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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

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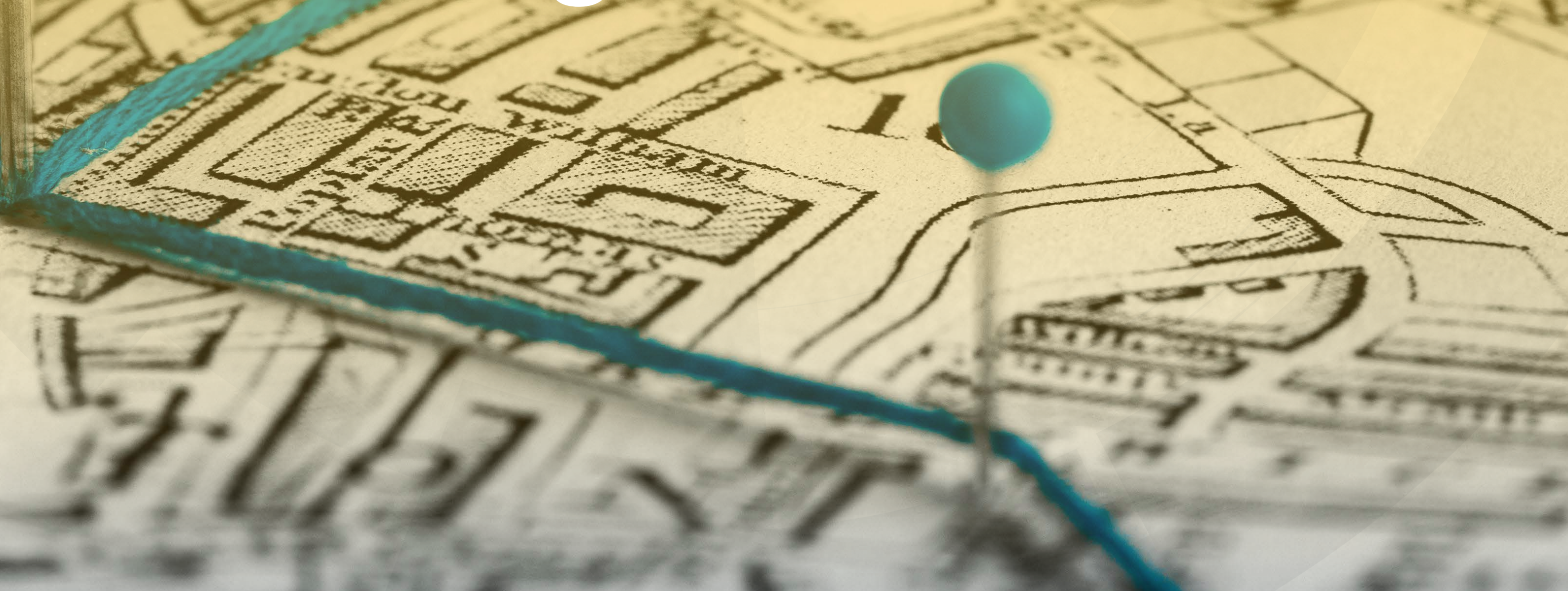
Integrated Transport Planning



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]

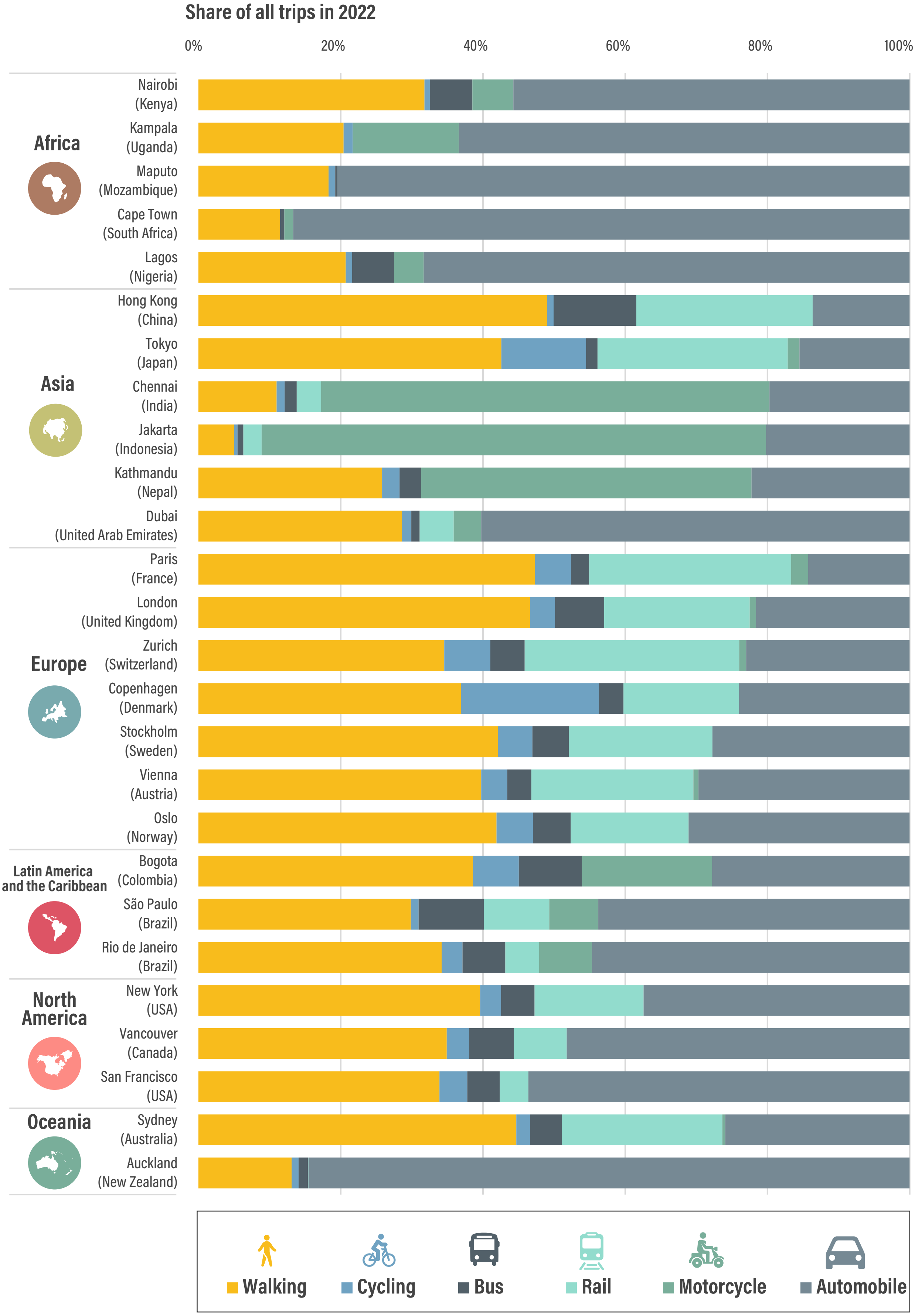
TABLE 1. Selected indicators for sustainable, integrated transport systems

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]

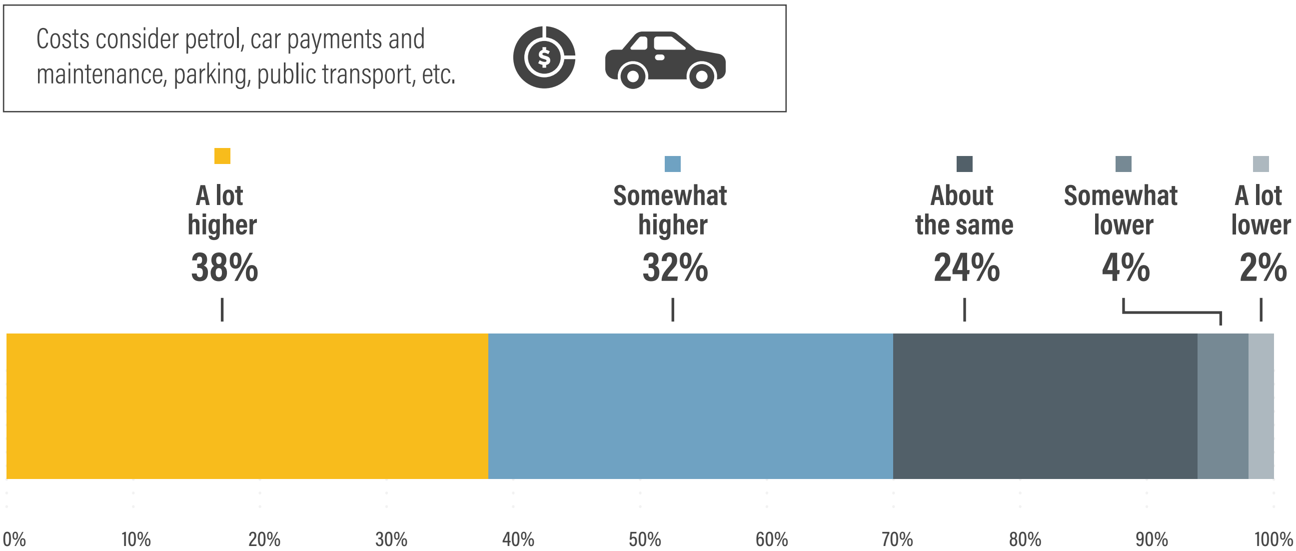
- In a survey of 20,000 people across 30 countries, 70% reported perceiving higher prices for fuel, car payments, vehicle maintenance, parking and public transport during a six-month period in 2021 **(see Figure 2)**.[79] Prices were most often perceived to have increased in Latin America, Central and 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.

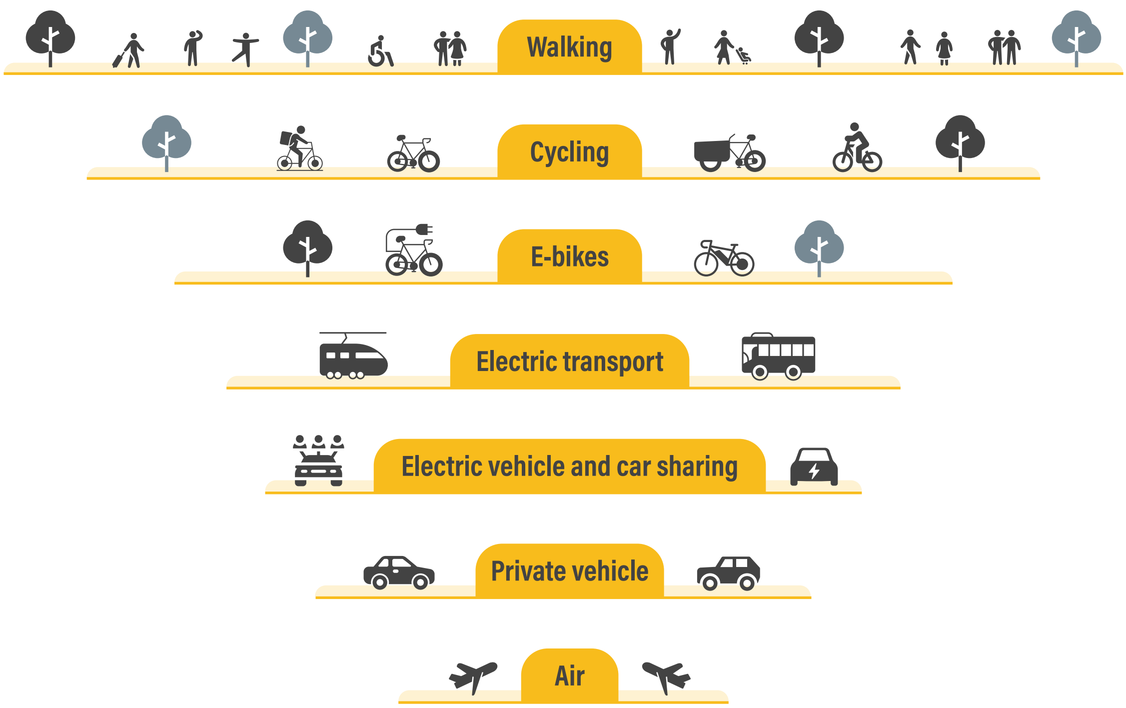
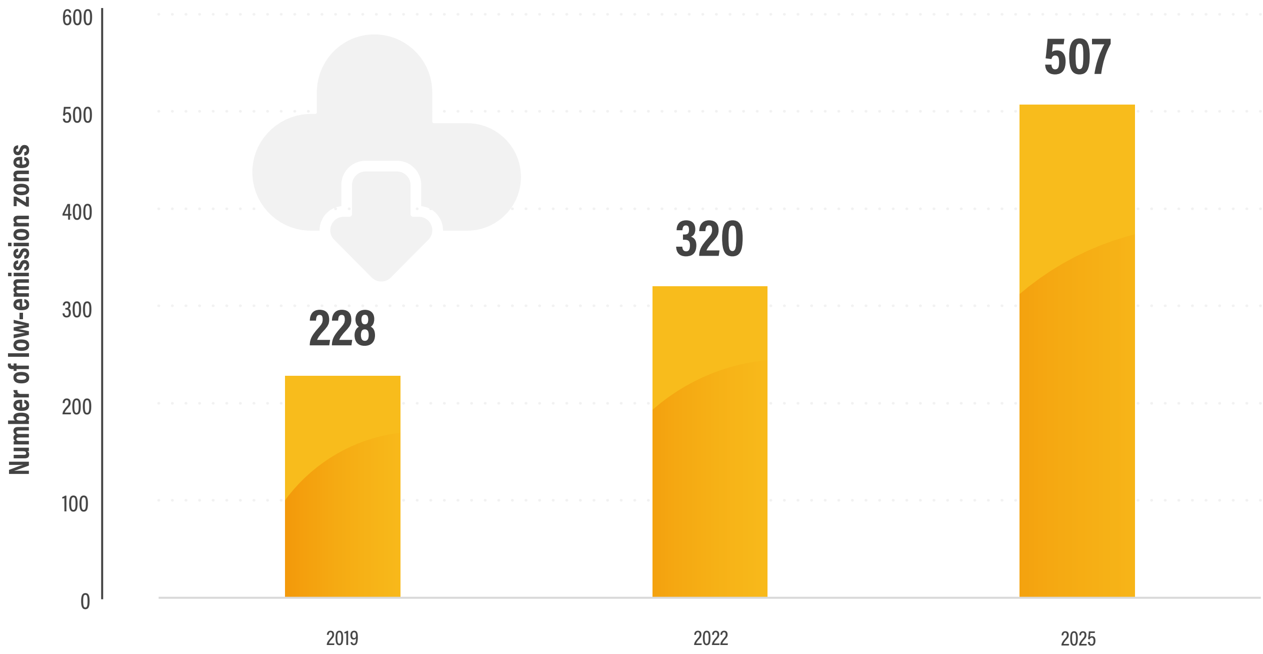


FIGURE 4. Active and planned low-emission zones in Europe, 2019, 2022 and 2025

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]

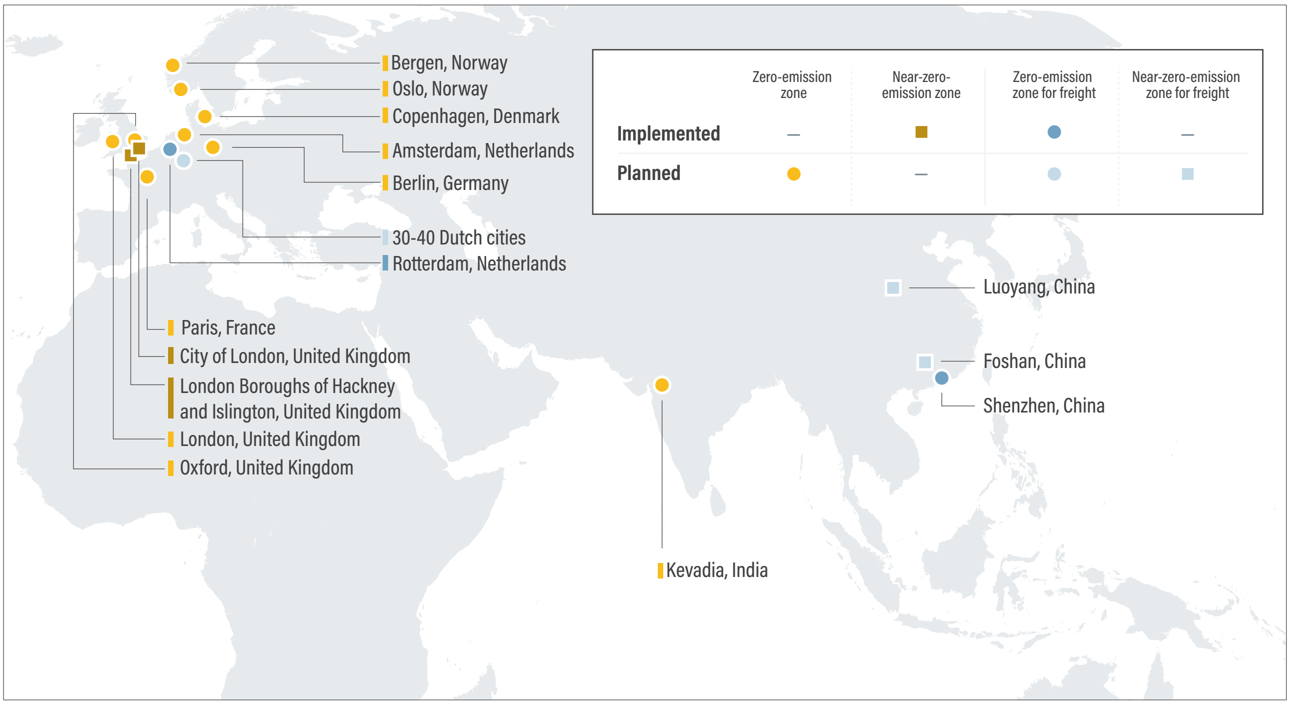
- The LEZ in Brussels (Belgium) was strengthened in 2022 to restrict the circulation of Euro 4 vehicles, the latest in a series of gradually tightened restrictions since the zone was introduced in 2018.[137]
- In 2022, Glasgow (UK) published plans to strengthen enforcement in its LEZ by mid-2023.[138]
- 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

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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.

Countries with some level of walking policy	GLOBAL 103 (50%)	AFRICA 19 (35%)	AMERICAS 17 (49%)	ASIA 26 (53%)	EUROPE 34 (69%)	OCEANIA 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]

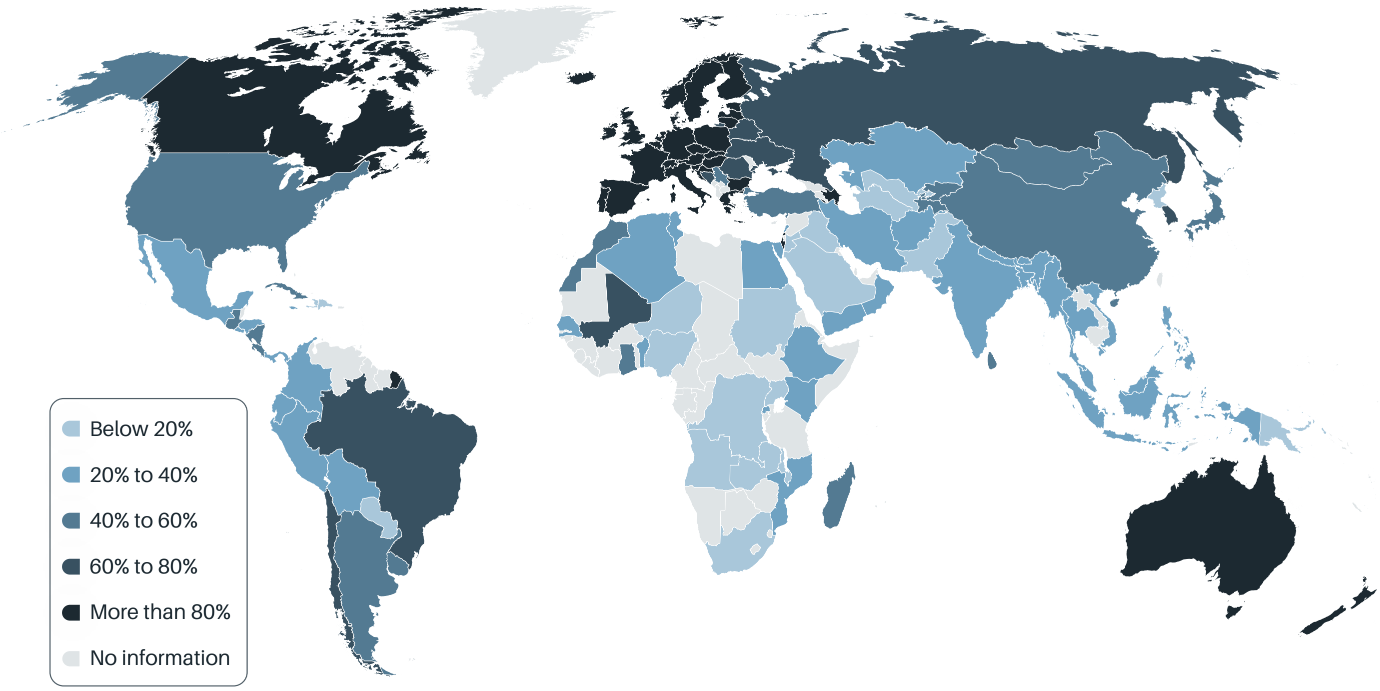
- The 2022 publication *Walking and Cycling in Africa* pioneered this approach for Africa and concluded, based on available data, that the average person in Africa walks for 56 minutes per day and that 31.7% of people in urban areas live within convenient access of public transport.[14]
- The analysis 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]

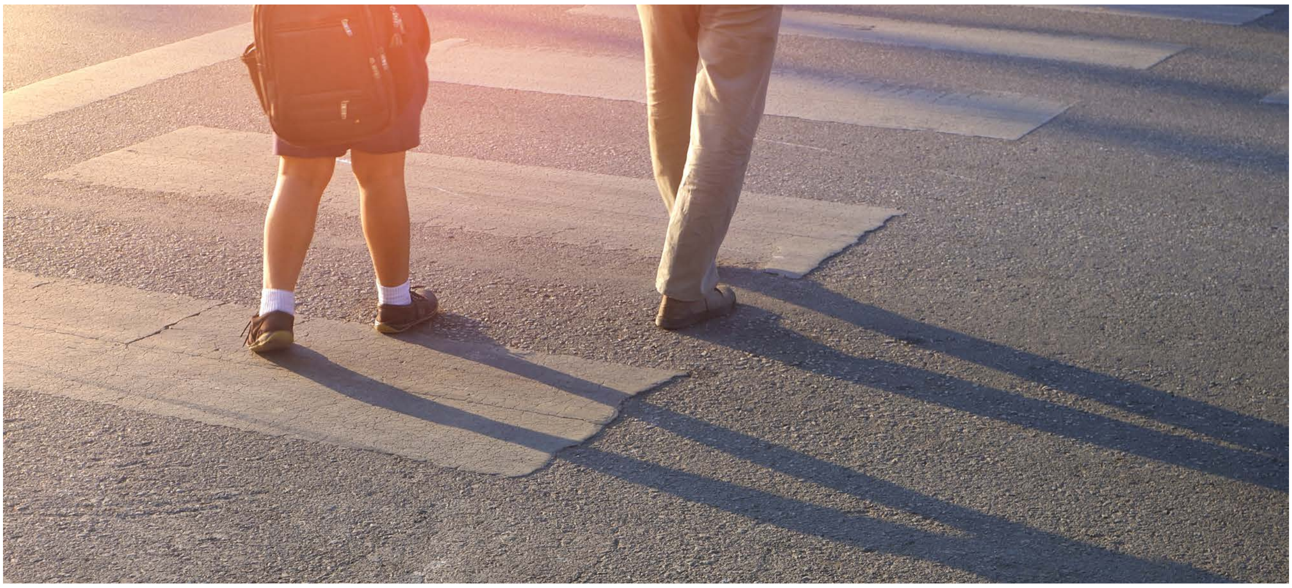
Proximity planning – such as the "15-minute city" in Paris (France), the "super blocks" in Barcelona (Spain) and the "low traffic neighbourhoods" in London (UK) – is experiencing a re-invigorated momentum.[43] Effective "Shift" and "Improve" measures related to walking include targeted behaviour change 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

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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.

City	Country	Modal share of cycling (%)					Share of females in cycle trips	Median age (years)				Median distance of cycle trip (km)	Median duration of cycle trip (minutes)
		All trips	Non-work trips	Work trips	All trips (males)	All trips (females)		Cyclists	All other road users	Male cyclists	Female cyclists		
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.

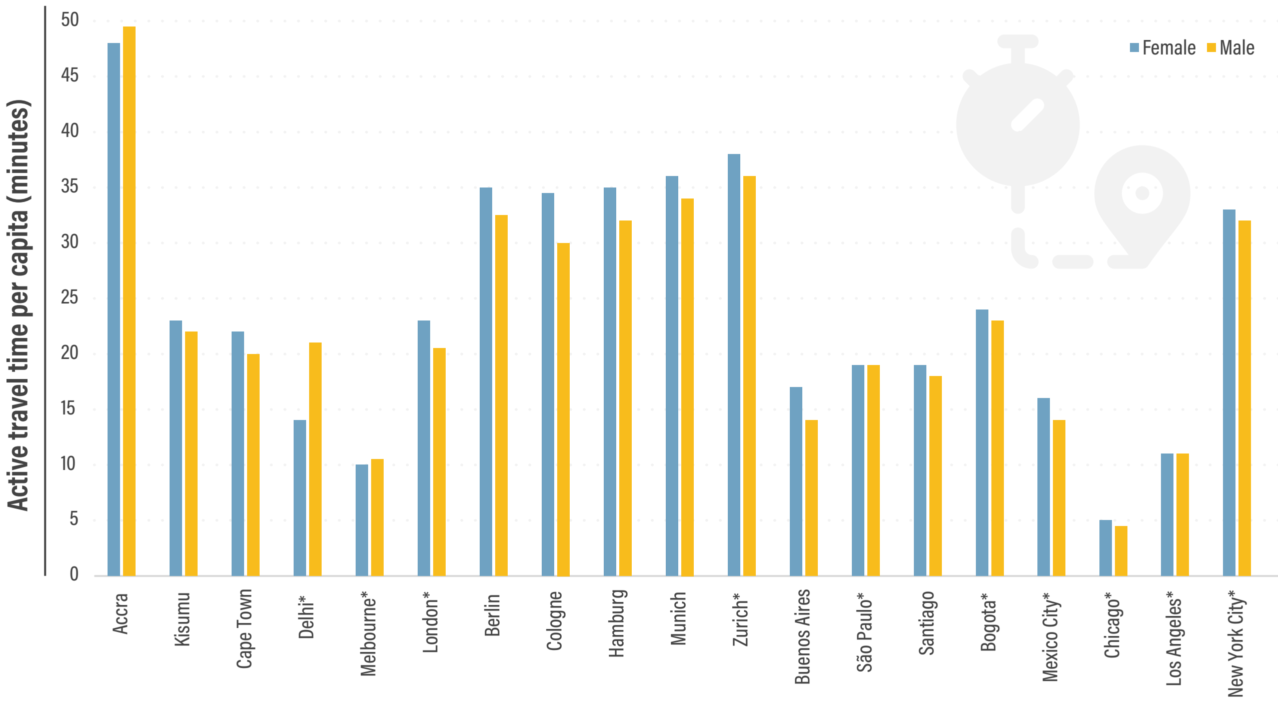
- In cities in Sub-Saharan Africa, cycling is more frequent among individuals with less formal education because of links to socio-economic status, such as not owning a car and having low income.[57]
- However, in cities in high-income countries, cycling is more frequent among people with high formal 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	*	
	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	Low-cycling, gender-unequal, highly age-unequal
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	*	
Buenos Aires	Argentina	3.3	34	0.64	1.11	1.01	2	Low-cycling, gender-unequal, age-equal (older adults)
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	
	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	Low-cycling, gender-unequal, age-equal (children only)
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	
	Germany	9.3	49	2.07	0.97	0.92	4	
	Switzerland	6.7	47	1.84	1	0.6	4	Medium-cycling, gender-equal, children over-represented
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	
	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	High-cycling, women over-represented, age-equal
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

MODULE 3 3.4

Shared Mobility

MODULE 3 | 3.4.1

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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]

