ITF Transport Outlook 2021

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Foreword

The Covid-19 pandemic has dramatically affected our daily lives and challenged the way we work, travel and live. It has created unprecedented challenges not least to the transport sector, with unheard-of limitations to the movement of people and goods.

At the same time, the pandemic has underscored and brought to universal attention the critical role the transport sector plays in ensuring the safe and timely delivery of vital goods and movement of essential workers to continue providing the services that our societies cannot function without.

How the pandemic will change the mobility of people and the transport of goods over the longer term is still very much uncertain. Governments are stepping in with force to mitigate the havoc it has wrought for public transport, aviation, rail and many other services that in normal times ensure the smooth movement of people and goods.

A quick recovery is firmly in our crosshairs at the moment, and rightly so. Yet we must not lose sight of our vision for transport's future: a transport system that is sustainable, and sustainable in a broad economic, social and environmental sense. For one thing, climate change will not be stopped without decarbonising transport, and that transformation must now happen.

The recovery from the pandemic offers a unique opportunity to reshape the transport sector in that vein. Well-targeted and purposefully designed recovery measures should be aligned towards a triple objective: revive the economy, combat climate change and strengthen social cohesion of our societies. Aligning policies to that end will require greater collaboration between all stakeholders and breaking down silos to overcome the barriers that stand in the way of the urgent progress that the world needs. This report examines which policies can achieve these ambitions together.

Young Tae Kim

Secretary-General
International Transport Forum

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The International Transport Forum is an intergovernmental organisation with 63 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

The Members of the Forum are: Albania, Armenia, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China (People's Republic of), Colombia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kazakhstan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Republic of Moldova, Mongolia, Montenegro, Morocco, the Netherlands, New Zealand, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, the United Arab Emirates, the United Kingdom, the United States and Uzbekistan.

Table of contents

Foreword 3

Acknowledgements 4

Reader's guide 10

Executive summary 14

1 Reshaping transport for a cleaner environment and fairer societies 17

In Brief 18
Inequality and climate change: The twin challenge 19
Transport and well-being: The underrated link 22
Transport CO_2 emissions: Significant and growing 22
Tackling emissions and inequality together 24
Shaping tomorrow's transport: The pandemic as a reset? 28
The human dimension: Catering for diversity in transport 33
The economic dimension: Recovery under uncertainty 39
Key takeaways 44
References 45

2 Pathways to decarbonise transport by 2050 53

In Brief 54
Recover, Reshape, Reshape+: Three possible futures for transport 55
Transport demand: Growth continues 60
Transport emissions and climate goals: Can we still get there? 67
Transport emissions and social equity: Who pays for decarbonisation? 72
Key takeaways 75
References 76

3 Urban passenger transport: Cities can make mobility sustainable, equitable and resilient 78

In Brief 79
Decarbonising urban passenger transport: The state of play 81
Mastering the pandemic: Challenges and opportunities for urban mobility after Covid-19 85
Recover, Reshape, Reshape+: Three possible futures for urban passenger transport 90
Demand for urban travel: Managing mobility in growing cities 95

CO_2 emissions from urban mobility: Improved services, smaller carbon footprint 100
Equity and well-being: Accessible cities and resilient networks 109
Policy recommendations 117
References 120

4 Non-urban passenger transport: A pivotal sector for greening transport 129

In Brief 130
Decarbonising non-urban passenger transport: The state of play 131
Mastering the pandemic: Challenges and opportunities for non-urban mobility after Covid-19 135
Recover, *Reshape*, *Reshape+*: Three possible futures for non-urban passenger transport 139
Demand for non-urban passenger transport: Quick recovery and continued growth 144
CO_2 emissions from non-urban passenger transport: Decoupling emissions from demand 150
Fair decarbonisation: Reducing non-urban passenger emissions in equitable ways 155
Policy recommendations 158
References 160
Note 164

5 Freight transport: Bold action can decarbonise movement of goods 165

In Brief 166
Decarbonising freight transport: The state of play 169
Mastering the pandemic: Challenges and opportunities for freight after Covid-19 175
Recover, Reshape, Reshape+: Three possible futures for freight transport 181
Demand for freight: Substantial growth at a slower pace 186
CO_2 emissions from freight transport: Reversing emission growth 193
Equitable freight decarbonisation: Avoiding regional imbalances 199
Policy recommendations 204
References 207

Annex A. Statistical Annex 212

FIGURES

Figure 1.1. CO_2 emissions of individual emitters by top 10%, middle 40% and bottom 50% 21
Figure 1.2. Global CO_2 emissions from fuel combustion by end-use sector 23
Figure 1.3. The relevance of transport for the United Nations Sustainable Development Goals 25
Figure 1.4. Global Covid-19 impacts on travel for users of Apple devices 29
Figure 1.5. Urban population by world region 35
Figure 1.6. Gender ratio by world region 36
Figure 1.7. Population distribution in world regions by age 39
Figure 1.8. Development of primary commodity price indices, 2010-20 43
Figure 2.1. Summary of sector-specific measures and assumptions by scenario 59
Figure 2.2. Elasticity of transport demand with respect to GDP growth under different scenarios 62
Figure 2.3. Global demand for passenger transport by sub-sector to 2050 63
Figure 2.4. Demand for passenger transport by world region to 2050 64
Figure 2.5. Global demand for freight transport by mode to 2050 65
Figure 2.6. Demand for surface freight transport by world region to 2050 66
Figure 2.7. Projected demand for maritime freight transport by world region to 2050 67
Figure 2.8. Three scenarios for future transport CO_2 emissions 68
Figure 2.9. CO_2 emissions for urban passenger, non-urban passenger and freight transport to 2050 69
Figure 2.10. Transport CO_2 emissions by world region to 2050 70
Figure 2.11. The impact of different post-pandemic recovery paths on transport CO_2 emissions in 2050 71
Figure 2.12. Per-capita transport CO_2 emissions and GDP by world region to 2050 73
Figure 3.1. CO_2 emissions per capita of urban passenger transport in 2015 82

Figure 3.2. Mode share of urban passenger CO_2 emissions by world region in 2015 85
Figure 3.3. Demand for urban passenger transport by mode to 2050 97
Figure 3.4. Mode shares for urban trips of different length in 2050 98
Figure 3.5. Demand for urban passenger transport by world region to 2050 99
Figure 3.6. Per capita demand for urban passenger transport by world region to 2050 100
Figure 3.7. CO_2 emissions from urban passenger transport by mode to 2050 102
Figure 3.8. Evolution of tank-to-wheel vs. well-to-tank CO_2 emissions from urban passenger transport to 2050 103
Figure 3.9. CO_2 emissions from urban passenger transport by world region in 2050 105
Figure 3.10. Per capita CO_2 emissions from urban passenger transport by world region in 2050 106
Figure 3.11. Pollutant emissions from urban passenger transport by world region to 2050 108
Figure 3.12. Potential accessibility improvements for public transport and car travel in different world regions by 2050 110
Figure 3.13. Resilience of urban transport systems by world region in 2050 116
Figure 4.1. Evolution of world air passenger traffic, 2010-19 133
Figure 4.2. Demand for non-urban passenger transport by sub-sector to 2050 145
Figure 4.3. Mode shares for non-urban passenger transport to 2050 146
Figure 4.4. Demand for non-urban passenger transport by world region to 2050 149
Figure 4.5. Per capita demand for non-urban passenger transport by world region to 2050 150
Figure 4.6. CO_2 emissions from non-urban passenger transport by sub-sector to 2050 151
Figure 4.7. Evolution of tank-to-wheel vs. well-to-tank CO_2 emissions from non-urban passenger transport to 2050 152
Figure 4.8. CO_2 emissions from non-urban passenger transport by world region to 2050 154
Figure 4.9. Per capita CO_2 emissions for non-urban passenger transport by world region to 2050 155
Figure 5.1. Freight transport demand and emission trends 168
Figure 5.2. Development of total maritime freight demand, 2000-18 169
Figure 5.3. Development of global airfreight traffic 2011-17 170
Figure 5.4. Surface freight demand by transport mode, 2016-19 171
Figure 5.5. Import-related freight transport by type of goods to 2050 187
Figure 5.6. Import- and export-related freight transport by world region in 2050 188
Figure 5.7. Freight activity by world region to 2050 189
Figure 5.8. Freight activity by transport mode to 2050 190
Figure 5.9. Global freight flows in the network by mode, 2015 191
Figure 5.10. Variation in freight flows between 2015 and 2050 192
Figure 5.11. CO_2 emissions from freight activity by transport mode in 2030 and 2050 194
Figure 5.12. Carbon intensity of freight by transport mode to 2050 195
Figure 5.13. CO_2 emissions from surface freight transport by world region in 2050 196
Figure 5.14. CO_2 emissions from maritime freight transport in 2050 197
Figure 5.15. CO_2 emissions from import- and export-related freight transport by world region to 2050 198
Figure 5.16. Evolution of tank-to-wheel/wake vs. well-to-tank CO_2 emissions from freight transport to 2050 199
Figure 5.17. Freight connectivity by world region, 2015 200
Figure 5.18. Changes in freight costs for exports by world region 201
Figure 5.19. Container freight rates 2011-20 203

TABLES

Table 1.1. Potential challenges and opportunities for decarbonising transport post-Covid-19 32
Table 1.2 Compound annual growth rate of urban populations 35
Table 1.3. GDP growth projections in world regions remain uncertain 40
Table 1.4. GDP growth rates used in ITF models for select regions and countries 41
Table 1.5. World merchandise trade 42
Table 1.6. Projected world merchandise trade by region 42
Table 2.1. Policy scenarios modelled in the ITF Transport Outlook 2021 57
Table 3.1. Potential challenges and opportunities for decarbonising urban transport post-Covid-19 86
Table 3.2. Summary of urban model updates 91
Table 3.3. Scenario specifications for urban passenger transport 93
Table 4.1. Potential challenges and opportunities for decarbonising non-urban transport post-Covid-19 138
Table 4.2. Summary of non-urban passenger model updates 140
Table 4.3. Scenario specifications for non-urban passenger transport 142

Table 5.1. Potential challenges and opportunities for decarbonising transport post-Covid-19 179
Table 5.2. Summary of freight model updates 182
Table 5.3. Scenario specifications for freight transport 184

Reader's guide

How to read the *ITF Transport Outlook 2021*

<table>
<tr><td>Chapter 1
Reshaping transport for a cleaner environment and fairer societies</td><td>Understand the broader theme of this Transport Outlook:
Introduces the realities of climate change and inequality, and the role of transport in both.
Recommends three policy priorities for equitable and sustainable transport systems, policy alignment, collaboration and a focus on accessibility.
Summarises the short and long-term impacts of Covid-19 on transport. Covered in more detail in Chapters 3 to 5
Population trends including urbanisation, gender and ageing
Economic trends including GDP growth and trade, and the assumptions made in the ITF models</td></tr>
<tr><td>Chapter 2
Pathways to decarbonise transport by 2050</td><td>An overview of modelling results
Presents an aggregate summary of transport demand, CO_2 emissions and equity considerations under the three policy scenarios across all policy sectors</td></tr>
<tr><td>Chapter 3
Urban passenger transport: Cities can make mobility sustainable, equitable and resilient</td><td rowspan="3">A detailed look at an equitable and sustainable transition for each transport sector. Topics covered include:
The state of decarbonisation in the sector and key strategies for the future
Impacts of Covid-19 on the sector in the short term, and the opportunities and challenges ahead
Details on the policy scenarios for the specific chapter
Projections for transport activity under policy scenarios
Projections for CO_2 emissions (and local pollutants in Chapter 3) under policy scenarios
The equity impacts of the policy scenarios and a discussion on making sure decarbonisation policies are equitably implemented
Policy recommendations</td></tr>
<tr><td>Chapter 4
Non-urban passenger transport: A pivotal sector for greening transport</td></tr>
<tr><td>Chapter 5
Freight transport: Bold action can decarbonise movement of goods</td></tr>
</table>

Glossary

The following table defines key terms used in the *ITF Transport Outlook 2021* including transport modes, transport policy measures and exogenous factors considered in each of the policy scenarios, scenario definitions and more.

Term	Definition
3D printing	An additive printing technology that creates 3D products through the successive addition of very thin layers of material.
Active and micromobility	In the context of this *Transport Outlook,* walking, cycling, scooters and all forms of e-micromobility that are privately owned or shared.
Active transport modes	Travel undertaken by foot, bicycle or other human-powered modes.
Air connectivity	Refers to the density, extensiveness, and directness of destinations in a transport network.
Autonomous vehicle	A vehicle operated by a driving system that either assists or replaces humans in the driving task. Automation can be of different degrees according to the portion of the operations the driving system can conduct without human intervention.
Biofuel	Fuels that are directly or indirectly produced from organic material, i.e. biomass, such as plant materials or animal waste. In this publication, biofuel refers to liquid biofuels, such as ethanol or biodiesel.
Car	A road motor vehicle, other than a moped or a motorcycle, primarily designed to carry one or more persons. This includes SUVs and is equivalent in the text to passenger light-duty vehicles (PLDVs).
City	Used as a generic term to designate all urban agglomerations. The boundaries of a city in the Transport Outlook tend to go beyond administrative boundaries (see *Functional urban area*).
Congestion	The relative travel time-loss at the peak traffic hour on the road network due to slower travel speeds.
Direct emissions	Tank-to-Wheel/-Wake emissions.
Eco-driving	Driver training whereby drivers are trained to adopt a more fuel-efficient driving style.
E-commerce	The sale or purchase of goods or services, conducted over computer networks by methods specifically designed to receive or place orders.
Freight transport demand/activity	A measure of the volume of freight travel, measured in tonne-kilometres.
Functional urban area (FUA) or macro FUA	Macro FUAs are aggregations of FUAs defined by the joint EC-OECD Cities in the World project and identified in the UN DESA World Urbanization Prospect 2018 project (United Nations, 2019; OECD/European Commission, 2020).
Gig economy	Work characterised by short-term contracts and freelance work. For example, in the transport sector, drivers in the app-based ridesharing and delivery industry are considered gig workers.
Indirect emissions	Well-to-tank emissions as well as those associated with the construction of infrastructure, manufacturing of vehicles etc.
Inter-city travel	Transport activity happening between cities/urban areas.
Local pollutants	Elements of ambient air pollution, including emissions of mono-nitrogen oxides (NO_x), sulphate (SO_4) and fine particulate matter ($PM_{2.5}$).
Mobility as a service (MaaS)	Digital platforms that enable demand-responsive route optimisation across modes, including dockless micro-mobility modes.

Term	Definition
Mode	Refers to the method of transport service. E.g. road, rail, waterway, air or private car, powered two-wheelers, bus, metro, or urban rail.
Mode split/mode share	Percentage of total passenger-kilometres or trips accounted for by a single mode of transport. Values should specify whether mode split/share is calculated based on trips of passenger-kilometres. Percentage of total freight tonne-kilometres accounted for by a single-mode.
Motorcycle	Powered two-wheeled vehicles, motorcycles and scooters, equivalent in this text to two-wheelers.
New Policies Scenario	The New Policies Scenario serves as the IEA baseline scenario. It takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be determined.
Paratransit	Public transport-like services operating under unclear regulatory frameworks. Paratransit is more common in developing countries where they serve a significant role in the transport system, operating in parallel to formal services. The term is also used in the United States and Canada to mean on-demand transport services, typically used by the elderly or those with mobility restrictions who find it difficult to use fixed-route systems. However, these services are not included in the Transport Outlook's definition of paratransit.
Passenger transport demand/activity	A measure of the volume of passenger travel, measured in passenger-kilometres.
Passenger-kilometres (pkm)	Unit of measurement for passenger transport activity representing the transport of one passenger over a distance of one kilometre.
Physical Internet	An open, shared global logistics system. It takes asset sharing and collaboration to its maximum potential. It is one global transport network using shared hubs. Such a system would require new standardised modular-packaging units, common protocol and tools, and shared logistics and digital assets.
Private vehicles	Private motorised vehicles including motorcycles and cars.
Public transport	Public transport services served by bus, metro, tram, and rail.
***Recover* scenario**	The least ambitious policy scenario modelled in this *Transport Outlook*. *Recover*, our current trajectory, includes existing commitments for decarbonisation and assumes governments prioritise economic recovery by reinforcing established economic activities.
Regional travel	Transport activity happening outside urban areas (rural, peri-urban areas).
***Reshape* scenario**	An ambitious policy scenario modelled in this *Transport Outlook*. *Reshape*, assumes a strong set of decarbonisation policies, characterised by pro-active policy action which responds to environmental challenges in the transport sector and supports the United Nations Sustainable Development Goals (UN SDGs).
***Reshape*+ scenario**	The most ambitious policy scenario modelled in this *Transport Outlook*. The *Reshape*+ scenario further reinforces some of the policies of *Reshape* based on opportunities for decarbonisation presented by the pandemic, such as encouraging certain trends and changes in travel behaviour. It enables the world to reach climate change mitigation goals faster and with more certainty.
Shared mobility	In the context of this *Transport Outlook,* this includes taxis, taxi-buses, and ridesharing. The modelled shared mobility results do not include shared micromobility (see 'active and micromobility').
Shared transport	If discussing both together, shared mobility and shared vehicles are sometimes referred to as shared transport.

