017, "Improving Paratransit Service: Lessons from Inter-city Matatu Cooperatives in Kenya", *Transport Policy*, Vol. 53 (January), pp. 79-88, https://doi.org/10.1016/j.tranpol.2016.09.003.

115 H. Fan, E. Beukes and X. Sheng, 2021, "Improving the Viability of Bus Rapid Transit Systems: Nine Factors for Sub-Saharan Africa", World Bank, https://blogs.worldbank.org/transport/improving-viability-bus-rapid-transit-systems-nine-factors-sub-saharan-africa.

116 ITDP, 2022, "Uganda", https://www.itdp.org/where-we-work/africa/uganda, accessed 31 January 2023; International Climate Initiative, op. cit. note 110.

117 C. Mimano, M. Kinyua and C. Kost, 2022, "Transit-Oriented Development as an Anchor to Compact, Equitable, and Accessible African Cities", SLOCAT Partnership, https://slocat.net/transit-oriented-development-as-an-anchor-to-compact-equitable-and-accessible-african-cities.

118 World Bank, 2022, "With Bus Rapid Transit, African Cities Are Riding Toward a Better Future", https://www.worldbank.org/en/news/feature/2022/11/28/with-bus-rapid-transit-african-cities-are-riding-toward-a-better-future.

119 Ethiopia Ministry of Transport, 2020, "National Transport Policy", http://ethiotransport.gov.et/T2/National_Transport%20Policy_EN.pdf.

120 European Commission, 2023, "Global Gateway: Team Europe Invests in Transformative Green Mobility in Nairobi", https://ec.europa.eu/commission/presscorner/detail/en/IP_23_1928; ESI Africa, 2023, "Electric Bus Line to Be Built in Nairobi Through EU, Kenya Partnership", https://www.esi-africa.com/industry-sectors/smart-technologies/electric-bus-line-to-be-built-in-nairobi-through-eu-kenya-partnership.

121 Cliffe Dekker Hofmeyer (CDH), 2022, "E-Mobility in Africa: Critical for Africa's Industrialisation", https://www.cliffedekkerhofmeyr.com/export/sites/cdh/en/sectors/downloads/eMobility-in-Africa-Guide.pdf

122 Wamwayi, op. cit. note 14.

123 CDH, op. cit. note 121.

124 IEA, 2023, "Global EV Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

125 Ibid

126 Ibid.

127 Ibid.

128 ESI Africa, 2023, "Uganda and Vehicle Company Partner to Introduce Electric Motorbikes", https://smartermobility-africa.com/uganda-and-vehicle-company-partner-to-introduce-electric-motorbikes.

129 International Climate Initiative, 2023, "Electric Cargo Bike 'Made in Ghana' – Contributing to the Transformation of Ghana's Transportation", https://www.international-climate-initiative.com/en/project/electric-cargo-bikes-made-in-ghana-contributing-to-the-transformation-of-ghanas-transportation-img2020-i-005-gha-cargo-e-bikes-made-in-ghana.

130 UN-Habitat, 2022, "Walking and Cycling in Africa – Evidence and Good Practice to Inspire Action", https://unhabitat.org/sites/default/files/2022/07/walking_and_cycling_in_africa.pdf.

131 ITDP, 2020, "Kisumu Sustainable Mobility Plan", https://www.kisumu.go.ke/wp-content/uploads/2020/12/Kisumu-Sustainable-Mobility-Plan-200716.pdf.

132 MobiliseYourCity, 2022, "Factsheet Douala", https://www.mobiliseyourcity.net/sites/default/files/2022-05/Douala%2C%20Cameroon_2.pdf; MobiliseYourCity, 2022, "Yaounde SUMP Summary", https://www.mobiliseyourcity.net/sites/default/files/2021-03/Yaounde%20SUMP%20Summary_final.pdf.

133 ITDP, 2021, "Rwanda", https://africa.itdp.org/where-we-work/rwanda; C. Mimano, M. Kinyua and C. Kost, 2022, "Transit-Oriented Development as an Anchor to Compact, Equitable, and Accessible African Cities", SLOCAT Partnership, https://slocat.net/transit-oriented-development-as-an-anchor-to-compact-equitable-and-accessible-african-cities.

134 World Bank, 2022, "With Bus Rapid Transit, African Cities Are Riding Toward a Better Future", https://www.worldbank.org/en/news/feature/2022/11/28/with-bus-rapid-transit-african-cities-are-riding-toward-a-better-future.

135 Green Climate Fund, 2021, "Dakar Bus Rapid Transit Pilot Project", https://www.greenclimate.fund/sites/default/files/document/14160-dakar-bus-rapid-transit-pilot-project.pdf.

136 ITDP, op. cit. note 133.

137 Nairobi City County Government, 2015, "Non Motorized Transport Policy", https://www.kara.or.ke/Nairobi%20City%20County%20Non%20Motorized%20Transport%20Policy.pdf.

138 SLOCAT Partnership and German Agency for International Cooperation (GIZ) (2022), "Climate Strategies for Transport in Africa", http://slocat.net/wp-content/uploads/2022/05/Africa-NDC-LTS-transport-infographic.pdf.

139 Ibid.

140 Ibid.

141 Ibid.

142 Ibid.

143 Ibid.

144 Ibid.

145 Ibid.

146 Ibid.

147 Ibid.

148 Ibid.

149 Ibid.

150 AfDB and IRF, 2023, "Safe and Efficient Urban Mobility for Africa", https://www.irf.global/safe-efficient-urban-mobility-for-africa.

151 Changing Transport, 2022, "Climate Strategies for Transport in Africa", https://changing-transport.org/publications/ndc-lts-transport-africa.

152 GIZ, 2022, "Develop Sustainable Transport Systems", https://www.giz.de/en/worldwide/82039.html; https://www.giz.de/expertise/downloads/Slides%20DigiWorkshop.pdf.

153 MobiliseYourCity, op. cit. note 5.

154 SLOCAT Partnership, 2022, "SLOCAT-VREF Young Leaders in Sustainable Transport", https://slocat.net/youngleaders.

155 SLOCAT Partnership, 2022, "African Voices Towards COP27", https://slocat.net/blog.

156 UNCTAD, 2023, "UNCTAD Training Bolsters Trade Facilitation in Southern Africa", https://unctad.org/news/unctad-training-bolsters-trade-facilitation-southern-africa; UNCTAD, 2022, "Boosting Trade Facilitation in West Africa", https://unctad.org/news/boosting-trade-facilitation-west-africa; UNCTAD, 2022, "UNCTAD Tool Accelerates Trade Facilitation Reforms in Developing Countries", https://unctad.org/news/unctad-tool-accelerates-trade-facilitation-reforms-developing-countries.

157 Volvo Research and Educational Foundation, 2023, "Mobility and Access in African Cities (MAC)", https://vref.se/mac.

158 UN-Habitat et al., op. cit. note 34.

2.2
ASIA REGIONAL OVERVIEW

1 Calculations by the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats (2018), "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

2 UN Economic and Social Commission for Asia and the Pacific (UNESCAP), 20 May 2022, "The War in Ukraine: Impacts, Exposure, and Policy Issues in Asia and the Pacific, p. 4, https://www.unescap.org/kp/2022/war-ukraine-impacts-exposure-and-policy-issues-asia-and-pacific.

3 UNESCAP, 2021, "Review of Developments in Transport in Asia and the Pacific 2021: Towards Sustainable, Inclusive and Resilient Urban Passenger Transport in Asian Cities", https://www.unescap.org/kp/2021/review-developments-transport-asia-and-pacific-2021-towards-sustainable-inclusive-and#.

4 UNESCAP, 2023, "Asia and the Pacific SDG Progress Report", p. XI, https://unescap.org/kp/2023/asia-and-pacific-sdg-progress-report-2023.

5 Ibid., p. XI.

6 Ibid., p. XI.

7 SLOCAT calculations based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

8 McKinsey & Company (2021)," The Asian Century, two years on: What's changed and what's next ", 18 October, https://www.mckinsey.com/featured-insights/future-of-asia/videos/the-asian-century-two-years-on-whats-changed-and-whats-next

9 W. Choi et al., 2021 ," Five windows of opportunity for postpandemic Asia", McKinsey & Company, 18 October, https://www.mckinsey.com/featured-insights/asia-pacific/five-windows-of-opportunity-for-postpandemic-asia

10 Ibid.

11 Worldometer(n.d.), "World Population: Past, Present, and Future", https://www.worldometers.info/world-population/#top20, accessed 27 May 2023.

12 UNICEF (2023), "As the pace of urbanization quickens in Asia-Pacific, so too does the threat of urban food insecurity – UN agencies report", 24 January, https://www.unicef.org/eap/press-releases/asia-pacific-threat-urban-food-insecurity

13 Asian Development Bank (ADB)(2020), *COVID-19 and Transport in Asia and the Pacific: Guidance Note,*", pp. iix-ix, https://www.adb.org/sites/default/files/institutional-document/623426/covid-19-transport-asia-pacific-guidance-note.pdf.

14 SLOCAT analysis based on O. Kulik, 2022, "Active-Conclusion / COVID19_mobility", https://github.com/ActiveConclusion/COVID19_ mobility/tree/master/waze_reports, accessed August 2022.

15 Ibid.; GlobeNewsWire(n.d.), "Variation of the yearly Congestion Level – 2021 vs 2019 (pre-COVID)", https://www.globenewswire.com/NewsRoom/AttachmentNg/406aa98c-6b84-4030-87a0-ffa520f8154a, (accessed 26 May 2023)

16 ADB (2022), "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", https://asiantransportoutlook.com/analytical-outputs/cop27-transport-tracker. **Figure 1** from ADB, 2022, "Asian Transport Outlook, TAS-VEP-038", (accessed 7 July 2023)

17 S. Gota and C. Huizenga, 2022, *Asian Transport 2030 Outlook*, ADB, https://asiantransportoutlook.com/documents/11/Asian_Transport_2030_Outlook_Nov_2022.pdf.

18 ADB, 2021, "National Transport Activity & Services (TAS)" dataset in "Asian Transport Outlook Database, 30 September 2022, https://data.adb.org/dataset/asian-transport-outlook-database.

19 **Figure 1** from International Road Federation (IRF), 2022, "World Road Statistics 2022", https://worldroadstatistics.org. https://datawarehouse.worldroadstatistics.org.

20 ADB, "National Transport Activity & Services (TAS)" dataset, op. cit. note 18.

21 ADB, 2022, "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", p. 25, https://asiantransportoutlook.com/analytical-outputs/cop27-transport-tracker;

22 S. Mao et al., 2021, "Total Cost of Ownership for Heavy Trucks in China: Battery-electric, Fuel Cell Electric, and Diesel Trucks", International Council on Clean Transportation (ICCT), https://theicct.org/wp-content/uploads/2021/12/ze-hdvs-china-tco-EN-nov21.pdf.

23 ADB, "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", op. cit. note 21.

24 Statista, 2023, "Market Share of Electric Cars (EV) in the Asia-Pacific region in 2022, by Selected Country", https://www.statista.com/statistics/1107877/apac-ev-market-share-by-country.

25 International Energy Agency (IEA), "Global EV Data Explorer", https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

26 IEA, "Trends in Electric Heavy-duty Vehicles", https://www.iea.org/reports/global-ev-outlook-2022/trends-in-electric-heavy-duty-vehicles, accessed 27 May 2023.

27 Mao et al., op. cit. note 22, p. i.

28 **Figure 2** from ADB, 2022, "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", op. cit. note 21, p. 9.

29 Statista, 2022, "Leading Modes of Transportation in Southeast Asia in 2022, by Country", https://www.statista.com/statistics/1338552/sea-leading-modes-of-transportation-by-country.

30 ADB, "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", op. cit. note 21, p. 9.

31 Ibid.

32 Statista, "Leading Modes of Transportation…", op. cit. note 29.

33 Ibid.

34 Ibid.

35 France 24, 2020, "Pakistan Opens First Metro Line After Years of Delays", france24.com/en/live-news/20201026-pakistan-opens-first-metro-line-after-years-of-delays.

36 A. Radford, 2022, "Bangladesh: Densely-populated Dhaka Gets First Metro Line", BBC News, https://www.bbc.com/news/world-asia-64111526.

37 D. Burroughs, 2021, "Hanoi Opens Vietnam's First Metro Line", International Railway Journal, https://www.railjournal.com/passenger/metros/hanoi-opens-vietnams-first-metro-line; J. Guild, 2022, "What Is Slowing Down Vietnam's Transport Infrastructure Projects?" The Diplomat, 15 November, https://thediplomat.com/2022/11/what-is-slowing-down-vietnams-transport-infrastructure-projects.

38 Xinhua, 2021, "Bullet Train for China-Laos Railway Arrives in Vientiane", Global Times, https://www.globaltimes.cn/page/202110/1236490.shtml.

39 D. Burroughs, 2022, "Jakarta – Bandung High-speed Line $US 2bn Over Budget", International Rail Journal, https://www.railjournal.com/infrastructure/jakarta-bandung-high-speed-line-us-2bn-over-budget.

40 Ahsden, 2019, " SMV Green / A rickshaw revolution", https://ashden.org/awards/winners/smv-green/ (accessed 7 July 2023)

41 M.B. Regmi and D. Pojani, 2022, "Meeting Urban Mobility Needs Through Paratransit and Informal Transport in Asia-Pacific Cities", UNESCAP, https://www.unescap.org/blog/meeting-urban-mobility-needs-through-paratransit-and-informal-transport-asia-pacific-cities.

42 MordorIntelligence (n.d.), " Bike Sharing Market Analysis", https://www.mordorintelligence.com/industry-reports/bike-sharing-market/market-size (accessed 9 July 2023)

43 P.K. Machavarapu and S. Ram, 2022, "Review on Public Bike Share Schemes in Large Developing Cities: A Case Study of Delhi, India", *Case Studies on Transport Policy*, Vol. 10, No. 4, pp. 2075-2091, Figure 1, https://www.sciencedirect.com/science/article/pii/S2213624X2200178X?via%3Dihub#f0005.

44 H. Jiang et al., 2020, "How Dockless Bike-sharing Changes Lives: An Analysis of Chinese Cities", World Resources Institute, https://doi.org/10.46830/wrirpt.18.00124.

45 Ibid.

46 S. Sung, A. Liu and J. Ma, 2022, "Status and Opportunities of Shared Mobility Systems in China", Volvo Research and Educational Foundations, https://vref.se/wp-content/uploads/2022/08/Informal-and-Shared-Mobility-Systems-in-China_220616.pdf.

47 L. Baker (2017), " Bike-hire users in Asia swapping cars, motorbikes and taxis for pedals, says Thomson Reuters", evolution, 26 September, https://www.transportxtra.com/publications/evolution/news/54757/publications/local-transport-today/news/54092/work-with-us-authorities-urge-dockless-bike-hire-operators/

48 N.A. Kadir, L. Ghee-Thean and C.H. Law, 2019, "An Interim Evaluation of Penang's First Bike-share Scheme", *Geografia*, Vol. 15, No. 3, http://journalarticle.ukm.my/14197/1/32345-107825-1-PB.pdf; P.K. Machavarapu and S. Ram, 2022, "Review on Public Bike Share Schemes in Large Developing Cities: A Case Study of Delhi, India", *Case Studies on Transport Policy*, Vol. 10, No. 4, pp. 2075-2091, https://www.sciencedirect.com/science/article/pii/S2213624X2200178X?via%3Dihub#f0005; Indonesia from L. Warlina and Y.A. Hermawan, 2020, "Smart Bike Sharing System as Sustainable Transportation", *IOP Conference Series: Materials Science and Engineering*, Vol. 879, No. 1, p. 012153, https://iopscience.iop.org/article/10.1088/1757-899X/879/1/012153/pdf

49 D. Ren, 2022, "Baidu Launches China's First Driverless Taxi Services in Chongqing and Wuhan in Landmark Moment for Autonomous Motoring", South China Morning Post, https://www.scmp.com/business/china-business/article/3188190/baidu-launches-chinas-first-driverless-taxi-services.

50 S. Foster, 2021, "UAE Reveals Its First Driverless Taxi", The National News, https://www.thenationalnews.com/uae/2021/11/23/uae-reveals-its-first-fully-autonomous-taxi.

51 Al Jazeera, 2022, "Global Air Travel Rebounds to 74 Percent of Pre-pandemic Levels", https://www.aljazeera.com/economy/2022/11/8/global-air-travel-rebounds-to-74-percent-of-pre-pandemic-levels.

52 ADB, 2020, "Covid-19 and Transport in Asia and the Pacific", p. iix. https://www.adb.org/sites/default/files/institutional-document/623426/covid-19-transport-asia-pacific-guidance-note.pdf.

53 Ibid., p. iix.

54 Ibid., p. 21.

55 International Air Transport Association, 2022, "Fall in Air Cargo Demand in Line with Expectations", https://www.iata.org/en/pressroom/2022-releases/2022-06-08-01.

56 Ibid.

57 ADB, "Covid-19 and Transport in Asia and the Pacific", op. cit. note 52, p. 21.

58 The Business Times, 2022, "Shanghai Port Rebounds as Lockdown Loosens But Backlog Remains", https://www.businesstimes.com.sg/companies-markets/transport-logistics/shanghai-port-rebounds-lockdown-loosens-backlog-remains.

59 ADB, "Covid-19 and Transport in Asia and the Pacific", op. cit. note 52, p. 22.

60 GlobeNewswire, 15 December 2022, "ASEAN Freight and Logistics Market – Growth, Trends, COVID-19 Impact, and Forecasts (2022- 2027)", https://www.globenewswire.com/news-release/2022/12/15/2574515/0/en/ASEAN-Freight-and-Logistics-Market-Growth-Trends-COVID-19-Impact-and-Forecasts-2022-2027.html.

61 REN21, 2023, "Renewables 2023 Global Status Report: Demand Modules", p. 46, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

62 Ibid., p. 46.

63 SLOCAT calculations based on Crippa et al., op. cit. note 7.

64 Ibid.

65 Ibid.

66 Ibid.

67 Ibid.

68 Ibid.

69 Ibid.

70 Ibid.

71 Ibid.

72 Ibid.

73 Council for Decarbonising Transport in Asia, 2022, "The Path to Zero: A Vision for Decarbonised Transport in Asia – Overcoming Blind Spots and Enabling Change", https://changing-transport.org/wp-content/uploads/202204_NDC-TIA-Council_The-Path-to-Zero.pdf.

74 Gota and Huizenga, op. cit. note 17, p. 19.; Council for Decarbonising Transport in Asia, 2022, "The Path to Zero: A Vision for Decarbonised Transport in Asia – Overcoming Blind Spots and Enabling Change", https://councilreport.ndctransportinitiativeforasia.org/https://changing-transport.org/wp-content/uploads/202204_NDC-TIA-Council_The-Path-to-Zero.pdf.

75 SLOCAT analysis of Crippa et al., op. cit. note 7

76 **Figure 3** from SLOCAT analysis of Crippa et al., op. cit. note 7

77 SLOCAT analysis of Crippa et al., op. cit. note 7.

78 NPR, 2022, "China Announces a Rollback of Its Strict Anti-COVID-19 Measures", https://www.npr.org/2022/12/07/1141172723/china-announces-a-roll-back-of-its-strict-anti-covid-19-measures.

79 Carbon Monitor, 2023, "CO2 Emissions Variation", https://carbonmonitor.org/variation, accessed 27 May 2023,

80 Ibid.

81 Ibid.

82 UNEP, "Restoring Clean Air", https://www.unep.org/regions/asia-and-pacific/regional-initiatives/restoring-clean-air, (accessed 7 July 2023).

83 R. Fuller et al., 2022, "Pollution and Health: A Progress Update", *The Lancet Planetary Health*, Vol. 6, No. 6, https://doi.org/10.1016/S2542-5196(22)00090-0.

84 Ibid.

85 ADB, 2022 , *Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020,* ADB Transport, Sharm El-Sheikh, https://asiantransportoutlook.com/documents/9/Climate_Tracker-14-11-2022.pdf

86 Asian Transport Outlook, 2021, "A New Perspective on Transport and Climate Change", p. 4, https://asiantransportoutlook.com/analytical-outputs/climate-change-in-asia.

87 **Figure 4** from ADB, "Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020", op. cit. note 21.

88 Council for Decarbonising Transport in Asia (2022), *The Path to Zero: A Vision for Decarbonised Transport in Asia,* https://changing-transport.org/wp-content/uploads/202204_NDC-TIA-Council_The-Path-to-Zero.pdf

89 Council for Decarbonising Transport in Asia (2022), *The Path to Zero: A Vision for Decarbonised Transport in Asia,* https://changing-transport.org/wp-content/uploads/202204_NDC-TIA-Council_The-Path-to-Zero.pdf, Annex 1.

90 Ibid., p. 99.

91 SLOCAT, 2022, "Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies", www.slocat.net/ndcs.

92 Ibid.

93 Ibid.

94 SLOCAT, 2022, *Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies*, October 2022 Update, https://slocat.net/wp-content/uploads/2022/01/Climate-Strategies-for-Transport_20221109-Final.pdf

95 ADB, 2022, *Tracking Transport and Climate Change Indicators in Asia and the Pacific 2000-2020,* ADB Transport, Sharm El-Sheikh, https://asiantransportoutlook.com/documents/9/Climate_Tracker-14-11-2022.pdf, p. 30.

96 SLOCAT, 2022, *Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies*, October 2022 Update, https://slocat.net/wp-content/uploads/2022/01/Climate-Strategies-for-Transport_20221109-Final.pdf

97 REN21, op. cit. note 61, p. 14; ICCT, 2021, "China's New Energy Vehicle Industrial Development Plan for 2021 to 2035", https://theicct.org/wp-content/uploads/2021/12/China-new-vehicle-industrial-dev-plan-jun2021.pdf; H. Nguyen Thanh, "Viet Nam Accelerates Plans to Phase Out Fossil Fuel Vehicles by 2050", Changing Transport, https://changing-transport.org/green-transport-action-plan, accessed 27 May 2023.

98 Sustainable Bus, 2022, "Israel Sets Target for Zero Emission Bus Purchases for Public Transport. 100% ZE Buses Mandatory in 2026", https://www.sustainable-bus.com/news/israel-target-zero-emissions-buses-public-transport.

99 S. Turton, 2022, "Cambodia Builds Up EV Infrastructure to Speed Electric Ambitions", Nikkei Asia, https://asia.nikkei.com/Business/Automobiles/Cambodia-builds-up-EV-infrastructure-to-speed-electric-ambitions.

100 HT Auto, 2021, "Mumbai's BEST Adds 60 More Electric Buses, Target 200 Double Decker Buses Too", https://auto.hindustantimes.com/auto/news/mumbais-best-adds-60-more-electric-buses-target-200-double-decker-buses-too-41634018382726.html.

101 Ibid.

102 M. Arnd, "NDC Update Vietnam: Focus on Credibility", Changing Transport, https://changing-transport.org/vietnam-ndc-update, accessed 27 May 2023.

103 Press Information Bureau Delhi, 2022, "PM Launches National Logistics Policy", 17 September, https://www.pib.gov.in/PressReleasePage.aspx?PRID=1860192.

104 China.org, 2022, "China Issues Plan to Enhance Multimodal Transport", 8 January, http://www.china.org.cn/business/2022-01/08/content_77977503.htm.

105 VOA, 2021, "Countries Agree to Create Green Shipping Lanes in Pursuit of Zero Carbon", 10 November, https://www.voanews.com/a/countries-agree-to-create-green-shipping-lanes-in-pursuit-of-zero-carbon/6307554.html.

106 The Maritime Executive, 2022, "Singapore Joins Global Initiative to Create Green Shipping Corridors", 4 April, https://www.maritime-executive.com/article/singapore-joins-global-initiative-to-create-green-shipping-corridors.

107 C40 Cities, 2022, "Port of Los Angeles, Port of Shanghai, and C40 Cities Announce Partnership to Create World's First Transpacific Green Shipping Corridor Between Ports in the United States and China", 28 January, https://www.c40.org/news/la-shanghai-green-shipping-corridor.

108 IEA, 2022, "Electric Vehicles", https://www.iea.org/reports/electric-vehicles.

109 MGTC, "Low Carbon Mobility Blueprint (LCMB)", https://www.mgtc.gov.my/what-we-do/low-carbon-mobility-2/low-carbon-mobility-blueprint, accessed 27 May 2023.

110 Regmi and Pojani, op. cit. note 41.

111 A. Calonzo, 2023, "Manila's Colorful Jeepneys Make Way for Carbon-Free Minibuses", Bloomberg, https://www.bloomberg.com/news/articles/2023-03-29/philippines-replaces-polluting-jeepneys-with-electric-minibuses.

112 Bloomberg, 2019, "In Beijing, You Have to Win a License Lottery to Buy a New Car!" https://www.bloomberg.com/news/articles/2019-02-27/in-beijing-you-have-to-win-a-license-lottery-to-buy-a-new-car; South China Morning Post, 13 May 2023, "Singapore's Middle Class Reels Over Record COE Prices: 'US$150,000 for a Toyota Corolla?'" https://www.scmp.com/week-asia/politics/article/3220384/singapores-middle-class-reels-over-record-coe-prices-us150000-toyota-corolla.

113 ASEAN Secretariat, 2022, "Guidelines for the Development of Sustainable Urban Mobility Plans (SUMP) in ASEAN Metropolitan Regions", https://asean.org/book/guidelines-for-the-development-of-sustainable-urban-mobility-plans-sump-in-asean-metropolitan-regions.

114 Mobilise Your City, 2022, "An Innovative Process Leads to an Ambitious Public Transport-focused SUMP for the City of Medan", 12 December, https://www.mobiliseyourcity.net/innovative-process-leads-ambitious-public-transport-focused-sump-city-medan.

115 Mobility Transition in China, 2021, "Sump Foshan Pilot: First Implementation of Sump Concept in China", https://transition-china.org/mobilityposts/sump-foshan-pilot-first-implementation-of-sump-concept-in-china.

116 A. Soni and K. Dubash, 2023, "The Dawn of India's Walking and Cycling Revolution", Institute for Transportation and Development Policy, 5 January, https://www.itdp.org/2023/01/05/india-walking-cycling-revolution-stmag-34.

117 Ibid.

118 J.P. Ibañez, 2021, "Completed Bike Lanes Approaching 500-km Mark", Business World, 12 July, https://www.bworldonline.com/economy/2021/07/12/381943/completed-bike-lanes-approaching-500-km-mark.

119 R.M. Nugraha and P.G. Bhwana, 2022, "309 KM of Jakarta Bike Lanes Established Before 2022 Ends", 31 August,Tempo, https://en.tempo.co/read/1628899/309-km-of-jakarta-bike-lanes-established-before-2022-ends.

120 Global Fuel Economy Initiative (GFEI), "National Standards: Detailed Case Studies: Japan", https://www.globalfueleconomy.org/transport/gfei/autotool/approaches/regulatory_policy/fuel_economy.asp#detailed_case_studies, accessed 27 May 2024; GFEI, "The Chinese Automotive Fuel Economy Policy", https://www.globalfueleconomy.org/transport/gfei/autotool/case_studies/apacific/china/cs_ap_china.asp, accessed 27 May 2024; GFEI, "India's Developing Automotive Fuel Economy Policy", https://www.globalfueleconomy.org/transport/gfei/autotool/case_studies/apacific/india/cs_ap_india.asp, accessed 27 May 2024; GFEI, "Republic of Korea Developing Automotive Fuel Economy Policy", https://www.globalfueleconomy.org/transport/gfei/autotool/case_studies/apacific/south_korea/cs_ap_sk.asp, accessed 27 May 2024.

121 REN21, 2022, "Renewables 2022 Global Status Report", https://www.ren21.net/gsr-2022/chapters/chapter_01/chapter_01/#sub_5.

122 GFEI, 2021, "ASEAN Countries Begin Process of Implementing Fuel Economy Roadmap", https://www.globalfueleconomy.org/blog/2021/february/asean-countries-begin-process-of-implementing-fuel-economy-roadmap.

123 REN21, "Demand Modules", op. cit. note 61, p. 14.

124 Mining Technology, 2023, "Successful Indonesian IPOs Reveal the 2023 Nickel Market Is Soaring", 21 April, https://www.mining-technology.com/comment/indonesia-ipos-2023-nickel-market.

125 REN21, "Demand Modules", op. cit. note 61, p. 14.

126 A. Shah, 2022, "India to Introduce New Battery Swapping Policy in EV Push", Reuters, https://www.reuters.com/technology/india-introduce-new-battery-swapping-policy-ev-push-2022-02-01.

127 A. Mandal et al., 2022, "Battery Ecosystem: A Global Overview, Gap Analysis in Indian Context, and Way forward for Ecosystem Development", NDC Transport Initiative for Asia (NDC-TIA), https://www.ndctransportinitiativeforasia.org/resources-list/giz-deloitte-battery-ecosystem-review-gap-analysis; A. Bhattacharjee, 28 February 2023, "EV Battery Recycling in India – Opportunities and Challenges", Clean Mobility Shift, https://cleanmobilityshift.com/ecosystem/ev-battery-recycling-in-india-opportunities-and-challenges.

128 Livemint, 2022, "CESL Issues - 5,500 Cr Tender to Buy 5,580 Electric Buses", https://www.livemint.com/companies/news/cesl-invites-bids-for-5-580-electric-buses-11642671551022.html.

129 GIZ, 2022, "Overview on Battery Swapping and Battery-as-a-Service (BaaS) in China", https://transition-china.org/mobilityposts/overview-on-battery-swapping-and-battery-as-a-service-baas-in-china.

130 Electrive.com, 2022, "Battery Reuse & Recycling Expand to Scale in China", 29 January, https://www.electrive.com/2022/01/29/battery-reuse-recycling-expands-to-scale-in-china.

131 K. Parsain, 2022, "Nepal's Electric Vehicle Imports Surge After Tax Cuts", Kathmandu Post, 2 February, https://kathmandupost.com/money/2022/02/02/nepal-s-electric-vehicle-imports-surge-after-tax-cuts.

132 S. Turton,2022, "Cambodia Builds Up EV Infrastructure to Speed Electric Ambitions", Nikkei Asia, 10 May, https://asia.nikkei.com/Business/Automobiles/Cambodia-builds-up-EV-infrastructure-to-speed-electric-ambitions.

133 VNA, 2022, "Hanoi Approves Pilot of E-bike Sharing Model Serving BRT Passengers", Vietnam Plus, 21 October, https://en.vietnamplus.vn/hanoi-approves-pilot-of-ebike-sharing-model-serving-brt-passengers/240451.vnp.

134 REN21, "Demand Modules", op. cit. note 61, p. 46.

135 Ibid., p. 41.

136 ADB, "Asian Transport Outlook", https://www.adb.org/what-we-do/topics/transport/asian-transport-outlook, accessed 6 July 2023.

137 Clean Air Asia, "Clean Air Asia", https://cleanairasia.org, accessed 6 July 2023.

138 NDC-TIA, "Council for Decarbonizing Transport in Asia", https://www.ndctransportinitiativeforasia.org/council-for-decarbonizing-transport, accessed 6 July 2023.

139 Global Climate Action Partnership, 2023, "Circularity of Electric Vehicle Batteries: From Materials and Manufacturing to Recycling. Four-part Training series for the Leadership Group for Clean Transport Asia: Summary Report for Phase 1 Technical Trainings", https://docs.google.com/document/d/14Uhx-BH3Zu9nOtofn4rcEuda2Cklg7UERrV3Mirrbug/edit.

140 NDC-TIA, "About", https://www.ndctransportinitiativeforasia.org/about, accessed 6 July 2023.

141 UN Centre for Regional Development, 2023, "Mapping of International Transport Policy Support Activities in EST Forum Participating Countries: Scope and Alignment with the Aichi 2030 Declaration", https://uncrd.un.org/sites/uncrd.un.org//files/est_final-report_uncrd-est-mapping-4april2023.pdf.

142 UNESCAP, "Asia-Pacific Initiative on Electric Mobility", https://www.unescap.org/projects/asia-pacific-initiative-on-electric-mobility, accessed 6 July 2023.

2.3
EUROPE REGIONAL OVERVIEW

1 Calculations by the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats (2018), "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

2 Reuters, 2022, "Public Transport Use in Europe Still Below Pre-pandemic Levels – ING Report", https://www.reuters.com/article/europe-public-transport-study-idINL1N2YZ0R5.

3 A. Gazzani and F. Ferriani (2022), "The impact of the war in Ukraine on energy prices: Consequences for firms' financial performance", CEPR, 7 October, https://cepr.org/voxeu/columns/impact-war-ukraine-energy-prices-consequences-firms-financial-performance; N. Chiwaya (2022), " Why Russia's Ukraine invasion spiked energy prices, in 4 charts", NBC News, 24 February, https://www.nbcnews.com/news/world/why-russia-s-ukraine-invasion-spiked-energy-prices-4-charts-n1289799.

4 Government of the United Kingdom, 2023, "Vehicles statistics," https://www.gov.uk/government/collections/vehicles-statistics; IRF, 2022, "World Road Statistics 2022," https://datawarehouse.worldroadstatistics.org.

5 Reuters, op. cit. note 2.

6 Eurostat, 2023, "Passenger Cars in the EU", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Passenger_cars_in_the_EU.

7 European Commission, 2021, "New Transport Proposals Target Greater Efficiency and More Sustainable Travel", https://transport.ec.europa.eu/news/efficient-and-green-mobility-2021-12-14_en.

8 Eurostat, May 2023, "Sustainable Development in the European Union: Monitoring Report on Progress Towards the SDGs in an EU Context", https://ec.europa.eu/eurostat/documents/15234730/16817772/KS-04-23-184-EN-N.pdf/845a1782-998d-a767-b097-f22ebe93d422?version=1.0&t=1684844648985.

9 European Environment Agency (nd), "Greenhouse gas emissions from transport in Europe", https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport , accessed 10 July 2023

10 Reuters, op. cit. note 2.

11 Share from Destatis, 2022, "Road Transport: Car Dominance Unbroken", https://www.destatis.de/Europa/EN/Topic/Transport/Car.html; fossil fuel reliance from Eurostat, "Passenger Cars in the EU", op. cit. note 6.

12 Eurostat, "Passenger Cars in the EU", op. cit. note 6.

13 Ibid.

14 Ibid.

15 Ibid.

16 Ibid.

17 IRF, op. cit. note 4.

18 IRF, op. cit. note 4. **Figure 1** from Eurostat, 2022, "Stock of Vehicles by Category and NUTS 2 Regions", https://ec.europa.eu/eurostat/databrowser/view/TRAN_R_VEHST__custom_3245293/default/table; Government of the United Kingdom, 2023, "Vehicles Statistics", https://www.gov.uk/government/collections/vehicles-statistics; IRF, 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org; E.A. Nanaki, 2018, "Measuring the Impact of Economic Crisis to the Greek Vehicle Market", *Sustainability*, Vol. 10, p. 510. https://doi.org/10.3390/su10020510.

19 IRF, op. cit. note 4.

20 IRF, op. cit. note 4.

21 Ibid.

22 Ibid.

23 Eurostat, "Passenger Cars in the EU", op. cit. note 6.

24 United Nations Environment Programme (UNEP), 2020, "Global Trade in Used Vehicles Report", pp. 25-26, https://www.unep.org/resources/report/global-trade-used-vehicles-report; UNEP, 2021, "Used Vehicles and the Environment – Progress and Updates 2021", https://www.unep.org/resources/report/used-vehicles-and-environment-progress-and-updates-2021.

25 IRF, op. cit. note 4.

26 Reuters, op. cit. note 2.

27 Ibid.

28 Ibid.

29 Ibid.

30 L. Laker, 2021, "Europe Doubles Down on Cycling in Post-Covid Recovery Plans", The Guardian (UK), https://www.theguardian.com/lifeandstyle/2021/mar/12/europe-cycling-post-covid-recovery-plans.

31 K. Vandy, 2020, "Coronavirus: How Pandemic Sparked European Cycling Revolution", BBC, https://www.bbc.co.uk/news/world-europe-54353914.

32 Google, 2023, "Environmental Insights Explorer", https://insights.sustainability.google, accessed 27 May 2023.

33 Vandy, op. cit. note 31.

34 Google, op. cit. note 32.

35 Ibid.

36 International Energy Agency (IEA), 2023, "Global Electric Vehicle Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

37 IEA, 2023, *Global Electric Vehicle Outlook*, Paris, https://www.iea.org/reports/global-ev-outlook-2023

38 Ibid.

39 Sustainable Bus, 2023, "Electric Bus Market Europe 2022, All the Figures. Guess the Leaders!" https://www.sustainable-bus.com/news/electric-bus-market-europe-2022.

40 Eurostat, 2022, "EU Meets 2020 Renewable Energy Target in Transport",https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220202-2.

41 REN21, 2023, *Renewables 2023 Global Status Report: Energy Demand*, p. 46, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

42 Eurostat, "EU Meets 2020 Renewable Energy Target in Transport", op. cit. note 40.

43 Ibid.

44 REN21, op. cit. note 41, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf, p. 46.

45 Eurostat, "Passenger Cars in the EU", op. cit. note 6, Table 1.

46 Eurostat (2019), "Glossary:Alternative fuel", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Alternative_fuel , accessed 10 July 2023

47 Ibid.

48 Eurostat, "Passenger Cars in the EU", op. cit. note 6, Table 1.

49 Ibid.

50 Ibid.

51 A. Gazzani and F. Ferriani (2022), "The impact of the war in Ukraine on energy prices: Consequences for firms' financial performance", CEPR, 7 October, https://cepr.org/voxeu/columns/impact-war-ukraine-energy-prices-consequences-firms-financial-performance; N. Chiwaya (2022), " Why Russia's Ukraine invasion spiked energy prices, in 4 charts", NBC News, 24 February, https://www.nbcnews.com/news/world/why-russia-s-ukraine-invasion-spiked-energy-prices-4-charts-n1289799.

52 A. Gazzani and F. Ferriani (2022), "The impact of the war in Ukraine on energy prices: Consequences for firms' financial performance", CEPR, 7 October, https://cepr.org/voxeu/columns/impact-war-ukraine-energy-prices-consequences-firms-financial-performance

53 Ibid.

54 **Box 1** based on the following sources: European Parliamentary Research Service (EPRS), 2022, "Russia's War on Ukraine: Implications for Transport", www.europarl.europa.eu/RegData/etudes/BRIE/2022/733536/EPRS_BRI(2022)733536_EN.pdf. According to EPRS, idem, the oil import ban is subject to transition periods to allow the sector and global markets to adapt and to allow the EU and its partners to secure alternative supplies and minimises the impact on global oil prices. Number of refugees based on United Nations High Commissioner for Refugees, 2023, "Ukraine Refugee Situation, Update from 3 January 2023", https://web.archive.org/web/20230105054519/https://data.unhcr.org/en/situations/ukraine.

55 Eurostat, 2021, "Air Passenger Transport Decreased by 73% in 2020", https://ec.europa.eu/eurostat/web/products-eurostat-news/-/EDN-20211206-1.

56 International Air Transport Association (IATA), 2022, "Air Passenger Numbers to Recover in 2024", https://www.iata.org/en/pressroom/2022-releases/2022-03-01-01.

57 Eurostat, 2021, "Rail transport Severely Impacted by COVID-19 in 2020", https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20211119-2.

58 Eurostat, 2022, "Railway Passenger Transport Statistics – Quarterly and Annual Data", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Railway_passenger_transport_statistics_-_quarterly_and_annual_data#In_2021.2C_the_EU_rail_passenger_transport_performance_partially_recovered_from_the_sharp_drop_in_2020.

59 J. Buckley, 2022, "Europe's New Train Routes for 2022", CNN, https://edition.cnn.com/travel/article/europe-new-train-routes-2022/index.html.

60 Eurostat, 2023, "Freight Transport Statistics – Modal Split", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Freight_transport_statistics_-_modal_split#Modal_split_of_freight_transport_in_the_EU; Eurostat, 2022, "Road Freight Transport Statistics", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_statistics#EU_road_freight_transport_increased_sharply_in_2021; S. Tan, 2022, "Shipping Rates Are Still Falling, in Another Sign That a Global Recession May Be Coming", CNBC, cnbc.com/2022/09/08/shipping-rates-are-still-falling-in-another-sign-that-a-global-recession-may-be-coming.html; McKinsey & Company, 2022, "Bold Moves to Boost European Rail Freight", https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/bold-moves-to-boost-european-rail-freight; J. Lerh, 2022, "Global Port Congestion, High Shipping Rates to Last into 2023 – Execs", Reuters, https://www.reuters.com/business/global-port-congestion-high-shipping-rates-last-into-2023-execs-2022-06-16.

61 Ibid.

62 Eurostat, 2023, "Freight Transport Statistics – Modal Split", op. cit. note 60.

63 ITF, "Modal Shift to Cleaner Transport Fails to Materialize", https://www.itf-oecd.org/modal-shift-transport-trends, accessed 27 May 2023.

64 Ibid.

65 ACEA, 25 January 2023, "Commercial Vehicle Registrations: -14.6% in 2022; -5.1% in December",

https://www.acea.auto/cv-registrations/commercial-vehicle-registrations-14-6-in-2022-5-1-in-december.

66 Eurostat, 2023, "Freight Transport Statistics – Modal Split", op. cit. note 60.

67 Ibid.

68 Ibid.

69 Ibid.

70 Ibid.

71 Ibid.

72 Ibid.

73 Ibid.

74 Ibid.

75 Ibid.

76 Analysis by the SLOCAT Partnership on Sustainable, Low Carbon Transport based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

77 Ibid.

78 Ibid.

79 Ibid.

80 **Figure 2** from European Environment Agency (nd), " Greenhouse gas emissions from transport in Europe", https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport , accessed 10 July 2023

81 Ibid.

82 **Figure 3** from Ibid.

83 SLOCAT analysis based on Crippa et al., op. cit. note 76.

84 L. Jensen (2021), *Climate action in Luxembourg: Latest state of play*, European Parliament, https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/690664/EPRS_BRI(2021)690664_EN.pdf; SLOCAT analysis based on M. Crippa et al., op. cit. note 76.

85 Energypedia, 2015, "Fuel Prices Luxembourg", https://energypedia.info/wiki/Fuel_Prices_Luxembourg. **Figure 4** from SLOCAT analysis based on Crippa et al., op. cit. note 76.

86 Ibid.

87 Ibid.

88 Ibid.

89 European Union Agency for Railways, 2021, "European Year of Rail 2021", https://www.era.europa.eu/content/european-year-rail-2021_en.

90 Greenpeace, 2021, "European Airline Bailout Tracker", https://www.greenpeace.org/eu-unit/issues/climate-energy/2725/airline-bailout-tracker.

91 Intelligent Transport, 2020, "The Trends Driving Europe's Mass Transit Future Forward", https://www.intelligenttransport.com/transport-articles/108725/the-trends-driving-europes-mass-transit-future-forward.

92 Ibid.

93 Polis, 2022, "Brussels Adapts Legislation to Ease Building Light Bike Lanes", https://www.polisnetwork.eu/news/brussels-adapts-legislation-to-ease-building-light-bike-lanes.

94 N. Camut, 2023, "Paris Votes to Ban Shared E-scooters", https://www.politico.eu/article/paris-bans-e-scooters-in-landmark-referendums.

95 European Commission, 2020, "Sustainable and Smart Mobility Strategy – Putting European Transport on Track for the Future", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-%3A52020DC0789.

96 Ibid.

97 European Commission, 2021, "New Transport Proposals Target Greater Efficiency and More Sustainable Travel", https://transport.ec.europa.eu/news/efficient-and-green-mobility-2021-12-14_en.

98 Ibid.

99 European Union, 2021, "Creating a Green and Efficient Trans-European Transport Network", https://transport.ec.europa.eu/system/files/2023-03/Creating_a_green_and_efficient_Trans-European_Transport_Network.pdf.

100 European Union, 2023, "TEN-T Revision", https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t/ten-t-revision_en.

101 European Commission, "New transport proposals target greater efficiency and more sustainable travel", op. cit. note 97.

102 CPK, 2023, "Joint Railway Investments for the Three Seas Region, CPK Railway Direction Days", https://www.cpk.pl/en/news/joint-railway-investments-for-the-three-seas-region-cpk-railway-direction-days.

103 Ibid.

104 Ibid.

105 M. Romain, 2023, "France's Short-haul Domestic Flight Ban: A Measure Lacking Substance", Le Monde, https://www.lemonde.fr/en/les-decodeurs/article/2023/05/26/france-s-short-haul-domestic-flight-ban-a-measure-lacking-substance_6028097_8.html.

106 Reuters, 2023, "First Night Train Connecting Brussels and Berlin Starts Operations", https://www.reuters.com/world/europe/first-night-train-connecting-brussels-berlin-starts-operations-2023-05-26.

107 European Parliament, 2023, "Review of the Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport", https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-intelligent-transport-systems-directive-review.

108 Ibid.

109 Government of the UK, 2021, "Government Publishes World's First 'Greenprint' to Decarbonise All Modes of Domestic Transport by 2050", https://www.gov.uk/government/news/government-publishes-worlds-first-greenprint-to-decarbonise-all-modes-of-domestic-transport-by-2050.

110 Ibid.

111 REN21, op. cit. note 41, p. 41.

112 Electrive, 2021, "EU Commission Presents 'Fit for 55' Climate Package", https://www.electrive.com/2021/07/14/eu-commission-presents-fit-for-55-climate-package; Electrive, 2022, "EU Council Confirms ICE Ban for Cars and Vans by 2035", https://www.electrive.com/2022/06/29/eu-council-decides-on-100-co2-reductions-for-cars-and-vans-by-2035.

113 Electrive, 28 2023, "EU Member States Adopt ICE Sales Ban Almost Unanimously", https://www.electrive.com/2023/03/28/eu-member-states-adopt-ice-sales-ban-almost-unanimously.

114 REN21, "GSR 2022 Datapack, Reference Table R10", https://www.ren21.net/wp-content/uploads/2019/05/GSR2022_Data_Pack_Final.xlsx.

115 R. Frost, 2021, "63% of European City Dwellers Want a Ban on Petrol and Diesel Cars", Euronews, https://www.euronews.com/green/2021/04/12/63-of-european-city-dwellers-want-a-ban-on-petrol-and-diesel-cars.

116 REN21, op. cit. note 50, p. 42.

117 E. Jupp, 2019, "Diesel Bans: Where Can't You Drive in the UK and Europe?" Motoring Research, https://www.motoringresearch.com/car-news/diesel-bans-uk-europe.

118 M. Collings, 2023, "Madrid Becomes the First Major European Capital to Have a 100% Clean Bus Fleet", Eltis, https://www.eltis.org/in-brief/news/madrid-becomes-first-major-european-capital-have-100-clean-bus-fleet; Transport & Environment, 2020, "Compressed Natural Gas Vehicles Are Not a Clean Solution for Transport: Review of the Latest Evidence Shows High Levels of Particle Emissions", https://www.transportenvironment.org/wp-content/uploads/2021/07/2020_06_TE_CNG_particle_report.pdf.

119 Sadler Consultants, 2022, "Urban Access Regulations in Europe", https://urbanaccessregulations.eu.

120 F. Ripa, 2021, "European Commission Releases New Urban Mobility Framework", https://www.eltis.org/in-brief/news/european-commission-releases-new-urban-mobility-framework.

121 Ertico, 2022, "What Is the Aim of the New European Urban Mobility Framework?" https://erticonetwork.com/what-is-the-aim-of-the-new-european-urban-mobility-framework.

122 ICLEI-Local Governments for Sustainability, 2018, "The Status of SUMPs in EU Member States", https://sumps-up.eu/fileadmin/user_upload/Tools_and_Resources/Reports/SUMPs-Up___PROSPERITY-SUMP-Status-in-EU-Report.pdf.

123 R. Frost, 2022, " From tax cuts to speed limits: How European governments are trying to cut fuel costs", Green News, 17 March, https://www.euronews.com/green/2022/03/16/from-tax-cuts-to-speed-limits-how-european-governments-are-trying-to-are-trying-to-cut-fue.

124 T.B. Deimon, 2023, "What effects for anti-inflation fare schemes in European public transport ?", egis, 20 June, https://www.egis-group.com/all-insights/what-effects-for-anti-inflation-fare-schemes-in-european-public-transport.

125 European Commission (2022), "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition", 18 May, https://neighbourhood-enlargement.ec.europa.eu/news/repowereu-plan-rapidly-reduce-dependence-russian-fossil-fuels-and-fast-forward-green-transition-2022-05-18_en.