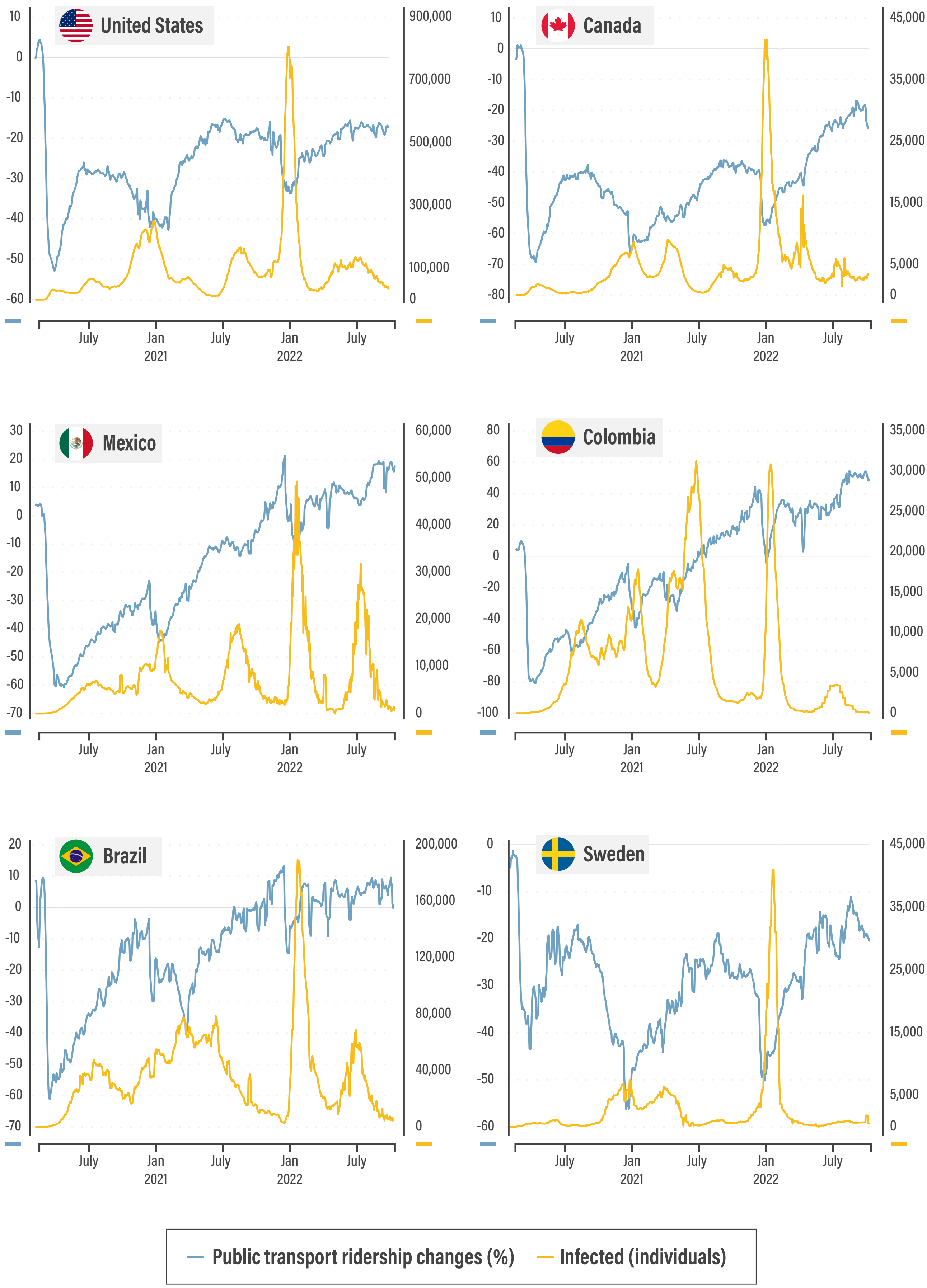
These trends contribute to lower levels of public transport use, particularly during rush hours, compared to pre-pandemic values.[23] The resulting reduced revenue from fares, complemented with reduced government subsidies and a lack of proper funding, can lead to budget deficits and quality of service deterioration, making public transport services less attractive and leading to greater private car use.[24]

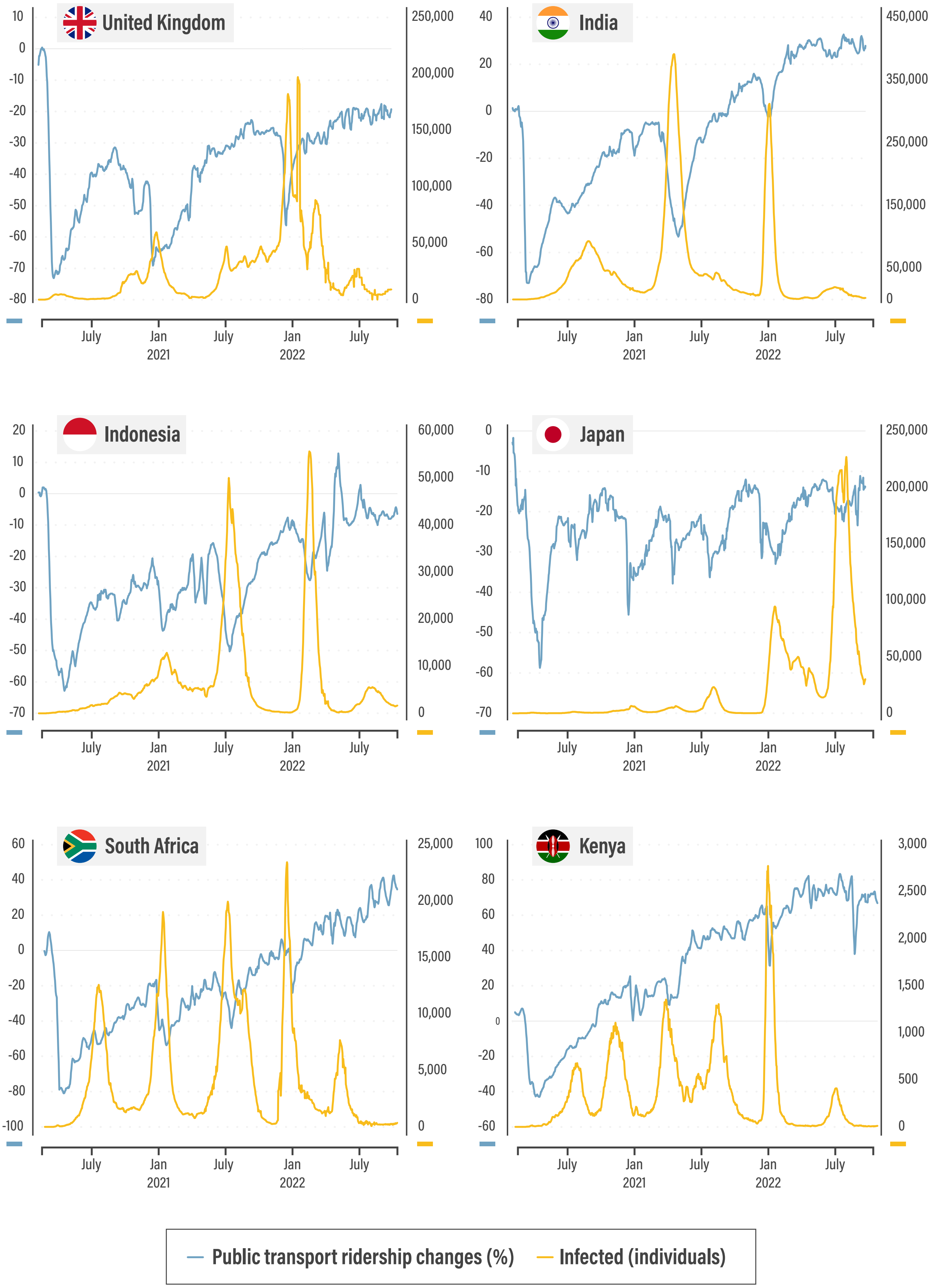
In February 2022, the Russian Federation's invasion of Ukraine sparked new travel restrictions and economic sanctions.[25] A subsequent US ban on imports of Russian oil, natural gas, and coal, as well as the European Union's pledge to cut imports of Russian oil by two-thirds, led to a surge in energy 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
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India
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20
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450,000
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Indonesia
20
10
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Japan
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200,000
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100,000
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South Africa
60
40
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0
-20
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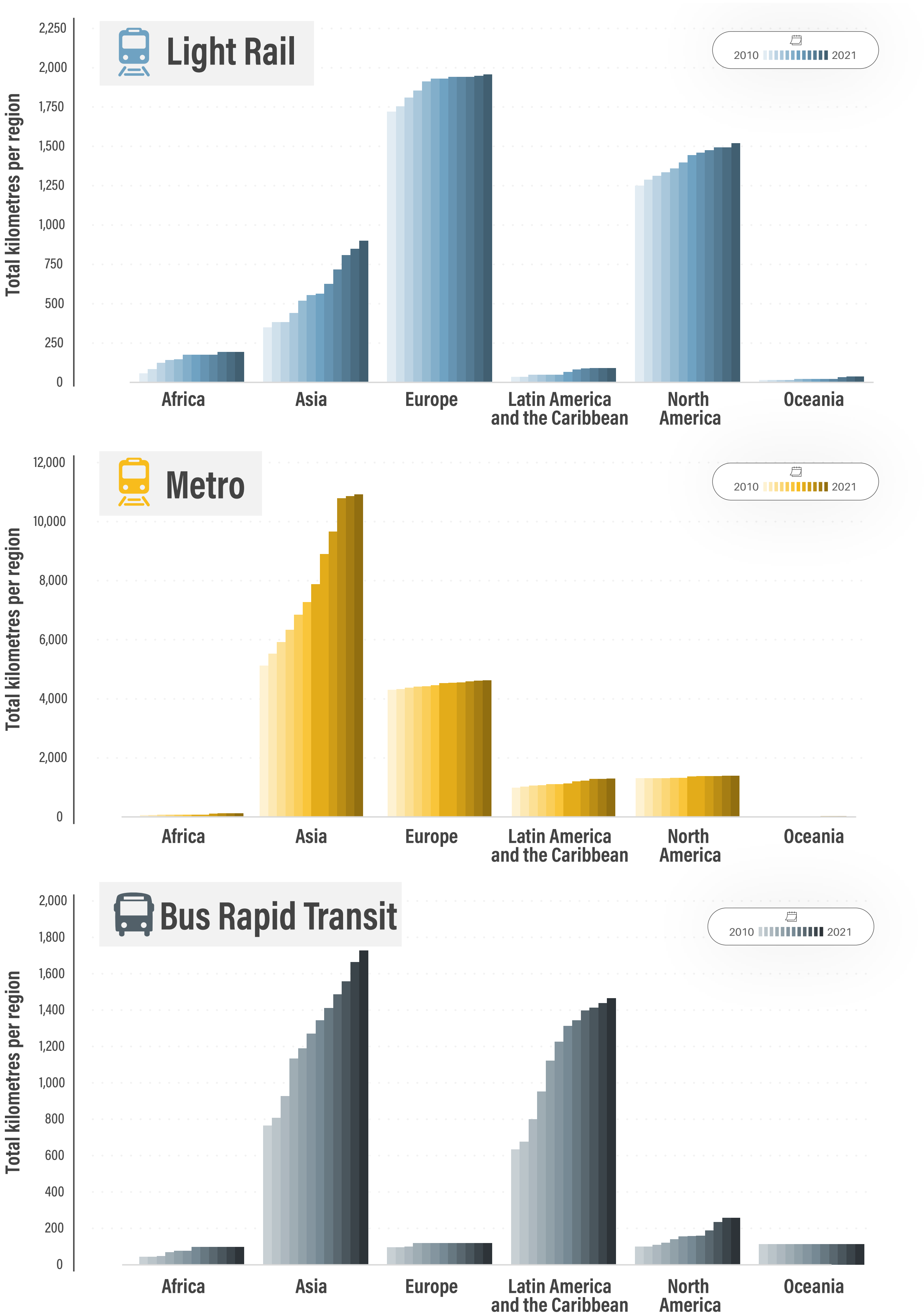
-60
-80
-100
25,000
20,000
15,000
10,000
5,000
0
Kenya
100
80
60
40
20
0
-20
-40
-60
3,000
2,500
2,000
1,500
1,000
500
0
July
Jan 2021
July
Jan 2022
July
Public transport ridership changes (%)
Infected (individuals)

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.

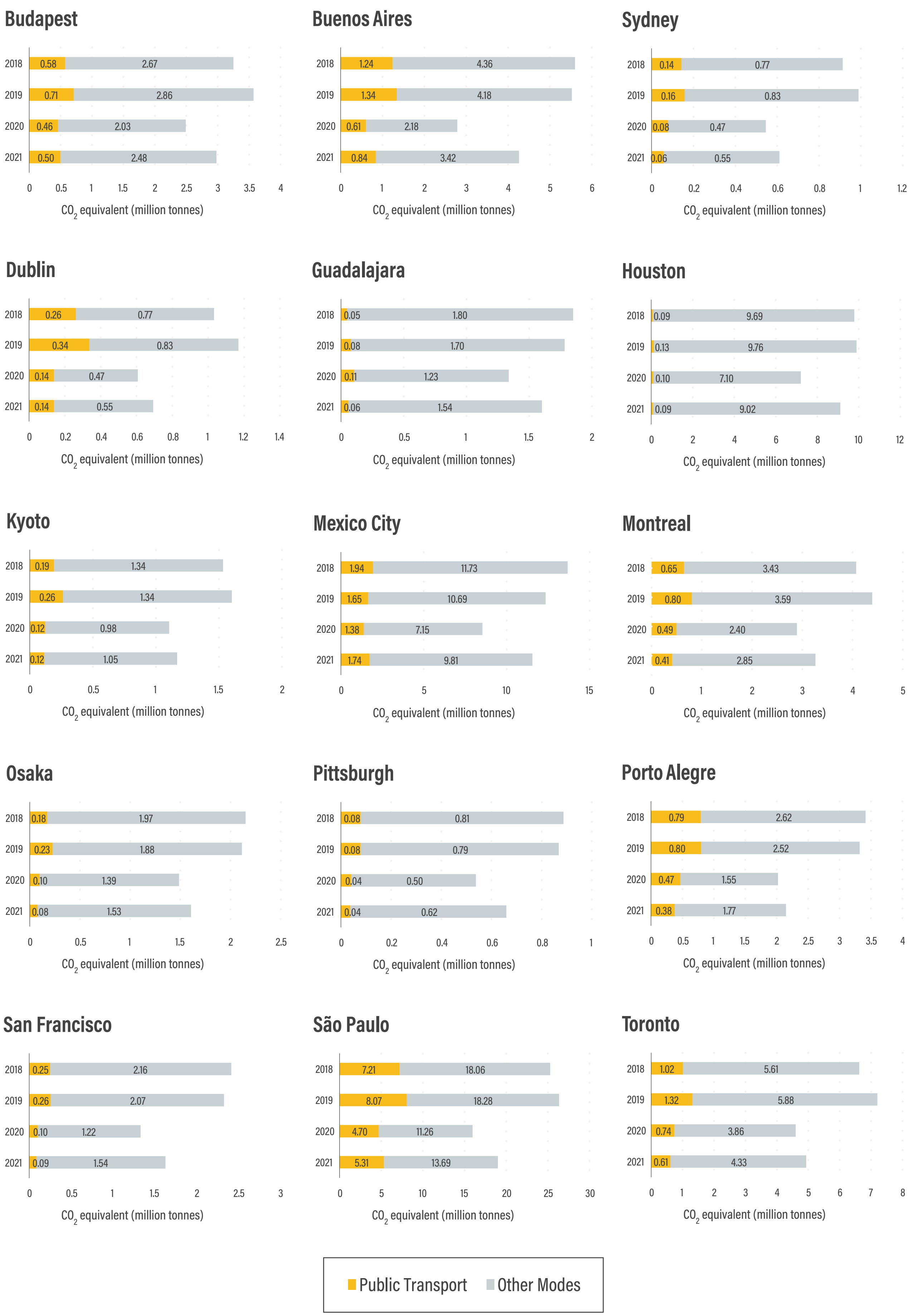
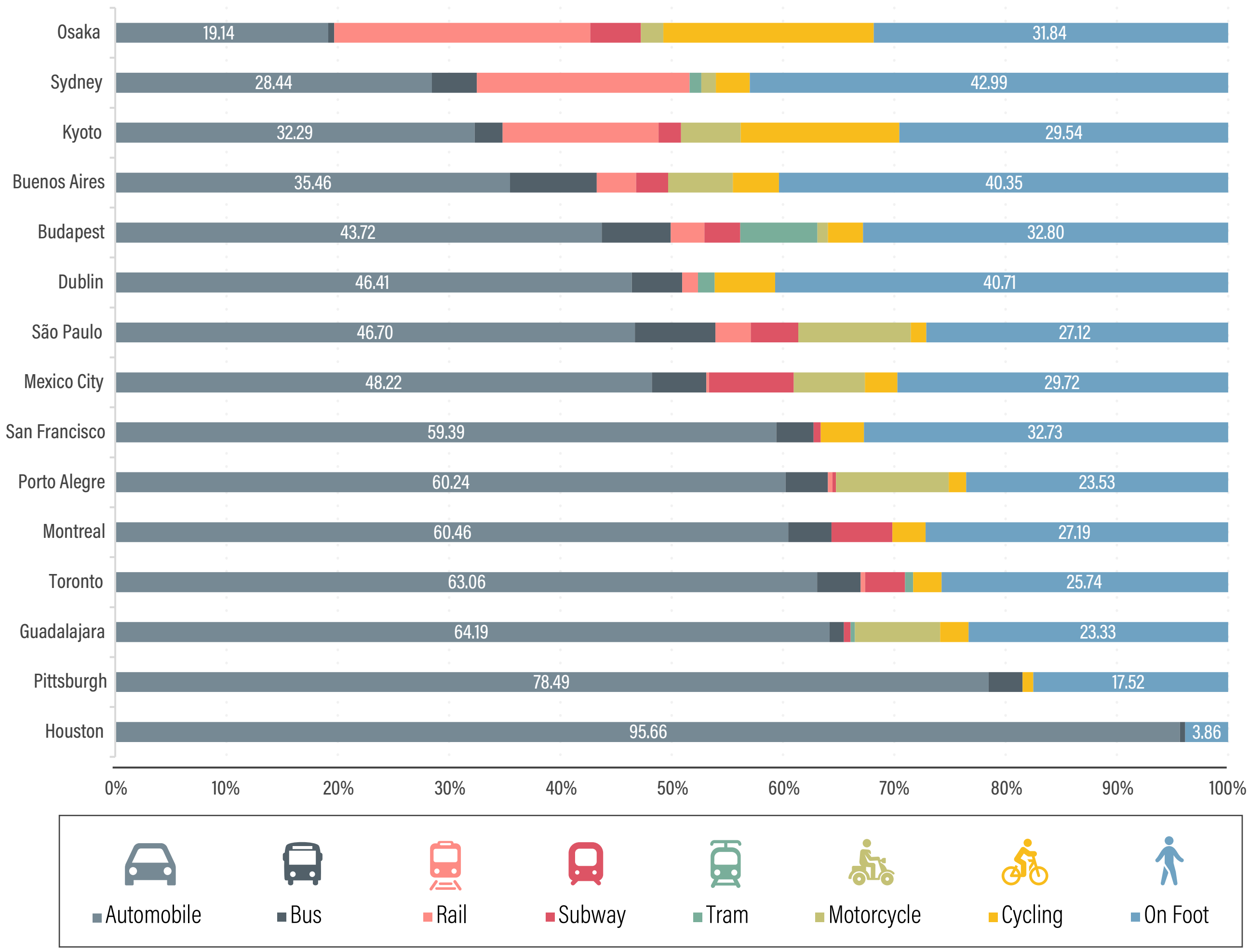


FIGURE 4. Modal share of selected cities, by total number of trips, 2021

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]

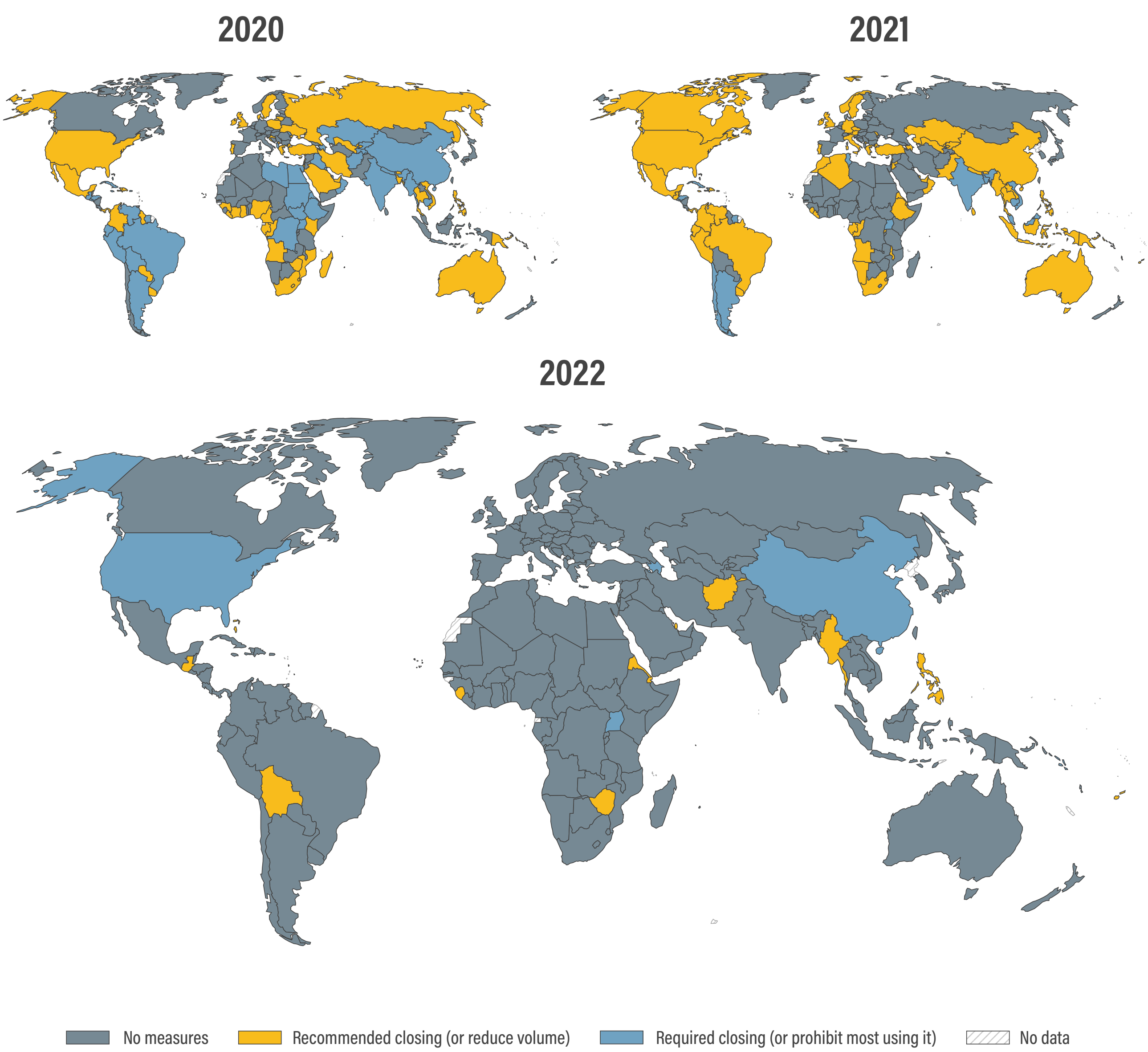
- In Europe, the increase in e-bus sales is attributed to national and city-level electrification targets, as well as the EU Clean Vehicles Directive, which mandates the procurement of zero-emission buses.[71] (*See Section 4.2 Vehicle Technologies.*)
- In 2021, three European countries registered more 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.

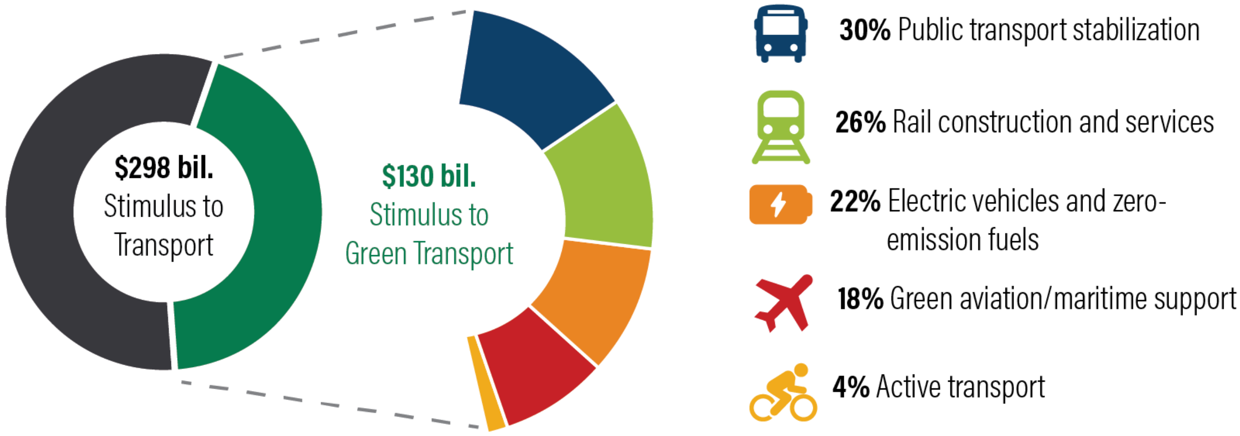
- In Brazil, where pandemic-related restrictions contributed to an estimated USD 188 million loss in daily fare revenues for bus operators, the government allocated 22% of subsidies to cover fare costs and to make public transport more accessible in over 150 cities as of June 2022.[77]
- Ireland, Italy, 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.

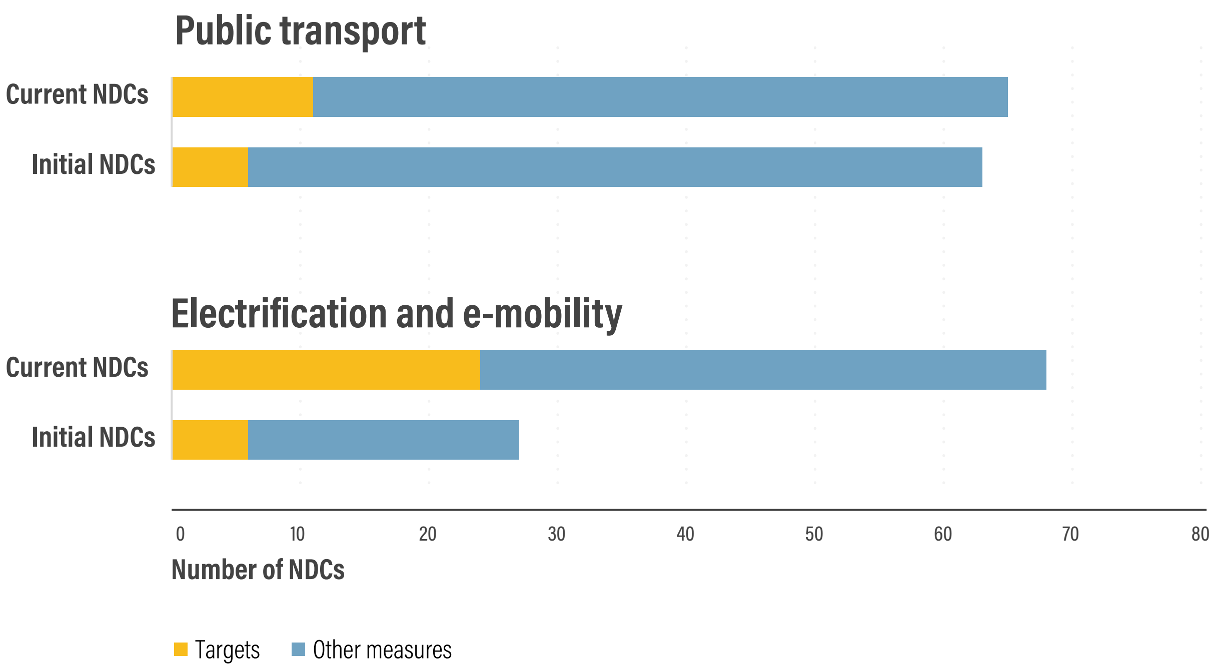
In addition, national governments and private enterprises have continued to invest in transport and public infrastructure. In the United States, the 2022 Inflation Reduction Act, coupled with investments provided through the bipartisan Infrastructure Investment and Jobs Act, allocate an unprecedented 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

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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.