Term	Definition
Shared vehicles	Shared ownership schemes for cars and motorcycles.
Slow steaming	Slow steaming is reducing the speed to decrease fuel consumption, saving costs and cutting emissions. Mostly discussed in the context of maritime transport, but it can be generalised to other non-urban freight transport modes.
Tank-to-wheel emissions	Emissions generated from the use of transport vehicles. Also known as tailpipe emissions. It does not include well-to-tank emissions, which make up part of the total emission pathway (well-to-wheel).
Teleworking	Carrying out work at a location that is remote from the employer's office while staying connected to the office via network technologies.
Three-wheeler	Powered three-wheeled vehicles, such as auto-rickshaws in India.
Tonne-kilometres (tkm)	Unit of measurement of goods transport which represents the transport of one tonne of goods over a distance of one kilometre.
Trade regionalisation	Current developments might indicate a more regionalised trade system in the future with increased trade exchanges within regions or trade blocks and a relative decrease of longer distance intra-regional trade. Emerging economies have gained a larger share in global trade and increasingly trade with each other. One of the major trends in trade policy is the continuous increase in preferential trade agreements at a regional level. Especially in Asia, intra-regional trade has increased in relative and absolute terms. For example, the share of Chinese exports directed to emerging and developing Asian countries has grown considerably in the last decade, accelerating in the most recent years.
Transit-oriented development	A dense development with access to public transport within walking distance and characterised by a mix of residential, employment, commercial and other uses.
Two-wheelers	Powered two-wheeled vehicles, motorcycles and scooters; equivalent in this text to motorcycles.
Vehicle-kilometre	A unit of measurement for freight and passenger transport demand that represents the movement of a single vehicle over a distance of one kilometre.
Well-to-tank emissions	Emissions generated from the production and transport of fuel (or another energy source such as electricity) for transport vehicle use.
Well-to-wheel emissions	The total emissions associated with transport vehicle use. Including well-to-tank (indirect) and tank-to-wheel (direct) emissions.

Executive summary

Background

The *ITF Transport Outlook 2021* presents scenarios for global transport demand over the next three decades to 2050. It covers passenger and freight transport and all transport modes. The scenarios include detailed projections for transport's CO_2 emissions under different conditions, allowing an assessment of the potential impacts of future transport activity on climate change.

This edition analyses the impact of the Covid-19 pandemic on transport systems and their role in social equity and human well-being. The scenarios model potential long-term changes caused by the pandemic and link them to challenges and opportunities for decarbonising transport. The *Transport Outlook* identifies policy actions that are critical to ensure an effective and equitable transition to sustainable mobility on an urban, regional and global level in the wake of the pandemic.

Three different scenarios were modelled. The *Recovery* scenario represents the world's current efforts, extrapolated to 2050. The *Reshape* scenario assumes governments will implement ambitious decarbonisation policies beyond those currently in place. In the *Reshape+* scenario, governments in addition leverage opportunities for transport decarbonisation created by the Covid-19 pandemic.

Findings

Total transport activity will more than double by 2050 compared to 2015 under the trajectory reflecting current efforts. Passenger transport will increase 2.3-fold. Freight transport will grow 2.6-fold. Total demand growth is slower than projected in the previous *Transport Outlook* edition, when a trifold increase was expected. The slower demand growth over the coming decades reflects less optimistic projections for economic growth and new decarbonisation commitments made in 2018/19. Future transport demand will reflect the uncertain path of recovery after the Covid-19 pandemic, which makes robust projections difficult. Continuing economic development and a growing world population will translate into more demand for transport overall, however.

Current transport decarbonisation policies are insufficient to pivot passenger and freight transport onto a sustainable path. CO_2 emissions from transport will increase by 16% to 2050 even if today's commitments to decarbonise transport are fully implemented. The expected emissions reductions from these policies will be more than offset by increased transport demand.

By contrast, more ambitious transport decarbonisation policies could reduce transport CO_2 emissions by almost 70% in 2050 compared to 2015. Such a reduction would bring the goal of the Paris Agreement to limit global warming to 1.5˚C into reach. It would require more and better-targeted actions to reduce unnecessary travel, shift transport activity to more sustainable modes, improve energy efficiency, and rapidly scale up the use of electric vehicles and low-carbon fuels.

Cities could cut their CO_2 emissions from urban mobility by as much as 80% compared to 2015 levels under ambitious decarbonisation agendas. Their high density of people, services and infrastructure puts cities in a frontline position to shift to low- or zero-emission transport options and implement effective demand management that could avoid 22% of urban transport activity compared to the current trajectory.

Regional and inter-city passenger transport is difficult to decarbonise. Yet by 2050, its CO_2 emissions could be less than half of those in 2015 with the right policies. Managing demand for air travel, longer car trips or regional rail travel is more challenging than for urban mobility. Measures to shift demand to sustainable modes where possible, enhanced vehicle efficiency and improved fuel technologies must all play a role in reversing the growth trend of non-urban passenger emissions.

The strong growth of freight activity calls for an increased focus on decarbonising goods transport. Freight's absolute CO_2 emissions will be 22% higher than 2015 by 2050 under current policies and its share of all transport emissions will continue to grow, albeit slowly. By contrast, absolute freight emissions could be 72% less than 2015 with policies to boost freight consolidation, enhance collaboration in supply chains, advance standardisation, and promote low-carbon technologies across the sector.

Encouraging behavioural change and harnessing stimulus packages for economic recovery from the pandemic to fast track the decarbonisation of transport will greatly accelerate the transition to sustainable mobility. Linking economic recovery with transport decarbonisation would bring the climate goals of the Paris Agreement within reach faster and with more certainty.

Decarbonisation policies should not put disproportional burdens on some citizens. Implementing policies carefully to avoid negative distributional effects is essential. Less well-off groups and regions bear most of the costs of climate change and the negative externalities created by the mobility choices of more prosperous parts of the population. Climate action should not make the vulnerable worse off, but aim to enhance social equity. A strong focus on improving accessibility will help to achieve both: making mobility more efficient and thus less emitting, and making it easier for citizens to access opportunities.

Policy insights

Align Covid-19 recovery packages to revive the economy, combat climate change and strengthen equity

In the wake of the pandemic, transport policies should pursue a threefold objective: aiding economic recovery, reducing harm to the environment and ensuring fair and equitable societal outcomes. Aligning these goals will build public support for such significant interventions. It will also make them more cost effective and easier to implement fast. Recovery from the Covid-19 crisis offers a singular chance to combine economic development with shifting mobility behaviour and scaling up low-carbon technologies, while increasing opportunities for citizens by improving access through better mobility solutions.

Implement much more ambitious policies that will reverse the growth of transport CO_2 emissions

Transport CO_2 emissions will continue to rise under current policies, not fall. A growing world population and increasing prosperity create new transport demand that will outstrip projected emissions reductions. The right policies can break the link between economic growth and transport emissions, however. Such policies will create incentives to avoid unnecessary travel, shift mobility to sustainable transport options, and improve vehicle technologies and alternative fuels. In the 2021 revision of the Nationally Determined Contributions under the Paris Agreement, governments must set ambitious targets, underpin them with concrete policies, and reinforce them by leveraging Covid-19 recovery packages to accelerate and deepen transport decarbonisation.

Target different transport sectors with strategies that reflect their specific decarbonisation potential and challenges

Different parts of the transport sector require different approaches to decarbonisation. Not all strategies to "avoid, shift, and improve" are applicable across the sector in the same way. Urban passenger transport can employ all three approaches to drastically reduce emissions by shortening travel distances, offering non-motorised options and achieving high user volumes on public transport. Decarbonising regional and intercity transport, in turn, will rely more on technological improvements, as demand for non-urban transport is difficult to manage. Freight transport can best reduce demand and emissions through low-carbon technologies, consolidation of loads, shorter supply chains and rapid digitalisation and standardisation of processes and technologies.

Support innovation to accelerate the technological breakthroughs needed to decarbonise transport

Technological advances are critical to effectively decarbonise transport, especially in otherwise hard-to-decarbonise areas. Reducing energy consumption of motorised travel requires investment in cleaner vehicles and fuels. Increasing the price of carbon-intensive transport will encourage a shift to low-carbon alternatives. Investing in charging infrastructure for road transport will increase consumer confidence in zero-emissions vehicles, and purchase subsidies can accelerate the transition by making clean mobility more affordable. Digital innovation will help the more efficient operation of public transport, other shared mobility services and freight logistics.

Shift the priority to improving accessibility

Shifting the focus of policy from increasing mobility to improving accessibility will better deliver on several goals, from climate change mitigation to sustainable development and human well-being. Transport planning tends to conflate increased capacity with improved accessibility. Yet travelling more and further does not mean citizens have easy access to where they need to go. Transport planning that serves citizens considers their desired destinations and focusses on how well transport options connect them.

Intensify collaboration with non-transport sectors and between public and private actors

Transport decarbonisation is inseparable from developments in other sectors. Most notably, sustainable mobility is only possible with clean energy production. A green electricity grid is crucial so electric vehicles can be truly emissions-free. In turn, low-carbon transport is central to sustainable trade and tourism. Digitalisation of transport services offers opportunities for more efficient routing, shared use of assets and better data to inform decisions. Close co-operation between governments and private actors in new mobility markets is imperative to maximise the social benefits of new services and minimise external costs. Finally, integrating land-use decisions and transport planning can reduce transport demand while improving accessibility for citizens.

1 Reshaping transport for a cleaner environment and fairer societies

This chapter examines transport's role in climate change and social inequality. It explores the impacts of Covid-19 on this and how to turn recovery into an opportunity for advancing decarbonisation and inclusion. It also explores global population trends and the changes in demographics that will influence the future needs of transport users. It recognises that policies set today under an uncertain economic outlook will profoundly affect the lives of future generations.

In Brief

Pandemic recovery must focus on cleaner and more equitable transport

A significant misalignment exists between incomes and climate change contributions made by individuals and countries. Those that contribute the least to climate change are those with the lowest economic opportunities and suffer most from its impacts. The health and economic consequences of Covid-19 exacerbate these disparities.

Transport is inextricably linked to the most critical issues of our time. It contributes considerably to people's well-being: it enables access to goods, services and social networks that support a good quality of life. At the same time, the negative externalities of transport, notably CO_2 emissions, are a growing concern for climate change. The Nationally Determined Contributions (NDCs), which outline countries' commitments under the Paris Agreement, are currently not on track to achieve the agreed outcomes. An ambitious revision is needed, with transport-specific actions.

A holistic transport policy agenda is vital to meeting the Paris Agreement and supporting the United Nations Sustainable Development Goals. An approach that tackles both transport inequality and decarbonisation in the post-pandemic era requires that:

- Transport policies **align** economic recovery, environmental mitigation and equity to ensure public support, cost-effectiveness and implementation within a realistic timeline;
- Transport policies shift from a mobility-focussed model to **accessibility-focussed** policies that seek to improve citizens' access to their needs;
- Transport **collaborates** more closely with other sectors such as energy, manufacturing, tourism, trade, Information and Communications Technology (ICT) and others. Public sector policy makers must also cultivate closer relationships with land-use planners and private sector transport service providers.

Future transport decisions must be made in the context of pandemic recovery and a very uncertain economic outlook for an increasingly urbanised world with ageing populations in many regions. The Covid-19 pandemic has resulted in unprecedented challenges and changes to transport activity. Cities came to a standstill as lockdowns were imposed worldwide. International travel dropped to record lows as borders closed. Freight transport had to adapt swiftly to keep essential goods flowing across borders. The transport sector adapted with initiatives to support essential workers in the fight against the coronavirus. Many transport workers became frontline staff, continuing to operate services at high risk to themselves.

As the world enters the recovery phase, there are many challenges to rebooting the transport sector. However, there are also unique opportunities to leverage changed behaviours observed during the pandemic and design economic stimulus packages that reshape the transport sector to support a more sustainable and inclusive future.

As the world responds to the human tragedy and economic crisis triggered by the Covid-19 pandemic, the long-term challenges of climate change and inequality loom ever larger on the horizon. Environmental and equity considerations are paramount as we strive for sustainability in a time of economic uncertainty.

This holds especially true for transport.

Transport is inextricably linked to both climate change and inequality. Mobility plays an integral role in determining the quality of our lives. Its dependence on fossil fuels also makes it a major contributor to climate change, however. Transport was responsible for 25% of direct CO_2 emissions from fuel combustion in 2018 (IEA, 2020[1]). *Climate change contributes to inequality in many ways. In addressing it, governments should ensure the most vulnerable do not have to bear further social costs. An equitable transport system improves the well-being of all its users by providing access to opportunities and distributing the costs fairly.*

Governments today have a unique opportunity to reduce transport emissions and increase transport equity by putting these two goals at the heart of their economic recovery strategies. The ITF Transport Outlook 2021 provides an evidence base to inform policy decisions, which can support this twin ambition. It aims to underpin an equitable mobility transition to a more sustainable and resilient transport system that is economically viable, politically feasible and centred on human well-being.

Inequality and climate change: The twin challenge

The causes and impacts of climate change are unequally distributed between developed and developing nations and between the wealthy and poor. The responsibility to take action and reduce emissions, therefore, is also not evenly shared. A fair transition (based on a polluter pays principle) calls on the largest cumulative emitters to bear a greater share of costs. Climate action should also ensure that those who are most vulnerable are, at the very least, not worse off: environmental and equity considerations must be at the heart of a transition to sustainable mobility.

The gap between rich and poor is at its highest level in 30 years within many countries, though economic inequality between countries has decreased in relative terms or stayed roughly constant (OECD, 2015[2]; United Nations, 2020[3]; Hasell, 2018[4]). More than 70% of the world population live in countries with growing inequality (United Nations, 2020[3]). In OECD countries, the top 10% of the population earned 9.6 times more than the poorest 10% in 2015. This ratio was seven in the 1980s and has been growing since. The declining incomes of the bottom 40% of the working population are of even more concern; so is the decline of the middle class in every generation since the baby boomers (OECD, 2015[2]; OECD, 2019[5]).

Rising income inequality has held back economic development. The OECD estimates that it has reduced cumulative gross domestic product (GDP) growth by 4.7 percentage points between 1990 and 2010 on average in its member countries (OECD, 2015[2]). Even where GDP has grown, this has not translated into rising living standards for median and lower-income earners (OECD, 2020[6]).

In parallel, climate change has emerged as the central global challenge. In response to global warming, the international community committed to limit the increase in global average temperatures to "well below 2˚C above pre-industrial levels" in the 2015 Paris Agreement and to "pursue efforts" to limit the rise to 1.5˚C. To this end, the signatories agreed to submit national climate action plans, known as nationally determined contributions (NDCs).

Countries now have a singular opportunity to enhance ambitions and detail climate actions that align with the 1.5˚C objective

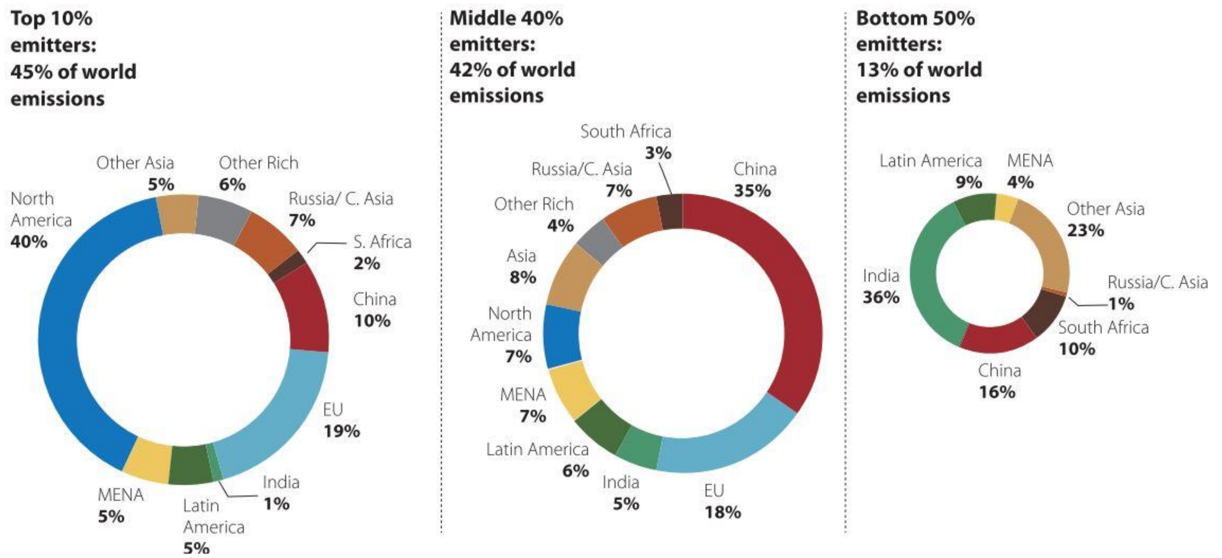
The stakes in the race against rising global temperatures are increasing. The latest data show that global CO_2 emissions continue to grow (IEA, 2020[7]). At the same time, new scientific evidence, notably in a 2018 special report by the Intergovernmental Panel on Climate Change, has highlighted the potentially drastic impact of global warming above 1.5˚C (IPCC, 2018[8]). Even the full implementation of the current NDCs, which are non-binding, would result in an average temperature increase of 3˚C or more (WRI, 2020[9]). The Paris Agreement requires countries to submit revised NDCs every five years. In 2020/21, countries have a singular opportunity to enhance ambitions and detail climate actions in the revised NDCs that align with the 1.5˚C objective.

The realities of economic inequality and climate change are closely intertwined. The causes and consequences of climate change are inequitably distributed. While the causes are linked to consumption by wealthier nations and individuals, the consequences affect developing nations more than developed countries and poorer citizens more than the wealthier ones within each country. Women are also impacted more than men, especially in developing nations: 80% of people displaced by climate change are women (UNDP, 2016). Those that face the worst consequences of climate change are the least responsible for causing it and have the least resources to cope with the harm – a “double injustice” (Gough, 2011[10]).

Global warming is responsible for an increase in income inequality of approximately 25% between countries over the past 50 years, compared to a scenario without anthropogenic warming (Diffenbaugh and Burke, 2019[11]). The gap results from years of decline in economic output in hotter and poorer countries most affected by rising temperatures and concurrent increases in many wealthier nations in cooler climates. Developed nations benefit disproportionately from the fossil fuel-based activities that cause climate change (Diffenbaugh and Burke, 2019[11]), the consequences of which – such as more frequent natural disasters – deepen existing fault lines of economic and social inequality (UNDP, 2019[12]).

