SLOCAT

Partnership on Sustainable,
Low Carbon Transport

Zooming In
Freight Transport and Logistics

Produced in cooperation with the KÜHNE FOUNDATION

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SLOCAT Transport, Climate and Sustainability Global Status Report - 3rd Edition

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

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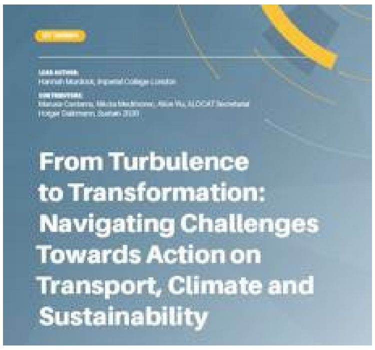

Takeaways for Decision Makers: From Turbulence to Transformation: Navigating Challenges Towards Action on Transport, Climate and Sustainability

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

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Introduction

This document provides an overview of key trends, challenges and opportunities in the intersection between freight transport, climate and sustainability. Recognising the essential role of freight transport in sustainable trade and development, it aims to shed a light on the data, knowledge, policy and finance needs to further strengthen freight systems that efficiently combine different low-carbon modes, share capacities and rely on sustainable first and last mile delivery.

This document is part of the Zooming In series of the SLOCAT Transport, Climate and Sustainability Global Status Report - 3 rd edition. Discover the **GSR collection** at https://tcc-gsr.com/collection/

The freight transport findings of the GSR 3rd edition compiled here show that the integration of the different low-carbon transport freight modes has not yet been sufficiently achieved in most regions; with Africa, Asia and Latin America and the Caribbean heavily relying on road freight. First and last-mile delivery is far from being sustainable, with traffic congestion and air pollution being aggravated by the still limited existence of targets, regulations and standards for mid- and heavy-duty vehicles. Policies and finance to raise the efficiency of low-carbon freight transport modes are not being implemented at the required scale and private sector stakeholders are mainly responding to global trends and external shocks.

The less attention that freight transport often receives compared to passenger transport needs to be corrected if we want to optimise the crucial role that freight transport and logistics can play in achieving decarbonised and equitable economies by mid-century, in alignment with the targets of the Paris Agreement on Climate Change and the Sustainable Development Goals.

1

Freight Transport Pathways to Reach Global Climate and Sustainability Goals

Zooming In: **Freight Transport and Logistics**
SLOCAT Transport, Climate and Sustainability
Global Status Report 3rd Edition

Demand for freight transport

Global freight transport activity, measured in tonne-kilometres, grew 68% between 2000 and 2015[1], and an additional 7% between 2019 and 2022 to surpass 179 trillion tonne-kilometres.[2] 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*).[3]

Road

In 2019, road transport accounted for 22% of freight activity globally, on average, although the modal split varies highly by location.[4]

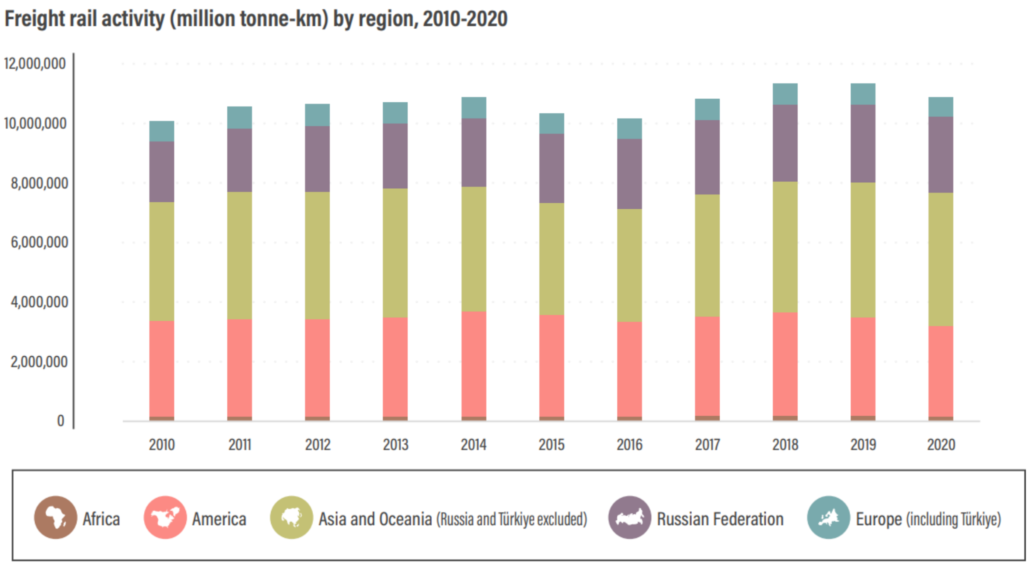
- In the European Union (EU), road freight continued to rank a distant second after maritime freight in 2021, representing around 24% of total freight transport (compared to 68% for maritime).[5]
- However, road transport dominated the freight sector in Germany, Japan and the United States in 2020.[6] (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).*

Rail

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.[7] By region, Asia and Oceania accounted for 41% of all rail freight activity in 2020, followed by the Americas (28%) (*see Figure 1*).[8]

- 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.[9]

Figure 1. Freight rail activity by region, 2004-2020



Source: See endnote 8 for this section.

Despite growth in freight rail activity during 2010-2020, more efforts on increasing rail freight volumes and efficiency are needed.[10] **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.**[11]

- Rail-based container-traffic between Europe and China fell 22% in 2022.[12]
- 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.[13]

Aviation

Aviation accounted for less than 1% of global freight activity in 2019.[14] During the COVID-19 pandemic in 2020, one-third of the revenue of airlines came from air cargo.[15] **Air cargo traffic reached an all-time high in 2021 and gradually returned to 2019 levels by the end of 2022.**[16]

Maritime shipping

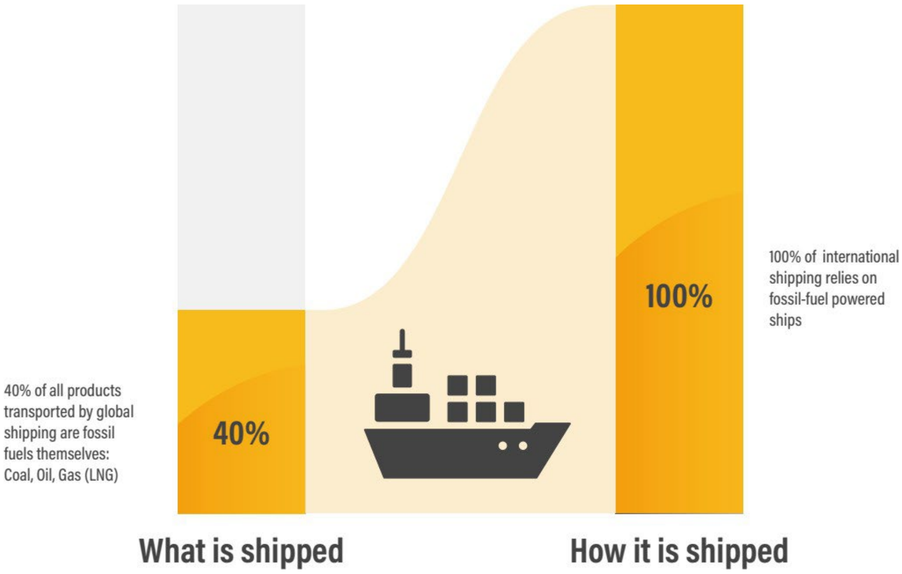
Maritime trade volumes have increased four-fold in the last four decades, leading to more competitive shipping rates through economies of scale.[17] **The maritime shipping industry moves around 11 billion tonnes of goods annually, roughly 300 times more than is moved by aircraft.**[18] In the EU, maritime shipping accounts for around 80% of total exports and imports by volume (and around 50% by value).[19]

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.[20] 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.[21]

Following the Russian Federation's 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.[22] 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).[23] Sourcing of grains and other food imports has since shifted to Australia and Brazil, among other countries.[24]

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.[25] 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.[26] In turn, nearly 100% of maritime shipping vessels relied on fossil fuels for propulsion as of March 2023 (*see Figure 2*).[27]

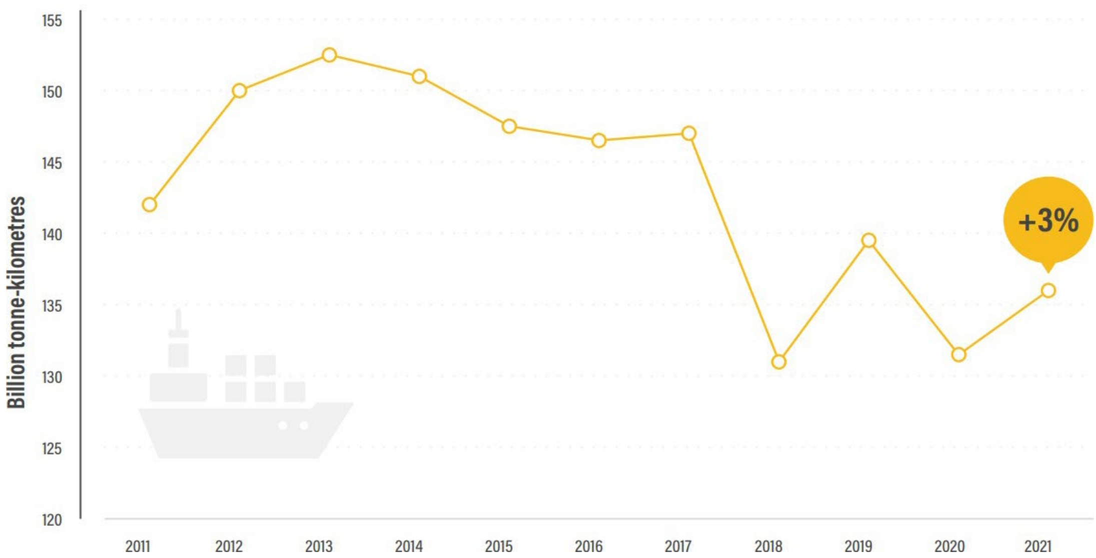
Figure 2. Shares of fossil fuels in international shipping and shipping vessel propulsion, as of March 2023



Source: See endnote 27 for this section.

Inland waterway freight activity in the EU increased 3.3% in 2021, with container ship demand rebounding after several years of volatility.[28] 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 3*).[29]

Figure 3. Inland waterway freight transport activity in the EU, 2011-2021



Source: See endnote 29 for this section.

The demand for global freight transportation is projected to further increase 2.0 times from 2019 to 2050.[30] **If unchecked, this growth poses a critical challenge to efforts to decarbonise freight transport.**[31] International trade and the geographically long global supply chains of many industries have contributed greatly to the rapid increase in emissions from freight transport.[32]

Key to addressing this challenge is to consider the role of structural and systemic factors, and their interaction with technology factors, in the effort to reach net zero emissions.[33]

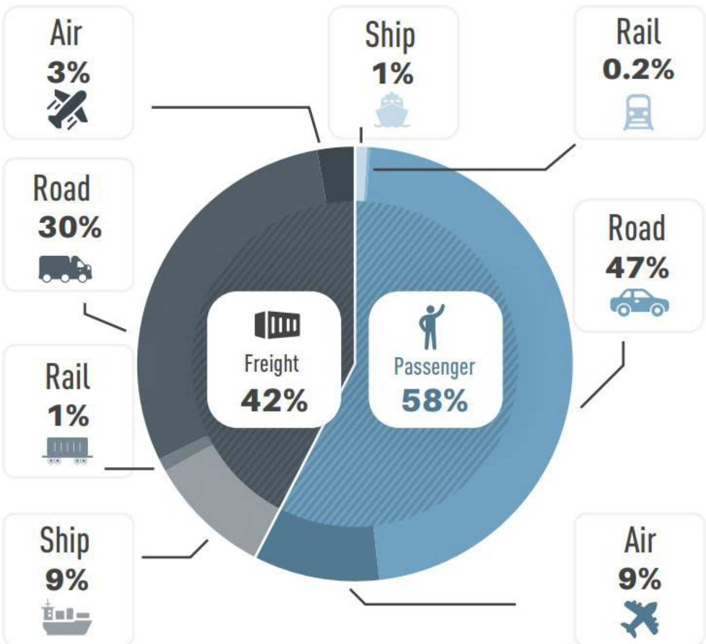
Freight and logistics' contribution to global greenhouse gas emissions and future pathways

Overall freight

The average annual growth in greenhouse gas emissions slowed during 2010-2019 in most sectors globally except for transport, which has remained heavily dependent on fossil fuels.[34] **In 2010, oil and petroleum products accounted for 97.4% of the energy use in transport, a share that fell slightly to 95.9% in 2020.**[35] **Transport emissions have continued to grow in both absolute and percentage terms (i.e. their share in total emissions). The slow progress in reducing emissions in "hard-to-abate" sub-sectors – such as aviation, long-distance road freight and shipping – has made it difficult to translate efficiency gains into absolute emission reductions.** 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.[36] Lack of regulations and the slow pace of operational and technological innovation are major reasons for ongoing increase in freight transport emissions.[37]

Emissions from freight transport comprise a growing share of transport emissions. In 2018, freight accounted for 40% of global transport CO_2 emissions, and passenger transport accounted for 60%.[38] **In 2019, freight's share of emissions increased to 42%, while passenger transport's share fell to 58%** (*see Figure 4*).[39] Freight was less affected by the impacts of the pandemic, with the CO_2 emissions from road freight in 2021 estimated to be only 1% below 2019 levels.[40] Urban freight transport contributed 25% of transport-related CO_2 emissions and accounted for 30-50% of other transport-related pollutants in 2015.[41]

Figure 4. Transport CO_2 emissions by activity and mode, 2019

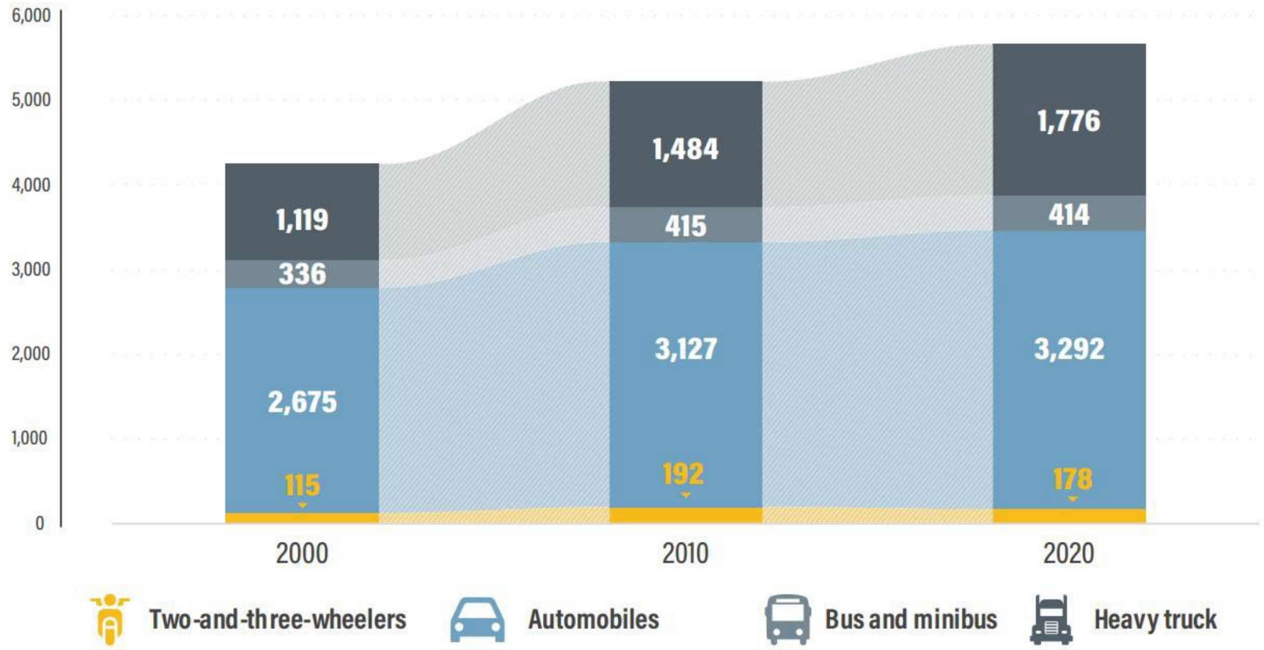


Source: See endnote 39 for this section.