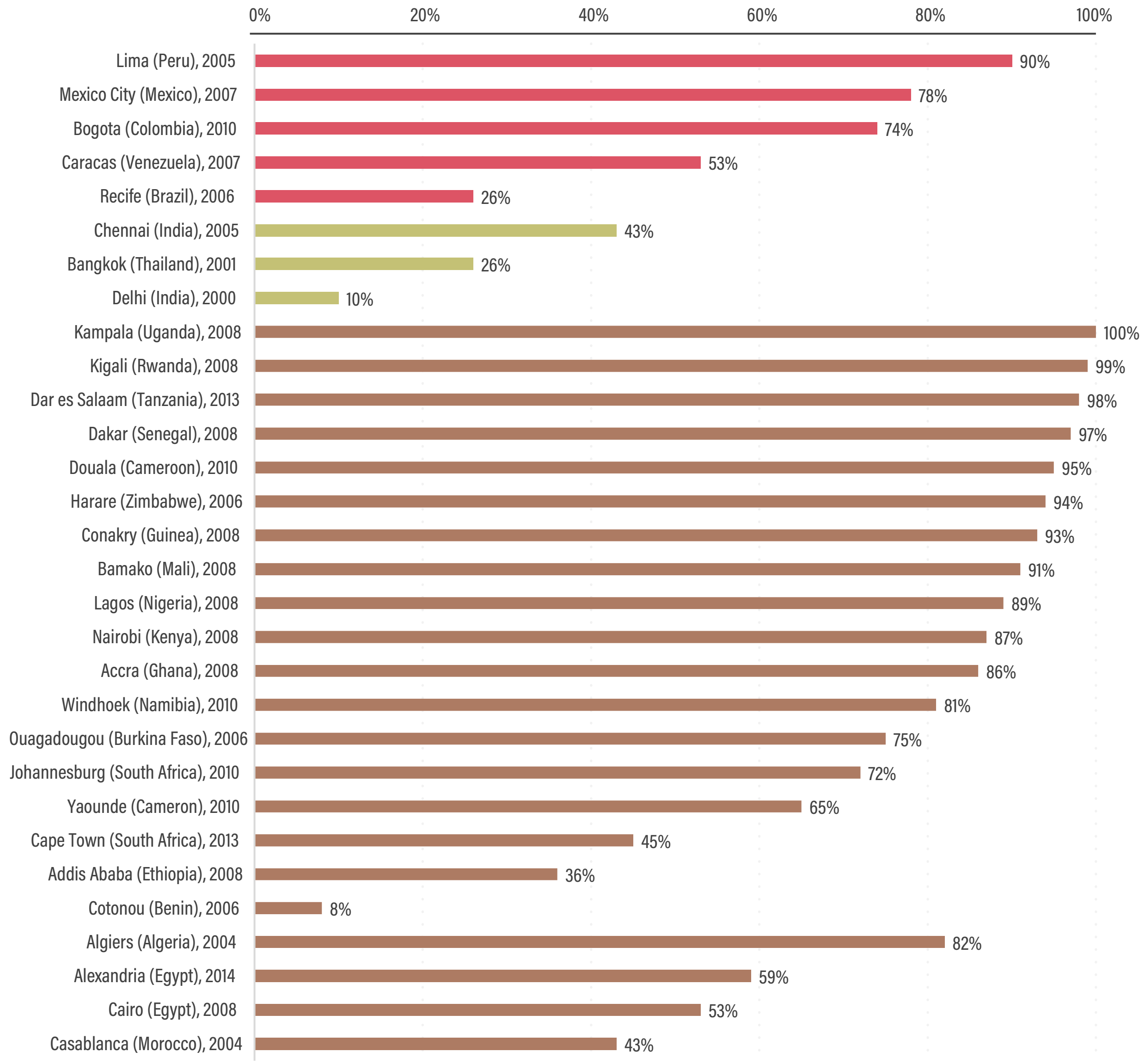
Demand trends

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]

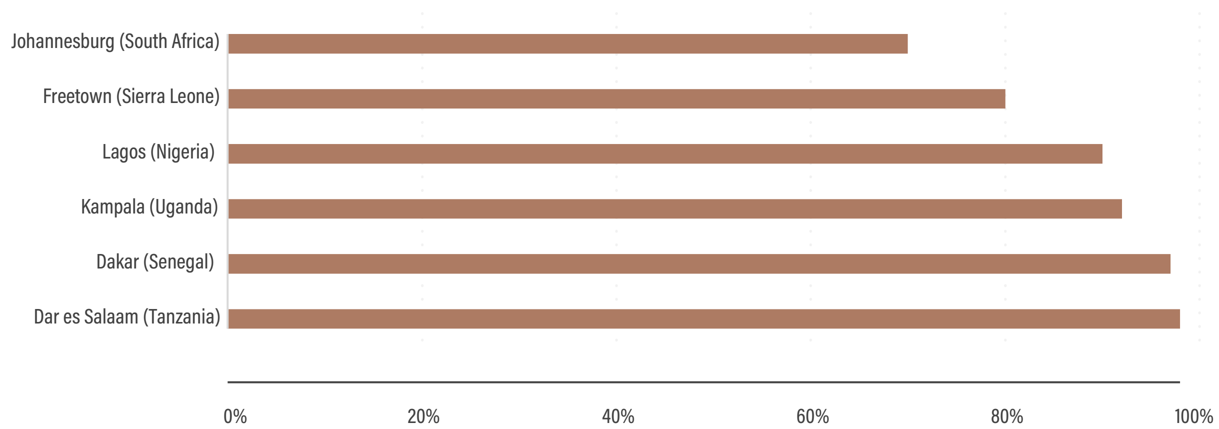
Minibuses are one of the highest-demand modes of informal transport in Africa.

- 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)

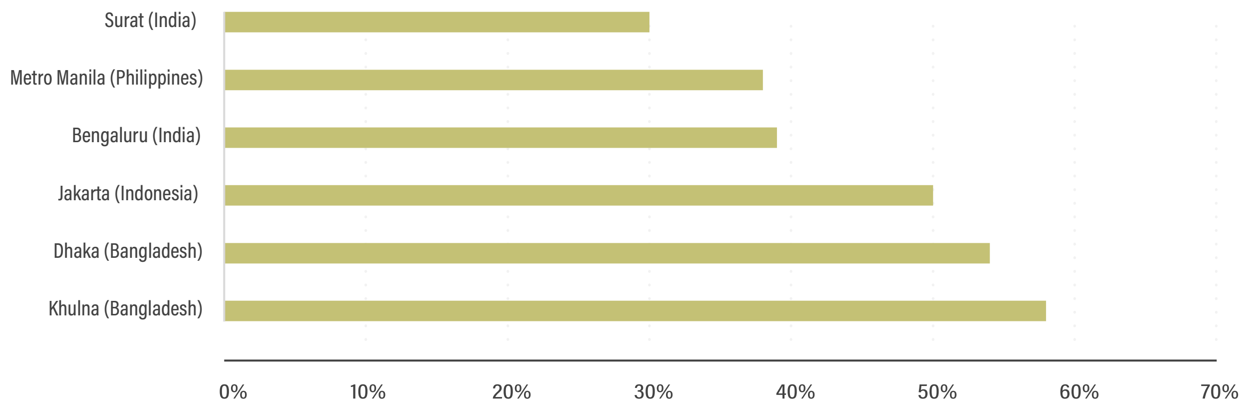
Asia

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]

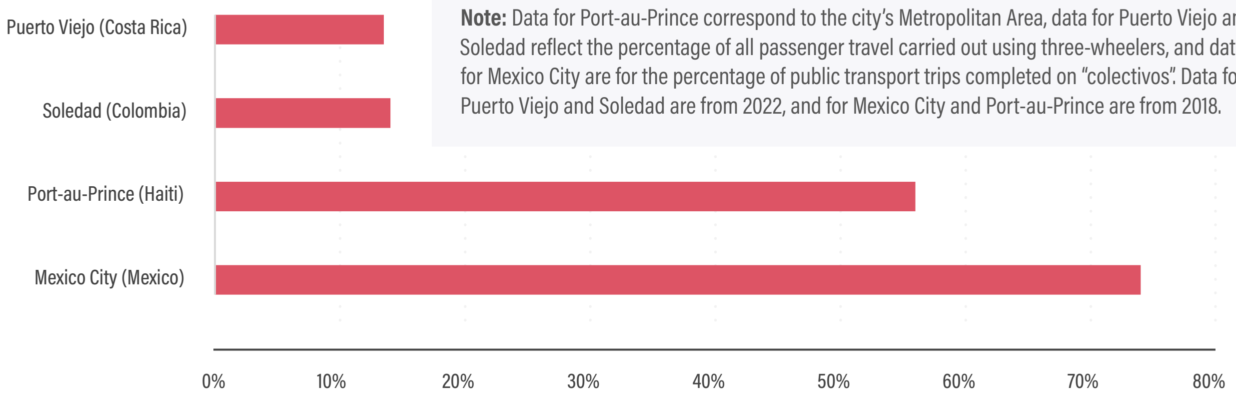
FIGURE 6. Common informal transport modes and local names for these services in Latin America and the Caribbean

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

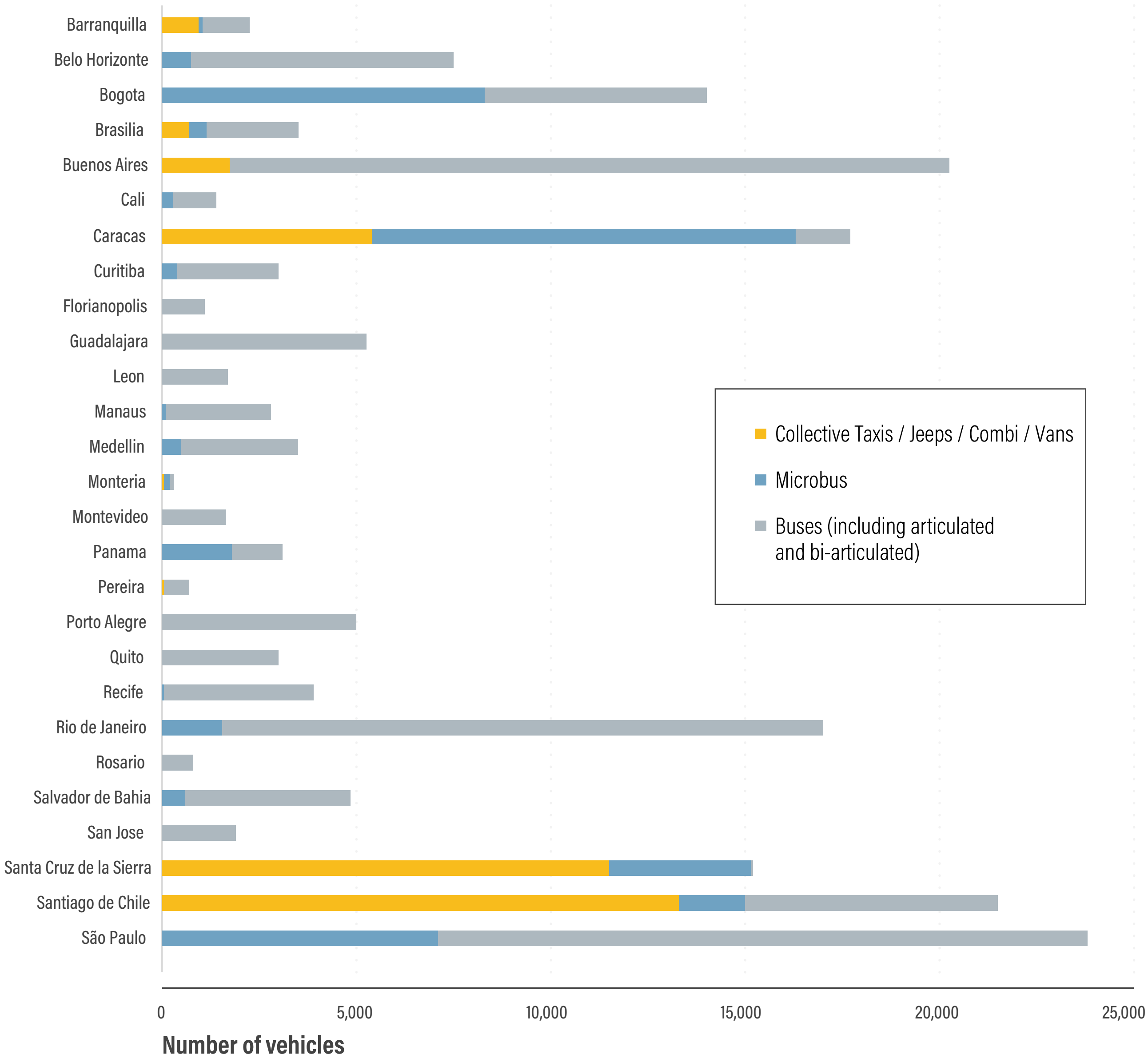
Source: See endnote 33 for this section.



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

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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

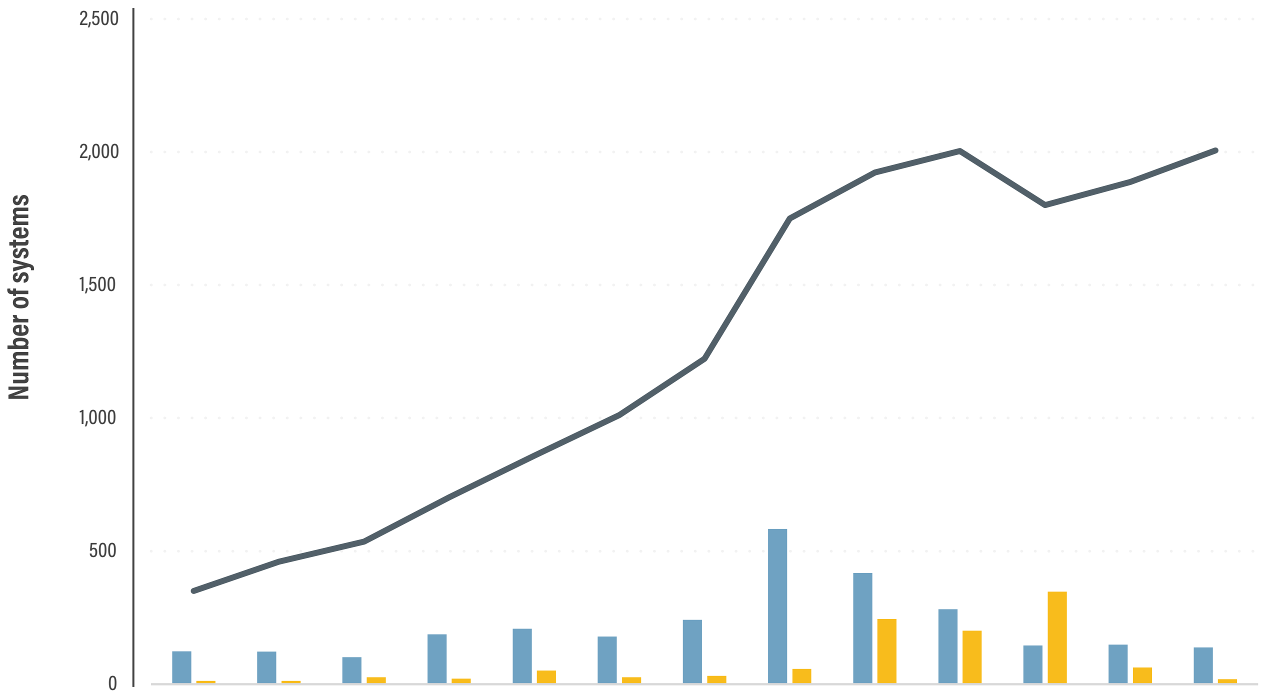
Micromobility refers to the use of smaller vehicles such as bikes, scooters and mopeds. In its shared form, it works similarly to carsharing, with users accessing the vehicles mostly in cities using an app. Besides increased mobility, this mode can foster greater use of active transport such as walking 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

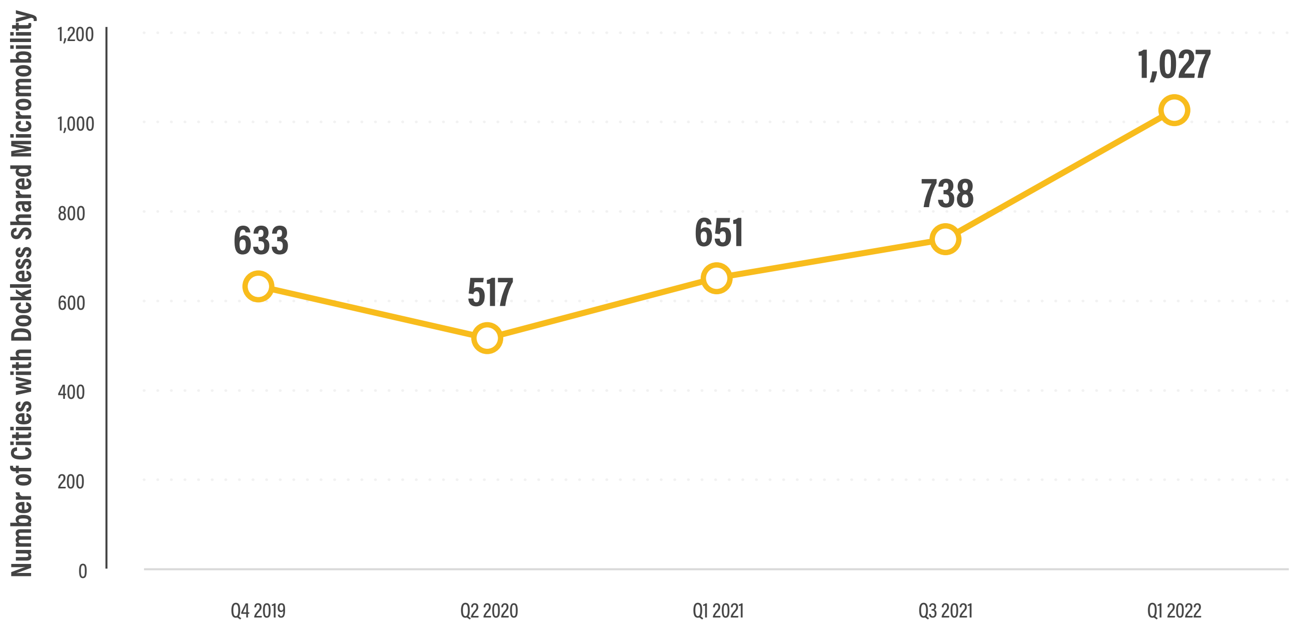
Source: See endnote 33 for this section.



	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

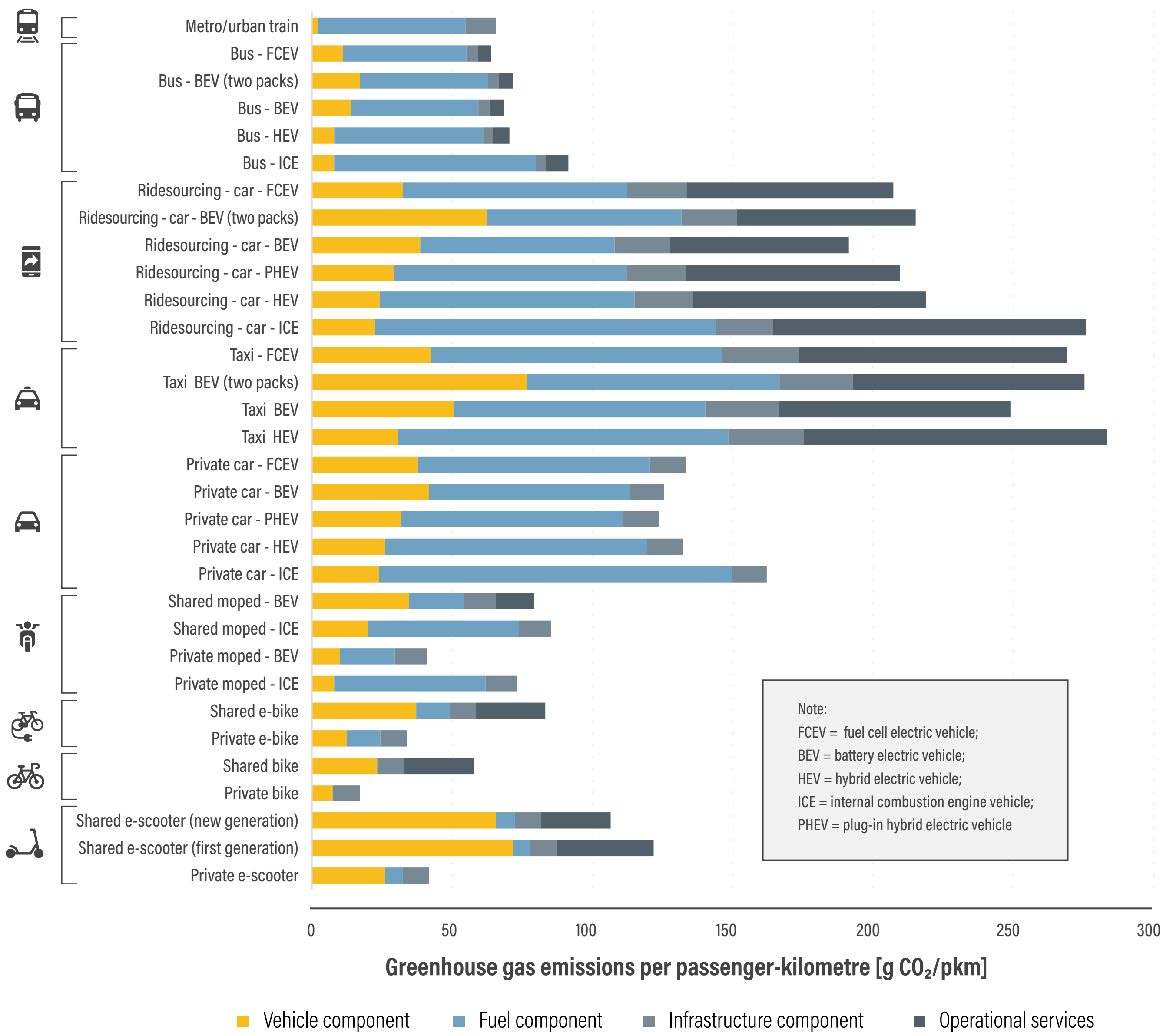
Policy making in the shared mobility space remains complicated. Cities have taken diverse approaches to regulation, with little evidence to conclude that one regulatory approach is better than another.[73]

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

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Rail

SLOCAT Partnership on Sustainable, Low Carbon Transport

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

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

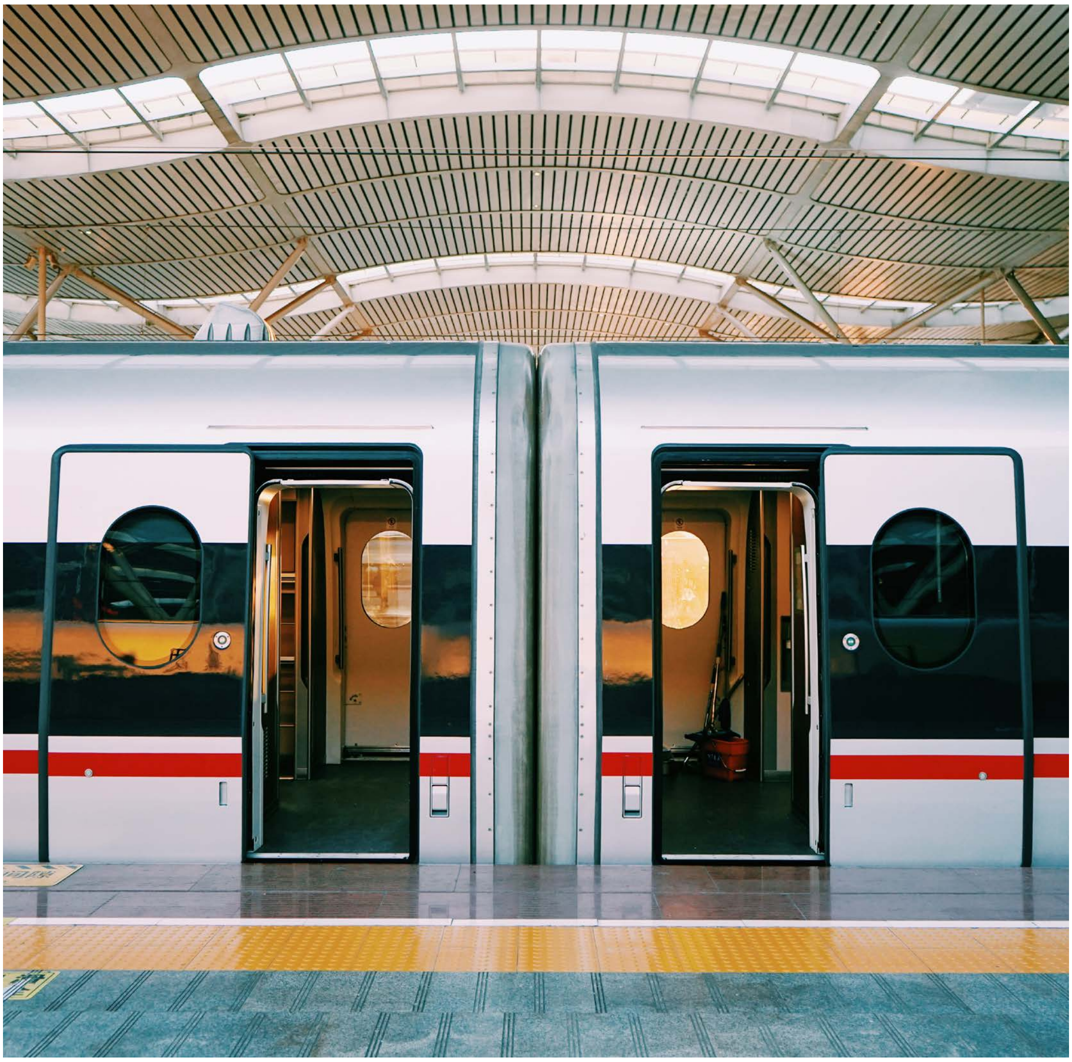
- Global passenger rail activity grew 29% between 2010 and 2019, from 3.22 trillion to 4.16 trillion passenger-kilometres.
- Due to mobility restrictions related to the COVID-19 pandemic, global passenger demand for rail services fell 37.7% in 2020 to 2.59 trillion passenger-kilometres.
- Rail use trends 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.

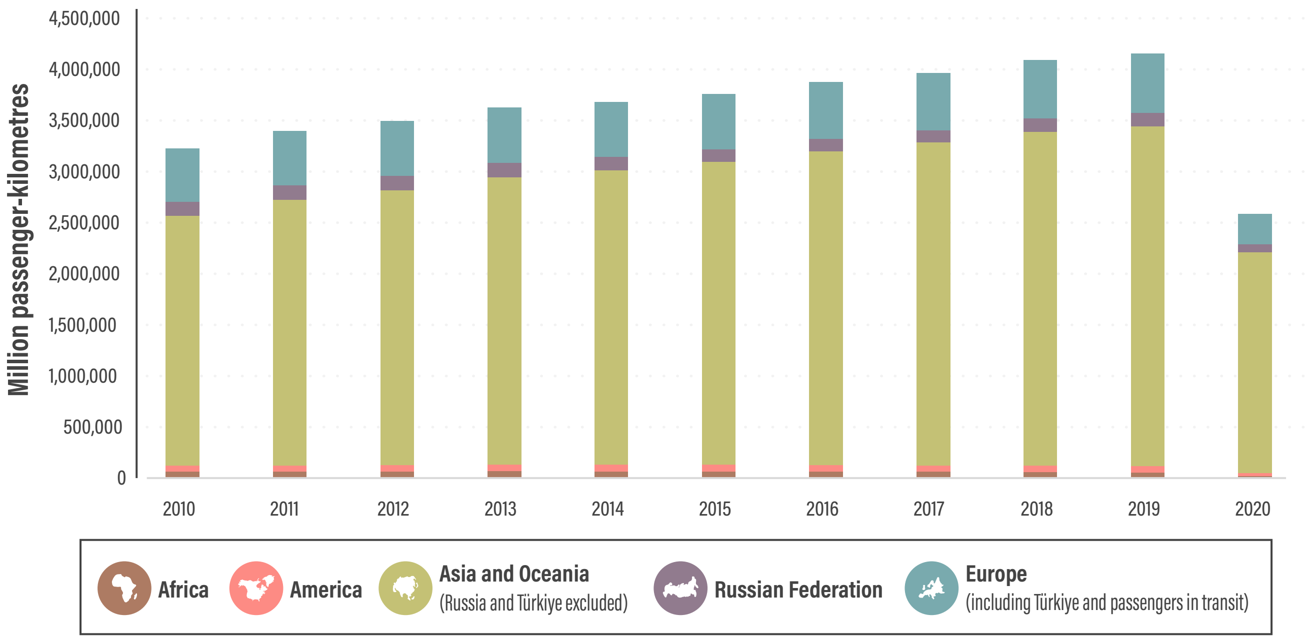


FIGURE 2. Freight rail activity by region, 2004-2020

Source: See endnote 19 for this section.

