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]

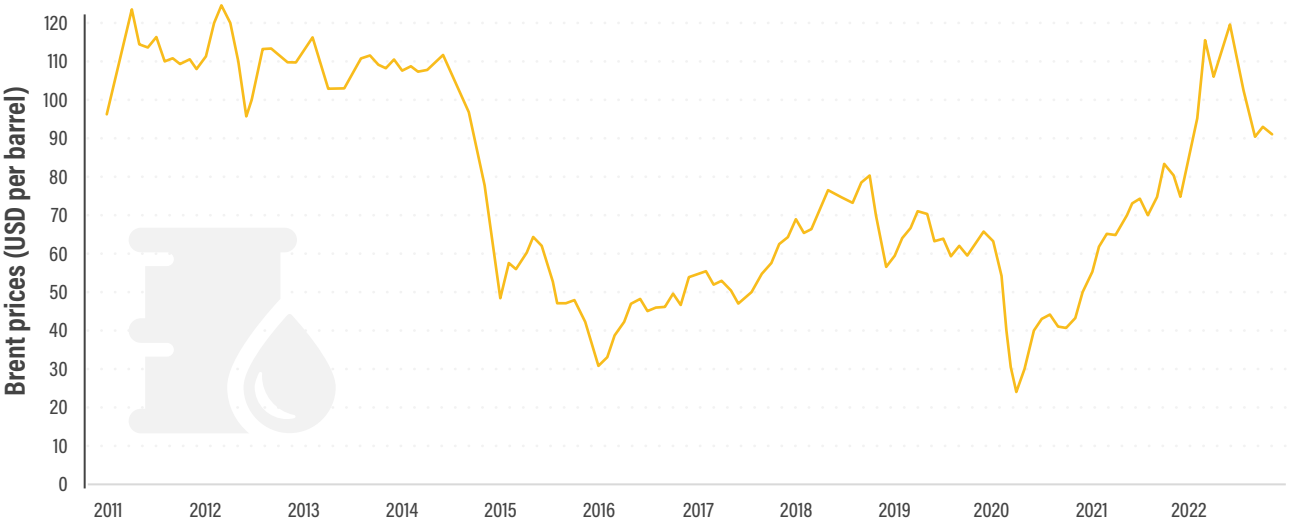
- In the European Union (EU), road freight continued to rank a distant second after maritime freight in 2021, representing around 24% of total freight transport (compared to 68% for maritime).[8]
- However, road transport dominated the freight sector in Germany, Japan and the United States in 2020.[9]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