126 European Commission, 2023, "European Green Deal: Agreement Reached on Cutting Maritime Transport Emissions by Promoting Sustainable Fuels for Shipping", https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1813.

127 Ibid.

128 POLIS Network, "ESCALATE", https://www.polisnetwork.eu/project/escalate, accessed 10 July 2023.

129 "COP26: Government leaders must commit to boosting cycling levels to reduce carbon emissions and reach global climate goals quickly and effectively ", https://cop26cycling.com/, accessed 10 July 2023

130 European Rail Research Advisory Council, 2020, "Rail Strategic Research and Innovation Agenda", https://uic.org/europe/IMG/pdf/20201207_rail-strategic-research-and-innovation-agenda.pdf.

131 ICLEI, 2023, "German Cities Harness Data-driven Approach for Low Carbon Transport Development and Sustainable Mobility Planning", https://bit.ly/3rha6D7.

132 POLIS Network, "GREEN-LOG", https://www.polisnetwork.eu/project/green-log, accessed 10 July 2023.

133 The Future Is Public Transport, https://thefutureispublictransport.org, accessed 10 July 2023.

2.4
LATIN AMERICA AND THE CARIBBEAN REGIONAL OVERVIEW

1 Calculations from the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats, 2018, "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

2 SLOCAT calculations based on UN, op. cit. note 1, and on UN Stats, op. cit. note 1.

3 UN Economic Commission for Latin America and the Caribbean (ECLAC), 2022, "Social Panorama of Latin America and the Caribbean", https://www.cepal.org/en/publications/48519-social-panorama-latin-america-and-caribbean-2022-transforming-education-basis.

4 Ibid.

5 Ibid.

6 United Nations Development Programme (UNDP), 2021, "Regional Human Development Report 2021 – Trapped: High Inequality and Low Growth in Latin America and the Caribbean", https://www.undp.org/latin-america/publications/regional-human-development-report-2021-trapped-high-inequality-and-low-growth-latin-america-and-caribbean.

7 Inter-American Development Bank (IDB), 2022, "Hechos estilizados de la movilidad urbana en América Latina y el Caribe", http://dx.doi.org/10.18235/0004239.

8 International Road Federation, 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

9 Ibid.

10 Revista Mototec, 2023, "Crece la tasa de motocicletas en cinco años en América Latina y el Caribe", https://www.revistamototec.com/crece-la-tasa-de-motocicletas-en-cinco-anos-en-america-latina-y-el-caribe.

11 IDB, 2022, "Transport for Inclusive Development: Defining a Path for Latin America and the Caribbean", http://dx.doi.org/10.18235/0004335.

12 Asociación Nacional Automotriz de Chile (ANAC), 2020, "Informe del Mercado Automotor Diciembre 2020", https://www.anac.cl/wp-content/uploads/2021/02/12-ANAC-Mercado-Automotor-Diciembre-2020-VF.pdf.

13 ANAC, 2021, "Informe del Mercado Automotor Diciembre 2021", https://www.anac.cl/wp-content/uploads/2022/01/12-ANAC-Mercado-Automotor-Diciembre-2021.pdf; ANAC, 2022, "Informe del Mercado Automotor Diciembre 2022", https://www.anac.cl/wp-content/uploads/2023/01/12-ANAC-Mercado-Automotor-Diciembre-2022dmb.pdf.

14 Asociación Automotriz del Perú (AAP), 2021, "Informe del Sector Automotor a Diciembre 2021", https://aap.org.pe/informes-estadisticos/diciembre-2021/Informe-Diciembre-2021.pdf; AAP, 2023, "Informe del Sector Automotor Diciembre 2022", https://aap.org.pe/informes-estadisticos/diciembre-2022/Informe-Diciembre-2022.pdf.

15 Abraciclo, 2022, "Dados do Sector", https://www.abraciclo.com.br/site/wp-content/uploads/2022/08/Abraciclo-Dados-do-Setor-2022-1.pdf

16 Abraciclo, 2022, "Dados do Sector", https://www.abraciclo.com.br/site/wp-content/uploads/2022/08/Abraciclo-Dados-do-Setor-2022-1.pdf; Expansión Datosmacro.com, "Matriculaciones de vehículos nuevos" https://datosmacro.expansion.com/negocios/matriculaciones-vehiculos?dr=2020-12, accessed 7 June 2023.

17 Andemos, 2021, "Informe Interactivo Sector Automotor", https://lookerstudio.google.com/reporting/ceb8deeb-3b00-4e08-8536-5a0f2ebb5cf2/page/p_hv0oqzkfoc.

18 Google, "Environmental Insights Explorer," https://insights.sustainability.google, accessed 1 March 2023.

19 Google, "Environmental Insights Explorer", https://insights.sustainability.google, accessed 1 March 2023.

20 UN-Habitat, 2023, "Urban Indicators Database", https://data.unhabitat.org/pages/urban-transport, accessed 7 March 2023.

21 UN-Habitat, 2023, "Urban Indicators Database", https://data.unhabitat.org/pages/urban-transport, accessed 7 March 2023.

22 International Association of Public Transport (UITP), 2022, "World Metro Figures 2021", https://cms.uitp.org/wp/wp-content/uploads/2022/05/Statistics-Brief-Metro-Figures-2021-web.pdf.

23 **Figure 2** from Apple Mobility Dataset, https://github.com/ActiveConclusion/COVID19_mobility, accessed 13 August 2022.

24 Ibid.

25 Google, op. cit. note 19.

26 Ibid.

27 Organisation for Economic Co-operation and Development, "OECD Statistics", https://stats.oecd.org, accessed 10 February 2023.

28 Ibid.

29 Associação Nacional das Empresas de Transportes Urbanos (NTU), 2022, "Anuário NTU: 2021-2022, Brasilia", https://www.ntu.org.br/novo/upload/Publicacao/Pub637956588268708311.pdf.

30 Ibid.

31 UITP, 2022, "New Guadalajara BRT Provides 170,000 with Sustainable Mobility", https://www.uitp.org/news/new-guadalajara-brt-provides-170000-with-sustainable-mobility; Primicias, 2023, "La fecha de inicio de operación del Metro de Quito vuelve a ser incierta", https://www.primicias.ec/noticias/sociedad/metro-quito-pruebas-pasajeros-trenes; Metro de Panama, 2023, "Todo listo para la puesta en operación del Ramal Línea 2", https://www.elmetrodepanama.com/todo-listo-para-la-puesta-en-operacion-del-ramal-linea-2; El Heraldo de México, 2022, "Línea 2 de Cablebús transporta a más de 23 millones de personas durante el 2022", https://heraldodemexico.com.mx/nacional/2022/12/27/linea-de-cablebus-transporta-mas-de-23-millones-de-personas-durante-el-2022-469152.html; M. Mora, 2022, "Tren Metropolitano, uno de los sistemas de transporte más modernos del país en Cochabamba", Bolivia.com, https://www.bolivia.com/actualidad/nacionales/tren-metropolitano-transporte-mas-moderno-cochabamba-366819.

32 World Resources Institute (WRI), Global Environment Facility (GEF) and IDB, 2020, "Informal and Semiformal Services in Latin America: An Overview of Public Transportation Reforms", http://dx.doi.org/10.18235/0002831.

33 N. Morales-Miranda et al., eds., 2021, "Enciclopedia del Transporte Informal en América Central. Centro para la Sostenibilidad Urbana & Agile City Partners: San José, Costa Rica", https://cpsurbana.org/documentos-y-publicaciones.

34 WRI, GEF and IDB, op. cit. note 32.

35 T. Calnek-Sugin and C. Heeckt, "Mobility for the Masses: The Essential Role of Informal Transport in the COVID-19 Recovery", London School of Economics and Political Science, https://www.lse.ac.uk/cities/publications/blogs/mobility-for-the-masses, accessed 28 February 2023.

36 Ibid.

37 Morales-Miranda et al., op. cit. note 33.

38 Google, op. cit. note 19.

39 Aliança Bike, 2023, "Venda de bicicletas tem queda de 35% em 2022, em comparação com 2021", https://aliancabike.org.br/venda-bicicletas-2022.

40 Ibid.

41 Aliança Bike, 2023, "Em crescimento sustentado, mercado de bicicletas elétricas bate recorde com 44,8 mil unidades e R$ 304 milhões em 2022", https://aliancabike.org.br/mercado-eletricas-2023.

42 IDB, op. cit. note 11.

43 Ibid.

44 L. Nieva, 2020, "Projeto +Bike se despede de Brasília", Jornal de Brasília, https://jornaldebrasilia.com.br/brasilia/projeto-bike-se-despede-de-brasilia; Correio Braziliense, 2021, "DF terá novo sistema de bicicletas compartilhadas a partir da próxima semana", https://www.correiobraziliense.com.br/cidades-df/2021/10/4954209-df-tera-novo-sistema-de-bicicletas-compartilhadas-a-partir-de-segunda-feira.html.

45 R. Nagashima, 2021, "Projeto de bicicletas compartilhadas é inaugurado em Brasilia", Correio Braziliense, https://www.correiobraziliense.com.br/cidades-df/2021/10/4954738-projeto-de-bicicletas-compartilhadas-e-inaugurado-em-brasilia.html.

46 Ibid.

47 Secretaría Distrital de Movilidad de Bogotá, 2022, "Semana de la Bici llega recargada: podrás pedalear en las bicis compartidas", https://bogota.gov.co/mi-ciudad/movilidad/semana-de-la-bici-en-bogota-inicia-sistema-de-bicicletas-compartidas.

48 Ibid.; Alcaldía de Bogotá, 2022, "Comienza a operar el Sistema de #BicisCompartidas de Bogotá", https://www.youtube.com/watch?v=EFQg-Z1e0zWo.

49 Alcaldía de Bogotá, op. cit. note 48.

50 S. Navarrete, 2022, "Rodrigo Díaz: La CDMX tiene todo para ser una capital ciclista", Expansión Política, https://politica.expansion.mx/cdmx/2022/07/05/nuevas-ecobici-cdmx-capital-ciclista-rodrigo-diaz-entrevista.

51 La Capital, 2023, "Programa MI bici Tu bici: Rosario se transforma en la primera ciudad en sumar bicicletas para chicos", https://www.lacapital.com.ar/la-ciudad/programa-mi-bici-tu-bici-rosario-se-transforma-la-primera-ciudad-sumar-bicicletas-chicos-n10059827.html.

52 Cadena 3, 2023, ""Mi Bici Tu Bici" se agranda para los más chicos", https://www.cadena3.com/noticia/siempre-juntos-rosario/mi-bici-tu-bici-se-agranda-para-los-mas-chicos_356231.

53 IDB, 2021, "Logisitics in Latin America and the Caribbean: Opportunities, Challenges and Courses of Action", http://dx.doi.org/10.18235/0003278.

54 IDB, 2020, "El transporte automotor de cargas en América Latina", http://dx.doi.org/10.18235/0002216; IDB, op. cit. note 53.

55 IDB, op. cit. note 54.

56 IDB, op. cit. note 53.

57 Ibid.

58 Despacio, 2023, "Prácticas de Bicilogística en América Latina", ICLEI-Local Governments for Sustainability, https://www.despacio.org/portfolio/practicas-de-bicilogistica-en-america-latina.

59 Transformative Urban Mobility Initiative (TUMI), 2021, "TUMI Challenge Fortaleza: Waste Pickers Start Using Electric Tricycles", https://www.transformative-mobility.org/news/tumi-challenge-fortaleza-waste-pickers-start-using-electric-tricycles.

60 G.S Laverde (2020), " Bicicarga, para hacer eficiente y sostenible la distribución de carga en Bogotá", Bogota Transport Commission, 9 December https://bogota.gov.co/mi-ciudad/movilidad/bicicarga-eficiente-y-sostenible-la-distribucion-de-carga-en-bogota

61 Despacio, op. cit. note 58; La Capital, 2022, "Rosario lanzó el nuevo sistema de bicis para el traslado de paquetería en el centro", https://www.lacapital.com.ar/la-ciudad/rosario-lanzo-el-nuevo-sistema-bicis-el-traslado-paqueteria-el-centro-n10031849.html.

62 Values differ from the 2nd edition of the SLOCAT Transport and Climate Change Global Status Report – 2nd edition as the most recent datasets use updated historic data.

63 SLOCAT calculations based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

64 Ibid.

65 Ibid.

66 Ibid.

67 Ibid.

68 Ibid.

69 Ibid.

70 Ibid.

71 SLOCAT, 2021, "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", www.tcc-gsr.com.

72 C. Barría, 2022, "Cómo subsidian la gasolina los paises de América Latina (y por qué es un tema tan controvertido", BBC News, https://www.bbc.com/mundo/noticias-62963924.

73 UN ECLAC, op. cit. note 3.

74 Global Petrol Prices, "Gasoline Prices", https://www.globalpetrolprices.com/gasoline_prices, accessed 6 February 2023; Global Petrol Prices, "Diesel Prices", https://www.globalpetrolprices.com/diesel_prices, accessed 5 February 2023.

75 Gobierno de Chile, "Chile Apoya Plan de Recuperación Inclusiva", https://www.gob.cl/chileapoya, accessed 9 February 2023; Gobierno de Chile, 2020, "Chile Apoya: Plan de Recuperación Inclusiva", https://hdl.handle.net/11626/18589.

76 Ministerio de Economía y Finanzas del Gobierno de Perú, 2022, "Exoneración del ISC e inclusión al FEPC del diésel y gasolinas de 84 y 90 octanos permitió atenuar el alza en el precio de estos productos Plataforma digital única del Estado Peruano", https://www.gob.pe/institucion/mef/noticias/608359-%20exoneracion-del-isc-e-inclusion-al-fepc-del-diesel-y-gasolinas-de-84-y-90-octanos-permitio-atenuar-el-alza-en-el-precio-de-estos-productos.

77 SLOCAT calculations based on Ibid.

78 J. Royo Gual, 2022, "Brasil registra una deflación del 0,68% en julio gracias una bajada del precio de los combustibles", El Pais, https://elpais.com/economia/2022-08-09/brasil-registra-una-deflacion-del-068-en-julio-gracias-una-bajada-del-precio-de-los-combustibles.html.

79 SLOCAT calculations based on SWI Swissinfo.ch, 2022, "Congreso brasileño aprobó ley que reduce impuesto para frenar inflación", https://www.swissinfo.ch/spa/brasil-impuestos_congreso-brasile%C3%B1o-aprob%C3%B3-ley-que-reduce-impuesto-para-frenar-inflaci%C3%B3n/47674832.

80 J.M. León Cabrera and M. Janetsky, 2022, "Protestas en Ecuador por el aumento de precios de combustibles y alimentos", New York Times, https://www.nytimes.com/es/2022/06/24/espanol/ecuador-protestas.html.

81 Los Angeles Times, 2022, "Panamá: Fijan precio de gasolina en diálogo por protestas", https://www.latimes.com/espanol/internacional/articulo/2022-07-18/panama-fijan-precio-de-gasolina-en-dialogo-por-protestas.

82 León Cabrera and Janetsky, op. cit. note 80; Los Angeles Times, op. cit. note 81.

83 International Energy Agency (IEA), 2023, "Global EV Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

84 International Energy Agency (IEA), 2023, "Global EV Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

85 Statista, "América Latina: venta de vehículos ligeros eléctricos 2021, por país", https://es.statista.com/estadisticas/1181574/registros-vehiculos-ligeros-electricos-america-latina-pais, accessed 2 March 2023.

86 Ministerio de Ambiente y Energía de Costa Rica, "Vehículos eléctricos en Costa Rica", https://energia.minae.go.cr/?p=5634, accessed 2 March 2023.

87 W. Herrera, 2023, "¡Récord! Más del 10% de vehículos registrados en diciembre fueron eléctricos en Costa Rica", La República, https://www.larepublica.net/noticia/record-latinoamerica-no-mas-del-10-de-vehiculos-registrados-en-diciembre-fueron-electricos-en-costa-rica.

88 Andemos Asociación Nacional de Movilidad Sostenible, 2022, "Anuario del sector automotor Colombia 2022", https://www.andemos.org/_files/ugd/d1a7a0_07a05a53825b402b9b332a7869aeb69d.pdf.

89 E-Bus Radar, "Electric Buses in Latin America", https://www.ebusradar.org, accessed April 2023.

90 Ibid.

91 Ibid.

92 Ibid.

93 New Energy, 2022, "Barbados Adds 14 Electric Buses to Their Fleet", https://newenergyevents.com/barbados-adds-14-electric-buses-to-their-fleet.

94 Proyecto Moves, 2022, "Hacia la movilidad eficiente y sostenible en Uruguay – Logros obtenidos, lecciones aprendidas y líneas de trabajo a futuro", https://moves.gub.uy/download/proyecto-moves-hacia-la-movilidad-eficiente-y-sostenible-en-uruguay.

95 Pan American Health Organization, 2022, "Mexico's New Mobility and Road Safety Law Could Be a Game-changer", https://www.paho.org/en/news/1-5-2022-mexicos-new-mobility-and-road-safety-law-could-be-game-changer.

96 Ministerio de Transportes y Telecomunicaciones de Chile, 2021, "Estrategia Nacional de Movilidad Sostenible (EMS)", https://www.subtrans.gob.cl/wp-content/uploads/2021/12/documento-ENMS-2-1.pdf.

97 Programa EUROCLIMA+, Proyecto Movés and REDES Planejamento e Política Pública, 2021, "Guía para la planificación de la movilidad urbana sostenible en Uruguay", https://www.euroclima.org/en/idiomas/guia-de-planificacion-de-la-movilidad-urbana-sostenible-en-uruguay/viewdocument/339.

98 Comisión Europea, Ministerio de Transporte de Colombia and Universidad EAFIT, 2022, "Estrategia Nacional de Movilidad Activa con enfoque de género y diferencial – ENMA", https://www.euroclima.org/seccion-publicaciones/tipo-de-documentos/estudios-publicaciones-2/estrategia-nacional-de-movilidad-activa-con-diferencia-de-genero-y-diferencial-de-colombia/viewdocument/477.

99 Ministerio de Transporte de Colombia, 2022, "Ministerio de Transporte presenta la Estrategia Nacional de Movilidad Activa para promover modos de transporte donde el desplazamiento depende de la energía de las personas", https://www.mintransporte.gov.co/publicaciones/11052/ministerio-de-transporte-presenta-la-estrategia-nacional-de-movilidad-activa-para-promover-modos-de-transporte-donde-el-desplazamiento-depende-de-la-energia-de-las-personas.

100 Changing Transport, "Ambato Presents Its SUMP to Move Towards Sustainable Mobility", https://changing-transport.org/mobility-sump-amabato, accessed January 2023; Gobierno Regional de Antofagasta Chile, 2022, "Antofagasta finaliza el diseño técnico de su Plan de Movilidad Urbana Sostenible (PMUS)", https://www.goreantofagasta.cl/antofagasta-finaliza-el-diseno-tecnico-de-su-plan-de-movilidad-urbana/goreantofagasta/2022-06-22/151013.html; Globo, 2022, "Plano Regional de Mobilidade e Logística da Baixada Santista é apresentado em audiência pública", https://g1.globo.com/sp/santos-regiao/noticia/2022/12/09/plano-regional-de-mobilidade-e-logistica-da-baixada-santista-e-apresentado-em-audiencia-publica.ghtml; Programa EUROCLIMA+, 2022, "La Habana presenta su Plan de Movilidad Urbana Sostenible", https://www.euroclima.org/contact-9/noticia-urbano/1741-cierre-proyecto-habana-movilidad-sostenible; Gobierno de Perú, 2021, "MPT presentó plan de movilidad urbana sostenible de trujillo al 2030", https://www.gob.pe/institucion/munitrujillo/noticias/546934-mpt-presento-plan-de-movilidad-urbana-sostenible-de-trujillo-al-2030.

101 EUROCLIMA, "Movilidad urbana", https://www.euroclima.org/movilidad, accessed February 2023; Autoridad de Transporte Urbano para Lima y Callao, 2022, "ATU presenta al equipo técnico a cargo de la ejecución del Plan de Movilidad Urbana 2022-2042 de Lima y Callao", Plataforma digital única del Estado Peruano, https://www.gob.pe/institucion/atu/noticias/675133-atu-presenta-al-equipo-tecnico-a-cargo-de-la-ejecucion-del-plan-de-movilidad-urbana-2022-2042-de-lima-y-callao.

102 Presidência da República, 2020, "LEI N- 14.000, DE 19 DE MAIO DE 2020", http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2020/Lei/L14000.htm#art1.

103 Ministério da Integração e do Desenvolvimento Regional, 2023, "Levantamento sobre a situação dos Planos de Mobilidade Urbana", https://www.gov.br/mdr/pt-br/assuntos/mobilidade-e-servicos-urbanos/planejamento-da-mobilidade-urbana/levantamento-sobre-a-situacao-dos-planos-de-mobilidade-urbana.

104 Ministerio de Transporte, 2020, "Mintransporte reglamenta Planes de Movilidad Sostenible y Segura para los Municipios, Distritos y Áreas Metropolitanas", https://mintransporte.gov.co/publicaciones/9134/mintransporte-reglamenta-planes-de-movilidad-sostenible-y-segura-para-los-municipios-distritos-y-areas-metropolitanas.

105 Municipalidad de San Isidro, 2021, "Ley de movilidad peatonal N° 9976", https://www.munisanisidro.go.cr/index.php/novedades/noticias/789-ley-de-movilidad-peatonal-n-9976.

106 Área Metropolitana del Valle de Aburrá, 2021, "Primera zona urbana de aire protegido en Colombia", https://www.metropol.gov.co/Paginas/Noticias/primera-zona-urbana-de-aire-protegido-en-colombia.aspx.; ITDP, 2023 , "What is a Low Emission Zone?", 22 February, https://www.itdp.org/2023/02/22/what-is-a-low-emission-zone/

107 Área Metropolitana del Valle de Aburrá, 2021, "Primera zona urbana de aire protegido en Colombia", https://www.metropol.gov.co/Paginas/Noticias/primera-zona-urbana-de-aire-protegido-en-colombia.aspx.

108 Rio Prefeitura, 2022, "Prefeitura lança Distrito de Baixa Emissão no Centro para melhorar a qualidade de vida da população", https://prefeitura.rio/fazenda/prefeitura-lanca-distrito-de-baixa-emissao-no-centro-para-melhorar-a-qualidade-de-vida-da-populacao.

109 Ministerio de Economía Gobierno de Argentina, "Etiqueta vehicular", https://www.argentina.gob.ar/economia/energia/eficiencia-energetica/etiqueta-vehicular, accessed 7 March 2023.

110 Secretaría de Ambiente de Bogotá, "Piloto de etiquetado: herramienta para clasificar ambientalmente los vehículos, según cuánto emiten", https://www.ambientebogota.gov.co/es/noticias-de-ambiente1/-/asset_publisher/CWsNLtoGa4f6/content/etiquetado-vehicular-ambiental-conozca-todo-sobre-su-implementacion, accessed 7 March 2023

111 L. Gellweiler, 2022, "Cycling Infrastructure in Cities: Bogotá's Ambitious Bicycle Network Expansion", TUMI, https://www.transformative-mobility.org/news/cycling-infrastructure-in-cities-bogot%C3%A1s-ambitious-bicycle-network-expansion.

112 Municipalidad de Lima (2021), " Firmamos acuerdo con la Cooperación Financiera Alemana para ejecutar 114 km de ciclovías ", Facebook Live, 29 November, https://www.facebook.com/MuniLima/videos/434642554819198; andina (2021), "Lima Metropolitana: construirán 114 km de ciclovías con una inversión de 20 mllns de euros", 29 November, https://andina.pe/agencia/noticia-lima-metropolitana-construiran-114-km-ciclovias-una-inversion-20-mllns-euros-871422.aspx.

113 Gobierno de la Ciudad de Mexico, 2022, "Duplicamos el número de ciclovías 26 September, https://gobierno.cdmx.gob.mx/noticias/duplicamos-el-numero-de-ciclovias.

114 El Financiero, 2019, "CDMX planea tener una red de ciclovías de 600 kilómetros", https://www.elfinanciero.com.mx/nacional/cdmx-planea-tener-una-red-de-ciclovias-de-600-kilometros; S. Navarrete, 2022, "Rodrigo Díaz: La CDMX tiene todo para ser una capital ciclista", Expansión Política, https://politica.expansion.mx/cdmx/2022/07/05/nuevas-ecobici-cdmx-capital-ciclista-rodrigo-diaz-entrevista.

115 Gobierno de la Ciudad de Buenos Aires, "Alcanzar 300 km de ciclovías y 1.000.000 de viajes diarios en bici", https://buenosaires.gob.ar/compromisos/alcanzar-300-km-de-ciclovias-y-1000000-de-viajes-diarios-en-bici, accessed February 2023.

116 Rio Prefeitura, 2023, "Prefeitura lança Plano de Expansão Cicloviária da cidade", https://prefeitura.rio/cidade/prefeitura-lanca-plano-de-expansao-cicloviaria-da-cidade.

117 Ministerio de Bienes Nacionales – Ministerio de Transportes y Telecomunicaciones, "Ciclovías", https://ciclovias.visorterritorial.cl, accessed 28 April 2023; Ministerio de Transportes y Telecomunicaciones, 2021, https://www.mtt.gob.cl/archivos/28458

118 Ministerio de Bienes Nacionales – Ministerio de Transportes y Telecomunicaciones, "Ciclovías", op. cit. note 117.

119 E. Russel, 2022, "Chile Passes Energy Storage, Electromobility Bill", Argus Media, https://www.argusmedia.com/es/news/2382343-chile-passes-energy-storage-electromobility-bill.

120 Ibid.

121 A. Portaluppi, 2022, "Histórico: Guatemala aprueba ley de incentivos a la movilidad eléctrica", Portal Movilidad, https://portalmovilidad.com/historico-guatemala-aprueba-ley-de-incentivos-a-la-movilidad-electrica.

122 Portal Movilidad, 2022, "Con nueva ley Costa Rica premia a vehículos eléctricos aplicando más incentivos", https://portalmovilidad.com/con-nueva-ley-costa-rica-premia-a-vehiculos-electricos-aplicando-mas-incentivos; Presidencia de Costa Rica, 2022, "Ejecutivo firma ley de incentivos de transporte verde", https://www.presidencia.go.cr/comunicados/2022/05/ejecutivo-firma-ley-de-incentivos-de-transporte-verde.

123 J. González, "Claves de la nueva Ley de Movilidad Eléctrica en Panamá", Latam Mobility, https://latamobility.com/claves-de-la-nueva-ley-de-movilidad-electrica-en-panama, accessed February 2023.

124 Agencia de Información Paraguaya, 2022, "Paraguay valida plan maestro para movilidad eléctrica en transporte público y logístico", https://www.ip-.gov.py/ip/paraguay-valida-plan-maestro-para-movilidad-electrica-en-transporte-publico-y-logistico.

125 Programa Euroclima+, 2022, "Uruguay presenta la Guía de Movilidad Urbana Eléctrica", https://www.euroclima.org/contact-9/noticia-urbano/1679-uruguay-presenta-guia-movilidad-urbana-electrica.

126 Montevideo Portal, 2022, "Gobierno subsidiará con US$ 500.000 compra de vehículos eléctricos en sector transporte", https://www.montevideo.com.uy/Noticias/Gobierno-subsidiara-con-US-500-000-compra-de-vehiculos-electricos-en-sector-transporte-uc835947.

127 IEA, 2023, "Global EV Data Explorer", https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

128 Ministerio de Energía Gobierno de Chile, 2021, "Estrategia Nacional de Electromovilidad 2021", https://energia.gob.cl/sites/default/files/documentos/estrategia_nacional_de_electromovilidad_2021_0.pdf.

129 J. González, "Claves de la nueva Ley de Movilidad Eléctrica en Panamá", Latam Mobility, https://latamobility.com/claves-de-la-nueva-ley-de-movilidad-electrica-en-panama, accessed February 2023.

130 TUMI, "Deep Dive City Curitiba", https://www.transformative-mobility.org/campaigns/curitiba, accessed January 2023.

131 TUMI, "Rio Fact Sheet", https://www.transformative-mobility.org/assets/publications/Tumi_Rio_Factsheet.pdf, accessed January 2023.

132 C. Hampel, 2022, "Sao Paulo Forbids the Purchase of Diesel Buses", Electrive, https://www.electrive.com/2022/12/06/sao-paulo-forbids-the-purchase-of-diesel-buses.

133 F. Hernández, 2023, "¿Cuándo iniciará operaciones el Transmetro Eléctrico en la zona 5?" SOY502, https://www.soy502.com/articulo/cuando-iniciara-operaciones-transmetro-electrico-zona-5-24039; O. García and A. Domínguez, 2022, "Cómo funcionará la Línea 5 del Transmetro con buses eléctricos y a cuántos usuarios se pretende beneficiar", Prensa Libre, https://www.prensalibre.com/ciudades/guatemala-ciudades/como-funcionara-la-linea-5-del-transmetro-con-buses-electricos-y-a-cuantos-usuarios-se-pretende-beneficiar-breaking.

134 A. Carrillo, 2022, "Copec construirá y energizará en Antofagasta el primer terminal de buses eléctricos fuera de Santiago", Diario Sustentable, https://www.diariosustentable.com/2022/11/copec-construira-y-energizara-en-antofagasta-el-primer-terminal-de-buses-electricos-fuera-de-santiago.

135 El Heraldo de México, 2022, "Línea 2 de Cablebús transporta a más de 23 millones de personas durante el 2022", https://heraldodemexico.com.mx/nacional/2022/12/27/linea-de-cablebus-transporta-mas-de-23-millones-de-personas-durante-el-2022-469152.html.

136 D. Santiago, 2022, "Línea 3 del Cablebús en CDMX: estaciones, ruta y cuándo se inaugural", Expansión Política, https://politica.expansion.mx/cdmx/2022/11/01/linea-3-cablebus-cdmx-ruta-estaciones.

137 M. Mora, 2022, "Tren Metropolitano, uno de los sistemas de transporte más modernos del país en Cochabamba", Bolivia.com, https://www.bolivia.com/actualidad/nacionales/tren-metropolitano-transporte-mas-moderno-cochabamba-366819.

138 H. Escamilla, 2022, "Fase 2 de la Línea 4 del Tren Ligero inicia esta semana, confirma gobierno de Jalisco", publimetro, https://www.publimetro.com.mx/jalisco/2022/12/14/linea-4-del-tren-ligero-inicia-su-fase-2-esta-semana; Líneas del Metro de Todo México, "Líneas del Metro en Guadalajara", https://lineasdelmetro.com.mx/guadalajara, accessed February 2023.

139 Programa EUROCLIMA+, 2022, "Llegan los tuc tucs eléctricos a San Juan Comalapa, Guatemala", https://www.euroclima.org/contact-9/noticia-urbano/1683-tuc-tucs-electricos-llegan-san-juan-comalapa-guatemala.

140 D. García Pedraza, 2023, "Metro de Bogotá: Así son los otros transportes masivos de América Latina", Latin American Post, https://latinamericanpost.com/es/43285-metro-de-bogot-as-son-los-otros-transportes-masivos-de-amrica-latina; BRT + Center of Excellence and EMBARQ, "Global BRT Data", https://brtdata.org, accessed 22 December 2022.

141 UITP, 2022, "New Guadalajara BRT provides 170,000 with sustainable mobility", https://www.uitp.org/news/new-guadalajara-brt-provides-170000-with-sustainable-mobility.

142 Primicias, 2023, "La fecha de inicio de operación del Metro de Quito vuelve a ser incierta", https://www.primicias.ec/noticias/sociedad/metro-quito-pruebas-pasajeros-trenes, accessed 23 January 2023.

143 Metro de Panama, 2023, "Todo listo para la puesta en operación del Ramal Línea 2", https://www.elmetrodepanama.com/todo-listo-para-la-puesta-en-operacion-del-ramal-linea-2.

144 RPP Noticias, 2023, "Línea 2 del Metro: ¿cuáles serán sus estaciones y cuántas ya están listas?" https://rpp.pe/peru/actualidad/linea-2-del-metro-cuales-seran-sus-estaciones-y-cuantas-ya-estan-listas-noticia-1462054.

145 El Colombiano, 2023, "Bogotá va a tener Metro sí o sí en 2028: alcaldesa dice que ya se está ejecutando el contrato", https://www.elcolombiano.com/colombia/metro-de-bogota-estara-para-2028-afirma-alcaldesa-claudia-lopez-JL20181459.

146 Agencia de Sostenibilidad Energética Gobierno de Chile, 2022, "Reporte Giro Limpio 2021", https://www.girolimpio.cl/wp-content/uploads/2022/05/Reporte_publico_GL.pdf.

147 Ministerio de Energía Gobierno de Chile, 2021, "Estrategia Nacional de Electromovilidad 2021", https://energia.gob.cl/sites/default/files/documentos/estrategia_nacional_de_electromovilidad_2021_0.pdf.

148 Ibid.; Agencia de Sostenibilidad Energética Gobierno de Chile, op. cit. note 146.

149 Ministerio de Economía Gobierno de Argentina, 2021, "Argentina y Chile armonizarán los programas Transporte Inteligente y Giro Limpio", https://www.argentina.gob.ar/noticias/argentina-y-chile-armonizaran-los-programas-transporte-inteligente-y-giro-limpio.

150 Agencia de Sostenibilidad Energética Gobierno de Chile, op. cit. note 146.

151 Secretaría de Medio Ambiente y Recursos Naturales Gobierno de Mexico, 2022, "Programa Transporte Limpio", https://www.gob.mx/semarnat/acciones-y-programas/programa-transporte-limpio-190236.

152 SLOCAT, 2022, "Climate Strategies for Transport: An Analysis of Nationally Determined Contributions and Long-Term Strategies, October 2022 Update", www.slocat.net/ndcs.

153 Ibid.

154 Ibid.

155 Ibid.

156 Ibid.

157 Ibid.

158 Ibid.

159 Ibid.

160 Ibid.

161 SLOCAT, 2022, "¿Hay coherencia entre las estrategias climáticas y las políticas de transporte? El caso de América Latina y el Caribe para los niveles nacional y subnacional", https://slocat.net/ndcs-lts-lac.

162 Asociación Sustentar, 2022, "Mapeo de necesidades, prioridades, retos e intereses en movilidad sostenible en Latino América y el Caribe", https://asociacionsustentar.org/acciones/cop26-movilidad-sostenible-ymhla-65w5h-9r7fx-m33bb-cy6lk; Asociación Sustentar, 2022, "Análisis de Capacitación Online Disponible en Movilidad Urbana Sostenible", https://asociacionsustentar.org/acciones/cop26-movilidad-sostenible-ymhla-65w5h-9r7fx-m33bb; Asociación Sustentar, 2022, "Mapeo de organizaciones e Iniciativas promoviendo la movilidad urbana sostenible en Latino América", https://asociacionsustentar.org/acciones/cop26-movilidad-sostenible-ymhla-65w5h-9r7fx.

163 C40 Cities Finance Facility, https://www.c40cff.org, accessed April 2023.

164 C40 Cities Finance Facility, 2022, "The CFF's New City Portfolio", https://www.c40cff.org/news-and-events/cff-city-portfolio.

165 Programa EUROCLIMA+, "EUROCLIMA+ A flagship programme of the European Union in Latin America", https://www.euroclima.org/en/home-en/about-the-programme, accessed 8 March 2023; Programa EUROCLIMA+, "Urban Mobility", https://

www.euroclima.org/index.php/en/about-mobility/description-urban, accessed 8 March 2023.

166 Programa EUROCLIMA+, "Urban Mobility", op. cit. note 165.

167 GEF, "Global Project to Support Countries with the Shift to Electric Mobility", https://www.thegef.org/projects-operations/projects/10270, accessed April 2023; GEF, 2021, "UN-led Partnership to Accelerate Electric Mobility Shift in 27 Countries", https://www.thegef.org/newsroom/press-releases/un-led-partnership-accelerate-electric-mobility-shift-27-countries.

168 ICLEI–Local Governments for Sustainability, "EcoLogistics", https://iclei.org/ecologistics, accessed 8 March 2023.

169 Ibid.

170 MobiliseYourCity, "About the Partnership", https://www.mobiliseyourcity.net/about_the_partnership, accessed 8 March 2023.

171 MobiliseYourCity, 2023, "MobiliseYourCity New SUMP Guidelines Offer African, Asian and Latin American Cities a Tailored Methodology for Mobility Planning", https://www.mobiliseyourcity.net/mobiliseyourcity-new-sump-guidelines-offer-african-asian-and-latin-american-cities-tailored.

172 Plataforma de Movilidad en Bicicleta de América Latina, "Sobre PLAMOBI", https://www.pla.mobi, accessed 8 March 2023.

173 International Council on Clean Transportation, "Zero Emission Bus Rapid-deployment Accelerator (ZEBRA)", https://theicct.org/initiatives-partnerships/zebra, accessed April 2023.

2.5
NORTH AMERICA REGIONAL OVERVIEW

1 Calculations from the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats, 2018, "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD;

2 US Environmental Protection Agency (EPA), 2023, "Sources of Greenhouse Gas Emissions", https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

3 The White House, 2021, "FACT SHEET: President Biden Renews U.S. Leadership on World Stage at U.N. Climate Conference (COP26)", https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/01/fact-sheet-president-biden-renews-u-s-leadership-on-world-stage-at-u-n-climate-conference-cop26.

4 Government of Canada, 2023, "Canada's Climate Plans and Targets", https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview.html, accessed 16 February 2023.

5 Climate Action Tracker, 2022, "USA", https://climateactiontracker.org/countries/usa, accessed 20 March 2023.

6 Climate Action Tracker, 2022, "Canada", https://climateactiontracker.org/countries/canada, accessed 20 March 2023.

7 US Bureau of Transportation Statistics (BTS), 2023, "U.S. Passenger-Miles (millions)", https://www.bts.gov/content/us-passenger-miles, accessed 10 February 2023.

8 Ibid.

9 US BTS, 2023, "U.S. Ton-Miles of Freight", https://www.bts.gov/content/us-ton-miles-freight, accessed 10 February 2023.

10 Statistics Canada, 2023, "Table 23-10-0057-01 Railway Industry Summary Statistics on Freight and Passenger Transportation", https://doi.org/10.25318/2310005701-eng, accessed 10 February 2023.

11 Ibid.

12 Alternative Fuels Data Center, 2022, "Annual Vehicle Miles Traveled in the United States", https://afdc.energy.gov/data/10315, accessed 15 February 2023.

13 US Census Bureau, 2022, "The Number of People Primarily Working from Home Tripled Between 2019 and 2021", https://www.census.gov/newsroom/press-releases/2022/people-working-from-home.html; US BTS, op. cit. note 7.

14 US Census Bureau, op. cit. note 13.

15 Ibid.

16 US Census Bureau, 2022, "Means of Transportation to Work by Vehicles Available", https://data.census.gov/table?q=transport&tid=ACSDT5Y2019.B08301.

17 International Road Federation (IRF), 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

18 **Figure 1** from International Road Federation (IRF), 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

19 US BTS, 2022, "U.S. Automobile and Truck Fleets by Use", https://www.bts.gov/content/us-automobile-and-truck-fleets-use-thousands; Statistics Canada, 2022, "Table 23-10-0067-01 – Vehicle Registrations, by Type of Vehicle", https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006701.

20 Statistics Canada, 2023, "Table 20-10-0024-01, New Motor Vehicle Registrations, Quarterly", https://doi.org/10.25318/2010002401-eng; Z. Shahan, 2022, "Fully Electric Vehicles Reached ~6% of Auto Sales in USA in 3rd Quarter", CleanTechnica, https://cleantechnica.com/2022/10/13/fully-electric-vehicles-reached-6-of-auto-sales-in-usa-in-3rd-quarter. **Figure 2** from US BTS, 2022, "U.S. Automobile and Truck Fleets by Use", https://www.bts.gov/content/us-automobile-and-truck-fleets-use-thousands; Statistics Canada, 2022, "Table 23-10-0067-01 – Vehicle Registrations, by Type of Vehicle", https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006701.

21 US Department of Energy, Office of Energy Efficiency and Renewable Energy, 2023, "FOTW #1276, February 6, 2023: U.S. New Light-Duty Vehicle Sales Totaled 13.8 million in 2022", https://www.energy.gov/eere/vehicles/articles/fotw-1276-february-6-2023-us-new-light-duty-vehicle-sales-totaled-138.

22 OICA, 2022, "Global Sales Statistics 2019-2021", https://www.oica.net/category/sales-statistics, accessed 20 August 2022.

23 SLOCAT, 2021, "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", www.tcc-gsr.com.

24 Alternative Fuels Data Center, 2022, "Light-Duty AFV, HEV, and Diesel Model Offerings by Technology/Fuel", https://afdc.energy.gov/data/10303, accessed 15 February 2023.

25 D. Mihalascu, 2023, "EVs Made Up 5.6 Percent of US Car Market in 2022 Driven by Tesla", InsideEVs, https://insideevs.com/news/653395/evs-made-up-5point6-percent-of-overall-us-car-market-in-2022-driven-by-tesla.

26 Ibid.

27 Statistics Canada, op. cit. note 20.

28 US Energy Information Administration (EIA), 2023, "Annual Energy Outlook 2023", https://www.eia.gov/outlooks/aeo/narrative/index.php.

29 International Energy Agency (IEA), 2022, "By 2030 EVs Represent More Than 60% of Vehicles Sold Globally, and Require an Adequate Surge in Chargers Installed in Buildings", https://www.iea.org/reports/by-2030-evs-represent-more-than-60-of-vehicles-sold-globally-and-require-an-adequate-surge-in-chargers-installed-in-buildings.

30 Ibid.

31 I. Boudway, 2022, "America's Best-Selling Electric Vehicles Ride on Two Wheels", Bloomberg, https://www.bloomberg.com/news/articles/2022-01-21/u-s-e-bike-sales-outpaced-electric-cars-in-2021.

32 N. Johnson, D. Fitch-Polse and S. Handy, 2023, "Impacts of E-bike Ownership on Travel Behavior: Evidence from Three Northern California Rebate Programs", National Center for Sustainable Transportation, University of California at Davis, https://escholarship.org/uc/item/5kb4b8jx.

33 T. Stewart, 2023, "Overview of Motor Vehicle Traffic Crashes in 2021", National Highway Traffic Safety Administration, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813435.

34 Ibid.

35 Governors Highway Safety Association, 2021, "Pedestrian Traffic Facilities by State", https://www.ghsa.org/sites/default/files/2021-03/Ped%20Spotlight%202021%20FINAL%203.23.21.pdf.

36 P. Gwam, 2021, "More and More American Pedestrians Are Dying Because of Larger Vehicles. Incorporating Data in Safety Regulations Can Help", Urban Wire, https://www.urban.org/urban-wire/more-and-more-american-pedestrians-are-dying-because-larger-vehicles-incorporating-data-safety-regulations-can-help.

37 International Association of Public Transport (UITP), 2022, "World Metro Figures, 2021", https://cms.uitp.org/wp/wp-content/uploads/2022/05/Statistics-Brief-Metro-Figures-2021-web.pdf, accessed 20 March 2023.

38 Ibid.

39 Financial Times, 2022, "Rising Petrol Prices Drive Americans on to Public Transport", https://www.ft.com/content/75d435fc-3e40-41b6-b4f0-0bf74321617a.

40 Ibid.

41 Ibid.

42 US EIA, 2023, "U.S. Regular All Formulations Retail Gasoline Prices", https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epmr_pte_nus_dpg&f=m, accessed 20 March 2023.

43 Australian Institute of Petroleum, 2022, "International Price Comparisons", https://www.aip.com.au/pricing/international-prices/international-price-comparisons, accessed 16 February 2023.

44 Shared-Use Mobility Center, 2022, "The State of Shared Mobility in 2021: Highlights from SUMC's Metro Profile Updates", https://sharedusemobilitycenter.org/the-state-of-shared-mobility-in-2021; Shared-Use Mobility Center, 2023, "A Review of Shared Mobility in 2022", https://learn.sharedusemobilitycenter.org/casestudy/a-review-of-shared-mobility-in-2022/#section-bike-share.

45 Ibid.

46 J. Fischer, N. Trisalyn and M. Winters, March 2022, "Changes in the Representativeness of Strava Bicycling Data during COVID-19", *Findings*, https://doi.org/10.32866/001c.33280.

47 K. Kim, M. Schoenberger and G. Rao, 2022, "Russia-Ukraine War Impact on Supply Chains and Inflation", KPMG, https://www.kpmg.us/insights/2022/russia-ukraine-war-impact-supply-chains-inflation.html.

48 M. Lavelle, 2022, "Russia's War in Ukraine Reveals a Risk for the EV Future: Price Shocks in Precious Metals", https://insideclimatenews.org/news/28032022/russias-war-in-ukraine-reveals-a-risk-for-the-ev-future-price-shocks-in-precious-metals.

49 SLOCAT analysis based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

50 Ibid.

51 **Figure 3** from Ibid.

52 Ibid.

53 C. Shirley, 2022, "Emissions of Carbon Dioxide in the Transportation Sector", Congressional Budget Office, https://www.cbo.gov/publication/58861.

54 Ibid.

55 SLOCAT analysis based on Crippa et al., op. cit. note 49.

56 Carbon Monitor, 2023, "CO2 emissions variation (%) – in all sectors", https://carbonmonitor.org/variation, accessed 16 February 2023.

57 IEA, 2021, "Global Energy Review: CO2 Emissions in 2020", https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020; Government of Canada, 2023, "Greenhouse Gas Emissions", https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html.

58 SLOCAT analysis based on Crippa et al., op. cit. note 49.

59 Ibid.

60 Ibid.

61 US EPA, 2022, "Fast Facts on Transportation Greenhouse Gas Emissions, 2020 U.S. Transportation Sector GHG Emissions by Source", https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.

62 Government of Canada, 2022, "Greenhouse Gas Sources and Sinks in Canada: Executive Summary 2022", https://www.canada.ca/en/environment-cli-

mate-change/services/climate-change/green-house-gas-emissions/sources-sinks-executive-summary-2022.html.

63 D.C. Vock, 2022, "Two States Cancel Highway Expansions After Years of Planning", Route Fifty, https://www.route-fifty.com/infrastructure/2022/06/two-states-cancel-highway-expansions-after-years-planning/367771.

64 D. Zipper, 2021, "The Unstoppable Appeal of Highway Expansion", Bloomberg, https://www.bloomberg.com/news/features/2021-09-28/why-widening-highways-doesn-t-bring-traffic-relief; Wikipedia, 2023, "Induced demand", https://en.wikipedia.org/wiki/Induced_demand

65 T. Litman, 2023, "Provincial Policies for Achieving Transportation Emission Reduction Targets: Comments for the BC Clean Transportation Action Plan Consultation Paper", Victoria Transport Policy Institute, https://www.vtpi.org/ppter.pdf.

66 California Air Pollution Control Association, 2021, "Handbook for Analyzing Greenhouse Gas Emission Reductions", www.caleemod.com/handbook/index.html.

67 Office of Governor Gavin Newsom, 2022, "Governor Newsom Signs Sweeping Climate Measures, Ushering in New Era of World-Leading Climate Action", State of California, https://www.gov.ca.gov/2022/09/16/governor-newsom-signs-sweeping-climate-measures-ushering-in-new-era-of-world-leading-climate-action.

68 MoveMinnesota, "A Milestone for Statewide VMT Reduction", https://www.movemn.org/a-milestone-for-statewide-vmt-reduction, accessed 10 June 2023.

69 D. Carlson and Z. Howard, 2010, "Impacts of VMT Reduction Strategies on Selected Areas and Groups", Washington State Department of Transportation, https://www.wsdot.wa.gov/research/reports/fullreports/751.1.pdf.

70 D. Shepardson, 2021, "U.S. Sets Goal of Net-zero Aviation Emissions by 2050", Reuters, https://www.reuters.com/business/cop/us-sets-goal-net-zero-aviation-emissions-by-2050-2021-11-09.

71 C. MilNeil and G. White, 2022, "Mayor Wu Announces Major Expansion of Boston's Bike Network", StreetsBlogMass, https://mass.streetsblog.org/2022/09/06/mayor-wu-plans-announcement-on-bostons-bike-network.

72 Ibid.

73 Government of Canada, 2022, "Active Transportation Fund", https://www.infrastructure.gc.ca/trans/active-actif-eng.html.