The emissions divide between rich and poor is apparent between countries, but especially so between individuals. Emission inequalities between countries have decreased due to the growing carbon footprint of the upper and middle class in developing nations. Within countries, emission-related inequality is rising, however. By 2015, inequality in CO_2 emissions within countries accounted for 50% of the global distribution of CO_2 emissions, while in 1998, it only contributed to one-third (Chancel and Piketty, 2015[13]). The top 10% of individual emitters in the world contribute to 45% of total global emissions, while the bottom 50% contribute 13% of emissions (Figure 1.1) (Chancel and Piketty, 2015[13]). A look at air travel, one of the most CO_2-intensive transport modes, makes these inequalities more apparent: only 11% of the world’s population travelled by air in 2018, and only around 4% took longer distance international flights. More than half of total aviation-related emissions are the responsibility of an affluent minority of not more than 1% of the global population (Gössling and Humpe, 2020[14]).

Figure 1.1. CO_2 emissions of individual emitters by top 10%, middle 40% and bottom 50%



Note: The figure shows that 45% of world CO_2 emissions are generated by 10% of the population. Of these individuals, 40% are from North America, 19% from the EU, and 10% from the People's Republic of China. Likewise, the bottom 50% of the population that generate the least, are responsible for just 13% of world CO_2 emissions. Of the lowest emitters, 36% are from India and 23% from other Asian countries. The remaining 42% of emissions are generated by the middle 40% of the population.
Source: Chancel and Piketty (2015[13]), *Carbon and inequality: from Kyoto to Paris*, http://piketty.pse.ens.fr/files/ChancelPiketty2015.pdf

Meaningful cuts in greenhouse gas emissions will inevitably require action by developed countries. As the largest cumulative emitters and also those with the greatest technological capacity and capital, these countries have both the greatest responsibility and the necessary means to address climate change (Thorwaldsson, 2019[15]) and, beyond that, implement the UN Sustainable Development Goals (SDGs).

Emission-reduction measures should also target where they will make the largest impact for the least cost. Investments in sustainability by developed nations should not be limited to their own countries. The social and economic benefits that accompany investments in technologies and green initiatives justify supporting action in developing nations as well. This will require technology transfers to narrow the gap between countries' access to existing technologies and capital (Kosolapova, 2020[16]). In the transport sector, tangible improvements to issues like air pollution, congestion, and safety, accompany progressive decarbonisation agendas and offer significant local benefits while also reducing global CO_2 emissions.

Economic inequality and climate change are closely intertwined. With its call for urgent and drastic climate action, the IPPC also emphasises the centrality of social justice and equity for any pathway to sustainable development (IPCC, 2018[8]; IPCC, 2018[17]). To reflect this linkage, international agreements and national policy agendas should focus on equitable decarbonisation policies which align with goals of social inclusion and sustainable development more broadly. At the international level, countries need to take responsibility for their CO_2 emissions. Each country's share of the world's total carbon footprint should also be distributed between communities and households fairly (CSER, 2018[18]). At a minimum, decarbonisation must ensure the most vulnerable are not left worse off. At their most ambitious, climate change mitigation policies can improve access for citizens and enhance the resilience of transport systems, if the distributional impacts of decarbonisation measures are addressed.

Transport and well-being: The underrated link

All citizens need transport to access goods and services and to facilitate social interactions**.** Our societies are built upon transport networks. They enable people to go to work and earn an income, to attend school and improve their opportunities in life, to see friends and relatives, to access health care, to go to the library, swimming pool, or park. The supply of essential goods, from food to medicine, depends on efficient, reliable logistics operations. Well-connected transport allows our social and professional networks to span the globe and provide an indispensable lifeline for remote communities.

Transport is inextricably linked to individual and collective well-being. Being mobile does not in itself improve the human condition; it is when mobility provides the means of access to a desired destination (ITF, 2019[19]). Many definitions and operationalisations of transport equity exist. This *Transport Outlook* considers equity from the perspective of accessibility to human needs such as goods, services, and social networks, as well as the equitable distribution of the benefits and costs of transport.

An equitable transport system allows everyone to satisfy their needs, irrespective of income, age, gender, or disabilities. The absence of an equitable transport system marginalises certain groups. Accessibility includes both the availability of opportunities (or destinations) for individuals and the availability of safe and affordable transport options to connect the individual to these opportunities, based on financial resources, mobility restrictions, etc. Individual needs vary over a lifetime, changing with life stage and by where they live relative to the destinations accessed (Banister, 2018[20]). While the diversity in resources and needs implies a certain degree of inequality between individuals, it is important that these transport inequalities remain minimal and understood by policy makers.

Inequalities in transport are detrimental to society. Lack of access marginalises groups and leaves people unable to achieve their highest potential, individually and collectively. Transport systems can entrench social inequalities. Inequalities in access occur based on income groups, ethnicity, gender, age groups, and between urban and rural areas. Lack of access to education or employment affects the economy by stunting human capital and labour market participation (Mackie, Laird and Johnson, 2012[21]). Life expectancy reduces and health care costs increase due to lack of access to regular care and opportunities to maintain healthy lifestyles (Porter, 2013[22]; WHO, 2011[23]). Furthermore, those who are "less travelled", because they cannot afford to, are also the "travelled upon" (Banister, 2018[20]; Sustainable Development Commission, 2011[24]). They bear the externalities of travel by the more fortunate. Externalities include communities severed by motorways and other infrastructure (Anciaes et al., 2016[25]), noise and air pollution (Rock, Ahern and Caulfield, 2014[26]), higher rates of traffic incidents, high household transport expenditure due to forced car ownership (Sustainable Development Commission, 2011[24]), among others.

Transport CO_2 emissions: Significant and growing

Transport has shrunk our world. People and goods are travelling further and more frequently than ever before (Banister, 2019[27]). In wealthier countries, people travel five times further daily than 60 years ago, on average (Banister, 2018[20]). The increase in the availability and affordability of transport has made us much more mobile, yet the costs to society and the environment have risen with it. Emissions and the unequal distribution of their costs across society grow with demand, especially for long-distance transport.

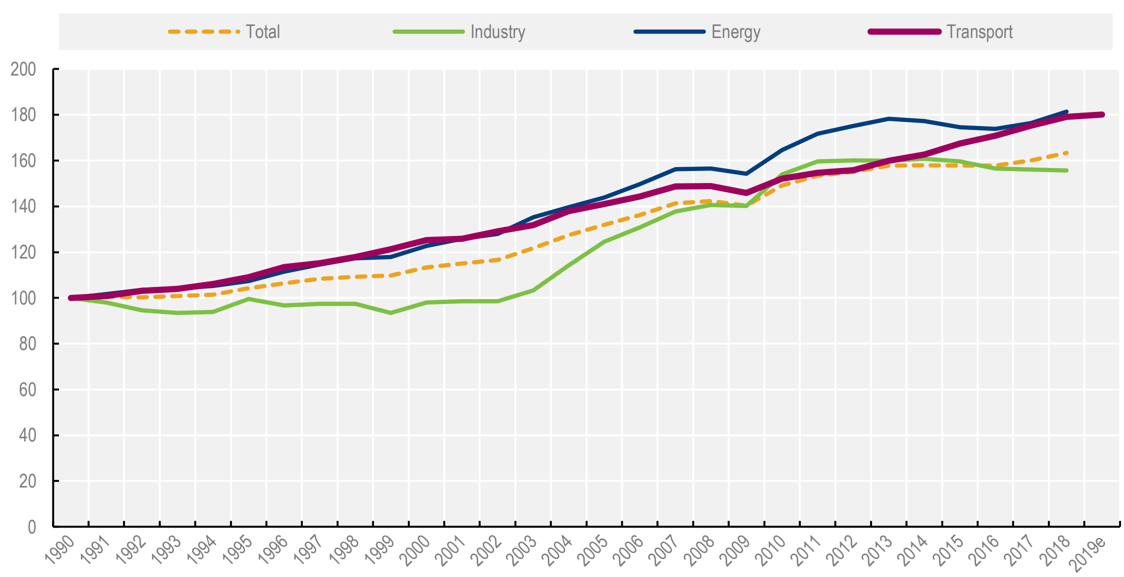
The rising demand for travel and freight makes it challenging to decarbonise transport. The increase in travel volume has more than offset improvements in vehicle and fuel technologies over the past few decades. The transport sector is the largest energy end-use sector, with a direct energy consumption of 121 exajoules (EJ) in 2018, jointly with the industry sector at 119 EJ (IEA, 2020[28]). The final energy used in transport vehicles is responsible for 25% of direct CO_2 emissions from fuel combustion in 2018 (IEA, 2020[1]). The transport sector depends more on oil than any other end-use sector: oil products represent

92% of transport's total final energy consumption (IEA, 2020[28]). Its high-energy use and a large share of carbon-intensive fuels make transport a major contributor to climate change – even before considering any additional emissions associated with transport, such as those from fuel production, vehicle manufacturing and infrastructure construction.

Transport sector CO_2 emissions have grown steadily for the last three decades, with a temporary dip during the 2008 financial crisis (Figure 1.2). The Covid-19-related shutdowns in 2020 also led to drops in CO_2 emissions, which ITF models estimate at 15% across the transport sector. Yet emissions will likely rebound as confinement measures are lifted and economies recover. In 2019, the year before the Covid-19 pandemic, global transport emissions increased by 0.5%; less than the 1.9% compound annual growth rate observed since 2000. Yet it still underlines that transport emissions are growing, and thus of growing concern (IEA, 2020[29]). Any delay in halting and reversing this trend in transport emissions will make overall emission targets increasingly difficult to reach.

Figure 1.2. Global CO_2 emissions from fuel combustion by end-use sector

Evolution of CO_2 emissions, 1990=100



Note: Data for 2019 are estimates. Energy includes "Electricity and heat producers" and "Other energy industries". Documentation for the data can be found here: https://iea.blob.core.windows.net/assets/474cf91a-636b-4fde-b416-56064e0c7042/WorldCO2_Documentation.pdf
Source: Data from 1990 to 2018 are from IEA (2020[1]), *CO_2 Emissions from Fuel Combustion*, https://www.iea.org/subscribe-to-data-services/co2-emissions-statistics. Transport emissions in 2019 are from IEA (2020[29]), *Tracking Clean Energy Progress: Transport*, https://www.iea.org/reports/tracking-transport-2020.

StatLink https://doi.org/10.1787/888934238261

Countries' current decarbonisation commitments are not enough to meet climate objectives. Even if signatories of the Paris Agreement meet all targets of their initial NDCs, the planet would far exceed the 1.5ºC and even the 2ºC global warming threshold (WRI, 2020[9]). Many NDCs list CO_2 reduction ambitions specifically for transport, but few include clear measures to reach them. While 81% of NDCs recognise transport as relevant, only 10% define transport-specific mitigation targets (ITF, 2018[30]). The implementation of all announced transport-related NDCs as of 2018 would fall short of the 2030 transport sector targets required to halt temperature increases to 2ºC compared to pre-industrial levels, with high probability. To reach it, transport-related NDCs would need to commit to an additional reduction of 600 million tonnes CO_2 by 2030 (ITF, 2018[30]).

Decisive policy action can transform transport, however. Limiting global warming to the more ambitious 1.5ºC target is possible if policies are put in place to manage demand, prioritise sustainable modes, improve vehicles and fuel technologies, and optimise operations. Given the role of transport in climate change, transport ministries need to be actively involved in determining national commitments and drafting the revised NDCs as well as creating clear pathways to reach these goals.

Broader support, dialogue and co-operation between governments, industry, and scientific research will be vital in identifying barriers to decarbonisation, and roles and responsibilities of different actors

Multi-stakeholder dialogues and co-operation are needed to turn plans into action. The results of this *Transport Outlook* are a diagnosis and a call to action. It shows how policy trajectories need to change and what must be done to slow and reverse transport sector contributions to CO_2 emissions. However, it is a starting point. Broader support, dialogue and co-operation between governments, industry, and scientific research will be vital in identifying barriers to decarbonisation, and roles and responsibilities of different actors. More detailed analysis, joint plans, and monitoring are all necessary to make collective action a reality.

Tackling emissions and inequality together

Tackling inequality and climate change together is a global imperative. Achieving this objective includes developing greener and more inclusive transport systems supported by efficient transport policies. The transport sector affects everyone and connects people across political and geographical boundaries. This makes it especially challenging for policy makers to enact changes. Effective transport-related climate and equity policies must be politically feasible, socially acceptable, and trusted. Specifically, such transport policies should meet three criteria: be aligned with measures for pandemic recovery, shift towards improving access to opportunities, and foster collaboration between transport and other sectors to break down silos.

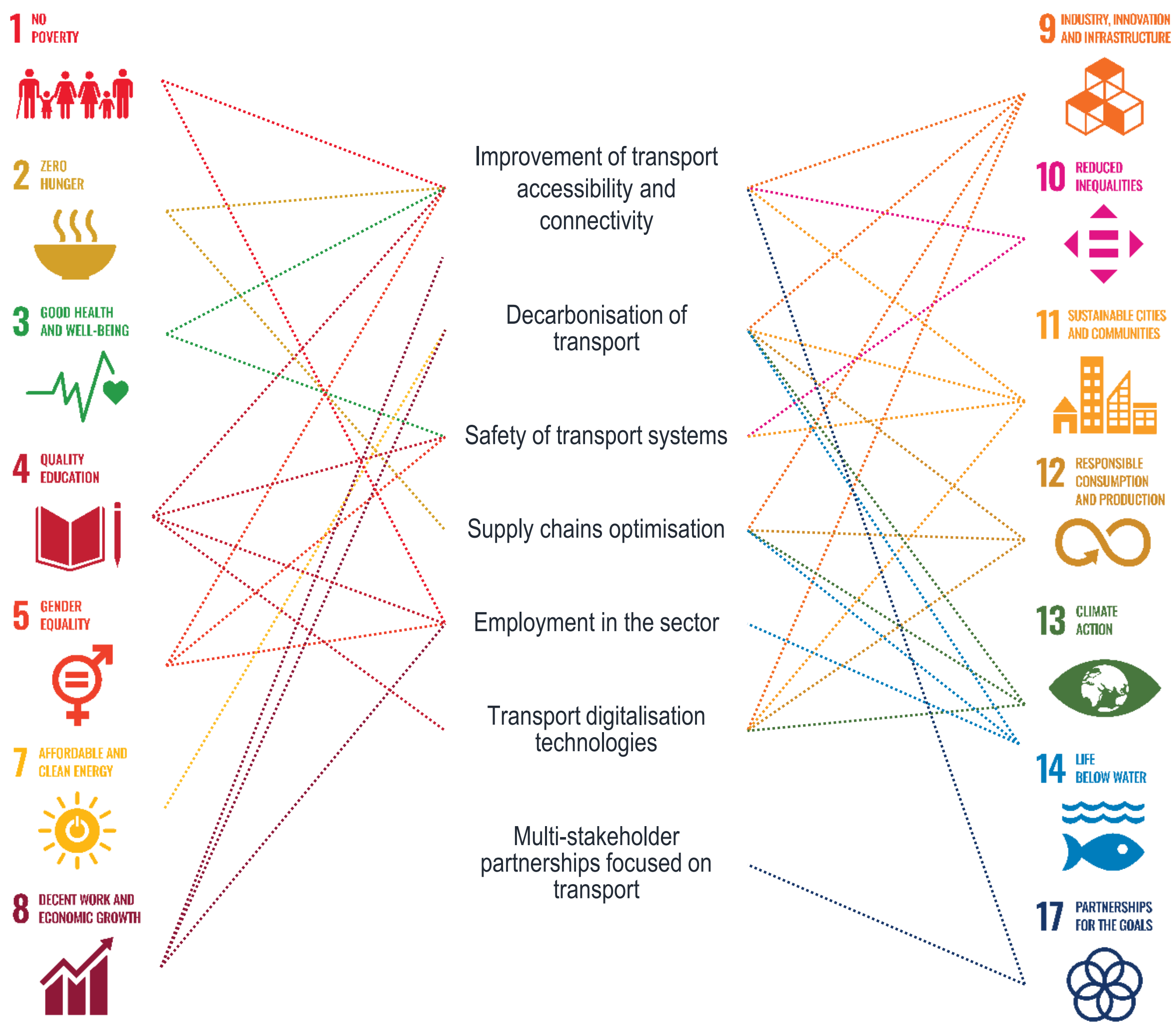
Ensuring aligned policies

Transport policy can be a catalyst for positive change or for conflict where broader issues of climate change and inequality come to a head. Citizens will support measures to make mobility more sustainable if they perceive them as "just" and not imposing an undue burden on the average person. Policies they perceive as reducing affordable access and part of a pattern of growing economic inequalities, on the other hand, can create social and political tensions (Thorwaldsson, 2019[15]).

Policy alignment is vital for prioritising funding in the coming years. Recovery packages should tackle economic, environmental and social goals simultaneously, rather than sequentially or in isolation, not least because of tight public finances and the environmental and social costs of an imbalanced focus on GDP growth (Buckle et al., 2020[31]). The financial costs of decarbonisation may seem high, but these investments can create new jobs, lower health-care costs, and protect biodiversity (CCC, 2019[32]; Banister, 2019[27]). Fulton et al. (2017[33]) have demonstrated that savings from prioritising public transport investment over car-based travel, for example, are likely to exceed costs. Investments in decarbonisation and digitalisation technologies can reduce costs and generate net long-term benefits and are well-suited to drive a post-Covid-19 economic recovery (ETC, 2020[34]; Varro, 2020[35]).

Such a unified, aligned, holistic approach will also support the broader agenda of the United Nations Sustainable Development Goals (SDGs). Transport is a cross-cutting contributor to many of these goals and is explicitly or implicitly linked to most of the 17 SDGs (Figure 1.3 and Box 1.1).

Figure 1.3. The relevance of transport for the United Nations Sustainable Development Goals



Note: The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States. https://www.un.org/sustainabledevelopment/.