Road

Road transport is the largest emitter of CO_2 among all transport modes, contributing 78% of total transport emissions in 2020.[42] Passenger transport accounted for more than two-thirds of the emissions from road transport, while road freight contributed the remaining nearly one-third.[43] CO_2 emissions from road transport have continued to increase over the past two decades (*see Figure 5*).[44] In 2019, road transport was responsible for 82% of passenger transport emissions and 69% of freight transport emissions.[45] 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.[46]

Figure 5. CO_2 emissions from road transport, by vehicle type, 2000-2020 (in Mt CO_2)



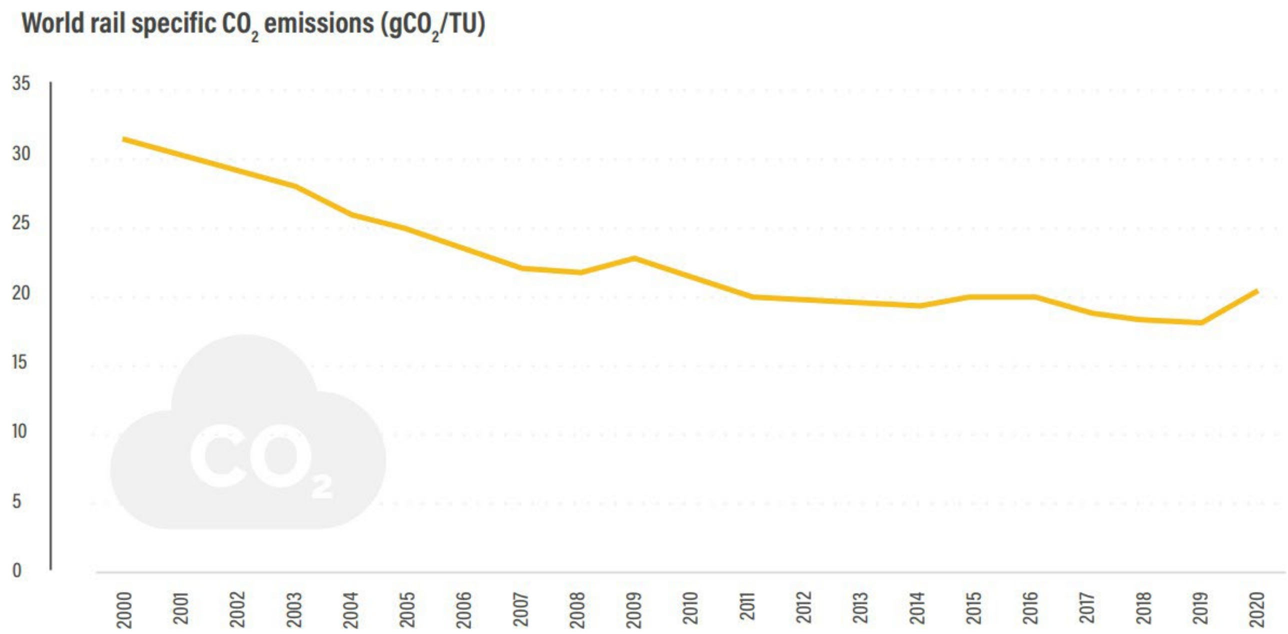
Source: See endnote 42 for this section

Land traffic contributes an estimated 5% of the mortality from small particulate matter ($PM_{2.5}$) globally, and as much as 32% in North America.[47] In addition to pollution impacts from urban land transport, freight transport activities in ports are key contributors to air pollution (nitrogen oxides and sulphur oxides) and leading causes of premature deaths.[48]

The share of diesel among all oil products used in road transport increased from 39.1% to 45.5% between 2000 and 2020.[49] This trend is driven largely by rising demand for freight transport, which is mostly diesel-powered. If fossil fuel-powered road freight continued, this will influence the future demand for biofuels. Meanwhile, in the EU, the share of new passenger cars that run on diesel fell from 27.9% in 2020 to 19.6% in 2021.[50]

Rail has the lowest greenhouse gas and energy intensity of all land transport modes, emitting on average 19 grams of CO_2 equivalent per passenger-kilometre in 2021, one-tenth the emissions of a medium-sized passenger car.[51] 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 6*).[52] 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.[53] **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.**[54]

Figure 6. CO_2 emissions intensity of global rail, 2000-2020



Source: See endnote 50 for this section.

Greater use of rail could reduce global transport emissions 11-16% in 2050 compared to a business-as-usual pathway, savings up to 300 million tonnes of emissions annually in China, India and North America.[55] 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.[56]

Aviation

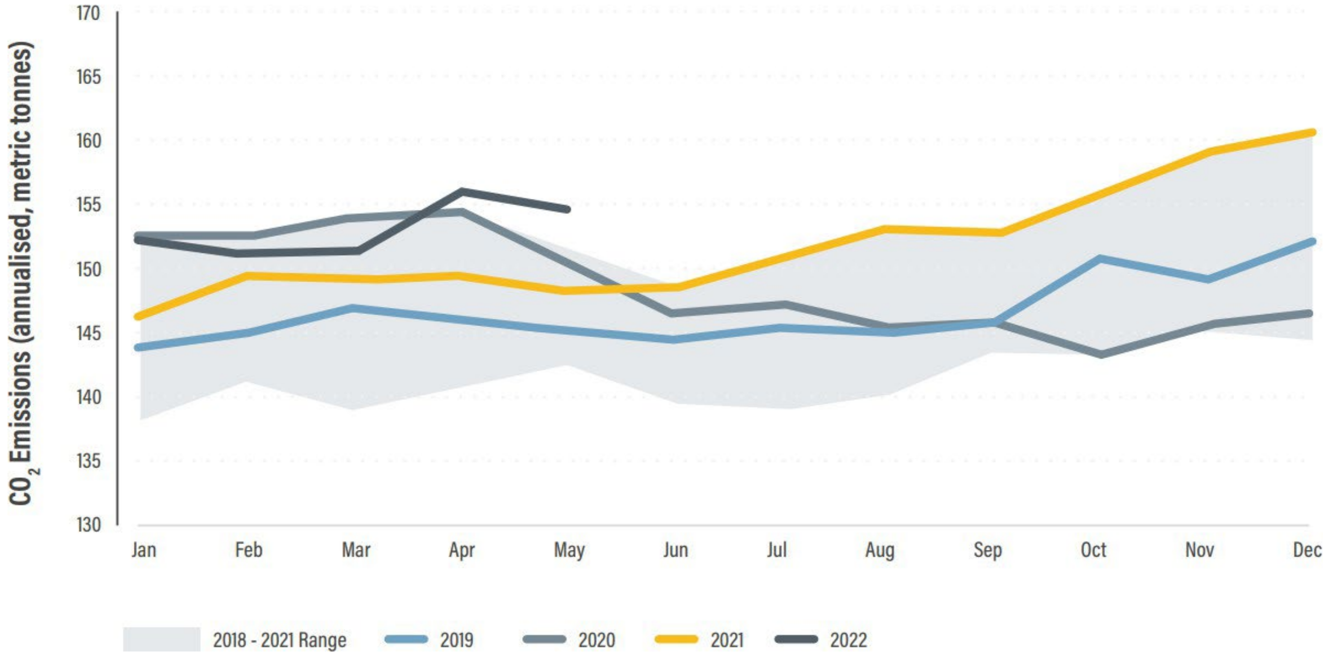
Aviation was responsible for 7% of the CO_2 emissions from freight transport in 2019.[57]

Maritime shipping

In January 2023, global maritime trade was transported on board 105,493 vessels of 100 gross tons (GT) and above, with oil tankers, bulk carriers, and container ships accounting for 85 percent of total capacity.[58]

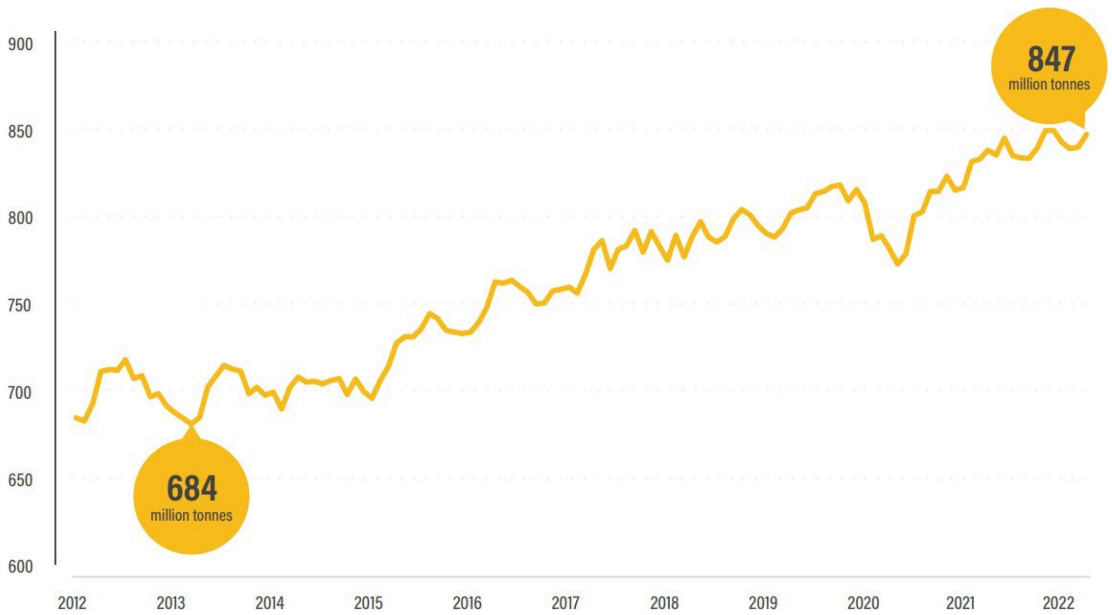
CO_2 emissions from the international shipping sector grew 5% in 2021, reversing a decline in 2020 and returning to 2017 levels.[59] International shipping emissions accounted for around 3% of total energy-related CO_2 emissions in 2021 and were poised to grow further in 2022 (*see Figure 7*).[60] **CO_2 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 8*).[61]

Figure 7. Monthly emissions from international shipping, 2019-2022



Source: See endnote 60 for this section.

Figure 8. CO_2 emissions from the world's commercial shipping fleet, 2012-2022

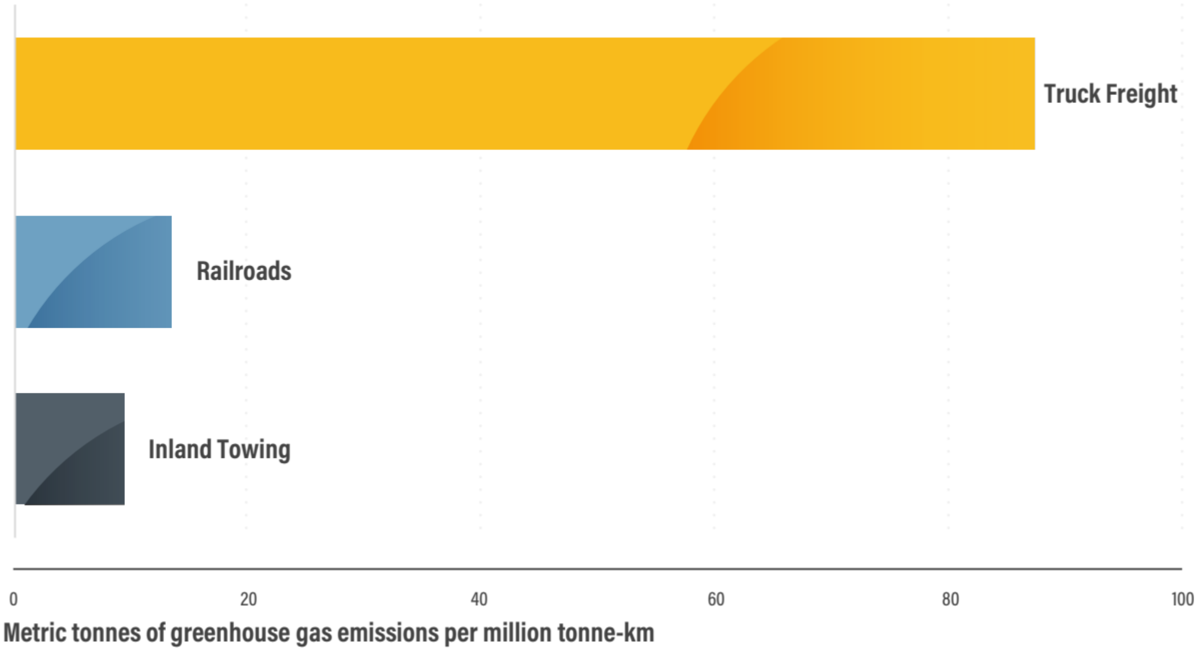


Source: See endnote 61 for this section.

In the EU, oil tankers and bulk carriers which transport coal, crude oil, petroleum products, and diesel, were responsible for 26% of total fleet emissions in 2021.[62] Globally, tankers and bulk and general cargo ships accounted for more than 50% of the total CO_2 emissions from the world's merchant fleet.[63]

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).[64] Inland waterway transport is responsible for 2% of the global greenhouse gas emissions from transport.[65] A modal comparison analysis of domestic freight transportation in the U.S demonstrated that 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 9*).[66] 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).[67]

Figure 9. Greenhouse gas emissions per million tonne-kilometres, by transport mode, 2019



Source: See endnote 66 for this section.

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.[68] Global maritime shipping released more emissions than all of Germany in 2021; nevertheless, emissions from international shipping and military vessels are not included in countries' national emission inventories.

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.[69] 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.[70] 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.[71] 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.[72]

Roughly 5% of maritime fuels must be zero carbon by 2030 to achieve the targets of the Paris Agreement.[73] **As of 2021, however, biofuels accounted for less than 1% of total shipping energy use.**[74] Oil products supplied more than 99% of the total energy for international shipping in 2021.[75]

- 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.**[76] Across 2022, 61% of tonnage ordered (35% by number) was alternative fuelled. Over half of tonnage ordered (397 orders, 36.7m GT) was LNG dual fuel, 7.0% was methanol (43 orders, 5.0m GT), 1.1% LPG (17 orders, 0.8m GT) and 1.2% included battery hybrid. 10.8% of orders were ammonia "ready" (90 orders, 7.7m GT), 1.4% of orders were LNG "ready" (31 orders), 0.1% were hydrogen "ready" and 22 orders were methanol "ready".[77] Scaling up these fuels further will require ports providing adequate fueling.[78]
- Around 50 methanol dual-fuelled vessels were ordered worldwide in 2022, as shipowners anticipate the need to replace ageing fleets.[79] 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.[80]

Pathways to support the implementation of the Paris Agreement and the 2030 Agenda for Sustainable Development

Transport emissions in a business-as-usual scenario

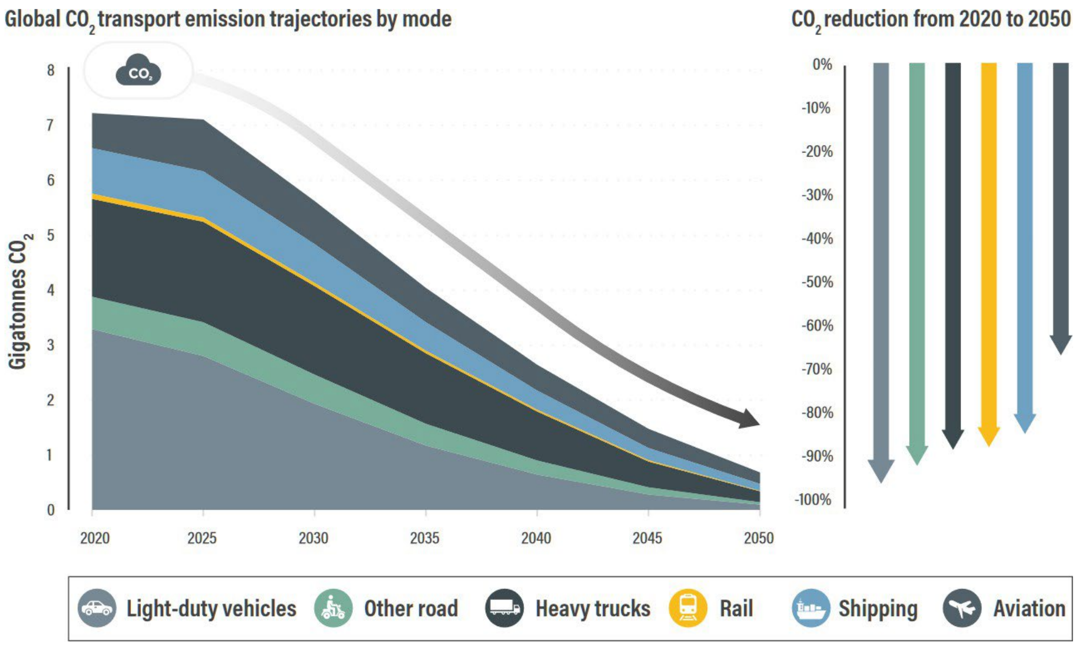
Freight transport emissions will likely continue to grow with rising demand for deliveries and transport of goods, as well as shifts to air freight.[81] **Under business as usual, transport activity is projected to nearly double by 2050, rising 1.8 times for passenger transport and 2.0 times for freight transport compared to 2019 levels**.[82] Growing demand for freight and passenger services is expected across all transport modes, particularly in Africa and Asia.[83]

Without more ambitious policies, transport CO_2 emissions could grow 16-50% by 2050.[84] **As a result, CO_2 emissions from freight transport would be 22% higher in 2050 than in 2015.**[85] International shipping CO_2 emissions would increase 40% over this period.[86] Under current policies, urban transport emissions would decrease slightly, by 5%.[87] In Asia, the largest regional emitter in 2019, transport CO_2 emissions could grow an estimated 1.5% annually to 2030, with the share of freight in Asia's transport emissions rising from 48% in 2000 to 57% in 2030.[88]

Pathways for decarbonising transport

Achieving low-carbon transport pathways that limit global warming to 1.5°C (with no or limited overshoot) will require a 59% reduction in transport-related CO_2 emissions by 2050, compared to 2020 levels.[89] In the International Energy Agency (IEA)'s Net Zero emission scenario, a 90% drop in transport CO_2 emissions (below 2020 levels) is required by 2050, with transport modes contributing differently to these reductions (*see Figure 10*).[90]

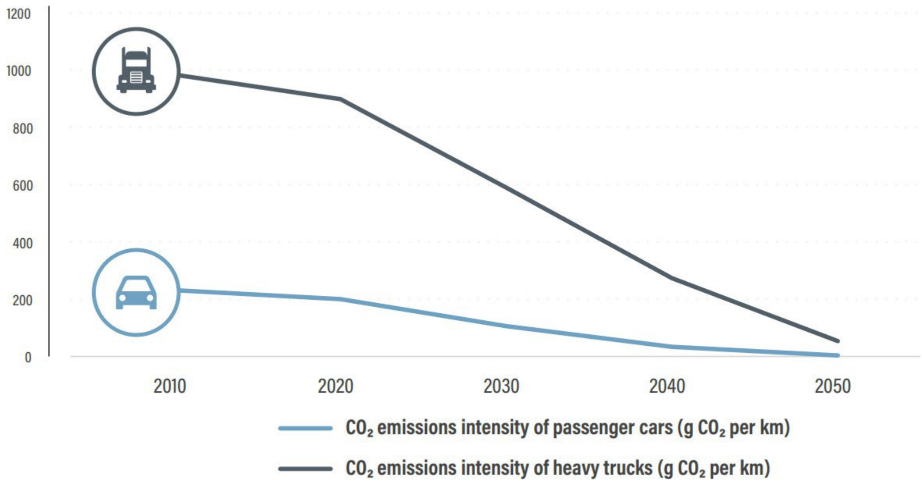
Figure 10. Global CO_2 transport emission trajectories by mode required to achieve IEA Net Zero emissions scenario



Source: See endnote 90 for this section.