74 Openstates, "SB 457, Personal Income Taxes: Credit: Reduction in Vehicles", https://openstates.org/ca/bills/20212022/SB457, accessed 14 February 2023.

75 Ibid.

76 G. Kuntzman, 2021, "IT'S OVER: State's Highest Court Sets Aside Last Challenges to City's 'Right of Way' Law", Streetsblog NYC, https://nyc.streetsblog.org/2021/10/12/its-over-states-highest-court-sets-aside-last-challenges-to-citys-right-of-way-law.

77 Bipartisan Policy Center, 2022, "Inflation Reduction Act (IRA) Summary: Energy and Climate Provisions", https://bipartisanpolicy.org/blog/inflation-reduction-act-summary-energy-climate-provisions.

78 US EIA, op. cit. note 28.

79 US Government, 2021, "The United States' Nationally Determined Contribution, Reducing Greenhouse Gases in the United States: A 2030 Emissions Target", https://unfccc.int/sites/default/files/NDC/2022-06/United%20States%20NDC%20April%2021%202021%20Final.pdf.

80 Bipartisan Policy Center, 2022, "Inflation Reduction Act (IRA) Summary: Energy and Climate Provisions", https://bipartisanpolicy.org/blog/inflation-reduction-act-summary-energy-climate-provisions.

81 Ibid.

82 Ibid.

83 Ibid.

84 Ibid.

85 Y. Freemark, 2022, "What the Inflation Reduction Act Did, and Didn't Do, for Sustainable Transportation", Urban Institute, https://www.urban.org/urban-wire/what-inflation-reduction-act-did-and-didnt-do-sustainable-transportation.

86 M. Mahajan et al., 2022, "Updated Inflation Reduction Act Modeling Using the Energy Policy Simulator", Energy Innovation Policy and Technology LLC, https://energyinnovation.org/wp-content/uploads/2022/08/Updated-Inflation-Reduction-Act-Modeling-Using-the-Energy-Policy-Simulator.pdf.

87 US Federal Highway Administration, 2023, "Bipartisan Infrastructure Law", https://www.fhwa.dot.gov/bipartisan-infrastructure-law.

88 Ibid.; The White House, 2022, "FACT SHEET: Vice President Harris Announces Actions to Accelerate Clean Transit Buses, School Buses, and Trucks", https://www.whitehouse.gov/briefing-room/statements-releases/2022/03/07/fact-sheet-vice-president-harris-announces-actions-to-accelerate-clean-transit-buses-school-buses-and-trucks.

89 The White House, 2021, "FACT SHEET: Historic Bipartisan Infrastructure Deal", https://www.whitehouse.gov/briefing-room/statements-releases/2021/07/28/fact-sheet-historic-bipartisan-infrastructure-deal.

90 The White House, 2021, "FACT SHEET: The Biden-- Harris Electric Vehicle Charging Action Plan", https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan.

91 US Department of Energy, Office of Energy and Renewable Energy, 2022, "The U.S. National Blueprint for Transport Decarbonization: A Joint Strategy to Transform Transportation", https://www.energy.gov/eere/us-national-blueprint-transportation-decarbonization-joint-strategy-transform-transportation.

92 Ibid.

93 Ibid.

94 Ibid.

95 US Department of Transportation, 2022, "Biden-Harris Administration Announces $1.5 Billion Available Through the 2023 RAISE Grant Program", https://www.transportation.gov/briefing-room/biden-harris-administration-announces-15-billion-available-through-2023-raise-grant.

96 Ibid.

97 R.P. Jones, 2021, "Trudeau Pledges Billions in Permanent Funding for Public Transit", https://www.cbc.ca/news/politics/trudeau-transit-fund-1.5908346.

98 C. Carey, 2022, "Vancouver to Quadruple Rapid Transit Network by 2050", CitiesToday, https://cities-today.com/vancouver-to-quadruple-rapid-transit-network-by-2050.

99 City of Boston, 2022, "Free Route 23, 28, and 29 Bus Program", https://www.boston.gov/departments/transportation/free-route-23-28-and-29-bus-program; T. Condon, 2022, "CT Bus Fares Have Been Free Since April 1. Ridership Is Now Exceeding Pre-COVID Totals", Connecticut Public, https://www.ctpublic.org/news/2022-09-27/ct-bus-fares-have-been-free-since-april-1-ridership-is-now-exceeding-pre-covid-totals.

100 J. Brasuell, 2021, "Congestion Pricing Study Taking Shape in Los Angeles", Planetizen, https://www.planetizen.com/news/2021/02/112301-congestion-pricing-study-taking-shape-los-angeles.

101 LA Metro, 2022, "Update on Four Concept Areas Under Study for Traffic Reduction Study", The Source,
https://thesource.metro.net/2022/01/26/update-on-four-concept-areas-under-study-for-traffic-reduction-study.

102 J. Fingas, 2022, "Canada Will Ban Sales of Combustion Engine Passenger Cars by 2035", Engadget, https://www.engadget.com/canada-combustion-engine-car-ban-2035-154623071.html.

103 The White House, 2021, "FACT SHEET: The Biden-Harris Electric Vehicle Charging Action Plan", https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan.

104 T. Tyler, 2023, "Almost Half of Americans Are Ready to Buy an EV in the Next 5 Years", CleanTechnica, https://cleantechnica.com/2023/04/26/almost-half-of-americans-are-ready-to-buy-an-ev-in-the-next-5-years-new-survey-claims.

105 C. Davenport, L. Friedman and B. Plumer, 2022, "California to Ban the Sale of New Gasoline Cars", New York Times, https://www.nytimes.com/2022/08/24/climate/california-gas-cars-emissions.html.

106 A.J. Hawkins, 2021, "California Will Require All Autonomous Vehicles to Be Zero-emission Starting in 2030", The Verge, https://www.theverge.com/2021/9/24/22691410/california-autonomous-vehicles-zero-emission-2030-newsom.

107 D. Shepardson, 2022, "U.S. Approves 50 States' EV Charging Plans", Reuters, https://www.reuters.com/business/autos-transportation/us-approves-50-states-ev-charging-plans-2022-09-27.

108 S. Hanley, 2021, "Petaluma First US City to Ban New Gas Stations", CleanTechnica, https://cleantechnica.com/2021/03/07/petaluma-first-us-city-to-ban-new-gas-stations.

109 R. Bellan, 2022, "General Motors, PG&E Pilot EVs as Backup Power Sources for Homes", TechCrunch, https://techcrunch.com/2022/03/08/general-motors-pge-pilot-evs-as-backup-power-sources-for-homes.

110 K. Wilson, 2022, "US DOT Will Double the Nation's Electric Bus Fleet (But It Will Still Be Tiny)", STREETSBLOGUSA, https://usa.streetsblog.org/2022/08/16/us-dot-seeks-to-double-the-nations-electric-bus-fleet-which-is-currently-tiny-and-will-still-be.

111 Green Car Congress, 2021, "Washington's King County Metro Acquiring 20 Additional New Flyer 60' Battery-Electric Buses", https://www.greencarcongress.com/2021/02/20210203-metro.html.

112 METRO, 2021, "WMATA Targets Zero-Emission Bus Fleet by 2045", https://www.metro-magazine.com/10146254/wmata-targets-zero-emission-bus-fleet-by-2045.

113 L. Sarabia, 2021, "Ottawa to Add 450 Zero-emission Buses to Its Transit Fleet by 2027, Become Fully Electric by 2036", Electric Autonomy, https://electricautonomy.ca/2021/06/08/ottawa-electric-buses.

114 US EPA, 2022, "Final EPA Standards for Heavy-Duty Vehicles to Slash Dangerous Pollution and Take Key Step Toward Accelerating Zero-Emissions Future", https://www.epa.gov/newsreleases/final-epa-standards-heavy-duty-vehicles-slash-dangerous-pollution-and-take-key-step.

115 M. Ngo, 2021, "Amtrak in the Infrastructure Bill: $66 Billion in New Funding, and an Adjusted Mandate", New York Times, https://www.nytimes.com/2021/08/02/us/politics/amtrak-trains-infrastructure.html.

116 Amtrack, 2021, "A Special Infrastructure Bill Update from Amtrack Connect US", https://www.amtrakconnectsus.com/special-infrastructure-bill.html.

117 CALSTART, "About", https://calstart.org/about, accessed 10 June 2023.

118 Environmental Defense Fund, "50+ Years of Big Impact", https://www.edf.org/impact, accessed 10 June 2023.

119 Hewlett Foundation, 2017, "Climate Initiative Strategy 2018-2023", https://hewlett.org/wp-content/uploads/2018/01/Hewlett-Foundation-Climate-Initiative-Strategy-2018-2023.pdf.

120 Institute of Transportation Studies, University of California at Davis, "About Us", https://its.ucdavis.edu/about, accessed 10 June 2023.

121 World Resources Institute (WRI), "North America", https://www.wri.org/north-america, accessed 10 June 2023; WRI, "Urban Mobility", https://www.wri.org/cities/urban-mobility, accessed 10 June 2023.

2.6
OCEANIA REGIONAL OVERVIEW

1 Calculations from the SLOCAT Partnership on Sustainable, Low Carbon Transport based on United Nations (UN), 2022, "World Population Prospects 2022", https://population.un.org/wpp, accessed 21 January 2023; UN Stats, 2018, "2018 Revision of World Urbanization Prospects", https://population.un.org/wup, accessed 28 December 2022; World Bank, 2023, "GDP (constant 2015 US$)", https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

2 Worldometer, "How Many Countries in Oceania?" https://www.worldometers.info/geography/how-many-countries-in-oceania, accessed 10 July 2023.

3 United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2022, "Policy Dialogue on the Opportunities to Reduce Reliance on Imported Fuel for the Pacific Island Countries", https://www.unescap.org/sites/default/d8files/event-documents/Concept%20note_Policy%20Dialogue%20on%20the%20Opportunities%20to%20Reduce%20Reliance%20on%20Imported%20Fuel%20for%20the%20Pacific%20Island%20Countries%20%2821%20June%202022%29_0.pdf.

4 C. Ashleigh, 2019, "In Small Island States, Resilient Transport Is Providing a Lifeline Against Disaster", World Bank, https://www.worldbank.org/en/news/feature/2019/06/11/in-small-island-states-resilient-transport-is-providing-a-lifeline-against-disasters.

5 International Monetary Fund (IMF), 2020, "Pacific Islands Threatened by COVID-19", https://www.imf.org/en/News/Articles/2020/05/27/na-05272020-pacific-islands-threatened-by-covid-19.

6 K. Smithies, 2022, "East Asia and Pacific Economic Recovery Faces Risks from the War in Ukraine, U.S. Monetary Tightening, and China Slowdown", World Bank, 4 April, ; UNESCAP (2022), *The War in Ukraine: Impacts, Exposure and Policy Issues in Asia and the Pacific,* https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP-2022-PB-War-in-Ukraine.pdf

7 New Zealand Ministry of Transport, "Household Travel: How", https://www.transport.govt.nz/statistics-and-insights/household-travel/sheet/how (accessed 12 July)

8 Commonwealth of Australia, 2022, "Australian Infrastructure and Transport Statistics – Yearbook 2022", https://www.bitre.gov.au/sites/default/files/documents/bitre-yearbook-2022.pdf.

9 Ibid.

10 Commonwealth of Australia, op. cit. note 8.

11 New Zealand Ministry of Transport, Household Travel", https://www.transport.govt.nz/statistics-and-insights/household-travel/sheet/how, accessed 20 April 2023.

12 UN-Habitat, "Urban Indicator Database", https://urban-data-guo-un-habitat.hub.arcgis.com/datasets/11-2-1-percentage-access-to-public-transport/explore, accessed 20 April 2023; United Nations (2021), *Sustainable transport, sustainable development,* Interagency report for second Global Sustainable Transport Conference, https://sdgs.un-.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf

13 *ADB (2022), Asian Transport Outlook, TAS-VEP-038, https://data.adb.org/dataset/asian-transport-outlook-database*

14 N. Qicatabua, 2022, "Achieving the Vision Through Integration: A Review for Fiji", Australasian Transport Research Forum, https://australasiantransportresearchforum.org.au/wp-content/uploads/2022/03/2001_Qicatabua.pdf.

15 Asian Development Bank (ADB), 2022, "Asian Transport Outlook", https://data.adb.org/dataset/asian-transport-outlook-database.

16 International Road Federation (IRF), 2022, "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org. **Figure 1** from idem.

17 Ibid.

18 Electric Vehicle Council (2023). 2022 Australian Electric Vehicle Industry Recap. Sydney, NSW. https://electricvehiclecouncil.com.au/wp-content/uploads/2023/02/AUSTRALIAN-ELECTRIC-VEHICLE-INDUSTRY-RECAP-2022.pdf?utm_medium=email&_hsmi=244757313&_hsenc=p2ANqtz--BFyBrzFDz-fANUJOXyAc-SKlBqn9ARCBBcdbeu-WGLxoFeyksh_5iMufPqdLWhh6Cp2byP_UKuPVzFE9VbTGbOU-duz1Lq2qdrVNAtVhdsWc-sFnhg&utm_content=244757313&utm_source=hs_automation

19 Electric Vehicle Council, 2023, "2022 Australian Electric Vehicle Industry Recap. Sydney, NSW", https://electricvehiclecouncil.com.au/wp-content/uploads/2023/02/AUSTRALIAN-ELECTRIC-VEHICLE-INDUSTRY-RECAP-2022.pdf.

20 Ibid.

21 Vehicle Database NZ, "New Zealand's EV Targets", https://evdb.nz/actual-vs-target, accessed 10 March 2023.

22 New Zealand Motor Industry Association, 2023, "Vehicle Sales", https://www.mia.org.nz/DesktopModules/EasyDNNNews/DocumentDownload.ashx?portalid=0&moduleid=842&articleid=1391&documentid=1565.

23 R. Smit and N. Surawski, 2022, "We May Be Underestimating Just How Bad Carbon-belching SUVs Are for the Climate – and for Our Health", The Conversation, https://theconversation.com/we-may-be-underestimating-just-how-bad-carbon-belching-suvs-are-for-the-climate-and-for-our-health-190743; K. Wild and A. Woodward, 2021, "Aggressive Marketing Has Driven the Rise of Utes on New Zealand Streets – Time to Hit the Brakes?" News24, https://www.news24.com/life/motoring/news/aggressive-marketing-has-driven-the-rise-of-utes-on-new-zealand-streets-time-to-hit-the-brakes-20211230-2.

24 P. Joshi et al., 2023, "Advancing Transportation Efficiency and Electric Vehicles in Tonga: A Review of Relevant Trends and Best Practices", National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy23osti/84078.pdf.

25 Ibid.

26 Ibid.; A. Fruean, 2021, "Govt. Reveals Electric Car Strategy", Samoa Observer, https://www.samoaobserver.ws/category/samoa/93435.

27 IMF, op. cit. note 5.

28 T. Schneider et al., 2022, "Pacific Islands Monitor", IMF, https://www.imf.org › Files › small-states-monitor.

29 IMF, op. cit. note 5.

30 Smithies, op. cit. note 6; UNESCAP, op. cit. note 6. https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP-2022-PB-War-in-Ukraine.pdf

31 United Nations Conference on Trade and Development (UNCTAD), 2021, "Transport and Trader Facilitation Series No. 15 COVID-19 and Maritime Transport Impact and Responses", https://unctad.org/system/files/official-document/dtltlb2021d1_en.pdf.

32 Ibid.

33 Ibid.

34 **Figure 2** from SLOCAT analysis based on O. Kulik, 2022, "ActiveConclusion / COVID19_mobility", https://github.com/ActiveConclusion/COVID19_mobility/tree/master/waze_reports, accessed August 2022.

35 T. Pele, 2023, "From Grounded to Takeoff: In-depth Analysis of Air Traffic Recovery After Covid-19 by Regions (2020-2023)", Spire Global, https://spire.com/blog/aviation/air-traffic-recovery-after-covid-19.

36 CAPA Centre for Aviation, 2022, "Mapping Australasia's Rocky Path to Recovery – CAPA Australia Pacific Aviation Summit", https://centreforaviation.com/analysis/reports/mapping-australasias-rocky-path-to-recovery-capa-australia-pacific-aviation-summit-623590.

37 Schneider et al., op. cit. note 28.

38 Republic of Vanuatu and Australian Government, "Vanuatu Transport Sector Support Program", https://www.dfat.gov.au/sites/default/files/vanuatu-transport-sector-support-program-phase-1-design-doc.pdf, accessed 10 March 2023.

39 Ibid.

40 UNESCAP, 2021, "Sustainable Urban Transport Index Report: Greater Suva Area, Fiji", https://www.unescap.org/kp/2021/sustainable-urban-transport-index-suti-report-greater-suva-area-fiji.

41 Ibid.

42 Ibid.

43 Ibid.

44 SLOCAT calculations based on M. Crippa et al., 2022, "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

45 Ibid.

46 P. Laird, 2020, "Transport Is Letting Australia Down in the Race to Cut Emissions", University of Wollongong Australia, https://www.uow.edu.au/media/2020/transport-is-letting-australia-down-in-the-race-to-cut-emissions.php.

47 SLOCAT analysis based on Crippa et al., op. cit. note 44.

48 Ibid.

49 Joshi et al., op. cit. note 24. **Figure 3** from SLOCAT analysis based on Crippa et al., op. cit. note 44.

50 SLOCAT analysis based on Crippa et al., op. cit. note 44.

51 Ibid.

52 Department of Climate Change, Energy, the Environment and Water, Australian Government, 2022, "Australia's Future Fuels and Vehicles Strategy Released", https://www.dcceew.gov.au/about/news/australias-future-fuels-and-vehicles-strategy-released.

53 Department of Climate Change, Energy, the Environment and Water, Australian Government, "National Electric Vehicle Strategy: Consultation Paper", https://consult.dcceew.gov.au/national-electric-vehicle-strategy, accessed 10 March 27023.

54 Department of Climate Change, Energy, the Environment and Water, Australian Government, "Vehicles and Fuels", https://www.energy.gov.au/government-priorities/vehicles-and-fuels.

55 T. Brennan, 2022, "Treasury Law Amendment (Electric Car Discount) Bill 2022", Parliament of Australia, https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/bd/bd2223a/23bd009.

56 Australian Renewable Energy Agency, 2022, "New Funding for ARENA in Federal Budget", https://arena.gov.au/news/new-funding-for-arena-in-federal-budget.

57 Ibid.

58 T. Khan, Z. Yang, A. Sen, and J. Miller (2022), "Fuel efficiency standards to decarbonize Australia's light-duty vehicles", 12 December, ICCT, https://theicct.org/publication/pv-australia-co2-standards-dec22/

59 Ibid.

60 T. Khan et al., 2022, "Fuel Efficiency Standards to Decarbonize Australia's Light-Duty Vehicles", International Council on Clean Transportation, https://theicct.org/publication/pv-australia-co2-standards-dec22.

61 International Energy Agency, 2021, "Fuel Economy in Australia", https://www.iea.org/articles/fuel-economy-in-australia.

62 Australian Government, "Vehicle Emission Standards", https://www.infrastructure.gov.au/infrastructure-transport-vehicles/vehicles/vehicle-safety-environment/emission-standards, accessed 10 March 2023.

63 J. Ardern, M. Wood and J. Shaw, 2021, "Government Moves on Climate Promises", New Zealand Government, https://www.beehive.govt.nz/release/government-moves-climate-promises.

64 New Zealand Government, 2021, "The Clean Car Import Standard – Reducing Vehicle CO2 Emissions to 105 Grams per Kilometre by 2025", https://www.beehive.govt.nz/sites/default/files/2021-01/Clean%20Car%20Import%20Standard%20Explainer_0.pdf.

65 M. Wood and J. Shaw, 2021, "Clean Car Package to Drive Down Emissions", New Zealand Government, https://www.beehive.govt.nz/release/clean-car-package-drive-down-emissions.

66 Joshi et al., op. cit. note 24.

67 World Bank, 2019, "In Small Island States Resilient Transport Is a Lifeline Against Disasters", https://www.worldbank.org/en/news/feature/2019/06/11/in-small-island-states-resilient-transport-is-providing-a-lifeline-against-disasters.

68 World Bank, 2020, "The World Bank Supporting Sustainable Development in Papua New Guinea and the Pacific Islands", https://www.theprif.org/sites/default/files/documents/WBPacificFlyer-June2020.pdf.

69 Ibid.

70 Global Green Growth Institute, "Powering Pacific Green Growth", https://storiesofchange.gggi.org/pacific/index.html, accessed 24 May 2023.

71 Vanuatu ICJ Initiative, 2023, "Port Vila Call for a Just Transition to a Fossil Fuel Free Pacific", https://www.vanuatuicj.com/call.

72 World Bank, 2017, "Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action", https://openknowledge.worldbank.org/entities/publication/7d71d8de-a47d-53c5-901d-3c01d81b0f74.

73 Australian Rail Track Corporation, "What Is Inland Rail", https://inlandrail.artc.com.au/what-is-inland-rail, accessed 10 March 2023.

74 Australian Flying, 2022, "Federal Government to Set Up SAF Council", https://www.australianflying.com.au/latest/federal-government-to-set-up-saf-council.

75 Lanzajet, 2023, "Sustainable Aviation Fuel Readies to Take Flight in Australia", https://www.lanzajet.com/sustainable-aviation-fuel-readies-to-take-flight-in-australia.

76 Department of Climate Change, Energy, the Environment and Water, Australian Government, "Australia's National Hydrogen Strategy", https://www.dcceew.gov.au/energy/publications/australias-national-hydrogen-strategy, accessed 10 March 2023.

77 Transport and Infrastructure Council, 2019, "National Freight & Supply Chain Strategy", https://www.freightaustralia.gov.au/sites/default/files/documents/national-freight-and-supply-chain-strategy.pdf.

78 Ibid.

79 Council Pacific Affairs, 2020, "Pacific Blue Shipping Partnership", https://www.councilpacificaffairs.org/news-media/pacific-blue-shipping-partnership.

80 Ibid.

81 Ibid.

82 Pacific Islands Forum Secretariat, 2022, "2050 Strategy for the Blue Pacific Continent", https://www.forumsec.org/wp-content/uploads/2022/08/PIFS-2050-Strategy-Blue-Pacific-Continent-WEB-5Aug2022.pdf.

83 Australian Government, 2022, "Australian Government Climate Change Commitment, Policies and Programs", https://www.aofm.gov.au/sites/default/files/2022-11-28/Aust%20Govt%20CC%20Actions%20Update%20November%202022_1.pdf.

84 Climateworks Centre, 2022, "Government Climate Action: Leading Policies and Programs in Australia", https://www.climateworkscentre.org/wp-content/uploads/2022/12/Government-climate-action-Australia-Climateworks-Centre-December-2022.pdf.

85 Ibid.

86 **Table 1** from A. Quicke and S. Parrott, 2022, "Next Stop: Zero Emissions Buses by 2030", The Australia Institute, https://australiainstitute.org.au/wp-content/uploads/2022/05/P1229-Next-stop-for-electric-buses-WEB.pdf .

87 Ibid.

88 New Zealand Government, 2022, "Aotearoa New Zealand's first emissions reduction plan, Chapter 10: Transport", https://environment.govt.nz/assets/Emissions-reduction-plan-chapter-10-transport.pdf.

89 Auckland Council, 2022, "The Pathways to Lower Transport Emissions in Auckland", OurAuckland, https://ourauckland.aucklandcouncil.govt.nz/news/2022/08/transport-emissions-reduction-pathway.

90 Transport Projects Wellington City Council, "Bike Network Documents", https://www.transportprojects.org.nz/current/bikenetwork/background-documents, accessed 10 March 2023.

91 S. Wray, 2022, "New Zealand Halves Public Transport Fare Rates as Fuel Prices Soar", Cities Today, https://cities-today.com/new-zealand-halves-public-transport-fares-as-fuel-prices-soar.

92 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and SLOCAT, 2023, "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker.

93 Ibid.

94 Ibid.

95 Regional Pacific NDC Hub, 2022, "Mandate, Vision and Objectives", https://pacificndc.org/our-work/vision-values.

96 Ibid.

97 Asia LEDS Partnership, "About Us", https://asialedspartnership.org/about-us, accessed 23 April 2023.

98 Climateworks Centre, "Our Story", https://www.climateworkscentre.org/our-story, accessed 23 April 2023. UNCTAD, "About UNCTAD", https://unctad.org/about, accessed 20 April 2023.

99 Government of New Caledonia, "The Pacific Island Development Forum (PIDF)", https://cooperation-regionale.gouv.nc/en/cooperation-pacific-cooperation-instances-and-programs/pacific-island-development-forum-pidf, accessed 10 March 2023.

100 Pacific Island Development Forum, 2019, "Resolution for the Observance of the Pacific Decade for Sustainable Transport 2020-2030", https://pidf.int/wp-content/uploads/2017/07/PIDF-Resolution-Pacific-Decade-for-Sustainable-Transport.pdf.

101 UNESCAP, "About ESCAP", https://www.unescap.org/our-work#, accessed 20 April 2023. UNCTAD, op. cit. note 98.

102 UNESCAP, "Subregional Office for the Pacific", https://www.unescap.org/subregional-office/pacific, accessed 20 April 2023.

103 International Association of Public Transport (UITP) Asia-Pacific, "UITP Worldwide", https://www.uitp.org/regions/asia-pacific, accessed 10 March 2023.

104 UITP, 2023, "Transit Oriented Development", https://www.uitp.org/trainings/transit-oriented-development.

105 United Nations Centre for Regional Development "About UNCRD", https://uncrd.un.org/about-uncrd, accessed 23 April 2023.

106 UNCTAD, op. cit. note 98, accessed 23 April 2023.

107 UNCTAD, "United Nations Development Account Projects", https://unctad.org/projects/united-nations-development-account-projects, accessed 23 April 2023.

108 Global Green Growth Institute , op. cit. note 70; UNDP Pacific Office in Fiji, "About Us", https://www.undp.org/pacific/about-us, accessed 10 March 2023.

3.1
INTEGRATED TRANSPORT PLANNING

1 World Bank (2015), "Integrated public transport systems make travel easier and more affordable", 5 April, https://www.worldbank.org/en/news/press-release/2015/04/07/integrated-public-transport-systems-make-travel-easier-and-more-affordable.

2 T. Litman (2007), "Developing indicators for comprehensive and sustainable transport planning", *Transportation Research Record*, Vol. 2017, No. 1, pp. 10-15, https://doi.org/10.3141/2017-02.

3 D. Levinson (2020), "Transport Access Manual: A Guide for Measuring Connection between People and Places", The Committee of the Transport Access Manual, https://transportist.org/2020/12/01/transport-access-manual-a-guide-for-measuring-connection-between-people-and-places.

4 J.P. Rodrigue (2023), "Transportation and Accessibility", The Geography of Transport Systems, https://transportgeography.org/contents/methods/transportation-accessibility, accessed 12 May 2023; P. Roberts and J. Babinard (2004), "Transport Strategy to Improve Accessibility in Developing Countries", World Bank, https://openknowledge.worldbank.org/entities/publication/270277d4-6beb-5926-8ced-d56df80f97b4.

5 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation", Transport and Climate Change Global Status Report – 2nd edition, www.tcc-gsr.com; C. McCahill (2021), "The amount we drive could make or break clean energy plans", State Smart Transportation Initiative, 13 September, https://ssti.us/2021/09/13/the-amount-we-drive-could-make-or-break-clean-energy-plans; A. Milovanoff, I.D. Posen and H.L. MacLean (2020), "Electrification of light-duty vehicle fleet alone will not meet mitigation targets", *Nature Climate Change*, Vol. 10, pp. 1102-1107, https://doi.org/10.1038/s41558-020-00921-7; C. Reid (2021), "Don't despair over climate report's horrors, there are fixes — but electric cars not one of them", Forbes, 8 August, https://www.forbes.com/sites/carltonreid/2021/08/08/dont-despair-over-climate-reports-horrors-there-are-fixes-but-electric-cars-not-one-of-them.

6 SLOCAT, op. cit. note 5; F. Bergk et al. (2016), "Klimaschutzbeitrag des Verkehrs bis 2050", Federal Environment Agency, https://www.umweltbundesamt.de/publikationen/klimaschutzbeitrag-des-verkehrs-bis-2050; H. Liimatainen (2018), "CO2 reduction costs and benefits in transport: Socio-technical scenarios", *European Journal of Futures Research*, Vol. 6, No. 1, pp. 1-12, https://doi.org/10.1186/S40309-018-0151-Y/FIGURES/4.

7 European Commission (2023), "Sustainable Urban Mobility Plans", https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/urban-mobility/urban-mobility-actions/sustainable-urban-mobility-plans_en, accessed 28 March 2023.

8 G. Ambrosino (2015), "Guidelines: Developing and Implementing a Sustainable Urban Logistics Plan", European Union, https://www.eltis.org/sites/default/files/trainingmaterials/enclose_d5_2_sulp_methodology_final_version_0.pdf.

9 O. Lah et al. (2020), "National Urban Mobility Policies & Investment Programmes – Guidelines", MobiliseYourCity Partnership, https://www.international-climate-initiative.com/en/iki-media/publication/national_urban_mobility_policies_and_investment_programmes_nump_guidelines.

10 World Bank (2018), "TOD Implementation Resources and Tools", Global Platform for Sustainable Cities, http://hdl.handle.net/10986/31121.

11 Smart Growth America (2022), "Complete Streets", https://smartgrowthamerica.org/what-are-complete-streets, accessed 5 July 2022.

12 Eurocities (2021), "Low emission zones: Challenges and solutions", 13 October, https://eurocities.eu/latest/low-emission-zones-challenges-and-solutions.

13 Mobility Lab (2023), "What is Transportation Demand Management?" https://mobilitylab.org/what-is-transportation-demand-management, accessed 15 May 2023; Victoria Transport Policy Institute (2023), "Online TDM Encyclopedia", https://www.vtpi.org/tdm, accessed 15 May 2023.

14 International Road Assessment Programme (iRAP) (2022), "Safe System Approach", https://toolkit.irap.org/management/safe-system-approach, accessed 5 July 2022.

15 Parking Reform Network (2023), "What is parking reform?" https://parkingreform.org/what-is-parking-reform, accessed 15 May 2023.

16 **Table 1** from T. Litman (2023), "Well Measured: Developing Indicators for Sustainable and Livable Transport Planning", Victoria Transport Policy Institute, 23 May, p. 85, https://www.vtpi.org/wellmeas.pdf. For more on indicators, see idem., pp. 22-24.

17 J.P. Rodrigue (2023), "Transportation Modes, Modal Competition and Modal Shift", The Geography of Transport Systems, https://transportgeography.org/contents/chapter5/transportation-modes-modal-competition-modal-shift, accessed 12 May 2023.

18 R. Buehler and J. Pucher (2023), "Overview of walking rates, walking safety, and government policies to encourage more and safer walking in Europe and North America", *Sustainability*, Vol. 15, No. 7, https://doi.org/10.3390/su15075719.

19 Google (2023), "Environmental Insights Explorer", https://insights.sustainability.google, accessed 17 May 2023.

20 **Figure 1** from Ibid.

21 Statista (2023), "Modal share of public transportation in inland passenger transportation in the European Union from 2011 to 2020, by country", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1381193/modal-share-of-public-transportation-by-country, accessed 6 July 2023.

22 Statista (2023), "Overall use of transport for all trips in the United Kingdom", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/300705/overall-use-of-transport-for-all-trips-in-the-united-kingdom, accessed 6 July 2023.

23 Ibid.

24 US Department of Transportation, Bureau of Transportation Statistics (2023), "Commute Mode", https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/commute-mode, accessed 6 July 2023.

25 Ibid.

26 See, for example, the following: Eurostat (2023), "Freight transport statistics – modal split", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Freight_transport_statistics_-_modal_split; J.P. Rodrigues (2020), "Modal Share of Freight Transportation, Selected Countries, 2020", in *The Geography of Transport Systems*, https://transportgeography.org/contents/chapter5/transportation-modes-modal-competition-modal-shift/modal-share-selected-countries.

27 T. Kawashima et al. (2021), "The relationship between fever rate and telework implementation as a social distancing measure against the COVID-19 pandemic in Japan", *Public Health*, Vol. 192, pp. 12-14, https://doi.org/10.1016/j.puhe.2020.05.018; B.P.Y. Loo and B. Wang (2018), "Factors associated with home-based e-working and e-shopping in Nanjing China", *Transportation*, Vol. 45, pp. 365-384, https://doi.org/10.1007/s11116-017-9792-0; P. Loa et al. (2021), "How have ride-sourcing users adapted to the first wave of the COVID-19 pandemic? Evidence from a survey-based study of the Greater Toronto Area", *Transportation Letters*, Vol. 13, pp. 404-413, https://doi.org/10.1080/19427867.2021.1892938.

28 A. Hook, B.K. Sovacool and S. Sorrell (2020), "A systematic review of the energy and climate impacts of teleworking", *Environmental Research Letters*, Vol. 15, No. 9, p. 093003, https://iopscience.iop.org/article/10.1088/1748-9326/ab8a84.

29 Organisation for Economic Co-operation and Development (OECD) (2020), "Cities policy responses, OECD Policy Responses to Coronavirus (COVID-19)", https://www.oecd.org/coronavirus/policy-responses/cities-policy-responses-fd1053ff.

30 T. Shibayama et al. (2021), "Impact of covid-19 lockdown on commuting: A multi-country perspective", *European Journal of Transport and Infrastructure Research*, Vol. 21, No. 1, pp. 70-93, https://doi.org/10.18757/ejtir.2021.21.1.5135.

31 N. Medimorec et al. (2020), "Impacts of COVID-19 on mobility: Preliminary analysis of regional trends on urban mobility", SLOCAT, https://slocat.net/wp-content/uploads/2020/0/SLOCAT_2020_COVID-19-Mobility-Analysis.pdf.

32 N. Bloom et al. (2020), "60 million fewer commuting hours per day: How Americans use time saved by working from home", CEPR, 23 September, https://cepr.org/voxeu/columns/60-million-fewer-commuting-hours-day-how-americans-use-time-saved-working-home.

33 P. Monthe (2022), "3 ways Africa needs to adapt to the era of remote working", World Economic Forum, 22 March, https://www.weforum.org/agenda/2022/03/3-ways-africa-remote-working.

34 MyJobMag (2021), "The state of remote work in Nigeria", 25 March, https://www.myjobmag.com/blog/the-state-of-remote-work-in-nigeria.

35 Monthe, op. cit. note 33.

36 P. Christidis, E. Navajas Cawood and D. Fiorello (2022), "Challenges for urban transport policy after the Covid-19 pandemic: Main findings from a survey in 20 European cities", *Transport Policy*, Vol. 129, pp. 105-116, https://doi.org/10.1016/j.tranpol.2022.10.007.

37 Ibid.

38 Statista (2023), "India urban dwellers average daily commute time", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1104025/india-urban-dwellers-average-daily-commute-time, accessed 6 July 2023.

39 Statista (2023), "Average daily travel time per capita in Italy 2002-2020", 3 February, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/745146/length-of-time-spent-for-commuting-purposes-per-capita-in-italy.

40 Statista (2022), "Weekly commute time among Japanese to and from school or work 1976-2021, by gender", 6 October, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/868495/japan-time-spent-commuting-school-work-weekly-average-by-gender.

41 Statista (2022), "U.S. workers' mean time to commute to work by region 2019", 13 September, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/798393/us-workers-average-commuting-time-region.

42 Statista (2023), "Time needed for commute in Great Britain, by transportation 2020", 23 March, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/300712/average-time-taken-to-travel-to-work-in-the-united-kingdom.

43 Ibid.

44 Statista (2022), "Number of major delays lasting more than 30 minutes of MRT Singapore 2015-2021", 7 June, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1007813/singapore-mass-rapid-transit-major-delays.

45 TomTom (2022), "TomTom Traffic Index Ranking 2022", https://www.tomtom.com/traffic-index/, accessed 1 August 2023.

46 INRIX (2023), "Traffic delays exceeded pre-COVID levels in 116 out of 295 cities tracked in the US and 249 out of 593 cities tracked in Europe", 2022 INRIX Traffic Scorecard Report, accessed 6 July 2023.

47 J.I. Levy et al. (2010), "The Public Health Costs of Traffic Congestion: A Health Risk Assessment", Harvard Centre for Risk Analysis, https://www.ibtta.org/sites/default/files/The%20Public%20Health%20Costs%20of%20Traffic%20Congestion.pdf; Mayor of London (2022), "Cost of congestion in capital revealed as car use remains high", 11 January, https://www.london.gov.uk/press-releases/mayoral/cost-of-congestion-in-capital-revealed.

48 MaaS Alliance (2023), "Mobility as a Service?" https://maas-alliance.eu/homepage/what-is-maas, accessed 1 August 2023.

49 GlobalNewsWire (2022), "Global Mobility as a Service (MaaS) Market Report 2022: Government Support for Digital Payments Bolsters Sector Growth", 20 December, https://www.globenewswire.com/en/news-release/2022/12/20/2576957/28124/en/Global-Mobility-as-a-Service-MaaS-Market-Report-2022-Government-Support-for-Digital-Payments-Bolsters-Sector-Growth.html.

50 J. Morris (2023), "The definition of accessibility and why most people get it wrong", Opinion, 5 March, https://wheelchairtravel.org/accessibility-definition-why-most-people-get-it-wrong; World Bank (2016), "Transport and Accessibility", 28 October, https://www.worldbank.org/en/topic/transport/brief/transport-and-social-responsibility.

51 Statista (2023), "Share of ADA accessible public transportation stations in the United States in 2020, by mode", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1297283/us-public-transit-station-accessibility-by-mode, accessed 1 August 2023

52 Statista (2023), "Share of accessible public transportation vehicles in the United States in 1993 and 2020, by type", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1297261/public-transit-vehicle-accessibility-us-by-type, accessed 1 August 2023.

53 Statista (2023), "Number of ADA accessible stations in public transportation in Canada as of September 2018, by mode", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/991005/canada-ada-accessible-stations-public-transportation-mode, accessed 1 August 2023.

54 35% reported waiting in lines to be the biggest barrier, while 30% reported issues with using websites and with lighting and sound levels; about 25% had difficulties with entrances or exits, announcements or alarms, floorplans or fixtures in buildings, and signs or directions; and 21% faced difficulties with bathrooms. Statista (2023), "Share of people with disabilities, difficulties or long-term conditions reporting a transportation barrier in Federal Sector Organizations in the last two years in Canada in 2021, by type", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1317120/types-transportation-barriers-people-disabilities-canada, accessed 1 August 2023

55 Statista (2023), " Number of train and RER stations accessible to people with reduced mobility in Paris and Île-de-France from 2007 to 2017", https://www.statista.com/statistics/1154009/accessibility-stations-rer-trains-paris-france-disabled-people/

56 Statista (2023), "Number of train and RER stations accessible to people with reduced mobility in Paris and Île-de-France from 2007 to 2017", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1154009/accessibility-stations-rer-trains-paris-france-disabled-people, accessed 1 August 2023; Wheelchair Travel.org, "Paris Public Transportation", https://wheelchairtravel.org/paris/public-transportation, accessed 24 May 2023.

57 E. De Clerk (2019), "The Barcelona Metro will be 100 per cent accessible by 2024", Intelligent Transport, 7 August, https://www.intelligenttransport.com/transport-news/85750/barcelona-metro-accessible-2024.

58 Wheelchair Travel (2023), "Seattle Public Transportation", https://wheelchairtravel.org/seattle/public-transportation, accessed 24 May 2023; A. Bettati et al. (2022), "Fostering an inclusive urban-transit system", McKinsey & Company, 16 February, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/fostering-an-inclusive-urban-transit-system.

59 World Bank, op. cit. note 50; N. Kalms and H. Korsmeyer (2017), "Gender makes a world of difference for safety on public transport", The Conversation, 17 July, https://theconversation.com/gender-makes-a-world-of-difference-for-safety-on-public-transport-80313.

60 World Bank, op. cit. note 50; Kalms and Korsmeyer, op. cit. note 59; M. Naidu (2020), "Do we consider non-binary gender issues while planning for the public transit spaces?" Urban Transport News, 30 September, https://urbantransportnews.com/article/do-we-consider-non-binary-gender-issues-while-planning-for-the-public-transit-spaces; C. Clark (2021), "Discrimination against trans and non-binary people is rife in the UK, report finds", Gay Times, 29 September, https://www.gaytimes.co.uk/life/discrimination-against-trans-and-non-binary-people-is-rife-in-the-uk-report-finds.

61 World Bank, op. cit. note 50.

62 Ibid.

63 Ibid.

64 Statista (2021), "Factors convincing women to use public transport India 2018", 15 March, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1046934/india-women-convincing-factors-to-use-public-transport.

65 M.C. Schaefer, personal communication with SLOCAT, 25 April 2023; Survey conducted by GIZ Albania in 2022.

66 Clark, op. cit. note 60.

67 Statista (2023), "Total security costs of public transportation companies in France from 2011 to 2020", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/467954/security-costs-public-transportation-france, accessed 1 August 2023.

68 World Bank, op. cit. note 50.

69 D. Chechulin (2021), "Building a transport system that works: Five insights from our 25-city report", McKinsey & Company, 11 August, https://www.mckinsey.com/capabilities/operations/our-insights/building-a-transport-system-that-works-five-insights-from-our-25-city-report.

70 Ibid.

71 Statista (2023), "Share of the population with easy access to public transport in Germany in 2020, by federal state", https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1310159/public-transport-accessibility-germany-by-state, accessed 1 August 2023.

72 N. Gandelman, T. Serebrisky and A. Suarez-Aleman (2019), "Household spending on transport in Latin America and the Caribbean: A dimension of transport affordability in the region", *Journal of Transport Geography*, Vol. 79 (July), https://www.sciencedirect.com/science/article/pii/S096669231830142X#bb0455.

73 Office for National Statistics (2020), "Family spending in the UK: April 2018 to March 2019", 19 March, https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/bulletins/familyspendingintheuk/april2018tomarch2019.

74 US Department of Transportation, Bureau of Transportation Statistics (2023), "Household Spending on Transportation: Average Household Spending", https://data.bts.gov/stories/s/Transportation-Economic-Trends-Transportation-Spen/ida7-k95k, accessed 1 August 2023.

75 Ibid.

76 Statista (2023), "Transportation consumer spending worldwide 2020, by country", https://www.statista.com/forecasts/1156508/transportation-consumer-spending-by-country, accessed 1 August 2023.

77 tralac (2023), "Transportation costs and efficiency in west and central Africa", https://www.tralac.org/discussions/article/9364-transportation-costs-and-efficiency-in-west-and-central-africa.html, accessed 1 August 2023.

78 P. Nagle and K. Temaj (2022), "Oil prices remain volatile amid demand pessimism and constrained supply", World Bank, 16 December, https://blogs.worldbank.org/opendata/oil-prices-remain-volatile-amid-demand-pessimism-and-constrained-supply.

79 World Economic Forum (2021), "Here's how rising inflation is affecting us around the world", 22 December, https://www.weforum.org/agenda/2021/12/rising-prices-inflation-ipsos-survey. **Figure 2** from Ipsos (2021), "Inflation: Consumer Perceptions in 30 Countries", p. 3, https://www.ipsos.com/sites/default/files/ct/news/documents/2021-12/Inflation-Dec-2021.pdf. Note: Based on 20,504 online survey respondents, aged 16-74, across 30 countries. The survey question asked: "Thinking about the prices you have paid for the following in recent weeks, do they generally seem higher, lower or about the same as they were six months ago?" The results were not adjusted to the population size of each country and thus are not intended to suggest a total result but are indicative for perceptions of cost increases.

80 World Economic Forum, op. cit. note 79.

81 GlobalPetrolPrices (2023), "Gasoline prices, litre, 31-Jul-2023", https://www.globalpetrolprices.com/gasoline_prices.

82 Ibid.

83 Ibid.; P. Cohen (2023), "The 10 countries with the cheapest gas prices", Factor Finders, 15 June, https://www.ezinvoicefactoring.com/cheapest-fuel-prices-by-country.

84 D. Clark (2023), "Main reasons that people have seen their cost of living increase Great Britain 2023", Statista, 10 May, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/1304937/great-britain-reasons-for-cost-of-living-increase.

85 A.H. Auchincloss et al. (2015), "Public parking fees and fines: A survey of U.S. cities", *Public Works Management & Policy*, Vol. 20, No. 1, pp. 49-59, https://journals.sagepub.com/doi/pdf/10.1177/1087724X13514380.

86 Statista (2023), "Public transport monthly ticket cost: key cities globally 2023", 10 May, https://www.statista.com/statistics/1154432/public-transport-monthly-ticket-cost-selected-cities-worldwide.

87 Ibid.

88 Statista (2022), "Cost for public transport in cities worldwide, 2018", 8 August, https://www-statista-com.iclibezp1.cc.ic.ac.uk/statistics/275438/public-transport-cost-cities.

89 Ibid.

90 Statista, op. cit. note 86.

91 J. Lazarus et al. (2021), "Bridging the Income and Digital Divide with Shared Automated Electric Vehicles", University of California at Berkeley, p. 4, https://escholarship.org/uc/item/5f1359rd.

92 Renewable Energy Policy Network for the 21st Century (REN21), "Renewables 2023 Global Status Report Collection: Renewables in Energy Demand", p. 40, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf. p. 39; International Energy Agency (IEA) (2022), "World Energy Outlook", p. 272, https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf; IEA (2021), "Global CO2 emissions from transport by subsector, 2000-2030", https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-transport-by-subsector-2000-2030.

93 IEA (2022), "Transport", https://www.iea.org/reports/transport; electricity use was split into fossil fuel-based and renewables using the global share of renewables in electricity and heat generation, from IEA (2022), "Energy Statistics Data Browser", https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser; trends over the past decade REN21, op. cit. note 92, p. 40.

94 Analysis from the SLOCAT Partnership for Sustainable, Low Carbon Transport (SLOCAT), based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries – 2022 Report", https://edgar.jrc.ec.europa.eu/report_2022.

95 Carbon Monitor (2023), "CO_2 Emissions Variation", https://carbonmonitor.org/variation, accessed 7 February 2023.

96 SLOCAT analysis based on Crippa et al., op. cit. note 94.

97 L. Cozzi and A. Petropoulos (2021), "Carbon emissions fell across all sectors in 2020 except for one – SUVs", IEA, 15 January, https://www.iea.org/commentaries/carbon-emissions-fell-across-all-sectors-in-2020-except-for-one-suvs; T. Litman (2023), "Comprehensive Transportation Emission Reduction Planning", 9 May, p. 3, https://www.vtpi.org/cterp.pdf.

98 L. Cozzi et al. (2023), "As their sales continue to rise, SUVs' global CO2 emissions are nearing 1 billion tonnes", IEA, 27 February, https://www.iea.org/commentaries/as-their-sales-continue-to-rise-suvs-global-co2-emissions-are-nearing-1-billion-tonnes.

99 A. Kowalska-Pyzalska (2022), "Perspectives of development of low emission zones in Poland: A short review", *Frontiers in Energy Research*, Vol. 10, https://doi.org/10.3389/fenrg.2022.898391; Transport and Environment (2019), "Low-emission zones are a success – but they must now move to zero-emission mobility", https://www.transportenvironment.org/sites/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf.

100 Eurocities (2021), "Low emission zones: challenges and solutions", 13 October, https://eurocities.eu/latest/low-emission-zones-challenges-and-solutions.

101 National Association of City Transportation Officials (2021), "4. Low-emission zones (LEZs)", in *Building Healthy Cities in the Doorstep-delivery Era: Sustainable Urban Freight Solutions from Around the World*, https://nacto.org/wp-content/uploads/2021/06/BuildingHealthyCities_Urban-Freight_LEZs.pdf.

102 Clean Cities Campaign (2022), "Quantifying the Impact of Low- and Zero-emission zones: Evidence Review", https://cleancitiescampaign.org/wp-content/uploads/2022/10/12009C_Quantifying-the-impact-of-low-and-zeroemission-zones-Evidence-Review_final.pdf.

103 Ibid.

104 I. Lebrusan and J. Toutouh (2020), "Using Smart City Tools to Evaluate the Effectiveness of a Low Emissions Zone in Spain: Madrid Central", Smart Cities, https://doi.org/10.3390/smartcities3020025.