Shifting focus from mobility to accessibility

Transport activity must decouple from economic growth. Historically both passenger and freight transport have evolved in lockstep with GDP growth. The objective thus was to enable faster, more convenient and cheaper travel over longer distances. Conventional wisdom in the transport sector settled on predicting future demand and then accommodating this prediction by providing infrastructure. With the environmental costs of fossil-fuelled mobility undeniable, decoupling mobility provision from the notion of economic growth is essential to contain climate change and maintain a strong economy (Gray et al., 2006[36]; Banister and Stead, 2002[37]; OECD, 2019[38]; Schleicher-Tappeser, Hey and Steen, 1998[39]).

Box 1.1. Gender, transport and the Sustainable Development Goals

The International Transport Forum's (ITF) work on gender in transport addresses gender issues in the sector to benefit not only women but all transport users. By working with public and private sector partners, international organisations and academia, the ITF is engaged in evidence-based policy improvement that will help contribute to several of the UN Sustainable Development Goals (SDGs).

Improving transport sustainability and equity also includes increasing the diversity of the transport workforce and improving the quality of its work (Ibarra et al., 2019[40]). An ITF paper *The Gender Dimension of the Transport* Workforce finds that women only represented 17% of the transport workforce in 2018. More policy measures are still needed to educate, train, hire, and retain women in the workforce, as well as improving existing labour laws to close the gender gap (Ng and Acker, 2020[41]).

The economic gains from increasing women's participation in the transport workforce are greater than an equivalent increase in male employment, as gender diversity creates benefits on its own through the inclusion of new skills, differences in risk preference and response to incentives (Ostry et al., 2018[42]). Studies also show that women challenge the dominant male norms and have been shown to make more sustainable decisions (Kronsell, Smidfelt Rosqvist and Winslott Hiselius, 2016[43]). An improvement in gender equality in the transport workforce helps advance SDG 5 Gender Equality and contributes to SDG 8 Decent Work and Economic Growth. A more diverse workforce in male-dominated maritime transport will also ultimately affect SDG 14 Life Below Water.

Gender equality in the transport workforce also leads to better planning and designing of transport services. As highlighted in the ITF paper *Understanding Urban Travel Behaviour by Gender for Efficient and Equitable Transport Policies* (Ng and Acker, 2018[44]), women have very different travel patterns and behaviours to men. Many authors cite the lack of safety on public transport as the main deterrent to women choosing the mode in the compendium *Women's Safety and Security, A Public Transport Priority* (ITF, 2018[45]). While currently transport services and policies are based primarily on the travel patterns of men, more inclusive planning would result in improving the accessibility of all user groups. This contributes to SDG 3 Good Health and Well-being while supporting SDG 11 Sustainable Cities and Communities and SDG 13 Climate Action by increasing the attractiveness of public transport.

People travelling more and travelling further (higher mobility) is not an indicator of improving accessibility. Higher mobility can, in fact, be a sign of poor transport options in places that require more trips and longer journeys to reach necessary destinations (OECD, 2019[38]). Transport planning that serves citizens' needs considers the destinations they wish to access and how well transport services connect origins and destinations. This shift in focus from mobility to accessibility is at the core of policies that enable transport to deliver a comprehensive set of goals from climate mitigation to sustainable development and well-being (ITF, 2019[19]). See Box 1.2 for OECD work focussing on applying a well-being lens beyond the transport sector to meet Paris Agreement goals.

Faster travel for some comes at a price for others. Road designs and land-use patterns favouring mobility over accessibility can include lower density developments and highways to allow for faster speeds. Designing for accessibility involves higher density development and roads with multiple intersections and connections to increase accessibility by alternative modes (Litman, 2003[46]). Transport networks that focus solely on faster travel and reduced congestion sacrifice safety, which is linked to lower speeds (ITF, 2020[47]). They also perpetuate car dependence and impact citizens' health by limiting options for active travel (Le, Buehler and Hankey, 2018[48]). Not least, they imply a low priority for the needs of individuals who do not own a car. The focus on time savings for road travel often benefits groups that already travel the most. They are less likely to help non-drivers, the elderly, low-income households, or those with mobility restrictions (Lucas, Tyler and Christodoulou, 2009[49]).

The externalities of mobility-focused transport systems must be internalised to understand the real cost and impact of increased travel. In fact, beyond the social and health consequences, higher vehicle-kilometres travelled (increased traffic and mobility) can negatively correlate with economic measures of productivity (Litman, 2014[50]). There is little reason to continue designing for a mobility-focused future when transport is a means to an end—access to the destination opportunity.

A focus on accessibility opens the doors to improving well-being while meeting the demand for travel in a more sustainable manner. By contrast, a mobility-focused transport strategy centres on providing for transport growth (Litman, 2003[46]; OECD, 2019[38]). As transport activity increases, mitigating outcomes that drive climate change becomes more and more challenging. But supporting the economy and ensuring access for citizens is possible with less transport activity. The scenario results in this report demonstrate that a balanced set of measures to reduce climate impacts can improve accessibility, lower growth of mobility demand, and drastically cut transport's CO_2 emissions.

Box 1.2. The OECD well-being approach to climate action

The approach argues for the systematic inclusion of well-being (including climate) outcomes in decision making. It calls for reassessing current policy priorities and reframing the metrics used to monitor progress and set decision-making criteria. It argues that this will lead to improved policy approaches that can trigger systemic change, which goes beyond improving the energy efficiency and reducing the carbon intensity of existing modes of consumption, production, and service delivery. At the economy-wide level, this begins with moving towards a "beyond-GDP" narrative, recognising that increases in GDP may or may not be correlated with increases in well-being and that it does not adequately reflect environmental damage. The approach aligns with a wider attempt of the OECD to move to "a broader conception of economic progress, [and] richer frameworks for economic, social and environmental analysis and a wider set of policy objectives" (OECD, 2020[6]); made explicit through the New Approaches to Economic Challenges (NAEC) initiative and the OECD Well-being Framework.

Applying a well-being lens to recovery from the Covid-19 pandemic

The Climate Change Expert Group paper *Addressing the Covid-19 and climate crises: Potential economic recovery pathways and their implications for climate change mitigation, NDCs and broader socio-economic goals* (Buckle et al., 2020[31]) provides a framework and categorises recovery measures announced by countries and cities for the surface transport sector into three stylised recovery pathways: *Rebound, Decoupling*: and *Wider well-being*. The work highlights that measures consistent with a wider well-being pathway (i.e. one that integrates economic recovery, CO_2 emission reductions and well-being outcomes) include but go beyond accelerating the move towards cleaner vehicle technologies and fuels. As such, recovery measures also need to help trigger a move away from car dependency (e.g. through tailoring support for electric vehicle charging facilities to enable a greater role for shared mobility; building on the reallocation of road space away from private vehicles that took place during the emergence from lockdown; and explicitly avoiding potential increase in sprawl). The document discusses how such recovery packages can deliver jobs and other well-being outcomes.

Collaborating for faster progress

Decarbonising transport needs the help of other sectors. Transport's many interdependencies require holistic policy approaches, bringing together decision-makers of different sectors for joint and targeted action. A longstanding priority area for enhanced co-ordination is the integration of decisions on transport planning and land use. Demand for the transport of people and goods heavily depends on the spatial distribution of the population, which is primarily dictated by zoning decisions. Yet, in many areas in the world, transport and urban/regional planning departments remain siloed.

New private mobility services challenge public regulators. The quick pace of change has left authorities unsure how to regulate shared mobility and micromobility services, and accommodate them in ways that benefit citizens, support environmental goals, uphold urban space management principles and ensure safety. Policymakers need to work with the private sector transport "disruptors" to help develop an environment that takes advantage of the benefits that new mobility services provide while mitigating the costs and negative externalities (ITF, 2016[51]; ITF, 2020[52]).

Mobility and accessibility increasingly rely on digital technology. Today's citizens use real-time information to find out when the next bus is coming, map out the least congested driving route, or hail a taxi. Vehicles rely on Information and Communications Technology (ICT) for routing, automation, emergency communication, and on-board diagnostics. ICT also enables working, socialising, and shopping without the need for physical travel. Freight transport uses ICT for optimising logistics through asset sharing, real-time feedback for eco-driving, the Physical Internet, and more. The International Energy Agency estimates that digitalisation in the road freight industry could reduce energy use by 20-25% (IEA, 2017[53]).

Vehicles with no tailpipe CO_2 emissions will still produce indirect emissions upstream. Emissions are generated not only by engines but during the production and delivery of fuels, for instance: electricity or hydrogen. Further impacts come from the extraction of raw materials, the manufacturing process for vehicles, and the construction, maintenance and operation of transport infrastructure. Therefore, policy makers should ensure that new vehicle technologies and transport systems improve environmental performance across the economy. Well-implemented technological shifts can exploit synergies between sectors. For example, electric vehicles can help electricity grids integrate renewable energy sources through managed charging schemes (McKinsey & Company, 2018[54]). The shift to electrification can also help to diversify national energy consumption, thereby aiding energy security.

More clean vehicles may mean lower tax revenues. Without proper anticipation, vehicle electrification and increased use of low-carbon fuels may lead to lower revenues from fossil fuel taxes. Tensions may ensue between the desirable environmental and health benefits of low-carbon mobility on the one hand and the wish to fund welfare programmes via fossil fuel taxes on the other. Preparing a transition to distance-based pricing for mobility and increased carbon taxes can address this challenge. However, consensual implementation will likely require a well-planned dialogue with stakeholders and effective engagement with the general public.

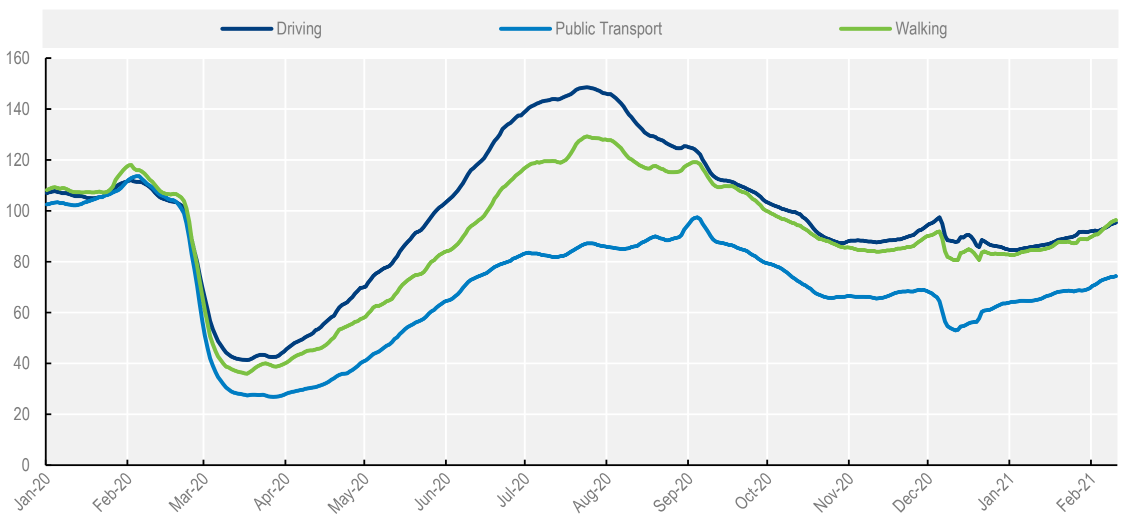
Shaping tomorrow's transport: The pandemic as a reset?

How the transport sector tackles decarbonisation and inequality over the coming years will be shaped by the new realities created by three main factors: the Covid-19 pandemic, the needs of a changing citizenry, and the development path of the economy. The pandemic has disrupted business as usual for transport. It has raised questions about the future attractiveness and viability of public transport, changed commuting patterns, and revealed more clearly how transport contributes to social inequalities. Today, still within the context of pandemic recovery and economic uncertainty, decisions must be taken on how to meet the future needs of an increasingly urban and rapidly ageing population in some parts of the globe.

The Covid-19 pandemic poses an unprecedented challenge to the transport sector and society as a whole. Covid-19 has forced us to reset our lives and take stock of how we work, live and travel. It has brought cities to a standstill, halted international travel, and strained supply chains, forcing logistics operations to pivot radically to keep goods flowing. Some trends in driving, public transport, and walking patterns can be seen in Figure 1.4, which approximates changes in travel demand during the pandemic based on routing requests of Apple Maps users. While the sample is biased and depicts only the habits of individuals with Apple devices, who are often wealthier, it illustrates the strong impact each wave of Covid-19 had on travel volumes and the relative impact on different modes. The pandemic also exacerbated economic and social inequalities, and transport had a role to play in it all. Economic losses, poorer health outcomes and diminished transport access affected vulnerable populations in particular (WRI, 2020[55]).

Figure 1.4. Global Covid-19 impacts on travel for users of Apple devices

January 2020-February 2021, 13 January 2020 = 100, seven-day moving average



Note: Seven-day average plotted from 19 January 2020. Data are missing for 11 and 12 May 2020, therefore are exempt from global average. Routing requests are a proxy for travel demand and do not include most habitual trips. They give an indication of the scale of travel demand contraction where Apple devices are present and Apple routing services are used. The sample is biased therefore this image is meant to be an illustrative example and not representative of the global population.
Source: Global averages computed based on Apple (2021[56]), *Apple Mobility Trends*, https://covid19.apple.com/mobility

StatLink https://doi.org/10.1787/888934238280

As the world moves towards recovery, there is an opportunity to do things differently. If enacted wisely, transport policies can aid economic recovery and at the same time move the planet towards greater environmental sustainability and social equity. Policy choices regarding spending and investments during recovery will determine the world's ability to mitigate climate change and reach sustainable development goals.

Job losses during the pandemic hit sectors unable to work from home most. Employment in the foodservice, retail, entertainment and tourism industries, the informal sector and the gig economy suffered in particular. Women are overrepresented in these industries and were thus strongly affected. Globally, 58% of employed women work in informal employment, and during the first month of the pandemic, informal workers lost an average of 60% of their income (UN Women, 2020[57]). Migrants, low wage workers, minority ethnic, and low-income communities in urban areas with inadequate housing and overcrowding saw much higher levels of community spread of Covid-19 (OECD, 2020[58]).

Essential service workers faced access restrictions as public transport cut services. In the United States, a third of essential workers commute by public transport, and two-thirds of them are from ethnic minorities (TransitCenter, 2020[59]). Poorer neighbourhoods in developing nations relying on privately operated paratransit services for connectivity were cut off when these services shut down because of a lack of users, forcing those depending on them to walk or cycle long distances (IGC, 2020[60]).

The transport sector launched countless initiatives to support the fight against Covid-19 in other ways, despite the enormous difficulties. Rail, public transport, bikesharing schemes, taxi and ride-hailing services offered free or discounted rides to health workers. App-based mobility services disseminated government health information and provided mobility data and analysis to governments. Automotive and aircraft companies switched resources to developing ventilators, and logistics firms helped health authorities set up Covid-19 testing centres (ITF, 2020[61]).

Public transport operators adapted operations to maintain services during the crisis. In many cities, buses and trains continued operating with reduced maximum capacity to allow physical distancing. They quickly installed plastic barriers to ensure separation and protection of bus drivers and other transport personnel. Operators suspended the on-board sale of tickets and front-door boarding to reduce exposure. Floor markings and other forms of signposting helped to communicate distancing requirements (McArthur and Smeds, 2020[62]; UITP, 2020[63]).

Transport workers were on the front line of the pandemic. Transport sector employees served medical and hospital staff and other vital workers during the pandemic, despite the greater exposure to health risks for themselves. Covid-19-related death rates among transport workers have been pronounced (ILO, 2020[64]), with data from some cities indicating a disproportionate impact on minorities. In London, 36 of the 44 transport workers who died of Coronavirus as of August 2020 were non-white (TfL, 2020[65]).

Covid-19 hit different parts of the transport sector in different ways. The main highlights of the pandemic's impact are summarised here, specifically on urban passenger travel, non-urban passenger travel and freight transport. They are examined more fully in Chapters 3, 4, and 5. An at-a-glance summary is provided in Table 1.1 below.

Urban transport has been transformed by the pandemic, notably due to confinement and record numbers of people working from home. In the United States, approximately 48% of the workforce worked from home, and 42% in the European Union (Sostero et al., 2020[66]; Bloom, 2020[67]). However, this applied primarily to higher-paying knowledge-sector jobs. Public transport and shared mobility faced some of the most significant challenges in their history during the pandemic due to a dramatic drop in the number of users, reduced service frequencies, suspended routes and the need to adapt to social distancing rules and sanitation requirements. Urban residents worldwide turned to walking, cycling and micromobility as public authorities fast-tracked temporary measures to encourage and facilitate this pandemic response.

The post-pandemic recovery provides a unique opportunity to encourage more active travel as part of economic recovery packages that fast track the deployment of fleets of cleaner private, shared and public transport vehicles. Looking further ahead, land-use planning and transit-oriented development must play a more significant role to ensure a sustainable urban model, regardless of potential future shifts in housing choices as a result of continued teleworking. If teleworking continues at significantly high rates, it may trigger a decentralisation of the city. Such a decentralisation does not necessarily imply more travel and higher emissions, though. Smart solutions and neighbourhood-centric development connected by a public transport network adapted from the traditional radial, peak-hour service can help cities achieve a more equitable and sustainable future. New forms of mobility can be effectively integrated into this public transport system, complementing it and rounding out a multimodal urban transport offer. Chapter 3 discusses these opportunities in greater detail.

Non-urban passenger transport fell dramatically during the pandemic, with long-distance travel particularly hard hit. Strict international travel restrictions and border closures reduced air travel by 94% worldwide in April 2020 compared to April 2019 (IATA, 2020[68]). The tourism sector and business travel were severely affected and subdued. Activity on regional and intercity bus and rail routes also dropped massively. The financial consequences for bus operators, in particular, could have significant negative impacts on social equity since bus travel is often the most affordable long-distance option. Support packages will be vital to help the longer-distance travel industries recover. Support must be carefully designed to aid a transition to more sustainable non-urban travel rather than returning to business as usual. Economic stimuli also provide an opportunity to invest in research, development and deployment of cleaner aircraft, road vehicles and fuels. Chapter 4 explores non-urban passenger transport in more detail.