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 11*).[91] Achieving the necessary reductions from road transport is essential for mitigating climate change but will require a concerted effort from governments, businesses and individuals.

Figure 11. Required emissions intensity pathway to 2050 according to the IEA's Net Zero scenario



Source: See endnote 91 for this section.

Shipping and aviation will contribute less than other modes due to the differing levels of technology maturity and readiness of scalable solutions.[92] To achieve a transport low-carbon pathway, several key milestones need to be met (*see Table 1*), including shifts to more energy-efficient modes, such as electric vehicles powered by renewable electricity sources, as well as public transport.[93]

Table 1. Milestones towards net zero transport emissions, according to the IEA Net Zero Scenario[94]

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

However, even in a low-carbon pathway, transport will be the second highest emitter of CO_2 among energy end-use sectors (after industry) by 2032, and by 2050 transport will be the most-polluting sector due to long-distance air travel.[95]

Current transport policies and measures are insufficient to put transport on a decarbonisation pathway in line with the 1.5°C target of the Paris Agreement. A 2022 assessment of 13 transport targets (such as public transport development, cycling infrastructure, sustainable aviation fuels, etc.) found that none of them were on track, with 2 of the targets (electric light-duty vehicle sales and electric bus sales) showing promise (although off track) and 7 of the targets heading in the right direction but well off-track. **Freight-related targets are categorised as "heading in the right direction but well off-track" by the World Resource Institute, such as the share of zero-emission fuels in maritime shipping fuel supply (target: 11% by 2030, currently at 0%, electric vehicles in medium- and heavy-duty vehicle sales (target: 30% by 2030, currently at 0.2%).**[96]

The IEA considers electric vehicles to be the only transport-related area that is on track with global scenarios for net zero emissions.[97] In 2022, electric car sales surpassed 10 million to account for 13% of the global new car market, resulting in 25 million electric passenger cars on the world's roads.[98] **For road freight, technical solutions are less mature and not yet readily available, but important developments are under way.**[99]

Looking at transport demand, in a low-carbon pathway, the maximum increase in passenger transport activity should be 50%, and in freight activity should be 20%, over the 2020-2050 period.[100] **Overall, the carbon intensity of the energy used in passenger and freight transport and of the fuels consumed needs to be halved by 2050.**[101] The CO_2 intensity for passenger and freight transport needs to be cut 45-51%, which corresponds to average annual energy efficiency improvements of 2.0-2.4%, to contribute to the Paris Agreement goals.[102] In parallel, the carbon intensity of fuels and other direct energy used needs to decrease 37-60% by 2050, compared to 2020 levels.[103]

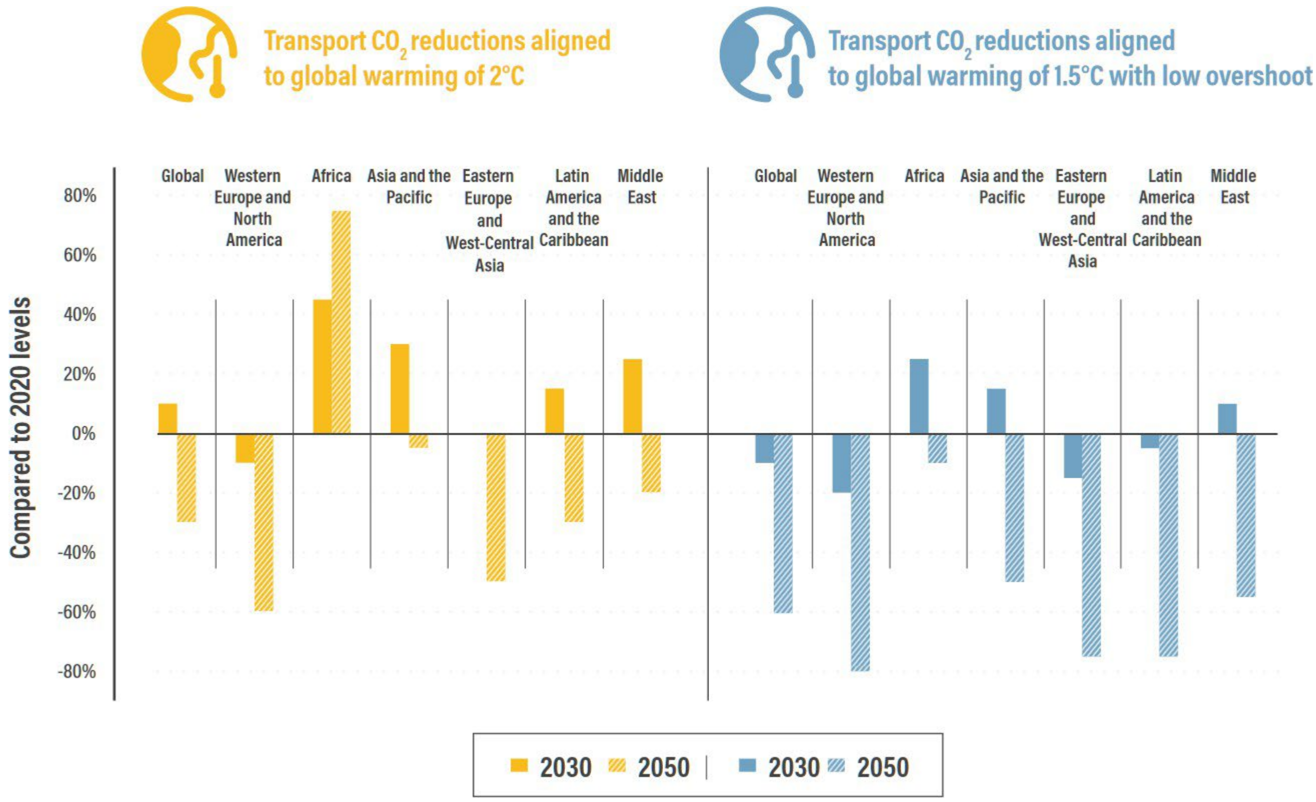
For freight transport, the picture is less clear, although at least moderate reductions are needed. Freight transport emissions could be reduced 76% below 2020 levels by 2050 with policies that support higher operational efficiencies, optimised routing and asset sharing, freight consolidation, enhanced collaboration in supply chains, shift to railways or inland waterways, standardisation and low-carbon solutions.[104] Ambitious actions on urban passenger transport can reduce emissions more than 80% below 2019 levels by 2050.[105]

To contribute to the achievement of the Paris Agreement targets, **international shipping** will need to become more efficient in the short-term and to switch to low-carbon fuels in the medium- to long-terms. This requires implementing approaches such as low steaming, wind-assistance technologies and low-carbon fuels (ammonia, biofuels and hydrogen). Advanced biofuels can supply 20% of the shipping sector's energy consumption by 2050, while ammonia and hydrogen can cover 60%.[106]

In June 2023, the International Maritime Organization (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%.[107] This is a major improvement from the IMO's initial 2018 strategy, which aimed at a 50% reduction by 2050.[108]

Looking at regional transport decarbonisation pathways, different regions need to contribute differently to the reduction of transport CO_2 emissions, with stronger reductions required in high-income countries than in low- and middle-income countries (*see Figure 12* and *Section 1.1 Transforming Transport and Mobility to Achieve the Targets of the Paris Agreement and the Sustainable Development Goals*).[109]

Figure 12. Regional transport decarbonisation pathways for 2030 and 2050, by scenario

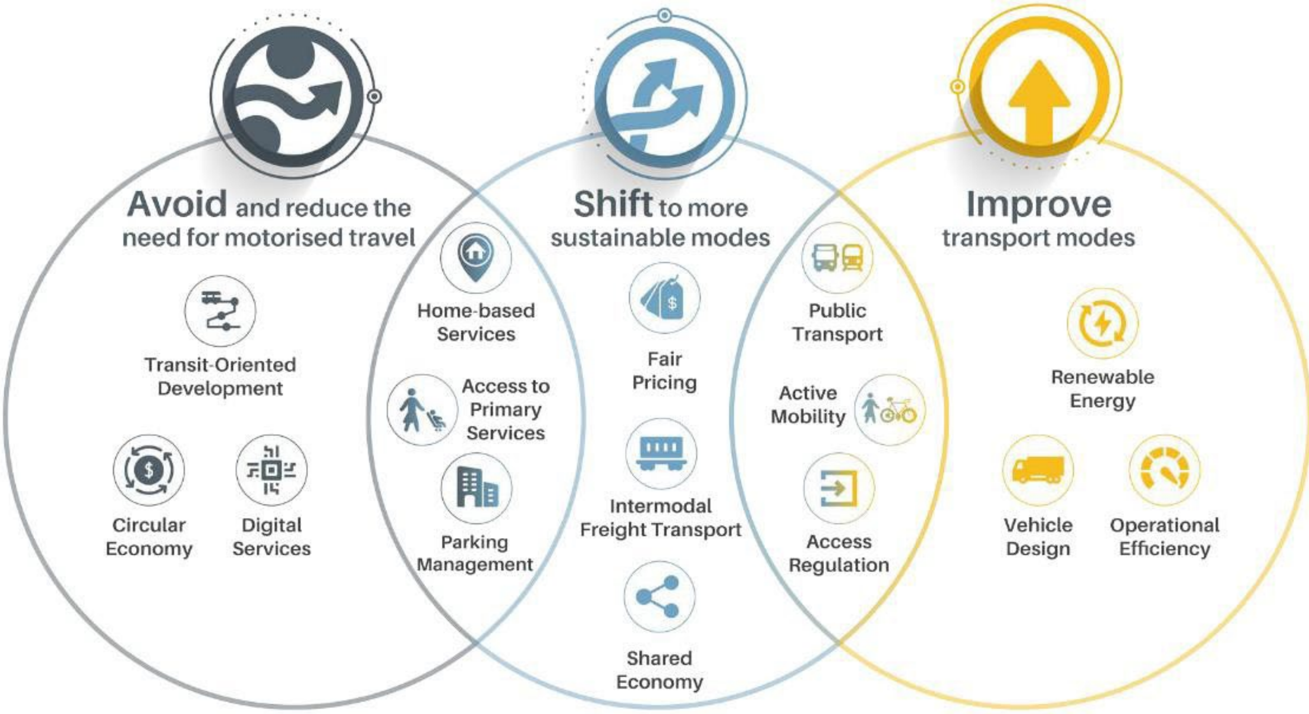


Source: See endnote 109 for this section.

Applying "Avoid-Shift-Improve" (A-S-I) measures across passenger and freight transport through integrated, inter-modal and multi-dimensional approaches remains critical to deliver such cross-cutting solutions for systemic transformation (*see Figure 13*). The A-S-I framework has been central to transport decarbonisation and sustainability efforts for more than a decade. It calls for transport and mobility systems that, while guaranteeing access to transport and mobility. Applied to freight transport, the elements are:

- *Avoid* unnecessary motorised transport of goods and deliveries;
- *Shift* to less carbon-intensive modes – that is, from fossil fuel-powered trucks to electrified road-rail freight, water-based freight, and cargo bikes for last-mile deliveries, among others; and
- *Improve* vehicle design, energy efficiency and clean energy sources for different types of freight vehicles.

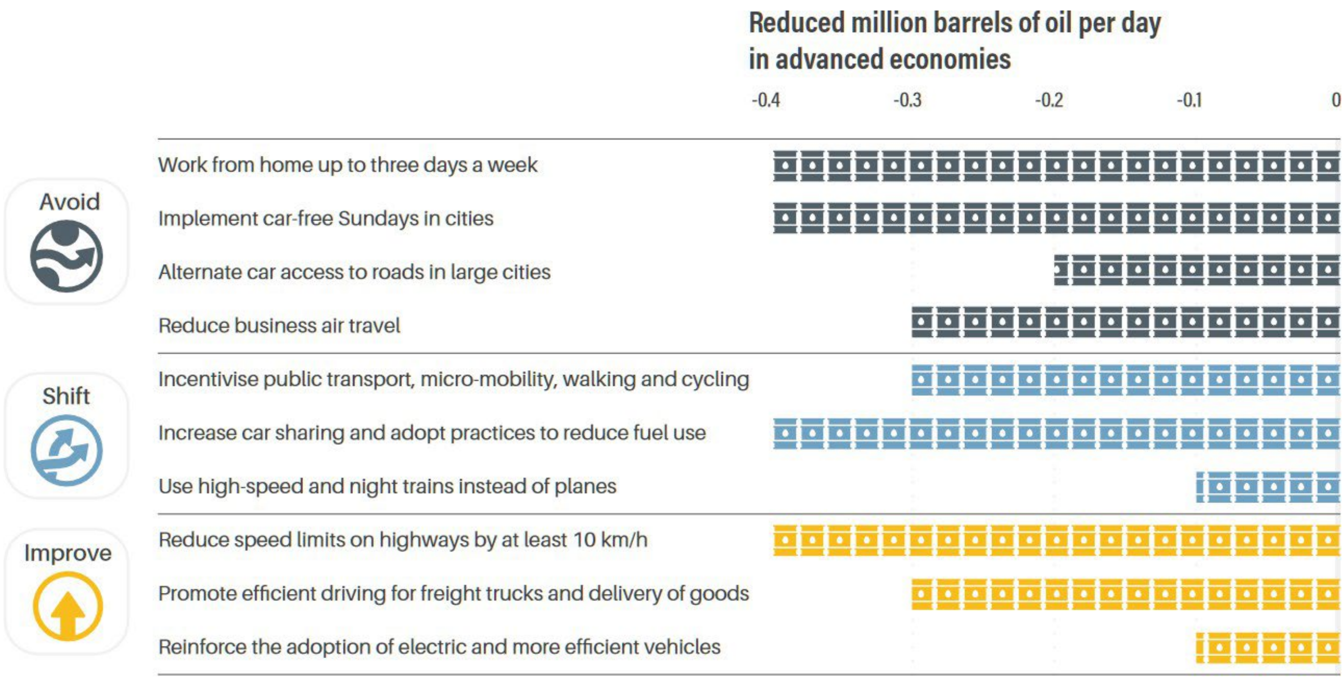
Figure 13. Avoid-Shift-Improve framework for transport



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

Shortly after the beginning of the Russian Federation's invasion of Ukraine in 2022, the IEA released a 10-point plan outlining how to cut oil use in advanced economies. The plan featured a detailed breakdown of how 2.9 million barrels of oil per day could be saved in the transport sector, revealing that quick measures related to "Avoid" can have a significant impact. Regarding freight, efficient driving for trucks and delivery of goods has a significant potential in reducing oil dependency (*see Figure 14*).[110]

Figure 14. Actions to reduce oil dependency in transport, through Avoid-Shift-Improve measures



Source: See endnote 110 for this section.

As a direct reaction to the Russian invasion of Ukraine, in March 2022 the European Commission presented the REPowerEU plan, with the aim of accelerating a shift to clean energy and reducing the region's reliance on Russian fossil fuels. Key steps relevant for transport are the transition to natural gas, liquefied natural gas and hydrogen; increased ambition to increase energy efficiency in transport; and a shift to more public transport, walking and cycling.[111]

Despite these and other steps, global fossil fuel subsidies have continued to rise, whereas strong financial support is lacking for sustainable, low-carbon transport and mobility options. A fundamental reform of transport economics is urgently needed to deliver the necessary just transformations at the speed and scale required to achieve the targets of the Paris Agreement and the SDGs.[112] (*See Section 5.1 Financing Sustainable Transport in Times of Limited Budgets.*)

Freight transport adaptation and resilience

Transport resilience can be defined according to two key aspects:

- **Resilience of transport:** Ability of transport and mobility systems to withstand, respond to, recover from and adapt to a range of shocks and stresses, both now and into the future. Key elements include operational and organisational resilience (e.g., offering redundancy and diversity of mode choice for communities of differing income levels and geographic locations and various types of goods) in addition to the physical resilience of the infrastructure itself.
- **Resilience through transport:** Capacity to enhance the resilience of people and communities through passenger mobility systems, and the resilience of enterprises, economies, and supply chains through freight transport systems. Resilient transport and mobility systems provide services and deliver benefits to communities that are most vulnerable to the impacts of climate change and to the most critical supply chains.[113]

Transport and mobility systems require not only infrastructure and operational resilience, but also resilience to shocks, macroeconomic and political disruptions, social events and climate change, to achieve financial sustainability.[114] Several disruptors already impact transport networks around the world, and many of these are exacerbated by climatic factors.