105 J. Gu et al. (2022), "Low emission zones reduced PM10 but not NO2 concentrations in Berlin and Munich, Germany", *Journal of Environmental Management*, Vol. 302, Part A, https://doi.org/10.1016/j.jenvman.2021.114048.

106 F.M. Santos, Á. Gómez-Losada and J.C.M. Pires (2019), "Impact of the implementation of Lisbon low emission zone on air quality", *Journal of Hazardous Materials*, Vol. 365, http://dx.doi.org/10.1016/j.jhazmat.2018.11.061.

107 Scottish Environment Protection Agency (2023), "Glasgow's Low Emission Zone", https://www.lowemissionzones.scot/uploads/docs/Glasgows-LEZ-prepared-by-SEPA.pdf, accessed 1 August 2023.

108 City of London (2020), "Air Quality in London 2016-2020: London Environment Strategy: Air Quality Impact Evaluation October 2020", https://www.london.gov.uk/sites/default/files/air_quality_in_london_2016-2020_october2020final.pdf.

109 J. Blumgart (2022), "Are trains or buses better for the environment?" Governing, 11 February, https://www.governing.com/next/are-trains-or-buses-better-for-the-environment.

110 C. MilNeil (2022), "International climate report demands 'systemic' changes to transportation and urban planning", Streets Blog Mass, 22 April, https://mass.streetsblog.org/2022/04/22/international-climate-report-demands-systemic-changes-to-transportation-and-urban-planning.

111 R. Steuteville (2023), "Feds release plan for compact communities to counter climate change", Public Square, 11 January, https://www.cnu.org/publicsquare/2023/01/11/federal-call-action-community-design-address-climate-change

112 F.R. Ashik, M.H. Rahman and M. Kamruzzaman (2022), "Investigating the impacts of transit-oriented development on transport-related CO2 emissions", *Transportation Research Part D: Transport and Environment*, Vol. 105, p. 103227, https://doi.org/10.1016/j.trd.2022.103227.

113 **Figure 3** from Action Net Zero (2023), "What are my sustainable transport options?" https://www.actionnetzero.org/guides-and-tools/sustainable-travel-options-transport-hierarchy, accessed 11 May 2023.

114 "Detected breaks in road CO2 emissions and their attribution", in N. Koch (2022), "Attributing agnostically detected large reductions in road CO2 emissions to policy mixes", *Nature Energy*, Vol. 7, Iss. 9, pp. 1-10, http://dx.doi.org/10.1038/s41560-022-01095-6.

115 Ibid.

116 F. Bergk et al., op. cit. note 6; SLOCAT, op. cit. note 5, p. 7.

117 Litman, op. cit. note 97.

118 European Commission (2023), "Sustainable Urban Mobility Plans (SUMPs) and Cycling", https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/cycling/guidance-cycling-projects-eu/policy-development-and-evaluation-tools/sustainable-urban-mobility-plans-sumps-and-cycling_en, accessed 23 May 2023.

119 MobiliseYourCity Partnership (2023), "Global Monitor 2023", https://www.mobiliseyourcity.net/global-monitor-2023.

120 Ibid.

121 H. Figg (2022), "SUMP for the city of Utrecht", Eltis, 29 November, https://www.eltis.org/resources/case-studies/sump-city-utrecht.

122 G. Bauer (2023), "First implementation of SUMP in China", Changing Transport, https://changing-transport.org/first-implementation-of-sump-in-china, accessed 1 August 2023.

123 H. Figg (2022), "Istanbul's new Sustainable Urban Mobility Plan", Eltis, 18 July, https://www.eltis.org/resources/case-studies/istanbuls-new-sustainable-urban-mobility-plan.

124 Euroclima (2021), "Emerging Metropolitan Mobility Strategy", https://www.euroclima.org/en/idiomas/estrategia-metropolitana-de-movilidad-emergente.

125 MobiliseYourCity Partnership (2022), "An innovative process leads to an ambitious public transport-focused SUMP for the city of Medan", https://www.mobiliseyourcity.net/innovative-process-leads-ambitious-public-transport-focused-sump-city-medan.

126 City of Tirana (2020), "Sustainable Urban Mobility Plan for the City of Tirana", https://tirana.al/en/uploads/2020/12/20201210161709_sump_tirana-volume-ii_the-plan_200724.pdf; Schaefer, op. cit. note 65.

127 A. Pharande, "Transit-oriented development – Making Indian cities liveable again", Construction Week, 23 November, https://www.constructionweekonline.in/people/transit-oriented-development-making-indian-cities-liveable-again.

128 US Department of Transportation, Federal Transit Administration (2022), "Biden-Harris Administration Announces $13.1 Million in Grant Awards to Help Communities Plan for Transit-Oriented Development", 17 November, https://www.transit.dot.gov/about/news/biden-harris-administration-announces-131-million-grant-awards-help-communities-plan; J. Skelley (2023), "California relaxes parking mandates to free up land for multifamily development – but will neighbors and lenders approve?" Urbanland, 3 January, https://urbanland.uli.org/planning-design/california-relaxes-parking-mandates-to-free-up-multifamily-development-but-will-neighbors-and-lenders-approve; Government of British Columbia (2022), "Province to increase housing, services near transit hubs", 5 April, https://news.gov.bc.ca/releases/2022TRAN0030-000492.

129 S. Freishtat and A. Yin (2022), "Chicago to reduce cars through transit-oriented development", Government Technology, 13 October, https://www.govtech.com/fs/chicago-to-reduce-cars-through-transit-oriented-development.

130 Waka Kotahi – NZ Transport Agency (2023), "Vehicle kilometres travelled (VKT) reduction", https://www.nzta.govt.nz/about-us/about-waka-kotahi-nz-transport-agency/environmental-and-social-responsibility/cerf-programme/cerf-delivery-programmes/vehicle-kilometres-travelled-vkt-reduction, accessed 14 May 2023; Transport Scotland (2023), "20% reduction in car km by 2030", https://www.transport.gov.scot/our-approach/environment/20-reduction-in-car-km-by-2030, accessed 14 May 2023; Transport Scotland (2020), "National Transport Strategy 2", 5 February https://www.transport.gov.scot/publication/national-transport-strategy-2. California Air Pollution Control Association (2021), "Handbook for Analyzing Greenhouse Gas Emission Reductions", www.caleemod.com/handbook/index.html.

131 Bans from REN21, op. cit. note 92, p. 42; lower shares (full list of policies) from REN21, "GSR 2023 Data Pack", Figure 11, www.ren21.net/gsr2023-data-pack.

132 Transport and Environment, op. cit. note 99.

133 **Figure 4** from Sadler Consultants (2022), "Urban Access Regulations in Europe", https://urbanaccessregulations.eu.

134 Ibid.

135 Ibid.

136 The Local (2022), "Crit'Air: Drivers face €750 fines in France's new low-emission zones", 25 October, https://www.thelocal.fr/20221025/critair-drivers-face-e750-fines-in-frances-new-low-emission-zones.

137 L. Walker (2022), "Brussels Low Emission Zone expands 1 July: Which cars face fines?" Brussels Times, https://www.brusselstimes.com/245612/brussels-low-emission-zone-expands-1-july-which-cars-face-fines.

138 Glasgow City Council (2022), "Glasgow Prepares Ahead of Low Emission Zone Enforcement", 21 September, https://www.glasgow.gov.uk/index.aspx?articleid=29660.

139 Green Car Congress (2022), "Mayor of London expanding Ultra Low Emission Zone London-wide; new £110M scrappage scheme", 26 November, https://www.greencarcongress.com/2022/11/20221126-ulez.html.

140 City of London (2021), "London Low Emission Zone – Six Month Report", https://www.london.gov.uk/sites/default/files/lez_six_month_on_report-final.pdf.

141 World Resources Institute (2017), "Study on International Practices for Low Emission Zone and Congestion Charging", https://www.wri.org/research/study-international-practices-low-emission-zone-and-congestion-charging.

142 M. Rizki et al. (2022), "Low emission zone (LEZ) expansion in Jakarta: Acceptability and restriction preference", *Sustainability*, Vol. 14, No. 19, p. 12334, https://doi.org/10.3390/su141912334.

143 C40 Knowledge Hub (2020), "Zero Emission Zones for Freight: Lessons from Beijing", https://www.c40knowledgehub.org/s/article/Zero-Emission-Zones-for-Freight-Lessons-from-Beijing.

144 H. Cui, P. Gode and S. Wappelhorst (2021), "A Global Overview of Zero-emission Zones in Cities and Their Development Progress", International Council on Clean Transportation (ICCT), https://theicct.org/sites/default/files/publications/global-cities-zez-dev-EN-aug21.pdf.

145 Transport and Environment, op. cit. note 99.

146 S. Wappelhorst and H. Cui (2022), "Update on zero-emission zone development progress in cities", ICCT ,https://theicct.org/wp-content/uploads/2022/08/Global-ZEZs-update-FINAL.pdf.

147 ITVX (2022), "What is a Zero Emission Zone and why is it being introduced in Oxford?" 28 February, https://www.itv.com/news/meridian/2022-02-25/what-is-a-zero-emission-zone-and-why-is-it-being-introduced-in-oxford; Urban Access Regulations in Europe (2023), "United Kingdom: London ZEZ – Islington and Hackney", https://urbanaccessregulations.eu/countries-mainmenu-147/united-kingdom-mainmenu-205/london-zez-islington-and-hackney, accessed 1 August 2023

148 Urban Access Regulations in Europe (2023), "Copenhagen (København) & Frederiksberg", https://urbanaccessregulations.eu/countries-mainmenu-147/denmark-mainmenu-221/kobenhavn-frederiksberg, accessed 1 August 2023.

149 Cui, Gode and Wappelhorst, op. cit. note 144.

150 Ibid.

151 Ibid.

152 Urban Access Regulations in Europe (2023), "Netherlands: Amsterdam", https://urbanaccess-regulations.eu/countries-mainmenu-147/netherlands-mainmenu-88/amsterdam, accessed 1 August 2023.

153 Cui, Gode and Wappelhorst, op. cit. note 144.

154 Transport Decarbonisation Alliance, C40 Cities and POLIS (2020), "How-to Guide Zero-Emission Zones – Don't Wait to Start with Freight!" https://www.polisnetwork.eu/wp-content/uploads/2020/12/ZEZ-F_How-to-Guide_low.pdf. **Figure 5** from Cui, Gode and Wappelhorst, op. cit. note 144.

155 POLIS (2021), "Absolute Zero: Introducing Zero Emission Zones", 2 January, https://www.polisnetwork.eu/article/absolute-zero-introducing-zero-emission-zones.

156 Netherlands Enterprise Agency – RVO (2023), "Zero-emission zones to be introduced in many cities from 2025", https://business.gov.nl/running-your-business/environmental-impact/making-your-business-sustainable/zero-emission-zones-to-be-introduced-in-many-cities-from-2025, accessed 1 August 2023.

157 Wappelhorst and Cui, op. cit. note 146.

158 Cui, Gode and Wappelhorst, op. cit. note 144; Shenzhen Public Security Bureau (2022), "Notice on Setting Green Logistic Zones to Ban the Use of Light-duty Diesel Trucks", 20 July, http://www.sz.gov.cn/cn/xxgk/zfxxgj/tzgg/content/post_9969657.html (using Google Translate).

159 Luoyang Public Security Bureau (2021), "Notice on Further Normalizing and Optimizing Road Access Management of Urban Delivery Trucks", 21 April, http://zw.lyd.com.cn/system/2021/04/21/032019328.shtml (using Google Translate).

160 Los Angeles Cleantech Incubator (2023), "Santa Monica Zero Emissions Delivery Zone Pilot", https://laincubator.org/zedz, accessed 1 August 2023.

161 Ibid.

162 MobiliseYourCity Partnership (2023), "MobiliseYourCity's projects in Africa", https://www.mobiliseyourcity.net/node/294, accessed 1 August 2023

163 Bauer, op. cit. note 122; City of Tirana, op. cit. note 126; Schaefer, op. cit. note 65; GIZ (2023), "Promoting sustainable and climate-friendly urban mobility", https://www.giz.de/en/worldwide/83138.html.

164 Institute for Transportation and Development Policy Africa (2023), "About us", https://africa.itdp.org/about, accessed 1 August 2023

165 ICLEI–Local Governments for Sustainability, "Ecologistics Community", https://sustainablemobility.iclei.org/ecologistics-community, accessed 16 May 2023; ICLEI, "Ecologistics Indicators", https://sustainablemobility.iclei.org/wpdm-package/ecologistics_indicators, accessed 16 May 2023.

3.2 WALKING

1 T. Litman (2023), "Evaluating Active and Micro Mode Emission Reduction Potentials", www.vtpi.org/amerp.pdf.

2 International Transport Forum (ITF) (2023), "Shaping post-covid mobility in cities: Summary and conclusions", https://www.itf-oecd.org/shaping-post-covid-mobility-cities.

3 Institute for Transportation and Development Policy (ITDP) and University of California at Davis (2021), "The Compact City Scenario – Electrified", https://www.itdp.org/publication/the-compact-city-scenario-electrified; S. Teske, S. Niklas and R. Langdon (2021), "TUMI Transport Outlook 1.50C – A global scenario to decarbonise transport", TUMI Management, https://www.transformative-mobility.org/publications/tumi-transport-outlook.

4 World Health Organization (WHO) (2018), "Global Action Plan for Physical Activity", https://www.who.int/publications/i/item/9789241514187; WHO (2022), "Global Status Report on Physical Activity 2022", https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022.

5 A. Berdichevskiy (2016), "How will we travel in the cities of tomorrow?" World Economic Forum, 8 February, https://www.weforum.org/agenda/2016/02/how-should-leaders-face-the-urban-mobility-challenges-of-tomorrow.

6 ITF (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

7 Ibid.

8 J. Leather et al. (2011), "Walkability and Pedestrian Facilities in Asian Cities", Asian Development Bank,https://www.adb.org/sites/default/files/publication/28679/adb-wp17-walkability-pedestrian-facilities-asian-cities.pdf.

9 Partnership for Active Travel and Health (PATH) (2022), "Make way for walking and cycling", https://pathforwalkingcycling.com/report.

10 ITF, op. cit. note 6.

11 Ibid.

12 Measuring Walking (2023), "International Walking Data Standard", https://www.measuring-walking.org, accessed March 2023.

13 **Table 1** from WHO, "Global Status Report on Physical Activity", op. cit. note 4.

14 United Nations Environment Programme (UNEP) and UN-Habitat (2022), "Walking and Cycling in Africa: Evidence and Good Practice to Inspire Action", https://www.unep.org/resources/report/walking-and-cycling-africa-evidence-and-good-practice-inspire-action.

15 Ibid.

16 Ibid.

17 Ibid.

18 WHO (2003), "The WHO STEPwise Approach to Surveillance of Noncommunicable Diseases (STEPS)", https://www.who.int/ncd_surveillance/en/steps_framework_dec03.pdf.

19 **Table 2** from WHO (2023), "Global Physical Activity Questionnaire (GPAQ)", https://www.who.int/ncds/surveillance/steps/GPAQ_EN.pdf, accessed March 2023.

20 UNEP and UN-Habitat, 2022, op. cit. note 14. **Table 3** from Ibid.

21 Ibid.

22 Ibid.

23 United Nations Department of Economic and Social Affairs (2023), "11. Make cities and human settlements inclusive, safe, resilient and sustainable", https://sdgs.un.org/goals/goal11, accessed March 2023.

24 Ibid.

25 **Figure 1** based on UN-Habitat (2023), "11.2.1 Percentage Access to Public Transport", https://data.unhabitat.org/datasets/11-2-1-percentage-access-to-public-transport/data, accessed March 2023.

26 S. Cooke et al. (2022), "Proximity is not access: A capabilities approach to non-motorised transport vulnerability in African cities", *Frontiers in Sustainable Cities*, Vol. 4, https://doi.org/10.3389/frsc.2022.811049.

27 **Table 4** from International Road Assessment Programme (iRAP) (2023), https://irap.org, accessed March 2023.

28 WHO, UN Road Safety Collaboration (2021), "Global Plan: Decade of Action for Road Safety 2021-2030", https://cdn.who.int/media/docs/default-source/documents/health-topics/road-traffic-injuries/global-plan-for-road-safety.pdf.

29 iRAP, op cit. note 27.

30 Ibid.

31 Ibid.

32 World Road Association (PIARC) (2017), "Vulnerable road users: Diagnosis of design and operational safety problems and potential countermeasures", https://www.piarc.org/en/order-library/27282-en-Vulnerable%20road%20users:%20Diagnosis%20of%20design%20and%20operational%20safety%20problems%20and%20potential%20countermeasures.

33 iRAP, op cit. note 27.

34 Walk Score (2023), https://www.walkscore.com, accessed March 2023.

35 Ibid.

36 C. Brand et al. (2021), "The climate change mitigation effects of daily active travel in cities", *Transportation Research Part D: Transport and Environment*, Vol. 93, https://doi.org/10.1016/j.trd.2021.102764.

37 P. Jaramillo et al. (2022), "Transport", in Intergovernmental Panel on Climate Change (IPCC), "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter10.pdf.

38 Ibid.

39 Ibid.

40 Litman, op. cit. note 1. **Box 1** from Ibid.

41 WHO, "Global Status Report on Physical Activity", op. cit. note 4.

42 Ibid.

43 University of California, Berkeley Institute of Transportation Studies (2023), "Proximity planning: A local strategy for global problems, or a global strategy for local problems?" 10 March, https://its.berkeley.edu/news/proximity-planning-local-strategy-global-problems-or-global-strategy-local-problems.

44 Walk21 (2023), www.walk21.com, accessed March, 2023.

45 Ibid.

46 Ibid.

47 Ibid.

48 Ibid.

49 PATH, op. cit. note 9.

50 S. Hurley (2022), "E298m announced to develop more walk and cycle routes", Raidió Teilifís Éireann, 24 January, https://www.rte.ie/news/politics/2022/0124/1275605-cycleways-and-walking-infrastructure.

51 Ibid.

52 Government of British Columbia (2022), "Province keeps eyes on the road with new Vision Zero funding", 5 April, https://news.gov.bc.ca/releases/2022HLTH0018-000486.

53 Khmer Times (2022), "Siem Reap welcomes new road infrastructure", 11 January, https://www.khmertimeskh.com/501004496/siem-reap-welcomes-new-road-infrastructure.

54 L. Gaucher and M. Gawlik (2022), "Barcelone capitalize sur son experience tactique pour transformer ses espaces publics", 22 April, https://www.institutparisregion.fr/amenagement-et-territoires/les-chroniques-de-lurbanisme-tactique/barcelone-capitalise-sur-son-experience-tactique-pour-transformer-ses-espaces-publics.

55 Brussels Regional Public Service (2020), "Good Move, The Regional Mobility Plan 2020-2030", https://mobilite-mobiliteit.brussels/en/good-move.

56 Medias de Bruxelles (2022), "La part de kilometres parcourus en voiture au plus bas à Bruuxelles: le vélo et la marche progressent", 28 July, https://bx1.be/categories/news/la-part-de-kilometres-parcourus-en-voiture-au-plus-bas-a-bruxelles-le-velo-et-la-marche-progressent.

57 Ibid.

58 United Nations Economic Commission for Europe (2022), "Vienna Declaration", https://thepep.unece.org/index.php/node/843.

59 Ibid.

60 Walk21, op cit. note 44.

61 Ministerio de Transporte de Colombia (2022), "Colombia lanza la Estrategia Nacional de Movilidad Activa para incentivar formas alternativas para movernos y cuidar de la sostenibilidad", 22 July, https://mintransporte.gov.co/publicaciones/11047/colombia-lanza-la-estrategia-nacional-de-movilidad-activa-para-incentivar-formas-alternativas-para-movernos-y-cuidar-de-la-sostenibilidad.

62 The International News (2022), "Non-motorised transport plan for Islamabad", 22 January, https://www.thenews.com.pk/print/927173-non-motorised-transport-plan-for-islamabad.

63 Walk21, op. cit. note 44.

64 Ibid.

65 Walk21 (2023), "Africa Network for Walking and Cycling", https://walk21.com/work/africa-network-walking-cycling, accessed March 2023; Volvo Research and Educational Foundations (VREF) (2023), "Walking as a Mode of Transport (Walking)", https://vref.se/walking, accessed , 2023.

66 PATH, op. cit. note 9.

67 VREF, op. cit. note 65.

3.3 CYCLING

1 Bike Europe (2022), "E-bikes now account for 10% of global bicycle sales", 2 December, https://www.bike-eu.com/44234/e-bikes-now-account-for-10-of-global-bicycle-sales.

2 European Parliament (2023), "Motion for a resolution on developing an EU cycling strategy, 2022/2909 (RSP)", https://www.europarl.europa.eu/doceo/document/B-9-2023-0102_EN.pdf.

3 A. Neves and C. Brand (2019), "Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach", *Transportation Research Part A: Policy and Practice*, Vol. 123, pp. 130-146, https://doi.org/10.1016/j.tra.2018.08.022.

4 Worldometer (2022), "Bicycles produced this year", https://www.worldometers.info/bicycles; O. Oke et al. (2015), "Tracking global bicycle ownership patterns", *Journal of Transport & Health*, Vol. 2, No. 4, pp. 490-501, https://doi.org/10.1016/j.jth.2015.08.006.

5 United Nations Environment Programme (UNEP) and UN-Habitat (2022), "Walking and Cycling in Africa: Evidence and Good Practice to Inspire Action", https://www.unep.org/resources/report/walking-and-cycling-africa-evidence-and-good-practice-inspire-action.

6 R. Buehler and J. Pucher (2022), "Cycling through the COVID-19 pandemic to a more sustainable transport future: Evidence from case studies of 14 large bicycle-friendly cities in Europe and North America", *Sustainability*, Vol. 14, No. 12, https://doi.org/10.3390/su14127293.

7 Mobility Foresights (2021), "Worldwide bicycle market size in 2021, with a forecast from 2022 to 2027", Statista, 12 July, https://www.statista.com/statistics/1356736/bicycle-market-forecast-global.

8 J. Watson (2023), "How many bicycles are in the world? – Figures that impress!" Bike the Sites, 16 May, https://www.bikethesites.com/how-many-bicycles-are-in-the-world.

9 D. Jones (2023), "How many bicycles are there in the world?" Discerning Cyclist, 7 April, https://discerningcyclist.com/how-many-bicycles-in-world.

10 UNEP and UN-Habitat, op. cit. note 5.

11 A.Z. Abdullah (2020), "Singapore sees cycling boom amid COVID-19, with increased ridership and bicycle sales", channelnewsasia, 25 August, https://www.channelnewsasia.com/singapore/covid-19-cycling-popularity-bicycle-sales-shared-bikes-631621.

12 Ibid.

13 Statistics Canada (2020), "More commuters now walk or bike to work than take public transit", The Daily, 10 August, https://www150.statcan.gc.ca/n1/daily-quotidien/200810/dq200810a-eng.htm.

14 K. Iassinovskaia (2021), "How pandemic bike lanes made some Canadian cities more accessible", CBC News, 18 March, https://www.cbc.ca/news/science/pandemic-bike-lanes-canada-1.5951863.

15 F. Richter (2022), "Pandemic-fueled bicycle boom is losing speed", Statista, 13 May, https://www.statista.com/chart/25088/us-consumer-spending-on-bicycles.

16 Aliança Bike (2023), "Brazilian Assocation of the Bicycle Sector: Technical Bulletin of Retail Trade", https://aliancabike.org.br/dados-do-setor/vendas-utilizacao, accessed 10 August 2023.

17 Buehler and Pucher, op. cit. note 6.

18 Ibid.

19 Ibid.

20 Statista (2022), "Projected global e-bike market size in key regions 2018-2030", 16 November, https://www.statista.com/statistics/1260524/global-e-bike-market-forecast-by-region.

21 Ibid.

22 Precedence Research (2022), "E-bike market size to worth around US$ 40.98 billion by 2030", Globenewswire, 7 February, https://www.globenewswire.com/news-release/2022/02/07/2380421/0/en/E-bike-Market-Size-to-Worth-Around-US-40-98-Billion-by-2030.html.

23 L. Lei, S. Carbon and G. Qian (2023), "Towards a National Active Mobility Strategy and an Indicator System for Active-Mobility Friendly Cities in China", Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), https://transition-china.org/wp-content/uploads/2023/01/ActiveMobility.pdf; Bloomberg (2021), "E-Bikes Rule China's Urban Streets: Hyperdrive Daily", 5 April, https://www.bloomberg.com/news/newsletters/2021-04-05/hyperdrive-daily-e-bikes-rule-china-s-urban-streets.

24 Ibid.

25 North American Bikeshare and Scootershare Association (NABSA) (2022), "3rd Annual Shared Mobility State of the Industry", https://doi.org/10.7922/G2H-D7T0P.

26 Ibid.

27 Ibid.

28 D. Fitch (2019), "Electric assisted bikes (e-bikes) show promise in getting people out of cars", University of California at Davis, https://escholarship.org/uc/item/3mm040km.

29 United Cities and Local Governments Asia-Pacific (2023), "Hangzhou: Public bicycle sharing and green travel practice", 31 March, https://uclg-aspac.org/hangzhou-public-bicycle-sharing-and-green-travel-practice.

30 H. Ngo (2021), "Bicycle share schemes have had huge success in some cities and flopped spectacularly in others – what is it that makes or breaks a bike share?" BBC Future Planet, 12 January, https://www.bbc.com/future/article/20210112-the-vast-bicycle-graveyards-of-china.

31 United Cities and Local Governments Asia-Pacific, op. cit. note 29.

32 Ibid.

33 Ibid.

34 F.Z. Menezes (2022), "Tembici saw shared bike use jump 34% in Latin America in two years", Latin America Business Stories, 23 May, https://labsnews.com/en/news/business/tembici-bike-sharing-study.

35 R. Goel (2022), "Cycling behaviour in 17 countries across 6 continents: Levels of cycling, who cycles, for what purpose, and how far?" *Transport Reviews*, Vol. 42, No. 1, https://doi.org/10.1080/01441647.2021.1915898.

36 Ibid.; IPSOS (2022), "Cycling Across the World, a 28-country Global Advisor Survey", May, https://www.ipsos.com/sites/default/files/ct/news/documents/2022-05/Global%20Advisor-Cycling%20Across%20the%20World-2022%20Report.pdf.

37 **Table 1** from Goel, op. cit. note 35.

38 Ibid.

39 Ibid.

40 **Table 2** from Ibid.

41 Ibid.

42 Ibid.

43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 Ibid.

48 Ibid

49 Ibid.

50 Ibid.

51 Ibid.

52 Ibid.

53 Ibid.

54 Ibid.

55 Ibid.

56 Ibid.

57 C.J. Mendiate et al. (2022), "Cycling in sub-Saharan African cities: Differences and similarities with developed world cities", *IATSS Research*, Vol. 46, No. 3, https://www.sciencedirect.com/science/article/pii/S0386111222000346.

58 H. Marquart et al. (2020), "The planned and the perceived city: A comparison of cyclists' and decision-makers' views on cycling quality", *Journal of Transport Geography*, Vol. 82, https://www.sciencedirect.com/science/article/pii/S0966692319303825; Mendiate et al., op. cit. note 57; S.A. Useche (2019), "Healthy but risky: A descriptive study on cyclists' encouraging and discouraging factors for using bicycles, habits and safety outcomes", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 62, pp. 587-598, https://www.sciencedirect.com/science/article/pii/S1369847818306934.

59 Ibid.

60 Ibid.

61 UNEP and UN-Habitat, op. cit. note 5.

62 M. Vanderschuren (2012), "Non Motorised Transport in Africa", https://www.researchgate.net/publication/282764517_Non_Motorised_Transport_in_Africa.

63 Mendiate et al., op. cit. note 57.

64 M. Branion-Calles et al. (2019), "Associations between individual characteristics, availability of bicycle infrastructure, and city-wide safety perceptions of bicycling: A cross-sectional survey of bicyclists in 6 Canadian and U.S. cities", *Transportation Research Part A: Policy and Practice*, Vol. 123, pp. 229-239, https://www.sciencedirect.com/science/article/pii/S0965856417314933.

65 L.D. Olvera et al. (2008), "Household transport expenditure in Sub-Saharan African cities: Measurement and analysis", *Journal of Transport Geography*, Vol. 16, No. 1, 2008, pp. 1-13, https://www.sciencedirect.com/science/article/pii/S0966692307000452.

66 Mendiate et al., op. cit. note 57.

67 E. Mullan (2012), "Swapping the Lycra for the suit: Determinants of cycling for transport among leisure cyclists in Ireland", *International Journal of Health Promotion and Education*, Vol. 50, p. 229, https://doi.org/10.1080/14635240.2012.702510.

68 S. Useche et al. (2019), "Healthy but risky: A descriptive study on cyclists' encouraging and discouraging factors for using bicycles, habits and safety outcomes", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 62, pp. 587-598, https://doi.org/10.1016/j.trf.2019.02.014.

69 Ibid.

70 A. Gauthier (2022), "Cycling's gender gap: Breaking the cycle of inequality", ITDP, 6 July, https://www.itdp.org/2022/07/06/cyclings-gender-gap.

71 Ibid.

72 Ibid.

73 S. Jaafari (2019), "Saudi cyclist says it takes a 'brave heart' to normalize the sport for women", 27 February, https://theworld.org/stories/2019-02-27/saudi-cyclist-says-it-takes-brave-heart-normalize-sport-women.

74 F. Bezhan (2019), "Women banned from cycling in bike-friendly Iranian city", https://www.rferl.org/a/iran-women-banned-cycling-isfahan/29949683.html.

75 R. Goel et al. (2022), "Gender differences in active travel in major cities across the world", *Transportation. Vol. 50*, https://doi.org/10.1007/s11116-021-10259-4.

76 Ibid.

77 Goel et al., op. cit. note 35.

78 Ibid.

79 Ibid.

80 Ibid.

81 Ibid.; Goel et al., op. cit. note 75.

82 World Health Organization (WHO) (2020), "Cyclist safety: An information resource for decision-makers and practitioners", https://www.who.int/publications/i/item/cyclist-safety-an-information-resource-for-decision-makers-and-practitioners.

83 UNEP and UN-Habitat, op. cit. note 5.

84 J. Egiguren et al. (2021), "Premature mortality of 2050 high bike use scenarios in 17 countries", *Environmental Health Perspectives*, Vol. 129, No. 12, https://doi.org/10.1289/ehp9073.

85 Ibid.

86 National Highway Traffic Safety Administration (2022), "Newly released estimates show traffic fatalities reached a 16-year high in 2021", 17 May, https://www.nhtsa.gov/press-releases/early-estimate-2021-traffic-fatalities.

87 Egiguren et al., op. cit. note 84.

88 Ibid.

89 Cherry (2022), "The case for cycling: Tackling climate change", We Are Cycling UK, 8 November, https://www.cyclinguk.org/briefing/case-cycling-tackling-climate-change.

90 E. Long (2023), "The Environmental Impact of Bikes and E-bikes", Environmental Protection, 13 January, https://eponline.com/articles/2023/01/13/environmental-impact-of-bikes-and-e-bikes.aspx.

91 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", www.tcc-gsr.com.

92 C. Brand et al. (2021), "The climate change mitigation impacts of active travel: Evidence from a longitudinal panel study in seven European cities", *Global Environmental Change*, Vol. 67, https://www.sciencedirect.com/science/article/pii/S0959378021000030.

93 Ibid.

94 European Cyclists' Federation (ECF) (2018), "The benefits of cycling: Unlocking their potential for Europe", https://ecf.com/resources/cycling-facts-and-figures.

95 W. Chen et al. (2022), "Historical patterns and sustainability implications of worldwide bicycle ownership and use", *Communications Earth and Environment*, Vol. 3, No. 171, https://doi.org/10.1038/s43247-022-00497-4.

96 I. Philips et al. (2022), "E-bikes and their capability to reduce car CO2 emissions", *Transport Policy*, Vol. 116, pp. 11-23, https://www.sciencedirect.com/science/article/pii/S0967070X21003401.

97 Ibid.

98 Ibid.

99 Ibid.

100 S. Wrighton and K. Reiter (2016), "CycleLogistics – moving Europe forward!" *Transportation Research Procedia*, Vol. 12, pp. 950-958, https://www.sciencedirect.com/science/article/pii/S2352146516000478.

101 Brussel Mobiliteit (2023), "Brussels breathes new life with Cairgo Bike", https://mobilite-mobiliteit.brussels/nl/news/brussel-herademt-met-cairgo-bike, accessed 10 August 2023; Brussel Mobiliteit (2022), "Shared cargo bikes in Brussels", 28 June, https://mobilite-mobiliteit-brussels.prezly.com/deelbakfietsen-in-brussel-r4q4fz.

102 E. Verlinghieri et al. (2021), "The Promise of Low-Carbon Freight: Benefits of Cargo Bikes in London", Possible, https://static1.squarespace.com/static/5d30896202a18c0001b49180/t/61091edc3acfda2f4af7d97f/1627987694676/The+Promise+of+Low-Carbon+Freight.pdf.

103 M. Sheth et al. (2019), "Measuring delivery route cost trade-offs between electric-assist cargo bicycles and delivery trucks in dense urban areas", *European Transport Research Review*, Vol. 11, https://doi.org/10.1186/s12544-019-0349-5.

104 M. Sutton (2021), "Business warm up to electric cargo bikes as 90% cost savings realized", Cycling Industry News, 16 July, https://cyclingindustry.news/electric-cargo-bikes.

105 FedEx (2021), "FedEx Express continues journey towards zero emissions delivery, as Edinburgh, Glasgow and Cambridge become the next UK cities to welcome e-cargo bikes", 2 December, https://newsroom.fedex.com/newsroom/europe-english/fedex-express-continues-journey-towards-zero-emissions-delivery-as-edinburgh-glasgow-and-cambridge-become-the-next-uk-cities-to-welcome-e-cargo-bikes.

106 J. Schünemann et al. (2022), "Life cycle assessment on electric cargo bikes for the use-case of urban freight transportation in Ghana", *Procedia CIRP*, Vol. 105, pp. 721-726, https://www.sciencedirect.com/science/article/pii/S2212827122001214.

107 L. Pearson et al. (2023), "Adults' self-reported barriers and enablers to riding a bike for transport: A systematic review", *Transport Reviews*, Vol. 43, No. 3, pp. 356-384, https://doi.org/10.1080/01441647.2022.2113570.

108 R. Mora et al. (2021), "Equity and accessibility of cycling infrastructure: An analysis of Santiago de Chile", *Journal of Transport Geography*, Vol. 91, https://www.sciencedirect.com/science/article/pii/S096669232100017X.

109 D. Taylor Reich (2022), "Protected Bicycle Lanes Protect the Climate: Measuring How Networks of Protected Bicycle Lanes Reduce Carbon Emissions, Transport Costs, and Premature Death", ITDP, https://www.itdp.org/wp-content/uploads/2022/10/CC-EMBARGOED-OCT192023.pdf.

110 Pearson et al., op. cit. note 107.

111 A.P. Tambapi et al. (2021), "Bicycle ownership and utilization in Tamale Metropolis; influencing factors and impacts to sustainable transport", *Heliyon*, Vol. 7, No. 6, p. e07133, https://doi.org/10.1016/j.heliyon.2021.e07133.

112 C.J. Mendiate et al. (2020), "Identifying clusters of cycling commuters and travel patterns: The case of Quelimane, Mozambique", *International Journal of Sustainable Transportation*, https://doi.org/10.1080/15568318.2020.1774947.

113 Mendiate et al., op. cit. note 57.

114 ITDP (2021), "Rwanda", https://africa.itdp.org/where-we-work/rwanda; C. Mimano, M. Kinyua and C. Kost (2022), "Transit-oriented development as an anchor to compact, equitable, and accessible African cities", SLOCAT Partnership, https://slocat.net/transit-oriented-development-as-an-anchor-to-compact-equitable-and-accessible-african-cities.

115 Urban Systems (2022), "Cycling Safety Study", City of Vancouver, https://vancouver.ca/files/cov/cycling-safety-study-final-report.pdf.

116 J. Uttley et al. (2020), "Road lighting density and brightness linked with increased cycling rates after-dark", *PLOS ONE*, Vol.15, No. 5, p. e0233105, https://doi.org/10.1371/journal.pone.0233105.

117 N. Boyon and R. Grimm (2022), "52% globally say cycling in their area is too dangerous", Ipsos, 24 May, https://www.ipsos.com/en/global-advisor-cycling-across-the-world-2022.

118 F. Küster et al. (2022), "The state of national cycling strategies in Europe (2022)", ECF, https://ecf.com/system/files/The_state_of_national_cycling_strategies_second_edition_2022.pdf.

119 F. Küster (2022), "National cycling strategies are growing in prominence but there is still long way to go", ECF, 22 December, https://ecf.com/news-and-events/news/national-cycling-strategies-are-growing-prominence-there-still-long-way-go.

120 ECF (2023), "National Cycling Policies – The Netherlands", https://ecf.com/policy-areas/cycling-all-policies/national-cycling-policies, accessed 30 June 2023; Netherlands Ministry of Infrastructre and Water Management (2022), "National Vision for the Future Bicycle – The power of the bicycle fully utilized!" https://open.overheid.nl/documenten/ronl-c7e81e32154ccb96643ac477e562518c37d24dea/pdf.

121 Fietsersbond (2022), "Ruim 1,1 miljard euro voor fietsinfrastructuur", 14 November, https://www.fietsersbond.nl/nieuws/ruim-miljard-voor-fietsinfrastructuur.

122 ECF (2023), "National Cycling Policies – Germany", https://ecf.com/policy-areas/cycling-all-policies/national-cycling-policies, accessed 30 June 2023.

123 C. Nijhuis (2021) "Germany plans to double cycling within ten years", Clean Energy Wire, 12 March, https://www.cleanenergywire.org/news/germany-plans-double-cycling-within-ten-years.

124 International Climate Initiative (2023), "Electric Cargo Bikes 'Made in Ghana' – Contributing to the Transformation of Ghana's Transportation", https://www.international-climate-initiative.com/en/project/electric-cargo-bikes-made-in-ghana-contributing-to-the-transformation-of-ghanas-transportation-img2020-i-005-gha-cargo-e-bikes-made-in-ghana.

125 ECF (2023), "National Cycling Policies – Finland", https://ecf.com/policy-areas/cycling-all-policies/national-cycling-policies, accessed 30 June 2023.

126 ITDP India (2022), "The Dawn of a Cycling Revolution", https://smartnet.niua.org/indiacyclechallenge/wp-content/uploads/2022/01/A-Dawn-of-a-Cycling-Revolution-Publication.pdf.

127 Ibid.

128 Government of Canada (2022), "Active Transportation Fund", https://www.infrastructure.gc.ca/trans/active-actif-eng.html.

129 EUROCLIMA+ (2022), "Promoting active mobility with a gender-differentiated approach in Colombia", 22 March, https://www.euroclima.org/en/recent-events-urban/articles-and-interviews/1605-promoting-active-mobility-with-a-gender-differentiated-approach-in-colombia.

130 Ministerio de Transporte de Colombia (2022), "Ministerio de Transporte presenta la Estrategia Nacional de Movilidad Activa para promover modos de transporte donde el desplazamiento depende de la energía de las personas", https://www.mintransporte.gov.co/publicaciones/11052/ministerio-de-transporte-presenta-la-estrategia-nacional-de-movilidad-activa-para-promover-modos-de-transporte-donde-el-desplazamiento-depende-de-la-energia-de-las-personas.

131 Transport Projects Wellington City Council (2023), "Bike Network Documents", https://www.transportprojects.org.nz/current/bikenetwork/background-documents, accessed 10 March 2023.

132 ECF (2023), "COVID-19 Cycling Measures Tracker", https://ecf.com/dashboard, accessed 21 January 2023.

133 Ibid., accessed 30 June.

134 Buehler and Pucher, op. cit. note 6; WHO (2022), "Walking and Cycling: Latest Evidence to Support Policy-making and Practice", https://www.who.int/europe/publications/i/item/9789289057882.

135 MCC Berlin (2021), "Corona crisis lesson: Additional bike lanes induce large increases in cycling", 30 March, https://www.mcc-berlin.net/en/news/information/information-detail/article/corona-crisis-lesson-additional-bike-lanes-induce-large-increases-in-cycling.html.

136 Ibid.

137 H. Grabar (2023), "How Paris kicked out the cars", Slate, 30 March, https://slate.com/business/2023/03/paris-car-ban-bikes-cycling-history-france.html.

138 Ibid.

139 Google (2023), "Environmental Insights Explorer", https://insights.sustainability.google, accessed 23 May 2023.

140 ECF, op. cit. note 132.

141 X. Wen (2023), "Beijing improves conditions for cyclists", ChinaDaily HK, 8 February, https://www.chinadailyhk.com/article/314019#Beijing-improves-conditions-for-cyclists.

142 Ibid.

143 J.P. Ibañez (2021), "Completed bike lanes approaching 500-km mark", Business World, 12 July, https://www.bworldonline.com/economy/2021/07/12/381943/completed-bike-lanes-approaching-500-km-mark.

144 R.M. Nugraha and P.G. Bhwana (2022), "309 KM of Jakarta bike lanes established before 2022 ends", Tempo, 31 August, https://en.tempo.co/read/1628899/309-km-of-jakarta-bike-lanes-established-before-2022-ends.

145 ITDP India, op. cit. note 126.

146 K. Iassinovskaia (2021), "How pandemic bike lanes made some Canadian cities more accessible", CBC News, 18 March, https://www.cbc.ca/news/science/pandemic-bike-lanes-canada-1.5951863. https://www.cbc.ca/news/science/author/katia-iassinovskaia-1.5951928

147 B. Lin et al. (2021), "The impact of COVID-19 cycling infrastructure on low-stress cycling accessibility: A case study in the City of Toronto", *Findings*, https://doi.org/10.32866/001c.19069.

148 C. MilNeil and G. White (2022), "Mayor Wu announces major expansion of Boston's bike network", StreetsBlogMass, 6 September, https://mass.streetsblog.org/2022/09/06/mayor-wu-plans-announcement-on-bostons-bike-network.

149 Ibid.

150 City of Fayetteville (2023), "Active Transportation Plan", https://www.fayetteville-ar.gov/DocumentCenter/View/28276/Active-Transportation-Plan---Update---2623-FINAL.

151 City of Wollongong (2023), "Wollongong Cycling Strategy 2030", https://wollongong.nsw.gov.au/__data/assets/pdf_file/0022/120586/Wollongong-Cycling-Strategy-2030.pdf.

152 Ibid.

153 Gran Fondo Guide (2023), "Khaled bin Mohamed bin Zayed attends inaugural Bike Abu Dhabi Festival", https://www.granfondoguide.com/Contents/Index/6977/khaled-bin-mohamed-bin-zayed-attends-inaugural-bike-abu-dhabi-festival, accessed 30 June 2023; Bike Abu Dhabi (2023), "Helping Abu Dhabi's cycling community to thrive", https://www.bike.abudhabi, accessed 23 February 2023.

154 L. Jaitman (2015), "Urban infrastructure in Latin America and the Caribbean: Public policy priorities", *Latin American Economic Review*, Vol. 24, pp. 1-57, https://doi.org/10.1007/s40503-015-0027-5.

155 L.J. Sibilski and F. Targa (2019), "Latin America's urban cycling culture: A model for other regions?" *Transport for Development*, 25 October, https://blogs.worldbank.org/transport/latin-americas-urban-cycling-culture-model-other-regions.

156 H. Ohlund et al. (2022), "Building emergent cycling infrastructure during the COVID-19 pandemic: The case of Zapopan", *Frontiers in Sustainable Cities*, Vol. 4, https://doi.org/10.3389/frsc.2022.805125.

157 WHO (2020), "Ciclovías Temporales, Bogotá, Colombia", 28 October, https://www.who.int/news-room/feature-stories/detail/ciclov%C3%ADas-temporales-bogot%C3%A1-colombia; L. Gellweiler (2022), "Cycling infrastructure in cities: Bogotá's ambitious bicycle network expansion", Transformative Urban Mobility Initiative, 14 June, https://transformative-mobility.org/cycling-infrastructure-in-cities-bogotas-ambitious-bicycle-network-expansion..

158 Gellweiler, op. cit. note 157.

159 Gobierno de la Ciudad de Mexico (2022), "Duplicamos el número de ciclovías", 26 September, https://gobierno.cdmx.gob.mx/noticias/duplicamos-el-numero-de-ciclovias.

160 El Financiero (2019), "CDMX planea tener una red de ciclovías de 600 kilómetros", https://www.elfinanciero.com.mx/nacional/cdmx-planea-tener-una-red-de-ciclovias-de-600-kilometros; S. Navarrete (2022), "Rodrigo Díaz: La CDMX tiene todo para ser una capital ciclista", Expansión Política, https://politica.expansion.mx/cdmx/2022/07/05/nuevas-ecobici-cdmx-capital-ciclista-rodrigo-diaz-entrevista.

161 C40Cities (2022), "Sustainable mobility for a carbon neutral, resilient and inclusive Buenos Aires", https://www.c40.org/case-studies/sustainable-mobility-buenos-aires/.

162 D. Broom (2021), "This is how Buenos Aires plans to achieve 1 million bike rides a day", World Economic Forum, 11 January, https://www.weforum.org/agenda/2021/01/buenos-aires-argentina-cycle-lanes-pollution.

163 Gobierno de la Ciudad de Buenos Aires (2023), "Alcanzar 300 km de ciclovías y 1.000.000 de viajes diarios en bici", https://buenosaires.gob.ar/compromisos/alcanzar-300-km-de-ciclovias-y-1000000-de-viajes-diarios-en-bici, accessed February 2023.

164 J. Johnson (2023), "Buenos Aires is making progress on its bicycle network, but more needs to be done", Momentum Magazine, 21 April, https://momentummag.com/buenos-aires-is-making-progress-on-its-bicycle-network-but-more-needs-to-be-done.

165 Ohlund et al., op. cit. note 156.

166 Ibid.

167 Ibid.

168 United Nations (2023), "World Bicycle Day, June 3", https://www.un.org/en/observances/bicycle-day.

169 United Nations (2022), "Integration of mainstream bicycling into public transportation systems for sustainable development: draft resolution / Armenia, Bahrain, Burundi, Jordan, Morocco, Philippines, Qatar, Tajikistan, Turkmenistan, Uzbekistan and Viet Nam", https://digitallibrary.un.org/record/3956443?ln=en#record-files-collapse-header.

170 Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (2021), "Pan-European Master Plan for Cycling Promotion", https://thepep.unece.org/sites/default/files/2021-06/MASTERPLAN_2021-05-20-II_BF%25203%2520June_0.pdf.

171 Ibid.

172 M. Brennan (2023), "European Parliament: Create a European Cycling Strategy!" ECF, 16 February, https://ecf.com/news-and-events/news/european-parliament-calls-double-cycling-europe-2030.

173 European Parliament, op. cit. note 2.

174 SLOCAT analysis based on GIZ and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

175 Ibid.

176 Ibid.

177 Ibid.

178 UN Climate Change Conference UK 2021 (2021), "COP26 Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans", 11 November, https://webarchive.nationalarchives.gov.uk/ukgwa/20230313122615/https://ukcop26.org/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans.

179 The Climate Group (2021), "COP26 declaration on accelerating the transition to 100% zero emission cars and vans", https://cop26transportdeclaration.org.

180 UNEP (2021),"Africa network for walking & cycling - Terms of Reference", 14 September, https://www.unep.org/resources/policy-and-strategy/africa-network-walking-cycling-terms-reference.

181 T. Delrive (2021), "COP26: Pro-cycling campaign backed by coalition of 350 organisations helps achieve recognition of active travel in COP26 transport declaration", ECF, 15 November, https://ecf.com/news-and-events/news/cop26-pro-cycling-campaign-backed-coalition-350-organisations-helps-achieve.

182 The Climate Group, op. cit. note 179.

183 M. Brennan (2022), "Report from COP27: Walking and cycling must play a greater role in decarbonising transport, according to over 400 organisations", ECF, 23 November, https://ecf.com/news-and-events/news/report-cop27-walking-and-cycling-must-play-greater-role-decarbonising-transport.

184 ITDP (2022), "Pedaling on: Celebrating one year of ITDP's Cycling Cities Campaign", 9 November, https://www.itdp.org/2022/11/09/one-year-of-itdp-cycling-cities.