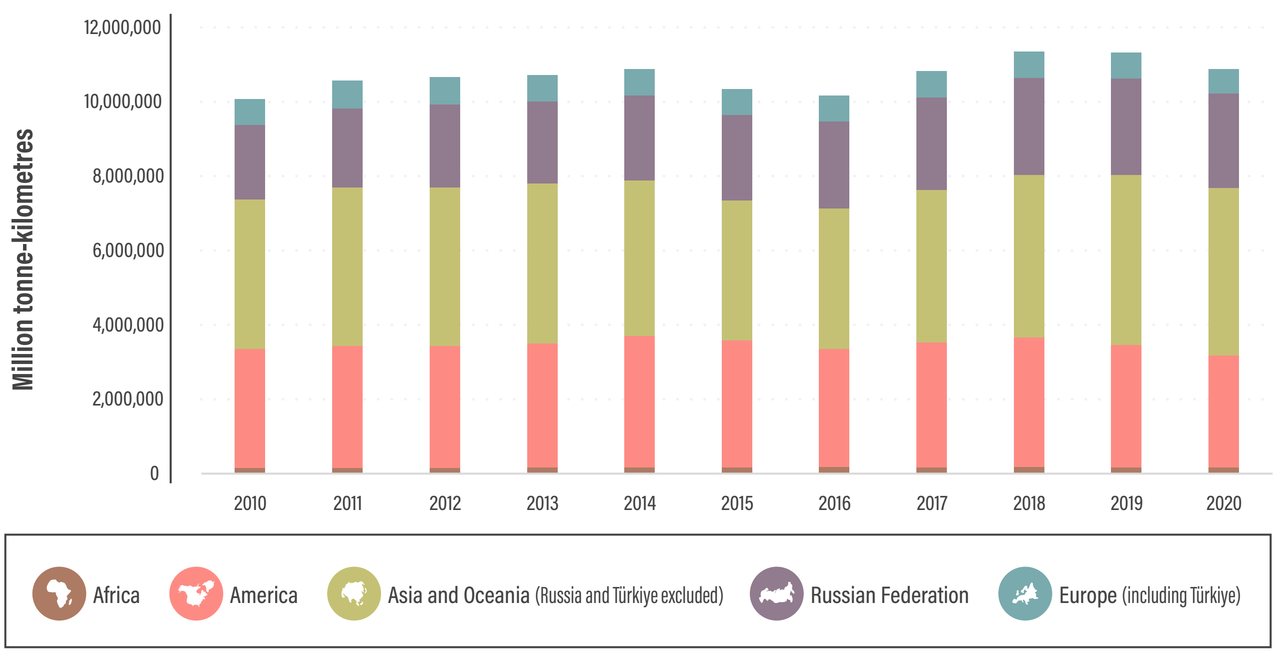


TABLE 1. Status of high-speed rail lines, by region, as of 2021 (in kilometres)

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.

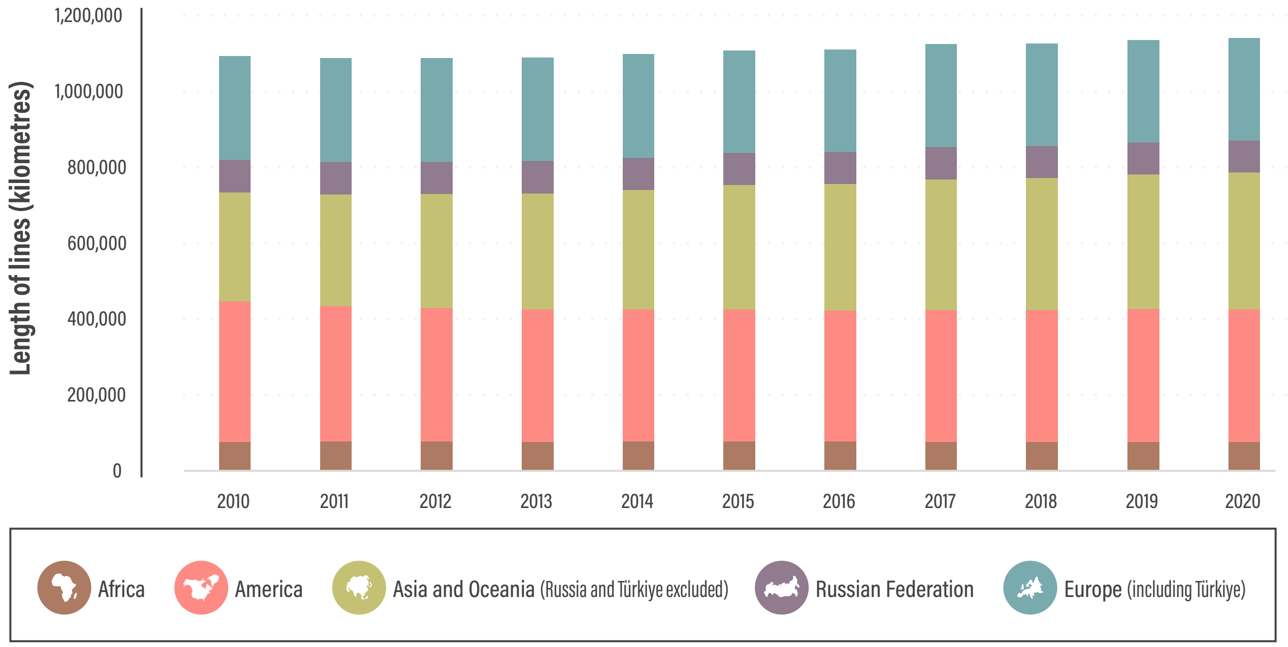


FIGURE 4. High-speed rail development in selected countries/regions, 2010-2021

Source: See endnote 30 for this section.

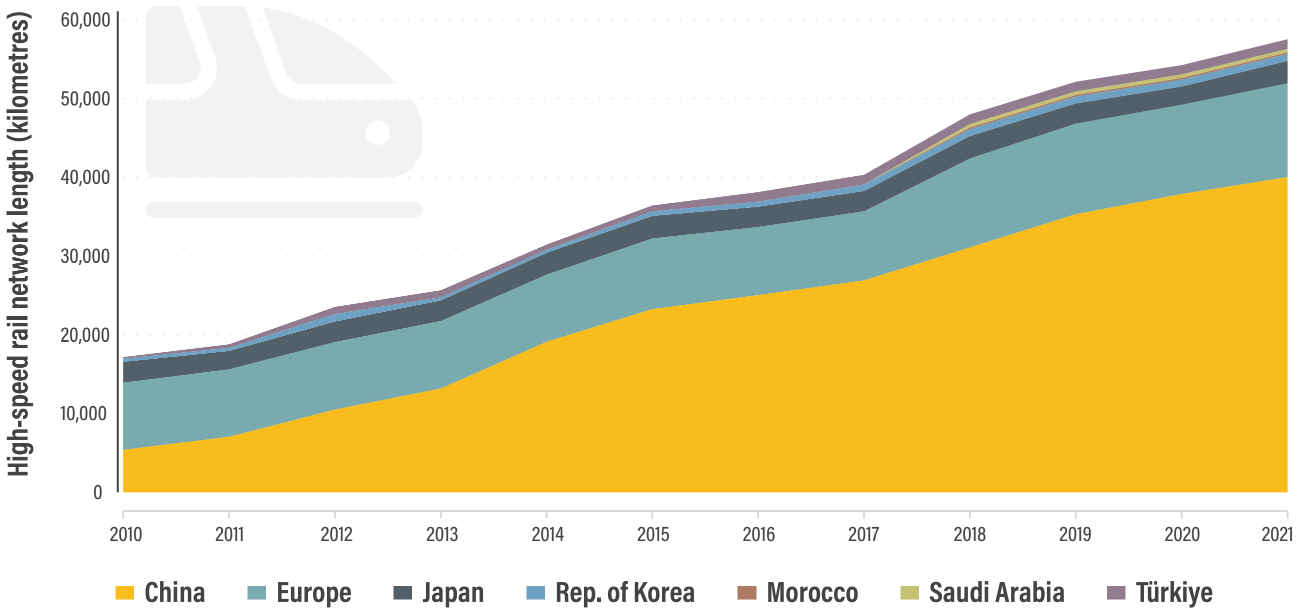


FIGURE 5. Status of global high-speed rail network by country/region, as of 2021

Source: See endnote 31 for this section.

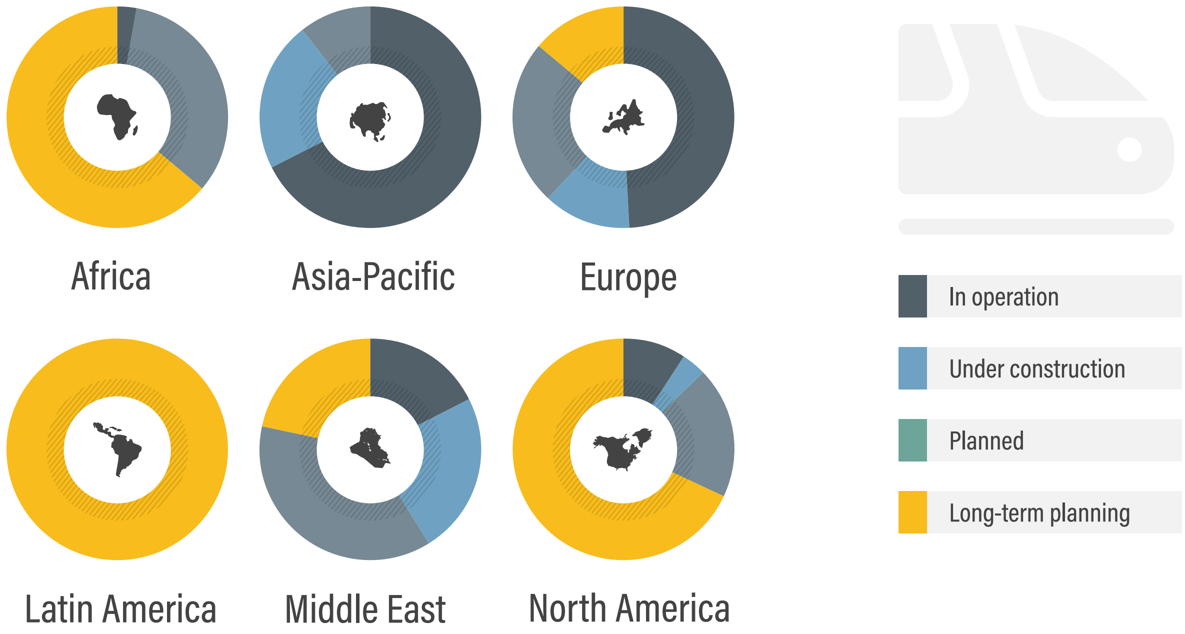
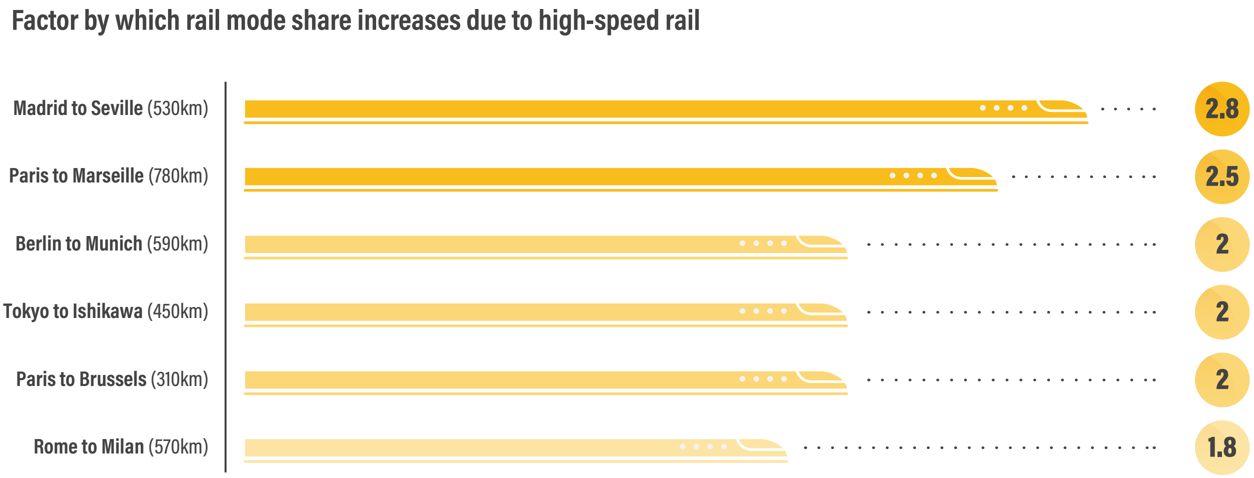


FIGURE 6. Increases in rail modal share due to high-speed rail

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.

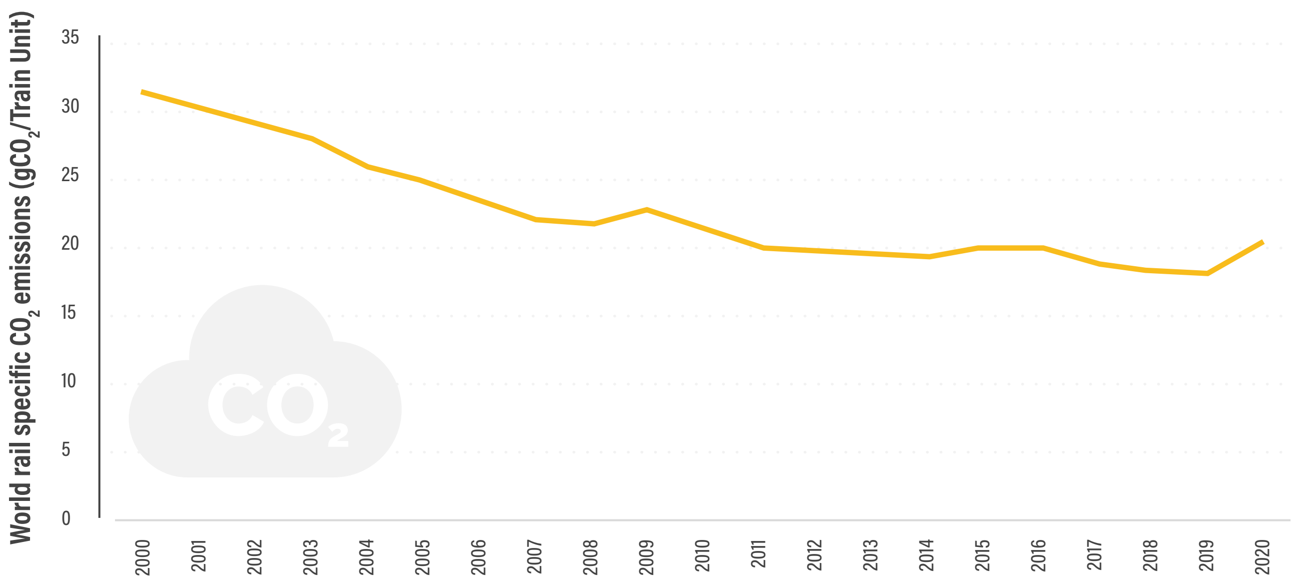
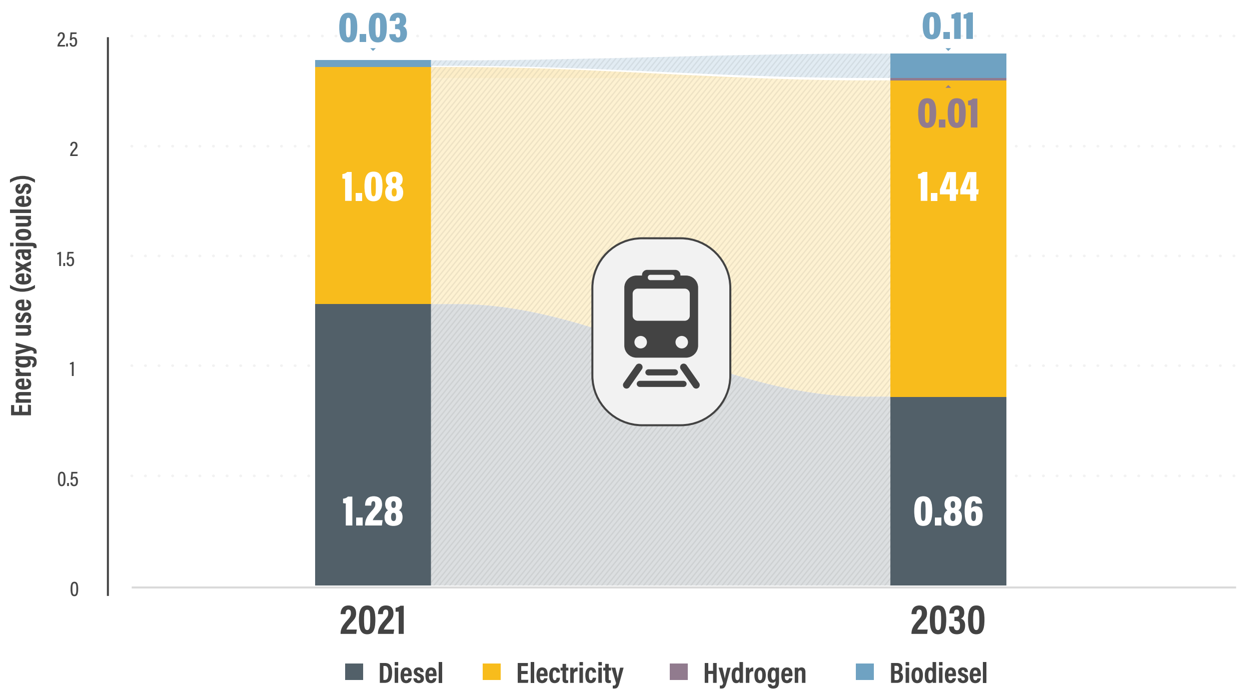


FIGURE 8. Energy use in the rail sector by source, 2021 and projections for 2030

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]

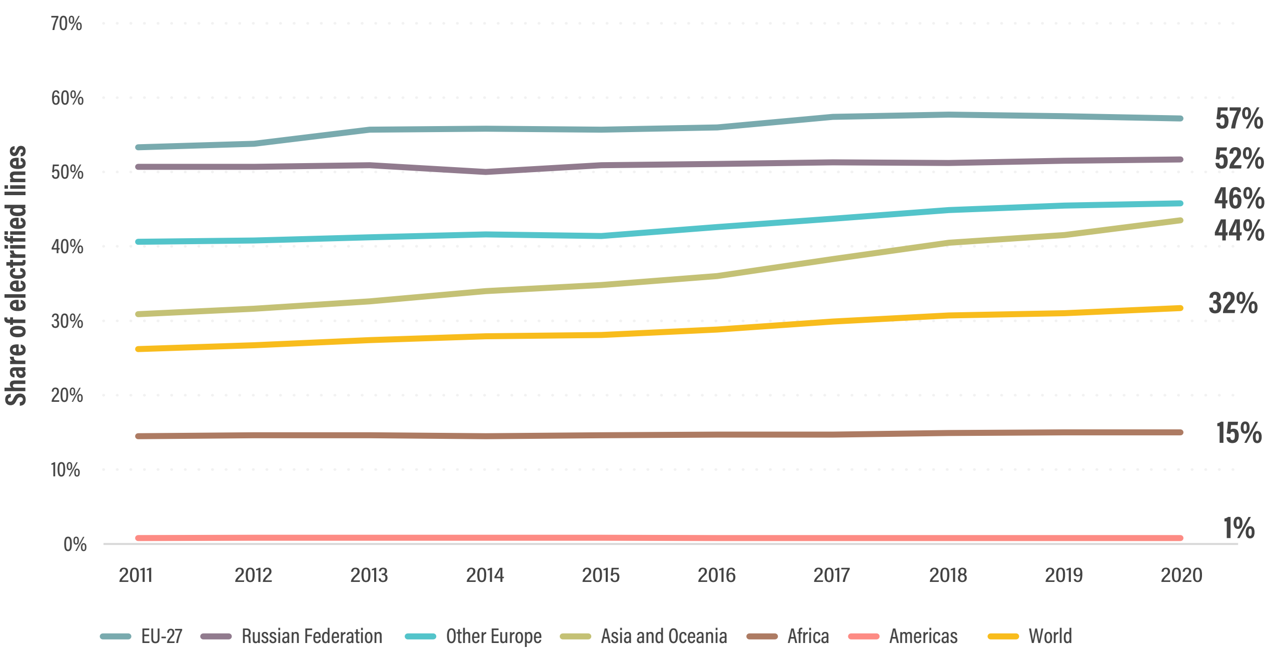
- In 2020, Indian Railways set an ambitious target to electrify all rail routes by December 2023 and to add more than 500 megawatts of renewable power (solar and wind).[56]
- Romania has allocated EUR 3.9 billion (USD 4.2 billion) from European Union (EU) recovery funds for rail modernisation – including 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

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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]

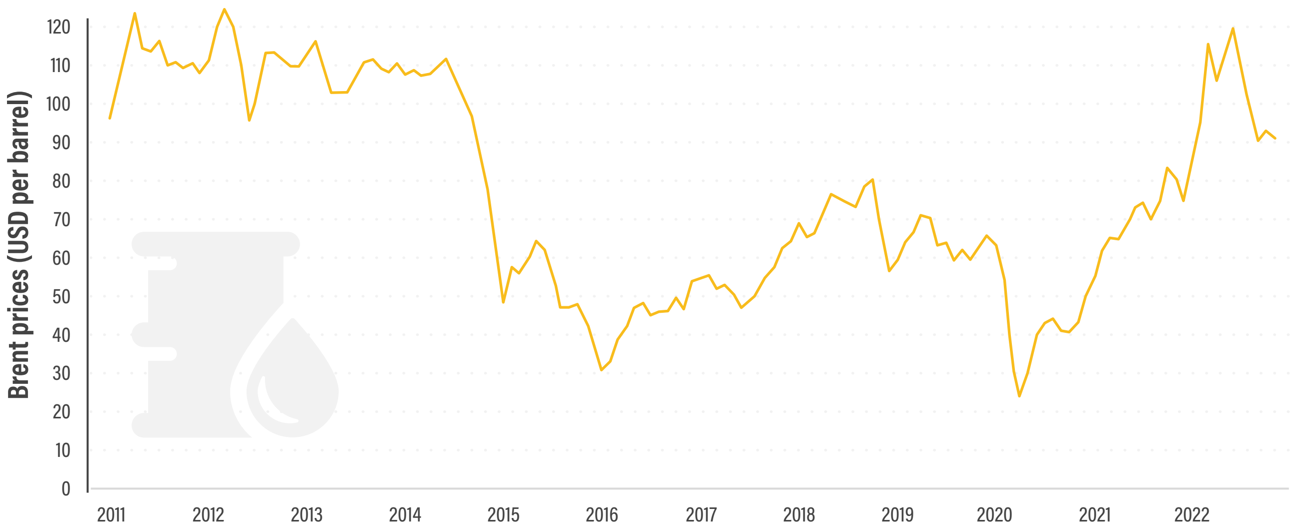
- In the European Union (EU), road freight continued to rank a distant second after maritime freight in 2021, representing around 24% of total freight transport (compared to 68% for maritime).[8]
- However, road transport dominated the freight sector in Germany, Japan and the United States in 2020.[9] (*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]

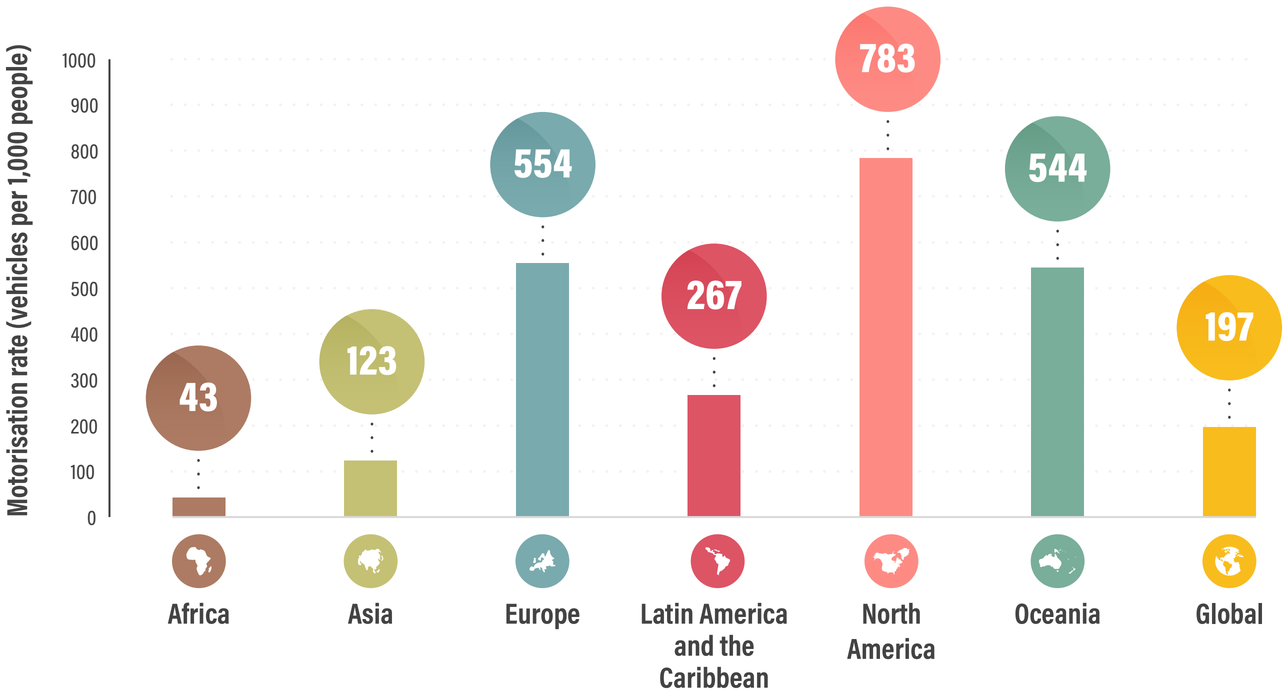
Motorisation rates, or the number of motor vehicles per 1,000 people, vary greatly by region, with the highest rate in North America – at four times the global average of 196 vehicles per 1,000 people – and the lowest rate in Africa, at a quarter of the global average, as of 2020 (see Figure 2).[22] 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]

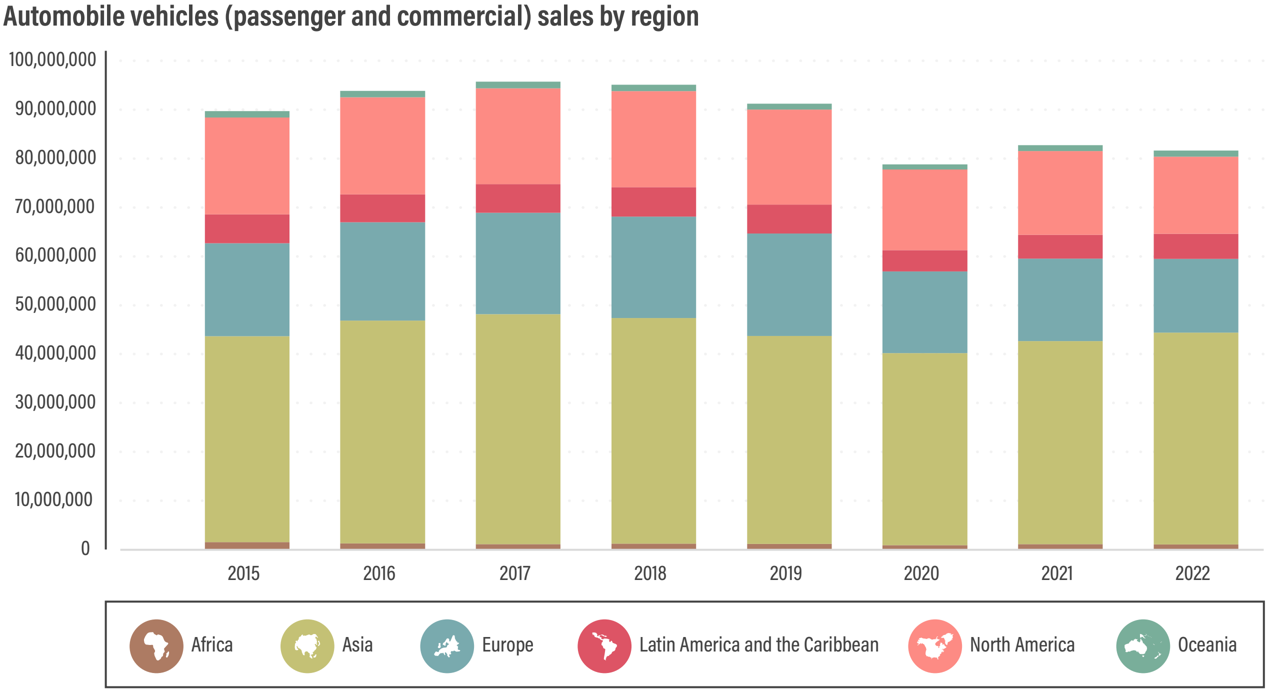
The relationship between income and car ownership is complex, and a wide range of factors influence whether someone chooses to own a car. Many current demographic and economic trends have the potential to reduce per capita vehicle travel and to increase the demand for affordable, healthy and resource-efficient 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.*)

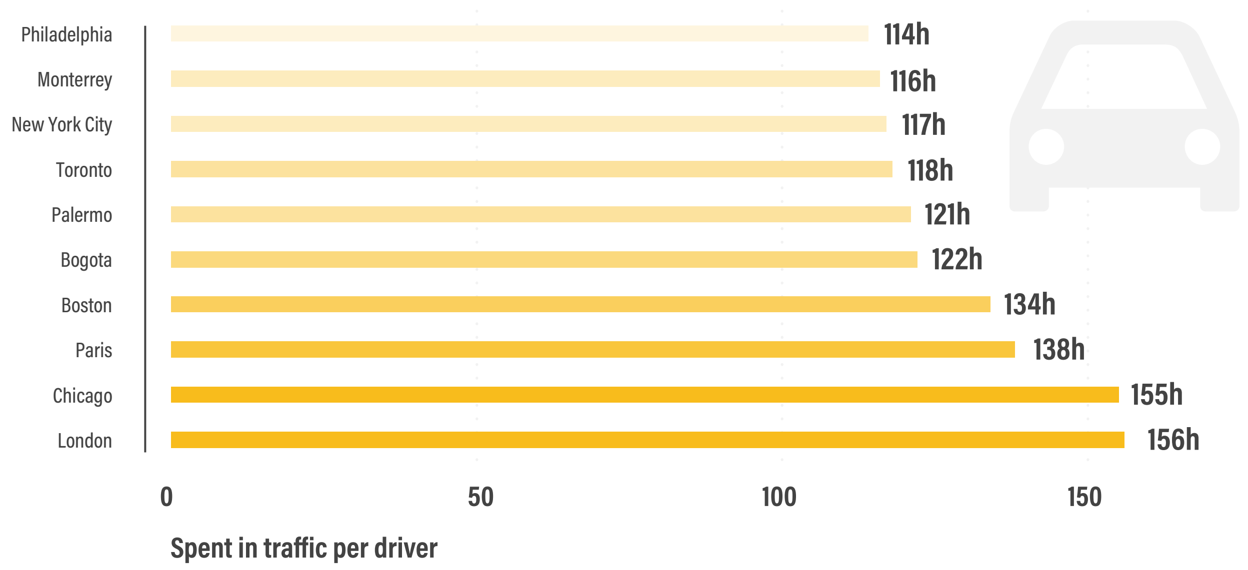
Global shares of electric heavy-duty vehicles remain relatively low, with electric buses accounting for around 3.1% of the total bus stock, and heavy-duty trucks comprising just 0.4% of the total truck stock in 2022.[46] However, as interest has grown, sales of new electric buses increased 15% in 2022 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.