The pandemic has underscored the vital role played by freight transport. The drop in freight demand was much more moderate than passenger travel. In some regions, home deliveries and e-commerce increased during the pandemic. For example, the United Kingdom saw a 50% increase in demand (Office for National Statistics, 2020[69]). The need for reliable supply chains in the face of closed borders forced the sector to adapt rapidly to keep essential goods flowing. Functioning supply chains are often taken for granted and their complexity, invisible to the average consumer, is rarely appreciated. This changed during the pandemic; the workers and companies that kept essential equipment running and vital goods flowing all of a sudden caught the public's attention.

This visibility boost could move freight transport higher up the list of public priorities, which could help accelerate the transition to cleaner goods transport. Low-hanging fruits in freight decarbonisation include ending fuel subsidies and incentivising the use of alternative fuels or deploying digital and automated technologies faster. Relaxing the just-in-time paradigm would enable better consolidation of loads and increase load factors. Speed reductions would better support multimodal solutions and thus create a less carbon-intensive supply chain. Chapter 5 expands on these concepts in greater depth.

How the pandemic will ultimately change the mobility of people and the transport of goods is still uncertain. It is already clear, however, that Covid-19 will have long-term effects on our transport systems as a result of changes in behaviour, changes in business models and as a result of government intervention. To what extent these factors will bring about positive economic, environmental and social results will largely depend on governments' commitment to policies that set the right priorities and offer the right incentives. Policies to reboot the economy and strengthen the resilience of transport networks can at the same time address environmental challenges and social inequalities – if they are designed and implemented well (Buckle et al., 2020[31]).

The right policies can consolidate progress towards sustainable transport made during the pandemic. The shift to active travel and micromobility in cities can be made permanent by allocating space for the safe use of these modes. More remote working can contribute to fewer commuting trips, and teleconferencing can limit the need for business travel. Reinforcing these trends can support sustainability goals. A the same time, countervailing trends such as the decline in public transport use and the rise in e-commerce could set back such efforts and should be contained.

Several economic stimulus packages target climate change through investments in transport. European governments have approved a stimulus package that earmarks nearly one-third of the budget to climate action, the largest amount ever allotted. It includes funds to stimulate the market for low and zero-emission vehicles and to develop energy resources (Krukowska and Lombrana, 2020[70]). The Next Generation EU recovery strategy, which aligns with the European Green Deal announced in 2019, calls for rolling out cleaner and more affordable public transport. South Korea plans to use its recovery instruments to expand its green mobility fleet (OECD, 2020[71]). The People's Republic of China will invest in electric vehicle chargers and support new renewable energy plants (Krukowska and Lombrana, 2020[70]). South Korea, Japan and China have all pledged to work towards carbon neutrality by 2050 (Carbon Brief, 2020[72]). The ASEAN Comprehensive Recovery Framework underlines the need to advance towards a more sustainable and resilient future, including strengthening transport connectivity (ASEAN, 2020[73]).

Table 1.1. Potential challenges and opportunities for decarbonising transport post-Covid-19

	Potential opportunities for decarbonisation	Potential challenges for decarbonisation
Short term impacts	Urban passenger transport • High levels of teleworking, reducing commuting trips • Increased use of active and micromobility • Rapid implementation of active mobility lanes/reallocation of road space • Reduction of car use, congestion, and pollution	Urban passenger transport • Reduction in public transport and shared mobility ridership due to health concerns and shift to car use
	Non-urban passenger transport • Increased teleworking, reduced business travel trips • Increase in fuel efficiency due to early retirement of older and less fuel-efficient aircrafts • Reduction in air travel • Increase in localised tourism due to health concerns	Non-urban passenger transport • Higher usage of private vehicles due to health concerns, leading to a reduction of cleaner 'shared' modes (bus, rail)
	Freight transport • Overall decrease in demand and transport activity • Reduction in consumption and transport of fossil fuels • Faster deployment of automation and digital solutions (e.g. at port terminals or border crossings) • Greater resilience of less carbon-intensive modes (rail and inland waterways)	Freight passenger transport • Increase in e-commerce and home deliveries • Companies delaying vehicle fleet renewals and other investments, including cleaner technologies
Long term/structural changes	Urban passenger transport • Increased teleworking, reducing commuting trips and increasing local trips • Focus on local trips and land use may favour land-use policy to densify neighbourhood centres. • Deployment of permanent active mobility infrastructure and reallocation of road space • Change in public transport funding systems to a more sustainable model	Urban passenger transport • Increase in car use due to health concerns • Reduction of public transport ridership due to change in habits or sanitary concerns • Lack of funds in private and public sector for research of sustainable fuels • Lack of funds to finance public transport. • Stimulus packages that support a return to the status quo • Unmanaged urban sprawl if people move out of cities due to teleworking
	Non-urban passenger transport • Paradigm shift for businesses reducing business travel trips • Increased localised tourism due to travel behaviour changes	Non-urban passenger transport • Higher usage of private vehicles and reduced usage of bus and rail modes due to changes in preferences

	Freight transport • Slower growth rate due to delay in economic activity • Faster decline of fossil fuels demand and energy required to transport fuels • Greater focus on resilience, not just efficiency, move from "just-in-time" to "just-in-case". Favours cargo consolidation, higher average loads and multimodal solutions. • Faster deployment of digital technology and automation that increase efficiency • A more suitable environment for logistical collaboration and share assets • Greater market concentration can speed up the adoption of greener tech and operations • Trade regionalisation can shorten supply chains and decrease transport activity (tonne-kilometres) even if the total volume (tonnes) remain the same	Freight transport • Lower costs of fossil fuels reducing the commercial attractiveness of cleaner technologies. New technologies tend to have higher initial costs but can have lower total ownership costs (TOCs) mostly due to lower fuel costs and consumption. With lower fuel costs the commercial break-even for new greener technologies is longer • Accelerated growth in e-commerce and home deliveries, increasing congestion, emissions and decreasing consolidation and average loads
	All sectors • Accelerated transition to cleaner technologies in response to policy signals and investments spurred by stimulus packages. • Greater political will and opportunity to foster greener technologies and operations	All sectors • Delays in the adoption of cleaner technologies due to a lack of investment by the private and public sector (e.g. slower renewal of fleets and deployment of new infrastructure) • Stimulus packages that support a return to the status quo

Note: Short-term impacts are based on observed changes in travel behaviour during the pandemic that hurt or hinder decarbonisation efforts. Most long-term and structural opportunities rely on well-designed recovery policies, while challenges add constraints to future decarbonisation.

Most stimulus funding will not help the climate, however. Instead, most packages will reinforce current, environmentally harmful trends (Vivid Economics, 2020[74]). The G20 countries have pledged USD 12.7 trillion towards post-pandemic economic stimulus as of December 2020. Yet, most of the funds support fossil fuel-based activities in the highest-emitting sectors, including agriculture, industry, waste, energy and transport (Vivid Economics, 2020[74]). Some governments use recovery packages to roll back environmental regulations and taxes and invest in fossil-fuel intensive energy and infrastructure projects (OECD, 2020[75]).

To ensure an equitable recovery, governments must look beyond the dominant narrative of economic growth. While up to the 1980s, GDP growth resulted in rising living standards, since then it is no longer correlated with improvements in well-being and equality (OECD, 2020[6]). The transport sector must play its role in supporting the economy and creating jobs. It also bears responsibility for ensuring that prosperity, job opportunities and the quality of work are shared in ways that improve lives rather than entrench inequalities (Ibarra et al., 2019[40]). Public funding and government support are crucial for the financial sustainability of transport after the Covid-19 crisis and will remain so for some time. In particular, it will define the transport sector's ability to pursue the transition to sustainable and equitable mobility. It is vitally important that governments refine their plans for economic recovery to enable this future.

The human dimension: Catering for diversity in transport

The shape of human settlements and the patterns of transport demand they create are key to developing sustainable transport policies. Population projections see urbanisation continuing in the future. But it will not take place uniformly across all regions. The specificities of how urban demographics develop will have important impacts on the provision of transport services, whether that population growth results in densification or expansion of the city.

Population growth and urbanisation will shape transport planning and investment. The global population continues to grow, which will have implications for transport policies and investment over the next 30 years. The world's population is projected to reach 9.7 billion people by 2050, up from 7.7 billion in 2019 (UN DESA, 2019[76]). At present, nearly 4.4 billion individuals live in urban areas around the world (Figure 1.5), with approximately 3.4 billion estimated to inhabit rural areas in 2018 (UN DESA, 2019[77]). By 2050, the urban population is projected to increase to almost 6.7 billion people, or 68% of the world's population. The rural population, on the other hand, is expected to peak and decline slightly to 3.1 billion by that time (UN DESA, 2019[77]).

Growing populations will put pressure on policy makers to meet increasing travel demand sustainably. Cities will need to integrate their transport policies with development planning to ensure they are easily navigable using sustainable modes. Sub-Saharan Africa will be the region with the highest urban growth rate over the next 30 years, with the urban population increasing by a factor of 2.7 (Figure 1.5). By 2050, Sub-Saharan Africa will be home to 20% of the world's urban population, up from 11% in 2020. Middle Eastern and North African countries will see the second-largest growth, with urban populations increasing by 60%. Asia will follow, seeing growth of close to 50% in total compared to 2020.

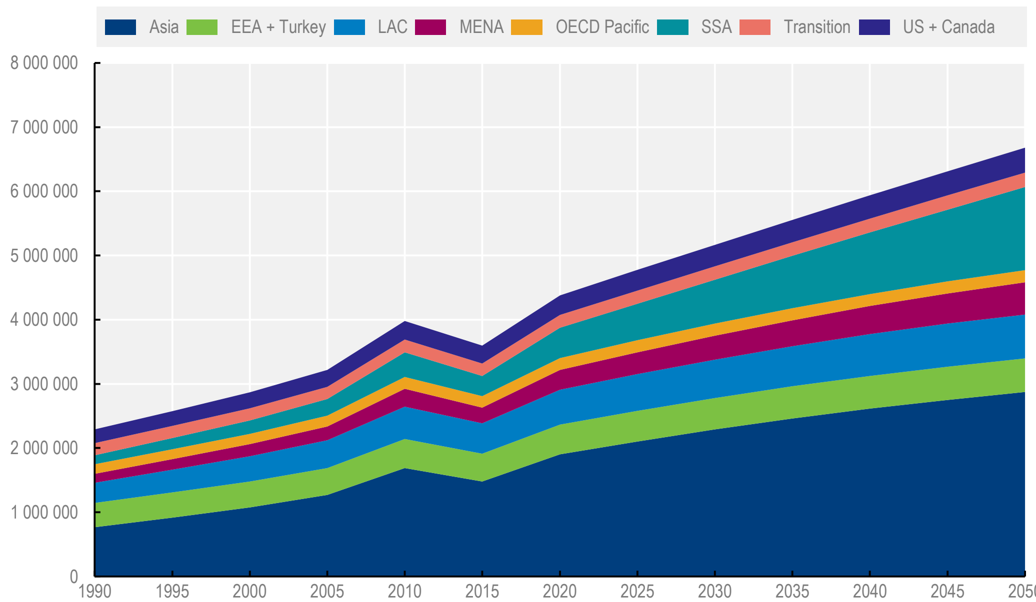
For regions with no significant population increase, measures should focus on encouraging and supporting more sustainable travel choices among residents and visitors. Some urban populations are expected to shrink. Authorities in these cities will need to plan for the impact on their funding capacity (OECD/European Commission, 2020[78]). Regions such as the European Economic Area (EEA) including Turkey, as well as the transition economies of the former Soviet Union, will see smaller increases over the next three decades, with population growth rates lower than before the last global recession and during the subsequent recovery. Projections see urban populations there roughly 13% above current levels by 2050.

The future shape of cities will be crucial for the sustainability of transport. Urban areas around the world are not growing uniformly. Cities with increasing population density accounted for more than half of urban population growth between 1975 and 2015 (OECD/European Commission, 2020[78]). Other cities are expanding their footprint. In most cities that recorded a growing number of inhabitants between 2000 and 2015, population growth was faster in the commuting belt, suggesting a trend towards decentralisation of the city (OECD/European Commission, 2020[78]). Expansion and decentralisation both have implications for the type and location of transport infrastructure those cities need and the scale of investment required to deliver it. Public transport, for example, is often the backbone of a sustainable transport system but is generally more cost-effective in high-density regions. Cities that increased the area over which infrastructure and services must be provided up to 2015 were predominantly located in low-income or low-middle income countries (OECD/European Commission, 2020[78]).

The Covid-19 pandemic may have an impact on urbanisation trends. There are indications that the pandemic has encouraged people to relocate out of cities to areas with more space (Haag, 2020[79]; Thomson Reuters Foundation, 2020[80]; Moody's Analytics, 2020[81]; OECD, 2020[82]). However, it is too early to know whether this will become an established trend. To a large extent, this will depend on how long the pandemic lasts and the degree to which practices like teleworking will prevail after restrictions are lifted. As an example, the Irish government published a National Remote Working Strategy in January 2021, prompted by the changes seen during the pandemic (Department of Enterprise, Trade and Employment, Ireland, 2020[83]; Government of Ireland, 2021[84]).

Figure 1.5. Urban population by world region

Thousands of people



Note: EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.
Source: data from United Nations (2018[85]), *World Urbanization Prospects: The 2018 Revision*, https://population.un.org/wup/

StatLink https://doi.org/10.1787/888934238299

Table 1.2 Compound annual growth rate of urban populations

	Compound Annual Growth Rate 2020-2050	Compound Annual Growth Rate 2020-2030	Compound Annual Growth Rate 2030-2050
Asia	1.39%	1.25%	1.14%
EEA + Turkey	0.39%	0.32%	0.35%
LAC	0.80%	0.72%	0.66%
MENA	1.64%	1.25%	1.51%
OECD Pacific	0.02%	0.06%	-0.03%
SSA	3.43%	2.52%	3.24%
Transition	0.41%	0.24%	0.44%
United States + Canada	0.80%	0.63%	0.72%

Source: United Nations (2018[85]), *World Urbanisation Prospects: The 2018 Revision*, https://population.un.org/wup/

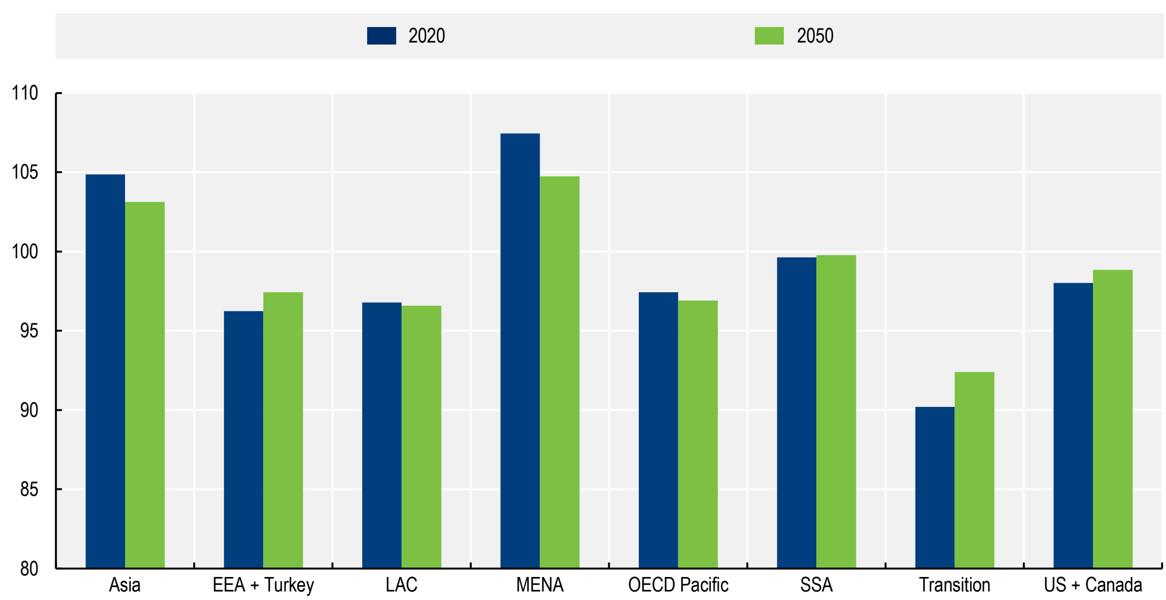
Women generally have more complex travel patterns than men. Their trip purposes often vary, happen outside peak hours and regularly combine multiple trips ("trip-chaining") (ITF, 2019[86])**.** Despite this, women are less likely to own a car (Duchène, 2011[87]). Women outnumber men in most regions and will continue to do so in the next 30 years (Figure 1.6). Transport planning practices have not always accounted for the variation in transport needs observed between men and women, however (Duchène, 2011[87]; ITF, 2019[86]).

Transport policies that do not reflect women's needs limit women's access to employment opportunities, to travel services and to other essentials. Women have a higher share of trips for domestic or care-based purposes (e.g. travel related to family or to providing food), to non-work locations and at non-standard times. Women are also more likely than men to be in part-time employment, in which case even their commuting trips do not follow the same peaks as the "standard" transport planning observations (Duchène, 2011[87]).

Safe and secure transport options are critical to influencing women's travel patterns and mode choices. Safety concerns are often cited as the biggest deterrent for women to not use certain transport options, notably public transport, taxis, shared mobility, cycling and walking. This is an important consideration in the planning of public transport services and infrastructure to ensure that public transport is also appealing and functional for women (Duchène, 2011[87]; ITF, 2018[45]; ITF, 2019[88]).