- **Consumption and commerce changes** – Online shopping demand, accelerated by the COVID-19 pandemic, has resulted in a substantial increase in home deliveries. Delivery vehicles often carry poorly optimised loads along local roads that may not be well suited to freight transport, contributing to higher congestion and emissions.[115] Since the pandemic, there has been considerable upheaval in global value chains, with tendencies towards re-localisation and "friend-shoring".[116]

Climate change impacts – including sea-level rise and coastal flooding, more intense storms and rainfall, and more extreme temperature swings – increase the vulnerability of passenger and freight transport and heighten the impacts of other disruptors.[117]

Natural hazards cause an estimated USD 15 billion a year in direct damage to transport systems worldwide; of this, an estimated USD 8 billion occurs in low- and middle-income countries, which experience the highest costs relative to their gross domestic product (GDP).[118] An estimated 27% of global road and rail assets are exposed to at least one cyclone, earthquake or flooding hazard.[119] Ports are even more exposed due to their placement along coastlines and rivers, with preliminary estimates indicating that 86% are exposed to three or more hazards.[120]

- Damage varies greatly among countries, with the most annual damage per kilometre of road and rail asset estimated in Vietnam, followed by Papua New Guinea and Myanmar.[121]
- In Pakistan, floods in 2022 caused more than USD 3.3 billion in damage to transport and communications, which was the third-largest sector with damages after housing (USD 5.6 billion) and agriculture (USD 3.7 billion).[122]
- In the EU, extreme weather alone contributed an average of EUR 2.5 billion (USD 2.7 billion) in direct damages to transport annually between 1998 and 2010, with indirect costs of disruption estimated at EUR 1 billion (USD 1.1 billion).[123]
- In the aviation sector, extreme weather was responsible for around 7% of US flight delays in 2020, and a further 15% of delays were due to non-extreme weather conditions.[124]

While uncertainty remains around specific factors and impacts, there is overwhelming scientific evidence that human-induced climate change has contributed to more frequent and intense extreme events.[125] Direct physical impacts on transport can be caused by sea-level rise and increased coastal flooding; more severe winds, unpredictable winters, more intense rainfall, changes in average rainfall, increasing average and extreme temperatures[126] and more intense storms.[127]

The Role of Business in Decarbonising Transport

To realise transport decarbonisation, a wide range of businesses, including original equipment manufacturers (i.e., transport manufacturers), providers of public and freight transport services, as well as companies that use transport, need to be involved.

Although businesses are demonstrating momentum in climate leadership across the 4 A's of Climate Leadership (Ambition, Action, Advocacy and Accountability), and taking different steps to decarbonise transport and to reduce emissions to contribute to international goals, collectively this remains insufficient to achieve a pathway that is consistent with the goal of keeping global temperature rise below 1.5 degrees Celsius (°C).[128]

Ambition

Transport manufacturers tend to focus on zero-emission vehicles, charging infrastructure, and renewable energy for shipping and aviation. Very few companies have set targets across all of their business areas and markets and have committed to phasing out fossil fuels. While the climate ambition of transport manufacturers is increasing, targets are not ambitious enough to achieve a 1.5°C pathway, especially for land transport, shipping and aviation. Moreover, regional differences in these commitments are apparent, especially for medium- and heavy-duty trucks and buses.[129]

The global shipping industry, through the Getting to Zero Coalition, has committed to operating commercially viable zero-emission vessels by 2030, along with the associated infrastructure, with the goal of full decarbonisation by 2050.[130] The International Maritime Organization has targeted halving global shipping emissions by 2050 (from 2008 levels) and approved a revised greenhouse gas strategy in 2023.[131] Alignment with a 1.5°C pathway requires reducing emissions from international shipping at least 34% below 2008 levels by 2030 and achieving zero emissions by 2050.[132]

Amongst the providers of public and freight transport, a next frontier is to commit to phasing out fossil fuels in the transport sector, which relies on oil-derived products for more than 90% of its energy and is more dependent than other sectors on the oil industry.[133] For example rail freight company ÖBB RCG has committed to carbon neutrality of its mobility sector by 2030 and of the entire company by 2040/50 through six key strategies; already, its rail operations in Austria, Germany and the Czech Republic are powered exclusively by green traction current.[134]

Amongst the companies that use transport, more than 2,400 companies covering more than a third of the global economy's market capitalisation – including 43 transport manufacturers and 124 transport service providers – have approved science-based targets for reducing greenhouse gas emissions.[135] However, it is unclear how many of these companies have set specific transport-related emission reduction targets. Meanwhile, a growing number of companies have committed to decarbonising their fleets.

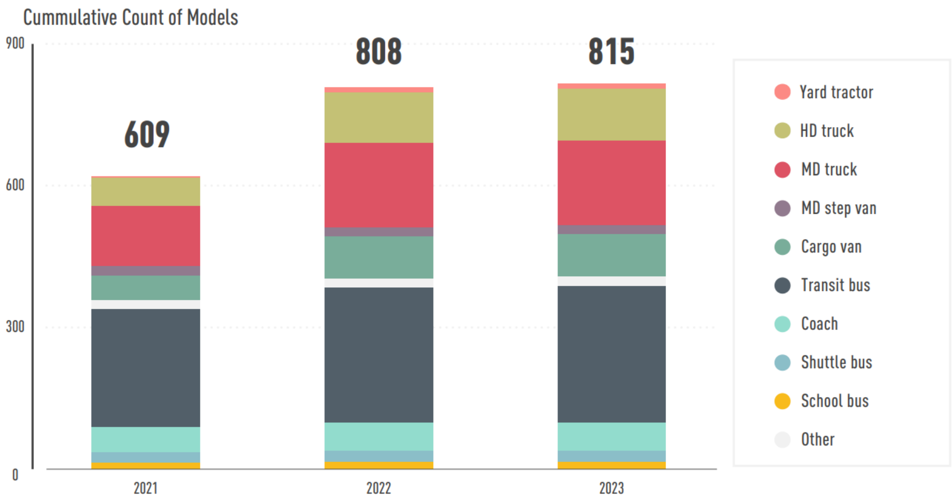
- **EV100** brings together more than 120 companies across 98 markets to transition their own or sub-contracted fleets of 5.5 million vehicles to electric vehicles, and to install charging infrastructure for employees and customers that will avoid 85 million tonnes of CO_2 by 2030.[136] In 2022, this was expanded with **EV100+** to cover zero-emission medium- and heavy-duty vehicles, sending a powerful demand signal to vehicle manufacturers and governments to accelerate the market scale-up worldwide.[137]
- Through the **First Movers Coalition**, shippers commit that by 2030 that they will: 1) use transport providers that only purchase zero-emission medium- and heavy-duty trucks; 2) ship at least 10% of goods internationally on ships using zero-emission fuels (and 100% by 2040); and 3) replace at least 5% of conventional jet fuel demand for air transport with SAF and/or zero-carbon emitting propulsion technologies.[138]

Action

The strongest progress among transport manufacturers has been on electric road vehicles and alternative fuels for ships and airplanes, as well as increasingly on digital solutions offered by multi-modal transport companies. To reach the IEA's 1.5°C target, the global automotive sector will need to increase annual production of zero- emission vehicles (battery electric and hydrogen) to 52% of total vehicle production in 2029.[139]

Auto companies that produce electric buses and trucks, most of which are Chinese, have rapidly gained market share. At the start of 2023, 815 models of electric (battery or fuel cell) buses and trucks were available, up 34% from 2021 and 187% from 2019 (*see Figure 15*).[140] **Electric truck** sales accounted for only 0.4% of total sales in 2022, resulting in 320,000 electric trucks on the roads in 2022.[141]

Figure 15. Global availability of zero-emission medium-and heavy-duty vehicles, by type, 2021-2023



Source: See endnote 140 for this section.

Innovation has also occurred in "hard-to-decarbonise" sub-sectors, including on zero-emission trucks, ships and planes; low-carbon fuels; batteries and other technologies; and infrastructure.[142] **While policy has played a role, manufacturers also have responded to customer demand and collaborated with suppliers of infrastructure, fuel and batteries, and other technologies.**[143]

For ships and airplanes, the emphasis has been more on alternative fuels than on zero-emission fleets or other measures such as mode shift and economic measures. Sustainable aviation fuels (SAF) that can reduce CO_2 emissions from air travel up to 80% are expected to play a bigger role.[144]

- According to the ReFuelEU Aviation Initiative passed in 2023, the use of SAF in aviation should achieve a minimum share of 2% by 2025, and increase each year to 20% by 2035, and 70% by 2050[145]
- In early 2023, the European Commission also adopted FuelEU Maritime Initiative, under the EU's Fit for 55 package, with an aim to reduce the greenhouse gas emission intensity of shipping fuels 2% by 2025 and 80% by 2050 to put maritime transport on the trajectory of the EU's climate targets for 2030 and 2050.[146]
- In 2018, Norway announced that only emission-free ships will be allowed to enter the country's two western World Heritage fjords from 2026, triggering Northern Xplorer to commission construction of a cruise ship that operates on hydrogen.[147]
- The US Inflation Reduction Act stimulates investments across decarbonisation technologies, while the EU's Alternative Fuels Infrastructure Regulations of March 2023 aims to fast-track the uptake of alternative fuels and vehicles.[148]
- SAF production reached at least an estimated 300 million litres in 2022, up 200% from 2021 (100 million litres), and more than 450,000 commercial flights used these fuels during the year.[149]
- However, SAF production in 2022 was still well below the 30 billion litres by 2030 and 450 billion litres by 2050 that are projected to be required annually under the 1.5°C and net zero pathways.[150]

Based on what providers of public and freight transport have disclosed, it is evident that many may not have determined the actions or allocated the funding required to meet their targets. However, some companies have disclosed new business models and strategies that, if scaled across the sector, could have a significant impact. For example, of 37 companies that offer multi-modal freight transport, 55% (20 companies) disclosed that they invest in **digital solutions** such as route optimisation and reducing empty miles, with UPS and Royal Mail plc reporting that these solutions reduce emissions.[151]

Companies that use transport, particularly shippers hold the key to making structural changes to freight transport by shifting to low-carbon modes and reducing demand through employing some strategies to "Shift" and "Avoid" emissions from freight transport. These include revisiting existing industrial processes and business models to reduce the number of freight movements, revamping industrial facilities and suppliers to reduce spatially fragmented supply chains and changing logistics organisations and lower transport service levels to support the consolidation of flows and facilitate modal shift. An example of this is IKEA which works with its transport providers and peers to reduce shipments and energy, replace with cleaner fuels and modes, and rethink the supply chain.[152]

Advocacy

Businesses have been more supportive of infrastructure and incentives for alternative fuels and zero emissions, while being more opposed to CO_2 targets, standards and accelerating the phase-out of internal combustion engines and fossil fuels. As of January 2023, a mix of policy advocacy positions existed in the EU among manufacturers and others across transport modes, however there is no clear picture on the position of logistic companies.[153]

Accountability

Disclosure of climate-relevant information by companies is becoming mainstream – with more than 18,000 companies disclosing to CDP in 2022 – but gaps in accountability remain. In 2022, 419 transport manufacturers (including 251 automakers) responded to the 2022 CDP climate questionnaire, the results of which are used to inform investors and other stakeholders.[154]

Opportunities to accelerate industry action

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

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

Setting science-based and other targets is not sufficient. The UN High Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities provided 10 recommendations for companies to ensure that pledges towards net zero do not lead to greenwashing.[155] For transport, actions should focus more on shifting and avoiding transport – through, for example, walking, cycling, public transport, fuller truck loads, local sourcing and working from home – while integrating gender considerations. Companies should balance out unabated emissions by purchasing only high-integrity carbon credits.

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

There is an over-reliance on technology-focused "Improve" strategies, despite growing evidence that "Avoid" and "Shift" strategies can contribute to 40-60% of transport emission reductions at lower costs.[156] The Intergovernmental Panel on Climate Change has further identified 10 systemic changes for transport to complement technological changes that will also contribute to sustainable economies and societies more broadly: 1) changes in urban form, 2) investment in transit and active transport infrastructure, 3) changes in economic structures, 4) teleworking, 5) dematerialisation of the economy, 6) supply chain management, 7) e-commerce, 8) smart mobility, 9) shared mobility and 10) vehicle automation.[157]

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

3) Companies can engage in more effective collaboration by complementing other stakeholders in climate and sustainability actions, working with all partners in the value chain, supporting just transition pathways for transport and joining initiatives that will truly help deliver the transition. Several key opportunities exist for more effective collaboration. First, companies should identify their unique roles alongside other stakeholders. For the freight transportation sector, the **Roadmap towards Zero Emission Logistics 2050** gives examples of complementing roles for different freight decarbonisation actions.[158]

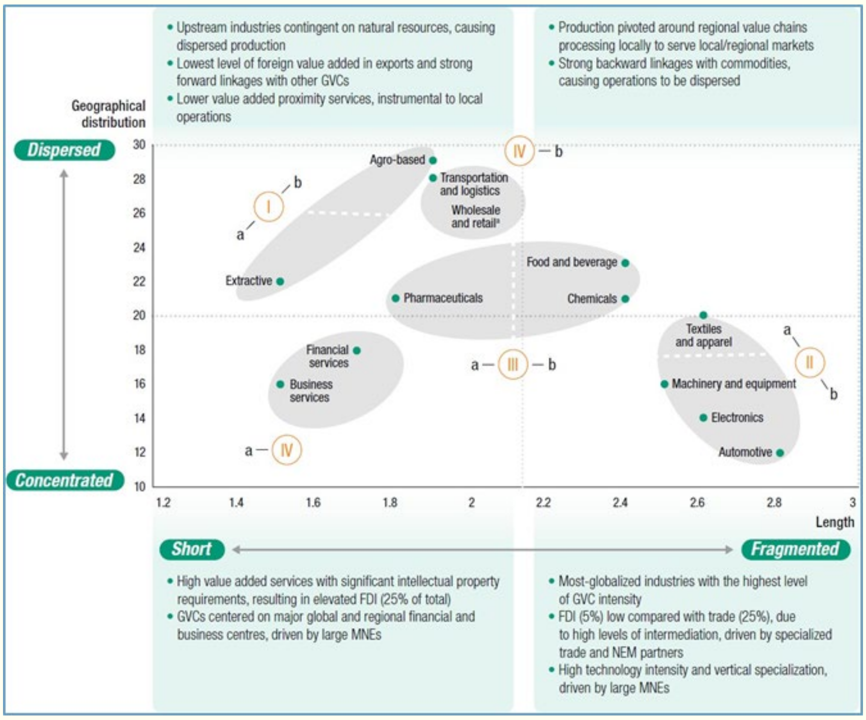
Box 1. *Shortening Global Supply Chains as a Key to Decarbonising Transport*

The historical development of global supply chains: past drivers

Today, international production is highly organised within global value chains, where the different stages of the production process are located across different countries.[159] As of 2021, an estimated 70% of international trade involved global value chains.[160]

Figure 16 proposes to characterise the current organisation of value chains according to their geographical distribution and length. This helps to identify four main industry types (I to IV): primary industries (low or high capital intensive), global value chain-intensive industries (low or high tech), geographically distributed industries (global or regional hubs) and services industries (low or high value added).[161] The industries with the longest and most fragmented global value chains are chemicals, electronics, automotive, machinery and equipment, textiles and apparel, and food and beverages.[162]

Figure 16. Length and geographical distribution of international production, by key industry type[163]



Source: See endnote 163 for this section.

Traditionally, five key factors have determined the structure of supply chains, although these factors vary depending on the value chain as well as on the step of the value chain being considered. They are:[164]

1) Labour costs and other non-economic labour-related regulations;
2) Sunk investment costs and public investment incentives;
3) Trade and transaction costs and non-economic transaction-related regulations;
4) Access to know-how/talents, technologies, infrastructure and supply sources;

5) Access to distribution markets, transport and logistics costs and lead time.

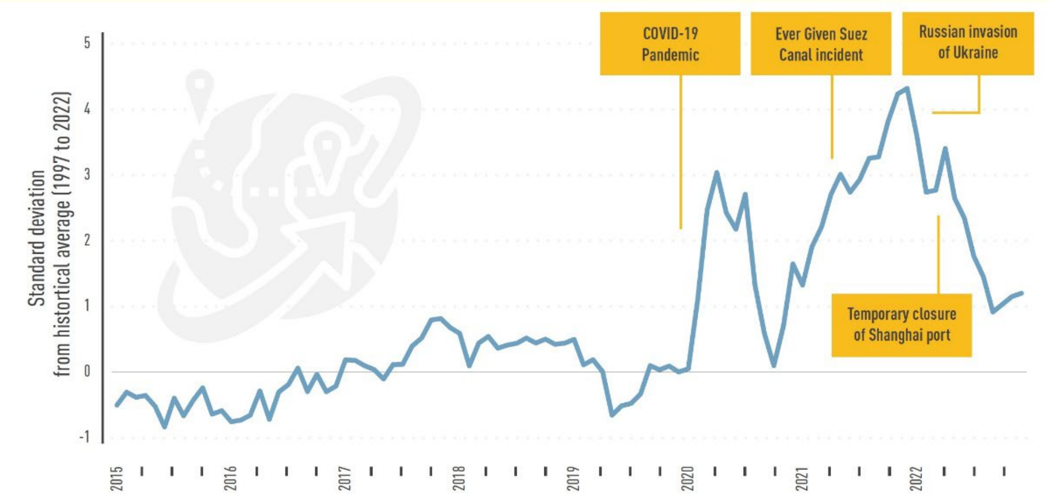
These five determinants also can depend on the relative cost structure and final price of the products, on the degree of reliance on extractive industries, and on the modularity of the production process, among others. Understanding these five determinants makes it possible to better analyse the underlying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

On the policy side, economic liberalisation and the development of international and multilateral trade agreements after World War II contributed to the reduction or elimination of tariffs, quotas, preferences and other trade barriers.[165] The General Agreement on Tariffs and Trade (GATT) grew to cover more countries, goods, and activities, leading in the 1990s to the creation of the World Trade Organization, involving more than 125 countries. Global competition among firms and economies led to dedicated national investment policies and export-oriented industrial policies.[166]

Recent disruptions to global supply chains: revealed vulnerabilities

In recent years, multiple crises such as the COVID-19 pandemic, the Russian Federation's invasion of Ukraine, and the blockage of the Suez Canal caused supply shortages, raising awareness of the fragility of global supply and logistics chains and their international dependencies. These disruptions resulted in the Global Supply Chain Pressure Index recording an all-time high value of 4.3 above the historical average of 1997 to 2022 *(see Figure 17)*.[167]

Figure 17. Global supply chain pressure index (higher value means higher pressure), 2015 to 2022



Source: See endnote 167 for this section.