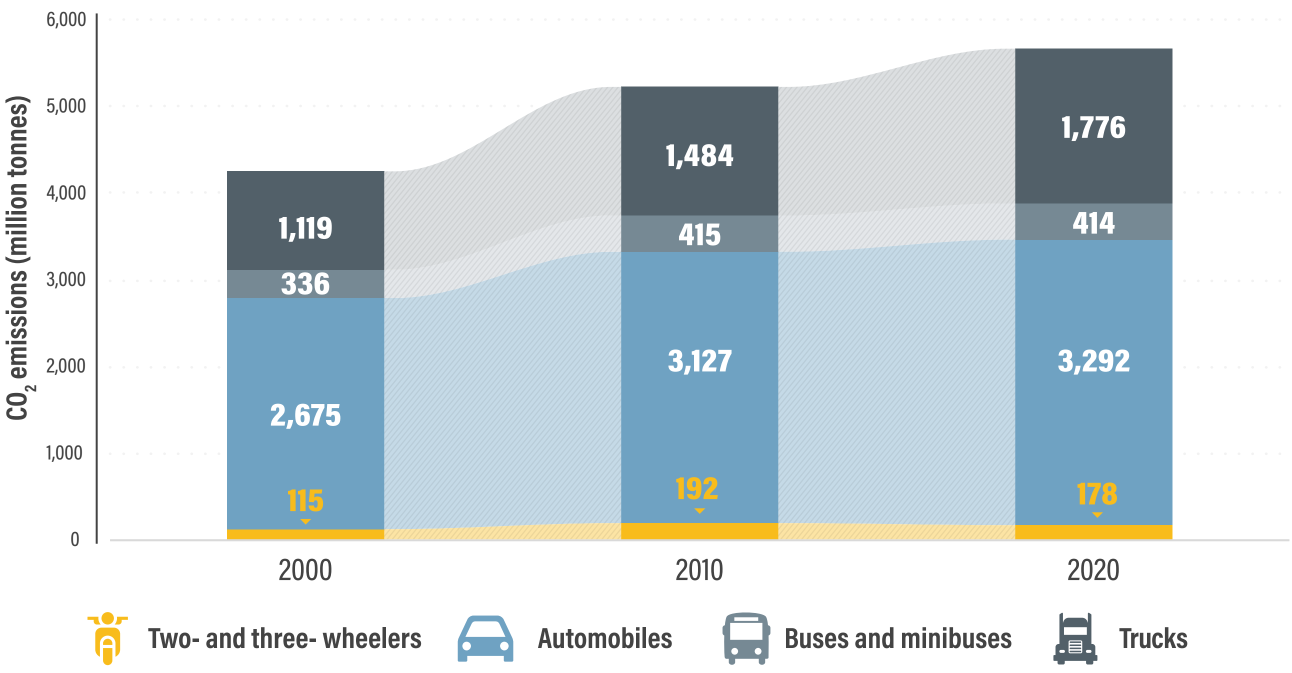


FIGURE 6. Per capita CO_2 emissions from road transport in countries globally, 2021 (in kilograms)

Source: See endnote 88 for this section.

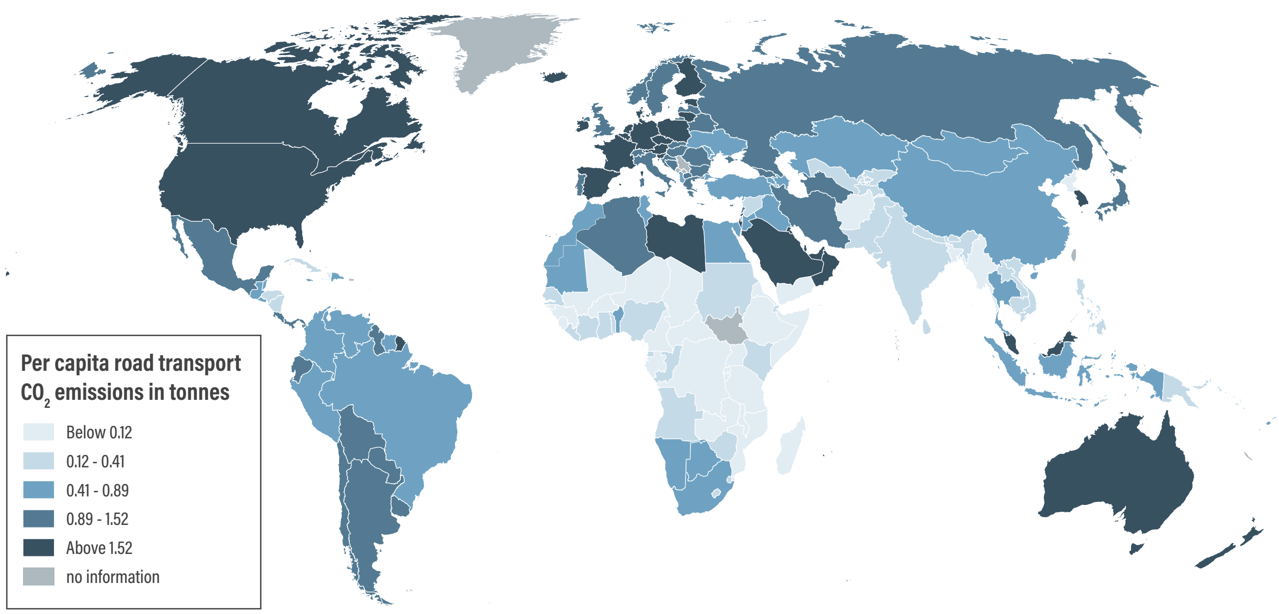
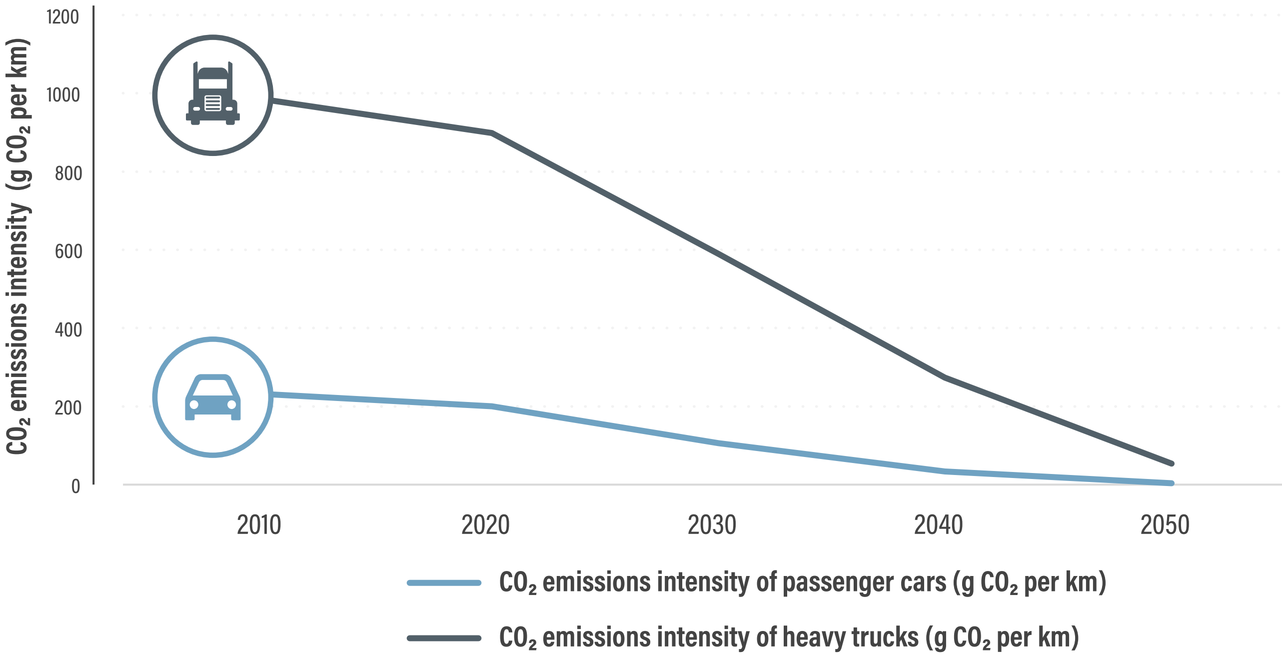


FIGURE 7. Required emissions intensity pathway to 2050 according to the International Energy Agency's Net Zero scenario

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

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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]

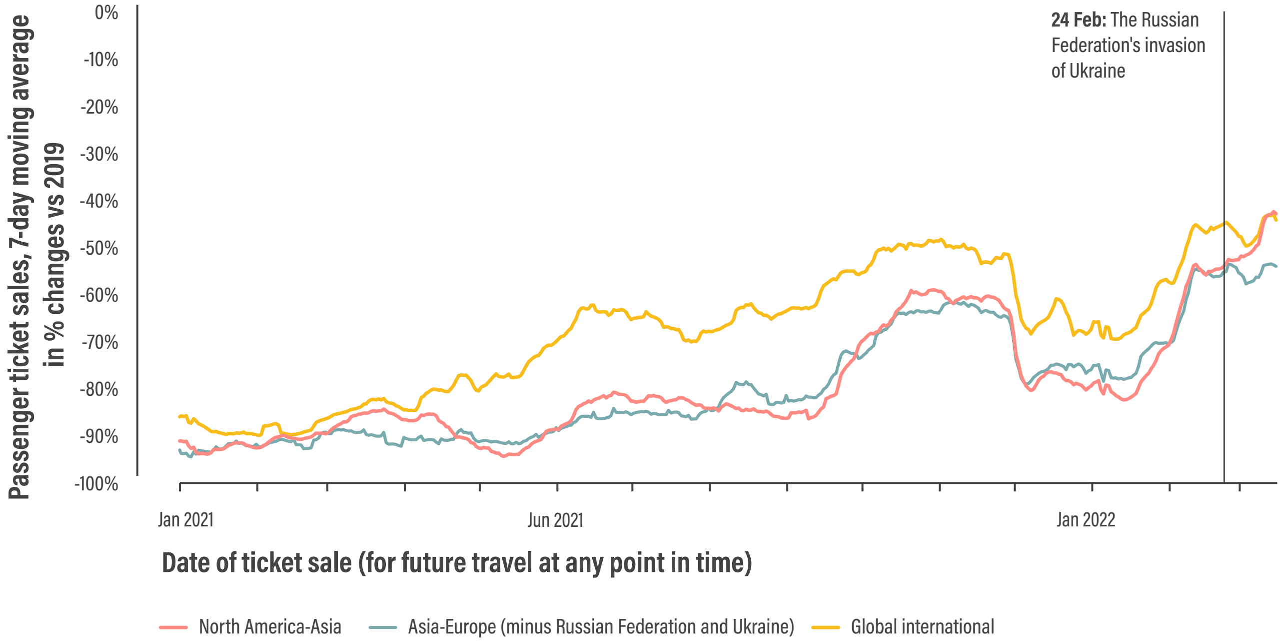
In March 2022, 36 countries closed their airspace to Russian airlines in reaction to the country's invasion of Ukraine, with the Russian Federation responding reciprocally.[18] **This gave airlines in China, India and the Middle East market advantages over airlines based in Europe and the United States. 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]

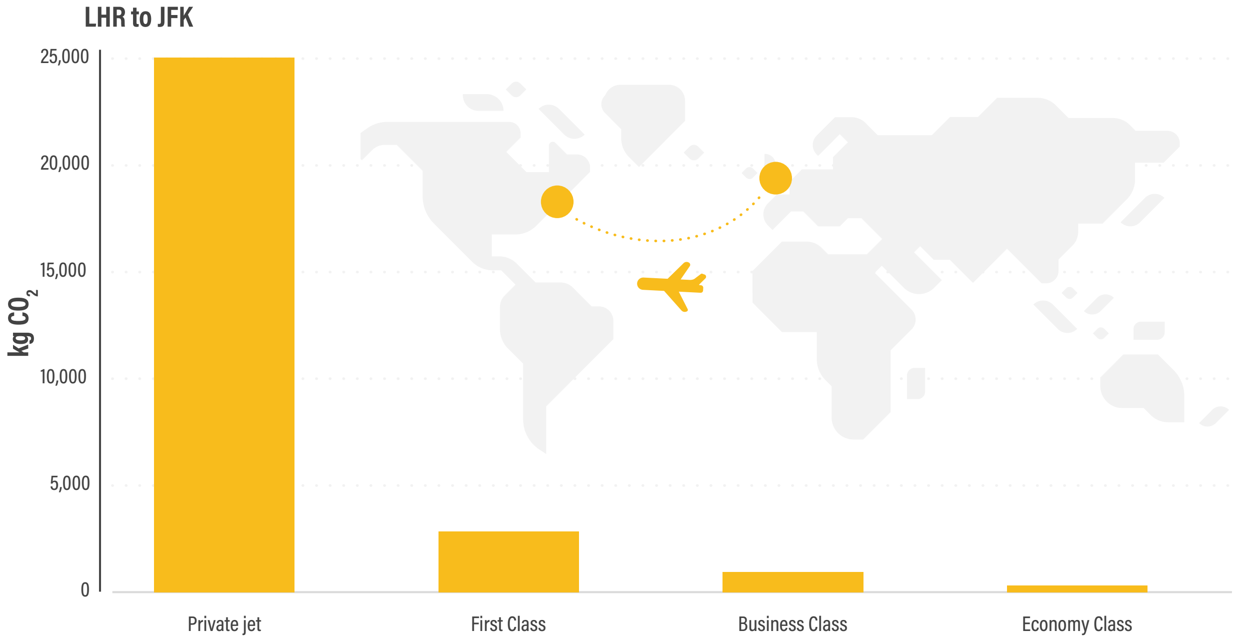
Aviation has contributed around 4% to human-caused climate change to date, despite being responsible for only 2.4% of annual global CO_2 emissions.[31] In 2018, commercial aviation contributed the vast majority of aviation CO_2 emissions (an estimated 88%), followed by military operations (8%) and private 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.

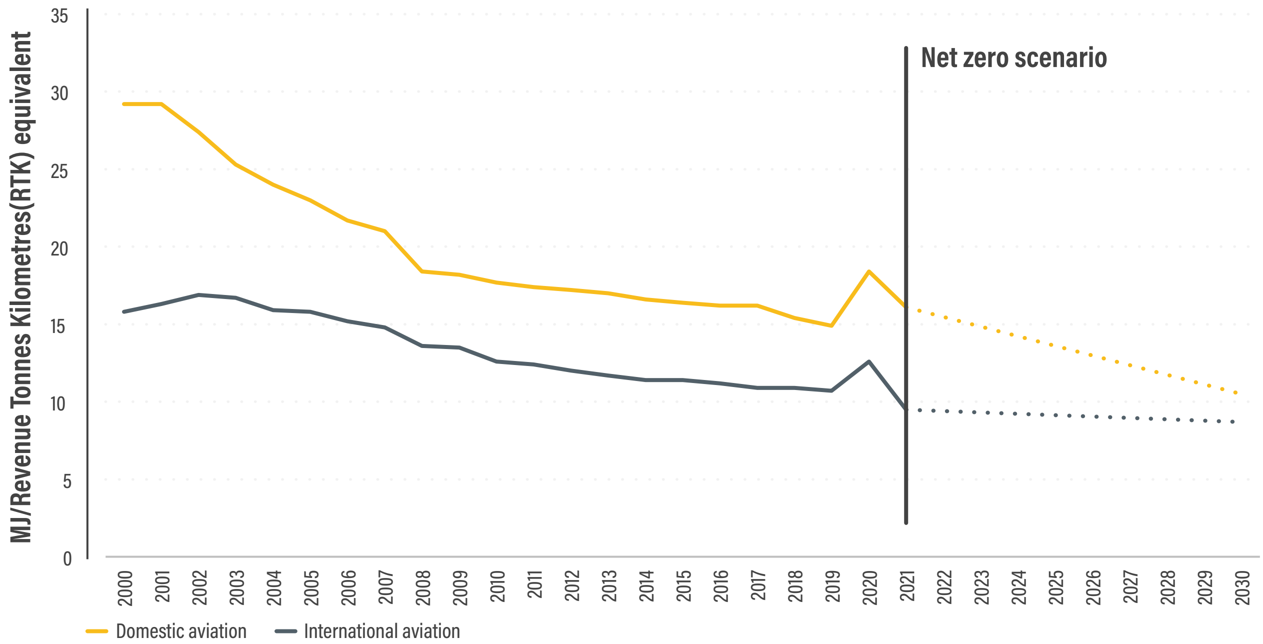
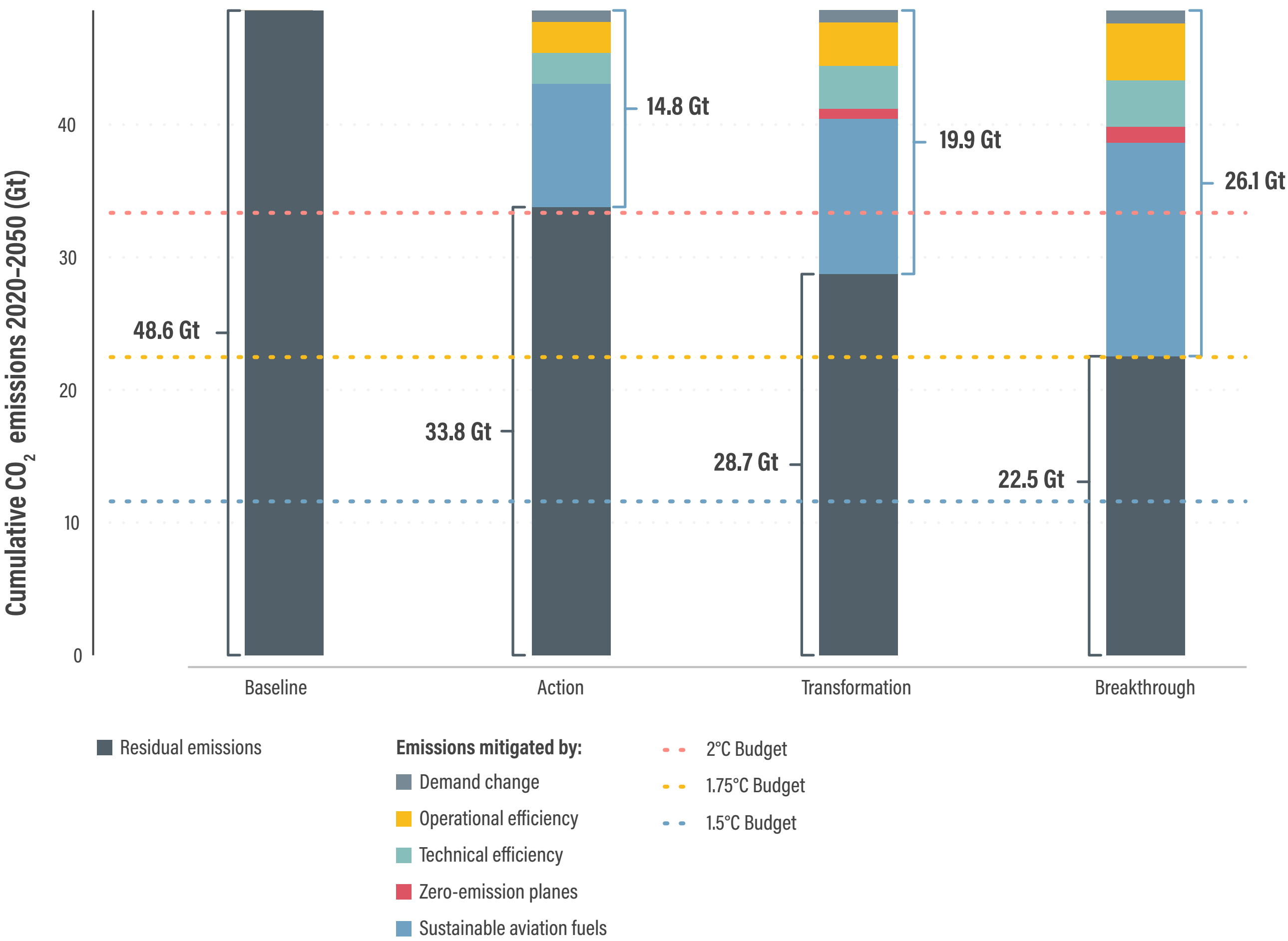


FIGURE 4. Scenarios for CO_2 emission mitigation from aviation, 2020-2050

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]

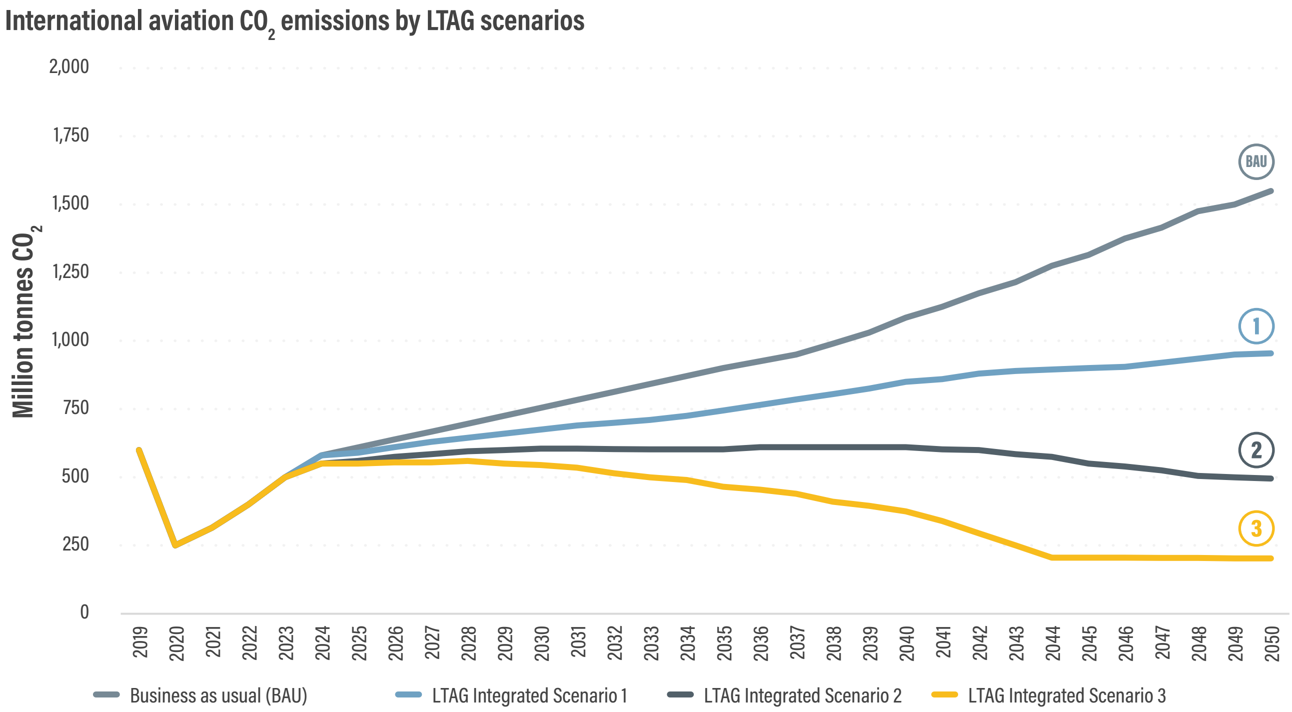
To align efforts to decarbonise the sector, the International Aviation Climate Ambition Coalition was established at the 2021 United Nations Climate Change Conference in Glasgow, United Kingdom (COP 26).[55] The Glasgow Climate Pact adopted at COP 26 states that "limiting warming to 1.5°C requires a 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

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Shipping

SLOCAT Partnership on Sustainable, Low Carbon Transport

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

Key findings

Demand trends

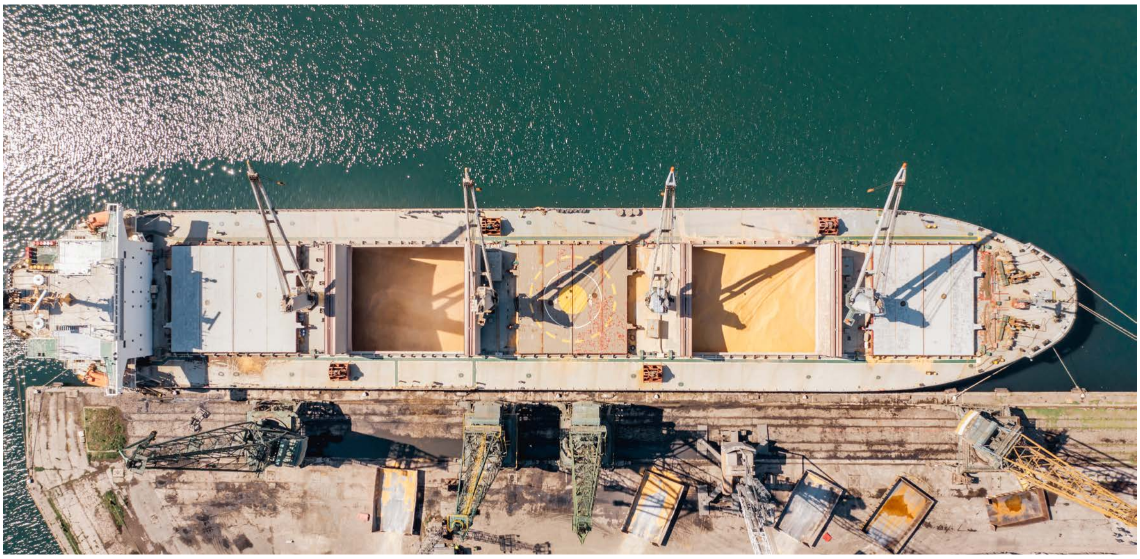
- Maritime trade volumes have increased four-fold in the last four decades, leading to more competitive shipping rates through economies of scale. The maritime shipping industry moves around 11 billion tonnes of goods annually, roughly 300 times more than is moved by aircraft.
- At the beginning of 2023, 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.