185 Union Cycliste Internationale (UCI) (2021), "UCI launches new sustainability guidelines and targets on World Bicycle Day", 3 June, https://www.uci.org/article/uci-launches-new-sustainability-guidelines-and-targets-on-world-bicycle-day/5QjiNKZc47uncUGjFab5or.

186 UCI (2023), "UCI Climate Action Charter", https://www.uci.org/uci-climate-action-charter/4inrJ3kdTJobJaDhopx0J0, accessed 30 June 2023.

187 UCI (2015), "UCI-funded research demonstrates that a switch from motorised vehicles to cycling would help confront these issues, while generating infrastructure savings of up to $25 trillion by 2050", 15 November, https://www.uci.org/article/uci-co-funded-research-quantifies-potential-savings-of-a-worldwide-cycling-culture--173390/7HLbYoK5CdKmxfSeHCu3X2.

188 Global Designing Cities Initiative (2023), "Bloomberg Initiative for Cycling Infrastructure", BICI, https://globaldesigningcities.org/bici, accessed 19 January 2023.

189 ECF (2023), "About us", https://ecf.com/about-us, accessed 30 June 2023.

3.4.1
PUBLIC TRANSPORT

1 Google LLC (2022), "Google COVID-19 Community Mobility Reports", https://www.google.com/covid19/mobility, accessed October 2022.

2 P. Rep. DeFazio (2021), "H.R.3684 – 117th Congress (2021-2022): Infrastructure Investment and Jobs Act", Library of Congress, https://www.congress.gov/bill/117th-congress/house-bill/3684/text - share; J.A. Yarmuth (2022), "H.R.5376 – 117th Congress (2021-2022): Inflation Reduction Act of 2022", http://www.congress.gov.

3 Google LLC, op. cit. note 1.

4 E. Dong, H. Du and L. Gardner (2020), "An interactive web-based dashboard to track COVID-19 in real time", *The Lancet Infectious Diseases*, Vol. 20, No. 5, pp. 533-534, https://doi.org/10.1016/S1473-3099(20)30120-1; Google LLC, op. cit. note 1; S. Woodhouse (2022), "US Public Transport Recovery Still Several Years Away, S&P Says", Bloomberg.com, 27 July, https://www.bloomberg.com/news/articles/2022-07-27/us-public-transport-recovery-still-several-years-away-s-p-says.

5 **Figure 1** from the following sources: Dong, Du and Gardner, op. cit. note 4 ; Google LLC, op. cit. note 1.

6 Dong, Du and Gardner, op. cit. note 4; Google LLC, op. cit. note 1.

7 G. Lozzi, I. Cré and C. Ramos (2022), "Research for TRAN Committee: Relaunching transport and tourism in the EU after COVID-19 – Part VI: Public Transport", European Parliament, https://www.europarl.europa.eu/RegData/etudes/STUD/2022/690899/IPOL_STU(2022)690899_EN.pdf.

8 Ibid.

9 C. Tan (2022), "Bus, train ridership in S'pore rises but numbers still far from pre-Covid-19 levels", The Straits Times, https://www.straitstimes.com/singapore/transport/bus-train-rides-rise-but-numbers-still-far-from-pre-covid-19-levels.

10 Woodhouse, op. cit. note 4.

11 Dong, Du and Gardner, op. cit. note 4; Google LLC, op. cit. note 1.

12 **Box 1** based on the following sources: A. Ardila-Gomez (2020), "In the fight against COVID-19, public transport should be the hero, not the villain", World Bank, 23 July, https://blogs.worldbank.org/transport/fight-against-covid-19-public-transport-should-be-hero-not-villain; Columbia University Irving Medical Center (2021), "CUIMC Infectious Disease Expert Weighs In on Commuting, COVID-19", 10 September, https://www.cuimc.columbia.edu/news/cuimc-infectious-disease-expert-weighs-commuting-covid-19; International Association of Public Transport (UITP) (2020), "Public Transport Is COVID-safe", https://www.uitp.org/publications/public-transport-is-covid-safe; H. Dong et al. (2021), "Understanding public transport satisfaction in post COVID-19 pandemic", *Transport Policy*, Vol. 101, pp. 81-88, https://doi.org/10.1016/j.tranpol.2020.12.004; D. Zukowski (2022), "Cities face rising transit crime that might deter riders", Smart Cities Dive, 25 February, https://www.smartcitiesdive.com/news/cities-face-rising-transit-crime-that-might-deter-riders/619301; B. El Deeb (2015), "Study on Ways and Methods to Eliminate Sexual Harassment in Egypt", UN Women, https://s3-eu-west-1.amazonaws.com/harassmap/media/uploaded-files/287_Summaryreport_eng_low-1.pdf; J.L. Williams, A.A. Malik and S. McTarnaghan (2020), "Gender-Based Violence on Public Transportation", US Agency for International Development, https://www.urban.org/research/publication/gender-based-violence-public-transportation; C. Duchene (2011), "Gender and Transport", International Transport Federation and Organisation for Economic Co-operation and Development (OECD), https://doi.org/10.1787/5kg9mq47w59w-en; E. Graham-Harrison (2015), "Women-only carriages around the world: Do they work?" The Guardian (UK), https://www.theguardian.com/world/2015/aug/26/women-only-train-carriages-around-the-world-jeremy-corbyn; T. Le Barbanchon, R. Rathelot and A. Roulet (2021), "Gender Differences in Job Search: Trading Off Commute Against Wage", *The Quarterly Journal of Economics*, Vol. 136, No. 1, pp. 381-426, https://doi.org/10.1093/qje/qjaa033; S. Zhen (2021), "Rethinking public transportation for women's safety and security", ICLEI Sustainable Mobility, 8 March, https://sustainablemobility.iclei.org/rethinking-public-transportation-for-womens-safety-and-security; M.M.T. Mendonca (2021), "Take five: Why safe transportation is vital for women and girls during the global pandemic", UN Women, 6 April, https://www.unwomen.org/en/news/stories/2021/4/take-five-transportation-is-vital-for-women-and-girls-during-pandemic.

13 UITP (2022), "World Metro Figures 2021", p. 8, https://cms.uitp.org/wp/wp-content/uploads/2022/05/Statistics-Brief-Metro-Figures-2021-web.pdf.

14 Ibid.

15 MTA (2022), "MTA Preliminary Budget Forecasts Fiscal Cliff Closer and Looms Larger as Ridership Recovery Delayed", 27 June, https://new.mta.info/press-release/mta-preliminary-budget-forecasts-fiscal-cliff-closer-and-looms-larger-ridership.

16 Ibid.

17 Ibid.

18 Guangzhou Transport Planning Research Institute Co. Ltd. (2021), "2020 Guangzhou Transportation Development Annual Report", http://www.gztpri.com/html/academic_research/2020_annual_report.html.

19 GSMA (2022), "Guangzhou 5G Smart Transportation City", https://www.gsma.com/5GHub/images/5G-Case-Study-Metro_2022-11-18-035245_pcxr.pdf, accessed 10 December 2022.

20 AECOM (2020), "Workforce mobility: What changed travel patterns mean for the office of the future", https://infrastructure.aecom.com/2020/workforce-mobility-what-changed-travel-patterns-mean-for-the-office-of-the-future.

21 Institution of Civil Engineers (2022), "Public transport funding after Covid-19 – what happens next?" https://www.ice.org.uk/news-insight/policy-and-advocacy/policy-engagement/ice-briefing-paper-public-transport-funding-after-covid-19-what-happens-next.

22 Ibid.

23 Ibid.

24 Ibid

25 European Parliament (2022), "Russia's war on Ukraine: Implications for transport", EPRS, https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733536/EPRS_BRI(2022)733536_EN.pdf.

26 GEP (2022), "Russia-Ukraine War's Effects on the Oil and Gas Industry", 5 July, https://www.gep.com/blog/mind/russia-ukraine-wars-effects-oil-and-gas-industry.

27 Ibid.

28 IQ Air (2020), "COVID-19 Air Quality Report", https://cms.iqair.com/sites/default/files/documents/REPORT-COVID-19-Impact-on-Air-Quality-in-10-Major-Cities_V6.pdf.

29 The German Way (2022), "About Germany's 9-Euro Monthly Public Transport Ticket", 16 May, https://www.german-way.com/travel-and-tourism/public-transport-in-germany/about-germanys-9-euro-ticket.

30 D. Burroughs (2022), "Germany introduces €49 ticket as 9-euro ticket successor", International Railway Journal, 3 November, https://www.railjournal.com/policy/germany-introduces-e49-ticket-as-9-euro-ticket-successor.

31 Infobae (2022), "Gabriel Boric presented an economic recovery plan for USD 3.7 billion", https://www.infobae.com/en/2022/04/08/gabriel-boric-presented-an-economic-recovery-plan-for-usd-37-billion.

32 T.J.C. Piad (2023), "Cost of mobility: As prices bite, some consumers turn to active mobility", Philippine Daily Inquirer, 4 July, https://business.inquirer.net/408352/cost-of-mobility-as-prices-bite-some-consumers-turn-to-active-transport.

33 BusinessWorld (2022), "Public transport system on brink of 'collapse' due to high fuel prices", 14 June, https://www.bworldonline.com/economy/2022/06/14/455032/public-transport-system-on-brink-of-collapse-due-to-high-fuel-prices.

34 UK Department for Transport (2023), "£2 bus fare cap to be extended and bus services protected with new funding", GOV.UK, https://www.gov.uk/government/news/2-bus-fare-cap-to-be-extended-and-bus-services-protected-with-new-funding.

35 UK Department for Transport (2022), "Millions encouraged to Get Around for £2 by bus", GOV.UK, https://www.gov.uk/government/news/millions-encouraged-to-get-around-for-2-by-bus.

36 Institute for Transportation and Development Policy (ITDP) (2022), "Rapid Transit Database", Version 4.00, last modified 1 January 2022, https://docs.google.com/spreadsheets/d/1uMuNG9rTGO52V-uuq6skyqmkH9U5yv1iSJDJYjH64MJM.

37 **Figure 2** from Ibid.

38 Y. Freemark (2022), "Openings and Construction Starts Planned for 2022", The Transport Politic, 24 January, https://www.thetransportpolitic.com/2022/01/24/openings-and-construction-starts-planned-for-2022; G. Topham (2021), "London Underground's Northern line extension comes into service", The Guardian (UK), https://www.theguardian.com/uk-news/2021/sep/20/london-undergrounds-northern-line-extension-comes-into-service.

39 China Ministry of Transport (2022), "2021 Urban Rail Transit Operation Report Card", https://www.thepaper.cn/newsDetail_forward_16268307; China Ministry of Transport (2021), "2020 Urban Rail Transit Operation Data Quick Report", https://www.thepaper.cn/newsDetail_forward_10664032.

40 Freemark, op. cit. note 38.

41 Ibid.

42 teleSUR (2022), "Ecuador Inaugurates First Subway Transportation System", https://www.telesurenglish.net/news/Ecuador-Inaugurates-First-Subway-Transportation-System-20221221-0022.html.

43 BRT+ Centre of Excellence and EMBARQ, "Global BRT Data", https://brtdata.org, accessed 22 December 2022.

44 ITDP, op. cit. note 36; additions for 2022 from SLOCAT Partnership on Sustainable, Low Carbon Transport based on various sources.

45 BRT+ Centre of Excellence and EMBARQ, op. cit. note 43.

46 M. Crippa et al. (2022), "CO2 Emissions of All World Countries", Joint Research Centre of the European Commission, https://data.europa.eu/doi/10.2760/730164.

47 M.A. Sahraei, E. Kuşkapan and M.Y. Çodur (2021), "Public transit usage and air quality index during the COVID-19 lockdown", *Journal of Environmental Management*, Vol. 286, p. 112166, https://doi.org/10.1016/j.jenvman.2021.112166.

48 SLOCAT (2023), "1.1. Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals", SLOCAT Transport, Climate and Sustainability Global Status Report 3rd Edition", https://tcc-gsr.com/wp-content/uploads/2023/06/1.1-Transforming-Transport-and-Mobility-to-Achieve-the-Targets-of-the-Paris-Agreement-and-the-Sustainable-Development-Goals.pdf.

49 **Figures 3 and 4** from Google Data, "Google Environmental Insights Explorer – Make Informed Decisions", https://insights.sustainability.google, accessed 1 December 2022.

50 IQ Air (2020), "COVID-19 Air Quality Report", https://cms.iqair.com/sites/default/files/documents/REPORT-COVID-19-Impact-on-Air-Quality-in-10-Major-Cities_V6.pdf.

51 Ibid.

52 Ibid.

53 Google Data, op. cit. note 49.

54 International Energy Agency (2022), "Trends in electric heavy-duty vehicles – Global EV Outlook 2022", https://www.iea.org/reports/global-ev-outlook-2022/trends-in-electric-heavy-duty-vehicles.

55 Ibid.

56 B. Kiss (2022), "Conquering the World: The Success of Chinese Electric Buses", Autonomy, 10 November, https://www.autonomy.paris/conquering-the-world-the-success-of-chinese-e-buses.

57 S. Mao et al. (2023), "Zero-emission bus and truck market in China: A 2021 update", International Council on Clean Transportation (ICCT), https://theicct.org/wp-content/uploads/2023/01/china-hvs-ze-bus-truck-market-2021-jan23.pdf.

58 Ibid.

59 J. Rodriguez Jr. (2023), "BYD Overcomes Tesla to Become World's Largest EV Maker", Jalopnik, 4 January, https://jalopnik.com/byd-overcomes-tesla-to-become-worlds-largest-ev-maker-1849949551.

60 Clean Mobility Shift (2021), "Seven charts showing how e-buses are more economical than their petrol or diesel counterparts in public transport", 7 April, https://cleanmobilityshift.com/market-trends/seven-charts-showing-how-e-buses-are-more-economical-than-their-petrol-or-diesel-counterparts-in-public-transport.

61 A. Triatmojo et al. (2023), "Evaluation of factors that affect total cost of ownership in support of Transjakarta's electric bus adoption plans", ICCT, https://theicct.org/wp-content/uploads/2023/04/E-bus-TCO-in-Indonesia-Working-Paper-12-A4-v4-FINAL-FOR-PUBLICATION47.pdf.

62 P. Kumar and A. Vijaykumar (2022), "Evaluation of the TCO for diesel and electric buses in Indonesia", Business World, https://india.busworld.org/sites/india/files/2022-01/Evolution%20of%20TCO%20for%20diesel%20and%20electric%20buses_WRI%20India.pdf.

63 R. Magisson-Javaux (2022), "Transdev Group deploys 406 new 100% electric buses in Bogotá", Transdev, 6 April, https://www.transdev.com/en/sustainable-mobility/406-electric-buses-in-bogota.

64 Ibid.

65 DTU (2023), "E-Bus Radar", https://www.ebusradar.org/en, accessed 12 February 2023.

66 M. Dawra and M.D. Pandey (2022), "Expanding the Footprint of the Grand Challenge Across Tier-II India", World Resources Institute (WRI) India, 12 September, https://wri-india.org/blog/expanding-footprint-grand-challenge-across-tier-ii-india.

67 A. Vijaykumar et al. (2022), "Key Lessons for India's Bus Electrification Drive", WRI India, 1 July, https://wri-india.org/blog/key-lessons-indias-bus-electrification-drive; S.C. Singh (2022), "CESL plans mega tender of 50,000 e-buses over 5 years", The Economic Times, https://economictimes.indiatimes.com/industry/renewables/cesl-plans-mega-tender-of-50000-e-buses-over-5-years/articleshow/91948742.cms.

68 Sustainable Bus Staff (2022), "900 e-buses deployed by Mowasalat during the FIFA World Cup. Our experience in Doha", https://www.sustainable-bus.com/news/yutong-qatar-electric-buses-doha.

69 Ibid.

70 Euromoney (2022), "Qatar looks to renewables to power sustainability transition", https://www.euromoney.com/cop27/article/2asmpja0eyducvb5q2tj4/investment/qatar-looks-to-renewables-to-power-sustainability-transition, H. Ritchie, M. Roser and P. Rosado, "Qatar: Energy Country Profile", Our World in Data, https://ourworldindata.org/energy/country/qatar, accessed 20 December 2022.

71 European Commission (2021), "Clean Vehicles Directive", 2 August, https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/clean-and-energy-efficient-vehicles/clean-vehicles-directive_en; S. Wappelhorst and F. Rodriguez (2021), "Decarbonizing bus fleets: Global overview of targets for phasing out combustion engine vehicles", ICCT, 9 December, https://theicct.org/decarbonizing-bus-fleets-global-overview-of-targets-for-phasing-out-combustion-engine-vehicles.

72 Sustainable Bus, "Electric bus, main fleets and projects around the world", https://www.sustainable-bus.com/electric-bus/electric-bus-public-transport-main-fleets-projects-around-world, accessed 20 December 2022.

73 C. Peat (2022), "Stagecoach commits to 80% electric bus expansion", Bus & Coach Buyer, 28 November, https://www.busandcoachbuyer.com/stagecoach-commits-to-80-electric-bus-expansion.

74 **Figure 5** from Blavatnik School of Government, University of Oxford (2023), "Oxford COVID-19 Government Response Tracker", updated 22 January 2023, https://ourworldindata.org/covid-international-domestic-travel; University of Oxford and Blavatnik School of Government (2022), "COVID-19 Government Response Tracker", https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker, accessed 10 December 2022.

75 **Table 1** from COVID Mobility Works (2022), "Find Mobility Responses", https://www.covidmobilityworks.org/find-responses, accessed 15 December 2022.

76 **Figure 6** from T. Fried, B. Welle and S. Avelleda (2021), "Steering a Green, Healthy, and Inclusive Recovery Through Transport", WRI, https://www.wri.org/research/green-recovery-transportation.

77 Associação Nacional das Empresas de Transportes Urbanos (2022), "Remuneração Dos Serviços-Financiamento da operação dos sistemas de transporte público coletivo nas cidades brasileiras", NTU, p. 40, https://www.ntu.org.br/novo/upload/Publicacao/Pub637956597766938349.pdf; E. Yam (2020), "Impact of COVID-19 on public transport", IGC, 6 August, https://www.theigc.org/blog/impact-of-covid-19-on-public-transport.

78 R. Carroll (2022), "Fare deal: Ireland joins Europe-wide efforts to coax people out of cars", The Guardian, 29 July 2022, https://www.theguardian.com/environment/2022/jul/29/fare-deal-ireland-joins-europe-wide-efforts-to-coax-people-out-of-cars; I.J. Trainor (2022), "This Italian region is offering free train fares until 2023", Falstaff, 12 October, https://www.falstaff.com/en/news/this-italian-region-is-offering-free-train-fares-until-2023; T. McClure (2022), "New Zealand halves public transport fares as petrol prices soar amid Russia-Ukraine war", The Guardian, 14 March, https://www.theguardian.com/world/2022/mar/14/new-zealand-halves-public-transport-fares-as-petrol-prices-soar-amid-russia-ukraine-war; UTA (2023), "Apply for the UTA reduced fare farepay card today", https://www.rideuta.com/Fares-And-Passes/Reduced-Fare, accessed 31 July 2023.

79 Fare Free Public Transport (2022), "Information about cities with fare free public transport", https://freepublictransport.info, Mobilité gratuite au Luxembourg (2020), "Free Mobility", 29 February, https://mobilitegratuite.lu/en/free-mobility.

80 Fare Free Public Transport, "Morungaba, Brazil", https://freepublictransport.info/city/morungaba/, accessed 29 February 2023; C. Thornton (2022), "For people in DC, the wheels on the bus will soon go 'round and round' for free", USA Today, 12 December, https://www.usatoday.com/story/news/nation/2022/12/16/washington-cities-free-bus-service/10889269002.

81 A. Kustar, B. Welle and T. H. Tun (2022), "Sustainable Urban Mobility in the NDCs: The Essential Role of Public Transport", WRI, 28 September, https://www.wri.org/research/sustainable-urban-mobility-ndcs-essential-role-public-transport.

82 Ibid.

83 T. Fransen et al. (2022), "The State of Nationally Determined Contributions: 2022", WRI, https://www.wri.org/research/state-nationally-determined-contributions-2022.

84 Ibid.

85 **Figure 7** from Ibid.

86 Ibid.

87 DeFazio, op. cit. note 2; Yarmuth, op. cit. note 2.

88 Ibid.

89 Ibid.

90 T. McDonnell (2022), "China has invested more in Africa than the other top eight lenders combined", Quartz, 10 February, https://qz.com/africa/2125769/china-has-invested-23-billion-in-africas-infrastructure.

91 International Institute for Sustainable Development (2021), "Chinese Investment in Africa Rises as Project Values and Bilateral Trade Decline", https://www.iisd.org/articles/chinese-investment-africa-bilateral-trade-decline.

92 **Box 2** based on the following sources: Sustainable Mobility for All (2022), "How to Unlock Public Transport for Climate Change and Sustainable Development: Six Areas for Action", World Bank, https://www.sum4all.org/data/files/how_to_unlock_public_transport_for_climate_and_sustainable_development-six_areas_for_action.pdf; UN General Assembly (2020), "Resolution adopted by the General Assembly", https://documents-dds-ny.un.org/doc/UNDOC/GEN/N20/226/30/PDF/N2022630.pdf.

93 UITP (2023), "About UITP", https://www.uitp.org/about, accessed 27 July, 2023.

94 UITP (2023), "Barcelona Declaration", https://www.uitp.org/about/barcelona-declaration, accessed 27 July, 2023.

95 International Union of Railways (UIC) (2023), "About UIC", https://uic.org/about/about-uic, accessed 27 July, 2023.

96 UIC (2020), "RAILISA (RAIL Information System and Analyses)", 21 July, https://uic.org/com/enews/article/railisa.

97 COP27 Egypt (2023), "Low Carbon Transport for Urban Sustainability", Sharm El-Sheikh, https://cop27.eg/assets/files/initiatives/LOTUS-BR-01-EGY-10-22-EN.pdf.

98 Transformative Urban Mobility Initiative (TUMI) (2021), "TUMI E-Bus Mission", 9 June, https://www.transformative-mobility.org/campaigns/tumi-e-bus-mission.

99 Ibid.

100 Zero-Emission Bus Resource Alliance (2022), "History", https://zebragrp.org/zebra-mission, accessed 27 July 2023.

3.4.2
INFORMAL TRANSPORT

1 World Resources Institute (WRI) (2023), "Toward Efficient Informal Urban Transit. Learning Guide", The CityFix Learn, https://thecityfixlearn.org/learning-guide/1101, accessed 20 January 2023; G. Jennings and R. Behrens (2017), "The Case for Investing in Informal transport: Strategies for Regulation and Reform", Volvo Research and Educational Foundations (VREF), https://old.vref.se/download/18.162aeb5015e73a8dc15e5e92/1506333871611/Investing%20in%20Informal transport%20-%20Jennings&Behrens%20-%20August%202017.pdf.

2 Jennings and Behrens, op. cit. note 1.

3 C. Venter, A. Mahendra and D. Hidalgo (2019), "From Mobility to Access for All: Expanding Urban Transportation Choices in the Global South. Working Paper", WRI, https://www.wri.org/research/mobility-access-all-expanding-urban-transportation-choices-global-south.

4 Z. Abraham et al. (2023), "Who counts what? What counts where? A global scan of data collection efforts in informal and shared mobility", Agile City Partners and VREF, https://vref.se/wp-content/uploads/2023/06/Who-counts-what-What-counts-where-ISM-Data-Study.pdf.

5 **Figure 1** from WRI, op. cit. note 1, p. 10, and from R. Behrens, D. McCormick and D. Mfinanga, eds. (2016), "Paratransit in African Cities: Operations, Regulation and Reform", https://www.routledge.com/Paratransit-in-African-Cities-Operations-Regulation-and-Reform-1st-Edition/Behrens-McCormick-Mfinanga/p/book/9780415870337.

6 C. McKerracher et al. (2022), "Electric Vehicle Outlook 2022", BloombergNEF, https://about.bnef.com/electric-vehicle-outlook.

7 International Energy Agency (IEA) (2022), "Global EV Outlook 2022", https://www.iea.org/reports/global-ev-outlook-2022.

8 I. Diouf et al. (2020), *Urban Mobility and COVID-19 in Africa*, Transport Global Practice, World Bank Group, and Africa Transport Policy Program, https://www.ssatp.org/sites/ssatp/files/publication/COVID19%20and%20Public%20Transport%20in%20Africa%20-%20FINAL%20-%20Aug2020%20-%20ENGLISH.pdf.

9 Ibid.

10 International Association of Public Transport (UITP) (2021), "Key Insights into transforming the informal transportation sector", https://www.uitp.org/publications/key-insights-into-transforming-the-informal-transport-sector.

11 V.K. Phun et al. (2022), "Influence of the COVID-19 pandemic on old-style LAMAT services in developing cities of Asia: The case study of Phnom Penh", *Asian Transport Studies*, Vol. 8 (30 June), p. 100080, https://doi.org/10.1016/j.eastsj.2022.100080.

12 N. Morales-Miranda et al. (2021), "Enciclopedia del Transporte Informal en América Central", Centro para la Sostenibilidad Urbana and Agile City Partners, https://drive.google.com/file/d/17MU6OYYAk2kAedAwShwfKa_eiyHj2x-f/view.

13 A. Kustar et al. (2023), *Connecting Informal Transport to Climate Action: Key Opportunities for Action*, WRI and VREF, https://vref.se/wp-content/uploads/2023/03/Connecting-Informal-Transport-to-the-Climate-Agenda-Key-Opportunities-for-Actions_fin.pdf. **Figure 2** from the following sources: C.J. Abraham et al. (2021), "Ray of hope for sub-Saharan Africa's Informal transport: Solar charging of urban electric minibus taxis in South Africa", *Energy for Sustainable Development*, Vol. 64 (October), pp. 118-127, https://doi.org/10.1016/j.esd.2021.08.003; R. Behrens et al. (2021), "Transitions – Informal Transport Compendium Report", GOV.UK, https://www.gov.uk/research-for-development-outputs/transitions-informal-transport-compendium-report; WRI, op. cit. note 1.

14 D.E. Agbiboa (2020), "How informal transport systems drive African cities", *Current History*, Vol. 199, No. 817, pp.175-181, https://www.researchgate.net/profile/Daniel-Agbiboa/publication/341470638_How_Informal_Transport_Systems_Drive_African_Cities/links/5ec332c5a6fdcc90d6825df0/How-Informal-Transport-Systems-Drive-African-Cities.pdf; Behrens et al., op. cit. note 13; A. San Gil and N. Morales-Miranda (forthcoming), "A Closer Look at Informal Transportation in the Global South", United Nations Development Programme (UNDP).

15 G. Falchetta, M. Noussan and A.T. Hammad (2021), "Comparing Informal transport in seven major African cities: An accessibility and network analysis", *Journal of Transport Geography*, Vol. 94 (June), p. 103131, https://doi.org/10.1016/j.jtrangeo.2021.103131.

16 Ibid.

17 L. Ribet (2022), "The role of data in electrifying informal transport", SLOCAT Partnership on Sustainable, Low Carbon Transport, https://slocat.net/the-role-of-data-in-electrifying-informal-transport.

18 Agbiboa, op. cit. note 14; Behrens et al., op. cit. note 13; San Gil and Morales-Miranda, op. cit. note 14. **Figure 3** from idem.

19 Abraham et al., op. cit. note 13.

20 Abraham et al., op. cit. note 4.

21 M. Tekest, T. Lika and M. Girma (2022), "Informal transport minibus taxi transport services in Addis Ababa", *Urban Planning and Transport Research*, Vol. 10, No. 1, pp. 311-332, https://doi.org/10.1080/21650020.2022.2086613.

22 Behrens et al., op. cit. note 13.

23 T. Bishop and T. Courtright (2022), "The Wheels of Change: Safe and Sustainable Motorcycles in Sub-Saharan Africa", FIA Foundation, https://drive.google.com/file/d/1HS34CSM75wXZMJDwcn2ohAsEjHNp90-E/edit.

24 Ibid.

25 **Figure 4** based on the following sources: United Nations Economic and Social Commission for Asia and the Pacific (2022), "Tracking Sustainable Mobility in Asia-Pacific Cities", https://repository.unescap.org/bitstream/handle/20.500.12870/5168/ESCAP-2022-RP-Tracking-Sustainable-Mobility-in-Asia-Pacific-Cities-2022.pdf; P. Thakur and S. Pal (2018), "Estimating vehicular emissions from auto rickshaws plying in Bengaluru", *International Journal of Scientific and Engineering Research*, Vol. 9, No. 4, pp. 2241-2245, http://dx.doi.org/10.14299/ijser.2018.05.04; Phun et al., op. cit. note 11.

26 R. Behrens, S. Chalermpong and D. Oviedo (2021), "Informal transport in the Global South", in C. Muller, J.D. Nelson and S. Ison, eds., *The Routledge Handbook of Public Transport*, pp. 236-251.

27 Abraham et al., op. cit. note 13; San Gil and Morales-Miranda, op. cit. note 14. **Figure 5** from idem.

28 Phun et al., op. cit. note 11; V.K. Phun et al. (2020), "Impact of ride-hailing apps on traditional LAMAT services in Asian developing cities: The Phnom Penh Case", *Asian Transport Studies*, Vol. 6, p. 100006, https://doi.org/10.1016/j.eastsj.2020.100006; V.K. Phun et al. (2019), "Informal transport as a connective mode for mass transit systems in Asian developing cities: Case of Bangkok in the era of ride-hailing services", *Transport Policy*, Vol. 75 (March), pp. 27-35, https://doi.org/10.1016/j.tranpol.2019.01.002; V.K. Phun and T. Yai (2016), "State of the art of Informal transport literatures in Asian developing countries", *Asian Transport Studies*, Vol. 4, No. 1, https://doi.org/10.11175/eastsats.4.57.

29 Abraham et al., op. cit. note 4.

30 Espelia-Codatu (2022), "Paratransit in Asia: Scalable solutions to Reform, Modernise and Integrate", Agence Française de Développement (AFD), MobiliseYourCity, https://www.mobiliseyourcity.net/sites/default/files/2022-05/%5BMobiliseYourCity%5D-Paratransit%20in%20Asia-Report.pdf.

31 E. Rail (2022), "Sustainable urban mobility plan for Medan metropolitan area (Mebidangro)", MobiliseYourCity and Agence Française de Développement, https://www.mobiliseyourcity.net/sites/default/files/2022-12/SUMP%20MEBIDANGRO%20FINAL%20REPORT_DRAFT%206_ENG.pdf.

32 WRI, op. cit. note 1; R. Behrens and P.S. Ferro (2015), "From direct to trunk-and-feeder public transport services in the Global South: Territorial implications", *Journal of Transport and Land Use*, Vol. 8, No. 1, https://doi.org/10.5198/jtlu.2015.389. **Figure 6** based on the following sources: Behrens, Chalermpong and Oviedo, op. cit. note 26; L. Wright, J.M. Tangwell and A. Dick (2021), "Public transportation in the Caribbean: Dominance of Informal transport modes", *The West Indian Journal of Engineering*, Vol. 43, No. 2, pp. 31-41, https://www.researchgate.net/profile/Leah-Wright-4/publication/349727222_Public_Transportation_in_the_Caribbean_Dominance_of_Paratransit_Modes/links/603ee6d592851c077f129a58/Public-Transportation-in-the-Caribbean-Dominance-of-Paratransit-Modes.pdf; Morales-Miranda et al., op. cit. note 12; San Gil and Morales-Miranda, op. cit. note 14.

33 **Figure 7** based on the following sources: Abraham et al., op. cit. note 4; D. Oviedo et al. (2022), "A snapshot of the informal organization of public transport operators in the Caribbean: Tap-Tap services in Port-Au-Prince", *Research in Transportation Business and Management*, Vol. 42 (March), p. 100733, https://doi.org/10.1016/j.rtbm.2021.100733; M. Nieto-Combariza et al. (forthcoming), "Motorised three-wheelers and their potential for just mobility in Caribbean urban areas". **Figure 8** from T. Hein et al. (2020), "Informal and Semi-formal Services in Latin America: An Overview of Public Transportation Reforms", Inter-American Development Bank, https://publications.iadb.org/en/informal-and-semi-formal-services-latin-america-overview-public-transportation-reforms.

34 Hein et al., op. cit. note 33.

35 Wright, Tangwell and Dick, op. cit. note 32.

36 WRI, op. cit. note 1.

37 Morales-Miranda et al., op. cit. note 12.

38 Ibid.

39 Ibid.

40 J. Nebrija et al. (forthcoming), "Seeing Informal Transportation. An Emerging Portrait", UNDP.

41 Wright, Tangwell and Dick, op. cit. note 32.

42 Ibid.

43 Businesswire (2022), "Dollaride's Clean Transit Access Program Wins $10 Million Clean Neighborhoods Challenge to Bring Electric Transit to NYC's Underserved Communities", https://www.businesswire.com/news/home/20221117005300/en/Dollaride's-Clean-Transit-Access-Program-Wins-10-Million-Clean-Neighborhoods-Challenge-to-Bring-Electric-Transit-to-NYC's-Underserved-Communities.

44 W. Kębłowski and L. Rekhviashvili (2022), "Moving in informal circles in the Global North: An inquiry into the navettes in Brussels", *Geoforum*, Vol. 136, pp. 251-261, https://doi.org/10.1016/j.geoforum.2020.08.014.

45 Businesswire, op. cit. note 43.

46 WRI, op. cit. note 1.

47 Ibid.

48 Abraham et al., op. cit. note 13.

49 Ibid.

50 Ibid.

51 M. Burger (2022), "First Electric Minibus Taxi Coming to South Africa Aims to Accelerate Green

Mobility Adoption", GoMetro, 9 June, https://gometroapp.com/first-electric-minibus-taxi-coming-to-south-africa; International Transport Forum (ITF) (2022), "Informal transport electrification in South Africa: GoMetro", https://www.youtube.com/watch?v=TzwZaiGBsFw.

52 Ibid.

53 Transformative Urban Mobility Initiative (TUMI), "Shared 3-wheel Electric Transport in El Kelaa des Sraghna Province", https://www.transformative-mobility.org/campaigns/shared-electric-transport-in-el-kelaa-des-sraghna, accessed February 2023.

54 Thakur and Pal, op. cit. note 25.

55 S.B. Nugroho and E. Zusman (2015), "Estimating greenhouse gas (GHG) emissions from Informal transport in Bandung, Indonesia: Reducing the transaction costs of generating conservative emissions baselines", *Natural Resources Forum*, Vol. 39, No. 1, pp. 53-63, https://doi.org/10.1111/1477-8947.12065.

56 TUMI (2020), "e-Rickshaws as Public Transport & Emergency Health Services", https://www.transformative-mobility.org/campaigns/e-rickshaws-as-public-transport-and-health-service-in-singra, accessed 14 February 2023.

57 IEA, op. cit. note 7.

58 S. Song, A. Liu and J. Ma (2022), "Status and Opportunities of Shared Mobility Systems in China", VREF, https://vref.se/wp-content/uploads/2022/08/Informal-and-Shared-Mobility-Systems-in-China_16june.pdf.

59 IEA, op. cit. note 7.

60 McKerracher et al., op. cit. note 6.

61 Nieto-Combariza et al., op. cit. note 33.

62 G-22 (2021), "Tuk Tuk Solar", https://www.g-22.org/tuk-tuk-solar.html, accessed 17 February 2023.

63 A. Kustar, B. Welle and T. Hein Tun (2022), "Sustainable Urban Mobility in the NDCs: The Essential Role of Public Transport", WRI, https://www.wri.org/research/sustainable-urban-mobility-ndcs-essential-role-public-transport.

64 **Table 1** based on the following sources: WRI, op. cit. note 1; S. Baffi and J-P. Lannes (2021), "Understanding Informal transport, Defining and diagnosing Informal transport for sustainable mobility planning", Mobilise Your City, https://changing-transport.org/wp-content/uploads/2021_Understanding-Informal transport.pdf; Abraham et al., op. cit. note 4; Nebrija et al., op. cit. note 40; BodaBoda Safety Association of Kenya, https://bak.co.ke, accessed 17 February 2023; San Gil and Morales-Miranda, op. cit. note 14; WRI, op. cit. note 1; UITP, op. cit. note 10; S. Bose (2019), "Metro launches 'Maha card', user friendly app", Times of India, https://timesofindia.indiatimes.com/city/nagpur/metro-launches-maha-card-user-friendly-app/articleshow/70926914.cms; Government of Mexico City (2020), "Plan de regulación de ciclotaxis histórico", https://semovi.cdmx.gob.mx/storage/app/media/regulacionchenero2020.pdf; Asian Development Bank (2022), "Asian Transport Database", https://data.adb.org/dataset/asian-transport-outlook-database, accessed 15 February 2023; Fons (2021), "LTFRB's Service Contracting Program", The Sakay Blog, https://blog.sakay.ph/service-contracting-program; Institute for Transportation and Development Policy (ITDP) (2023), "Dokumentasi Evaluasi Program Buy-the Service Teman Bus di Indonesia", https://itdp-indonesia.org/wp-content/uploads/2023/02/Laporan-Full-Dokumentasi-Evaluasi-Program-Buy-the-Service-di-Indonesia-1.pdf; E. Beukes, "Informal transport Improvement in South Africa: Context, History, and Recent Initiatives", Informal Transport Day: A TT23 Side Event, Informal Transport Professionalization: The South African Experience, March 2023.

65 WRI, op. cit. note 1.

66 **Box 1** based on the following sources: progress towards SDG 11.2 from Abraham et al., op. cit. note 13; Nieto-Combariza et al., op. cit. note 33; Thakur and Pal, op. cit. note 25; WRI, op. cit. note 13.

67 Asian Development Bank, op. cit. note 64.

68 Digital Transport for Africa (2023), https://digitaltransport4africa.org, accessed 15 February 2023.

69 Global Labour Institute (2023), "Informal Transport", https://www.gli-manchester.net/informal-transport, accessed 15 February 2023; International Transport Workers' Federation (2023), "Informal Transport", https://www.gli-manchester.net/informal-transport, accessed 15 February 2023.

70 Global Network for Popular Transportation (2023), "What is the Global Network for Popular Transportation?" https://www.populartransport.net, accessed 15 February 2023.

71 UITP (2023), "Informal Transport", https://www.uitp.org/topics/informal-transport, accessed 15 February 2023.

72 ITF (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

73 ITF (2023), "Decarbonising Transport initiative", https://www.itf-oecd.org/decarbonising-transport, accessed 15 February 2023.

74 Ibid.

75 Mobilise Your City (2023), "About the Partnership", https://www.mobiliseyourcity.net/about_the_partnership, accessed 15 February 2023.

76 TUMI (2023), https://www.transformative-mobility.org, accessed 15 February 2023.

77 Ibid.

78 United Nations Environment Programme (2023), "Clean air and reduced greenhouse gas emissions with electric two and three wheelers", https://www.unep.org/explore-topics/transport/what-we-do/electric-mobility/electric-two-and-three-wheelers, accessed 14 February 2023.

79 VREF (2023), "Informal and Shared Mobility in Low and Middle Income Countries", https://vref.se/ism, accessed 15 February 2023.

3.4.3
APP-DRIVEN SHARED TRANSPORT

1 S. Castellanos, S. Grant-Muller and K. Wright (2022), "Technology, transport, and the sharing economy: Towards a working taxonomy for shared mobility", *Transport Reviews*, Vol. 42, No. 3, pp. 318-336, https://doi.org/10.1080/01441647.2021.1968976.

2 World Resources Institute (WRI) Mexico (2021), "Demand Responsive Transit: Understanding Emerging Solutions", https://wrimexico.org/sites/default/files/Demand_Responsive_Transit_FINAL.pdf.

3 J. Osman (2021), "Two & Half Years Later, UBER Remains Below Its IPO Price. The CEO Is Buying. Here's Why the Stock Can Gain 50%", Forbes, 13 December, https://www.forbes.com/sites/jimosman/2021/12/13/two--half-years-later-uber-remains-below-its-ipo-price-the-ceo-is-buying-heres-why-the-stock-can-gain-50.

4 R. Bellan (2022), "E-bike subsidies, consolidation and IPOs: Our 2023 micromobility predictions", Tech Crunch, 29 December, https://techcrunch.com/2022/12/29/e-bike-subsidies-consolidation-and-ipos-our-2023-micromobility-predictions.

5 G. Santos (2018), "Sustainability and Shared Mobility Models", *Sustainability*, Vol. 10, No. 9, p. 3194, https://doi.org/10.3390/su10093194; Shared-Use Mobility Center, "What is shared mobility?" https://sharedusemobilitycenter.org/what-is-shared-mobility, accessed May 2023.

6 M. Flor, A. Ortuño and B. Guirao (2022), "Does the Implementation of Ride-Hailing Services Affect Urban Road Safety? The Experience of Madrid", *International Journal of Environmental Research and Public Health*, Vol. 19, No. 5, p. 3078, https://doi.org/10.3390/ijerph19053078.

7 E. Karpinski, E. Bayles and T. Sanders (2022), "Safety Analysis for Micromobility: Recommendations on Risk Metrics and Data Collection", *Transportation Research Record*, Vol. 2676, No. 12, pp. 420-435, https://doi.org/10.1177/03611981221095523.

8 New Urban Mobility Alliance (NUMO) (2023), "All Possible Commutes: How Micromobility and Realistic Car Travel Times Impact Accessibility Analyses", https://www.numo.global/resources/all-possible-commutes-accessibility-analysis-micromobility-paper.

9 Y. Ge et al. (2020), "Racial discrimination in transportation network companies", *Journal of Public Economics*, Vol. 190, p. 104205, https://doi.org/10.1016/j.jpubeco.2020.104205.

10 I. Duncan, "Uber wooed Russia's rich and powerful but failed there anyway", 11 July 2022, https://www.washingtonpost.com/world/2022/07/11/uber-leak-russia-lobbying.

11 Wunder Mobility, "Station-based sharing models – all you need to know", https://www.wundermobility.com/blog/station-based, accessed May 2023.

12 Berg Insight (2022), "The Carsharing Telematics Market – 5th Edition", https://www.researchandmarkets.com/reports/5316994/the-carsharing-telematics-market-5th-edition.

13 M. Nicholas and M. Rajon Bernard (2021), "Success factors for electric carsharing", International Council on Clean Transportation, https://theicct.org/sites/default/files/publications/na-us-eu-ldv-electric-carsharing-factors-aug21_0.pdf.

14 Berg Insight (2022), "Carsharing on the rise but performance varies among regional markets", 9 November, https://www.berginsight.com/carsharing-on-the-rise-but-performance-varies-among-regional-markets.

15 Global Market Insights (2023), "Car Sharing Market Size By Application (Business, Private), By Business Model (Round Trip, One Way), By Model (P2P, Station-based, Free-floating) & Global Forecast, 2023 – 2032", https://www.gminsights.com/industry-analysis/carsharing-market.

16 Berg Insight, op. cit. note 17.

17 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), "Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation, Transport and Climate Change Global Status Report – 2nd edition", www.tcc-gsr.com.

18 M. Srivastava and H. Ying Wong (2023), "The Development of Mobility as a Service in China and Its Impact on Automobile Manufacturers: A Business Model Innovation", *Journal of Innovation Economics & Management*, Vol. 40, pp. 225-263, https://doi.org/10.3917/jie.pr1.0136.

19 Turo (2022), "Turo is launching in Australia", 18 October, https://turo.com/blog/news/turo-is-launching-in-australia.

20 Zoomcar (2022), "Zoomcar achieves over 25,000 registered vehicles on its car sharing marketplace", Cision, 27 September, https://www.prnewswire.com/news-releases/zoomcar-achieves-over-25-000-registered-vehicles-on-its-car-sharing-marketplace-301633887.html.

21 F. Melo (2022), "St. Paul, Minneapolis officially launch all-electric car-sharing network", Twin Cities.com Pioneer Press, 13 May, https://www.twincities.com/2022/05/13/st-paul-minneapolis-officially-launch-all-electric-car-sharing-network.

22 Zity (2023), "Zity grows 56% in 2022 and exceeds the record highs of billing reached in 2019", 2 February, https://zity.eco/en/blog/press-release-zity-2022.

23 S. Casero (2023), "Zity creció un 56% en 2022 y es rentable en Madrid desde el pasado mes de octubre", El Confidencial, 3 February, https://www.elconfidencial.com/motor/nueva-movilidad/2023-02-03/zity-carsharing-madrid-electrico-dacia-spring-renault-zoe_3568975.

24 A. Tirachini (2020), "Ride-hailing, travel behaviour and sustainable mobility: An international review", *Transportation*, Vol. 47, pp. 2011-2047, https://doi.org/10.1007/s11116-019-10070-2.

25 Statista (2023), "Ride-hailing & Taxi – Worldwide", https://www.statista.com/outlook/mmo/shared-mobility/shared-rides/ride-hailing-taxi/worldwide - analyst-opinion.

26 Mordor Intelligence, "Ride-Hailing Market – Growth, Trends, Covid-19 Impact, and Forecasts (2023-2028)", https://www.mordorintelligence.com/industry-reports/ride-hailing-market, accessed January 2023.

27 bne IntelliNews (2023), "Estonia's Bolt set to invest €500mn towards Africa services expansion", 20 February, https://www.intellinews.com/estonia-s-bolt-set-to-invest-500mn-towards-africa-services-expansion-270505.

28 Reuters (2023), "China to launch state-backed transport platform for ride-hailing, trucking", CNN, 18 January, https://www.cnn.com/2023/01/18/tech/china-transport-official-hnk-intl/index.html.

29 Ibid.

30 Reuters (2023), "Ride-hailing app Cabify shutters Ecuador operations", 15 February, https://www.reuters.com/technology/ride-hailing-app-cabify-shutters-ecuador-operations-2023-02-15.

31 euronews (2022), "Uber-rival Beat withdraws from Latin America", 9 November, https://www.euronews.com/next/2022/11/09/beat-latam.

32 K. Browning (2022), "Uber distances itself from Yandex.Taxi, the Russian ride-sharing service", New York Times, 28 February, https://www.nytimes.com/2022/02/28/business/russia-uber-yandex-taxi.html.

33 Meddin Bike-sharing World Map (2022), "The Meddin Bike-sharing World Map Report", https://bikesharingworldmap.com/reports/bswm_mid-2022report.pdf. Note that we removed the number of dockless bikesharing systems as to not double-count with the NUMO data; NUMO (2023), "NUMO Atlas", https://www.numo.global/new-mobility-atlas#2/22.9/19.5, accessed 11 July 2023.

34 NUMO, op. cit. note 33.

35 Ibid.

36 Ibid.

37 H. Jiang et al. (2020), "How Dockless Bike-sharing Changes Lives: An Analysis of Chinese Cities", World Resources Institute, https://doi.org/10.46830/wrirpt.18.00124.

38 S. Sung, A. Liu and J. Ma (2022), "Status and Opportunities of Shared Mobility Systems in China", Volvo Research and Educational Foundations, https://vref.se/wp-content/uploads/2022/08/Informal-and-Shared-Mobility-Systems-in-China_220616.pdf.

39 B. Kras et al. (2021), "MaaS in China", https://dutchmobilityinnovations.com/fileattachment?file=13PHEABcNnpdmCQcM2GE-2g%3D%3D&v=1&isDownload=true.

40 R. Bellan (2021), "Bird is the latest operator to integrate its e-scooters and e-bikes with Google Maps", Tech Crunch, 17 August, https://techcrunch.com/2021/08/17/bird-is-the-latest-operator-to-integrate-its-e-scooters-and-e-bikes-with-google-maps.

41 Markets and Markets (2023), "Mobility as a service market", https://www.marketsandmarkets.com/Market-Reports/mobility-as-a-service-market-78519888.html, accessed January 2023.

42 GlobalNewsWire (2022), "Global Mobility as a Service (MaaS) Market Report 2022: Government Support for Digital Payments Bolsters Sector Growth", 20 December, https://www.globenewswire.com/en/news-release/2022/12/20/2576957/28124/en/Global-Mobility-as-a-Service-MaaS-Market-Report-2022-Government-Support-for-Digital-Payments-Bolsters-Sector-Growth.html.

43 Green Car Congress (2022), "Juniper: Mobility-as-a-Service spend to exceed 350% globally over next 5 years", 7 December, https://www.greencarcongress.com/2022/12/20221207-jumipermaas.html.

44 N. Middleton (2023), "New Mobility-as-a-Service report reveals four key trends for 2023", fleetworld, https://fleetworld.co.uk/new-mobility-as-a-service-report-reveals-four-key-trends-for-2023, accessed 6 July 2023.