Figure 1.6. Gender ratio by world region

Males per 100 females



Note: Data are according to the medium-variant projections. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.
Source: UN DESA (2019[89]), *World Population Prospects 2019, Online Edition. Rev. 1.*, https://population.un.org/wpp/

StatLink https://doi.org/10.1787/888934238318

Improving the representation of women in the transport workforce can help create more inclusive policies and transport systems, especially where women occupy decision-making roles (Ng and Acker, 2020[90]). Improving transport sustainability and equitability includes increasing the diversity of the transport workforce and improving the quality of its work (Ibarra et al., 2019[40]). Studies show that women are critical economic agents capable of transforming societies and economies by challenging the dominant male norms. Women have been shown to make more sustainable decisions, which makes gender parity in decision-making roles critical to the decarbonisation of the transport sector (Kronsell, Smidfelt Rosqvist and Winslott Hiselius, 2016[43]). Increasing the representation and visibility of women at all stages of transport policy, planning, implementation, and usage of transport projects make transport more responsive to the needs of all users (Fraszczyk and Piip, 2019[91]).

Better decision making requires better data. Data on trips that include demographic information give transport policy makers and planners a clear picture of the difference in travel habits between different groups in society and help to improve planning decisions. Such data are not always available or sufficiently granular to understand the travel habits of different demographic groups and model the potential societal impacts of policies on them. Box 1.3 discusses recent ITF work on this concerning women and transport.

Box 1.3. The need for better data to support social equity in transport

Transport planners need better data. They cannot design equitable and sustainable transport systems, without understanding the different travel needs and preferences of users. Everyone depends upon some form of transport to access health services, educational institutions, and job markets. When the transport needs of segments of the population are ignored, those concerned are left behind, with limited access to basic needs and fewer opportunities to contribute to the economy.

Three key dimensions to explore when trying to understand the diversity of mobility needs are age, gender and income. An ITF report, *Understanding Urban Travel Behaviour by Gender for Efficient and Equitable Transport Policies, which looked at* the differences in travel behaviour highlighted the importance of all three socio-economic categories in determining transport mode choice but showed gender to be the most robust determinant (Ng and Acker, 2018[92]). Indeed, work streams on gender and transport have been growing in recent years at the ITF, as well as at the FIA Foundation, GIZ, *Mujeres en Movimiento* (Women in Motion Network), the International Association of Public Transport (UITP), the United Nations Economic Commission for Europe, and the World Bank. Within these organisations, numerous initiatives on gender have been launched in both developing and developed countries. A common thread through all of the discussions on gender and transport, or equitable transport systems more generally, is that we are missing the data needed to understand differences between transport users and thus to provide equitable transport services and infrastructure design. In other words, the right kind of data are simply not being collected.

For several years, the ITF has been engaging with the national statistics offices and transport ministries of its member countries to review existing data on transport users by socio-economic categories. This has confirmed that there is a significant data gap. In 2020, the ITF began a collection of travel survey data by age, gender and employment status. The data included average trips per day and average distance per trip for the following modes: bike, car, motorcycle, bus, light rail, and heavy rail. There has been at least partial coverage of data collected from twenty-two ITF member countries and three non-members. The travel survey data were used to calibrate the urban passenger model for the *ITF Transport Outlook 2021*.

To close these data gaps, the ITF will continue to discuss with its stakeholders recommended scopes and methods for collecting gender-disaggregated transport data, as well as how such data can generate equitable and sustainable transport policies. Work will continue on gender biases within new big data sources, and what this means for artificial intelligence and machine learning in the transport sector, as well as solutions to overcome these issues.

Accessibility-oriented policies will encourage sustainable mobility choices among older citizens. Policy makers will need to consider the shifting mobility needs of a growing proportion of older transport users in many regions to ensure they maintain levels of accessibility in the future (OECD, 2001[93]; Frye, 2011[94]). Accessibility is important to support social interactions and help reduce the risk of isolation among older people (Frye, 2011[94]). It is also necessary to access essential services, such as health care and food supplies. The number of people in the global population aged over 65 years has more than doubled in the last 30 years. It is set to double again between 2020 and 2050. This represents an additional 821 million more people in 2050 aged over 65, with that age segment growing faster than any other group.

This is becoming a more urgent issue in some regions than others (Figure 1.7). In Europe, the over-65 age group is the only cohort that is projected to grow in size between 2025 and 2050. By that year, it will make up nearly a quarter of the region's population (UN DESA, 2019[95]). In the OECD Pacific countries, their share will exceed 30% (Figure 1.7). Sub-Saharan Africa, on the other hand, has a very young population and although the over-65 age group will double by 2050, it will still make up less than 10% of the population.

Policy makers will need to consider the shifting mobility needs of a growing proportion of older transport users in many regions

Public transport that is high quality, accessible and serves destinations older people wish to reach is important (WHO, 2007[96]; OECD, 2017[97])**.** As with differences in transport patterns observed by gender, older citizens' needs are not always served by conventional transport planning (WHO, 2007[96]). Seniors who can drive are likely to wish to continue as long as possible (OECD, 2001[93]). However, a large proportion of those over 65 also suffers from impairments that can reduce their mobility (OECD, 2001[93]; OECD, 2017[97]). The decision to retire from driving means is linked to available alternatives that ensure continued mobility and thus social interaction (OECD, 2001[93]; Metz, 2011[98]; Schwanen and Páez, 2010[99]).

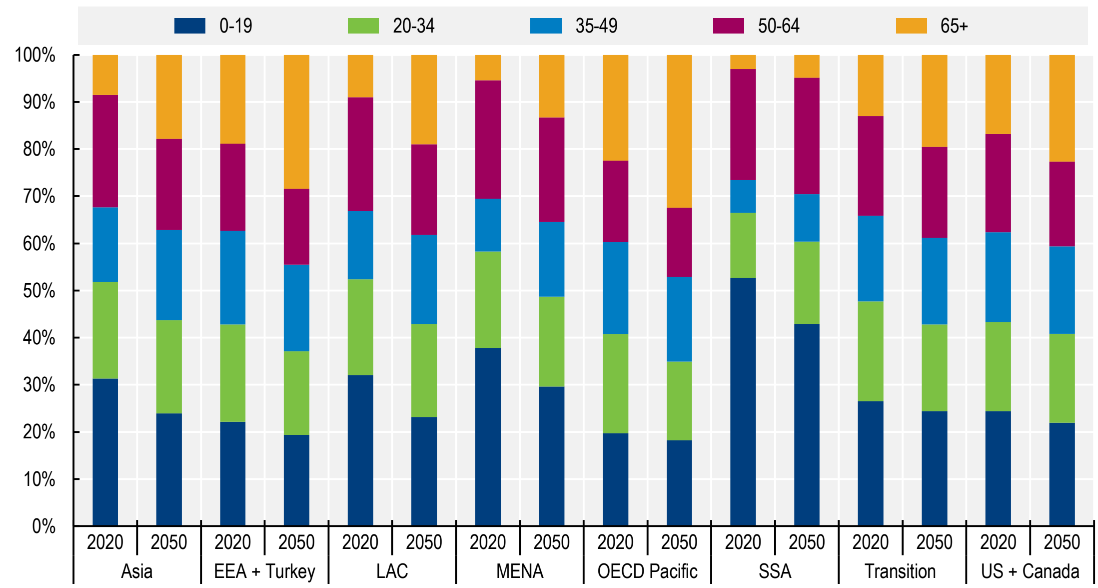
Affordable transport options are important for ageing communities (WHO, 2007[96]). An ageing population can have implications for public transport funds regarding the possible use of fares and ticketing policies, like concession fares, to support mobility-related aspects of well-being as people age (Metz, 2011[98]). However, proper analysis of planned policies must ensure they are the most effective use of funding for improving transport outcomes and reaching those who are most in need (Frye, 2011[94]).

A perception of safety is an important consideration for older users' transport choices (OECD, 2001[93]; WHO, 2007[96]). This relates to physical safety and security when using public transport (WHO, 2007[96]) as well as road safety (OECD, 2001[93]). Public transport use by seniors can be encouraged through accessible vehicles, stops and stations, and by enhancing attractiveness and comfort. Improving the built environment and vehicle technology can support better road safety for older drivers, cyclists and pavement users (OECD, 2001[93]; WHO, 2007[96]).

Land-use planning policies that ensure proximity to essential services allow citizens to grow older in their own community without sacrificing their independent mobility (OECD, 2017[97]; OECD, 2001[93]; WHO, 2007[96]; Frye, 2011[94]). Neighbourhoods with a range of housing options, intergenerational communities, and easy access to essential services and social life create opportunities to better support an older population (WHO, 2007[96]).

Figure 1.7. Population distribution in world regions by age

Proportion of population



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Source: UN DESA (2019[89]), *World Population Prospects 2019, Online Edition. Rev. 1*, https://population.un.org/wpp/

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The economic dimension: Recovery under uncertainty

The extent of the pandemic's impact on the economy and transport activity is extremely difficult to gauge. Estimates at the time of writing projected falls in GDP of between -7.6% and -3.4% in 2020 (Table 1.3). This section sets out the projections for the economic impact based on 2020 estimates which fed into the assumptions for the modelling in the *ITF Transport Outlook* and discusses the implications of these trends for transport.

The latest *OECD Economic Outlook Interim Report* published in March 2021 offers a more optimistic picture of global economic recovery than previous projections. However, it maintains that the decisive factors for the ultimate path are vaccine rollout and the potential emergence of variants of the coronavirus. The modelling results for transport demand and emissions are thus a function of very uncertain economic projections. A what-if analysis that contrasts results under the assumed economic lag due to Covid-19 and under pre-pandemic economic patterns is illustrated in Figure 2.11 in Chapter 2.

Whether considering projections from 2020, as used in the ITF models, or the latest March 2021 values, they are all still lower than pre-pandemic (2019) projections for a given year. When interpreting the results of this report its should be kept in mind that if actual GDP growth is higher than assumed in the models (Table 1.4), transport emissions would lie between the two what-if scenarios - higher than those given in this report, but lower than the pre-pandemic scenario. If future economic growth surpasses the rates projected in 2019, emissions could be expected to be even higher than the pre-pandemic scenario.

The global economic downturn due to Covid-19 has reduced transport demand. Higher GDP is generally linked to a growing demand for transport. While there is a drive to decouple transport demand from GDP growth to enable decarbonisation in an economic growth context, it is still linked, especially to demand for international transport. In mid-2020, a global GDP rate of -7.6% was expected in 2020, with OECD countries to suffer more significant declines (-9.3%) than Non-OECD countries (-6.1%). By December 2020, estimates were less severe, with the global GDP rate at -4.2%, and by March 2021, the impact was expected to be -3.4%. The Euro area was anticipated to suffer the largest decline, with a drop in GDP of -11.5%, adjusted to -6.8% in the March 2021 projections. In most regions, the GDP rate is expected to return to growth in 2021 (Table 1.3). Notably, China's GDP rate remained positive in 2020 based estimates in March 2021, contrary to initial projections, and is expected to continue growing strongly.

Growth rates are slower than projected in 2019, but the trends seen then are set to continue. Based on the OECD (2020[100]) and IMF (2020[101]) projections in mid-2020, the compound annual GDP growth rate (CAGR) was assumed to be 2.2% for the 2015 to 2030 period (OECD, 2020[102]) in the ITF models for this *Transport Outlook* (Table 1.4). This is down from the projection of 3.3% in the previous *Transport Outlook* (2019[103]). It is expected to improve, resulting in a CAGR of 2.6% over the 2015-50 period (OECD, 2020[102]). The OECD figures reflect a "double hit" scenario, which includes the second wave of infections at the end of 2020.

Output is not anticipated to return to pre-pandemic levels in 2021 unless vaccine production and distribution improves (OECD, 2021[104]). Vaccine rollout remains uneven between countries and continues to have an unequal economic impact on different sectors. Initial analysis, before the second Covid-19 wave hit, saw year-on-year retail sales of domestic goods, health-related goods and clothing growing again by August 2021 in many countries. But sales were still projected to be down for activities that would tend to generate trips or constitute a trip themselves, such as activities, holidays, travel and events (OECD, 2020[105]). The tourism sector and tourism-dependent economies are projected to take a particularly strong hit as a result of travel restrictions and lingering reticence among consumers to travel internationally during a pandemic (IMF, 2020[106]; OECD, 2020[107]).

Table 1.3. GDP growth projections in world regions remain uncertain

Percentage change over previous year

	2017	2018	2019*	2020*	2021*	2022*
OECD				Projections from OECD Economic Outlook Volume 2020 Issue 1 / Volume 2020 Issue 2 / Interim report March 2021, where available		
World	3.7	3.4	2.7	-7.6 / -4.2 / -3.4	2.8 / 4.2 / 5.6	-- / 3.7 / 4
OECD countries	2.7	2.3	1.7	-9.3 / -5.5 / -	2.2 / 3.3 / --	-- / 3.2 / --
Euro Area	2.7	1.9	1.3	-11.5 / -7.5 / -6.8	3.5 / 3.6 / 3.9	-- / 3.3 / 3.8
Japan	2.2	0.3	0.7	-7.3 / -5.3 / -4.8	-0.5 / 2.3 / 2.7	-- / 1.5 / 1.8
United States	2.4	2.9	2.3	-8.5 / -3.7 / -3.5	1.9 / 3.2 / 6.5	-- / 3.5 / 4
Non-OECD countries	4.6	4.4	3.5	-6.1 / -3 / -	3.2 / 5.1 / --	-- / 4.2 / --
Brazil	1.3	1.3	1.1	-9.1 / -6 / -4.4	2.4 / 2.6 / 3.7	-- / 2.2 / 2.7
China	6.9	6.7	6.1	-3.7 / 1.8 / 2.3	4.5 / 8 / 7.8	-- / 4.9 / 4.9
India	7.0	6.1	4.2	-7.3 / -9.9 / -7.4	8.1 / 7.9 / 12.6	-- / 4.8 / 5.4

	2017	2018	2019*	2020*	2021*	2022*
World Bank						
World	3.3	3.0	2.4	-5.2	4.2	--
Advanced economies	2.5	2.1	1.6	-7.0	3.9	--
Emerging market and developing economies	4.5	4.3	3.5	-2.5	4.6	--
IMF						
World	3.9	3.6	2.9	-4.9	5.4	
Advanced economies	2.5	2.2	1.7	-8.0	4.8	
Emerging market and developing economies	4.8	4.5	3.7	-3.0	5.9	
	4.8	4.5	3.7	-3.0	5.9	

Note: * Figures for 2020, 2021 and 2022 are projections. World Bank figures for 2019 are estimates. OECD projections from the Economic Outlook, Volume 2020 Issue 1 are from the Double-hit Scenario.
Source: (OECD, 2020), *OECD Economic Outlook, Volume 2020 Issue 1*, https://doi.org/10.1787/0d1d1e2e-en , (OECD, 2020), *OECD Economic Outlook, Volume 2020 Issue 2*, https://doi.org/10.1787/39a88ab1-en; (OECD, 2021), *OECD Economic Outlook, Interim report March 2021*, https://doi.org/10.1787/34bfd999-en; (World Bank, 2020) *Global Economic Prospects*, https://www.worldbank.org/en/publication/global-economic-prospects and (IMF, 2020), *World Economic Outlook*, https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020.

Table 1.4. GDP growth rates used in ITF models for select regions and countries

Compound annual growth rate

	2015-30*	2015-50*
World	2.2	2.6
OECD countries	1.3	1.6
Euro Area	1.0	1.3
Japan	0.6	1.0
United States	1.2	1.6
Non-OECD countries	2.9	3.1
Brazil	1.5	1.7
China	3.6	3.0
India	4.6	4.7

Source: *Assumed growth rates for 2015-2030 and 2015-2050 are ITF estimates based on the OECD (2020[100]) *OECD ENV-Linkages model*, http://www.oecd.org/environment/indicators-modelling-outlooks/modelling.htm; IMF (2020[101]) *World Economic Outlook Update, June 2020*, https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020.

Global merchandise trade was hit more strongly when the pandemic struck than by the 2008 financial crisis, based on preliminary data (UNCTAD, 2020[108]) (ITF, 2020[109]). Supply chain disruptions led to factory closures and the shutting down of assembly lines. Freight transport in 2020 is estimated by ITF to have been -6.7% below 2019 levels. ITF models for this Transport Outlook assume a five-year loss of trade activity, roughly in line with the initial WTO optimistic scenario (WTO, 2020[110]).

The ultimate impact of the pandemic on trade is still unclear. At the time of writing, a strong worldwide decline in trade of -9.2% is expected for 2020, followed by a 7.2% rebound in 2021 (Table 1.5). This represents an improvement on initial forecasts early in the pandemic, when the hit to trade was projected to be closer to -20% (WTO, 2020[111]). The greatest drop is expected for North American exports (-14.7%), followed by Europe (-11.7%). Imports are projected to decrease noticeably in South and Central America (-13.5%) and Europe (-10.3%). Between 2015 and 2030, the compound annual merchandise trade growth rate worldwide is expected to be 2.4%, rising to 2.7% over the longer term to 2050 (Table 1.6). This is down from 3.4% and 3.2% projected for those periods before the pandemic (ITF, 2019[103]). Compound annual growth through to 2030 in the Asian region is expected to see the strongest growth in exports (3.8%). However, in the long run, SSA is expected to have a stronger growth rate with a compound annual growth rate of 5.2% through to 2050.