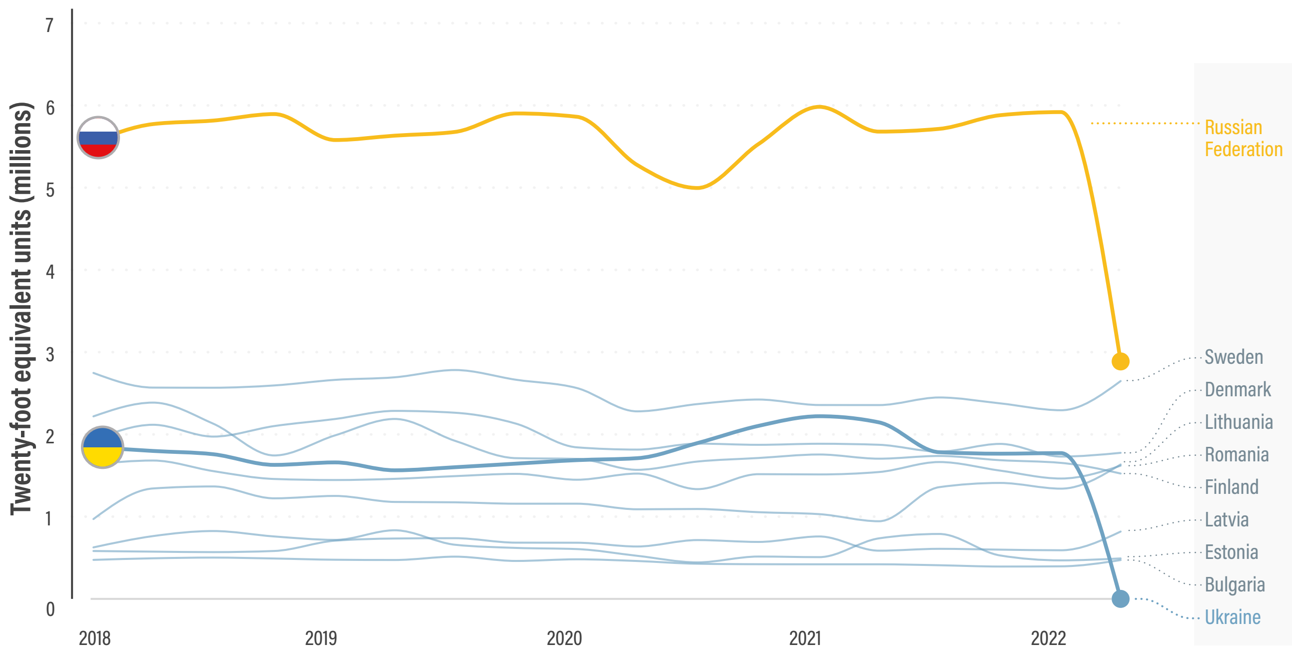


FIGURE 2. Shares of fossil fuels in international shipping and shipping vessel propulsion, as of March 2023

Source: See endnote 16 for this section.

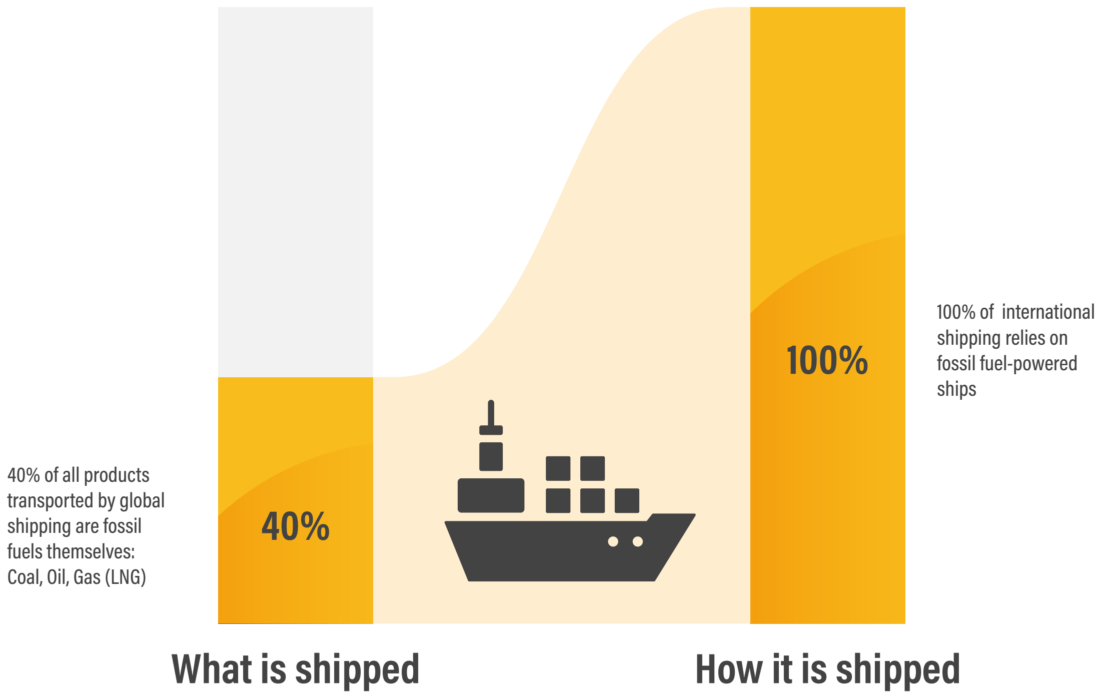
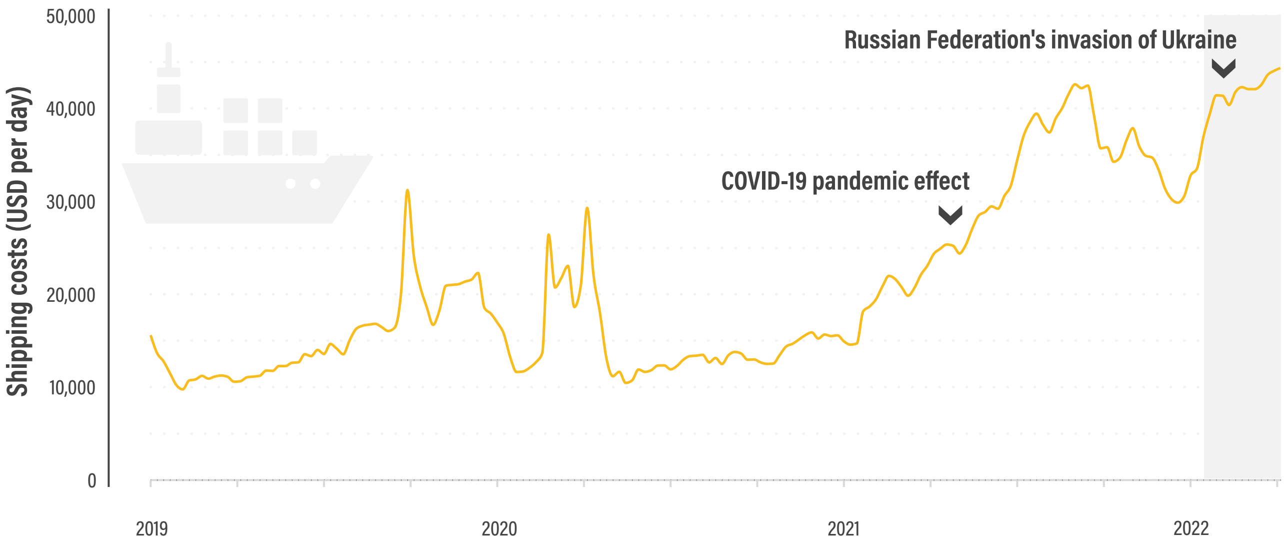


FIGURE 3. Rising costs of shipping, 2019 to mid-2022

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]

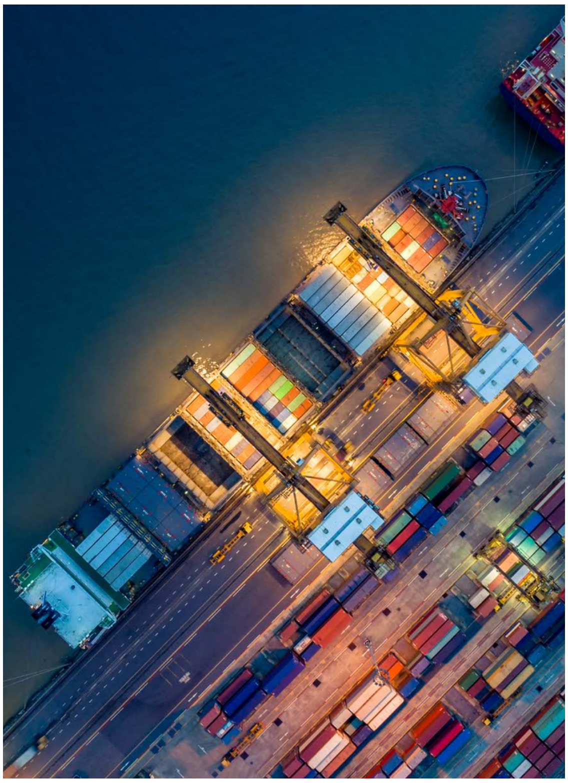
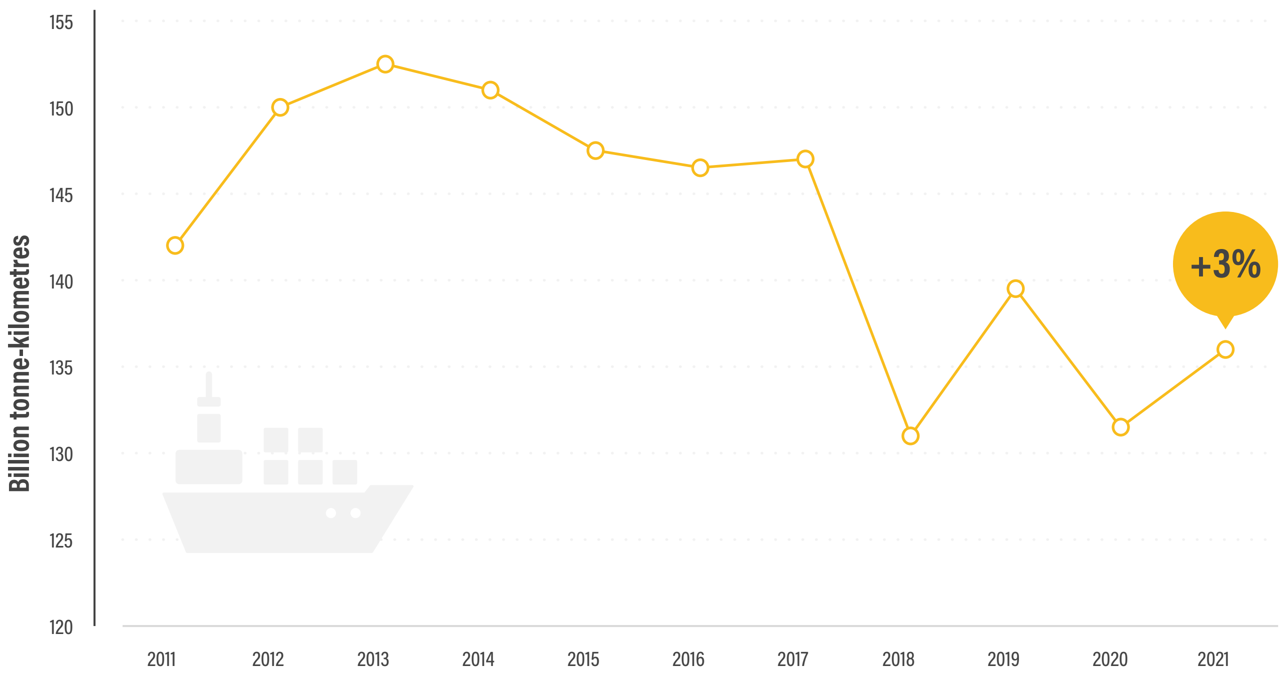


FIGURE 4. Inland waterway freight transport activity in the European Union, 2011-2021

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.

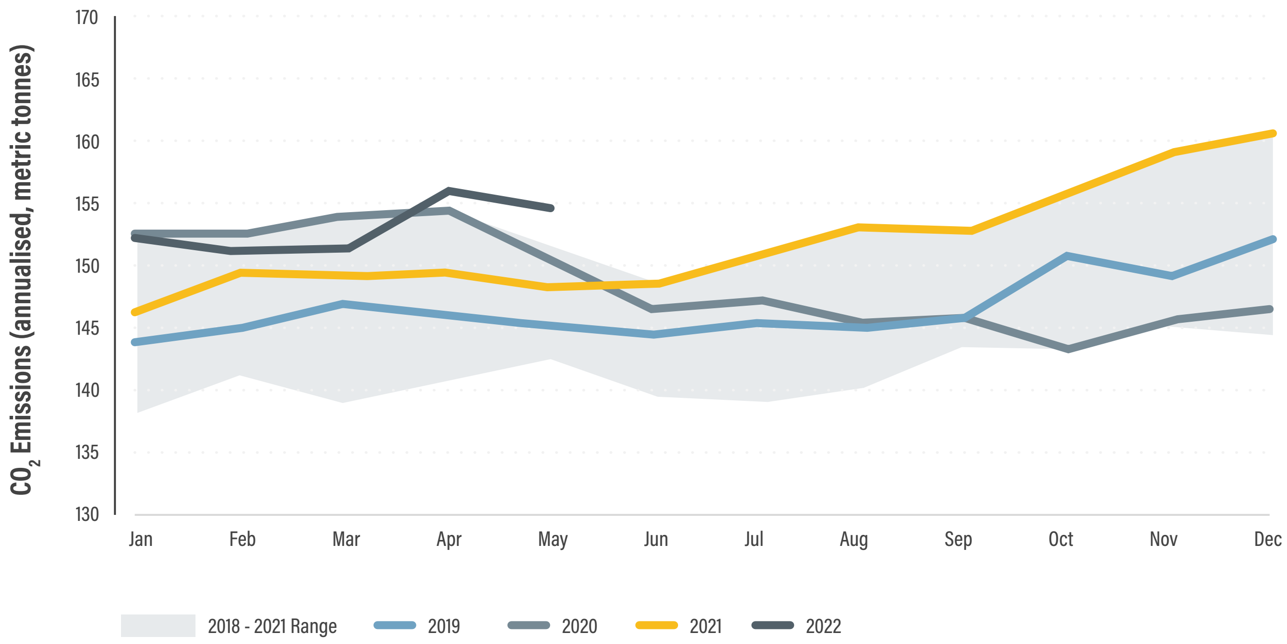


FIGURE 6. CO_2 emissions from the world's commercial shipping fleet, 2012-2022

Source: See endnote 30 for this section.

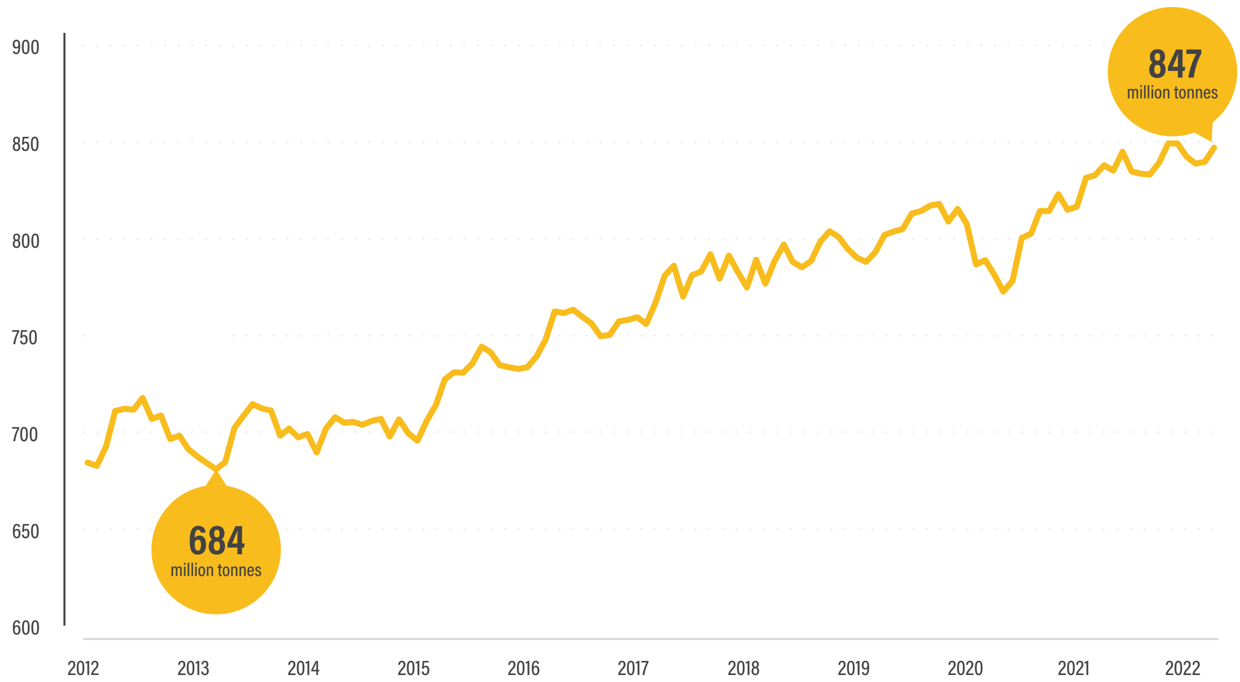
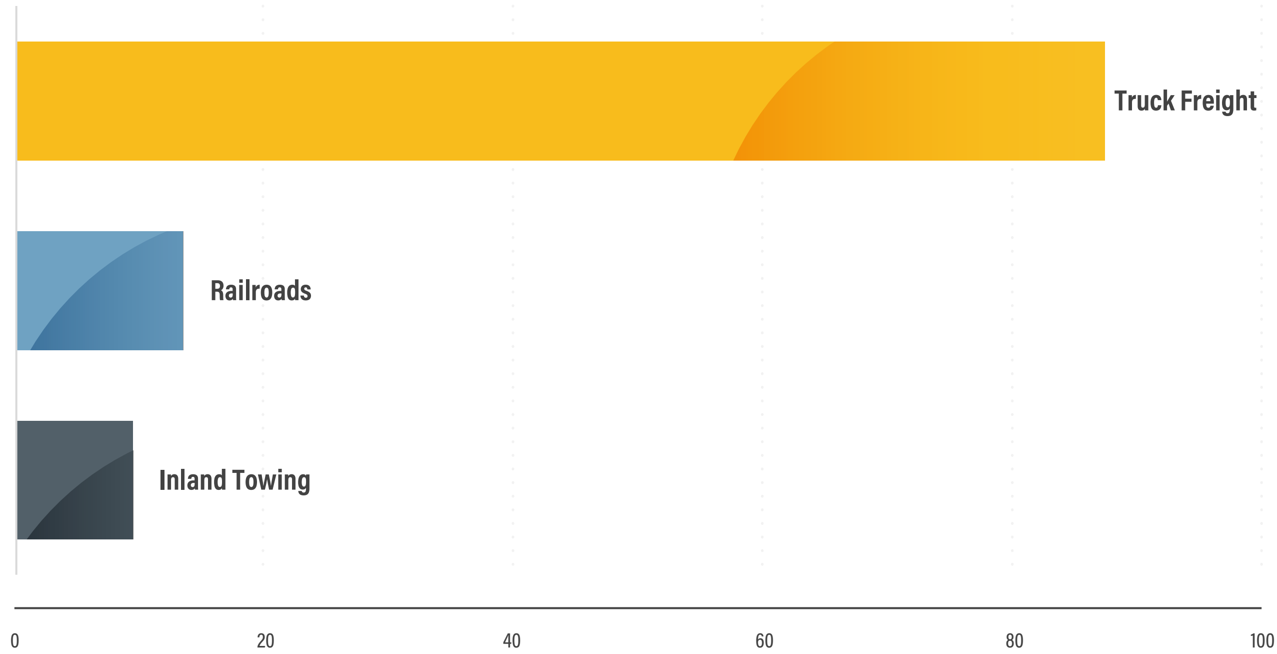


FIGURE 7. Greenhouse gas emissions per million tonne-kilometres, by transport mode, 2019

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]

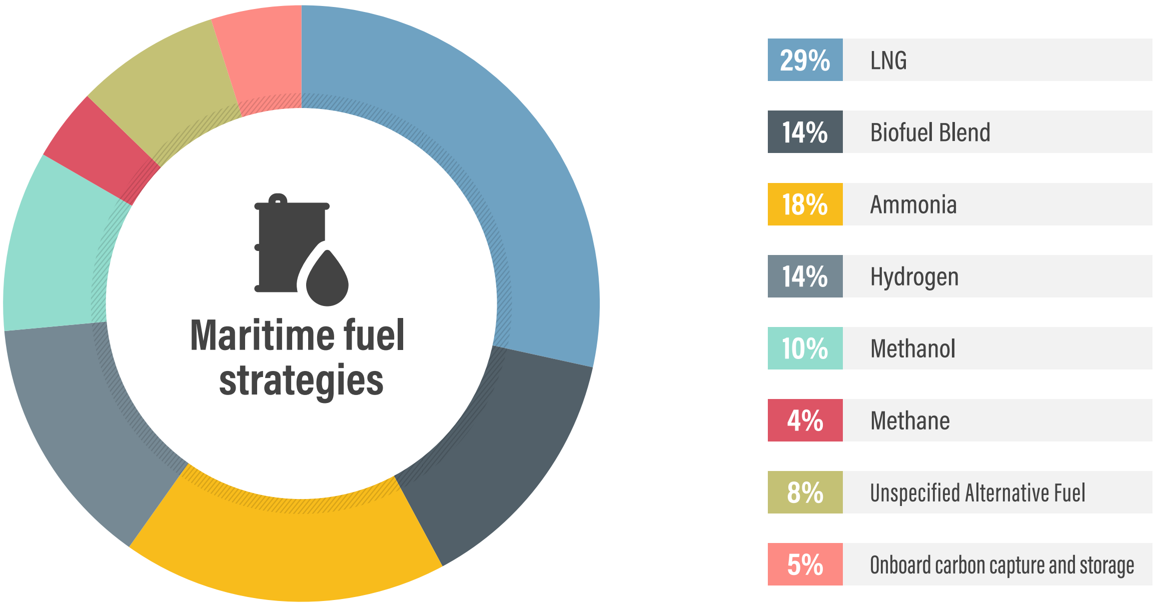
The revised IMO strategy does not directly enforce a carbon price for maritime shipping despite earlier IMO working group meetings giving hope for such an economic levy, which was seen as a breakthrough by many Parties to the Paris Agreement.[65] After more than a decade of contention, countries seemed 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

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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]

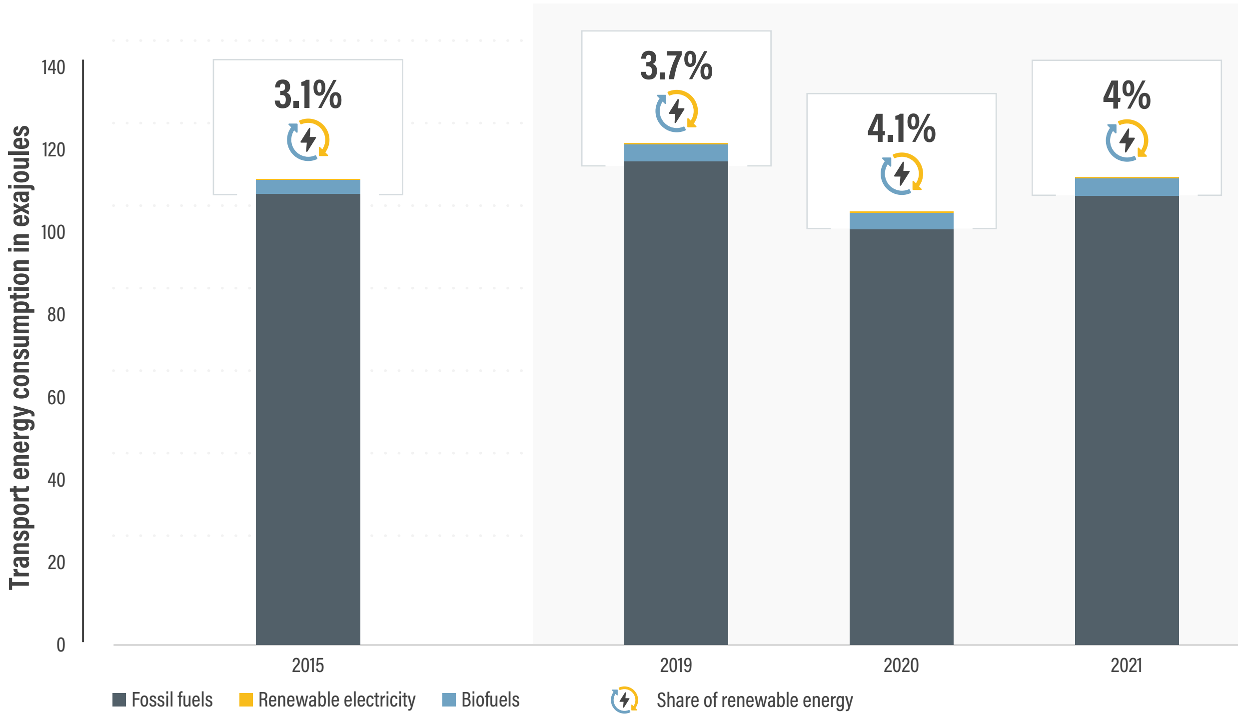
Demand trends

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.

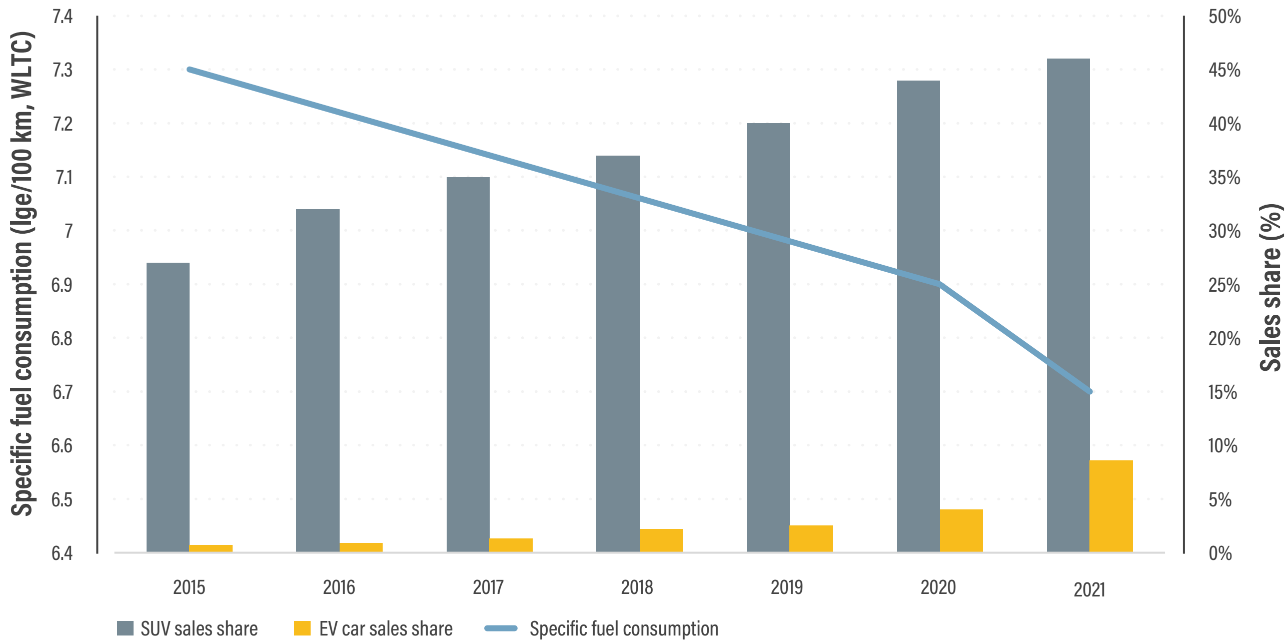


TABLE 1. Electricity requirements of different vehicle propulsion technologies

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

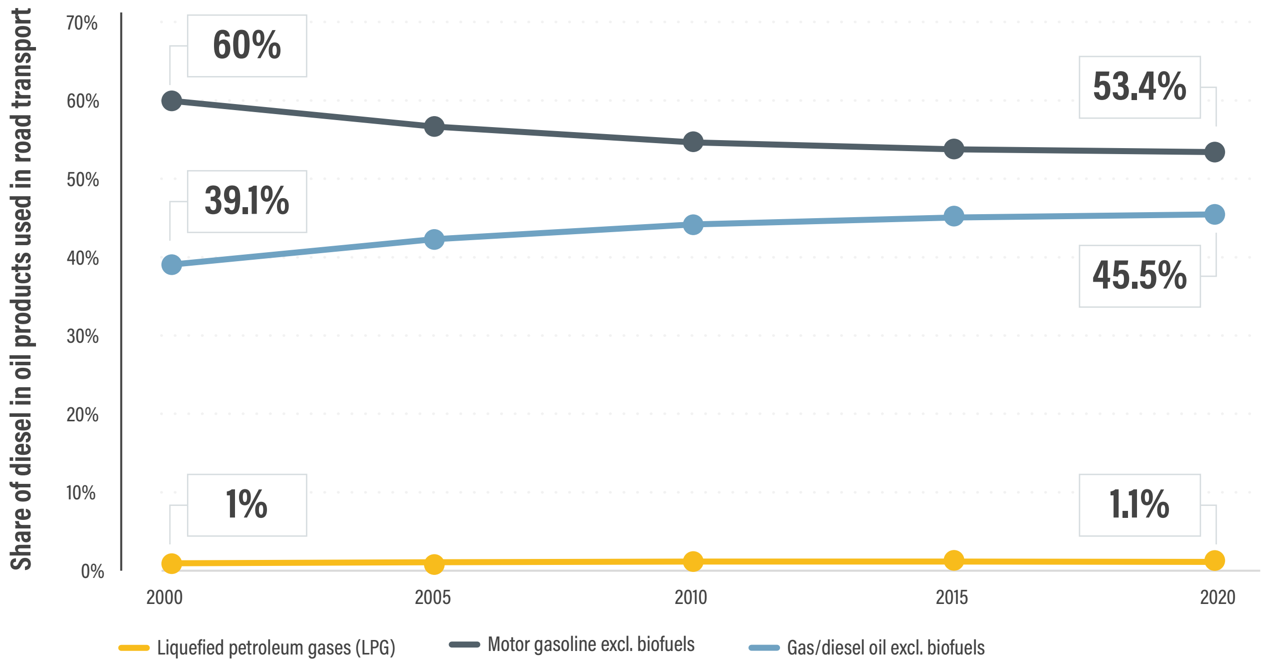
will influence the future demand for biofuels. Meanwhile, in the European Union (EU), the share of new passenger cars that run on diesel fell from 27.9% in 2020 to 19.6% in 2021.[24]

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.