At the same time, ongoing shifts could accelerate reductions in the lengths of supply chains. Given that technological solutions for reducing freight transport emissions – such as zero-emission vessels, aircraft and long- distance trucks – are still far from maturity, it will be necessary to give greater attention to the systemic reorganisation of global supply chains in the effort to reach net zero emissions, and to minimise risks to industry during the energy transition.[168]

The future of global supply chains: a changing context

As both companies and policy makers express rising concerns about resiliency, many are considering associated strategies to relocate production facilities and suppliers closer to customers.[169] According to a 2019 analysis, a reduction in the average length of supply chains began in 2012.[170] Four structural changes are contributing to the reduced distances for value chains and international trade:

1) **The shift in economic policies from market liberalisation towards protectionism:** Since the global financial crisis of 2007-2008, the international economic policy agenda has shifted towards the development of protectionist measures among the G20 economies.[171]

2) **Changes in the international security context to reinforce security of supply and ensure the independence of critical value chains:** New investment restrictions or regulations in recent years have reflected concerns about national security and foreign ownership of technology firms, strategic assets, and land and natural resources.[172]

3) **Rising pressures to reduce emissions:** Since the Paris Agreement in 2015, environmental concerns related to the impact of human activities on climate change and biodiversity loss have grown in importance. As of 2022, more than 58 countries and one-fifth of the world's largest companies had committed to reaching carbon neutrality.[173] Governments have been pushed to act by adopting more and better sustainability policies.[174] Businesses are turning to life-cycle assessments to measure the environmental impacts along the value chain for each step of a product's life cycle, from production to transport, distribution and disposal. The Smart Freight Centre's Global Logistics Emission Council (GLEC) Framework is the only globally recognised methodology to help companies harmonise the calculation and reporting of the logistics greenhouse gas footprint across the multi-modal supply chain.[175]

4) **New manufacturing technologies:** Finally, new manufacturing technologies such as automation and additive manufacturing have impacted industrial production costs by favouring reshoring and nearshoring. However, innovations in communication technologies such as 5G, cloud computing and artificial intelligence could have the opposite effect on the length of value chains.[176]

Perspectives for the international climate cooperation agenda

The international scientific community has noted that "systemic changes" related to transformations in structural demand could play a large role in keeping global temperature rise below 1.5 degrees Celsius (°C). A key recommendation is for the transport sector to better articulate the needed transformations related to supply chain management, which include reducing movements and distances, alongside technological changes.[177] However, a review of the Long-Term Strategies (LTS) of the five leading economies – **China**, **India**, **Japan**, the **United States** and the **EU** – published between 2020 and 2022 found that none of them mention phrases related to shortening supply chain distances, reducing freight movements or reducing long-distance freight, shifting supply chains closer and developing local production-consumption ecosystems. This reveals an important gap between science and policy *(see Spotlight 4 Shortening Global Supply Chains)*.

An international policy agenda is needed to work on identifying barriers and enablers for strengthening international cooperation towards shorter and more resilient supply chains. Critical international cooperation activities should help to discuss opportunities and issues related to the changing context and coordinate collective action to avoid unilateral and unfair decisions.

In the perspective of the first Global Stocktake (2022-2023) and future revisions of countries' Nationally Determined Contributions (NDCs) and LTS under the Paris Agreement, the regionalisation of supply chains closer to customers should be better integrated. To secure their place in the future net zero economy, countries can use their NDCs to set their freight transport and logistics systems on track to become net zero and resilient. Some key elements of a NDC that enables impactful action on decarbonisation and resilience of freight transport and global supply chains include:[178]

1) **Setting robust freight transport targets** to reduce freight transport emissions, ensure that a certain share of goods is transported by rail or waterways, mandate a share of fuels for trucks supported by renewable energy and transform infrastructure;
2) **Including mitigation actions for freight transport structured by the A-S-I framework**;
3) **Adapting freight transport with measures that improve the resilience of infrastructure** including all- weather roads and general flood protection, ports that account for sea level rise and extreme weather events, early warning systems, multiple and short supply chains and plans for alternative freight transport; and
4) **Featuring actions to achieve more ambitious international maritime and aviation transport targets and emissions.**

Freight and logistics in NDCs, Long-term strategies and Voluntary National Reviews

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

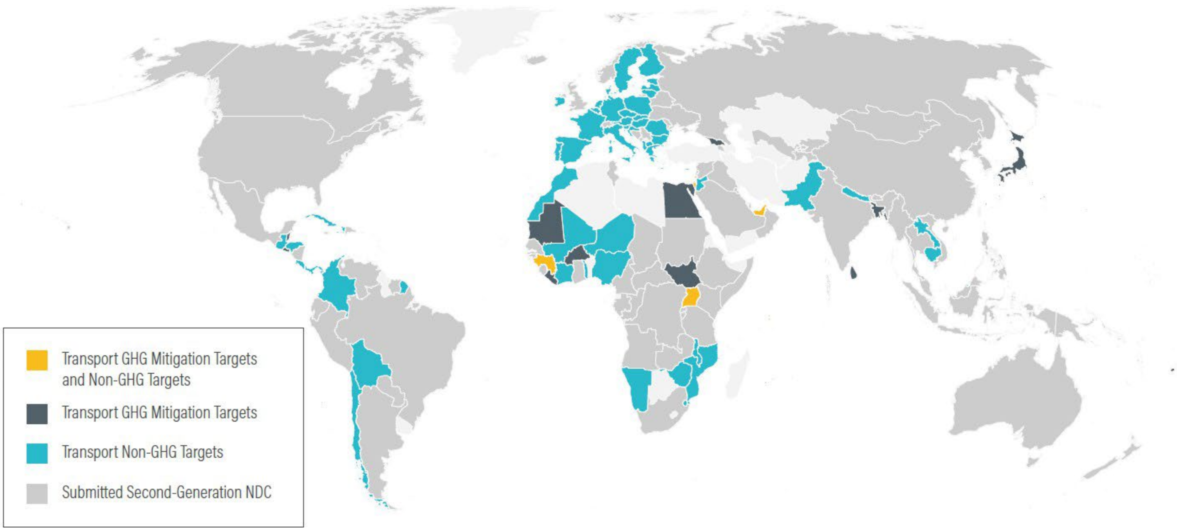
Freight in Nationally Determined Contributions

Most countries (169 countries in total) submitted second-generation Nationally Determined Contributions (NDCs) before the end of 2022, taking the opportunity to strengthen their overall climate ambitions.[179] **On average, the second-generation NDCs included more transport mitigation and adaptation actions than the first generation of NDCs. Each second-generation NDC featured nearly twice as many transport mitigation actions as did first-generation NDCs.**[180] In absolute numbers, there are more freight actions in the second-generation NDCs than in the first-generation NDCs, indicating a slow tendency towards increased ambition to decarbonise freight.[181]

The second-generation NDCs featured twice as many transport targets as the first-generation ones.[182] **Of the second-generation NDCs, 23 (or 16%) had a target for mitigating transport greenhouse gas emissions, mostly for countries in Europe and Africa and for the year 2030** (*see Figure 18*).[183] Non-greenhouse gas targets for transport that feature a quantitative target for a specific year doubled as well in the second-generation NDCs compared to the first-generation ones. The most frequent non-greenhouse gas targets were related to zero-emission vehicles (39%), followed by vehicle efficiency (25%), mode share (10%), biofuels (10%), infrastructure (9%), "Avoid" strategies (4%) and renewable energy (3%).[184]

- Albania outlines the target to shift 30% of road transport (passenger and freight) to railways and waterways by 2030 and 50% by 2050.
- Uganda has set the target to rehabilitate 634 km of railways by 2026 to support a modal shift from road to rail and to achieve a 22% improvement in the energy consumption of diesel locomotives by 2030 compared to 2015 levels.

Figure 18. Transport targets, by type, in second-generation NDCs



Source: See endnote 183 for this section.

In both generations of NDCs, there were very few explicit mentions of freight-related actions. Around two-thirds of the transport mitigation actions in each generation of NDCs did not explicitly mention freight or passengers, while 25% mentioned passenger transport and only around 5% mentioned freight transport.[185]

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.[186] 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.[187] In total, rail-focused mitigation actions were covered by 37 second-generation NDCs.[188]

- India's NDC commits to raising the share of rail traffic for freight from 35% in 2022 to 45% by 2030.[189]
- 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.[190]
- Thailand is promoting a road-to-rail modal shift for both freight and passenger traffic, as part of the Environmentally Sustainable Transport System Plan.[191]
- 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.[192]

As the frequency of extreme weather events continues to increase, global supply chains are at increased risk for disruptions.[193] **However, the NDCs neglect to specify freight transport adaptation and resilience.** As of 2022, Nauru's was the only second-generation NDC with freight transport adaptation actions specifically Nauru intends to increase the resilience of the port facilities.

Freight in Long-Term Strategies

By the end of 2022, only a quarter of the world's countries had developed Long-Term Strategies (LTS).[194] **All LTS mentioned transport, although only 22% of LTS (13 countries) outlined transport targets, with nearly all having a target year of 2050.**[195]

In LTS, the ratio between freight (35%) and passenger (54%) transport mitigation actions is slightly more balanced than in the second-generation NDCs. There are several actions targeting trucks, rail and inland water transport. Only Japan's LTS mentions content related to adaptation of logistics systems.

Freight in Voluntary National Reviews

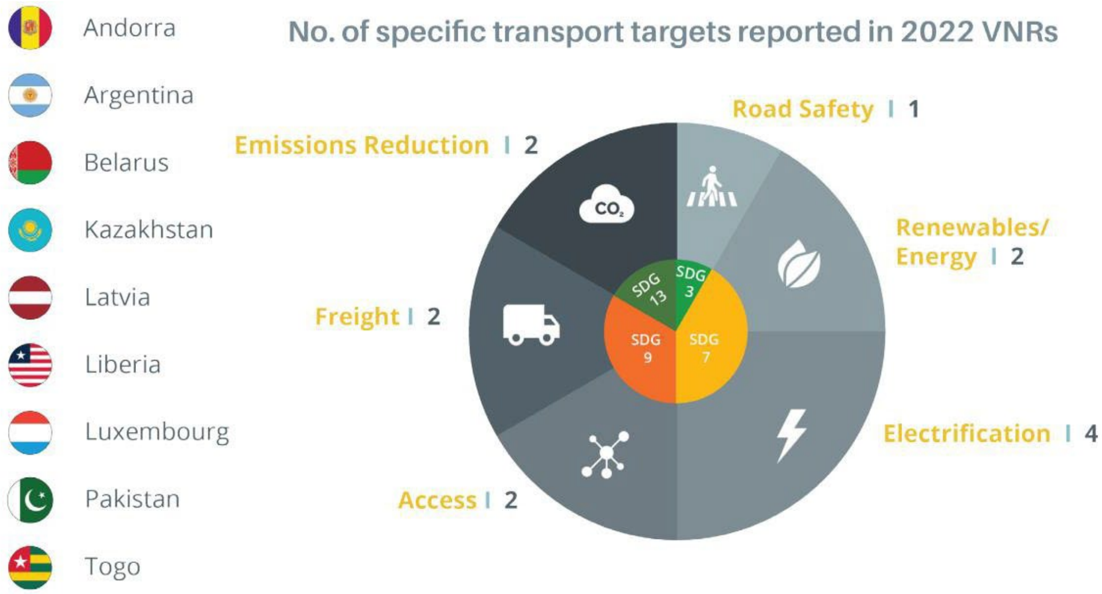
The Voluntary National Reviews (VNRs) from 2016 to 2022 revealed consensus on the role of transport as a key contributor to implementation of the SDGs.[196] **In the first VNR reporting cycle (2016-2019), 92% of VNRs (144 of 156 VNRs) highlighted progress in the transport sector, and 18% of VNRs reported specific targets covering 12 areas in sustainable transport.**[197]

In 2022, 21% of the VNRs (9 out of 42 VNRs) mentioned specific transport targets, up from 20% (9 out of 40) in 2021 and 17% (8 out of 47) in 2020.[198] Targets were focused on, among others, electrification, freight, road safety and renewable energy (*see Figure 19*).[199] Of the 9 VNRs with transport-specific targets reported in the Voluntary National Reviews in 2022, only Argentina had a freight-related target to increase the share of freight transported by rail to 9% by 2025 and 11% by 2030.

In the 2022 VNRs, most of the mentions focused on developing transport infrastructure in the context of passenger and freight activities (SDG 9 on industry, innovation (SDG 9 on industry, innovation and infrastructure), all-season rural roads (SDG 9) and public transport systems (SDG 11 on sustainable cities and communities). Significant attention was also given to reducing traffic fatalities and injuries (SDG 3 on good health and well-being) and increasing renewable energy; reducing final energy consumption in the transport sector (SDG 7 on affordable and clean energy) and curbing mobile-source greenhouse gas emissions (SDG 13 on climate action).[200]

Compared to previous years, there was a slight increase in mentions of gender-sensitive transport policies (SDG 5), possibly because SDG 5 was a focus of the 2022 UN High-Level Political Forum on Sustainable Development. Relatively fewer VNRs mentioned measures to phase out fossil fuel subsidies (SDG 12) and curb mobile-source greenhouse gas emissions (SDG 13), despite 40% of the VNRs spelling out connections with SDG 13.[201]

Figure 19. Number of specific transport targets mentioned in 2022 Voluntary National Reviews



Source: See endnote 199 for this section.

Box 2. Initiatives and active collaboration between different actors in the community

SLOCAT partners engaged in dozens of initiatives on freight during 2020-2022, including:

- 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.[202]

- 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.[203]

- The **EcoLogistics** project of **ICLEI–Local Governments for Sustainability** promotes low-carbon urban freight policies and practices.[204] For example, in 2022 Rosario (Argentina) added 20 cargo bikes to its public bike sharing scheme, targeting merchants, entrepreneurs and workers in the city centre.[205]

- The **ICLEI–Local Governments for Sustainability** project EcoLogistics aims to advance effective regulatory, planning and logistical instruments to support low-carbon urban freight.[206] It currently supports cities in Argentina and Colombia to develop urban freight strategies and viable alternatives to low-quality, diesel- powered freight vehicles, particularly for last-mile logistics.[207]

- 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.[208] The signatories, representing around 5% of global medium- and heavy-duty vehicle sales, must report progress annually and develop plans to support their ambitions.[209]
- 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.[210] 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.[211]

- The **UN Conference on Trade and Development (UNCTAD)** helps emerging economies access the benefits of a globalised economy more fairly and effectively – through analysis, facilitating consensus building, and offering technical assistance – to help them use trade, investment, finance and technology as vehicles for inclusive and sustainable development.[212]

- A panoply of multi-stakeholder transport initiatives began to emerge at **COP 21 in 2015.** Inspired by the call to action by UN Secretary General Ban Ki-moon at the 2014 Climate Summit and followed up by the Lima Paris Action Agenda (LPAA), 15 transport initiatives established by non-state actors in the transport sector were showcased at COP 21.[213] At COP 22, the action agenda was renamed the Marrakech Partnership for Global Climate Action (MPGCA), and 11 more transport initiatives joined the initial core group of transport initiatives to engage in the UNFCCC via the MPGCA, covering both passenger and freight transport and touching on all transport sectors and modes. Together, these transport initiatives represented a broad range of multi-stakeholder coalitions for transport mitigation and adaptation; demonstrated on-the-ground transport actions that yield significant climate and sustainability impacts; and helped to scale up the ambition of NDCs in the sector.

- **At the 2022 UN Climate Change Conference in Sharm El-Sheikh, Egypt (COP 27), the COP 27 Presidency of Egypt launched an initiative on low-carbon transport for urban sustainability that aims to "activate systemic change beyond the legacy 'mode-first' mindset (i.e., focus on specific transport modes)".**[214] Among the 14 flagship initiatives of the COP 27 Presidency is the Low Carbon Transport for Urban Sustainability (LOTUS) initiative, which aims to activate systemic change to improve and decarbonise the urban mobility landscape, and specifically to scale up investment for electric vehicles and sustainable mobility infrastructure (led by the Institute for Transportation and Development Policy, the World Resources Institute and Smart Freight Centre).

- Additionally, during COP 27 the **Green Shipping Challenge** was initiated. Countries, ports and companies made more than 40 announcements under the Green Shipping Challenge, including an agreement between the Netherlands, Norway, the United Kingdom and the United States to establish green shipping corridors.[215]

Financing Sustainable Transport in Time of Limited Budgets

Infrastructure investment gaps

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.[216] 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.[217]

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.