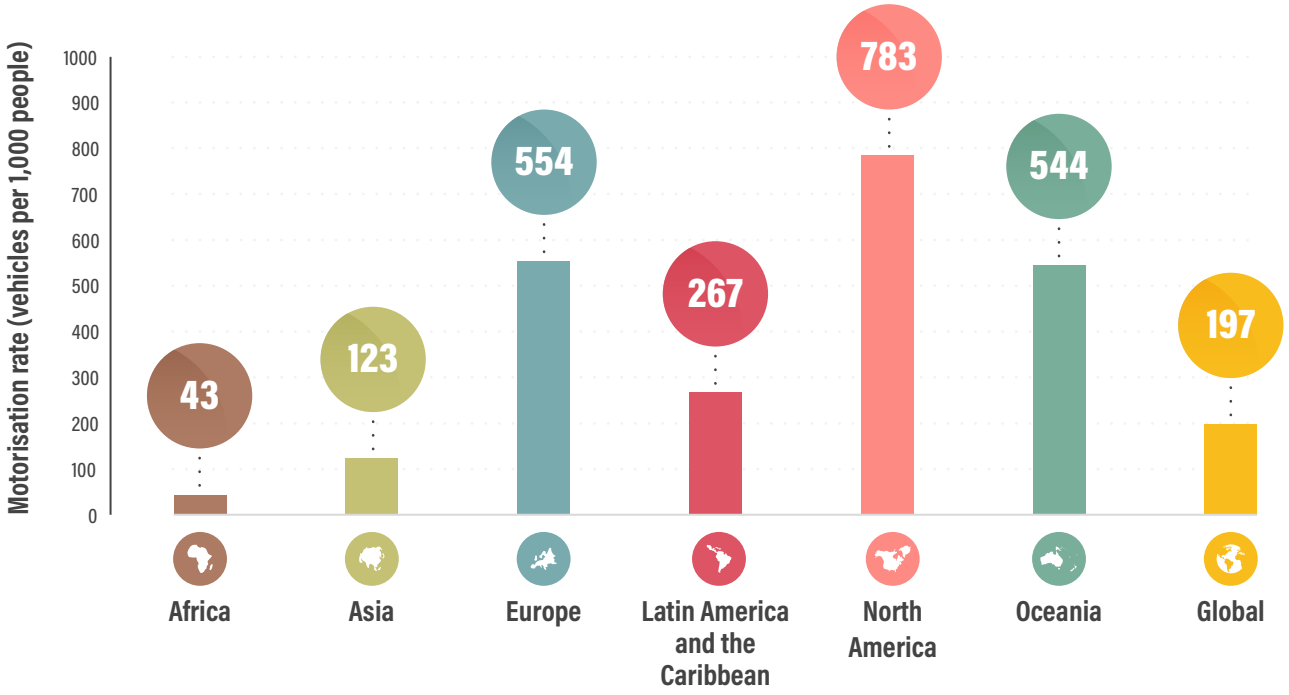
Motorisation rates, or the number of motor vehicles per 1,000 people, vary greatly by region, with the highest rate in North America – at four times the global average of 196 vehicles per 1,000 people – and the lowest rate in Africa, at a quarter of the global average, as of 2020 (see Figure 2).[22]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

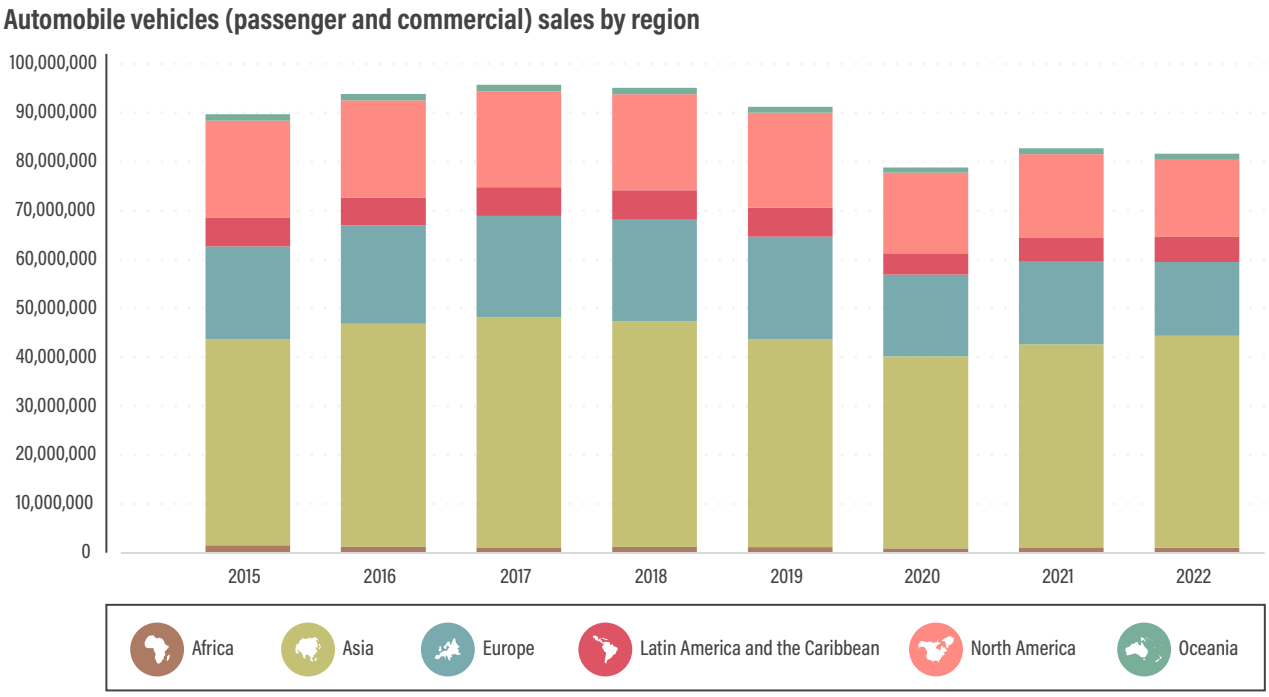
The relationship between income and car ownership is complex, and a wide range of factors influence whether someone chooses to own a car. Many current demographic and economic trends have the potential to reduce per capita vehicle travel and to increase the demand for affordable, healthy and resource-efficient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