45 Ibid.

46 M. Say (2023), "Transport for Wales shows mobility-as-a-service ambition", UKAuthority, 6 February, https://www.ukauthority.com/articles/transport-for-wales-shows-mobility-as-a-service-ambition.

47 Tampa.gov (2022), "City of Tampa Launches Mobility as a Service (MaaS) App", 12 December, https://www.tampa.gov/news/city-tampa-launches-mobility-service-maas-app-111716.

48 D.J. Reck, H. Martin and K.W. Axhausen (2022), "Mode choice, substitution patterns and environmental impacts of shared and personal micro-mobility", *Transportation Research Part D: Transport and Environment*, Vol. 102, p. 103134, https://doi.org/10.1016/j.trd.2021.103134.

49 L. Amatuni et al. (2020), "Does car sharing reduce greenhouse gas emissions? Assessing the modal shift and lifetime shift rebound effects from a life cycle perspective", *Journal of Cleaner Production*, Vol. 266, p. 121869, https://doi.org/10.1016/j.jclepro.2020.121869.

50 N. Ding et al. (2019), "Life cycle assessment of car sharing models and the effect on GWP of urban transportation: A case study of Beijing", *Science of the Total Environment*, Vol. 688, pp. 1137-1144. https://doi.org/10.1016/j.scitotenv.2019.06.111.

51 Electrive (2020), "Trend Europe: Electrification in car-sharing fleets", 8 March, https://www.electrive.com/2020/03/08/trend-europe-electrification-in-car-sharing-fleets; Miles (2022), "WeShare

becomes MILES", https://miles-mobility.com/en-de/miles-weshare, accessed 1 August 2023.

52 Zipcar (2023), "Zipcar Joins White House EV Acceleration Challenge Committing 25% of Its EV Fleet to Empower Disadvantaged Communities", 17 April, https://www.zipcar.com/press/news/ev-white-house-challenge.

53 Tirachini (2020), op. cit. note 24.

54 A. Henao and W.E. Marshall (2019), "The impact of ride-hailing on vehicle miles traveled", *Transportation*, Vol. 46, pp. 2173-2194, https://doi.org/10.1007/s11116-018-9923-2.

55 Y. Zhao et al. (2023), "Feasibility, economic and carbon reduction benefits of ride-hailing vehicle electrification by coupling travel trajectory and charging infrastructure data", *Applied Energy*, Vol. 342, https://doi.org/10.1016/j.apenergy.2023.121102.

56 Uber (2023), "Together on the road to zero emissions", https://www.uber.com/us/en/drive/services/electric, accessed May 2023.

57 BGE (2022), "BGE launches an EV ride-hailing program with Lyft", 21 July, https://www.bgenow.com/2022/07/21/bge-launches-an-ev-ride-hailing-program-with-lyft.

58 European Investment Bank (2022), "Spain: Cabify receives €40 million EIB loan to finance a zero-emission fleet of electric vehicles", 19 December, https://www.eib.org/en/press/all/2022-547-cabify-receives-eur-40-million-eib-loan-to-finance-a-zero-emission-fleet-of-electric-vehicles-in-spain; El Mundo (2022), "Cabify recibe 40 millones de crédito del BEI para comprar 1.400 coches eléctricos", 12 May, https://www.elmundo.es/motor/2022/05/12/627d1e2cfdddffc3798b45c4.html.

59 El Mundo, op. cit. note 58.

60 F. Lambert (2023), "Hertz and Uber announce deployment of 25,000 Tesla and Polestar EVs in Europe", Electrek, 17 January, https://electrek.co/2023/01/17/hertz-uber-deployment-25000-tesla-polestar-evs-europe.

61 Reck, Martin and Axhausen, op. cit. note 48.

62 International Transport Forum (2020), "Good to Go? Assessing the Environmental Performance of New Mobility", https://www.itf-oecd.org/good-go-assessing-environmental-performance-new-mobility.

63 Reck, Martin and Axhausen, op. cit. note 48.

64 B. Sun et al. (2021), "Estimating energy bounds for adoption of shared micromobility", *Transportation Research Part D: Transport and Environment*, Vol. 100, https://doi.org/10.1016/j.trd.2021.103012.

65 Ibid.

66 L. Gebhardt et al. (2022), "Can shared E-scooters reduce CO2 emissions by substituting car trips in Germany?" *Transportation Research Part D: Transport and Environment*, Vol. 109, p. 103328, https://doi.org/10.1016/j.trd.2022.103328.

67 H. Jiang, S. Song and L. Lu (2020), "Dockless Bike Sharing Can Create Healthy, Resilient Urban Mobility", World Resources Institute, 17 November, https://www.wri.org/insights/dockless-bike-sharing-can-create-healthy-resilient-urban-mobility.

68 P. Labee, S. Rasouli and F. Liao (2022), "The implications of mobility as a service for urban emissions", *Transportation Research Part D: Transport and Environment*, Vol. 102, p. 103128, https://www.sciencedirect.com/science/article/pii/S1361920921004235.

69 Business Wire (2022), "Fuel Cost Savings from Mobility-as-a-Service Use to Reach $10.8 Billion by 2027; Driven by Rising Cost of Private Vehicles", Juniper Research, 3 October, https://www.businesswire.com/news/home/20221002005012/en/Juniper-Research-Fuel-Cost-Savings-from-Mobility-as-a-Service-Use-to-Reach-10.8-billion-by-2027-Driven-by-Rising-Cost-of-Private-Vehicles.

70 Labee, Rasouli and Liao, op. cit. note 68.

71 Ibid.

72 H. Lindkvist and L. Melander (2022), "How sustainable are urban transport services? A comparison of MaaS and UCC", *Research in Transportation Business & Management*, Vol. 43, p. 100829, https://doi.org/10.1016/j.rtbm.2022.100829.

73 Shared-Use Mobility Center (2023), "Micromobility Policy Atlas", https://learn.sharedusemobilitycenter.org/atlas, accessed January 2023.

74 M. Bologna (2021), "Car-Sharing Platforms in Peak Demand Become Newest Tax Target", Bloomberg Tax, 8 June, https://news.bloombergtax.com/daily-tax-report-state/car-sharing-platforms-in-peak-demand-become-newest-tax-target.

75 A. Tuominen et al. (2019), "Facilitating practices for sustainable car sharing policies – An integrated approach utilizing user data, urban form variables and mobility patterns", *Transportation Research Interdisciplinary Perspectives*, Vol. 2, p. 100055, https://doi.org/10.1016/j.trip.2019.100055.

76 S. Sitaula (2020), "A new app is helping the taxi industry compete with Uber", 19 May, https://businesschief.com/technology-and-ai/new-app-helping-taxi-industry-compete-uber.

77 A. Hawkins (2022), "Uber will feature NYC taxi cabs in its app under groundbreaking new deal", The Verge, 24 March, https://www.theverge.com/2022/3/24/22994332/uber-yellow-taxi-app-nyc-curb-cmt-arro-deal.

78 Federal Register (2020), "Framework for Automated Driving System Safety", https://www.federalregister.gov/documents/2020/12/03/2020-25930/framework-for-automated-driving-system-safety.

79 D. Ren (2022), "Baidu launches China's first driverless taxi services in Chongqing and Wuhan in landmark moment for autonomous motoring", South China Morning Post, 8 August, https://www.scmp.com/business/china-business/article/3188190/baidu-launches-chinas-first-driverless-taxi-services.

80 D. Kaur (2023), "Baidu granted with the first license to test out driverless taxis in Beijing", Techwire Asia, 4 January, https://techwireasia.com/2023/01/baidu-granted-with-the-first-license-to-test-out-driverless-taxis-in-beijing.

81 A. Nedelea (2022), "Hyundai Launches Driverless Ride Hailing Service in Korea", Inside EVs, 9 June, https://insideevs.com/news/591230/hyundai-korea-driverless-robotaxi-launched.

82 A. Hawkins (2022), "Cruise is now charging for rides in its driverless vehicles in San Francisco", The Verge, 23 June, https://www.theverge.com/2022/6/23/23180156/cruise-driverless-vehicle-charge-riders-san-francisco.

83 P. Slowik, S. Wappelhorst and N. Lutsey (2019), "How Can Taxes and Fees on Ride-Hailing Fleets Steer Them to Electrify?" International Council on Clean Transportation, https://theicct.org/sites/default/files/publications/EV_TNC_ridehailing_wp_20190919.pdf.

84 California Air Resources Board (2023), "Clean Miles Standard", https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard, accessed January 2023; Green Car Congress (2021), "CARB approves Clean Miles Standard for TNCs", 21 May, https://www.greencarcongress.com/2021/05/20210521-cms.html.

85 M. Tu (2021), "Launched During the Pandemic, Metro's $1 Rideshare Experiment Is Expanding to the Westside", dot.LA, 1 December, https://dot.la/metro-micro-expands-2655891997.html.

86 CMS Francis Lefebvre (2020), "La loi d'orientation des mobilités (LOM) et les vélos et trottinettes en libre-service", 6 February, https://cms.law/fr/fra/news-information/la-loi-d-orientation-des-mobilites-lom-et-les-velos-et-trottinettes-en-libre-service.

87 Electrive (2020), "Lime, Tier and Dott win Paris electric kick scooter tender", 27 July, https://www.electrive.com/2020/07/27/lime-tier-and-dott-win-paris-e-kick-scooter-tender.

88 Bird (2020), "Encouraging Better Scooter Parking in Paris Through Design and Incentives", 4 February, https://www.bird.co/blog/encouraging-better-scooter-parking-in-paris-through-design-and-incentives.

89 France 24 (2021), "Paris e-scooters forced to slow down in busy areas", 15 November, https://www.france24.com/en/live-news/20211115-paris-e-scooters-forced-to-slow-down-in-busy-areas.

90 N. Camut (2023), "Paris votes to ban shared e-scooters", Politico, 3 April, https://www.politico.eu/article/paris-bans-e-scooters-in-landmark-referendums.

91 C. Giaume (2023), "Paris bans shared e-scooters after a public consultation", Eltis, 25 April, https://www.eltis.org/in-brief/news/paris-bans-shared-e-scooters-after-public-consultation.

92 M. Modijefsky (2021), "Oslo adopts restrictions on e-scooters", Eltis, 2 August, https://www.eltis.org/in-brief/news/oslo-adopts-restrictions-e-scooters.

93 Ibid.

94 C. Duxbury (2022), "Stockholm's clampdown on 'chaotic' e-scooters", Politico, 17 January, https://www.politico.eu/article/stockholm-sweden-clamp-down-e-scooters-voi.

95 I. Anderson (2022), "Electric Scooter Revolution Faces a Reckoning in Stockholm", Bloomberg, 20 August, https://www.bloomberg.com/news/articles/2022-08-20/stockholm-targets-electric-scooters-with-more-restrictions.

96 L. Pajuelo (2023), "¿Conduce un patinete eléctrico? Estas son las normas que debe cumplir", El País, 23 January, https://elpais.com/tecnologia/tu-tecnologia/2023-01-23/conduces-un-patinete-electrico-estas-son-las-normas-que-debes-cumplir.html.

97 Intelligent Transport (2022), "Bird exits key European and U.S. markets to refocus on financial self-sustainability", 20 October, https://www.intelligenttransport.com/transport-news/140561/bird-exits-european-u-s-markets-financial-self-sustainability.

98 G. Kuntzman (2022), "Bronx Scooter Pilot to Become Permanent — And Likely Expand", Streetsblog, 14 November, https://nyc.streetsblog.org/2022/11/14/bronx-scooter-pilot-to-become-permanent-and-maybe-even-expand.

99 Ibid.

100 SmartCitiesWorld (2022), "Victoria Government launches e-scooter trial programme", 26 January, https://www.smartcitiesworld.net/micromobility/victoria-government-launches-e-scooter-trial-programme-7352.

101 PBSC (2021), "Québec City goes electric!" 23 March, https://www.pbsc.com/blog/2021/03/quebec-city-goes-electric.

102 Intelligent Transport (2022), "E-bikes now available for hire as part of Transport for London's Santander Cycles scheme", 13 October, https://www.intelligenttransport.com/transport-news/140331/e-bikes-available-londons-santander-cycles-scheme.

103 Global Times (2022), "Cairo launches 1st bike-sharing project to promote eco-friendly transport", 21 October, https://www.globaltimes.cn/page/202210/1277637.shtml.

104 Vietnam+ (2022), "Hanoi approves pilot of e-bike sharing model serving BRT passengers", 21 October, https://en.vietnamplus.vn/hanoi-approves-pilot-of-ebike-sharing-model-serving-brt-passengers/240451.vnp.

105 Secretaría Distrital de Movilidad de Bogotá (2022), "Semana de la Bici llega recargada: podrás pedalear en las bicis compartidas", 18 September, https://bogota.gov.co/mi-ciudad/movilidad/semana-de-la-bici-en-bogota-inicia-sistema-de-bicicletas-compartidas; Alcaldía de Bogotá, 2022, "Comienza a operar el Sistema de #BicisCompartidas de Bogotá", 30 September, https://www.youtube.com/watch?v=EFQgZ1e0zWo.

106 S. Navarrete (2022), "Rodrigo Díaz: La CDMX tiene todo para ser una capital ciclista", Expansión Politica, 5 July, https://politica.expansion.mx/cdmx/2022/07/05/nuevas-ecobici-cdmx-capital-ciclista-rodrigo-diaz-entrevista.

107 Open Mobility Foundation (2023), "About MDS", https://www.openmobilityfoundation.org/about-mds, accessed January 2023.

108 Ibid.

109 S. Nicola (2023), "Berlin Tries to Cut Private Car Use With One-Stop Mobility App", Bloomberg, 5 January, https://www.bloomberg.com/news/articles/2023-01-05/berlin-tries-to-cut-traffic-and-emissions-with-jelbi-mobility-sharing-app.

110 J. Plautz (2021), "Pittsburgh's new MaaS platform and mobility hubs aim to support 'universal basic mobility'", Smart Cities Dive, 22 July, https://www.smartcitiesdive.com/news/pittsburghs-new-maas-platform-and-mobility-hubs-aim-to-support-universal/603723; Tampa.gov, op. cit. note 47; S. Song (2022), "Mobility-as-a-Service (Maas) Guideline for Chinese Cities and Case Studies", World Resources Institute, https://wri.org.cn/en/report/MaaS-Guideline-for-Chinese-Cities-and-Case-Studies.

111 Whim (2023), https://whimapp.com/helsinki/en, accessed 1 August 2023.

112 Better Bikeshare Partnership (2023), "About", https://betterbikeshare.org/about, accessed 2 August 2023.

113 MaaS Alliance (2023), https://maas-alliance.eu, accessed 2 August 2023.

114 MaaS Alliance (2023), "Working Together", https://maas-alliance.eu/homepage/working-together/#working-groups, accessed 2 August 2023

115 NUMO (2023), "NUMO New Mobility Atlas", https://www.numo.global/spotlight-on/micromobility/numo-new-mobility-atlas, accessed 2 August 2023.

116 Open Mobility Foundation (2023), "About MDS", https://www.openmobilityfoundation.org/about-mds, accessed 2 August 2023.

117 International Transport Forum (2023), "About the Corporate Partnership Board", https://www.itf-oecd.org/cpb, accessed January 2023; POLIS (2023), "New and shared mobility services", https://www.polisnetwork.eu/topic/new-and-shared-mobility-services-2, accessed January 2023; NUMO (2023), "Alliance News", https://www.numo.global/news, accessed January 2023; Open Mobility Foundation (2023), "Members", https://www.openmobilityfoundation.org/members, accessed January 2023.

3.5 RAIL

1 International Energy Agency (IEA) (2021), "Net Zero by 2050", https://www.iea.org/reports/net-zero-by-2050.

2 Union of Railways (UIC) Sustainability (2022), "The sustainable mobility we want", https://shop.uic.org/en/other-documents/14384-the-sustainable-mobility-that-we-want.html.

3 Ibid.

4 Ibid.

5 UIC (2023), "Passenger kilometers, tonne kilometers, and line kilometers time series over the period 2004-2020", https://uic.org/IMG/pdf/passenger-tonne-line-kilometers-timeseries-over-period-2004-2020.pdf, accessed 21 June 2023.

6 Ibid.

7 G. Lozzi (2022), "Relaunching transport and tourism in the EU after COVID-19: Part VI: Public Transport", European Parliament Committee on Transport and Tourism, https://www.europarl.europa.eu/RegData/etudes/STUD/2022/690899/IPOL_STU(2022)690899_EN.pdf.

8 Renewable Energy Policy Network for the 21st Century (REN21) (2023), "Renewables 2023 Global Status Report Collection: Renewables in Energy Demand", https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

9 **Figure 1** from UIC, op. cit. note 5.

10 S. Elzas (2020), "France to use medicalised high-speed trains to transport Covid-19 victims to hospital", RFI, 26 March, https://www.rfi.fr/en/france/20200326-france-to-use-medicalised-high-speed-trains-to-transport-covid-19-victims-to-hospital.

11 UIC (2023), "Traffic trends among UIC member companies in 2022", 8 June, https://uic-stats.uic.org/resources.

12 Ibid.; Intelligent Transport (2023), "UK rail passenger numbers exceed pre-pandemic levels", 16 March, https://www.intelligenttransport.com/transport-news/144702/uk-rail-passenger-numbers-exceed-pre-pandemic-levels.

13 UIC (2021), "Mobility post-Covid: An opportunity for railways", Roland Berger, https://uic.org/IMG/pdf/mobility-post-covid-an-opportunity-for-railways.pdf.

14 M. Guigon and P. Lorand (2022), "Boosting Passenger Preference for Rail", UIC and McKinsey & Company, https://uic.org/IMG/pdf/20220728_-_uic_and_mckinsey_bossting_passenger_preference_for_rail_final_online.pdf.

15 Ibid.

16 Ibid.

17 D. Briginshaw (2022), "Switzerland revises Rail 2050 strategy to help meet climate objectives", International Rail Journal, 4 July, https://www.railjournal.com/policy/switzerland-revises-rail-2050-strategy-to-help-meet-climate-objectives.

18 UIC, op. cit. note 5.

19 **Figure 2** from Ibid.

20 J.H. Havenga, et al. (2015), Provincial logistics costs in South Africa's Western Cape province: Microcosm of national freight logistics challenges, *Journal of Transport and Supply Chain Management*, Vol. 9, No. 1, https://scholar.sun.ac.za/server/api/core/bitstreams/79b02224-dd16-4704-8f83-c965a4c3d2da/content.

21 Eurasian Rail Alliance Index (2022), "The Eurasian Railway Route and Prospects for China's Exports to Russia", https://index1520.com/en/analytics/evraziyskiy-zheleznodorozhnyy-marshrut-i-perspektivy-eksporta-kitaya-v-rossiyu.

22 Eurasian Rail Alliance Index (ERAI) (2023), "The Eurasian Railway Route and Prospects for China's Exports to Russia", 31 May, https://index1520.com/en/analytics/evraziyskiy-zheleznodorozhnyy-marshrut-i-perspektivy-eksporta-kitaya-v-rossiyu.

23 H. Cokelaere and S.A. Aarup (2022), "Ukraine war shakes up China-Europe railway express", Politico, https://www.politico.eu/article/ukraine-china-silk-road-railway.

24 W.N. Glucroft (2022), "Germany introduces 3 months of cheap travel", DW, 20 May, https://www.dw.com/en/germany-introduces-9-ticket-to-offset-the-impact-of-the-ukraine-war/a-61788020; S. Weichselbaumer (2022), "Study by the Technical University of Munich: What did the 9-euro ticket bring?" BR24, 21 July, https://www.br.de/nachricht-en/bayern/tum-studie-was-hat-das-9-euro-ticket-gebracht,TCEiny0.

25 Weichselbaumer, op. cit. note 24.

26 Deutsche Bahn (2023), "The Deutschland-Ticket is here", https://www.bahn.com/en/offers/regional/deutschlandticket, accessed 20 July 2023.

27 Deutsche Bahn Cargo (2022), "Rail aid link to Ukraine begins operating", 27 July, https://www.dbcargo.com/rail-de-en/logistics-news/db-cargo-db-schenker-launch-of-rail-aid-link-to-ukraine-7331014.

28 **Figure 3** from UIC, op. cit. note 5.

29 Ibid.

30 Railway Pro (2023), "World's high-speed rail network is growing", 8 March, https://www.railwaypro.com/wp/worlds-high-speed-rail-network-is-evolving. **Figure 4** from UIC (2023), "Railisa", https://uic-stats.uic.org.

31 **Figure 5** and **Table 1** from UIC, op. cit. note 30.

32 **Figure 6** from Guigon and Lorand, op. cit. note 14.

33 UIC, op. cit. note 30.

34 S. Watanabe (2023), "China Railway expands high-speed network as profits take back seat", Nikkei Asia, 29 January, https://asia.nikkei.com/Business/Transportation/China-Railway-expands-high-speed-network-as-profits-take-back-seat.

35 UIC, op. cit. note 30

36 Cooperativa Authors (2021), "Proyecto de tren rápido Santiago-Valparaíso se congeló producto de la pandemia", Cooperativa.cl, 15 February, https://cooperativa.cl/noticias/pais/transportes/ferrocarriles/proyecto-de-tren-rapido-santiago-valparaiso-se-congelo-producto-de-la/2021-02-15/170400.html; R. Diamond (2021), "Can new interest in S.A.-to-Monterrey train make it reality?" mySA, 1 September, https://www.mysanantonio.com/sa-inc/article/Mexico-revives-of-dream-of-San-16428503.php; Massa - Pesagem e Automação Industrial (2021), "Trem de alta velocidade no Brasil: realidade ou futuro?" 4 October, https://massa.ind.br/trem-de-alta-velocidade-no-brasil.

37 M. Sahnouni (2023), "Morocco's high-speed train trial run finishes in Marrakech", Morocco World News, https://www.moroccoworldnews.com/2023/01/353710/moroccos-high-speed-train-trial-run-finishes-in-marrakech.

38 Arab News (2023), "IsDB approves $345m for Egypt's electric train project", https://www.arabnews.com/node/2279911/business-economy.

39 Guigon and Lorand, op. cit. note 14.

40 D. Briginshaw, "Brazil plans 3300km of new lines worth $US 10.16bn", International Rail Journal, 13 September, https://www.railjournal.com/freight/brazil-plans-3300km-of-new-lines-worth-us-10-16bn.

41 E. Geerts (2022), "Romania to study first high-speed railway and revamp rail infrastructure", RailTech.com, 28 April, https://www.railtech.com/infrastructure/2022/04/28/romania-plans-to-study-first-high-speed-railway-and-revamps-rail-infrastructure.

42 Guigon and Lorand, op. cit. note 14.

43 H. Ritchie (2020), "Which form of transport has the smallest carbon footprint?" https://ourworldindata.org/travel-carbon-footprint.

44 **Figure 7** from UIC (2021), "Traction energy & emissions database", https://www.co2-data.org/login , accessed 10 August 2023.

45 UIC, op. cit. note 44; ITF (2020), "COVID-19 Transport Brief: Transport Policy Responses to the Coronavirus Crisis", OECD, https://www.itf-oecd.org/sites/default/files/transport-policy-responses-covid-19.pdf.

46 G. Wade (2023), "Location vs market based carbon reporting", Zevero, 27 February, https://www.zevero.earth/post/location-vs-market-based-carbon-reporting.

47 UIC, op. cit. note 44.

48 IEA (2019), "The Future of Rail", https://www.iea.org/reports/the-future-of-rail.

49 Ibid.

50 European Commission, "Rail: Electrification of rail infrastructure", European Alternative Fuels Observatory, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/rail, accessed 11 August 2023

51 **Figure 8** from IEA (2022), "Rail", https://www.iea.org/reports/rail.

52 Ibid.

53 European Commission, op. cit. note 50.

54 REN21, op. cit. note 8.

55 **Figure 9** from UIC, op. cit. note 30.

56 Rail Analysis India (2020), "Indian Railways targets electrification of 7000 Route km for 2020-21; All Broad Gauge network to be electrified by December 2023", 15 July, https://news.railanalysis.com/indian-railways-targets-electrification-of-7000-route-km-for-2020-21-all-broad-gauge-network-to-be-electrified-by-december-2023.

57 I. Todorović (2021), "Romania allocates EUR 3.9 billion from EU recovery funds to zero carbon railway", Balkan Green Energy News, 30 September, https://balkangreenenergynews.com/romania-allocates-eur-3-9-billion-from-eu-recovery-funds-to-zero-carbon-railway.

58 Transport Scotland (2020), "Rail Services Decarbonisation Action Plan", https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf.

59 RailwayPro (2022), "FS Italiane to invest EUR 190 billion until 2031", 20 May, https://www.railwaypro.com/wp/fs-italiane-to-invest-eur-190-billion-until-2031.

60 Livemint (2022), "Indian Railways first solar power plant at Bina which feeds traction power directly", 24 February, https://www.livemint.com/news/india/indian-railways-first-solar-power-plant-at-bina-which-feeds-traction-power-directly-watch-video-11645691000801.html.

61 Leonard (2021), "Rail mobility and hydrogen", https://leonard.vinci.com/en/hydrogen-working-groupe_rail-mobility-and-hydrogen_focus-article-4.

62 Alstom (2023), "Alstom Coradia iLint - the world's 1st hydrogen powered passenger train", https://www.alstom.com/solutions/rolling-stock/alstom-coradia-ilint-worlds-1st-hydrogen-powered-passenger-train, accessed 20 July 2023.

63 Alstom (2022), "World premiere: 14 Coradia iLint to start passenger service on first 100% hydrogen operated route", 24 August, https://www.alstom.com/press-releases-news/2022/8/world-premiere-14-coradia-ilint-start-passenger-service-first-100.

64 E. Geerts (2022), "Romania to study first high-speed railway and revamp rail infrastructure", RailTech.com, 28 April, https://www.railtech.com/infrastruc-

ture/2022/04/28/romania-plans-to-study-first-high-speed-railway-and-revamps-rail-infrastructure.

65 Ibid.

66 A. Ott et al. (2021), "Safe, smart, and green: Boosting European passenger rail's modal share", https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/safe-smart-and-green-boosting-european-passenger-rails-modal-share.

67 RailTech.com (2020), "New European mobility strategy aims to triple high-speed rail traffic", 10 December, https://www.railtech.com/policy/2020/12/10/new-european-mobility-strategy-aims-to-triple-high-speed-rail-traffic.

68 National Conference of State Legislatures (2021), "Infrastructure Investment and Jobs Act", 16 November, https://www.ncsl.org/state-federal/infrastructure-investment-and-jobs-act.

69 The White House (2021), "UPDATED FACT SHEET: Bipartisan Infrastructure Investment and Jobs Act", 2 August, https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/02/updated-fact-sheet-bipartisan-infrastructure-investment-and-jobs-act.

70 BBC News (2022), "Saudi Arabia: 28,000 women apply for 30 train driver jobs", 17 February, https://www.bbc.com/news/world-middle-east-60414143.

71 IEA, op. cit. note 1.

72 African Development Bank and African Union (2023), "Programme for Infrastructure Development in Africa (PIDA): Interconnecting, integrating and transforming a continent", https://www.icafrica.org/fileadmin/documents/PIDA/PIDA Executive Summary - English_re.pdf, accessed 11 August 2023.

73 M. Eccles (2022), "EU approves France's short-haul flight ban – but only for 3 routes", Politico, 2 December, https://www.politico.eu/article/eu-greenlights-frances-short-haul-ban-but-only-on-3-routes.

74 D. Kaminski-Morrow (2022), "Three domestic routes meet criteria for French short-haul flight ban", Flight Global, 2 December, https://www.flightglobal.com/air-transport/three-domestic-routes-meet-criteria-for-french-short-haul-flight-ban/151207.article.

75 Briginshaw, op. cit. note 17.

76 UIC (2022), "Manifesto for the UIC Centenary: Rail solutions for a better future", https://uic.org/IMG/pdf/uic-manifesto_rail-solutions-for-a-better-future.pdf.

77 Centralny Port Komunikacyjny (2023), "Joint Railway Investments for the Three Seas Region. CPK Railways Direction Days", 18 January, https://www.cpk.pl/en/news/joint-railway-investments-for-the-three-seas-region-cpk-railway-direction-days.

78 UIC, op. cit. note 76.

79 African Union Commission (2015), "Agenda 2063: The Africa We Want", https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Agenda2063_Popular_Version_English.pdf.

80 Ibid.

81 DW (2022), "Egypt signs €8 billion deal with Siemens for high-speed rail", https://www.dw.com/en/egypt-signs-8-billion-deal-with-siemens-for-high-speed-rail-system/a-61967258.

82 Railway Technology (2022), "Tanzania and Burundi to establish 282m-long railway route", 17 January, https://www.railway-technology.com/news/tanzania-burundi-railway-route; N. Dausen (2022), "Tanzania, Burundi sign accord to build $900 mln railway line, seek finance", Reuters, 17 January, https://www.reuters.com/article/tanzania-railways-burundi/tanzania-burundi-sign-accord-to-build-900-mln-railway-line-seek-finance-idUSL8N2TX0SX.

83 African Development Bank Group (2022), "The Dakar TER, an express train to development in Senegal", 27 June, https://www.afdb.org/en/success-stories/dakar-ter-express-train-development-senegal-52985.

84 K. Novak (2023), "USD 3 billion for UAE-Oman rail network", Rail Market News, 24 February, https://railmarket.com/news/infrastructure/2998-usd-3-billion-for-uae-oman-rail-network.

85 Analysis from SLOCAT Partnership on Sustainable, Low Carbon Transport based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

86 Ibid.

87 Ibid.

88 A. Pannu (2022), "India Railways aids India's NDC: Set goals for net zero emissions by 2030", The Quint World, 28 November, https://www.thequint.com/climate-change/indian-railways-aids-indias-ndc-set-goals-for-net-zero-emissions-by-2030.

89 Government of Egypt (2022), "Egypt's First Updated Nationally Determined Contributions", United Nations Framework Convention on Climate Change (UNFCCC), https://unfccc.int/sites/default/files/NDC/2022-07/Egypt%20Updated%20NDC.pdf.

90 Government of Thailand (2020), "Thailand's Updated Nationally Determined Contributions", UNFCCC, https://unfccc.int/sites/default/files/NDC/2022-06/Thailand%20Updated%20NDC.pdf.

91 United Arab Emirates (2020), "Second Nationally Determined Contribution of the United Arab Emirates", UNFCCC, https://unfccc.int/sites/default/files/NDC/2022-06/UAE%20Second%20NDC%20-%20UNFCCC%20Submission%20-%20English%20-%20FINAL.pdf.

92 UIC (2023), "About UIC", https://uic.org/about/about-uic/#UIC-s-mission, accessed 11 August 2023.

93 UIC, op. cit. note 76.

94 UIC (2021), "UIC and UITP publish a joint statement for the Transport Thematic Day", 10 November, https://uic.org/com/enews/article/uic-and-uitp-publish-a-joint-statement-for-the-transport-thematic-day.

3.6
ROAD TRANSPORT

1 National Highways (2021), "Net Zero Highways: Our 2030 / 2040 / 2050 Plan", https://nationalhighways.co.uk/our-work/environment/net-zero-highways, accessed 18 July 2023.

2 F. Bergk et al. (2016), "Klimaschutzbeitrag des Verkehrs bis 2050", https://www.umweltbundesamt.de/publikationen/klimaschutzbeitrag-des-verkehrs-bis-2050#:~:text=Ein%20wesentliches%20Ziel%20dieses%20Vorhabens,95%20%25%20in%202050%20gegen%C3%BCber%20 1990; SLOCAT Partnership on Sustainable, Low Carbon Transport (2020), "Transport and Climate Change Global Status Report (2nd ed.)", p. 7, https://tcc-gsr.com/2nd-edition/.

3 Statista (2022), "Global passenger mobility demand in 2018 and 2022, by major transportation mode", https://www.statista.com/statistics/1031444/global-passenger-mobility-demand-transport-mode.

4 Ibid.

5 Google (2023), "Environmental Insights Explorer", https://insights.sustainability.google, accessed 17 May 2023.

6 International Transport Forum (ITF) (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023.

7 Ibid.

8 Eurostat (2023), "Freight transport statistics – modal split", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Freight_transport_statistics_-_modal_split, accessed 21 July 2023.

9 J.P. Rodrigue (2020), "Modal Share of Freight Transportation, Selected Countries, 2020", in *The Geography of Transport Systems*, Routledge, https://transportgeography.org/contents/chapter5/transportation-modes-modal-competition-modal-shift/modal-share-selected-countries.

10 **Figure 1** from P. Nagle and K. Temaj (2022), "Oil prices remain volatile amid demand pessimism and constrained supply", World Bank, 16 December, https://blogs.worldbank.org/opendata/oil-prices-remain-volatile-amid-demand-pessimism-and-constrained-supply.

11 International Energy Agency (IEA) (2022), "Transport", https://www.iea.org/reports/transport; Renewable Energy Policy Network for the 21st Century (REN21) (2023), "Renewables 2023 Global Status Report: Renewables in Energy Demand", p. 40, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

12 REN21, op. cit. note 11.

13 INRIX (2023), "2022 INRIX Global Traffic Scorecard", https://inrix.com/scorecard.

14 Prices are for Brent crude, obtained from Ibid. and from OilPrice.com, "Oil Price Charts", https://oilprice.com/oil-price-charts, accessed 28 March 2023.

15 P. Nagle and K. Temaj (2022), "Oil prices remain volatile amid demand pessimism and constrained supply ", World Bank Blogs, 16 December, https://blogs.worldbank.org/opendata/oil-prices-remain-volatile-amid-demand-pessimism-and-constrained-supply.

16 Ibid.

17 Ibid.

18 Ibid., p. 4.

19 Ibid.

20 Ibid.

21 J. Lazarus et al. (2021), "Bridging the Income and Digital Divide with Shared Automated Electric Vehicles", University of California at Berkeley Transportation Sustainability Research Center, https://doi.org/10.7922/G2707ZQ4.

22 **Figure 2** from International Road Federation (IRF) (2022), "World Road Statistics 2022", https://datawarehouse.worldroadstatistics.org.

23 T. Bishop and T. Courtright (2022), "The Wheels of Change: Safe and Sustainable Motorcycles in Sub-Saharan Africa", FIA Foundation, https://www.fiafoundation.org/media/jyvc3fyh/motorcycle-report-low-res-spreads.pdf.

24 Ibid.

25 Euromonitor (2015), "Top Developed World Cities with Low Reliance on Car-based Mobility", https://www.euromonitor.com/article/top-developed-world-cities-with-low-reliance-on-car-based-mobility; N. Davies (2020), "How major cities are trying to keep people walking and cycling", The Conversation, 11 May, https://theconversation.com/how-major-cities-are-trying-to-keep-people-walking-and-cycling-137909.

26 Office for National Statistics (2019), "Percentage of households with cars by income group, tenure and household composition: Table A47", https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/datasets/percentageofhouseholdswithcarsbyincomegrouptenureandhouseholdcompositionuktablea47.

27 Global Data (2019), "Higher vehicle ownership across developing nations comes at a cost, says GlobalData", 18 September, https://www.globaldata.com/media/business-fundamentals/higher-vehicle-ownership-across-developing-nations-comes-at-a-cost-says-globaldata.

28 US Department of Transportation, Federal Highway Administration (2012), "Exploring the Relationship between Travel Demand and Economic Growth", Figure 1, https://www.fhwa.dot.gov/policy/otps/pubs/vmt_gdp/index.cfm.

29 U. Chrobak (2021), "How America is tackling its greatest source of emissions", BBC News, 21 October, https://www.bbc.com/future/article/20211019-climate-change-how-the-us-can-drive-less.

30 T. Litman, personal communication with SLOCAT, 1 May 2023.

31 J.P. Rodrigue (2020), "The Geography of Transport Systems (5th Edition)", Routledge, https://doi.org/10.4324/9780429346323.

32 Ibid.

33 A. Solum (2022), "Top Boomtowns in America – 2022 Edition", SmartAsset, 2 December, https://smartasset.com/data-studies/top-boomtowns-in-america-2022; Walk Score (2023), https://www.walkscore.com, accessed 21 May 2023.

34 Office for National Statistics, op. cit. note 26.

35 Ibid.

36 X. Delclòs-Alió et al. (2023), "Cars in Latin America: An exploration of the urban landscape and street network correlates of motorization in 300 cities", *Travel Behaviour and Society*, Vol. 30, pp. 192-201, https://doi.org/10.1016/j.tbs.2022.09.005.

37 **Figure 3** from International Organization of Motor Vehicle Manufacturers (OICA) (2023), "Global Sales Statistics 2019-2022", https://www.oica.net/category/sales-statistics, accessed 21 July 2023.

38 Ibid.

39 Ibid.

40 Ibid.

41 IEA (2023), "Global Electric Vehicle Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

42 Ibid.

43 REN21 (2022), "Sidebar 4. Market and Industry Trends for Electric Vehicles", in *Renewables 2022 Global Status Report*, https://www.ren21.net/gsr-2022/chapters/chapter_01/chapter_01/#sidebar_4.

44 B. Cooley (2022), "The most important car automation trends of 2022", CNET, 4 March, https://www.cnet.com/roadshow/news/the-most-important-self-driving-cars-of-2022.

45 IEA (2023), "Global Electric Vehicle Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

46 Ibid.

47 Ibid.

48 IEA (2023), "Trends in charging infrastructure", Global EV Outlook 2023, https://www.iea.org/reports/global-ev-outlook-2023/trends-in-charging-infrastructure.

49 Fast chargers are more than 22 kilowatts (kW) and can serve light-duty vehicles with power ratings of up to 350 kW. Slow chargers are less than or equal to 22 kW. IEA (2022), "Global EV Outlook 2022: Securing supplies for an electric future", https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf.

50 Ibid.

51 IEA (2022), "Global EV Outlook 2022: Trends in charging infrastructure", https://www.iea.org/reports/global-ev-outlook-2022/trends-in-charging-infrastructure.

52 R. Harrabin (2019), "Electric cars 'will not solve transport problem,' report warns", BBC News, 5 July, https://www.bbc.co.uk/news/uk-48875361.

53 C. Ratti (2020), "Car-parking space: The next great urban frontier", World Economic Forum, 10 December, weforum.org/agenda/2020/12/urban-mobility-car-parking-space; Parking Reform Network, "What is Parking Reform?" https://parkingreform.org/what-is-parking-reform, accessed 15 May 2023.

54 A.H. Auchincloss et al. (2015), "Public Parking Fees and Fines: A Survey of U.S. Cities", *Public Works Management & Policy*, Vol. 20, No. 1, pp. 49-59, https://journals.sagepub.com/doi/pdf/10.1177/1087724X13514380.

55 Parkopedia (2022), "Global Parking Index 2022", https://business.parkopedia.com/global-parking-index-2022-1.

56 Ibid.

57 Ibid., p. 8

58 Ibid., p. 13

59 Ibid.

60 J. Levy et al. (2010), "Evaluation of the public health impacts of traffic congestion: A health risk assessment", *Environmental Health*, Vol. 9, No. 65, https://doi.org/10.1186/1476-069X-9-65; Mayor of London (2022), "Cost of congestion in capital revealed as car use remains high", 11 January, https://www.london.gov.uk/press-releases/mayoral/cost-of-congestion-in-capital-revealed.

61 H. Chandler-Wilde (2023), "These are the world's most congested cities", Bloomberg, 10 January, https://www.bloomberg.com/news/articles/2023-01-10/these-are-the-world-s-most-congested-cities.

62 This represented 70 of the 404 cities considered, spanning 58 countries on 6 continents. TomTom (2023), "TomTom Traffic Index: Ranking 2022", https://www.tomtom.com/traffic-index/ranking.

63 M. Beedham (2022), "Here are the world's most congested cities according to the 2021 TomTom Traffic Index", TomTom, 9 February, https://www.tomtom.com/newsroom/explainers-and-insights/the-most-congested-cities-in-2021.

64 Traffic delays exceeded pre-COVID levels in 116 out of 295 cities tracked in the United States and 249 out of 593 cities tracked in Europe. INRIX, op. cit. note 13.

65 **Figure 4** from Ibid.

66 TomTom, op. cit. note 62.

67 INRIX, op. cit. note 13.

68 D. Chechulin et al. (2021), "Building a transport system that works: Five insights from our 25-city

report", McKinsey & Company, 11 August, https://www.mckinsey.com/capabilities/operations/our-insights/building-a-transport-system-that-works-five-insights-from-our-25-city-report.

69 Süddeutsche Zeitung (2022), "Less traffic jams with the nine-euro ticket", 30 June, https://www.sueddeutsche.de/wirtschaft/9-euro-ticket-stau-tom-tom-1.5612144.

70 INRIX, op. cit. note 13.

71 Ibid.

72 Ibid.

73 Ibid.

74 ITF (2021), "Road Safety Annual Report 2021: The Impact of Covid-19", OECD, https://www.itf-oecd.org/sites/default/files/docs/irtad-road-safety-annual-report-2021.pdf.

75 European Commission (2023), "Fatigue and crash risk", Mobility & Transport – Road Safety, https://road-safety.transport.ec.europa.eu/statistics-and-analysis/statistics-and-analysis-archive/fatigue/fatigue-and-crash-risk_en, accessed 21 July 2023; E. Yurday (2022), "Leading causes of car accidents UK 2022", NimbleFins, 5 May, https://www.nimblefins.co.uk/cheap-car-insurance/top-causes-car-accidents-uk; A.E. Retallack and B. Ostendorf (2019), "Current Understanding of the Effects of Congestion on Traffic Accidents", *International Journal of Environmental Research and Public Health*, Vol. 16, No. 18, p. 3400, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6766193.

76 Vision Zero Network, "What is Vision Zero?" https://visionzeronetwork.org/about/what-is-vision-zero, accessed 21 July 2023.

77 ITF (2022), "Road Safety Annual Report 2022", https://www.itf-oecd.org/sites/default/files/docs/irtad-road-safety-annual-report-2022.pdf.

78 US Department of Transportation, National Highway Traffic Safety Administration (2022), "Early Estimates of Motor Vehicle Traffic Fatalities and Fatality Rate by Sub-Categories in 2021", https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813298.

79 M. Kaste (2023), "America's roads are more dangerous, as police pull over fewer drivers", NPR, 6 April, https://www.npr.org/2023/04/06/1167980495/americas-roads-are-more-dangerous-as-police-pull-over-fewer-drivers.

80 IEA, op. cit. note 11; electricity use was split into fossil fuel-based and renewables using the global share of renewables in electricity and heat generation, from IEA (2022), "Energy Statistics Data Browser", https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser; trends over the past decade from REN21, op. cit. note 11, p. 40.

81 IEA (2022), "World Energy Outlook 2022", https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf.

82 REN21, op. cit. note 11, p. 39; IEA, op. cit. note 81, p. 272.

83 IEA (2021), "Global CO2 emissions from transport by subsector, 2000-2030", 4 November, https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-transport-by-subsector-2000-2030.

84 Ibid.

85 **Figure 5** from Ibid.

86 IEA, op. cit. note 81.

87 SLOCAT analysis based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries", Joint Research Centre of the European Union, https://edgar.jrc.ec.europa.eu/dataset_ghg70.

88 **Figure 6** from SLOCAT analysis based on Ibid.

89 Determined following the Worldwide Harmonized Light Vehicles Test Procedure (WLTP). International Council on Clean Transportation (2022), "CO2 emissions from new passenger cars in Europe: Car manufacturers' performance in 2021", https://theicct.org/wp-content/uploads/2022/08/co2-new-passenger-cars-europe-aug22.pdf.

90 CityNews (2023), "Energy agency: SUV growth weighs on emissions, batteries", 27 February, https://toronto.citynews.ca/2023/02/27/energy-agency-suv-growth-weighs-on-emissions-batteries.

91 L. Cozzi and A. Petropoulos (2021), "Carbon emissions fell across all sectors in 2020 except for one – SUVs", IEA, 15 January, https://www.iea.org/commentaries/carbon-emissions-fell-across-all-sectors-in-2020-except-for-one-suvs.

92 CityNews, op. cit. note 90.

93 Ibid.

94 Ibid.

95 Cozzi and Petropoulos, op. cit. note 91.

96 T. Litman (2023), "Comprehensive Transportation Emission Reduction Planning: Guidelines for Evaluating Transportation Emission Reduction Strategies", Victoria Transport Policy Institute, p. 3, https://www.vtpi.org/cterp.pdf?trk=public_post_share-update_update-text.

97 F. Vrbanić et al. (2022), "Influence of Variable Speed Limit Control on Fuel and Electric Energy Consumption, and Exhaust Gas Emissions in Mixed Traffic Flows", *Sustainability*, Vol. 14, p. 932, https://doi.org/10.3390/su14020932.

98 Ibid.

99 H. Egge (2016), "Speed warning system saves lives and reduces emissions", Norwegian SciTech News, 1 December, https://norwegianscitechnews.com/2016/12/speed-warning-system-saves-lives-reduces-emissions.

100 Z. Wadud (2016), "Will self-driving cars reduce energy use and make travel better for the environment?" The Conversation, 26 February, https://theconversation.com/will-self-driving-cars-reduce-energy-use-and-make-travel-better-for-the-environment-55363; Statista, "Market Insights: Mobility", https://www.statista.com/outlook/mobility-markets, accessed 21 July 2023. A UK study estimated that the roll-out of self-driving vehicles could increase congestion 85% by 2060 due to the potential increase in mobility of the elderly and people without a driving licence, from G. Hope (2023), "Self-Driving Cars could 'Increase UK congestion by 85%'", IOT World Today, 19 January, https://www.iotworldtoday.com/transportation-logistics/self-driving-cars-could-increase-uk-congestion-by-85-. A 2022 study in Southern California (USA) projected that the introduction of autonomous vehicles could lead to a 9% increase in vehicle-kilometres travelled and a 9-10% increase in greenhouse gas emissions, from University of California at Los Angeles (UCLA) (2022), "Connected and Automated Vehicle Impacts in Southern California: Travel Behavior, Demand, and Transport System Perspectives", https://doi.org/10.17610/T6NW2P. In contrast, another California study from 2021 concluded that subsidies for public transit rather were the most effective tool in reducing vehicle-kilometres travelled, from J. Lazarus et al. (2021), "Bridging the Income and Digital Divide with Shared Automated Electric Vehicles", March, https://escholarship.org/uc/item/5f1359rd. The organisation Shared Mobility Principles for Livable Cities (www.sharedmobilityprinciples.org) recommends specific policies to ensure that autonomous vehicles support sustainability goals. Most governments are interested in automated vehicles, while the private sector has often focused on purely autonomous vehicles, from S. Shaheen, personal communication with SLOCAT, 25 April 2023.

101 Litman, op. cit. note 30.

102 **Figure 7** from IEA (2021), "World Energy Outlook 2021", Table 1.2, p. 37, https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf.

103 N. Koch et al. (2022), "Attributing agnostically detected large reductions in road CO2 emissions to policy mixes", *Nature Energy*, Vol. 7, No. 9, pp. 1-10, https://www.researchgate.net/publication/362858478_Attributing_agnostically_detected_large_reductions_in_road_CO2_emissions_to_policy_mixes; Bergk et al., op. cit. note 2; SLOCAT, op. cit. note 2, p. 7.

104 Action Net Zero (2022), "What are my sustainable transport options?" https://www.actionnetzero.org/guides-and-tools/sustainable-travel-options-transport-hierarchy; SLOCAT, "Avoid-Shift-Improve Refocusing", https://slocat.net/asi, accessed 20 May 2023.

105 100% bans from REN21, op. cit. note 11, p. 42; lower shares (full list of policies) from REN21 (2023), "GSR 2023 Data Pack", Figure 11, www.ren21.net/gsr2023-data-pack.

106 REN21, op. cit. note 11, p. 42.

107 Council of the European Union (2022), "First 'Fit for 55' proposal agreed: The EU strengthens targets for CO2 emissions for new cars and vans", 27 October, https://www.consilium.europa.eu/en/press/press-releases/2022/10/27/first-fit-for-55-proposal-agreed-the-eu-strengthens-targets-for-co2-emissions-for-new-cars-and-vans.

108 Ibid.

109 N. Cunningham (2021), "Canada announces plans to phase out ICE vehicles by 2035", The Fuse, 6 July, https://energyfuse.org/canada-announces-plans-to-phase-out-ice-vehicles-by-2035.