Climate finance totalled USD 653 billion in 2019/20, with around a quarter of it (USD 169 billion) going to the transport sector.[218] 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.[219] 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.[220]

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.[221]

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.[222] 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.[223] 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.[224]

Global investment needs for transport infrastructure through 2050 are an estimated USD 50 trillion.[225] Reducing emissions through low carbon urban mobility would require investments totalling USD 1.83 trillion (around 2% of global gross GDP), which would result in estimated savings of USD 2.8 trillion in 2030 and nearly USD 7.0 trillion in 2050.[226]

2

Regional Freight Transport and Climate Change Trends

Africa

Freight transport in Africa faces a multitude of infrastructure and social challenges. The African Continental Free Trade Area (AfCTA) agreement, which came into force in 2019, is projected to increase intra-Africa trade demand 28%, leading to the additional need by 2030 for 2 million trucks, 100,000 rail wagons, 250 aircraft and more than 100 vessels.[227] The region faces low inter-regional and intra-African trade, poor inland road quality, inadequate port and rail capacity, and slow development in transport technologies – all of which have been exacerbated by the pandemic and by the Russian Federation's invasion of Ukraine.[228]

- In 2020, transport costs along the Northern Corridor freight route from Mombasa to Kampala increased 48% due to pandemic-related delays.[229]
- Border-crossing times increased from less than 24 hours in the first quarter of 2020 (pre-pandemic), to more than five or six days during the COVID-19 pandemic.[230]
- In 2022, South Africa ranked highest in Africa on the Freight and Logistics Performance Index, due to the country's efficient, well-integrated and intermodal transport system.[231]
- The Liner Shipping Connectivity Index value for Africa declined from 18 in 2020 to 17.6 in 2021, as shipping lines and carriers re-assigned ships to Asia and North America due to port congestion and COVID-19 pandemic related restrictions on workforces.[232]

Roads are the predominant mode of transport in Africa, carrying at least 80% of goods and around 90% of passengers.[233] Limited rail transport and the high costs of air transport leave road transport as the only practicable alternative for freight in most countries in Sub-Saharan Africa. The immense pressure on road networks, coupled with poor maintenance cultures, has resulted in sub-standard road conditions across the region.[234]

- Cameroon has 10 times more unpaved roads (50,000 kilometres total) than paved roads (5,000 kilometres); the country's roads are poorly maintained, with routes unpassable during the rainy season, leading to high transport costs and to long delays of freight goods due to truck diversions.[235]
- In Ghana, more than 97% of passenger and freight transport is by road.[236]

The Russian Federation's invasion of Ukraine has had major short- and long-term implications for the transport landscape in Africa.[237] The conflict occurred at a time when African countries were still struggling to recover from the destabilising effects of the COVID-19 pandemic.[238]

- In 2022, transport costs doubled in some African countries, such as Namibia, Nigeria and South Africa.[239] This was due to a global mismatch in supply and demand in shipping, port and inland capacity caused by pandemic-related declines and the subsequent rapid recovery in trade volumes.[240]

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. 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.**[241] A sustainable integrated transport system must be accessible to users of all income levels.

Asia

Decreased economic activity during the pandemic, followed by the Russian Federation's invasion of Ukraine, led to significant shifts in freight transport across Asia.[242] In some places, urban freight and logistics activity grew to take advantage of emerging trends, including increased online shopping and food deliveries.[243] Air cargo activity in the Asia-Pacific region fell 16% in March 2020 compared to March 2019, similar to declines seen in most world regions.[244] Air cargo volumes also fell nearly 16% in April 2022 compared to April 2021; the decline is attributed to the Russian Federation's invasion of Ukraine (as both countries have been key cargo handlers), to Chinese labour shortages, and to an overall reduction in export orders.[245] Still, the Asia-Pacific region had the highest share of the air cargo market globally in 2022, at 32.5%.[246]

- Port calls at the Chinese ports of Shanghai (the world's largest) and Yangshang fell 17% by January 2020 compared to one year earlier, which led to knock-on effects globally.[247] By May 2022, the port of Shanghai had rebounded to reach 95% of pre-pandemic activity.[248]
- Rail freight in Asia experienced mixed impacts during the pandemic, with China seeing a 24% increase in rail freight movement to Europe in the first quarter of 2020 compared to the first quarter of 2019, while India saw a 28% decline in domestic rail freight traffic in April-May 2020 compared to 2019.[249]
- Trade volumes between China and the Association of Southeast Asian Nations (ASEAN) region increased 28% in 2021, as the latter became China's biggest trading partner for the second year in a row.[250]

Estimates for 2015 indicate that CO_2 emissions from freight transport are slightly larger (around 55%) than from passenger transport in Asia.[251] The rising demand for road freight movement in the region is expected to further drive emissions.[252]

Some countries are setting transport-specific targets aimed s at improving the efficiency of the freight sector, ranging from reducing energy use to increasing efficiency and multi-modality.

- Since 2017, Vietnam has included in its NDC targets for changing freight transport models to address energy consumption.[253]
- In 2022, India launched its National Logistics Policy to improve the efficiency of the freight sector.[254]
- China issued a five-year work plan in 2022 to promote multi-modality in its freight sector.[255]

Policies focused on sustainable mobility have continued to expand in Asia, as more countries develop policy frameworks supporting low-carbon urban mobility, as well as freight transport. Zero-emission zones for freight transport (ZEZ-Fs) have been implemented in many Chinese cities, to advance zero-emission freight goals and reduce congestion.[256] In 2023, the Chinese cities Luoyang and Shenzhen expanded the ZEZ-Fs.[257] Policies focused on electric mobility, urban rail and active mobility have received greater importance in the region in recent years. Due in large part to policy support, particularly in China and to a lesser extent in India, Asia has the highest share of electric vehicles globally.[258]

Europe

From 2011 to 2021, the modal split in freight transport remained relatively stable in the EU, with some minor fluctuations and changes in share among modes: shares of maritime, rail and inland waterway transport decreased, and this trend continued through 2022.[259] The decline was due to factors including effects from the pandemic, shrinking demand for goods, changes in port congestion, higher freight costs, supply chain disruptions, increasingly competitive truck transport, and the decline in traditional customer industries for rail freight (such as coal and petrol).[260] **Meanwhile, the share of road freight increased slightly as it rebounded from the pandemic (with strong increases in 2021), and air freight transport remained stable.**[261]

The effects of the pandemic led to a 5% decline in containerised freight transport across Europe in 2020, following continuous increases over the previous decade.[262] In 2021, inland freight grew 15% in the region.[263] However, the market for new commercial road vehicles in the EU fell nearly 15% between 2020 and 2022 due to supply chain issues limiting the availability of vehicles.[264]

Maritime transport accounted for more than two-thirds (67.9%) of freight tonne-kilometres in the EU during 2011-2021.[265]

- Latvia registered the highest growth in maritime transport during this period (up 8.5 percentage points) followed by Estonia (up 6.0), while Sweden recorded the largest drop (down 5.9).[266]
- From 2011 to 2021, the share of inland waterways in total freight transport decreased in 11 of the 17 EU Member States for which this mode of transport is applicable.[267] The largest drop in the inland waterway transport share was in Luxembourg (down 3.2 percentage points), while slight increases were seen in the Slovak Republic (up 0.7 percentage points) and Finland (up 0.1).[268]
- The share of road transport in total EU freight transport peaked at nearly 25% in 2021, after rising by 0.6 percentage points from the previous year.[269] In 2021, the share increased the most in Romania (up 3.7 percentage points), while the largest decrease was in the Slovak Republic (down 3.4).[270]
- The share of rail in total freight transport dropped in Switzerland and in 16 of the 25 EU Member States that have railways during 2011-2021.[271] Latvia had the largest fall in rail's share during the decade (down 22.9 percentage points), followed by Lithuania (down 10.8).[272]
- The share of air transport in total freight transport remained relatively stable in all EU countries during 2011-2021.[273] The highest increases in the share of air in total freight transport were in Latvia (up 0.9 percentage points) and Luxembourg (up 0.6).[274]

In more sweeping action at the EU level, **in 2020, the European Commission released its Sustainable and Smart Mobility Strategy, which lays the foundation towards a green and digital transformation and more resiliency to future crises.**[275] The major targets on freight are for zero-emission vessels to become ready for market by 2030 and rail freight traffic to double by 2050.[276]

As part of the European Green Deal, the European Commission adopted four proposals in 2021 aimed at modernising the EU's transport system to support cleaner, smarter mobility.[277] Such proposals would put the transport sector on track to cut its emissions 90% by 2050, with plans to increase connectivity and shift more passengers and freight away from road transport to rail and inland waterways.

By 2022, several European countries had adopted policies and targets aimed at promoting or discouraging certain vehicle types or fuels, and many cities had designated low-emission zones to limit polluting vehicles and improve liveability. Almost all countries in the region had biofuel blending mandates and advanced biofuel targets, in addition to those set at the EU level.[278] (*See Section 4.1 on Transport Energy Sources.*)

- An increasing number of European cities have adopted low-emission zones, ultra-low emission zones, or zero-emission zones, including those targeting freight vehicles. **Active low-emission zones in the EU-27, the United Kingdom and Norway increased 40% between 2019 and 2022, with projections for an additional 58% growth by 2025, to reach a total of 507 zones** (particularly as related laws come into force in France, Poland and Spain).[279] (*See Section 3.1 on Integrated Transport Planning.*)

Specifically, for freight, the European Commission agreed in 2022 to include emissions from shipping in the EU Emissions Trading System.[280] **In early 2023, it adopted FuelEU Maritime, aimed at reducing the greenhouse gas emission intensity of shipping fuels 2% by 2025 and 80% by 2050.**[281]

Notable developments supporting sustainable transport systems also occurred outside the EU since 2020. In 2021, the UK government published its Transport Decarbonisation Plan, which includes a proposed target to ban the sale of heavy goods vehicles fuelled by diesel and petrol by 2040, with a similar target for light-duty vehicles by 2035.[282]

Latin America and the Caribbean

Road transport dominates freight transport in the region. A 2021 study found that in South America trucks account for around 85% of national and 30% of regional freight transport and logistics, and in Central America road transport accounts for nearly 100% of freight transport.[283] Data on performance are scarce due to the high diversity of operators, from a large number of small and informal enterprises to few large companies with a high degree of specialisation.[284] Heavy vehicles in the region have an average age of 15 years, and in several countries a large share of trucks are more than 20 years old.[285] Rail freight represents less than 3% of the region's overall freight transport.[286] **River and maritime transport account for 95% of international trade in the region, although inland waterways are poorly developed.**[287]

Cycling for first- and last-mile deliveries has increased in the region. Although this practice is deeply rooted in low-income segments as a source of informal employment, newer initiatives using cargo bikes or tricycles aim to reduce pollution and road congestion caused by freight transport and urban waste collection efforts, and to improve social inclusion.[288]

- In 2021, with support from the Development Bank of Latin America (CAF) and Germany's GIZ, Fortaleza (Brazil) launched the Re-ciclo project, which donates electric tricycles to wastepicker associations to replace their heavy carts and to test the tricycles for urban logistics purposes.[289]
- Between December 2020 and May 2022, with the support of the World Bank, Bogotá (Colombia) carried out the BiciCarga project with businesses of different sectors, which implemented a distribution scheme using electric cargo bikes. The project aimed to assess the necessary requirements for the sustainability of this distribution model.[290]
- With support from ICLEI-Local Governments for Sustainability, Rosario (Argentina) added 20 cargo bikes to its public bike sharing scheme in 2022, targeting merchants, entrepreneurs and workers in the city centre.[291]

Transport emissions relative to economic output were higher in Latin America and the Caribbean than in any other region except Africa in 2021, at 1.07 tonnes of CO_2 per USD 10,000, and were above the global average of 0.77 tonnes of CO_2 per USD 10,000 in 2021.[292] **This may be due to the dominance of road freight transport and to the absence of more cost-effective and energy-efficient modes such as rail and shipping across the region.**[293]

Strategic plans, financial incentives and regulatory elements have emerged in the region to promote the electrification of road transport, many to facilitate the acquisition or operation of electric vehicles.

- In 2022, Paraguay presented its Master Plan for Multimodal Electric Mobility for Public and Logistic Transport, which lays out a roadmap to 2040 that includes quality criteria and programmes to introduce electric vehicles in public and freight transport.[294]

Argentina, Brazil, Chile and Mexico all have programmes to improve the energy efficiency of freight transport and reduce its emissions, with a focus on innovative technologies and cutting fuel use.[295]

- In 2018, Chile implemented Giro Limpio, a voluntary programme that seeks to certify and recognise efforts by transport companies to improve their energy and environmental performance. As of July 2021, the programme involved 180 carriers accounting for 15% of Chile's transported cargo, 462 million litres of diesel consumption and 1,313,080 tonnes of CO_2-equivalent emissions.[296] The programme aims to reduce 32 million litres of diesel use and avoid 91,000 tonnes of CO_2-equivalent emissions, and seeks to reach 10% of the national truck fleet by early 2024.[297]
- In 2021, Chile and Argentina began harmonising the regulations of Giro Limpio and Transporte Inteligente, Argentina's own freight transport energy efficiency programme.[298]
- Chile launched the programme Vuelo Limpio in November 2021 to improve the energy efficiency of air transport (goods and passengers), with the participation of three airlines and an air taxi company.[299]
- Mexico's voluntary programme for cargo transport companies, Programa Transporte Limpio, reported 718 participating companies as of December 2022 and a total of 7 million tonnes of avoided CO_2 in 2021.[300]

North America

Despite the COVID-19 pandemic, freight activity in the US surpassed 5,250 billion tonne-miles in 2020, declining only for railroads (down 11%) and water transport (down 5%).[301] In Canada, freight statistics show that rail activity increased 2% during 2015-2020, but between 2019 and 2020 the number of tonne-kilometres travelled fell from 455 billion to 423 billion.[302]

US transport emissions have gradually shifted from passenger transport towards freight transport. Between 2015 and 2020, the share of US transport sector emissions originating from light-duty vehicles fell from 60% to 57%, while the share from medium- and heavy-duty trucks grew from 23% to 26%.[303] In Canada, road transport (light-duty vehicles and trucks) was the major contributor to emission growth until 2019, but this sub-sector experienced the greatest decline in 2020.[304]

The US Infrastructure Investment and Jobs Act of 2021 (also known as the Bipartisan Infrastructure Law) allocates USD 550 billion in new infrastructure investment from 2022 through 2026.[305] It represents the largest ever long-term investment in infrastructure in the United States and promises to provide significant improvements to transport.[306]The US Departments of Energy, Transportation, and Housing and Urban Development, together with the Environmental Protection Agency, signed a Memorandum of Understanding on transport decarbonisation in September 2022, followed by the release of the first US National Blueprint for Transportation Decarbonisation in January 2023.[307] The comprehensive strategy encompasses actions to increase convenience (through land use and planning), improve efficiency (through expanding public transport and rail and improving vehicle efficiency) and transition to clean vehicles (zero-emission vehicles).[308] It supports the target in the US Nationally Determined Contribution of reducing CO_2 emissions 50-52% below 2005 levels by 2030 and the target of net zero carbon emissions by 2050.[309]

The US Department of Transportation also published a notice for USD 1.5 billion in grant funding for the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) programme through 2023, including both at regional and local scales.[310] In 2022, the RAISE programme funded 166 freight and passenger transport projects across 50 states, along with the District of Columbia, Puerto Rico, the Northern Mariana Islands and the US Virgin Islands.[311]

Oceania

The Russian Federation's invasion of Ukraine further threatened the region's economic recovery, as disruptions affected shipping and freight corridors through the Pacific.[312]

- In the first 24 weeks of 2020, overall shipping activity in Oceania fell 12.3%, the second largest decline globally after Europe.[313] Passenger maritime transport fell 18% in the first half of the year.[314] Oceania also was among the most impacted regions for maritime freight (along with Africa), as container ship calls fell 12.4% in the beginning of 2020.[315]
- International aviation to and from Oceania started to rebound in 2022, but as of the beginning of the year international flights were still 40% below pre-pandemic levels.[316]
- By 2022, Australia and New Zealand surpassed the average for the Asia-Pacific region in recovery rates for airline capacity for international travel compared to 2019.[317] Fiji led small-island countries in the return to near pre-pandemic aviation activity by 2022.[318]

Australia continued to be the largest emitter of transport CO_2 in the region and the 17th largest emitter globally in 2021, releasing more than 84 million tonnes.[319] This was due largely to the continued reliance on passenger vehicles with high fuel consumption, as well as energy-intensive road freight.[320]

During 2021 and 2022, countries in Oceania, including small-island states, enacted policy measures to enable and support electric vehicle uptake and to improve fuel efficiency standards.

- In 2021, Australia released its Future Fuels and Vehicles Strategy, backed by the AUD 250 million (USD 170 million) Future Fuel Funds to support charging infrastructure and commercial fleet transitions.[321] Australia's consultation for a National EV Strategy began in September 2022 to define goals, objectives and actions to enable Australians to access the best transport technologies and help meet emission reduction targets.[322]
- In 2022, the Australian government doubled the existing investment in the Driving the Nation Fund, allocating AUD 500 million (USD 340 million) to support electric vehicle charging infrastructure for highways, as well as hydrogen highways for key freight routes.[323] In 2022, Australia passed Electric Car Discount legislation that exempts eligible electric cars from the fringe benefits tax and import tariffs.[324]

Freight system improvements are under way in Australia. Through the Inland Rail Project, a 1,600-kilometre freight rail project, was initiated in 2018 and is anticipated to be complete by 2027 to service the country's freight demands and to shift more goods to rail. This priority infrastructure project is supported by USD 14.5 billion in funding from the Australian government, with the rest from the Australian Rail Track Corporation (ARTC), grants and public-private partnerships.[325]

Since 2019, Australia has increased its ambition on alternative fuels, such as hydrogen and sustainable aviation fuels.

- Australia established a Sustainable Aviation Fuel (SAF) Council in October 2022, modelled on the United Kingdom's Jet Zero Council.[326] Australia's flag carrier, the Qantas Group, is committed to using 10% SAF by 2030 and achieving net zero emissions by 2050.[327]
- Australia's National Hydrogen Strategy 2019 sets out actions for building the hydrogen industry and considers transport as a key potential use sector.[328]
- The country's National Freight and Supply Chain Strategy 2019 sets an agenda for co-ordinated and well-planned government and industry action across all freight modes over the next 20 years and beyond.[329] The emphasis is on economic objectives and building Australian competitiveness; some decarbonisation could occur through operational efficiencies and inter-modality, but no targets for freight decarbonisation have been set.[330]

Climate action in New Zealand is being realised through comprehensive planning approaches, active mobility and support for public transport at the national and local levels.