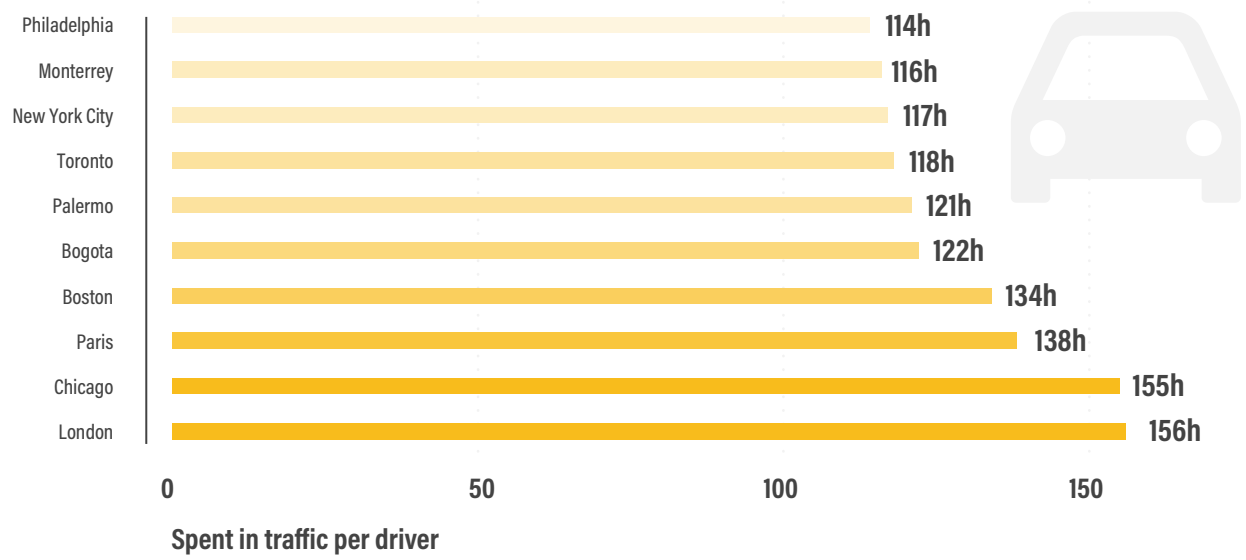
Global shares of electric heavy-duty vehicles remain relatively low, with electric buses accounting for around 3.1% of the total bus stock, and heavy-duty trucks comprising just 0.4% of the total truck stock in 2022.[46] However, as interest has grown, sales of new electric buses increased 15% in 2022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