110 Office of Governor Gavin Newsom (2022), "California releases world's first plan to achieve net zero carbon pollution", 16 November, https://www.gov.ca.gov/2022/11/16/california-releases-worlds-first-plan-to-achieve-net-zero-carbon-pollution.

111 Waka Kotahi – NZ Transport Agency, "Vehicle kilometres travelled (VKT) reduction", https://www.nzta.govt.nz/about-us/about-waka-kotahi-nz-transport-agency/environmental-and-social-responsibility/cerf-programme/cerf-delivery-programmes/vehicle-kilometres-travelled-vkt-reduction, accessed 14 May 2023.

112 Transport Scotland (2023), "20% reduction in car km by 2030", https://www.transport.gov.scot/our-approach/environment/20-reduction-in-car-km-by-2030, accessed 14 May 2023; Transport Scotland (2020), "National Transport Strategy 2", 5 February, https://www.transport.gov.scot/publication/national-transport-strategy-2.

113 K. Hymel (2019), "If you build it, they will drive: Measuring induced demand for vehicle travel in urban areas", *Transport Policy*, Vol. 76, pp. 57-66, https://www.sciencedirect.com/science/article/abs/pii/S0967070X18301720.

114 L. Alter (2021), "Austria cancels highway projects to reduce climate risk", Treehugger, 14 December, https://www.treehugger.com/austria-cancels-highway-projects-5212671.

115 A. Marshall (2021), "The US is gently discouraging states from building new highways", Wired, 16 December, https://www.wired.com/story/us-gently-discouraging-states-building-new-highways.

116 National Highways (2021), "Net Zero Highways: Our 2030 / 2040 / 2050 Plan", p. 2, https://nationalhighways.co.uk/media/eispcjem/net-zero-highways-our-2030-2040-2050-plan.pdf.

117 IEA, "Electric Vehicles", https://www.iea.org/reports/electric-vehicles, accessed 2 August 2023.

118 Bergk et al., op. cit. note 2; SLOCAT, op. cit. note 2, p. 7.

119 S. Yu and T. Munroe (2022), "China to cut new energy vehicle subsidies by 30% in 2022", Reuters, 31 December, https://www.reuters.com/world/china/china-cut-new-energy-vehicle-subsidies-by-30-2022-2021-12-31.

120 J. Kollewe (2022), "Government pulls plug on its remaining UK electric car subsidies", The Guardian (UK), 14 June, https://www.theguardian.com/business/2022/jun/14/government-pulls-plug-on-its-remaining-uk-electric-car-subsidies.

121 National Grid (2022), "What is EV charging anxiety – and is range anxiety a thing of the past?" 11 October, https://www.nationalgrid.com/group/what-ev-charging-anxiety-and-range-anxiety-thing-past.

122 M. Lewis (2021), "England will be first country to require new homes to include EV chargers [update]", Electrek, 22 November, https://electrek.

co/2021/11/22/england-will-be-first-country-to-require-new-homes-to-include-ev-chargers; J. Packroff (2022), "EU Parliament adopts targets for EV charging infrastructure", Euractiv, 20 October, https://www.euractiv.com/section/electric-cars/news/eu-parliament-adopts-targets-for-ev-charging-infrastructure.

123 Public Senate (2022), "The obligation to install photovoltaic panels on large outdoor car parks adopted in the Senate", 4 November, https://www.publicsenat.fr/article/parlementaire/l-obligation-de-pose-de-panneaux-photovoltaiques-sur-les-grands-parkings.

124 REN21, op. cit. note 11, pp. 39-40.

125 Ibid.

126 Ibid.

127 Ibid.

128 Natural Resources Defense Council (2022), "What is congestion pricing?" 25 May, https://www.nrdc.org/stories/what-is-congestion-pricing; US Department of Transportation, Federal Highway Administration (2023), "Congestion pricing: Environmental benefits", https://ops.fhwa.dot.gov/congestionpricing/resources/enviro_benefits.htm, accessed 22 May 2023.

129 D. van Amelsfort (2015), "Introduction to Congestion Charging A Guide for Practitioners in Developing Cities", Asian Development Bank and GIZ, https://www.adb.org/sites/default/files/publication/159940/introduction-congestion-charging.pdf

130 For example, sparking opposition from store owners and taxi drivers who fear losses to business. B. Schofield and N. Rigby (2022), "Mothers in Cambridge start campaign to support congestion charge", BBC News, 10 December, https://www.bbc.co.uk/news/uk-england-cambridgeshire-63919087; BBC News (2022), "Cambridge: Campaigners rally against congestion charge plans", 27 November, https://www.bbc.co.uk/news/uk-england-cambridgeshire-63773692; D.M. Dunn and R. Rivard (2022), "New York pushes ahead on congestion pricing. Now comes the hard part", Politico, 8 November, https://www.politico.com/news/2022/08/11/new-york-new-jersey-congestion-pricing-00050929.

131 J. Tirone (2022), "Congestion pricing, the route more cities are taking", Washington Post, 17 August, https://www.washingtonpost.com/business/congestion-pricing-the-route-more-cities-are-taking/2022/08/16/09376d08-1d8e-11ed-9ce6-68253bd31864_story.html.

132 D.M. Dunn (2022), "It's a global phenomenon – now New York is poised to lead the nation in congestion pricing", Politico, 9 March, https://www.politico.com/news/2022/09/03/as-new-york-moves-forward-on-congestion-pricing-00054379.

133 S. Carpenter (2021), "Santa Monica, downtown LA could see congestion pricing in 2025", Spectrum News 1, 9 February, https://spectrumnews1.com/ca/la-west/transportation/2021/02/09/santa-monica--downtown-la-could-see-congestion-pricing-by-2025; Office of Extraordinary Innovation (2021), "With congestion increasing, here's an update on Metro's Traffic Reduction Study", The Source, 24 June, https://thesource.metro.net/2021/06/24/with-congestion-increasing-heres-an-update-on-metros-traffic-reduction-study; LA Metro (2022), "Update on four concept areas under study for Traffic Reduction Study", The Source, 26 January, https://thesource.metro.net/2022/01/26/update-on-four-concept-areas-under-study-for-traffic-reduction-study.

134 BBC News (2021),"Cambridge congestion charge: Five-year plan considered", 27 August https://www.bbc.com/news/uk-england-cambridgeshire-62692057.

135 Schofield and Rigby, op. cit. note 130; Intelligent Transport (2023), "London's congestion charge celebrates 20 years of success", 17 February, https://www.intelligenttransport.com/transport-news/143883/londons-congestion-charge-celebrates-20-years-of-success; Dunn, op. cit. note 132.

136 Dunn, op. cit. note 132.

137 Organisation for Economic Co-operation and Development (2022), "In Practice: London's congestion charge and its low emission zones", https://www.oecd.org/climate-action/ipac/practices/london-s-congestion-charge-and-its-low-emission-zones-c6cd48e9, accessed 24 July 2023.

138 S. Rothbard, personal communication with SLOCAT, 21 April 2023; M. Pugno, personal communication with SLOCAT, 4 May 2023; EDF, "The Green Freight Handbook", 19 February 2019, https://storage.googleapis.com/scsc/Green%20Freight/EDF-Green-Freight-Handbook.pdf; ICLEI–Local Governments for Sustainability (2023), "Ecologistics Indicators", https://sustainablemobility.iclei.org/wpdm-package/ecologistics_indicators, accessed 16 May 2023.

139 REN21 (2022), "Renewables 2022 Global Status Report: Global Overview", https://www.ren21.net/gsr-2022/chapters/chapter_01/chapter_01/#sub_5.

140 Ibid.

141 US Environmental Protection Agency (EPA) (2022), "Final EPA Standards for Heavy-Duty Vehicles to Slash Dangerous Pollution and Take Key Step Toward Accelerating Zero-Emissions Future", 20 December, https://www.epa.gov/newsreleases/final-epa-standards-heavy-duty-vehicles-slash-dangerous-pollution-and-take-key-step.

142 Ibid.

143 ICLEI, op. cit. note 138.

144 E. White (2022), "Anti-speeding tech Is now mandatory In European Union", Autoweek, 7 July, https://www.autoweek.com/news/industry-news/a40543584/anti-speeding-tech-mandatory-in-european-union.

145 Pan-American Health Organization (2022), "The new General Law of Mobility and Road Safety in Mexico could change the rules of the game", 1 May, https://www.paho.org/es/noticias/1-5-2022-nueva-ley-general-movilidad-seguridad-vial-mexico-podria-cambiar-reglas-juego.

146 European Investment Bank (2022), "Sustainable Transport Overview", https://www.eib.org/attachments/publications/sustainable_transport_overview_2022_en.pdf.

147 US Department of Transportation (2022), "National Road Safety Strategy", https://www.transport.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf.

148 M. Hutchings and D. Davies (2022), "Speed limit to be lowered to 20mph in Wales", BBC News, 12 July, https://www.bbc.com/news/uk-wales-62020427.

149 Accelerating to Zero Coalition (2023), "The Zero Emission Vehicles Declaration", https://acceleratingtozero.org/the-declaration/, accessed 21 July 2023.

150 Race To Zero (2023), "2030 Breakthroughs", https://racetozero.unfccc.int/system/breakthroughs, accessed 21 July 2023.

151 International Road Assessment Programme (2021), "Partnerships for 2030 Impact", https://resources.irap.org/General/iRAP_Plan_for_Decade_of_Action.pdf.

152 World Health Organization and United Nations Regional Commissions (2021), "Global Plan: Decade of Action for Global Road Safety 2021-2030", https://cdn.who.int/media/docs/default-source/documents/health-topics/road-traffic-injuries/global-plan-for-road-safety.pdf.

153 IRF (2023), "The IRF Data Warehouse", https://worldroadstatistics.org/data-warehouse, accessed 21 July 2023.

154 Transport Decarbonisation Alliance (2023), "New Landmark Commitment: 100% Zero-Emission New Truck and Bus Sales & Manufacturing by 2040", https://tda-mobility.org/global-memorandum-of-understanding-on-zero-emission-medium-and-heavy-duty-vehicles, accessed 21 July 2023.

3.7 AVIATION

1 M. Toh (2023), "Global air traffic may return to pre-Covid levels in June, with China leading the way", CNN Business, 16 January, https://www.cnn.com/2023/01/16/business/air-travel-pre-covid-levels-june-2023-intl-hnk/index.html.

2 International Air Transport Association (IATA) (2023), "Airfares recover amid soaring jet fuel costs and inflation", 21 April, https://www.iata.org/en/iata-repository/publications/economic-reports/airfares-recover-amid-soaring-jet-fuel-costs-and-inflation.

3 United Nations World Tourism Organization (2023), "Impact Assessment of the Covid-19 Outbreak on International Tourism", https://www.unwto.org/impact-assessment-of-the-covid-19-outbreak-on-international-tourism, accessed 13 June 2023.

4 D. Carrington (2020), "1% of people cause half of global aviation emissions – study ", The Guardian, 17 November, https://www.theguardian.com/business/2020/nov/17/people-cause-global-aviation-emissions-study-covid-19.

5 Intergovernmental Panel on Climate Change (IPCC) (2022), "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf; UK Department of Transport (2021), "COP 26 Declaration: International Aviation Climate Ambition Coalition", GOV.UK, 10 November, https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition; F. Sehlleier (2023), "Still alive? An update on the COP26 initiatives for transport decarbonisation", https://changing-transport.org/still-alive-an-update-on-the-cop26-initiatives-for-transport-decarbonization, accessed 15 June 2023.

6 International Civil Aviation Organization (ICAO) (2022), "States adopt net-zero 2050 global aspirational goal for international flight operations", 7 October, https://www.icao.int/Newsroom/Pages/States-adopts-netzero-2050-aspirational-goal-for-international-flight-operations.aspx.

7 International Transport Forum (ITF) (2023), "ITF Transport Outlook 2023", https://www.itf-oecd.org/itf-transport-outlook-2023; Shell (2020), "The Energy Transformation Scenarios", https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html.

8 Ibid.

9 IATA (2022), "What types of cargo are transported by air?" 7 September, https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/what-types-of-cargo-are-transported-by-air.

10 IATA (2023), "Air Cargo Market Analysis", https://www.iata.org/en/iata-repository/publications/economic-reports/air-cargo-market-analysis---january-2023.

11 ICAO (2023), "ICAO forecasts complete and sustainable recovery and growth of air passenger demand in 2023", 8 February, https://www.icao.int/Newsroom/Pages/ICAO-forecasts-complete-and-sustainable-recovery-and-growth-of-air-passenger-demand-in-2023.aspx.

12 IATA (2022), "The impact of the war in Ukraine on the aviation industry", https://www.iata.org/en/iata-repository/publications/economic-reports/the-impact-of-the-conflict-between-russia-and-ukraine-on-aviation. **Figure 1** from IATA (2022), "The impact of the war in Ukraine on the aviation industry", https://www.iata.org/en/iata-repository/publications/economic-reports/the-impact-of-the-conflict-between-russia-and-ukraine-on-aviation.

13 TradeArabia (2023), "Air travel to surpass pre-pandemic levels this year: ICAO", Zawya, 9 February, https://www.zawya.com/en/business/travel-and-tourism/air-travel-to-surpass-pre-pandemic-levels-this-year-icao-crtrliuy.

14 ICAO, op. cit. note 6.

15 A. Gavine (2023), "Complete recovery of aviation due in Q1 2023", Aircraft Interiors International, 10 February, https://www.aircraftinteriorsinternational.com/news/industry-news/complete-recovery-of-aviation-due-in-q1-2023.html.

16 IEA (2022), "Aviation Subsector Tracking Report", https://www.iea.org/reports/aviation.

17 Ibid.

18 Reuters (2022), "Russian flights bans hit airlines from 36 countries – aviation authority", 28 February, https://www.reuters.com/business/aerospace-defense/russia-imposes-sweeping-flight-bans-airlines-36-countries-2022-02-28.

19 J. Bailey (2023), "One year of war: How Russia's war in Ukraine is affecting aviation", Simple Flying, 24 February, https://simpleflying.com/one-year-of-war-how-russias-war-in-ukraine-is-affecting-aviation.

20 Ibid.

21 IATA, op. cit. note 9; K. Kelly and M. Walker (2023), "Banned from Russian airspace, U.S. airlines look to restrict competitors", New York Times, https://www.nytimes.com/2023/03/17/us/politics/russia-us-airlines-ukraine.html.

22 International Transport Workers' Federation (2022), "A Zero Carbon Future for the Aviation Sector", https://www.itfglobal.org/en/reports-publications/zero-carbon-future-aviation-sector.

23 Ibid.

24 Ibid.

25 IATA, op. cit. note 9.

26 C. Isidore (2022), "Airfares are going up. Blame full planes, not fuel prices", CNN Business, 15 March, https://edition.cnn.com/2022/03/15/business/rising-airfares-fuel-prices/index.html.

27 IATA and McKinsey & Company (2022), "Understanding the Pandemic's Impact on the Aviation Value Chain", https://www.iata.org/en/iata-repository/publications/economic-reports/understanding-the-pandemics-impact-on-the-aviation-value-chain.

28 IEA, op. cit. note 16.

29 Ibid.

30 Ibid.

31 M. Klöwer et al. (2021), "Quantifying aviation's contribution to global warming", *Environmental Research Letters*, Vol. 16, p. 104027, https://iopscience.iop.org/article/10.1088/1748-9326/ac286e.

32 S. Gössling and A. Humpe (2020), "The global scale, distribution and growth of aviation: Implications for climate change", *Global Environmental Change*, Vol. 65, p. 102194, https://doi.org/10.1016/j.gloenvcha.2020.102194.

33 Ibid.

34 Ibid.

35 Real World Visuals (2022), "One-percenters take to the air", 26 May, https://www.realworldvisuals.com/blog-1/one-percenters-take-to-the-air.

36 **Figure 2** from Ibid.

37 Yard Digital PR Team (2022), "Just plane wrong: Celebs with the worst private jet CO_2 emissions", Yard Insights, 29 July, https://weareyard.com/insights/worst-celebrity-private-jet-co2-emission-offenders.

38 IEA (2022), "Behavioural Changes: Energy System Overview", https://www.iea.org/reports/behavioural-changes.

39 Klöwer et al., op. cit. note 31.

40 Ibid.

41 Ibid.

42 IEA, op. cit. note 16.

43 **Figure 3** from Ibid.

44 B. Graver et al. (2022), "Vision 2050: Aligning Aviation with the Paris Agreement", International Council on Clean Transportation (ICCT), https://theicct.org/wp-content/uploads/2022/06/Aviation-2050-Report-A4-v6.pdf.

45 Ibid. **Figure 4** from idem.

46 Ibid.

47 Ibid.

48 Ibid.

49 L. Limb (2022), "It's official: France bans short haul domestic flights in favour of train travel", EuroNews, 23 May, https://www.euronews.com/green/2022/12/02/is-france-banning-private-jets-everything-we-know-from-a-week-of-green-transport-proposals.

50 M. Eccles and J. Posaner (2021), "French minister: We won't push EU short-haul flight ban", Politico, 16 November, https://www.politico.eu/article/french-transport-minister-backs-national-approach-to-short-haul-flight-bans.

51 N. Chokshi (2022), "Airlines cash in as flexible work changes travel patterns", New York Times, 21 October, https://www.nytimes.com/2022/10/21/business/airlines-flex-work-travel.html.

52 S. Zheng (2023), "Would a frequent flying tax be progressive?" ICCT, 24 February, https://theicct.org/aviation-fft-global-feb23.

53 **Figure 5** from ICAO, op. cit. note 6.

54 SLOCAT Partnership on Sustainable, Low Carbon Transport (2022), "COP27 Outcomes for Sustainable, Low Carbon Transport", www.slocat.net/cop27.

55 United Nations Climate Change Conference UK in Partnership with Italy (2021), "International Aviation Climate Ambition Coalition: COP 26 Declaration", The National Archives, 10 November, https://ukcop26.org/cop-26-declaration-international-aviation-climate-ambition-coalition.

56 United Nations (2021), "COP26: Together for our planet", https://www.un.org/en/climatechange/cop26.

57 J. Faber et al. (2022), "Impacts of a CO2 Ceiling for Dutch Aviation", CE Delft, https://www.rijksoverheid.nl/documenten/rapporten/2023/01/17/bijlage-2-effectenstudie-nationaal-co2-plafond-internationale-luchtvaart.

58 SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

59 Ibid.

60 IPCC, op. cit. note 5.

61 E3G (2022), "COP27: Designing a work programme to scale up pre-2030 mitigation ambition & implementation for 1.5˚C", https://www.e3g.org/wp-content/uploads/E3G-Briefing-Executive-Summary-COP27-Designing-a-Work-Programme-to-Scale-Up-Mitigation-Ambition-and-Implementation-March-2022.pdf.

62 United Nations Framework Convention on Climate Change (UNFCCC) (2023), "First Global Dialogue and Investment Focused Event Under the Sharm el-Sheikh Mitigation Ambition and Implementation Work Programme", 5 June, https://unfccc.int/event/first-global-dialogue-and-investment-focused-event-under-the-sharm-el-sheikh-mitigation-ambition-and.

63 B. Scholl (2023), "What will it take to scale sustainable aviation fuel in the next decade?" World Economic Forum, 10 January, https://www.weforum.org/agenda/2023/01/scale-sustainable-aviation-fuel-in-the-next-decade-davos23.

64 ITF (2021), "Decarbonising Air Transport: Acting Now for the Future", https://www.itf-oecd.org/sites/default/files/docs/decarbonising-air-transport-future.pdf.

65 S. Bakker (2023), Personal communication through peer review comments

66 S. Searle (2020), "E-fuels won't save the internal combustion engine", ICCT, https://theicct.org/e-fuels-wont-save-the-internal-combustion-engine.

67 US Departments of Energy, Transportation, and Agriculture and US Environmental Protection Agency (2022), "SAF Grand Challenge Roadmap: Flight Plan for Sustainable Aviation Fuel", https://www.energy.gov/sites/default/files/2022-09/beto-saf-gc-roadmap-report-sept-2022.pdf.

68 Ministry of Infrastructure and Water Management (2022), "Energy Chains for Carbon Neutral Mobility: Efficiency, Costs and Land Use in Perspective", Netherlands Institute for Transport Policy Analysis, https://english.kimnet.nl/publications/publications/2022/09/09/energy-chains-for-carbon-neutral-mobility.

69 Graver et al., op. cit. note 44.

70 T. Rains (2022), "Airbus just flew its mammoth A380 superjumbo jet using fuel made with cooking oil", Business Insider, 30 March, https://www.businessinsider.com/airbus-operated-a380-jet-with-100-sustainable-aviation-fuel-saf-2022-3.

71 M. Lewis (2021), "Chevron and Gevo partner to produce sustainable aviation fuel", Electrek, 14 September, https://electrek.co/2021/09/14/chevron-gevo-to-produce-sustainable-aviation-fuel.

72 S.G. Carroll (2023), "Deal struck to make sustainable jet fuels mandatory for all EU flights", Euractiv, 26 April, https://www.euractiv.com/section/aviation/news/deal-struck-to-make-sustainable-jet-fuels-mandatory-for-all-eu-flights.

73 Ibid.

74 Ricardo (2023), "Advanced Fuels Fund", https://www.ricardo.com/en/news-and-insights/campaigns/aff, accessed 13 June 2023.

75 Transport & Environment (2022), "Europe's largest airlines claim net zero future whilst lobbying to weaken EU's climate laws", 7 April, https://www.transportenvironment.org/discover/europes-largest-airlines-claim-net-zero-future-whilst-lobbying-to-weaken-eus-climate-laws.

76 Ibid.

77 Ibid.

78 Movin'On Lab (2022), "'Hundreds' of companies race to master electric planes", https://lab.movinonconnect.com/s/article/Hundreds-of-Companies-Race-to-Master-Electric-Planes.

79 D. Shephardson (2022), "U.S. outlines roadmap to boost sustainable aviation fuel", Reuters, 23 September, https://www.reuters.com/business/energy/us-outlines-roadmap-boost-sustainable-aviation-fuel-use-2022-09-23.

80 J. Mukhopadhaya and B. Graver (2022), "Performance analysis of regional electric aircraft", ICCT, https://theicct.org/publication/global-aviation-performance-analysis-regional-electric-aircraft-jul22.

81 Movin'On Lab, op. cit. note 78.

82 R. Cooper (2021), "DHL announces order of first-ever all-electric cargo planes", Climate Action, 4 August, https://www.climateaction.org/news/dhl-announces-order-of-first-ever-all-electric-cargo-planes.

83 SLOCAT (2022), "E-Mobility Trends and Targets", https://slocat.net/e-mobility-targets.

84 D. Nickel (2022), "SAS aims for electric flights in Norway by 2028", https://www.lifeinnorway.net/sas-aims-for-electric-flights-in-norway-by-2028.

85 IEA, op. cit. note 16.

86 L. Benquet (2022), "Airbus invests in world's largest clean hydrogen infrastructure fund managed by Hy24", Climate Action, 26 July, https://www.climateaction.org/news/airbus-invests-in-worlds-largest-clean-hydrogen-infrastructure-fund-managed.

87 Climate Action (2022), "American Airlines announces investment in hydrogen projects", 12 October, https://www.climateaction.org/news/american-airlines-announces-investment-in-hydrogen-projects.

88 D. Boffey (2022), "Dutch group targets hydrogen-fuelled commercial flight in 2028", The Guardian (UK), 13 June, https://www.theguardian.com/environment/2022/jun/13/dutch-group-targets-hydrogen-fuelled-commercial-flight-in-2028.

89 O. Story (2021), "Plans for new zero emission hydrogen plane backed by UK Government unveiled", Climate Action, 7 December, https://www.climateaction.org/news/plans-for-new-zero-emission-hydrogen-plane-backed-by-uk-government-unveiled.

3.8
SHIPPING

1 International Maritime Organization (IMO) (2023), "Revised GHG reduction strategy for global shipping adopted", 7 July, https://www.imo.org/en/MediaCentre/PressBriefings/pages/Revised-GHG-reduction-strategy-for-global-shipping-adopted-.aspx.

2 B. Comer (2023), "IMO's newly revised GHG strategy: What it means for shipping and the Paris Agreement", International Council on Clean Transportation (ICCT), 7 July, https://theicct.org/marine-imo-updated-ghg-strategy-jul23.

3 United Nations Global Compact (2021), "Maritime Just Transition Task Force", https://unglobalcompact.org/take-action/think-labs/just-transition/about.

4 International Chamber of Shipping (ICS) (2023), "Shipping and World Trade: World Seaborne Trade", https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-world-seaborne-trade, accessed 16 June 2023.

5 Climate Now (2022), "Global shipping industry emissions", https://climatenow.com/video/shipping-industry-emissions.

6 ICS (2023), "Shipping and world trade: Driving prosperity", https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-driving-prosperity, accessed 12 June 2023.

7 J. Bhonsle (2023), "10 trends expected to define supply chains and shipping In 2023", Marine Insight, 8 February, https://www.marineinsight.com/maritime-law/trends-expected-to-define-supply-chains-and-shipping.

8 xChange (2022), "Container turnaround times in Asia accelerate, but port congestion in Europe and the US prevents supply chain recovery", 11 January, https://www.container-xchange.com/press-center/container-turnaround-times-in-asia-accelerate-but-port-congestion-in-europe-and-the-us-prevents-supply-chain-recovery.

9 United Nations (UN) (2022), "New deal to resume grain exports through Ukrainian ports 'beacon of hope' for easing global food crisis, United Nations political affairs chief tells Security Council", 29 July, https://press.un.org/en/2022/sc14990.doc.htm.

10 UN Conference on Trade and Development (UNCTAD) (2022), "The Impact on Trade and Development of the War in Ukraine: UNCTAD Rapid Assessment", https://unctad.org/system/files/official-document/osginf2022d1_en.pdf.

11 UNCTAD (2022), "Maritime Trade Disrupted: The War in Ukraine and Its Effects on Maritime Trade Logistics", https://unctad.org/system/files/official-document/osginf2022d2_en.pdf.

12 Ibid.

13 **Figure 1** from Ibid.

14 N. Degnarain (2020), "Calls for global shipping to ditch fossil fuels and meet climate goals", Forbes, 25 September, https://www.forbes.com/sites/nishandegnarain/2020/09/25/loud-calls-for-global-shipping-to-ditch-fossil-fuels-and-meet-climate-goals.

15 UNCTAD (2022), "Review of Maritime Transport 2022: Navigating Stormy Waters", https://unctad.org/rmt2022.

16 P. Fragkos (2022), "Decarbonizing the International Shipping and Aviation Sectors", *Energies*, Vol. 15, p. 9650, https://doi.org/10.3390/en15249650; UNCTAD, op. cit. note 15. **Figure 2** from Degnarain, op. cit. note 14.

17 C. Davy (2019), "Global shipping industry at risk of asset stranding as fossil fuels phased out", China Dialogue Ocean, 17 July, https://chinadialogueocean.net/en/climate/9192-global-shipping-industry-asset-stranding.

18 Ibid.

19 UNCTAD, op. cit. note 15.

20 Ibid.

21 Ibid.

22 Ibid.

23 **Figure 3** from UNCTAD, op. cit. note 11.

24 International Energy Agency (IEA) (2021), "Transport Biofuels Tracking Report", https://www.iea.org/reports/transport-biofuels.

25 T. Solakivi et al. (2022), "Cost competitiveness of alternative maritime fuels in the new regulatory framework", *Transportation Research Part D: Transport and Environment*, Vol. 113, https://www.sciencedirect.com/science/article/pii/S1361920922003261.

26 Eurostat (2022), "Inland waterways 2021: Freight transport up by 3%", 30 September, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220930-1.

27 **Figure 4** from Ibid.

28 Analysis by SLOCAT Partnership on Sustainable, Low Carbon Transport based on M. Crippa et al. (2022), "CO2 Emissions of All World Countries – 2022 Report", EDGAR, https://edgar.jrc.ec.europa.eu/report_2022.

29 **Figure 5** from Marine Benchmark (2023), "Insights", https://www.marinebenchmark.com/insights, accessed 12 June 2023.

30 **Figure 6** from UNCTAD, op. cit. note 15.

31 SLOCAT analysis based on Crippa et al., op. cit. note 28.

32 IEA (2022), "International Shipping Subsector Tracking Report", https://www.iea.org/reports/international-shipping.

33 Ibid.

34 X. Mao and Z. Meng (2022), "Decarbonizing China's coastal shipping: The role of fuel efficiency and low-carbon fuels", ICCT, 27 June, https://theicct.org/publication/china-marine-decarbonizing-chinas-coastal-shipping-jun22.

35 Ibid.

36 P. Jaramillo et al. (2022), "Transport", in Intergovernmental Panel on Climate Change (IPCC), "Climate Change 2022: Mitigation of Climate Change", https://www.ipcc.ch/report/sixth-assessment-report-working-group-3.

37 Ibid.

38 **Figure 7** from Texas Transportation Institute (2022), "A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001-2019, Texas", https://www.nationalwaterwaysfoundation.org/file/28/tti%202022%20final%20report%202001-2019%201.pdf.

39 B.R. Cavalcante de Barros et al. (2022), "Inland waterway transport and the 2030 Agenda: Taxonomy of sustainability issues", *Cleaner Engineering and Technology*, Vol. 8, p. 100462, https://doi.org/10.1016/j.clet.2022.100462.

40 IEA, op. cit. note 32.

41 Ibid.

42 Ibid.

43 UNCTAD, op. cit. note 15.

44 P. Osterkamp et al. (2021), "Five percent zero emission fuels by 2030 needed for Paris-aligned shipping decarbonization", Global Maritime Forum, 9 March, https://www.globalmaritimeforum.org/news/five-percent-zero-emission-fuels-by-2030-needed-for-paris-aligned-shipping-decarbonization.

45 L. Hine and I. Ang (2022), "Methanol momentum surges as shipowners tee up a slew of container ship orders", TradeWinds, 30 June, https://www.tradewindsnews.com/gas/methanol-momentum-surges-as-shipowners-tee-up-a-slew-of-container-ship-orders/2-1-1248217.

46 P. Wolfram et al. (2022), "Using ammonia as a shipping fuel could disturb the nitrogen cycle", *Nature Energy*, Vol. 7, pp. 1112-1114, https://www.nature.com/articles/s41560-022-01124-4.

47 C. De Beukelaer (2023), "Wind-powered cargo ships are the future: Debunking 4 myths that stand in the way of cutting emissions", The Conversation, 14 February, https://theconversation.com/wind-powered-cargo-ships-are-the-future-debunking-4-myths-that-stand-in-the-way-of-cutting-emissions-199396.

48 Ibid.

49 L. Blain (2022), "Giant supertanker uses 9.8% less fuel thanks to 130-foot sails", New Atlas, 2 October, https://newatlas.com/marine/new-aden-supertanker-sails.

50 De Beukelaer, op. cit. note 47.

51 Ibid.

52 J. Kersey, N.D. Popovich and A.A. Phadke (2022), "Rapid battery cost declines accelerate the prospects of all-electric interregional container shipping", *Nature Energy*, Vol. 7, pp. 664-674, https://www.nature.com/articles/s41560-022-01065-y.

53 CBS Bay Area (2022), "Air quality regulators tighten harbor craft rules to cut down pollution in West Oakland", CBS News, 25 March, https://www.cbsnews.com/sanfrancisco/news/air-quality-regulators-tighten-harbor-craft-rules-to-cut-down-pollution-in-west-oakland.

54 Kersey, Popovich and Phadke, op. cit. note 52.

55 Ibid.

56 De Beukelaer, op. cit. note 47.

57 IMO (2022), "Rules on ship carbon intensity and rating system enter into force", 1 November, https://www.imo.org/en/MediaCentre/PressBriefings/pages/CII-and-EEXI-entry-into-force.aspx.

58 R. Anderson and A. Watson (2023), "The IMO Carbon Intensity Indicator (CII): What is it and how to prepare?" CarbonChain, 21 January, https://www.carbonchain.com/blog/the-imo-carbon-intensity-indicator-cii-what-is-it-and-how-to-prepare.

59 IMO, op. cit. note 57.

60 IMO, op. cit. note 1.

61 IMO (2023), "Initial IMO GHG Strategy", https://www.imo.org/en/MediaCentre/HotTopics/pages/reducing-greenhouse-gas-emissions-from-ships.aspx, accessed 24 July 2023

62 IMO, op. cit. note 1.

63 Ibid.

64 Comer, op. cit. note 2.

65 I. Gerretsen (2022), "UN body makes 'breakthrough' on carbon price proposal for shipping", Climate Home News, 23 May, https://www.climatechangenews.com/2022/05/23/un-body-makes-breakthrough-on-carbon-price-proposal-for-shipping.

66 Ibid.

67 IMO (2023), "Annex 1, RESOLUTION MEPC.377(80), 2023 IMO Strategy on Reduction of GHG Emissions from Ships", https://wwwcdn.imo.org/localresources/en/MediaCentre/PressBriefings/Documents/Clean%20version%20of%20Annex%201.pdf.

68 Gerretsen, op. cit. note 65.

69 J. Lo (2021), "Pacific islands make lonely case for carbon price on shipping", Climate Home News, 16 June, https://climatechangenews.com/2021/06/16/pacific-islands-make-lonely-case-carbon-price-shipping.

70 J. Wittels (2021), "Maersk seeks $150-a-ton carbon tax on shipping fuel", Bloomberg, 2 June, https://www.bloomberg.com/news/articles/2021-06-02/shipping-giant-maersk-seeks-150-a-ton-carbon-tax-on-ship-fuel.

71 Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (2022), "Ready, set, decarbonize! Are shipowners committed to a net zero future?" https://cms.zerocarbonshipping.com/media/uploads/documents/Ready-Set-Decarbonize-Assessment-Report-May-2022.pdf.

72 Ibid.

73 **Figure 8** from Ibid.

74 P. Gururaja (2022), "A big first step toward green shipping corridors", ClimateWorks Foundation, 7 February, https://www.climateworks.org/blog/green-shipping-corridors.

75 D. Thomas (2021), "Amazon, Ikea and Unilever pledge zero-carbon shipping by 2040", BBC News, 19 October, https://www.bbc.com/news/business-58970877.

76 C40 Cities (2022), "Port of Los Angeles, Port of Shanghai, and C40 Cities announce partnership to create world's first transpacific green shipping corridor between ports in the United States and China", 28 January, https://www.c40.org/news/la-shanghai-green-shipping-corridor; Gururaja, op. cit. note 74.

77 European Commission (2020), "Sustainable and Smart Mobility Strategy – Putting European Transport on Track for the Future", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-%3A52020DC0789.

78 Eurostat (2023), "Freight transport statistics – modal split", https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Freight_transport_statistics_-_modal_split#Modal_split_of_freight_transport_in_the_EU.

79 M. Selwyn (2022), "Paving the way for a decarbonized shipping industry that leaves no one behind", Race To Zero, 9 November, https://climatechampions.unfccc.int/paving-the-way-for-a-decarbonized-shipping-industry-that-leaves-no-one-behind.

80 Gururaja, op. cit. note 74.

81 IPCC (2022), "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf.

82 International Renewable Energy Agency (2021), "A Pathway to Decarbonise the Shipping Sector by 2050", https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Oct/IRENA_Decarbonising_Shipping_2021.pdf.

83 Transport & Environment (2018), "Aviation & shipping emissions and national climate pledges: Ensuring Paris pledges are truly economy-wide", https://www.transportenvironment.org/wp-content/uploads/2021/07/2018_05_Briefing_NDCs_and_Paris_agreement.pdf.

84 SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

85 Ibid.

86 Ibid.

87 Ibid.

88 Ibid.

89 UNCTAD, op. cit. note 11.

4.1
TRANSPORT ENERGY SOURCES

1 World Health Organization (2022), "Ambient (outdoor) air pollution", 19 December, https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

2 Renewable Energy Policy Network for the 21st Century (REN21) (2022), "Renewables 2022 Global Status Report", https://www.ren21.net/gsr-2022; REN21 and FIA Foundation (2020), "Renewable Energy Pathways in Road Transport", 18 November, https://www.ren21.net/2020-re-pathways-in-road-transport; International Council on Clean Transportation (ICCT) (2022), "Life-cycle analysis of greenhouse gas emissions of hydrogen, and recommendations for China", 19 October, https://theicct.org/publication/china-fuels-lca-ghgs-hydrogen-oct22.

3 International Energy Agency (IEA) (2022), "Transport", https://www.iea.org/reports/transport; electricity use was split into fossil fuel-based and renewables using the global share of renewables in electricity and heat generation, from IEA (2022), "Energy Statistics Data Browser", https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser; trends over the past decade from REN21 (2023), "Renewables 2023 Global Status Report: Energy Demand Modules", p. 40, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

4 IEA (2022), "Global EV Outlook 2022", https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf; WHICHCAR (2022), "How many cars are there in the world?" 23 April, https://www.whichcar.com.au/news/how-many-cars-are-there-in-the-world; Our World in Data (2023), "Share of electricity production from renewables, 2022", https://ourworldindata.org/grapher/share-electricity-renewables, accessed 5 June 2023.

5 IEA (2023), "Aviation", https://www.iea.org/energy-system/transport/aviation.

6 F. Bergk et al. (2016), "Klimaschutzbeitrag des Verkehrs bis 2050", Umwelt Bundesamt, https://www.umweltbundesamt.de/publikationen/klimaschutzbeitrag-des-verkehrs-bis-2050; SLOCAT Partnership on Sustainable, Low Carbon Transport (2020), "Global Transport and Climate Change in Transport and Climate Change Global Status Report, Second Edition", https://tcc-gsr.com/wp-content/uploads/2021/06/Slocat-Global-Status-Report-2nd-edition.pdf.

7 S. Teske, S. Niklas and R. Langdon (2021), "TUMI Transport Outlook 1.5°C – A global scenario to decarbonise transport", Transformative Urban Mobility Initiative, https://www.transformative-mobility.org/wp-content/uploads/2023/03/TUMI-Transport-Outlook-Sol1tB.pdf.

8 Ibid.

9 REN21 (2023), "Renewables 2023 Global Status Report: Transport in Focus", https://www.ren21.net/gsr-2023/modules/energy_demand/03_transport_in_focus; WHICHCAR, op. cit. note 4; Our World in Data, op. cit. note 4.

10 Ibid.

11 IEA, "Energy Statistics Data Browser", op. cit. note 3; **Figure 1** from I IEA, "Transport", op. cit. note 3.

12 IEA (2021), "Oil Market Report", 13 July, https://iea.blob.core.windows.net/assets/d54cfc69-ed0f-44ed-b1fe-ad63b2259456/-13JULY2022_OilMarketReport.pdf

13 IEA (2022), "Oil Market Report", 14 December, https://iea.blob.core.windows.net/assets/8220f981-4820-42ae-ab81-2156627243d8/-14DEC2022_OilMarketReport.pdf

14 Ibid.

15 IEA, op. cit. note 12; IEA, op. cit. note 13.

16 IEA (2022), "World Energy Outlook 2022", https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf; IEA (2022), "Oil Market Report", 13 April, https://iea.blob.core.windows.net/assets/eb61211f-1248-4a94-b146-e87e13aa067a/-13APR2022_OilMarketReport_.pdf.

17 IEA (2022), "Cars and Vans Subsector Tracking Report", https://www.iea.org/reports/cars-and-vans; IEA (2022), "Global EV Data Explorer", https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

18 Ibid. **Figure 2** from IEA, op. cit. note 17.

19 Global Fuel Economy Initiative (2020), "Vehicle Efficiency and Electrification: A Global Status Report", https://www.globalfueleconomy.org/media/791561/gfei-global-status-report-2020.pdf; IEA, "Cars and Vans Subsector Tracking Report", op. cit. note 17.

20 L. Cozzi and A. Petropoulos (2021), "Carbon emissions fell across all sectors in 2020 except for one – SUVs", IEA, 15 January, https://www.iea.org/commentaries/carbon-emissions-fell-across-all-sectors-in-2020-except-for-one-suvs.

21 International Transport Forum (2021), "Cleaner Vehicles: Achieving a Resilient Technology Transition", https://www.itf-oecd.org/sites/default/files/docs/cleaner-vehicles-technology-transition.pdf; Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018), "The Future Cost of Electricity-Based Synthetic Fuels", https://www.agora-verkehrswende.de/en/publications/the-future-cost-of-electricity-based-synthetic-fuels. **Table 1** from International Transport Forum , op. cit. this note.

22 Transport & Environment (2023), "Hydrogen & efuels", https://www.transportenvironment.org/challenges/energy/hydrogen-efuels.

23 **Figure 3** from IEA (2022), "World Energy Statistics", https://www.iea.org/data-and-statistics/data-product/world-energy-statistics (accessed 6 June 2022.)

24 European Automobile Manufacturers' Association (ACEA) (2023), "Fuel types of new passenger cars in the EU", 18 May, https://www.acea.auto/figure/fuel-types-of-new-passenger-cars-in-eu.

25 IEA, "Transport", op. cit. note 3.

26 IEA (2022), "Trucks and Buses", https://www.iea.org/reports/trucks-and-buses.

27 IEA (2021), "India Energy Outlook", https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf.

28 IEA, "Transport", op. cit. note 3.

29 REN21, op. cit. note 2.

30 Ibid.

31 **Figure 4** from Ibid.

32 Ibid.

33 Transport & Environment, op. cit. note 22.

34 Transport & Environment (2023), "EU defines what makes hydrogen 'green'", 13 February, https://www.transportenvironment.org/discover/eu-defines-what-makes-hydrogen-green; REN21, op. cit. note 3.

35 REN21, op. cit. note 3.

36 Ibid.

37 Ibid.

38 R. Lillie and T. Plakhotniuk (2023), "Green Hydrogen: The Impact on Transport and Energy", RBS International, https://www.rbsinternational.com/insights/2023/01/green-hydrogen-the-impact-on-transport-and-energy.html.

39 International Energy Agency (IEA), Global EV Outlook 2022, https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf; WHICHCAR(2022),"How many cars are there in the world?", 23 April, https://www.whichcar.com.au/news/how-many-cars-are-there-in-the-world

40 **Figure 5** from IEA, "Global EV Data Explorer", op. cit. note 17; IEA, "Energy Statistics Data Browser", op. cit. note 3.

41 Ibid., both references.

42 IEA (2022), "Rail Subsector Tracking Report", https://www.iea.org/reports/rail.

43 Ibid.

44 World Economic Forum (2020), "New Zealand's first electric plane just completed the longest flight across water: Here's what's happening with electric aviation", 9 November, https://www.weforum.org/agenda/2020/11/electric-planes-aviation-future-innovation; Airbus (2023), "Hybrid and electric flight: Laying the groundwork for decarbonising aviation", https://www.airbus.com/en/innovation/zero-emission-journey/electric-flight, accessed 12 January 2023.

45 B. Jeong et al. (2022), "Is electric battery propulsion for ships truly the lifecycle energy solution for marine environmental protection as a whole?" *Journal of Cleaner Production*, Vol. 355, https://doi.org/10.1016/j.jclepro.2022.131756.

46 Our World in Data, op. cit. note 4.

47 Ibid.

48 REN21 (2021), "Renewables 2021 Global Status Report", https://www.ren21.net/gsr-2021/chapters/chapter_01/chapter_01/#sub_8.

49 International Air Transport Association (IATA) (2022), "2022 SAF production increases 200% – more incentives needed to reach net zero", https://www.iata.org/en/pressroom/2022-releases/2022-12-07-01.

50 IEA, op. cit. note 5.

51 International Civil Aviation Organization (ICAO) (2022), "Sustainable Aviation Fuel (SAF)", https://www.icao.int/environmental-protection/pages/SAF.aspx.

52 Ibid.

53 IEA (2022), "Global CO2 emissions from transport by subsector, 2000-2030", 26 October, https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-transport-by-subsector-2000-2030.

54 European Environment Agency (2022), "Transport and environment report 2021: Decarbonising road transport — the role of vehicles, fuels and transport demand", https://www.eea.europa.eu/publications/transport-and-environment-report-2021

55 **Figure 6** from European Environment Agency (2022), "Transport and environment report 2021: Decarbonising road transport — the role of vehicles, fuels and transport demand", https://www.eea.europa.eu/publications/transport-and-environment-report-2021.

56 International Renewable Energy Agency (IRENA) and International Labour Organization (ILO) (2022), "Renewable Energy and Jobs: Annual Review 2022", https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Sep/IRENA_Renewable_energy_and_jobs_2022.pdf.

57 Ibid.

58 Council for Decarbonising Asia (2022), "The Path to Zero: A Vision for Decarbonised Transport in Asia", NDC Transport Initiative for Asia, https://councilreport.ndctransportinitiativeforasia.org.

59 Social Progress Imperative (2022), "Just Transition Score", p. 3, https://www.socialprogress.org/static/e1977d5b833d24ddcfd4a0ad381262f9/Just%20Transition%20Score%20-%20Social%20Progress%20Imperative-%202022.pdf; IRENA and ILO, op. cit. note 56, pp. 32-46.

60 ICCT (2021), "Ambitious yet Feasible: Vision 2050 Scenario", 30 June, https://theicct.org/ambitious-yet-feasible-video-jun21.

61 **Figure 7** from ICCT (2020), "Vision 2050: A Strategy to Decarbonize the Global Transport Sector by Mid-Century", https://theicct.org/vision-2050.

62 ICCT, op. cit. note 61

63 Ibid.

64 ICCT (2022), "Passenger vehicle greenhouse gas emissions and fuel consumption", https://theicct.org/pv-fuel-economy; Swiss Federal Office of Energy (2022), "CO2 emission regulations for new cars and light commercial vehicles", 6 November, https://www.bfe.admin.ch/bfe/en/home/efficiency/mobility/co2-emission-regulations-for-new-cars-and-light-commercial-vehicles.html; UK Department of Transport (2020), "CO2 emission performance standards for new passenger cars and light commercial vehicles",13 October, https://www.gov.uk/government/consultations/regulating-co2-emission-standards-for-new-cars-and-vans-after-transition/co2-emission-performance-standards-for-new-passenger-cars-and-light-commercial-vehicles.

65 **Figure 8** from ICCT, op. cit. note 64.

66 O. Delgado and S. Pettigrew (2022), "New legislation in Chile shows climate leadership", ICCT, 25 April, https://theicct.org/chile-latam-lvs-leg-en-apr22.

67 US Department of Transportation (2022), "USDOT announces new vehicle fuel economy standards for model year 2024-2026", 1 April, https://www.transportation.gov/briefing-room/usdot-announces-new-vehicle-fuel-economy-standards-model-year-2024-2026.

68 European Commission (2022), "CO2 emission performance standards for cars and vans", https://climate.ec.europa.eu/eu-action/european-green-deal/delivering-european-green-deal/co2-emission-performance-standards-cars-and-vans_en; European Council (2023), "Timeline – European Green Deal and Fit for 55", https://www.consilium.europa.eu/en/policies/green-deal/timeline-european-green-deal-and-fit-for-55, accessed 4 April 2023.

69 N. Hirose (2021), "Malaysia issues standard for energy efficient vehicle certificate", EnvilianceAsia, 23 June, https://enviliance.com/regions/southeast-asia/my/report_2906; K. Aoki (2022), "Malaysia to consider mandatory labeling of carbon emissions for road vehicles", EnvilianceAsia, 1 September, https://enviliance.com/regions/southeast-asia/my/report_7833.

70 United Nations Environment Programme (UNEP) (2020), "Used Vehicles and the Environment", https://www.unep.org/resources/report/global-trade-used-vehicles-report; UNEP (2021), "Used Vehicles and the Environment – Update and Progress 2021", http://airqualityandmobility.org/usedvehicles/usedvehicles_updatereport2021.pdf.

71 Waka Kotahi New Zealand Transport Agency (2023), "Clean Car Standard overview", https://www.nzta.govt.nz/vehicles/clean-car-programme/clean-car-standard/overview, accessed 2 March 2023.

72 Ibid.

73 UNEP, "Used Vehicles and the Environment – Update and Progress 2021", op. cit. note 71.

74 A. Kitimo (2023), "Transporters protest ban on used trucks", Nation, 9 January, https://nation.africa/kenya/business/technology/transporters-protest-ban-on-used-trucks-4080012.

75 O. Guguyu (2022), "Uganda import rule boosts Kenya car dealers", Nation, 12 April, https://nation.africa/kenya/business/uganda-import-rule-boosts-kenya-car-dealers-3779302.