Table 1.5. World merchandise trade

Percentage change over previous year

	2018	2019	2020*	2021*
World	2.9	-0.1	-9.2	7.2
Exports				
North America	3.8	1	-14.7	10.7
South and Central America	0.1	-2.2	-7.7	5.4
Europe	2.0	0.1	-11.7	8.2
Asia	3.7	0.9	-4.5	5.7
Other regions	0.7	-2.9	-9.5	6.1
Imports				
North America	5.2	-0.4	-8.7	6.7
South and Central America	5.3	-2.1	-13.5	6.5
Europe	1.5	0.5	-10.3	8.7
Asia	4.9	-0.6	-4.4	6.2
Other regions	0.3	1.5	-16.0	5.6

Note: *Figures for 2020 onwards are projections.
Source: (WTO, 2020[112]), www.wto.org/english/news_e/pres20_e/pr862_e.htm

Table 1.6. Projected world merchandise trade by region

Compound annual growth rate

	2015-30	2015-50
World	2.4	2.7
Exports		
Asia	3.8	4.2
EEA + Turkey	1.6	1.5
LAC	2.0	2.9
MENA	0.8	1.2
OECD Pacific	1.6	2.1
SSA	2.7	5.2
Transition	2.1	2.0
United States + Canada	2.5	2.0
Imports		
Asia	1.3	3.5
EEA + Turkey	0.8	2.0
LAC	1.2	2.9
MENA	1.2	3.4

	2015-30	2015-50
OECD Pacific	0.9	2.3
SSA	1.4	4.3
Transition	0.8	2.1
United States + Canada	0.9	2.6

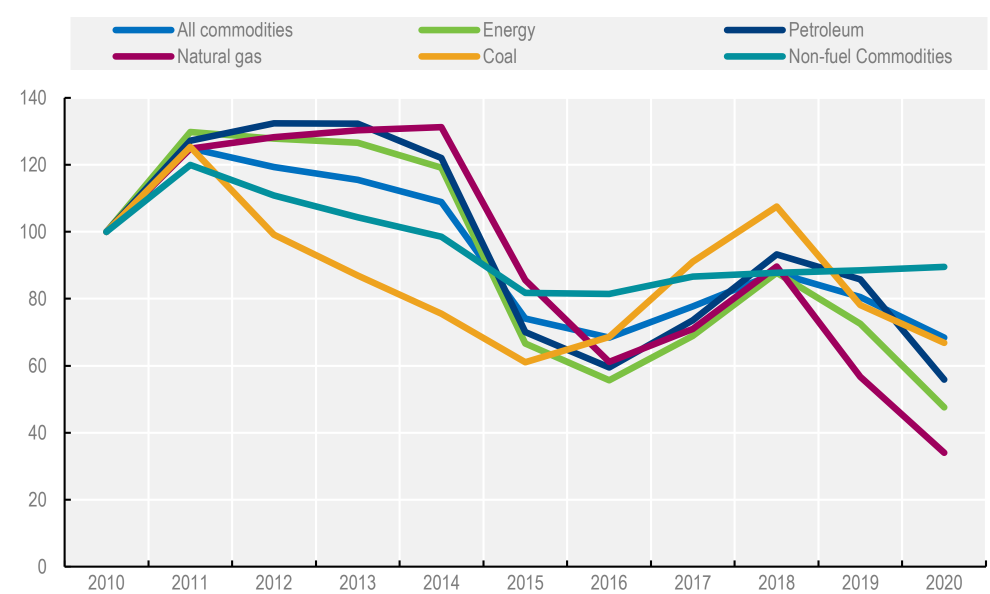
Source: Data are based on the OECD ENV linkages model, http://www.oecd.org/environment/indicators-modelling-outlooks/modelling.htm.

Prices for natural gas, energy, coal and petroleum have been on a downward trend since 2018. The Covid-19 pandemic, and the resulting impact on demand for oil, caused the OPEC+ group of countries to introduce restrictions on production that will last until April 2022. Producers in the United States also reduced supply. As a result, oil prices recovered somewhat but not to the level seen in January 2020 before the restrictions (IMF, 2020[106]). Oil prices have a particularly significant impact on the transport sector. Price fluctuations can influence travel behaviour and investment in alternative fuels, which in turn influences CO_2 emissions from the transport sector.

The disruption caused by the pandemic perpetuates uncertainty around transport demand and oil prices (IMF, 2020[106]). From the perspective of oil demand, road traffic did bounce back after the first travel restrictions. However, the effects of the pandemic continue to be felt in the air travel industry, suppressing demand for oil from that sector.

Figure 1.8. Development of primary commodity price indices, 2010-20

Constant USD, 2010=100



Note: Petroleum refers to petroleum crude spot average prices for the United Kingdom. Brent, Dubai and West Texas Intermediate. Natural gas includes European, Japanese, and American indices. Coal includes Australian and South African indices.
Source: IMF (2020[113]) *IMF Primary Commodity Prices*, http://www.imf.org/external/np/res/commod/index.aspx.

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Key takeaways

- Transport is inextricably linked to the most critical issues of our time, climate change and social equity. It must play a central role in policy agendas that address them in a well-aligned way.
- The Covid-19 pandemic has severely impacted the economy and transport demand. It remains uncertain what the pandemic's long-term impact on future economic growth and transport activity will be.
- Pandemic recovery offers a singular chance to accelerate initiatives to mitigate global warming and help achieve the UN Sustainable Development Goals.
- Covid-19 recovery packages must align economic recovery with policies that combat climate change and strengthen equity.
- The decarbonisation of transport depends on other sectors as well. Collaboration is imperative.
- Transport policies must focus on increasing accessibility, not simply accommodating more travel.
- Urbanisation will continue, but not evenly. Transport policy makers and land-use planners will need to integrate their processes to ensure sustainable, accessible cities.
- Transport policy, planning and design must take an inclusive approach to address the specific travel needs of women, seniors and other groups overlooked in the past.
- Better data is needed to inform inclusive policy-making and transport planning.

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2 Pathways to decarbonise transport by 2050

This chapter presents three policy scenarios for the development of transport demand and associated emissions over the next 30 years. Results are aggregated across passenger and freight transport and provide an overall view of the entire transport sector. It also discusses global approaches to transport decarbonisation that will ensure fair burden-sharing among social groups and countries.

In Brief

Better transport for tomorrow requires action now

Transport is at a pivotal moment. Will its share of global emissions continue to grow? Or can it meet the decarbonisation targets of the Paris Agreement by 2050? This chapter presents the *Recover*, *Reshape* and *Reshape+* scenarios: three different decarbonisation routes that transport could take over the next 30 years. They diverge in their approach and ambition, and show how the choices made now would play out as the world strives to keep global warming to below 1.5˚C.

The *Recover* scenario is based on the world's current trajectory of implemented and announced policies. It assumes that the international community adheres to its current climate initiatives, but will base economic recovery from the Covid-19 pandemic largely on the economic practices of past decades. The return to such a "normal" will take us down the wrong road: In the *Recover* scenario, the international community falls well short of its agreed climate goals. Transport CO_2 emissions would not decrease; they would surge to more than triple the amount targeted for 2050 as the maximum that would limit global warming.

The *Reshape* and *Reshape+* scenarios present more optimistic visions of the future. Under *Reshape*, governments adopt transformational decarbonisation policies that pivot transport onto a sustainable path and put the climate goals of the Paris Agreement within reach. In the *Reshape+* scenario, policies for pandemic recovery are accelerated and reinforced in a way that puts transport on a fast track to achieving the climate goals. In a *Reshape* and *Reshape+* world, the historic link between economic growth and rising transport emissions is broken. Transport demand still grows, but emissions fall.

The core assumption of the *Reshape* and *Reshape+* is an ambitious decarbonisation agenda. Their policies succeed in avoiding unnecessary travel, shifting mobility to more sustainable transport options, improving transport technologies in ways that make them less emitting They also enhance the resilience of transport networks.

Such ambitious policies can and must be executed in a way that ensures fair burden-sharing and avoids adding to existing inequalities. Implementation of climate policies, especially those that involve pricing mechanisms, should account for the specific impacts on different groups of society. They also should leverage global capital to enable all world regions to pursue effective transport decarbonisation.

The ITF Transport Outlook 2021 presents projections for transport demand and related emissions under three different policy scenarios for the coming three decades. Recover, representing the world's current trajectory, includes existing commitments for decarbonisation and assumes governments prioritise economic recovery by reinforcing established economic activities. It shows that current ambitions are not enough to achieve climate change mitigation targets, exceeding the carbon budget for the transport sector defined by the experts of the International Panel on Climate Change (IPCC, 2018[1]) *that would still be consistent with limiting global warming to below 1.5˚C. The Reshape scenario assumes an ambitious set of decarbonisation policies, characterised by pro-active policies which* respond to environmental challenges in the transport sector and support the *United Nations' Sustainable Development Goals (SDGs). As a result, staying within transport's carbon budget becomes a possibility. The Reshape+ scenario reinforces the policies of Reshape and exploits opportunities for decarbonisation created by the Covid-19 pandemic, such as encouraging certain changes in travel behaviour. Under Reshape+ scenarios, the international community could reach its goals for climate change mitigation faster and with more certainty.*

Recover, Reshape, Reshape+: Three possible futures for transport

The *Recover*, *Reshape* and *Reshape+* scenarios assess the impacts of different policy pathways on global transport demand, greenhouse gas emissions (reported as CO_2 equivalents), local pollutant emissions, accessibility, connectivity and resilience (depending on the sector) up to 2050. The emissions are based on transport activity and do not include emissions from vehicle production or construction and operation of transport infrastructure.

The three scenarios represent increasingly ambitious efforts by policy makers to decarbonise the transport sector while also meeting the UN Sustainable Development Goals (SDGs). All scenarios account for the Covid-19 pandemic by including the same baseline economic assumptions for the pandemic's impacts. Uncertainty surrounds its economic fallout, the behavioural shifts it may trigger, and the extent to which it will affect transport supply and travel patterns both in the long and short term. The ITF models use middle-of-the-road assumptions that lie somewhere between the most optimistic and most pessimistic forecasts available at the time of modelling.

For GDP and trade in 2020, the ITF models assume a drop in all world regions, based on the International Monetary Fund's *World Economic Outlook* June update (IMF, 2020[2]) and the World Trade Organization's *Trade Statistics and Outlook* (WTO, 2020[3]) applied to baseline GDP and trade values from the OECD ENV-Linkages model (OECD, 2020[4]). Following years assume the previous country-specific growth rates after 2020. This is approximated by a five-year delay in GDP and trade projections compared to pre-Covid-19 levels from 2020. Assumptions of economic activity and trade are held constant between all scenarios to better compare the true transport policy impact on activity, CO_2 emissions and other outcomes. Air connectivity growth is also adjusted to account for the severity of the pandemic's impact on aviation. For 2020, ITF models assume a drop in flight frequencies and pre-Covid-19 growth rates to meet the projections for 2025 by the International Air Transport Association (IATA, 2020[5]).

In *Recover,* governments prioritise economic recovery by reinforcing established economic activities. They continue to pursue existing (or imminent) commitments to decarbonise the transport sector, predating the pandemic. Alongside these, governments take action with policies that ensure some of the transport trends that hinder decarbonisation observed during Covid-19 revert back to previous patterns by 2030, as a bare minimum. These include reversing trends in greater private car use and reducing public transport ridership, for example. Changes in behaviour such as reduced business travel or significant shifts to active mobility, which have lowered CO_2 emissions, also revert to pre-pandemic norms by 2030. These short-term trends are listed in Chapter 1 (Table 1.1.). Due to limited policy action on technology innovation, cost reduction in clean energy and transport technologies does not take place to the extent it could. The *Recover* scenario is an updated version of the *Current Ambition* scenario in the *ITF Transport Outlook 2019*, accounting for Covid-19 related changes and policies announced since.

The *Reshape* scenario represents a paradigm shift for transport. Governments adopt transformational transport decarbonisation policies in the post-pandemic era. These encourage changes in the behaviour of transport users, uptake of cleaner energy and vehicle technologies, digitalisation to improve transport efficiency, and infrastructure investment to help meet environmental and social development goals. As in *Recover*, the *Reshape* scenario also assumes that transport trends and patterns observed during the pandemic revert to previous patterns by 2030.

In *Reshape+*, governments seize decarbonisation opportunities created by the pandemic, which reinforce the policy efforts in *Reshape*. Measures reinforce changes in travel behaviour observed during the pandemic, such as reducing business travel or encouraging walking and cycling. Some of these policies are fast-tracked or implemented more forcefully than in *Reshape*. The scenario assumptions also include pandemic impacts on non-transport sectors that may nevertheless influence transport, for instance, a regionalisation of trade due to near-sourcing to improve resilience. Under *Reshape+*, CO_2 emission targets for the transport sector can be achieved sooner and with more certainty and with less reliance on CO_2 mitigation technologies whose efficacy is still uncertain.

The *Reshape* and *Reshape*+ scenarios show what is possible with technologies and policies available today, but with increased investments and more political ambition. The policies act additively, meaning that while there are adjustments made for regions, most policies are applied to most regions with some adjustment for regional contexts. Results are not prescriptive in assigning certain combinations of measures to specific regions. The results show what is technically feasible under full implementation. Still, it is recognised that there may be political and financial constraints that require prioritisation of measures depending on local contexts. The policy scenarios show what may happen at a global and regional level under a set of policies to manage transport demand, shift to more sustainable modes, and improve the energy efficiency of vehicles and fuels.

There are many modelling approaches to assess necessary actions for decarbonisation. The ITF models are demand-based and favour a bottom-up approach which starts with potential policy scenarios and evaluates resulting activity and CO_2 emissions. Other useful modelling exercises such as backcasting from a specific goal offers a different set of advantages and drawbacks. Backcasting starts with a goal and works backwards to see where demand and technologies must be to meet such a goal. The ITF favours the current method over backcasting because it allows for creating the most realistic, and therefore relevant scenarios. The current lack of data available to determine regional and sectoral goals across the globe means that selecting a realistic scenario that reflects the unique constraints of every region is not possible.

This chapter provides aggregate long-term results from the sector chapters and presents an overall summary of possible future trends under the policy scenarios. Aggregate CO_2 emissions are compared against the carbon targets for transport as determined by the (IPCC, 2018[1]). Chapters 3 to 5 discuss how the transport challenges created by Covid-19 can be addressed and how decarbonisation and sustainable mobility policies can be implemented equitably to achieve environmental and societal goals.

Table 2.1. Policy scenarios modelled in the ITF Transport Outlook 2021

Scenario	Economic impacts	Transport impacts of Covid-19	Decarbonisation policies
Recover A return to normal	Economic impacts linger in the form of a five-year GDP and trade projection "step back".	Trends and impacts of Covid-19 that present opportunities and challenges to decarbonisation both go back to pre-pandemic trajectories by 2030. i.e. Trends that hinder decarbonisation are mitigated; trends that help are not reinforced.	Continue with the current/imminent policies in place with some effort to address decarbonisation impacts from the pandemic.
Reshape A change of paradigm			A transformative decarbonisation policy agenda.
Reshape+ Reinforcing *Reshape*	Economic assumptions are held constant to allow comparison of transport policy impacts between scenarios	Trends and impacts of Covid-19 that present challenges to decarbonisation both go back to pre-pandemic trajectories by 2030. i.e. Trends that hinder decarbonisation are mitigated. Opportunities for decarbonisation as a result of Covid-19 are leveraged and reinforced beyond 2030.	A more aggressive policy agenda that leverages Covid-19 recovery to aid in decarbonisation efforts

Note: See Table 1.1 in Chapter 1 for more details on the short- and long-term challenges and opportunities for decarbonisation in the transport sector.

Measures to decarbonise transport: Avoid, shift, improve

Transport decarbonisation measures aim to *avoid* unnecessary travel, *shift* necessary travel to sustainable modes and *improve* vehicle and energy technologies. In recent years, the latter has also encompassed the improvement of transport system efficiency. These measures have positive impacts on CO_2 emissions but vary in their impact on society. Concentrating on any one of these in isolation will not solve the social and environmental challenges transport faces. Instead, policy makers will need to adopt a holistic approach to prioritising policies based on a balance of what is most appropriate in terms of impact, sector, and region.

***Avoid measures* reduce transport activity without limiting access to goods and services.** For instance, integrated urban planning with mixed neighbourhoods can reduce trip lengths. Teleconferencing can replace some air travel. Avoid measures aim to offer the same economic and social benefits with fewer passenger-kilometres (or tonne-kilometres) travelled. Avoid measures can help reduce demand, but their effectiveness and pace of adoption are limited by the constraints posed by structural issues including the distribution of jobs, existing land-use patterns and the presence of pre-existing infrastructure. For example, sprawled neighbourhoods require densification to enable this sort of demand reduction.

***Shift measures* transfer trips from energy-intensive transport modes to energy-efficient ones.** A shift from motorised to active modes is most desirable, where possible. It also provides benefits by reducing costs for users, congestion and air pollution. For longer urban trips, using urban rail instead of private cars delivers a 91% lower final energy use per passenger-kilometre (IEA, 2020[6]). Similar reductions hold for shifts from aviation to high-speed rail (93% lower energy use per passenger-kilometre) and from trucks to freight rail (72% lower energy use per tonne-kilometre) (IEA, 2020[6]). Other lifecycle aspects need to be accounted for, however, including emissions associated with infrastructure (IEA, 2019[7]). Policy makers can promote a shift to more efficient transport modes by facilitating safe active travel and supporting the roll-out of public transport infrastructure. Additional support for the promotion and support of energy, resource and space-efficient transport modes can be provided by resources raised from taxation on land-use requirements, congestion, and energy use of private cars, and through financial incentives for energy-efficient transport modes.

A complete shift away from high-emission modes is not feasible. For many long-distance and international movements, aviation is the most feasible choice. Mode shift is difficult to achieve at scale because rail services can only replace air travel on high-demand routes and over a limited distance (IEA, 2019[7]). In the freight sector, a sizable component would still be moved by truck even if the maximum possible amount of road freight were shifted to rail and inland waterways. Freight rail services are best suited for major axes of freight transport flows, but road transport offers greater flexibility for the timely delivery of goods. In passenger transport, a shift away from private vehicles is only possible if alternatives are available. Shifting to active travel modes and public transport in compact urban areas is easier due to the density of infrastructure and services and relatively short trip distances. However, such shifts are more limited in rural and peri-urban areas where low-density developments and longer trip distances make public transport and active travel more challenging. Policy measures also have different impacts depending on socio-demographic characteristics and attitudes of individuals. The ITF urban passenger model partially accounts for these by differentiating the impact of policies by age and gender cohorts.