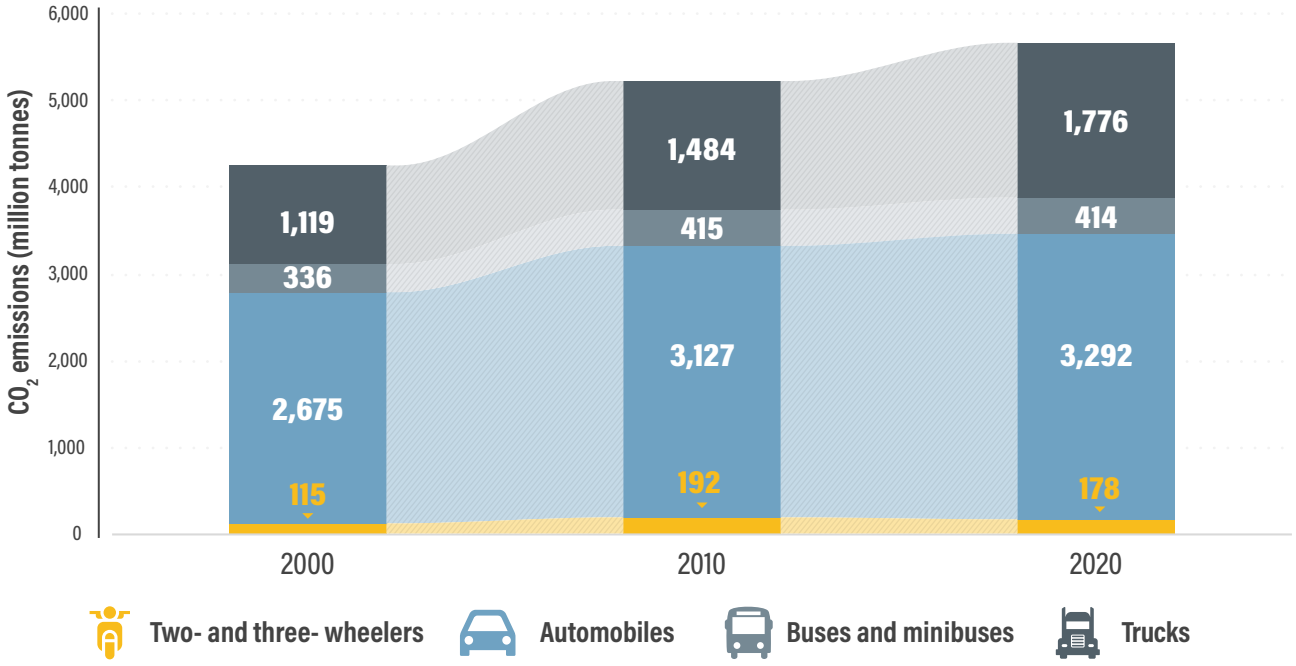


FIGURE 6. Per capita CO_2 emissions from road transport in countries globally, 2021 (in kilograms)

Source: See endnote 88 for this section.