- New Zealand's Decarbonising Transport Action Plan 2022-2025 sets out four transport targets to support the goal of reducing transport emissions 41% below 2019 levels by 2035: 1) reduce total kilometres travelled by the light fleet 20% by 2035 through improved urban form and providing better travel options, particularly in the largest cities; 2) increase zero-emission vehicles to 30% of the light fleet by 2035; 3) reduce emissions from freight transport 35% by 2035; and 4) reduce the emissions intensity of transport fuel 10%.[331]
- In 2022, Auckland Council's Environment and Climate Change Committee adopted the Transport Emissions Reduction Pathway, to support and enable Te Tāruke-ā-Tāwhiri's required 64% reduction in transport emissions.[332]

The NDCs submitted by Oceania countries under the Paris Agreement as of 2022 offer a wide-ranging set of climate change mitigation and adaptation activities. The NDCs of Pacific islands target improvements in shipping.

- Kiribati intends to develop a national maritime action plan and to introduce small and efficient freight and passenger ships;
- The Federated States of Micronesia will update existing vessels with renewable energy power sources and secure additional vessels for transport between islands and for emergency response operations;
- Solomon Islands will promote renewable and energy efficient technologies for water and land transport.[333]

Spotlight - Transport Adaptation, Resilience and Decarbonisation in Small Island Developing States

SIDS are highly dependent on maritime and air transport, although road transport is the dominant transport mode in terms of fuel use.[334] Transport modes vary among SIDS depending on the country's size, location and main economic activities. In general, SIDS rely heavily on transport for tourism. For nearly two-thirds of SIDS, the tourism sector represents more than 20% of the GDP, and this share reaches 58% in Palau and 65% in the Maldives, underscoring the importance of maintaining the sector's resilience.[335]

For many SIDS, land transport accounts for the bulk of imported fuel use, followed by electricity generation and maritime transport. [336] **Thus, phasing out fossil fuels in these sectors is the main lever for both reducing emissions and increasing energy security** (through greater resilience to price spikes). Strategies identified for SIDS to decarbonise transport are largely similar to those for decarbonising urban and land transport systems in other regions (*see Section 3.1 Integrated Transport Planning*). [337] However, strategies in SIDS also must include integrated planning for inter-island transport, greening of ports and maritime and aviation operations, use of small boats for coastal travel, a regional approach to aviation services, and adoption of low-emission aviation and shipping technology.[338]

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

- In 2020, the Marshall Islands set the objectives of reducing domestic shipping emissions 40% by 2030 and fully decarbonising the sector by 2050.[339]
- The Marshall Islands, Kiribati and the Solomon Islands have been influential within the IMO in advocating for scaled-up ambition in decarbonising shipping.[340]

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

- Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) has administered the Regional Pacific NDC Hub to support Pacific Island countries in reviewing, enhancing and implementing their climate commitments, including helping to identify opportunities to bring the transport sector to the fore and connect climate ambitions at the national and local levels.[341] This hub is implemented in partnership with the Global Green Growth Institute, the Pacific Community, and the Secretariat of the Pacific Regional Environment Programme, and served 14 member countries as of early 2023: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Palau, Papua New Guinea, Nauru, Niue, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.
- From 2017 to 2023, GIZ supported the Marshall Islands in reducing emissions and transitioning to energy efficient transport in the maritime sector through the Transitioning to Low Carbon Sea Transport project.[342]
- The Global Green Growth Institute has supported the SIDS within its membership – Fiji, Kiribati, Papua New Guinea, Tonga and Vanuatu – in pursuing a low-carbon development approach while also promoting increased resilience.[343]
- Implemented by the IMO and funded by the EU, the Global Maritime Technology Cooperation Centre's (MTCC) Network Project was established in 2017 and extended to March 2022, with the objective of supporting least developed countries and SIDS in particular to improve energy efficiency and decrease emissions in the shipping sector.[344]

3

Selected Climate and Sustainability Responses in Freight Transport

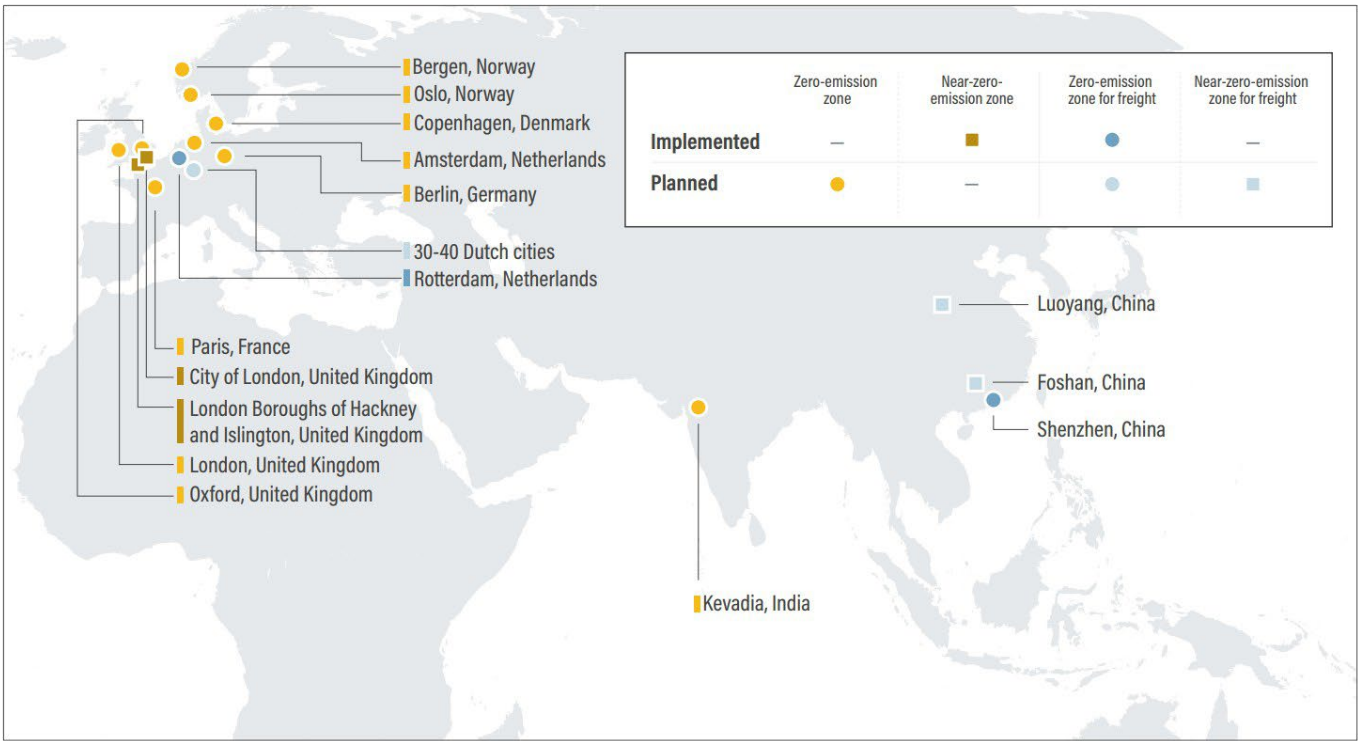
This section provides a selection of climate and sustainability interventions which have been implemented in the freight transport sub-sectors and modes. These have been presented in a mode-based approach including integrated transport planning, cycling, informal transport, rail, shipping, aviation and road transport. It is not an overview of all the measures being implemented nor a comprehensive list of possible measures.

Integrated Transport Planning

Many urban areas have adopted and piloted access regulations, zero-emission zones and clear air zones to reduce emissions and improve air quality. Several cities have established specific zero-emission zones for freight transport (ZEZ-Fs), ranging from urban delivery vans to medium- and heavy-duty trucks (*see Figure 20*).[345]

- The zero-emission zone in Oslo (Norway), scheduled to enter into force in 2023, commenced with a "Car-Free City Life" area where pedestrians and cyclists have priority over private cars; the measure is set to expand to other areas of the city by 2026.[346]
- Jakarta (Indonesia) began implementing a low-emission zone pilot project in the Kota Tua Tourism Area in early 2021, addressing air quality, safety and social inclusion issues.[347] 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.[348]
- A ZEZ-F pilot in Shenzhen (China), implemented in 2018 to cover 22 square kilometres (1.1% of the total city area), applies to light-duty trucks and was scheduled to expand in July 2023.[349] 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.[350]
- 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.[351]
- The Netherlands announced in 2021 that it was aiming to implement ZEZ-Fs in 30-40 of the country's largest cities by 2025.[352] As of 1 January 2025, any city in the Netherlands would be permitted to designate areas as a ZEZ-F.[353]

Figure 20. Implemented and planned zero-emission zones and variants as of July 2022



Source: See endnote 345 for this section.

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.[354] In an integrated transport system, the arrangement of transport infrastructure is key to ensuring access[355], and improving access and mobility is key for poverty reduction and increased participation in economic and social activities.[356] 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.[357] Rather, prioritising measures that lead to avoiding unnecessary trips and shifting to more sustainable modes can maximise emission reductions and wider sustainability benefits.[358]

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.[359] Similarly, sustainable urban logistics plans (SULPs) focus on city-level logistics to achieve sustainable freight operations in overall urban mobility planning.[360] 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.[361]

Table 2 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.[362] Many of these indicators are discussed below, based on data availability.

Table 2. Selected indicators for sustainable, integrated transport systems

	Economic	Social	Environmental
Most important (should usually be used)	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
	Average freight transport speed and reliability	Overall transport system satisfaction rating (based on objective user surveys)	Air and noise pollution exposure and health impacts

Cycling

Cargo bikes are increasingly recognised globally as a more both 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.[363]
- 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.[364]
- 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.[365]
- 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.[366]
- In a UK study, cargo bikes resulted in cost savings of 80-90% compared to using commercial vans.[367]
- FedEx aims to expand its fleet of e-cargo bikes in the United Kingdom as its moves towards a zero-emission delivery service.[368]
- 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.[369]
- 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.[370]
- 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.[371]

Informal Transport

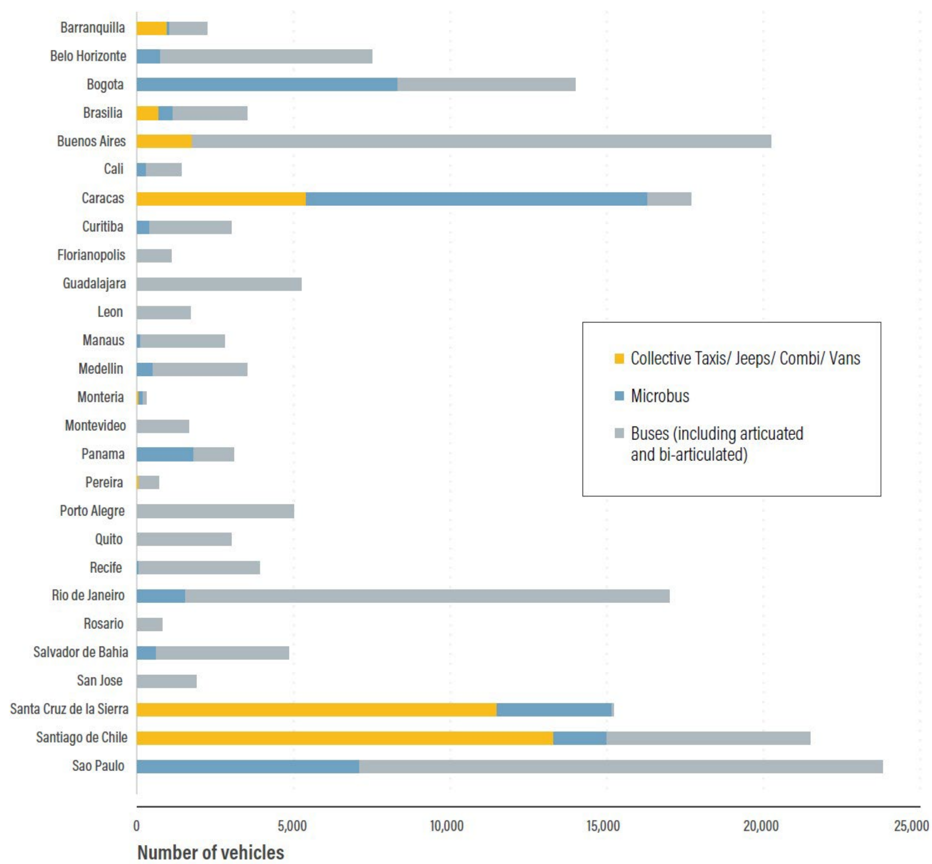
Informal transport services are among the most common urban mobility systems globally. They are present in nearly every city and town in low- and middle-income countries and even in the underserved fringes of cities in high-income countries.[372]

In some African cities, up to more than 95% of all passenger and freight motorised trips are made using informal transport.[373] However, there is a knowledge gap in the split of passenger and freight in the informal transport sector.

People in Asian cities rely heavily on informal transport, with the modal share for these services reaching up to 58% in selected cities.[374]

In many Latin American and Caribbean cities, more than half of all trips taken via shared transport are provided by informal transport services, which have varying names and modes .[375] 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 or on the fleet numbers available to meet existing demand.[376] **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 21*).[377] Studies to explore the motivations behind the use of informal transport in the region found that 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 also provide passenger transport in rural areas where road access is limited.[378]

Figure 21. Motorised collective transport vehicle fleets in different cities in Latin America and the Caribbean, 2020



Source: See endnote 377 for this section.

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.[379]

Two- and three-wheelers are major modes for informal transport. In Africa, 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.**[380] The largest fleets are in West and East Africa.[381]

Electrification efforts for two- and three-wheelers 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.[382] **Most sales of electric two- and three-wheelers are in Asia (especially in China, India and Vietnam), and the vehicles are projected to continue to be the largest electrified road transport fleet globally.**[383]

- 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.[384]
- 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.[385]
- 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.[386]
- 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.[387] The electrification of two- and three-wheelers has contributed nearly half (45%) of China's total emission reductions from vehicle electrification.[388]
- In 2021, sales of electric two- and three-wheelers reached 230,000 in Vietnam and nearly 300,000 in India.[389] By 2018, almost 40% of India's three-wheeler fleet was electric.[390]
- 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.[391]
- 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.[392]

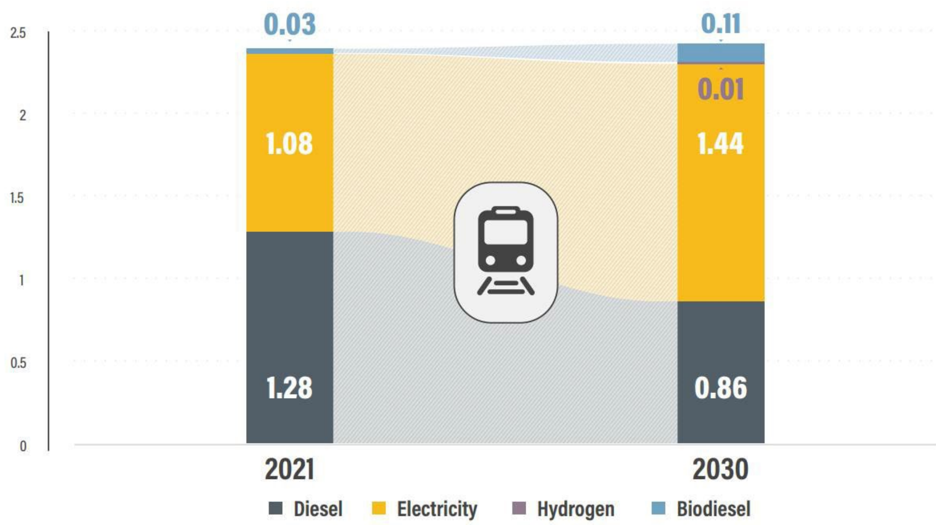
Informal transport can also be found in high-income countries, although to a far lesser extent. When such services are linked to the use of technology or digital platforms, they either are part of government-supported pilots or services, or are quickly regulated under categories such as app-based mobility, demand-responsive transport, ride-hailing or mobility-as-a-service.

Rail

Between 2010 and 2020, rail lines globally were extended by nearly 50,000 kilometers (4.7%) to reach 1.1 million kilometers, although very little growth occurred outside of Asia.[393] **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.**[394]

Rail is the most electrified mode of transport, with around 45% of its energy use coming from electricity in 2021.[395] In 2021, global energy use for rail was spilt roughly evenly between diesel fuel (1.22 exajoules) and electricity (1.03 exajoules), with a small contribution from biodiesel *(see Figure 22).*[396] 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.**[397] In Europe, the electricity share was already close to 60% as of 2021.[398] **In 2021, freight rail consumed four times more energy than passenger rail.**[399]

Figure 22. Energy use in the rail sector by source, 2021 and projections for 2030

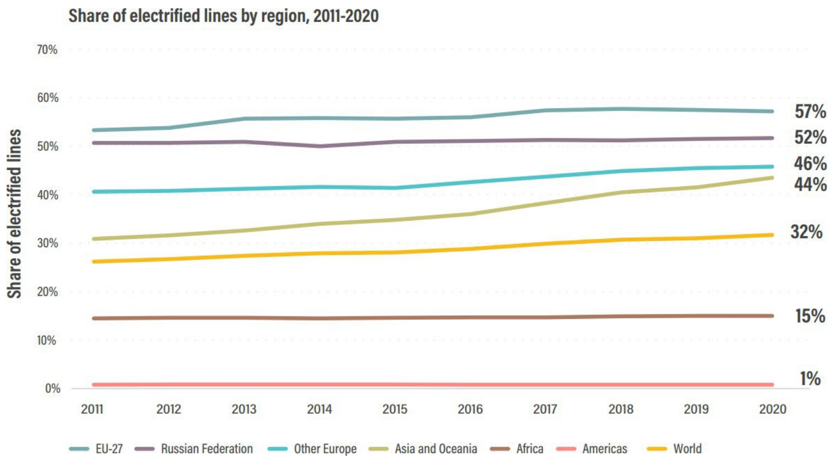


Source: See endnote 396 for this section.