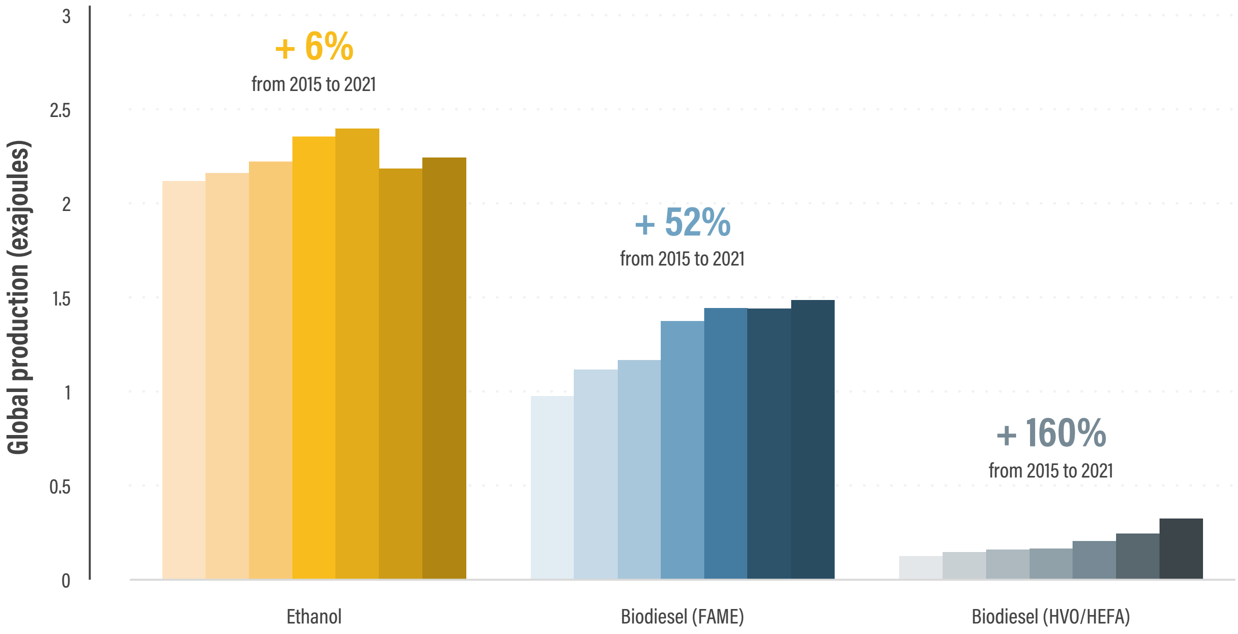
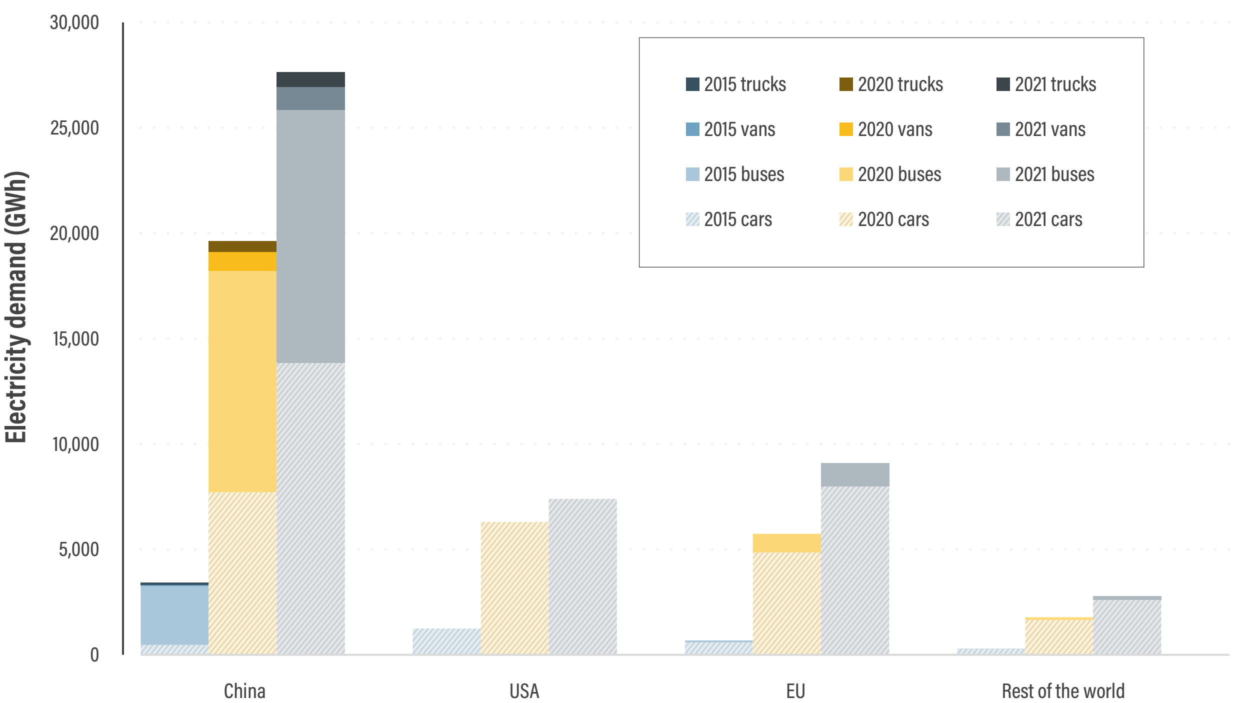


FIGURE 5. Electricity demand from electric vehicles in selected countries/regions, by vehicle type, 2015, 2020 and 2021

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

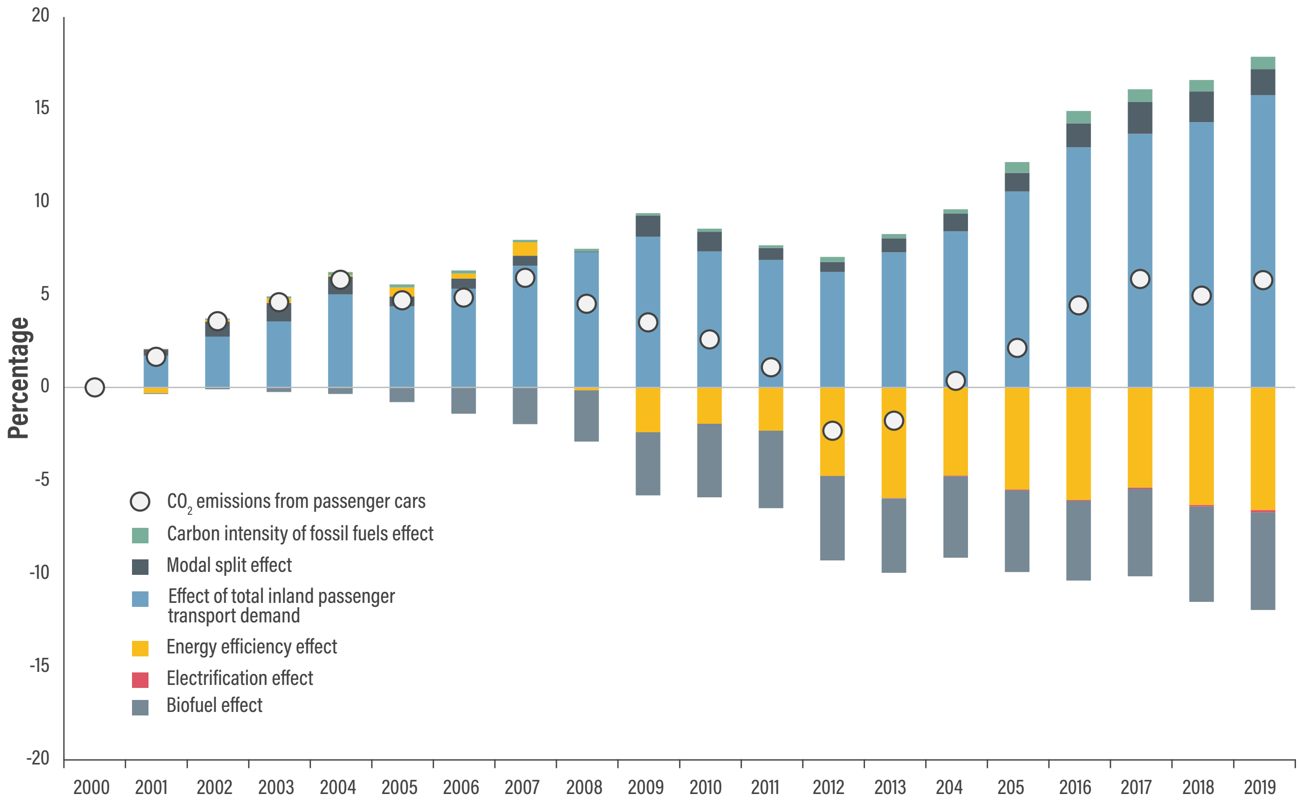
Carbon dioxide (CO_2) emissions from road transport increased steadily between 2000 and 2020 (*see Section 3.6 Road Transport*).[53] Even regions where emission standards were increasingly strict saw growth due to rising transport demand. In the EU, emissions from passenger cars increased 5.8% between 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_2 eq emissions from passenger cars in the EU-27, by contributing factor, 2000-2019

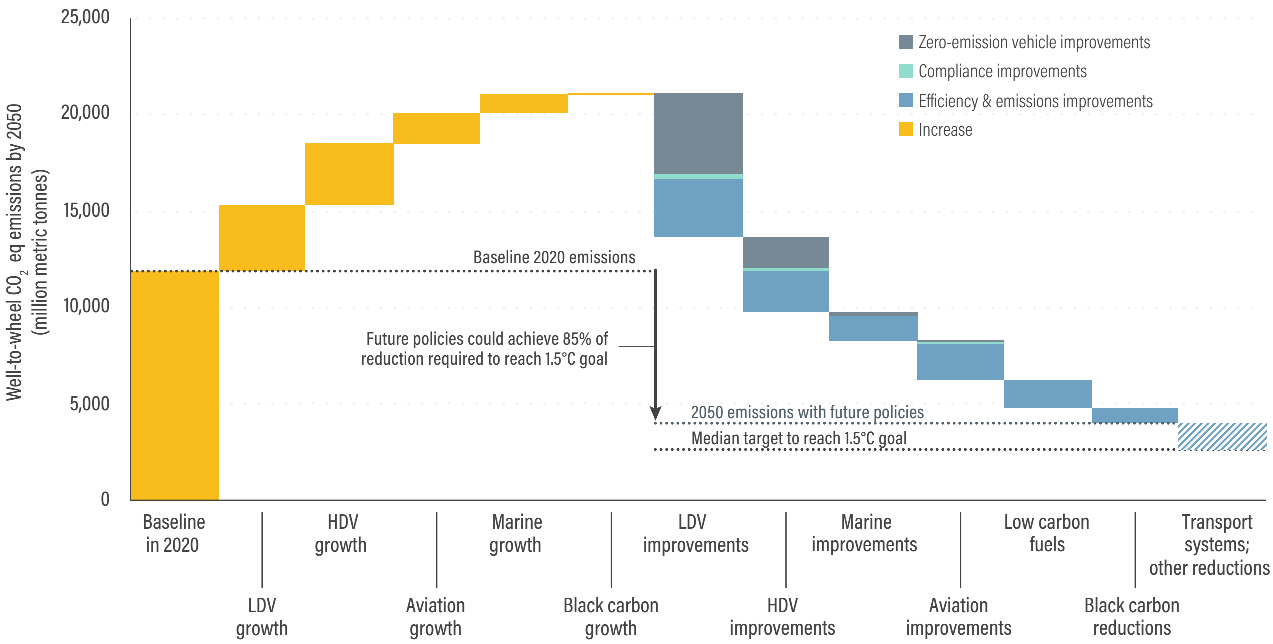
Source: See endnote 56 for this section.



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]

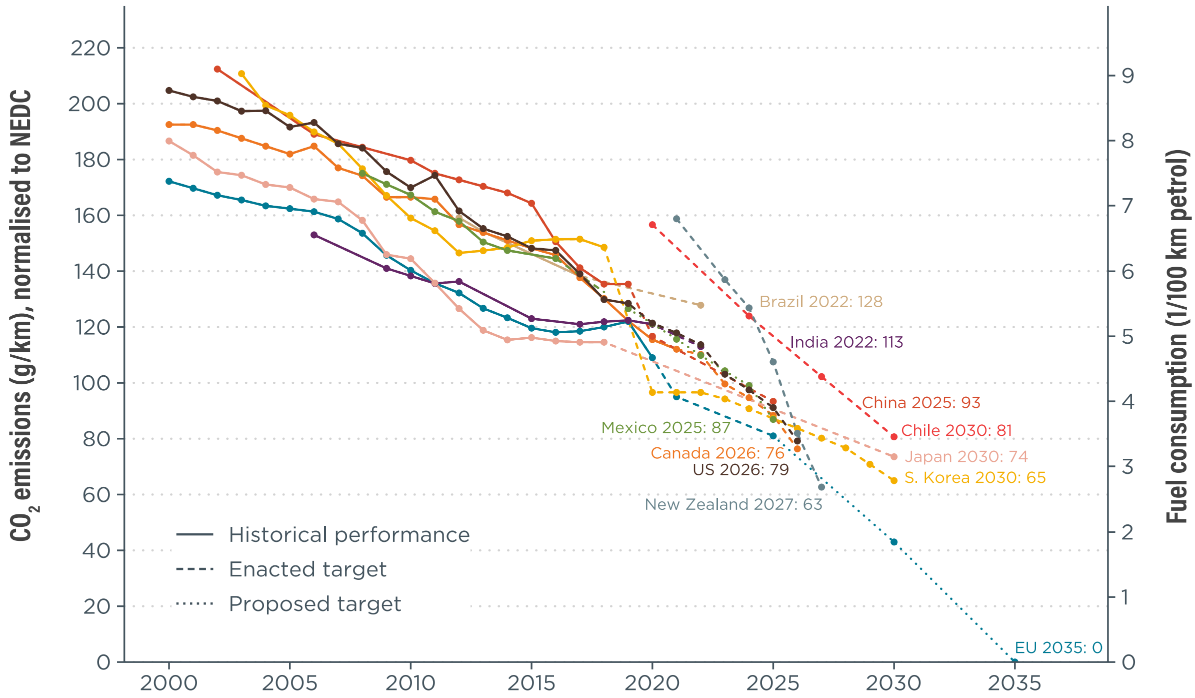
Energy efficiency plays a major role in decarbonising the maritime and aviation sectors under the ICCT's "ambitious yet feasible" scenario. The scenario assumes an improvement in ship efficiency of 70% by 2040, with only 17% of energy demand being met by zero-emission vessels.[62] In aviation, emissions 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

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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.


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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]

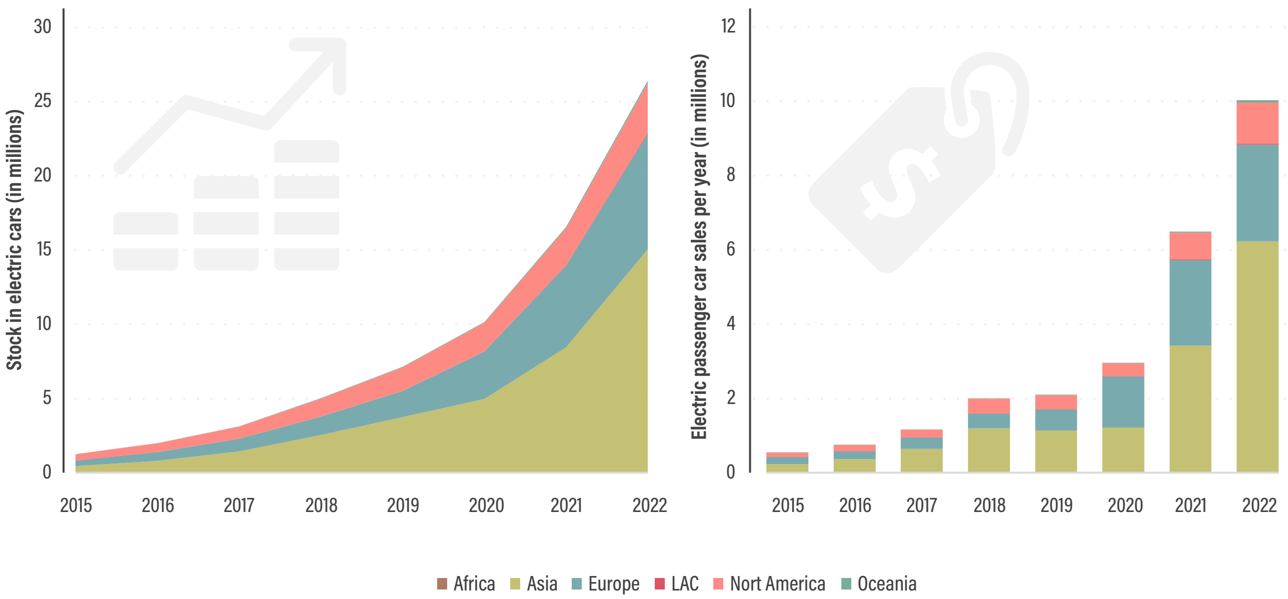
The global electric car fleet increased 154% between 2020 and 2022, maintaining five-year average growth of 53%.[13] The global electric car stock totalled 26 million units in 2022, more than five times the number in 2018 (see Figure 1).[14] **However, electric vehicles still accounted for only around 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]

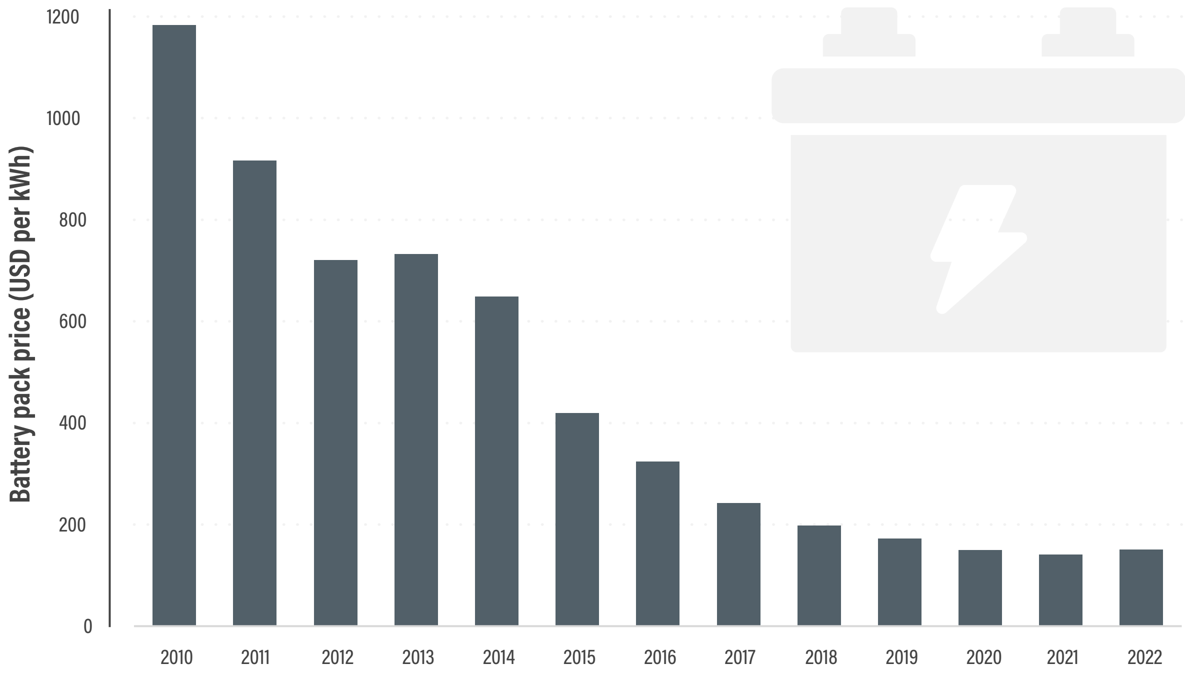
- China was home to roughly two-thirds (62%) of the world's public chargers in 2022, or more than 1.7 million.[45] The Republic of Korea – with 201,000 public chargers, or 7% of the global total – overtook the United States (with 130,000, or 5%) during the year.[46]
- By the end of 2022, Europe had 430,000 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]

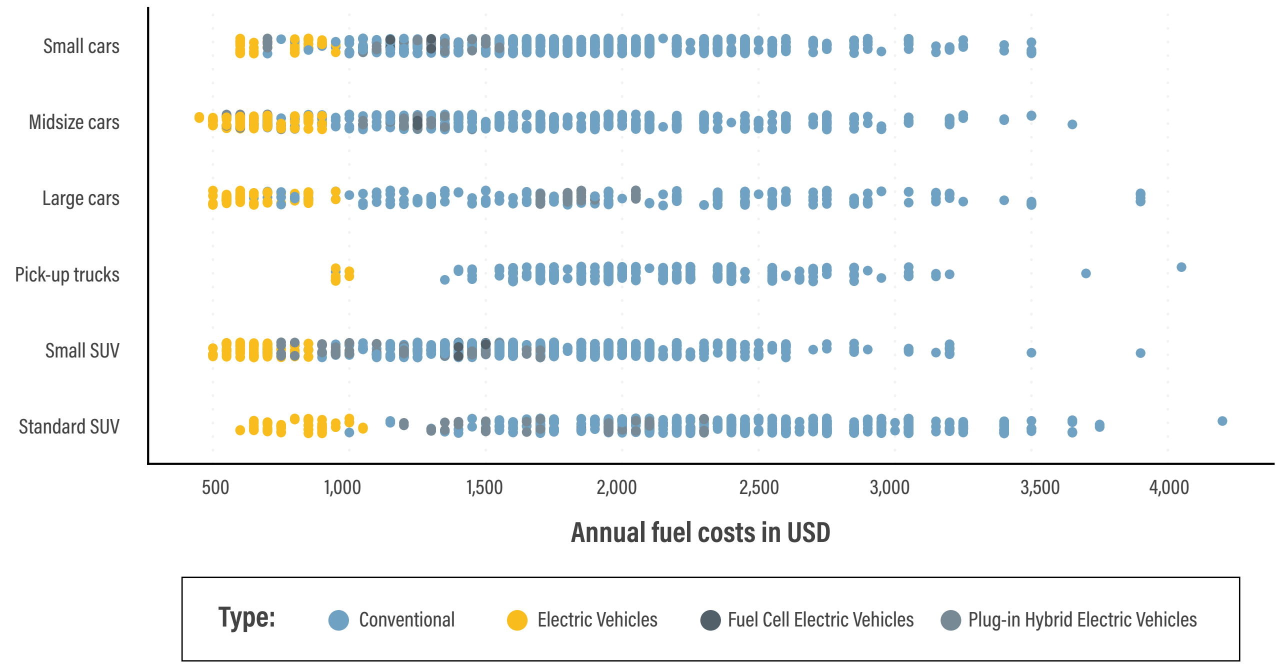
A major driver of future demand for electric vehicles is lower fuel costs, which were at least a third those of diesel and petrol in 2022.[67] Electric passenger cars released between 2021 to 2023 in the United States showed the lowest annual fuel costs per household among all fuel types (see Figure 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]

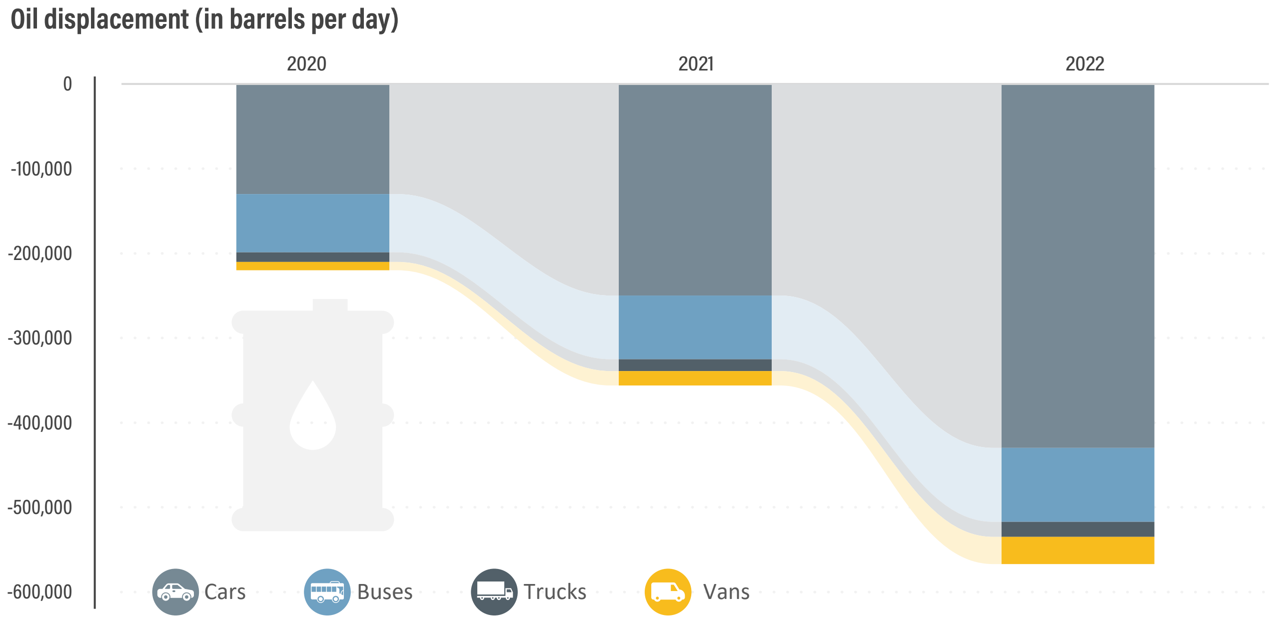
Aggressive emission reduction pathways aligned with the goal of keeping global warming below 1.5°C by 2050 feature a significant uptake of electric vehicles, with at least 80% of cars and small commercial vehicles being electric by 2050.[79]

- 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

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MODULE 5 5.1

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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.

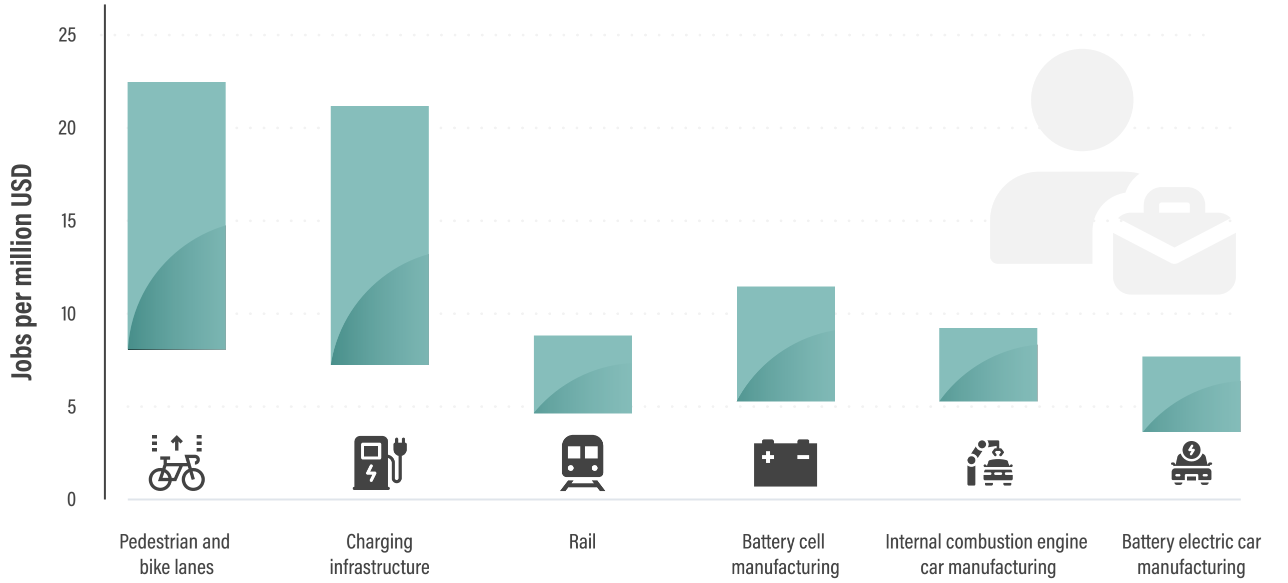
Current investment and financing for transport infrastructure

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.