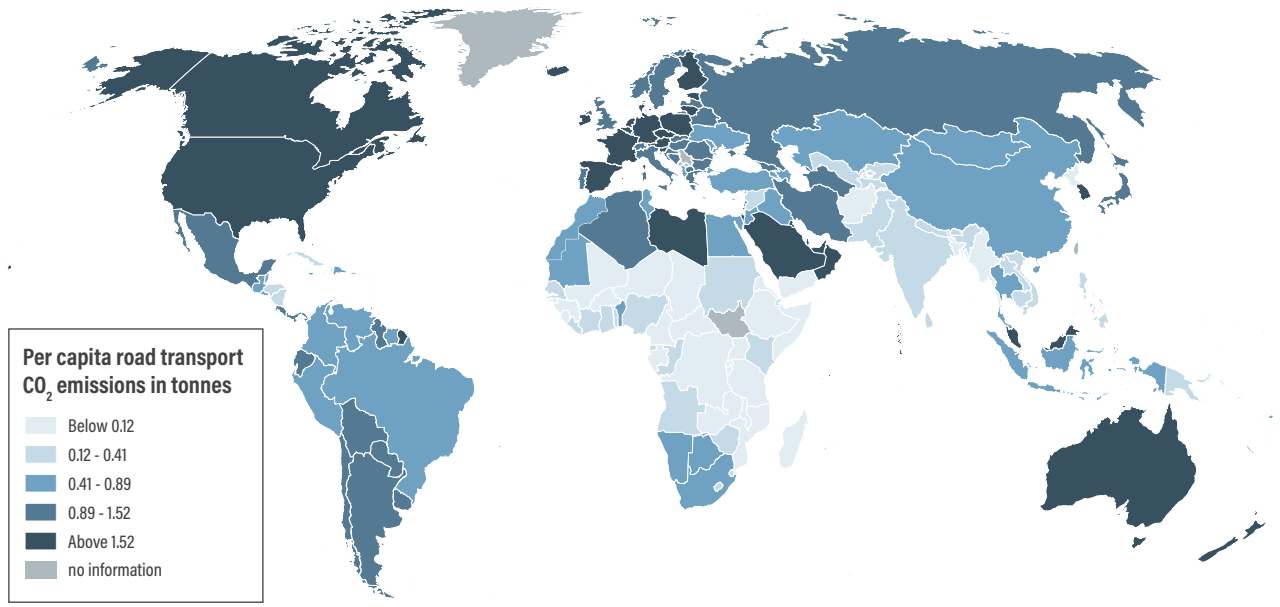
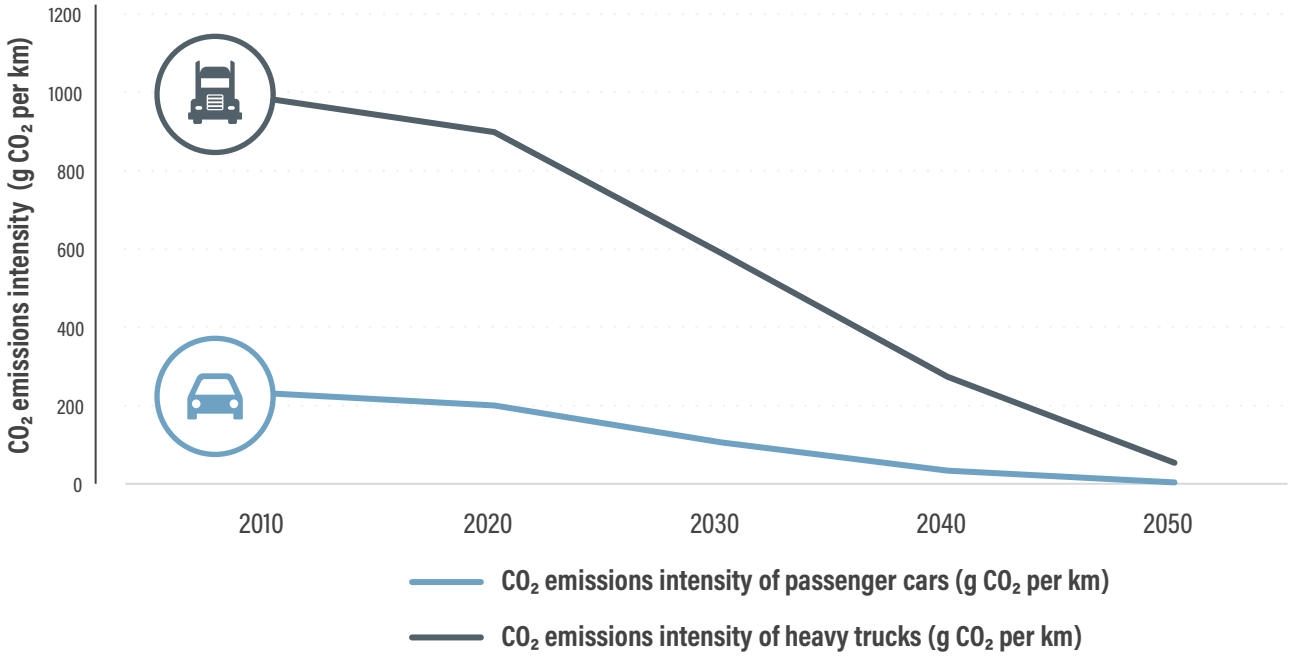


FIGURE 7. Required emissions intensity pathway to 2050 according to the International Energy Agency's Net Zero scenario

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]

3.6
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