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 23*).[400]

- 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).[401]
- Romania has allocated EUR 3.9 billion (USD 4.2 billion) from 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.[402]
- Scotland's Rail Services Decarbonisation Action Plan aims to decarbonise passenger rail by 2035 through significant rail electrification, a large-scale mode shift to rail, and some battery or hybrid trains.[403]

Figure 23. Share of electrified rail lines by region, 2011-2020



Source: See endnote 400 for this section.

Because trains are large energy consumers, decarbonising the electricity grid using 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 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.[404]
- Indian Railways is working with partners to install and connect new renewable power generation facilities, including solar farms that directly feed rail traction power.[405]

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.[406]

- The world's first hydrogen-powered train, the Coradia iLint developed by Alstom, began serving passengers in 2018.[407]
- 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.[408]
- Romania plans to modernise its rail with the acquisition of 12 hydrogen-powered electric trainsets and 55 upgraded electric locomotives.[409] 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.[410]

Road Transport

Since 2020, a rise in the global average price of oil has led to higher fuel prices, affecting overall transport costs (*see Figure 24*). [411] **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. [412] **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.** [413] **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***). [414]

- 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. [415]
- 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. [416] However, industry analysts expect prices to remain well above their recent five-year average of USD 60 per barrel. [417]

Figure 24. Average crude oil price globally, 2011-2022

Source: See endnote 411 for this section.

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. [418]

- In 2022, the EU's Fit for 55 package called for an effective ban on the sale of internal combustion engine cars by 2035. [419] 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. [420]
- 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. [421]

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.[422]

- As of 2022, just five countries – Canada, China, India, Japan and the United States – had fuel economy standards that apply to heavy-duty vehicles.[423] No additional countries have adopted such standards since 2017.[424]
- In 2022, the United States finalised its strongest ever national standards to reduce emissions from heavy-duty trucks, starting with the 2027 model year.[425] 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.[426]
- 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.[427]

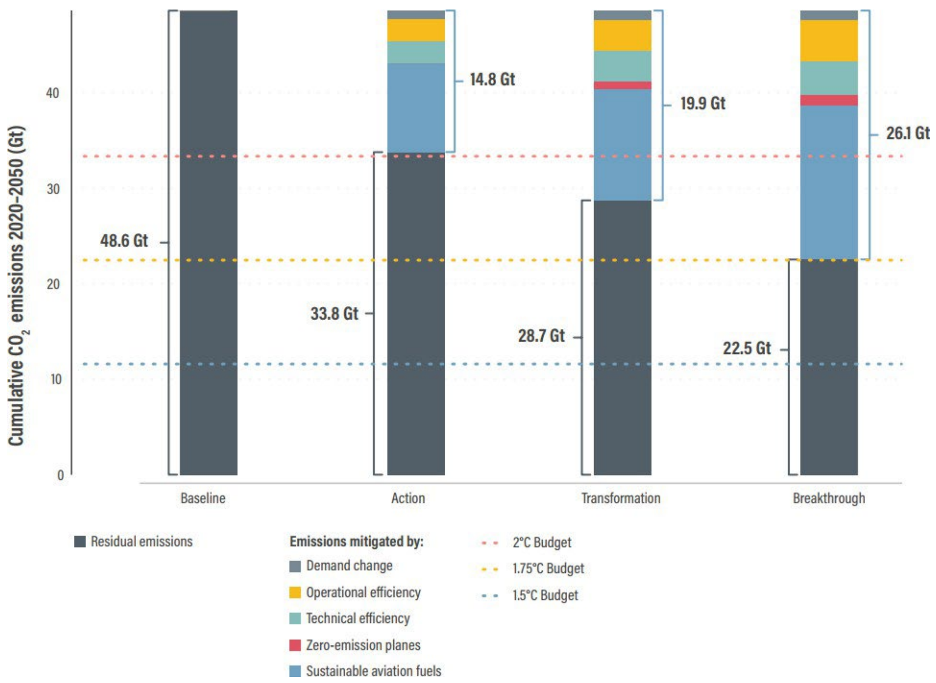
Aviation

Electric aircraft development has accelerated in numerous countries, spawning new partnerships among established passenger and freight transport providers and emerging technology companies.[428] 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.[429] 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.[430]

- 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.[431]
- In 2021, DHL Express announced an order of 12 all-electric cargo planes from Eviation, an emerging US-based manufacturer.[432]
- Norway set a target in 2018 for all short-haul flights to be electric by 2040.[433] The first electric plane prototypes were announced in 2022 and were expected to begin commercial operation by 2028.[434]

By scaling up sustainable aviation fuel (SAF), aviation's CO_2 emissions could fall 9% to 94% below 2019 levels by 2050, improving operational efficiency and powering aircraft with liquid hydrogen.[435] SAF offers the largest mitigation potential, contributing around 60% of the emission reductions under various decarbonisation scenarios (*see Figure 25*).[436] Improvements in the operational and technical efficiency of aircraft represent 33% of the reduction potential, while the use of hydrogen accounts for 4-5%.[437]

Figure 25. Scenarios for CO_2 emission mitigation from aviation, 2020-2050

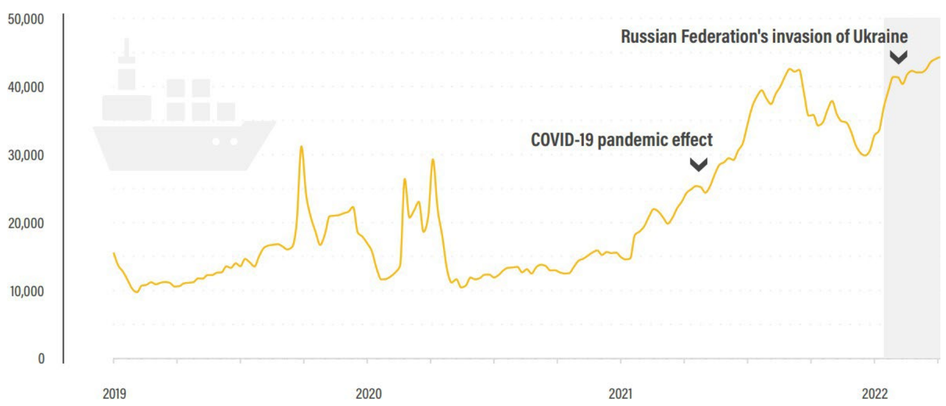


Source: See endnote 436 for this section.

Shipping

Since mid-2020, higher shipping costs have been driven by events such as the COVID-19 pandemic and the Russian Federation's 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.[438] The average fuel surcharge by container shipping lines rose nearly 50% during this period (*see Figure 26*).[439]

Figure 26. Rising costs of shipping, 2019 to mid-2022 (in USD per day)

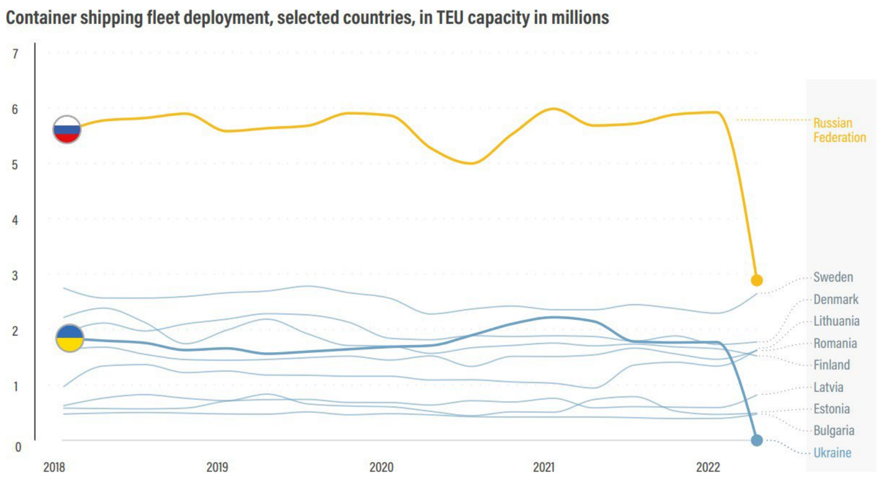


Source: See endnote 439 for this section.

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.[440] 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.[441]

In vulnerable regions that depend highly on maritime transport, such as SIDS, consumer prices could increase up to 8.1% between 2021 and 2022, according to the UN Conference on Trade and Development (UNCTAD).[442] 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 27*).[443]

Figure 27. Container shipping fleet deployment of selected countries (by capacity in 20-foot equivalent units), 2018 to mid- 2022



Source: See endnote 443 for this section.

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.[444] 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.[445]

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.[446] 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.[447] 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.[448]

In 2023, the IMO adopted a revised strategy to reduce greenhouse gas emissions from international shipping.[449] The 2023 IMO greenhouse gas strategy aims to:

- to reduce greenhouse gas emissions from international shipping to at least 70% below 2008 levels by 2040, and striving for 80%;
- 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.[450]

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 is non-binding and remains insufficient to support the carbon budget in a scenario of keeping global temperature rise below 1.5°C.[451]

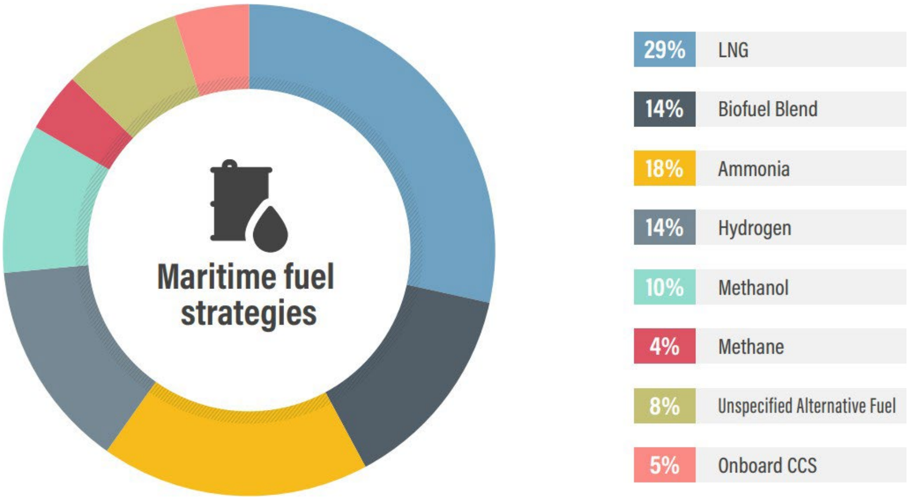
The revised IMO strategy does not directly enforce a carbon price for maritime shipping despite earlier IMO working group meetings giving hope for such an economic levy, which was seen as a breakthrough by many Parties to the Paris Agreement.[452] After more than a decade of contention, countries seemed 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.[453] The revised strategy features the possibility of a carbon price as a potential mid-term measure for reducing greenhouse gas emissions.[454]

- 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.[455]
- The Marshall Islands and Solomon Islands have proposed a carbon price of USD 100 per tonne on shipping fuels.[456]
- Maersk, the world's largest container shipping company, has proposed a price of USD 150 per tonne to accelerate use of low-carbon fuels. [457]

A global carbon price on maritime shipping would create further incentives to accelerate development of biofuels, wind propulsion and battery-electric vessels.[458] A global carbon pricing regime could build on lessons learned from the EU's Emissions Trading Scheme, which includes international shipping emissions.

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.[459] **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.**[460] Companies with pledges have higher levels of reported emissions disclosure and related decarbonisation actions *(see Figure 28)*.[461]

Figure 28. Proportion of fuel strategies in industry commitments on maritime shipping decarbonisation, as of 2022



Source: See endnote 461 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.[462]

- 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.[463]
- 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.[464]

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*).[465] 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.[466]

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.[467] 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.[468] **Maritime shipping has been identified as one of the "hard-to-abate" sectors targeted under the Mitigation Work Programme adopted in 2022.**[469]

Emissions from international shipping continue to be outside the scope of countries' NDCs towards reducing emissions, due to a lack of clarity in the Paris Agreement.[470] 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.[471] 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.[472]

- 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.[473]
- China aims to increase the share of railways and waterways in freight activity and to expand its use of zero-emission vessels.[474]
- Micronesia intends to update vessels to increase ship efficiency, embed renewable energy as a power source and add more vessels for response operations.[475]
- 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.[476]

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 Federation's invasion of Ukraine poses novel challenges to decarbonisation of the shipping industry, which requires additional financial, technical and policy support for widespread implementation of low-carbon measures.[477]

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.[478] Wind propulsion has been a niche solution as shipping companies have failed to bear the full environmental and societal costs of burning fossil fuels.[479]

- 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%.[480]
- 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%.[481]
- 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.[482]

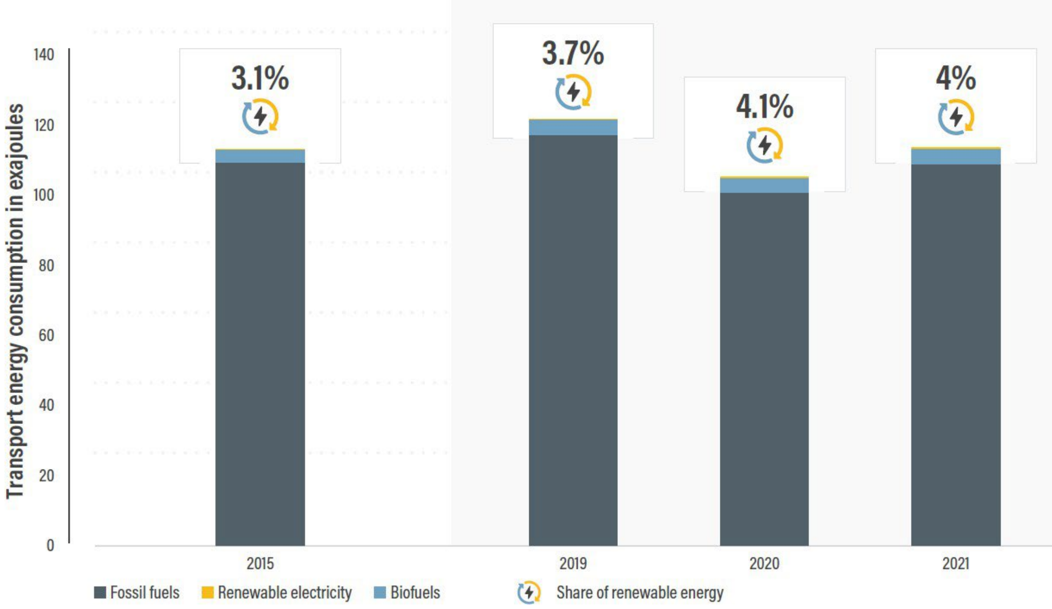
Battery-electric propulsion is emerging as a low-emission option for the marine shipping sector, due to its considerable potential for emission reduction.[483] Advantages of battery-electric vessels include improvements in battery energy storage, increasing availability of renewable electricity, and 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.[484]
- 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.[485]
- 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.[486]

Transport Energy Sources

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%.[487] 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 29*).[488]

Figure 29. Energy consumption in transport, by energy source, 2015, 2019 to 2021



Source: See endnote 488 for this section.

The average specific fuel consumption (fuel use per 100 kilometres) has been declining.[489] These improvements have been slowed by a trend towards increasing vehicle size and weight.[490] **In particular, the increased popularity of SUVs and trucks poses a huge challenge to reducing energy consumption and emissions in the sector**[491].

In road transport, direct use of electricity is most efficient from an energy perspective, where this is technically and logistically feasible. *However, t*he share of diesel among all oil products used in road transport increased from 39.1% to 45.5% between 2000 and 2020.[492] **This trend is driven largely by rising demand for freight transport, which is mostly diesel-powered.** If fossil fuel-powered road freight continued, this will influence the future demand for biofuels. The share of natural gas used in transport increased from 3.6% to 4.5% between 2015 and 2021.[493] Natural gas consumption for trucks and buses remained stable over this period.[494]

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.[495] **The main policies supporting biofuels are blending mandates set by countries.**[496]

Hydrogen can play a role whenever direct electrification is impossible.[497] **Hydrogen is considered plausible for road transport (for use in heavy-duty vehicles for long distances) and for aviation and shipping.**[498] Although fuel cell electric vehicles are less efficient than battery electric vehicles, they could be an option for reducing emission from heavy-duty vehicles in the medium term.[499] However, most fuel cell vehicles (82%) were light-duty vehicles as of 2021.[500] 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).[501] As of 2020, green hydrogen was at least three times more expensive to produce than grey hydrogen.[502]

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).[503]

- 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.[504]
- 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).[505]
- New Zealand adopted a new procurement requirement in 2022 that requires all public transport buses purchased starting in January 2025 to be zero emissions.[506]
- 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.[507]
- 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).[508]

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.[509]

Electric Vehicles

The number of electric medium- and heavy-duty trucks increased 19% in 2022 to 322,000 vehicles.[510] 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.[511]

- 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.[512]
- 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.[513]
- 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.[514]
- 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.[515]

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.[516]

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.[517]

Endnotes

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