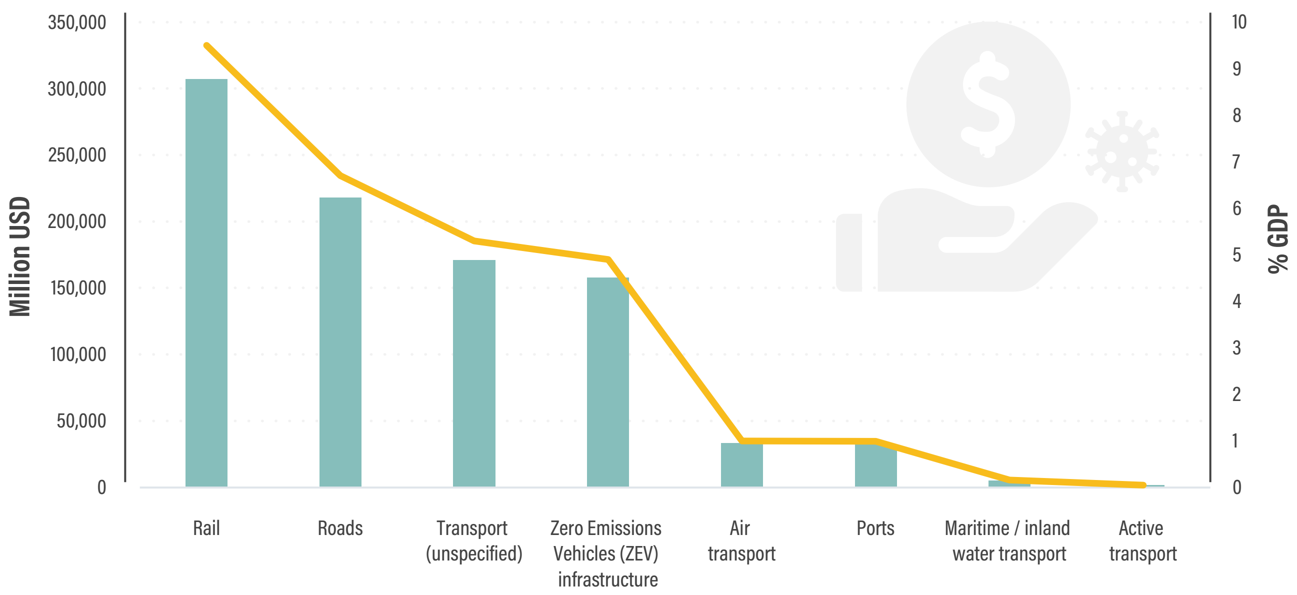
The employment benefits of sustainable transport investments exceed those of other sectors (including building retrofits and solar/wind power conversion) and can be especially high in low- and middle-income regions.[6] Globally, the transport investments with the highest potential to multiply employment 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.

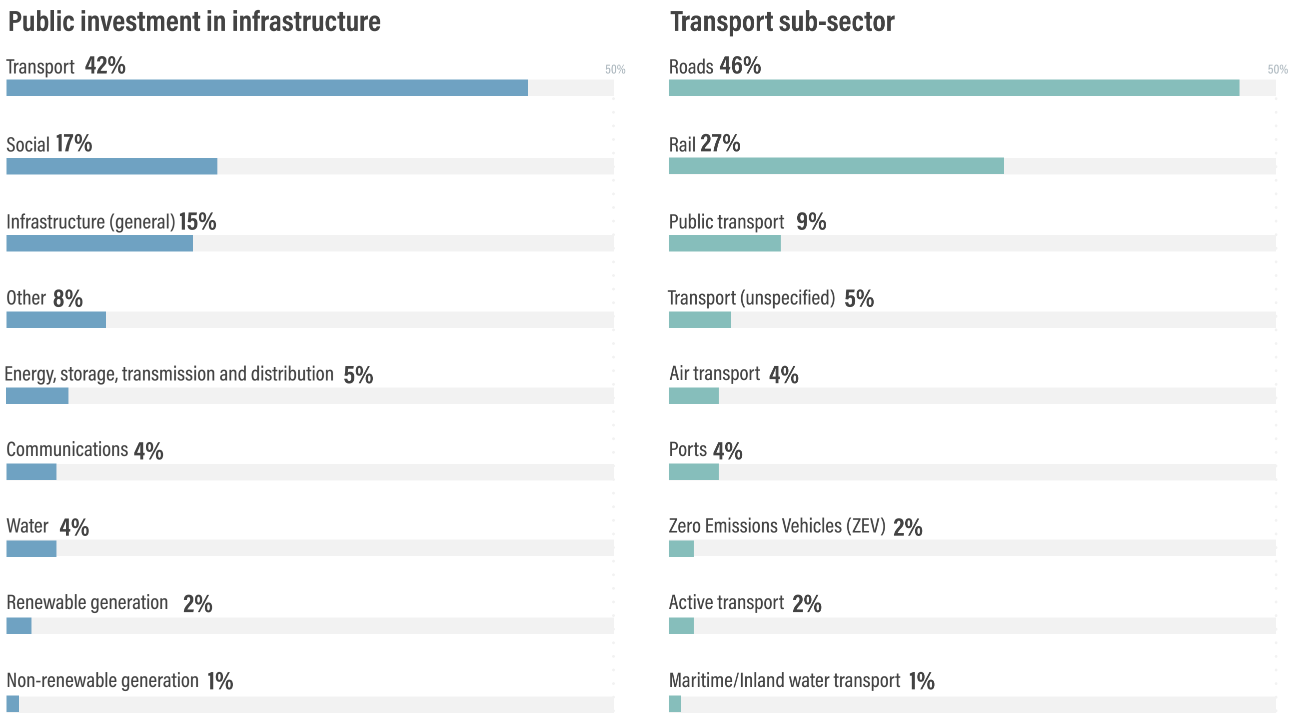
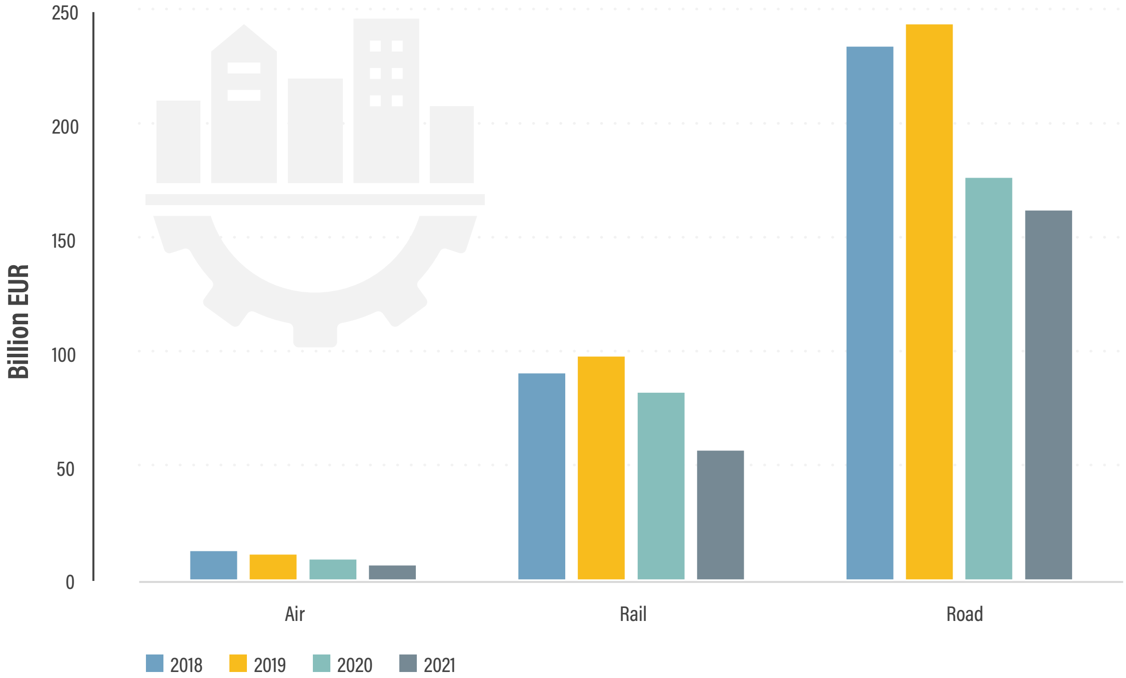


FIGURE 4. Transport infrastructure investments in OECD countries, 2018-2021

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]

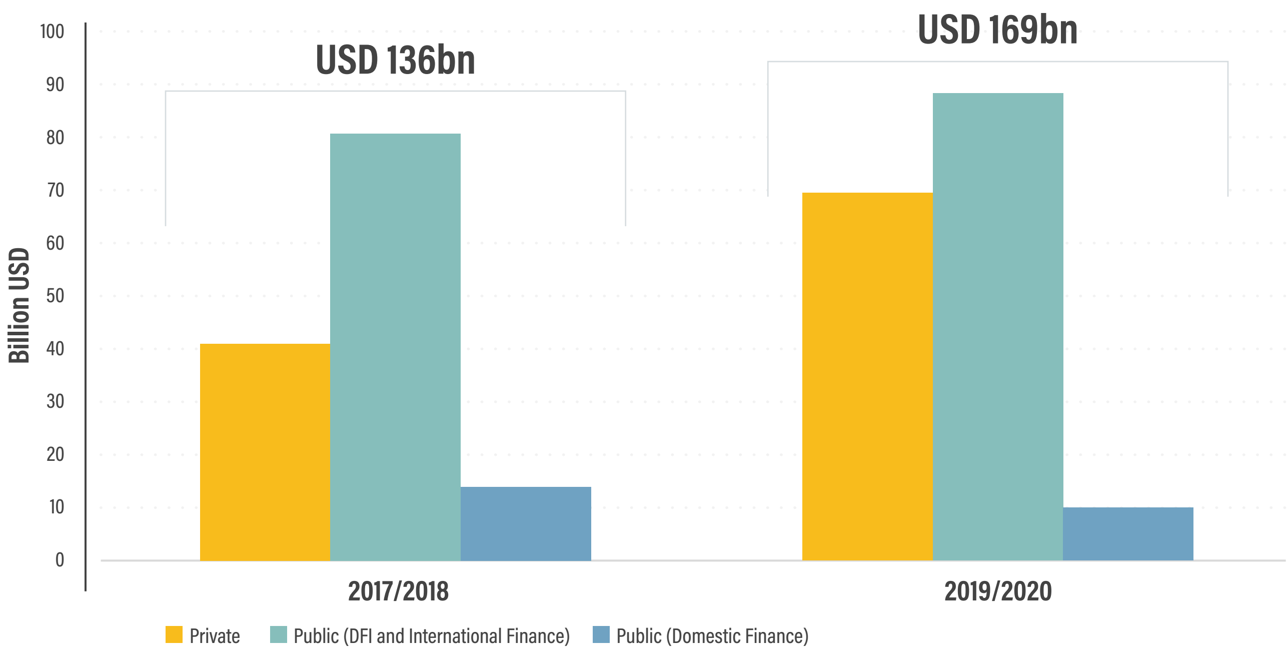
Despite significant pledges to increase multilateral climate financing through various low-carbon mechanisms, only a small share of these funds cover transport decarbonisation projects.[28] Addressing this gap requires reassessing public sector funding priorities and exploring new opportunities to mobilise 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

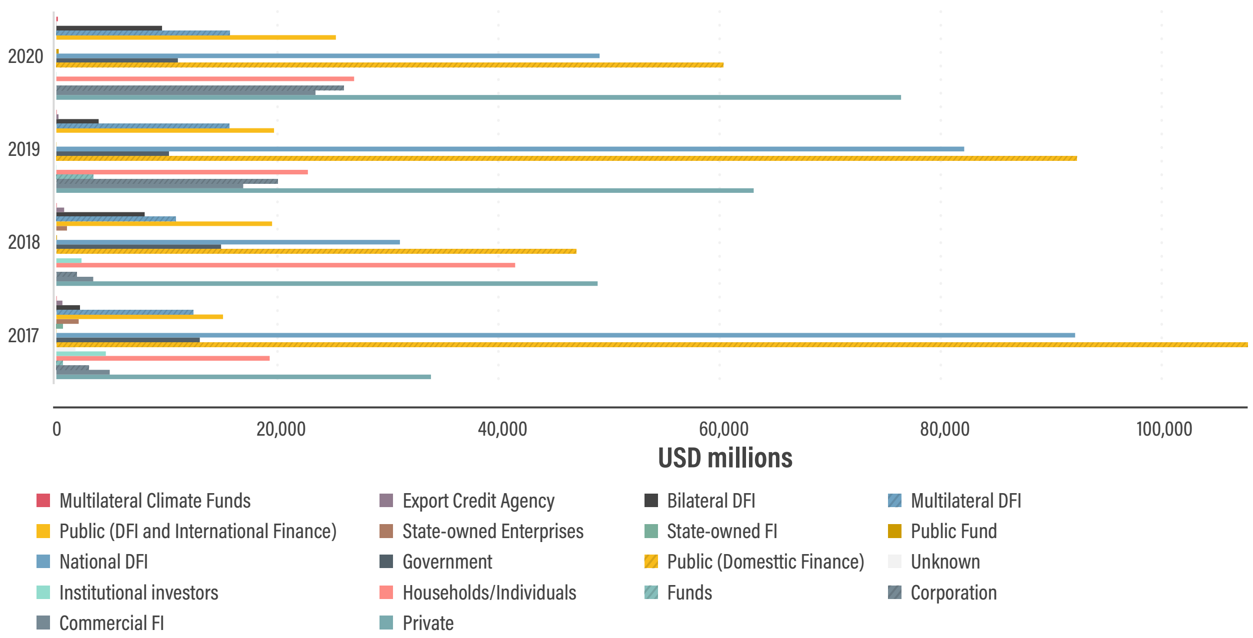
Source: See endnote 25 for this section.



Note: DFI = development finance institution

FIGURE 6. Financing for transport mitigation and adaptation, by type of financier, 2017-2020

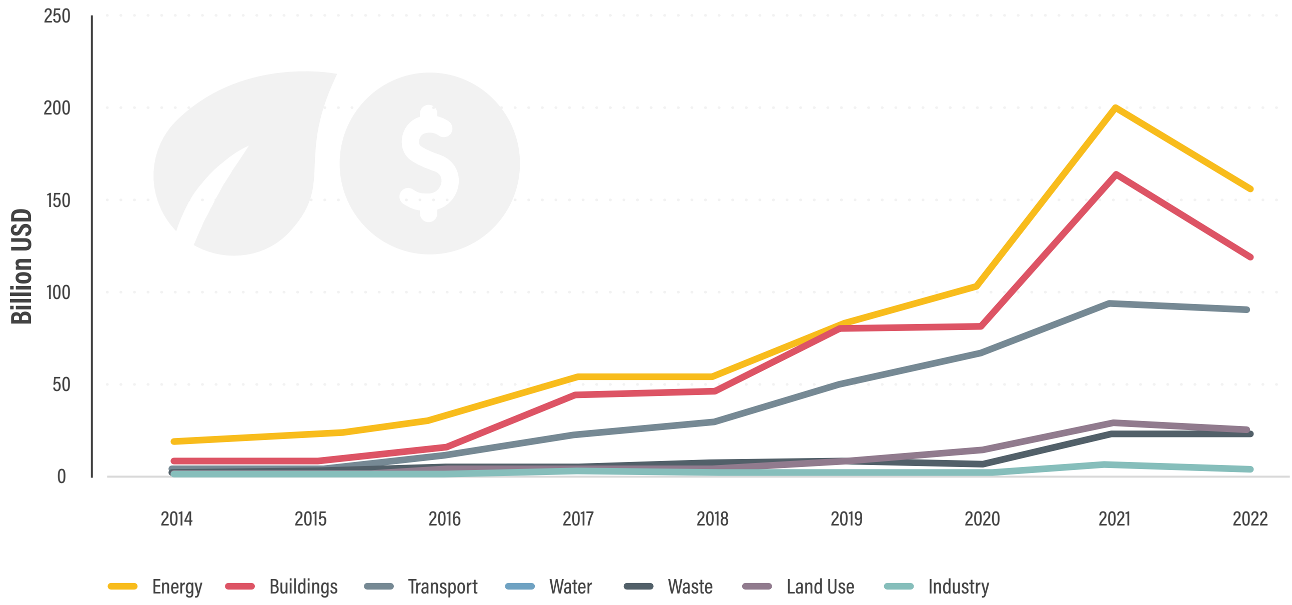
Source: See endnote 30 for this section.



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]

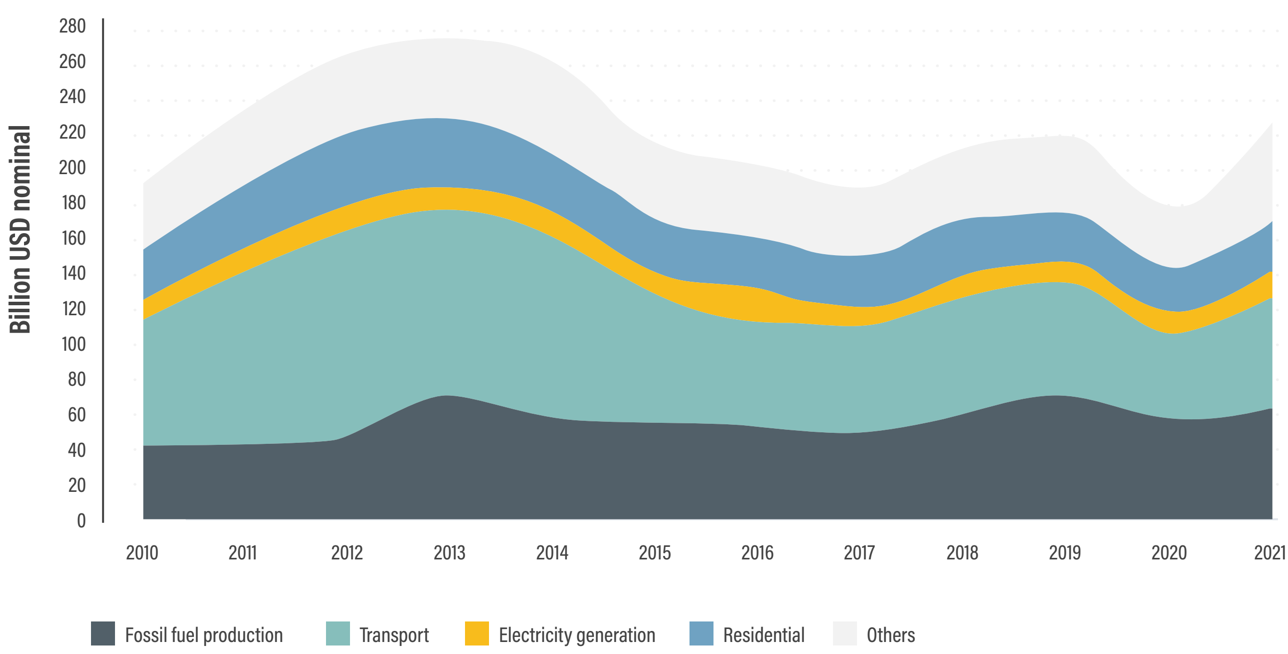
- In 2022, India adopted the Production Linked Incentives (PLI) scheme, which includes a programme to boost domestic battery manufacturing, with a budget of INR 181 billion (USD 2.2 billion).[59] India also adopted the Automobile and Auto Component PLI scheme, which grants incentives for sales of advanced 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]

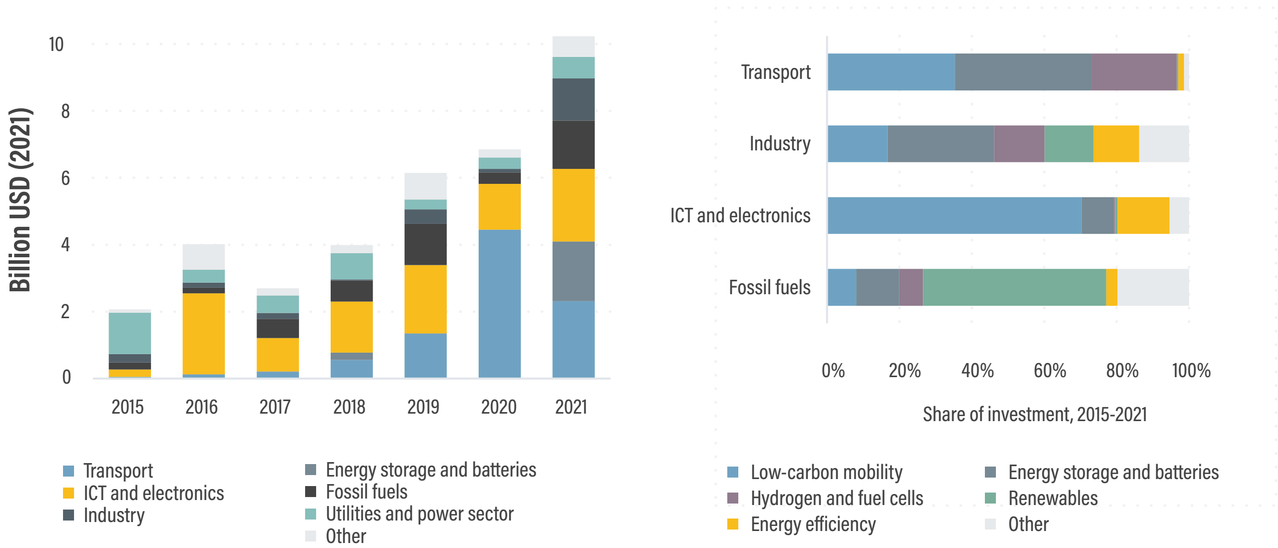
- Late-stage venture capital for energy storage and batteries surged to more than USD 12 billion in 2021, accounting for 45% of total year-on-year growth.[71]

FIGURE 9. Corporate venture capital investment in clean energy start-ups, 2015-2021

Source: See endnote 67 for this section.

Corporate VC investment in clean energy start-ups reaches an all-time high

Corporate VC investment in clean energy start-ups, by sector of corporate investor (left), and by technology area of start-up in which four of these sectors invest (right), 2015-2021



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.

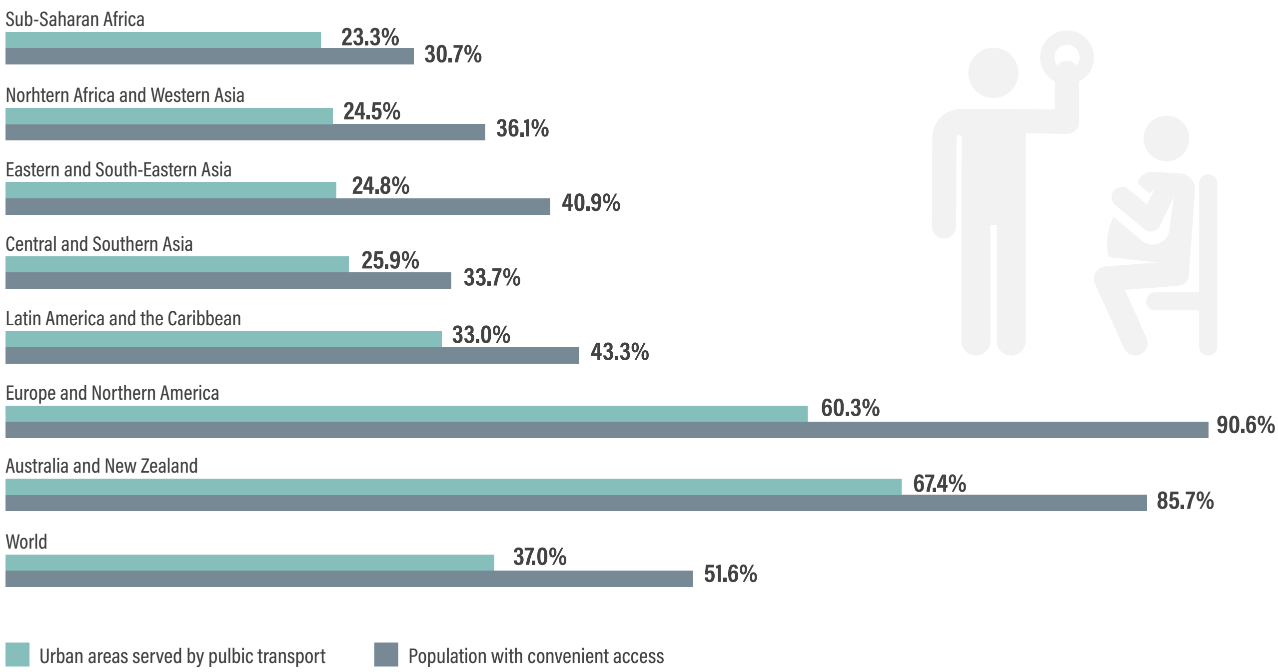
- In China, the battery developer Svolt raised more than USD 3 billion, and in Chinese Taipei the solid-state electric vehicle battery maker ProLogium Technology secured USD 326 million to expand production overseas.[72]
- In the United States, after raising USD 160 million from investors including BMW, 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]

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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.

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

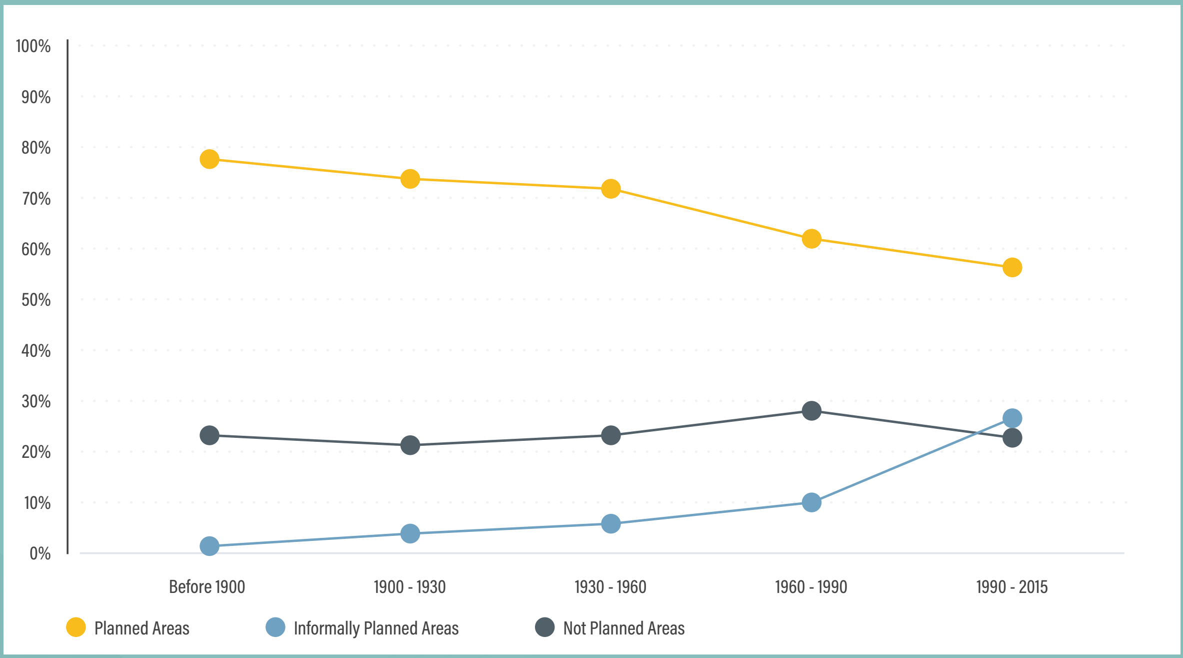
In addition to conflicting political directives or lack of investments at scale, deficiencies in administrative structures and limitations in personnel and institutional capacities are essential and frequent challenges that hinder integrated transport and mobility planning efforts.

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
CO_2 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
NO_2 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

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SPOTLIGHT 2 TRANSPORT ADAPTATION, RESILIENCE AND DECARBONISATION IN SMALL ISLAND DEVELOPING STATES

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SPOTLIGHT 4 SHORTENING GLOBAL SUPPLY CHAINS AS A KEY TO DECARBONISING TRANSPORT

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