76 IEA (2021), "Fuel Economy in Brazil: Technology Report", https://www.iea.org/articles/fuel-economy-in-brazil.

77 Although the United Kingdom continues to apply EU standards, it is not yet clear whether it would continue to follow proposed changes to EU regulations; see Government of the United Kingdom (2020), "The New Heavy Duty Vehicles (Carbon Dioxide Emission Performance Standards) (Amendment) (EU Exit) Regulations 2020", https://www.legislation.gov.uk/uksi/2020/1402/regulation/3/made; IEA (2022), "Trucks and Buses Tracking Report", https://www.iea.org/reports/trucks-and-buses.

78 European Commission (2023), "Reducing CO2 emissions from heavy-duty vehicles", https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en, accessed 8 June 2023.

79 S. Pettigrew (2022), "Fuel economy standards and zero-emission vehicle targets in Chile", ICCT, https://theicct.org/wp-content/uploads/2022/08/lat-am-lvs-hvs-chile-EN-aug22.pdf.

80 New Zealand Transport Agency (2022), "Requirements for urban buses in New Zealand", https://www.nzta.govt.nz/resources/requirements-for-urban-buses.

81 DriveToZero (2023), "Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles", https://globaldrivetozero.org/mou-nations, accessed 2 March 2023.

82 B. Sharpe and D. Schaller (2021), "Analysis of heavy-duty vehicle fuel efficiency technology uptake in California and Canada", ICCT, https://theicct.org/wp-content/uploads/2021/06/HDV-fuel-efficiency-tech-California-Canada-apr2021.pdf.

83 CleanAirAsia (2022), "Policies on vehicle emission decarbonization efforts take limelight in fuel economy event" 23 June, https://cleanairasia.org/our-news/policies-vehicle-emission-decarbonization-efforts-take-limelight-fuel-economy-event.

84 Ibid.

85 Energy Efficiency and Conservation Authority (2022), "The Vehicle Fuel Economy Label is changing", https://www.eeca.govt.nz/regulations/vehicle-emissions-and-energy-economy-labelling-programme/the-vehicle-fuel-economy-label-is-changing.

86 A. Lertsirirungsun (2022), "The success and failure of Indonesia's new car tax reforms", LMC Automotive, 26 August, https://lmc-auto.com/news-and-insights/the-success-and-failure-of-indonesias-new-car-tax-reforms.

87 REN21 (2023), "Renewables 2023 Global Status Report: Demand Modules Data Pack", https://www.ren21.net/gsr2023-data-pack, accessed 4 June 2023.

88 Government of Canada (2023), "Clean Fuel Regulations", 17 February, https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations.html.

89 Government of the United Kingdom (2022), "Guidance: E10 petrol explained", GOV.UK, 2 November, https://www.gov.uk/guidance/e10-petrol-explained.

90 Ministry of Petroleum and Natural Gas (2021), "Roadmap for Ethanol Blending in India 2020-25: Report of the Expert Committee", NITI Aayog, https://niti.gov.in/sites/default/files/2021-06/EthanolBlendingInIndia_compressed.pdf; J. O'Malley and S. Searle (2021), "India, don't fall for ethanol: Roadmap leads National Policy on Biofuels off track", ICCT, 26 August, https://theicct.org/india-dont-fall-for-ethanol-roadmap-leads-national-policy-on-biofuels-off-track.

91 Enerdata (2021), "Argentina halves biodiesel mandate to 5%", 20 July, https://www.enerdata.net/publications/daily-energy-news/argentina-halves-biodiesel-mandate-5.html.

92 Argentina.gob.ar (2022), "Martinez: 'Más Biodiesel, Refinerías a plena producción, más facilidades para importar, más controles'", 16 June, https://www.argentina.gob.ar/noticias/martinez-mas-biodiesel-refinerias-plena-produccion-mas-facilidades-para-importar-mas; Argentina.gob.ar (2022), "Se puso en marcha una Comisión Especial de Biocombustible para 'dar previsibilidad y certidumbre al sector'", 19 October, https://www.argentina.gob.ar/noticias/se-puso-en-marcha-una-comision-especial-de-biocombustible-para-dar-previsibilidad-y.

93 J. Lane (2023), "The Daily Digest's Biofuels Mandates Around the World 2023 – Brazil", The Digest, 2 January, https://www.biofuelsdigest.com/bdigest/2023/01/02/the-daily-digests-biofuels-mandates-around-the-world-2023/5.

94 A.L. Lopes Toledo, personal communication with SLOCAT, 25 April 2023; Brazil National Agency for Petroleum, Natural Gas and Biofuels (2023), "RenovaBio", Ministry of Mines and Energy, 4 March, https://www.gov.br/anp/pt-br/assuntos/renovabio.

95 Ibid.

96 Government of Finland (2022), "Press release: Lower distribution obligation for transport fuels to continue in 2023", 19 September, https://valtioneuvosto.fi/en/-/1410877/lower-distribution-obligation-for-transport-fuels-to-continue-in-2023; J. McGarrity (2022), "New relaxations on blending mandates could reduce biofuels demand", Fastmarkets, 13 April, https://www.fastmarkets.com/insights/new-relaxations-on-blending-mandates-could-reduce-biofuels-demand.

97 Ibid., both references.

98 Enerdata (2021), "Malaysia delays B20 biodiesel mandate in transport sector to 2022", 11 January, https://www.enerdata.net/publications/daily-energy-news/malaysia-delays-b20-biodiesel-mandate-transport-sector-2022.html; Biofuels International (2022), "Malaysia aims to implement B20 biodiesel mandate by end of 2022", 5 January, https://biofuels-news.com/news/malaysia-aims-to-implement-b20-biodiesel-mandate-by-end-of-2022.

99 US Department of Agriculture, Foreign Agricultural Service (2022), "Colombia Biofuels Annual", https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_Bogota_Colombia_CO2022-0012.pdf; Bangkok Post (2022), "Energy committee restricts options to biodiesel B5", 1 February, https://www.bangkokpost.com/business/2257099/energy-committee-restricts-options-to-biodiesel-b5.

100 US Department of Agriculture, Foreign Agricultural Service (2022), "Biofuel Mandates in the EU by Member State – 2022", https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuel%20Mandates%20in%20the%20EU%20by%20Member%20State%20-%202022_Berlin_European%20Union_E42022-0044.pdf; REN21, op. cit. note 87, Figure 10.

101 REN21, op. cit. note 87.

102 L. Moffitt (2022), "South Korea to boost domestic biofuels use", Argus Media, 14 October, https://www.argusmedia.com/en/news/2380561-south-korea-to-boost-domestic-biofuels-use.

103 M. Koster et al. (2022), "Overview of biofuels policies and markets across the EU", ePURE, https://www.epure.org/wp-content/uploads/2022/10/221011-DEF-REP-Overview-of-biofuels-policies-and-markets-across-the-EU-October-2022.pdf.

104 Ministry of Business, Innovation & Employment (2023), "Biofuels and the sustainable biofuel obligation", https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-generation-and-markets/liquid-fuel-market/biofuels, accessed 20 March 2023.

105 US Department of Agriculture, Foreign Agricultural Service (2022), "Indonesia: Biofuels Annual", https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_Jakarta_Indonesia_ID2022-0017.pdf.

106 Eswatini (2022), "First Nationally Determined Contributions (NDCs)", United Nations Framework Convention on Climate Change (UNFCCC), https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7609; Guatemala (2022), "Contribución Nacionalmente Determinada de Guatemala (Updated submission)", UNFCCC, https://unfccc.int/node/499594; Lao People's Democratic Republic (2021), "Nationally Determined Contribution", UNFCCC, https://unfccc.int/sites/default/files/NDC/2022-06/NDC%202020%20of%20Lao%20PDR%20%28English%29%2C%2009%20April%202021%20%281%29.pdf; Malawi (2022), "Nationally determined contributions (NDCs)", UNFCCC,

https://unfccc.int/documents/497772; Mali (2022), "Nationally determined contributions (NDCs)", UNFCCC, https://unfccc.int/documents/499564; Vanuatu (2022), "Nationally Determined Contributions (NDCs)", UNFCCC, https://unfccc.int/documents/578782.

107 SLOCAT and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (2022), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker; REN21, op. cit. note 2.

108 European Commission (2022), "European Green Deal: New rules agreed on applying the EU emissions trading system in the aviation sector", 9 December, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7609.

109 European Council (2023), "Fit for 55", https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition, accessed 4 April 2023.

110 European Council (2022), "Fit for 55 package: Council adopts its position on three texts relating to the transport sector", 2 June, https://www.consilium.europa.eu/en/press/press-releases/2022/06/02/fit-for-55-package-council-adopts-its-position-on-three-texts-relating-to-the-transport-sector.

111 UK Department for Transport (2023), "Pathway to net zero aviation: Developing the UK sustainable aviation fuel mandate ", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147350/pathway-to-net-zero-aviation-developing-the-uk-sustainable-aviation-fuel-mandate.pdf.

4.2
VEHICLE TECHNOLOGIES

1 M. Knoope and L. Krabbenborg (2023), "Urban Distribution with Cargo Bikes and Other LEFVs: An Initial Study", Netherlands Ministry of Water and Infrastructure Management, https://english.kimnet.nl/publications/publications/2023/01/09/urban-distribution-with-cargo-bikes-and-other-lefvs.

2 Institute for Transportation and Development Policy and University of California at Davis (2021), "The Compact City Scenario – Electrified the Only Way to 1.5°C", https://www.itdp.org/wp-content/uploads/2021/12/EN_Compact-Cities-BRIEF_SINGLEPAGE.pdf.

3 United Nations Department of Economic and Social Affairs (2018), "Accelerating SDG 7 Achievement: Policy Brief 16 Interlinkages Between Energy and Transport", https://sustainabledevelopment.un.org/content/documents/17501PB16.pdf.

4 IEA (2022), "Global EV Outlook 2022", https://www.iea.org/reports/global-ev-outlook-2022.

5 IEA (2023), "Global EV Outlook 2023", https://www.iea.org/reports/global-ev-outlook-2023.

6 IEA, "Global EV Outlook 2022", op. cit. note 4; IEA, "Global EV Outlook 2023", op. cit. note 5.

7 **Figure 1** from IEA, "Global EV Outlook 2023", op. cit. note 5

8 IEA, "Global EV Outlook 2023", op. cit. note 5.

9 IEA, "Global EV Outlook 2023", op. cit. note 5; L. Paoli and T. Gül (2022), "Electric cars fend off supply challenges to more than double global sales", IEA, 30 January, https://www.iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales.

10 IEA (2023), "Passenger car sales, 2010-2022", 20 February, https://www.iea.org/data-and-statistics/charts/passenger-car-sales-2010-2022

11 A. Ajanovic (2022), The impact of COVID- 19 on the market prospects of electric passenger cars, *WIREs Energy and Environment*, Vol. 11, No. 5, https://doi.org/10.1002/wene.451.

12 M.J. Nieuwenhuijsen, O. Hahad and T. Münzel (2021), "The COVID-19 pandemic as a starting point to accelerate improvements in health in our cities through better urban and transport planning", *Environmental Science and Pollution Research*, Vol. 29, No. 12, pp. 16783-85, https://doi.org/10.1007/s11356-021-18364-8.

13 IEA, "Global EV Data Explorer – Data Tools", https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

14 Ibid.

15 IEA, "Global EV Outlook 2022", op. cit. note 4; WHICHCAR (2022), "How many cars are there in the world?" 23 April, https://www.whichcar.com.au/news/how-many-cars-are-there-in-the-world.

16 IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13.

17 Climate Group (2022), "5.5 million vehicles committed to electric by global businesses", 23 March, https://www.theclimategroup.org/our-work/news/55-million-vehicles-committed-electric-global-businesses.

18 Climate Group EV100 (2022), "EV100 Progress and Insights Report", https://www.theclimategroup.org/sites/default/files/2022-03/EV100%20Progress%20and%20Insights%20Report%202022_0.pdf.

19 Transport & Environment (2023), "Company cars: Corporate fleets are low-hanging fruit in the decarbonisation of road transport", https://www.transportenvironment.org/challenges/cars/company-cars, accessed 8 August 2023.

20 E. Wong (2022), "Electric four-wheel vehicles are the fastest growing sector of the clean energy industry", rest of world, 8 September, https://restofworld.org/2022/scooters-and-3-wheelers-are-really-whats-driving-an-ev-revolution.

21 IEA, "Global EV Outlook 2023", op. cit. note 5.

22 Ibid.

23 Ibid.

24 Ibid.

25 IEA, "Global EV Outlook 2022", op. cit. note 4.

26 IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13.

27 IEA, "Global EV Outlook 2023", op. cit. note 5.

28 Ibid.

29 Ibid.

30 IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13.

31 IEA, "Global EV Outlook 2023", op. cit. note 5.

32 IEA, "Global EV Outlook 2022", op. cit. note 4.

33 IEA, "Global EV Outlook 2023", op. cit. note 5.

34 IEA, "Global EV Outlook 2022", op. cit. note 4.

35 European Commission, "Vehicles and fleet", European Alternative Fuels Observatory, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet, accessed 8 August 2023.

36 Ibid.

37 Sustainable Bus (2022), "Electric bus, main fleets and projects around the world", 16 January, https://www.sustainable-bus.com/electric-bus/electric-bus-public-transport-main-fleets-projects-around-world.

38 Ibid.

39 United Nations Environment Programme (UNEP) (2021), "Used Vehicles and the Environment: A Global Overview of Used Light Duty Vehicles: Update and Progress 2021", http://airqualityandmobility.org/usedvehicles/usedvehicles_updatereport2021.pdf.

40 Ibid.

41 IEA, "Global EV Outlook 2023", op. cit. note 5.

42 IEA, "Global EV Outlook 2023", op. cit. note 5.

43 Ibid.

44 Ibid.

45 Ibid.

46 IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13

47 European Commission, "European Union (EU27)", European Alternative Fuels Observatory, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27, accessed 18 August 2023.

48 Statista (2023), "Topic: Electric Vehicles Worldwide", https://www.statista.com/outlook/mmo/electric-vehicles/worldwide, accessed 18 August 2023.

49 IEA, "Global EV Outlook 2023", op. cit. note 5.

50 Ibid.

51 Ibid.

52 European Commission, "European Union (EU27)", op. cit. note 47.

53 **Figure 2** from BloombergNEF (2022), "Lithium-ion battery pack prices rise for first time to an average of $151/kWh", 6 December, https://about.bnef.com/blog/lithium-ion-battery-pack-prices-rise-for-first-time-to-an-average-of-151-kwh.

54 W.N., D. (2022), "How has the Russia-Ukraine war affected the e-mobility industry in the UK and EU?" LinkedIn, 5 September, https://www.linkedin.com/pulse/how-has-russia-ukraine-war-affected-e-mobility-uk-eu-nama-njobvu-.

55 Ibid.; D. Ravichandran (2022), "Russia-Ukraine conflict exposes risks in EV supply chains", Emerging Technology News, 10 May, https://etn.news/e-mobility-blogs/russia-ukraine-conflict-exposes-risks-in-ev-supply-chains.

56 S. Shetty (2022), "Opinion: Impact of the Russia-Ukraine war on the global EV industry", EMobility+, 27 May, https://emobilityplus.com/2022/05/27/opinion-impact-of-the-russia-ukraine-war-on-the-global-ev-industry.

57 BloombergNEF (2022), "Lithium-ion battery pack prices rise for first time to an average of $151/kWh", 6 December, https://about.bnef.com/blog/lithium-ion-battery-pack-prices-rise-for-first-time-to-an-average-of-151-kwh.

58 V. Henze (2021), "Battery pack prices fall to an average of $132/kWh, but rising commodity prices start to bite", BloombergNEF, 30 November, https://about.bnef.com/blog/battery-pack-prices-fall-to-an-average-of-132-kwh-but-rising-commodity-prices-start-to-bite.

59 P. LeBeau (2022), "EV battery costs could spike 22% by 2026 as raw material shortages drag on", CNBC, 18 May, https://www.cnbc.com/2022/05/18/ev-battery-costs-set-to-spike-as-raw-material-shortages-drags-on.html; D.R. Baker (2022), "EV transition threatened as battery prices rise for first time", Bloomberg, 6 December, https://www.bloomberg.com/news/articles/2022-12-06/battery-prices-climb-for-first-time-just-as-more-evs-hit-market.

60 L. Mauler et al. (2021), "Battery cost forecasting: A review of methods and results with an outlook to 2050", *Energy & Environmental Science*, Vol. 14, pp. 4712-4739, https://doi.org/10.1039/D1EE01530C.

61 P. Jaramillo et al. (2022), "Transport", in IPCC (2022), "Climate Change 2022: Mitigation of Climate Change", https://www.ipcc.ch/report/sixth-assessment-report-working-group-3.

62 Ibid.

63 Astute Analytica (2022), "Electric vehicle battery swapping market report 2022-2030", 11 November, https://www.astuteanalytica.com/industry-report/electric-vehicle-battery-swapping-market.

64 C. Hampel (2023), "Nio counts 10 battery swapping stations in Europe", Elective, 3 January, https://www.electrive.com/2023/01/03/nio-counts-10-battery-swapping-stations-in-europe.

65 Astute Analytica, op. cit. note 63; Asian Development Bank (2022), "Electric Motorcycle Charging Infrastructure Road Map for Indonesia", https://www.adb.org/sites/default/files/publication/830831/electric-motorcycle-charging-infrastructure-indonesia.pdf.

66 Astute Analytica, op. cit. note 63.

67 U.S. Department of Energy and U.S. Environmental Protection Agency (2022), "Fuel Economy data", https://www.fueleconomy.gov/feg/download.shtml, accessed 18 August 2023

68 **Figure 3** from Ibid.

69 Ibid.

70 IEA (2023), "Global EV Outlook 2023", op. cit. note 5.

71 IEA, "Global EV Data Explorer – Data Tools," op. cit. note 13

72 Jaramillo et al., op. cit. note 61.

73 IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13.

74 IEA (2021), "Net Zero by 2050", https://www.iea.org/reports/net-zero-by-2050.

75 Jaramillo et al., op. cit. note 61.

76 IEA (2021), "Global Energy Review 2021 – Analysis", https://www.iea.org/reports/global-energy-review-2021.

77 IEA (2022), "Defying expectations, CO2 emissions from global fossil fuel combustion are set to grow in 2022 by only a fraction of last year's big increase", 19 October, https://www.iea.org/news/defying-expectations-co2-emissions-from-global-fossil-fuel-combustion-are-set-to-grow-in-2022-by-only-a-fraction-of-last-year-s-big-increase.

78 World Resources Institute (2022), "Transport, Systems Change Lab", https://systemschangelab.org/transport.

79 Jaramillo et al. (2022), op. cit. note 61.

80 IEA (2023), "Global EV Outlook 2023", op. cit. note 5.

81 IEA (2023), "Global EV Outlook 2023", op. cit. note 5.

82 S. Teske et al. (2022), "The Internal Combustion Engine Bubble", Greenpeace, https://www.greenpeace.de/publikationen/ICE-Bubble_2.pdf.

83 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), "*Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonisation*, Transport and Climate Change Global Status Report – 2nd Edition", www.tcc-gsr.com.

84 InfluenceMap (2023), "Automotive Climate Tool", https://automotive.influencemap.org, updated January 2023.

85 IEA (2022), "Defying expectations, CO2 emissions from global fossil fuel combustion are set to grow in 2022 by only a fraction of last year's big increase", 19 October, https://www.iea.org/news/defying-expectations-co2-emissions-from-global-fossil-fuel-combustion-are-set-to-grow-in-2022-by-only-a-fraction-of-last-year-s-big-increase

86 **Figure 4 from** IEA, "Global EV Data Explorer – Data Tools", op. cit. note 13.

87 IEA, "Global EV Outlook 2022", op. cit. note 4; IEA, "Global EV Outlook 2023", op. cit. note 5.

88 Ibid.

89 LEVA (2022), "44% = 57 million tonnes CO2 eq per year", https://leva-eu.com/44-57-million-tonnes-co2-eq-per-year.

90 SLOCAT Partnership on Sustainable, Low Carbon Transport (2021), op. cit. note 83.

91 E-Bus Radar (2023), "Latin America", https://www.ebusradar.org/en, accessed 15 August 2023.

92 Jaramillo et al., op. cit. note 61.

93 J.P Skeete et al. (2020), Beyond the EVent horizon: Battery waste, recycling, and sustainability in the United Kingdom electric vehicle transition, *Energy Research & Social Science*, Vol. 69, https://www.sciencedirect.com/science/article/pii/S2214629620301572

94 F. Knobloch et al. (2020), "Net emission reductions from electric cars and heat pumps in 59 world regions over time", *Nature Sustainability*, Vol. 3, No. 6, pp. 437-47, https://doi.org/10.1038/s41893-020-0488-7.

95 Ibid.

96 Massachusetts Institute of Technology (2022), "Are electric vehicles definitely better for the climate than gas-powered cars?" MIT Climate Portal, https://climate.mit.edu/ask-mit/are-electric-vehicles-definitely-better-climate-gas-powered-cars.

97 Intergovernmental Panel on Climate Change (2022), "Summary for Policymakers", in "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf.

98 Ibid.

99 P. Wolfram et al. (2021), "Pricing indirect emissions accelerates low-carbon transition of US light vehicle sector", *Nature Communications*, Vol. 12, No. 1, https://doi.org/10.1038/s41467-021-27247-y.

100 J. Davis-Peccoud, H. Morrison and B. Noack (2022), "Circular strategies could cut emissions from materials used in vehicles by 60% by 2040", Bain & Company, https://www.bain.com/about/media-center/press-releases/2022/circular-strategies-could-cut-emissions-from-materials-used-in-vehicles-by-60---by-2040--bain--company-analysis.

101 J. L. Richter (2022), "A circular economy approach is needed for electric vehicles", Nature Electronics, Vol. 5, Pages 5–7, https://doi.org/10.1038/s41928-021-00711-9 ; or European Environment Agency (EEA), 2018, Electric vehicles from life cycle and circular economy perspectives, TERM 2018: Transport and Environment Reporting Mechanism (TERM) report, https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle

102 Reuters (2023), "EU lawmakers approve legislation to make batteries greener", 14 June, https://www.reuters.com/sustainability/eu-lawmakers-approve-legislation-make-batteries-greener-2023-06-14.

103 ZEV Transition Council (2023), "Phase-out targets: LDV", 24 May, https://zevtc.org/tracking-progress/light-duty-vehicle-map/, accessed 19 August 2023

104 Ibid.

105 J. Posaner (2023), "EU ministers pass 2035 car engine ban law", Politico, 28 March, https://www.politico.eu/article/eu-ministers-pass-2035-car-engine-ban-law/

106 European Commission (2023), "European Green Deal: Commission proposes 2030 zero-emissions target for new city buses and 90% emissions reductions for new trucks by 2040", Press Release (Strasbourg), 14 February, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_762

107 O. Delgado and S. Pettigrew (2022), "New legislation in Chile shows climate leadership", ICCT, 25 April, https://theicct.org/chile-latam-lvs-leg-en-apr22/

108 P. Hemmersbaugh, P. Wierenga, and D. Lavey (2023), "Ambitious new EPA auto emissions standards proposal aims to accelerate electrification of US transportation", DLA Piper, 18 April, https://www.dlapiper.com/en-us/insights/publications/2023/04/ambitious-new-epa-auto-emissions-standards-proposal-aims-to-accelerate-electrification

109 C. Randall (2022), "Canada issues regulations for the phase out of combustion vehicles", Electrive, 22 December, https://www.electrive.com/2022/12/22/canada-issues-regulations-for-the-phase-out-of-combustion-vehicles/

110 California Air Resources Board (CARB), 2022, "California moves to accelerate to 100% new zero-emission vehicle sales by 2035", 25 August, https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035

111 C. Davenport (2023), "California to Require Half of All Heavy Trucks Sold by 2035 to Be Electric", The New York Times, 31 March, https://www.nytimes.com/2023/03/31/climate/california-electric-trucks-emissions.html

112 SLOCAT (2021), "Transport Knowledge Base (TraKB) – SLOCAT Transport and Climate Change Global Status Report", https://tcc-gsr.com/data/transport-knowledge-base-trakb.

113 Sustainable Bus (2021), "Another batch of 406 e-buses for Bogota (Colombia). Again with BYD's logo", 5 January, https://www.sustainable-bus.com/electric-bus/byd-e-buses-bogota; C. Randall (2022), "Germany funds 472 new electric buses for Hamburg", Electrive, 1 April, https://www.electrive.com/2022/04/01/germany-funds-472-new-electric-buses-for-hamburg; Nepali Times (2022), "Nepal's journey to electric public transport", Global Voices, 24 April, https://globalvoices.org/2022/04/24/nepals-journey-to-electric-public-transport; Sustainable Bus (2021), "A deal for potential 1,000 electric school buses for Lion Electric. The 'conditional purchase' from Student Transportation of Canada", 25 October, https://www.sustainable-bus.com/news/1000-electric-school-buses-lion-electric-student-transportation-canada; M. Turner (2022), "New report shows how California is leading the nation in cleaning up school buses", California Air Resources Board, 12 October, https://ww2.arb.ca.gov/news/new-report-shows-how-california-leading-nation-cleaning-school-buses.

114 C40 Cities (2022), "São Paulo bans new diesel buses in city fleet", 29 November, https://www.c40.org/news/sao-paulo-bans-new-diesel-buses; C40 Cities (2020), "Bogotá's Climate Emergency Declaration", https://www.c40knowledgehub.org/s/article/Bogota-s-Climate-Emergency-Declaration.

115 CMM Chile (2020), "From pilots to scale: Lessons from electric bus deployments in Santiago de Chile", C40 Knowledge Hub, https://www.c40knowledgehub.org/s/article/From-Pilots-to-Scale-Lessons-from-Electric-Bus-Deployments-in-Santiago-de-Chile; Sustainable Bus (2020), "BVG Berlin towards 2030: 25 per cent more buses in the future full electric fleet", 13 July, https://www.sustainable-bus.com/news/bvg-berlin-towards-2030-25-per-cent-more-buses-in-the-future-full-electric-fleet.

116 Transformative Urban Mobility Initiative (2022), "Factsheet: Rio de Janeiro", https://www.transformative-mobility.org/publications/factsheet-rio-de-janeiro; The Hindu (2023), "80% of Delhi's bus fleet will be electric by 2025: CM Arvind Kejriwal", 2 January, https://www.thehindu.com/news/cities/Delhi/80-of-delhis-bus-fleet-will-run-on-electric-by-2025-cm-arvind-kejriwal/article66329475.ece; Nikkei Asia (2022), "Cambodia builds up EV infrastructure to supercharge electric ambitions", The Cambodia Daily, 11 May, https://english.cambodiadaily.com/environment/cambodia-builds-up-ev-infrastructure-to-supercharge-electric-ambitions-177861.

117 M. Dawra, M. Dutta Pandey and S. Bhatia (2022), "Expanding the Footprint of the Grand Challenge Across Tier-II India", WRI India, 12 September, https://www.wri-india.org/blog/expanding-footprint-grand-challenge-across-tier-ii-india

118 Ministry of Power (2022), "CESL discovers lowest ever prices for 5450 buses under the FAME II Scheme",26 April, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1820225.

119 Tamil Nadu (2023), "Electric Vehicles Policy", https://evreporter.com/wp-content/uploads/2023/02/1676367398305.pdf.

120 CNBC (2023), "CESL selects six companies to supply 6,465 e-buses, claims cost savings up to 50% vs fossil fuel buses", 20 February, https://www.cnbctv18.com/auto/cesl-selects-six-companies-to-supply-6465-e-buses-claims-cost-savings-up-to-50-vs-fossil-fuel-buses-15981051.htm.

121 C40 Cities Climate Leadership Group (2022), "Green and Healthy Streets: The C40 Fossil Fuel Free Streets Declaration", C40 Knowledge Hub, https://www.c40knowledgehub.org/s/article/Green-and-Healthy-Streets-The-C40-Fossil-Fuel-Free-Streets-Declaration.

122 S. Turton (2022)," Cambodia builds up EV infrastructure to speed electric ambitions", Nikkei Asia, 10 May, https://asia.nikkei.com/Business/Automobiles/Cambodia-builds-up-EV-infrastructure-to-speed-electric-ambitions

123 ESI Africa (2023), "Electric Bus Line To Be Built In Nairobi Through EU, Kenya Partnership", Smarter Mobility Africa, 3 April, https://smartermobility-africa.com/electric-bus-line-to-be-built-in-nairobi-through-eu-kenya-partnership/

124 Vietnamplus (2022), "New buses to be powered by electricity, green energy from 2025", 30 July, https://en.vietnamplus.vn/new-buses-to-be-powered-by-electricity-green-energy-from-2025/234606.vnp

125 T. Venkatraman (2020), "Mumbai's public bike-sharing now popular, 9,772 trips made in November", Hindustan Times, 3 December, https://www.hindustantimes.com/mumbai-news/mumbai-s-public-bike-sharing-now-popular-9-772-trips-made-in-november/story-p97yL0g1XUowmx7ysBvtxN.html; R. Morley (2021), "New e-bike sharing service launches in Stockholm", BikeBiz, https://bikebiz.com/new-e-bike-sharing-service-launches-in-stockholm/amp.

126 M. Toll (2022), "This country is paying car drivers nearly $4,000 to switch to an electric bike", Electrek, 22 August, https://electrek.co/2022/08/22/france-paying-car-drivers-switch-electric-bike.

127 L-A. Ramírez (2022), "Llegan Los Tuc Tucs Eléctricos a San Juan Comalapa, Guatemala", Euroclima, 18 May, https://www.euroclima.org/

contact-9/noticia-urbano/1683-tuc-tucs-electricos-llegan-san-juan-comalapa-guatemala; Reuters (2022), "India orders rickshaws around Delhi to run on cleaner fuel", 1 December, https://www.reuters.com/business/environment/india-pollution-body-orders-autorickshaws-around-delhi-run-cleaner-fuel-2022-12-01; Kawa News (2022), "Sudan: The electric tuk-tuk as a solution to sustainable mobility", 5 May, https://kawa-news.com/en/sudan-the-electric-tuk-tuk-as-a-solution-to-sustainable-mobility.

128 Reuters, "India orders rickshaws...", op. cit. note 127.

129 ESI Africa (2023), "Uganda And Vehicle Company Partner To Introduce Electric Motorbikes", Smarter Mobility Africa, 11 April, https://smartermobility-africa.com/uganda-and-vehicle-company-partner-to-introduce-electric-motorbikes.

130 M. Lewis (2021), "England will be first country to require new homes to include EV chargers [update]", Electrek, 22 November, https://electrek.co/2021/11/22/england-will-be-first-country-to-require-new-homes-to-include-ev-chargers.

131 Department for Transport, Government of UK (2022), "Tenfold expansion in chargepoints by 2030 as government drives EV revolution", https://www.gov.uk/government/news/tenfold-expansion-in-chargepoints-by-2030-as-government-drives-ev-revolution.

132 J. Packroff (2022), "EU Parliament adopts targets for EV charging infrastructure", Euractiv, 20 October, https://www.euractiv.com/section/electric-cars/news/eu-parliament-adopts-targets-for-ev-charging-infrastructure.

133 S. Wappelhorst (2022), "Incentivizing Zero- and Low-Emission Vehicles: The Magic of Feebate Programs", 8 June, International Council on Clean Transportation, https://theicct.org/magic-of-feebate-programs-jun22.

134 Ibid.

135 S. Yu and T. Munroe (2022), "China to cut New Energy Vehicle subsidies by 30% in 2022", Reuters, 31 December, https://www.reuters.com/world/china/china-cut-new-energy-vehicle-subsidies-by-30-2022-2021-12-31.

136 Ibid.

137 C. Randall (2021), "South Korea introduces upper limit for EV subsidies", Electrive, 4 January, https://www.electrive.com/2021/01/04/korea-introduces-upper-limit-for-ev-subsidies/; Y. Kwak and I. Kim (2023), "Korea's new EV subsidy plan favors Hyundai over Tesla, other imports", The Korea Economic Daily, 3 February, https://www.kedglobal.com/business-politics/newsView/ked202302030011

138 S. Wappelhorst op.cit. note 133

139 SLOCAT analysis based on Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and SLOCAT (2023), "Tracker of Climate Strategies for Transport", https://changing-transport.org/tracker-expert.

140 Ibid.

141 Ibid.

142 Government of the UK (2022), "COP26 declaration on accelerating the transition to 100% zero emission cars and vans", https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans.

143 Accelerating to Zero Coalition (2023), "A truly global movement", https://acceleratingtozero.org/a-truly-global-movement, accessed 17 August 2023.

144 Drive to Zero Campaign (2022), "Global Memorandum of Understanding on Zero-emission Medium- and Heavy-duty Vehicles", https://globaldrivetozero.org/mou-nations.

145 Lienert, P. (2022), "World's top automakers plan to spend $1.2T through 2023 on EVs, batteries", Global News, 21 October, https://globalnews.ca/news/9216759/evs-batteries-spending-automakers.

146 C. Shen et al. (2023), "*THE GLOBAL AUTOMAKER RATING 2022: Who is leading the transition to electric vehicles?",* ICCT, Paris, https://theicct.org/publication/the-global-automaker-rating-2022-may23/

147 IEA, "Global EV Outlook 2023", op. cit. note 5.

148 Ibid.

149 S. Elbein and S. Udasin (2023), "'Virtual' power plants get a boost", The Hill, 10 January, https://thehill.com/policy/equilibrium-sustainability/3807712-virtual-power-plants-get-a-boost.

150 Sustainable Mobility for All (2021), "Electromobility in the Global South: An Equitable Transition Toward Road Passenger Transport Decarbonization", https://www.sum4all.org/data/files/05-electromobility_in_the_global_south_an_equitable_transition_toward_road_passenger_transport_decarbonization_032322_v2_0.pdf.

151 IEA (2023), "Global EV Policy Explorer", https://www.iea.org/data-and-statistics/data-tools/global-ev-policy-explorer, accessed 9 August 2023.

152 La Nación (2023), "Taiwan will donate 10 electric buses to strengthen electromobility in the country", 11 January, https://www.lanacion.com.py/negocios/2023/01/11/taiwan-donara-10-buses-electricos-para-el-fortalecimiento-de-la-electromovilidad-en-el-pais

153 Kawa News, op. cit. note 127.

154 Accelerating to Zero Coalition (2023), "Accelerating to Zero Coalition", https://acceleratingtozero.org, accessed 17 August 2023.

155 Accelerating to Zero Coalition (2023), "The Zero Emission Vehicles Declaration: COP26 declaration on accelerating the transition to 100% zero emission cars and vans", https://acceleratingtozero.org/the-declaration/, accessed 17 August 2023.

156 Climate Group (2022), "5.5 million vehicles committed to electric by global businesses", 23 March, https://www.theclimategroup.org/our-work/news/55-million-vehicles-committed-electric-global-businesses

157 Clean Energy Ministerial (2023), "EV30@30 CAMPAIGN", https://www.cleanenergyministerial.org/initiatives-campaigns/ev3030-campaign/, accessed 17 August 2023.

158 GlobalDrivetoZero (2021), "The Program", https://globaldrivetozero.org/about/program/, accessed 17 August 2023.

159 GlobalDrivetoZero (2021), " Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles", 27 October, https://globaldrivetozero.org/about/program/

160 Transformative Urban Mobility Initiative (2022), "TUMI E-Bus Mission", https://transformative-mobility.org/focus-area/tumi-e-bus-mission/, accessed 22 August 2023.

161 C40 (2023), "Zero Emission Bus Rapid-deployment Accelerator (ZEBRA) Partnership", https://www.c40.org/what-we-do/scaling-up-climate-action/transportation/zero-emission-rapid-deployment-accelerator-zebra-partnership/, accessed 22 August 2023.

162 ZEV Transition Council (2022), "Enabling the transition to be faster, cheaper, and easier for all", https://zevtc.org/, accessed 22 August 2023.

5.1
FINANCING SUSTAINABLE TRANSPORT IN TIMES OF LIMITED BUDGETS

1 Oxford Economics (2023), "Global Infrastructure Outlook", https://outlook.gihub.org, accessed 28 August 2023.

2 Precedence Research (2023), "Transportation Services Market (By Purpose: Commuter Travel, Tourism and Leisure Travel, Business Travel, Cargo and Freight Travel, Shipping and Delivery Travel; By Destination: Domestic, International; By Type: Public Buses, Electric Buses, Subways, Taxis, Auto Rickshaws, Ferries, Other Public Transport Vehicles) - Global Industry Analysis, Size, Share, Growth, Trends, Regional Outlook, and Forecast 2023-2032", https://www.precedenceresearch.com/transportation-services-market.

3 Infrastructure Consortium for Africa (2023), "Spending by African governments on Infrastructure", https://www.icafrica.org/en/topics-programmes/spending-by-african-governments-on-infrastructure, accessed 28 August 2023.

4 Ibid.

5 Oxford Economics, op. cit. note 1.

6 International Finance Corporation (IFC) (2021), "A Green Reboot for Emerging Markets: Key Sectors for Post-COVID Sustainable Growth", https://www.ifc.org/wps/wcm/connect/26f79a1b-c191-494b-b2d9-c891e138bb37/IFC_GreenReport_FINAL_web.pdf.

7 **Figure 1** from International Energy Agency (IEA) (2020), "Employment multipliers for investment in the transport sector", 17 June, https://www.iea.org/data-and-statistics/charts/employment-multipliers-for-investment-in-the-transport-sector.

8 IFC, op. cit. note 6.

9 C40 Cities Climate Leadership Group (2020), "Technical Report: The Case for a Green and Just Recovery", https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000gRCH/24OgS-bRwj1hZ305yJbyPMZJQKhXXWNYE8k8sr2ADsi8.

10 **Figure 2** from Global Infrastructure Hub, Infra tracker, https://infratracker.gihub.org, accessed 31 July 2023.

11 Ibid.

12 Ibid.

13 IEA (2022), "Record clean energy spending is set to help global energy investment grow by 8% in 2022", 22 June, https://www.iea.org/news/record-clean-energy-spending-is-set-to-help-global-energy-investment-grow-by-8-in-2022.

14 World Bank (2023), "The World Bank in Africa", https://www.worldbank.org/en/region/afr/overview, accessed 28 August 2023.

15 Ibid.

16 IEA (2022), "World Energy Investment 2022", https://www.iea.org/reports/world-energy-investment-2022.

17 Ibid.

18 **Figure 3** from Global Infrastructure Hub, op. cit. note 10.

19 International Transport Forum (2021), "ITF Transport Statistics", https://www.oecd-ilibrary.org/finance-and-investment/data/itf-transport-statistics/transport-infrastructure-investment-and-maintenance_g2g55573-en, accessed 17 May 2021.

20 **Figure 4** from Organisation for Economic Co-operation and Development (OECD) Data (2023), "Infrastructure investment", https://data.oecd.org/transport/infrastructure-investment.htm, accessed 31 July 2023.

21 Ibid.

22 L. Mofor (2019), "Africa has a $100 billion infrastructure problem. What's missing?" Brink News, 20 March, https://www.brinknews.com/africa-has-a-100-billion-infrastructure-problem-whats-missing.

23 T. Serebrisky et al. (2018), "Lifting the Veil on Infrastructure Investment Data in Latin America and the Caribbean", Inter-American Development Bank (IDB), https://publications.iadb.org/publications/english/document/Lifting-the-Veil-on-Infrastructure-Investment-Data-in-Latin-America-and-the-Caribbean.pdf.

24 Development Bank of Latin America, Economic Commission for Latin America and the Caribbean, and IDB (2021), "Infralatam: Data on public investment in economic infrastructure in Latin America and the Caribbean", http://www.infralatam.info/en/home, accessed 20 May 2021.

25 **Figure 5** from B. Buchner et al. (2019), "Global Landscape of Climate Finance 2019", Climate Policy Initiative (CPI), https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/2019-Global-Landscape-of-Climate-Finance.pdf.

26 Ibid. Estimates of the investment required to achieve the low-carbon transition range from USD 1.6 trillion to USD 3.8 trillion annually between 2016 and 2050, for supply-side energy system investments alone (IPCC), while the Global Commission on Adaptation (GCA) estimates adaptation costs of USD 180 billion annually from 2020 to 2030. See H. de Coninck et al. (2018), "Chapter 4. Strengthening and Implementing the Global Response", in V. Masson-Delmotte et al., eds., *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C*, https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter4_High_Res.pdf.

27 R. Krantz, K. Søgaard and T. Smith (2020), "The scale of investment needed to decarbonize international shipping", Global Maritime Forum, 20 January, https://www.globalmaritimeforum.org/news/the-scale-of-investment-needed-to-decarbonize-international-shipping; Energy Transition Commission (2018), "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century. Sector Focus: Aviation", http://www.energy-transitions.org/sites/default/files/ETC%20sectoral%20focus%20-%20Aviation_final.pdf; MIT Energy Initiative (2019), "Insights into Future Mobility", http://energy.mit.edu/insightsintofuturemobility.

28 R. Sims et al. (2014), "Chapter 8. Transport", in O. Edenhofer et al., eds., *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf.

29 CPI (2020), "Global Landscape of Climate Finance", https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021.

30 **Figure 6** from Ibid.

31 Climate Bonds Initiative (2022), "Interactive Data Platform", https://www.climatebonds.net/market/data.

32 Ibid.

33 Ibid.

34 Ibid.

35 Ibid.

36 Ibid.

37 Ibid.

38 **Figure 7** from Ibid., accessed 24 July 2023.

39 Ibid.

40 World Bank (2023), "State and Trends of Carbon Pricing 2023", https://openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f.

41 Ibid.

42 World Bank, op. cit. note 40.

43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 Ibid.

48 Ibid.

49 Ibid.

50 Ibid.

51 IEA, op. cit. note 16.

52 Ibid.

53 Ibid.

54 Ibid.

55 Ibid.

56 Ibid.

57 Ibid.

58 Ibid.

59 Ibid.

60 Ibid.

61 Ibid.

62 IEA (2022), "Transport", https://www.iea.org/reports/transport; electricity use was split into fossil fuel-based and renewables using the global share of renewables in electricity and heat generation, from IEA (2022), "Energy Statistics Data Browser", https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser; trends over the past decade from REN21 (2023), "Renewables 2023 Global Status Report: Energy Demand Modules", p. 40, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_Demand_Modules.pdf.

63 **Figure 8** from OECD, "Government Support and Subsidies Portal", https://www.oecd.org/subsidies, accessed 26 August 2023. The OECD Inventory of Support Measures for Fossil Fuels measures support to fossil fuel production and consumption across 51 advanced and emerging economies. Data are updated annually and go back to 2010.

64 Ibid.

65 OECD, op. cit. note 63.

66 IEA, op. cit. note 16.

67 **Figure 9** from Ibid.

68 Ibid.

69 Ibid.

70 Ibid.

71 Ibid.

72 Ibid.

73 Ibid.

74 Ibid.

75 Ibid.

76 Ibid.

77 **Figure 10** from United Nations, "UN Stats", UNstats.un.org, accessed 5 August 2023.

78 **Box 2** based on the following sources: J. Rozenberg and M. Fay (2019), "Beyond the Gap: How Countries Can Afford the Infrastructure They Need While Protecting the Planet", World Bank, https://openknowledge.worldbank.org/entities/publication/95801508-1130-5ed0-843a-113b50285006; J.P. Brichetti (2021), "The Infrastructure Gap in Latin America and the Caribbean: Investment Needed Through 2030 to Meet the Sustainable Development Goals", IDB, https://publications.iadb.org/en/infrastructure-gap-latin-america-and-caribbean-investment-needed-through-2030-meet-sustainable; Asian Development Bank (2017), "Meeting Asia's Infrastructure Needs", https://www.adb.org/publications/asia-infrastructure-needs.

79 OECD (2017), "Investing in Climate, Investing in Growth", https://doi.org/10.1787/9789264273528-en.

80 Global Infrastructure Hub, op. cit. note 10.

81 Ibid.

82 Global Infrastructure Hub (2021), "Transport", https://www.gihub.org/sectors/transport, accessed 17 May 2021.

83 Coalition for Urban Transitions (2019), "Climate Emergency, Urban Opportunity", World Resources Institute, Ross Center for Sustainable Cities and C40 Cities Climate Leadership Group, https://urbantransitions.global/urban-opportunity.

84 Ibid.

85 International Road Assessment Programme (2021), "3 star or better", https://irap.org/3-star-or-better, accessed 17 May 2021.

86 Word Bank (2020), "Rural Access Index", 23 April, https://datacatalog.worldbank.org/dataset/rural-access-index-rai.

87 Climate Bonds Initiative (2022), "Low Carbon Transport", https://www.climatebonds.net/standard/transport, accessed 1 September 2023.

88 Transformative Urban Mobility Initiative, German Federal Ministry for Economic Cooperation and Development, Deutsche Gesellschaft für Internationale Zusammenarbeit, World Resources Institute and SLOCAT Partnership on Sustainable, Low Carbon Transport (2022), "Financing Fundamentals For the Decarbonization of the Transport Sector – International Public Investments for Sustainable Mobility Projects", https://transformative-mobility.org/financing-fundamentals-for-the-decarbonization-of-the-transport-sector-international-public-investments-for-sustainable-mobility-projects, accessed 1 September 2023.

89 SLOCAT (2023), "Towards a Gold Standard for Transport Investment", https://slocat.net/towards-gold-standard-for-transport-investment, accessed 1 September 2023.

90 World Resources Institute (2022), "Reimagining Public Transport", https://www.wri.org/initiatives/reimagining-public-transport, accessed 1 September 2023.

S5
SPOTLIGHT 5: CAPACITY AND INSTITUTIONAL SUPPORT TO ACHIEVE SUSTAINABLE, LOW CARBON TRANSPORT

1 International Transport Forum (ITF) (2023), "How Improving Public Transport and Shared Mobility Can Reduce Urban Passenger Carbon Emissions: Scenario Results and Policy Findings", https://www.itf-oecd.org/sites/default/files/docs/reducing-urban-passenger-carbon-emissions.pdf, accessed 10 August 2023.

2 **Figure 1** from UN-Habitat (2020), "World Cities Report 2020: The Value of Sustainable Urbanization", https://unhabitat.org/world-cities-report-2020-the-value-of-sustainable-urbanization.

3 Ibid.

4 World Bank Data (2023), "Urban population (% of total population)", https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS, accessed 25 August 2023.

5 United Nations Department of Economic and Social Affairs (UNDESA) (2023), "68% of the world population projected to live in urban areas by 2050, says UN", https://www.un.org/uk/desa/68-world-population-projected-live-urban-areas-2050-says-un, accessed 8 August 2023.

6 UNDESA (2019), "World Population Prospects 2019: Highlights", https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_kf_wpp2019_10keyfindings.pdf.

7 World Bank (2023), "Leaders in urban transport planning (LUTP)", https://www.worldbank.org/en/programs/leaders-in-urban-transport-planning-program, accessed 10 August 2023.

8 campus-togo (2023), "Campus Senghor au Togo", https://sites.google.com/usenghor.org/campus-togo/accueil-2021/master-2-tmdva-2019-2, accessed 10 August 2023.

9 MobiliseYourCity (2022), "Introducing MobiliseYourCity's Training Catalogue", 9 December, https://www.mobiliseyourcity.net/introducing-mobiliseyourcitys-training-catalogue.

10 Transformative Urban Mobility Initiative (TUMI) (2023), "Trainings & E-Learnings", https://transformative-mobility.org/knowledge-hub/trainings-e-learnings, accessed 10 August 2023.

11 Future Learn (2023), "Transforming Urban Mobility: Introduction to Transport Planning for Sustainable Cities", https://www.futurelearn.com/courses/introducing-sustainable-urban-mobility, accessed 10 August 2023.

This report should be cited as:
SLOCAT (2023), Global Status Report on Transport, Climate and Sustainability – 3rd edition, www.tcc-gsr.com.

The development of this report was led by Maruxa Cardama, Angel Cortez, Emily Hosek, Agustina Krapp, Nikola Medimorec and Alice Yiu from the SLOCAT secretariat. Our warm thanks to the many SLOCAT partners and experts from the wider transport community who have shaped this report. A significant share of the research for this report was conducted on a voluntary basis.

For a full list of acknowledgements, please visit the online page here.

www.tcc-gsr.com I #TransportClimateStatus

SLOCAT Partnership on Sustainable, Low Carbon Transport

Transport, Climate and Sustainability
Global Status Report - 3rd edition