Improve measures **enhance the energy efficiency of vehicles, lower the carbon intensity of fuels or increase operational efficiency.** Optimised routing can reduce emissions from congestion, asset sharing in logistics can increase load factors, and seamless transfers between transport modes can make multimodal solutions more attractive. Fuel economy standards can accelerate the adoption of new vehicle technologies and thereby reduce fuel use. Carbon taxes, low-carbon fuel standards or biofuel blending mandates lower the emission-intensity of transport fuels. Promoting a shift to electric vehicles can both improve the energy efficiency of vehicles and facilitate the use of electricity, which can be a low-emission source of energy. These policies can also stimulate major investments in material extraction and recycling, battery manufacturing, the refurbishment or construction of vehicle manufacturing facilities, the deployment of reinforced and smart electricity grids and charging infrastructure, with a positive impact on economic development.

The policy measures included in *Recover*, *Reshape*, and *Reshape+* scenarios are illustrated in Figure 2.1 for all sectors. More detailed assumptions for each measure are available in the sector-specific discussions in Chapters 3-5. More than 60 decarbonisation measures for all modes and transport sectors are available in the *Transport Climate Action Directory,* a database provided by ITF for use by governments and industry (see Box 2.1).

Figure 2.1. Summary of sector-specific measures and assumptions by scenario

Note: Please see Tables 3.3, 4.3 and 5.3 for more detailed descriptions of measures in each sector.

Box 2.1. The Transport Climate Action Directory

Climate change cannot be stopped without addressing the transport sector. In 2016, after the signing of the Paris Agreement, the International Transport Forum (ITF) launched the Decarbonising Transport initiative to help governments and industry transform their climate ambitions into actions through carbon-neutral mobility.

The Decarbonising Transport initiative (www.itf-oecd.org/decarbonising-transport) is a partnership of more than 70 governments, organisations, institutions, foundations, and companies under the auspices of the ITF. In July 2020, the Transport Climate Action Directory, a key output of the Decarbonising Transport initiative, was launched.

The *Transport Climate Action Directory* (TCAD) (http://www.itf-oecd.org/tcad) is an online database of policy measures to reduce transport CO_2 emissions across all modes including maritime and aviation, and for both passenger and freight activity. It currently contains more than 60 different mitigation measures along with an evidence base to help assess their effectiveness. It is a living directory, and additional measures will be reviewed and added over time.

The web tool offers the user filters to short-list measures for targeted decarbonisation results. The categories include measure type, transport mode and geographic scope. For ease of use, the Transport Climate Action Directory also categorises decarbonisation measures under five different policy outcomes:

- Improved design, operations and planning of transport systems
- Electrification
- Low carbon fuels and energy vectors
- Mode shift and demand management
- Innovation and up-scaling

The outline for each measure is concise and includes links to external sources. Each outline contains a description of the measure and potential impact on CO_2 emissions. A costs section describes potential sources of cost and potential co-benefits, to help with evaluating business cases and further understanding of how a measure could contribute to wider objectives. Equally, some considerations that may need to be taken into account in implementation planning are outlined. There is also a function allowing users to suggest additional information for the measures or to propose new measures for inclusion in the directory. This further allows the sharing of knowledge from one user to others.

Transport demand: Growth continues

Both passenger and freight sectors are projected to continue growing in the long term. Total passenger-kilometres and freight demand (measured in tonne-kilometres) will more than double by 2050 under current policies, even if their growth rates diminish as a result of the global pandemic. When compared to the Current Ambition scenario of the *ITF Transport Outlook 2019*, the growth of total passenger and freight activity is now lower than projected due to updates to reflect new policy commitments and less optimistic economic growth figures, even before the effects of the Covid-19 pandemic were felt.

As economies and populations grow, demand for goods grows, as does the number of people with the desire and means to travel. Yet economic growth that comes in tandem with increased transport activity is unsustainable because of the huge negative impacts its emissions create. Only decoupling transport activity and emissions from economic activity will enable us to maintain a strong economy while saving the climate and, ultimately, improving human well-being,

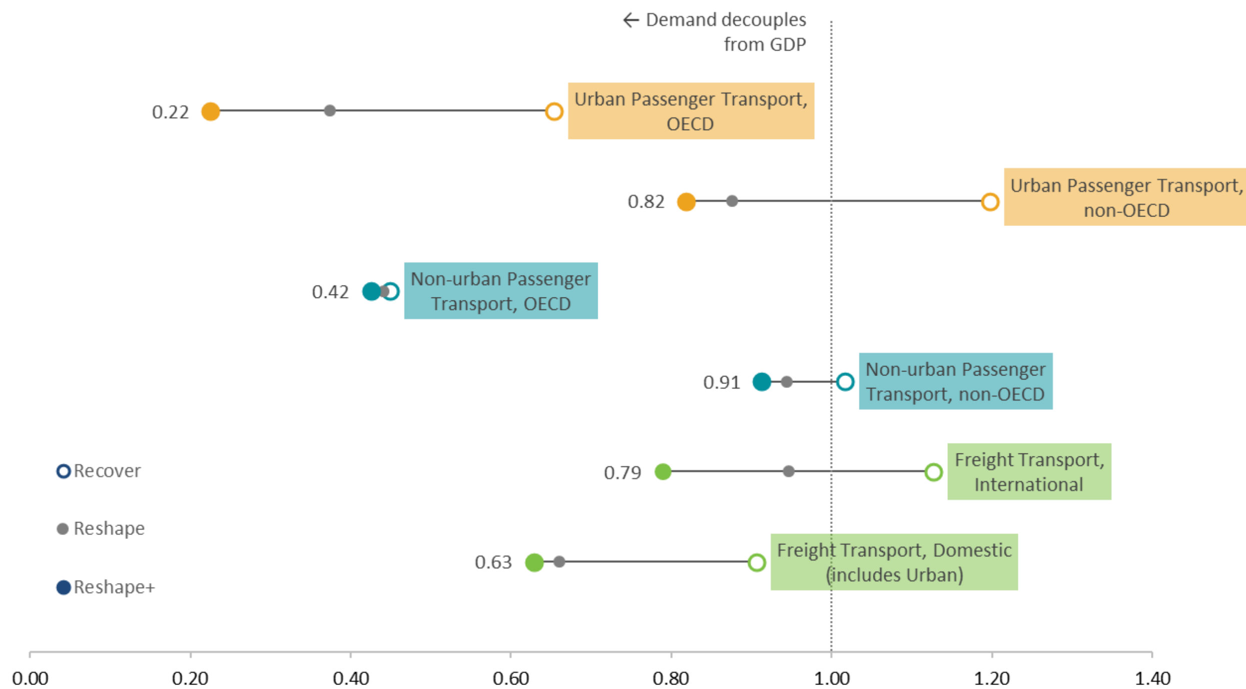
The modelling results for all sectors indicate a decoupling of transport activity from GDP growth by 2050 if government policies follow the *Reshape* or *Reshape+* scenario. Under *Recover* policies, only passenger transport in OECD countries, which are primarily developed economies, no longer correlates strongly with changes in GDP. Figure 2.2 compares the sensitivity of transport demand to GDP. The comparison is based on the elasticity of transport demand concerning GDP. For example, a demand elasticity of 0.5 means that for every 1% increase in GDP (in 2011 USD), transport activity (in passenger or tonne-kilometres) will increase by 0.5%. An elasticity of less than 1 indicates decoupling (Tapio, 2005[8]) because the increase in GDP is stronger than the increase in demand. Lower elasticity values indicate greater decoupling between demand and GDP.

Urban transport activity can decouple from GDP growth to a significant degree. GDP and population growth are already expected to be comparatively lower in OECD countries than the rest of the world, but urban passenger transport growth is expected to be even less. The urban demand elasticity is very responsive to higher ambition policies, reducing elasticity from 0.65 to 0.22 between *Recover* and *Reshape*. Differences between passenger transport behaviour in OECD and non-OECD countries are partially due to higher rates of teleworking in the *Reshape* and *Reshape+* scenario, which is expected to be more prevalent in wealthier economies (Dingel and Neiman, 2020[9]). In addition, in some emerging non-OECD economies, the existing trip rates are quite low. As incomes and quality of life increases in these regions, it may unlock latent demand and increase per-capita trip rates. Supposing current policies continue, as under a *Recover* scenario, cities in non-OECD countries would likely grow in sprawling patterns that increase average trip distances. In such a scenario, transport demand would grow more in line with the economy causing a significant surge in demand. However, the scenarios show that urban transport activity in non-OECD countries responds to an accessibility-focussed approach, decoupling from economic growth under *Reshape* and *Reshape+* due to more sustainable land-use policies and other measures.

Growth of non-urban passenger transport and GDP remains linked, even under higher-ambition decarbonisation policies. Unlike urban passenger transport and to a certain extent regional non-urban transport, which can be influenced by land-use changes to enable individuals to access opportunities closer to home, intercity non-urban passenger transport has limited potential to shorten trips since it entails longer distances and limited alternative destinations. While some long-distance tourism may be substituted by destinations closer to home, the primary way to reduce non-urban transport activity is to reduce the number of trips. This happens to a certain extent through teleconferencing (especially after Covid-19), although the impact is not as strong as teleworking in urban travel. The demand elasticity of OECD countries shows the least responsiveness to the policy scenarios, while non-OECD countries show greater sensitivity. Economic growth and non-urban passenger activity in OECD countries are more decoupled in absolute terms. As incomes increase and latent travel demand is realised, the responsiveness of transport demand to GDP in non-OECD countries could decrease.

Domestic freight is less sensitive to GDP growth than international freight transport. Under *Recover* policies, international freight remains coupled with GDP growth. Both international and domestic freight decouples under *Reshape* policies. However, changes in trade patterns, including a reduction in demand for fossil fuels and potential trade regionalisation, play a part in reducing international freight activity even more significantly under the policies of a *Reshape+* scenario. Domestic freight is not as affected since international trade shifts to more regional goods transport in *Reshape+.*

Figure 2.2. Elasticity of transport demand with respect to GDP growth under different scenarios



Note: Elasticity is calculated as the change in demand (passenger-kilometres or tonne-kilometres) from 2015 to 2050 divided by change in GDP (in 2011 USD) from 2015 to 2050. Elasticities less than one indicate decoupling (i.e. GDP grows more than demand); lower values indicate greater decoupling.

Source: GDP data is from ITF estimates used in the models. Based on the OECD (2020[4]) *OECD ENV-Linkages model*, http://www.oecd.org/environment/indicators-modelling-outlooks/modelling.htm and the IMF (2020[2]), *World Economic Outlook Update*, June 2020, https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020.

StatLink https://doi.org/10.1787/888934238375

Passenger transport demand

After a temporary reduction in 2020, passenger transport demand doubles between 2015 and 2050 under the *Recover* scenario (Figure 2.3). *Reshape* policies could reduce this expected activity by 10% in 2050, and *Reshape+* policies could achieve a reduction of 13%.

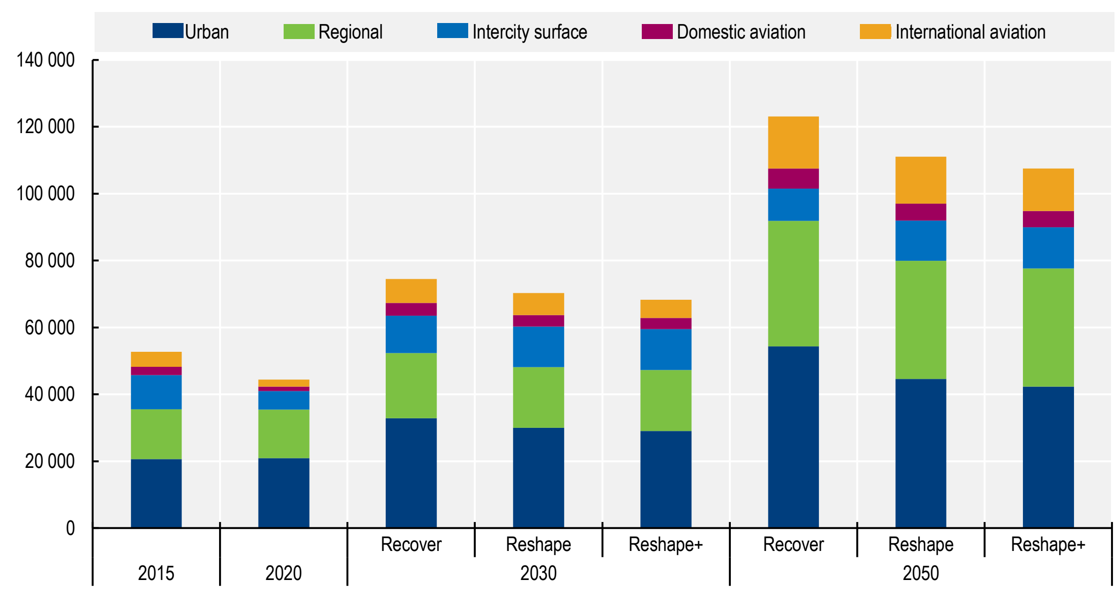
Daily travel will contribute to nearly three-quarters of total passenger demand by 2050 under a *Recover* policy environment. Most urban and regional activity (in rural and peri-urban areas) is comprised of daily trips. Together these trips make up two-thirds of demand in 2015, and by 2050 could make up three-quarters (under *Recover* policies). Accessibility-focussed policies to change land-use patterns and increased adoption of teleworking in the *Reshape+* scenario could successfully reduce 22% of 2050 urban demand compared to *Recover.* Regional demand has less potential for reduction due to limited alternatives; *Reshape+* policies could cut passenger-kilometres by 6% in 2050.

Aviation sees the largest relative growth by 2050, increasing by a factor of 3.5 compared to 2015 under the *Recover* scenario. Demand for air travel is expected to make a strong recovery after the Covid-19 pandemic, particularly for international flights. ITF estimates see aviation should reach 2019 levels by around 2023. Stringent policy measures such as carbon pricing and ticket taxes have only a modest impact as it remains the primary mode of intercity travel in all scenarios due to limited alternatives. As personal lives and business become increasingly globalised, demand for international travel also rises. Stronger policy action under a *Reshape* scenario reduces domestic aviation demand by 17% compared to *Recover* in 2050, while international aviation is reduced by 10%. Under *Reshape+,* these reductions are 19% and 18%, respectively, for domestic and international aviation. The more pronounced change for international travel in *Reshape+* shows what may be possible if some post-pandemic behaviours persist, including teleconferencing to replace some business travel and the shift away from long-distance tourism.

Intercity surface travel declines in absolute terms as aviation gains market share in the *Recover* scenario. However, under *Reshape* and *Reshape+* policies, surface modes become relatively more attractive, and some of aviation's share is redistributed to them. With the increasing availability of rail infrastructure and the development of low-emission road vehicles, which are less affected by carbon-pricing schemes, intercity surface modes become more attractive.

Figure 2.3. Global demand for passenger transport by sub-sector to 2050

By sub-sector, under three scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Regional refers to daily local transport activity that happens outside of urban areas (peri-urban, rural); intercity surface refers to transport movements by private road vehicles (two- and three-wheelers, cars), buses, and rail between urban areas

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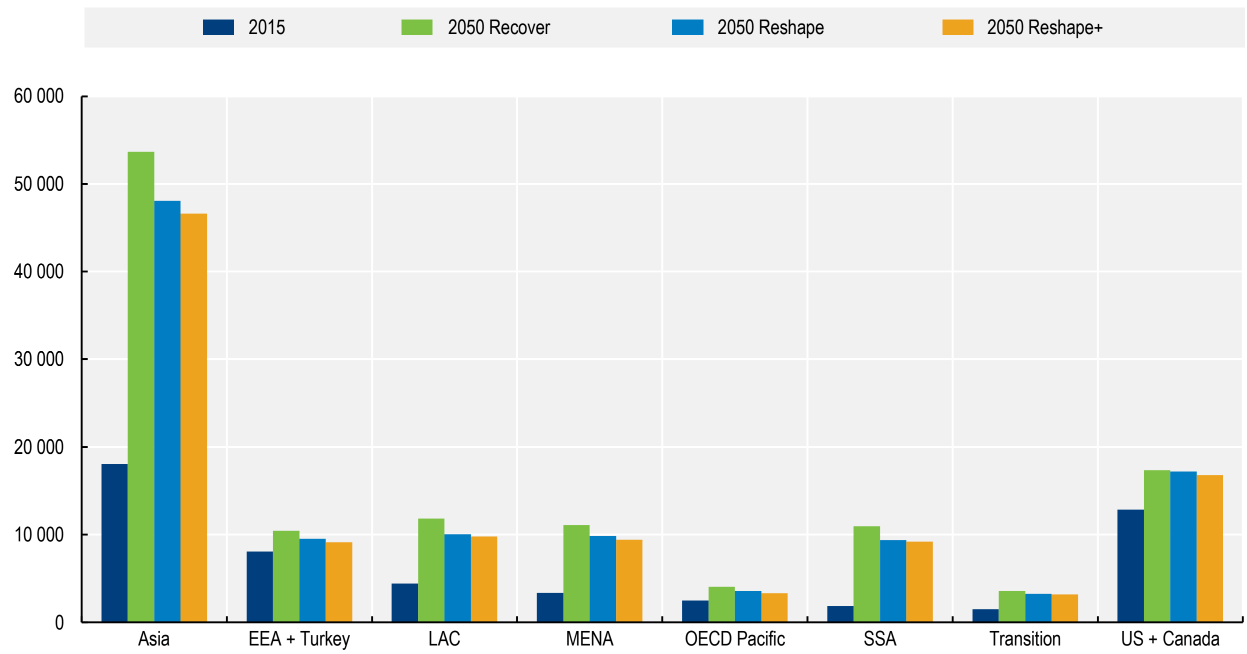
Transport demand increases in all regions regardless of policy scenario. Demand for passenger transport grows most significantly in regions where population and economic growth are expected to be the highest. In absolute terms, Figure 2.4 demonstrates that Asia grows the most, firmly establishing the region as the largest generator of transport demand by a significant margin. A more progressive policy agenda in the region, as envisioned in *Reshape+* achieves a reduction of 7 trillion passenger-kilometres in 2050, compared to *Recover*. Relative to *Recover* results in 2050, OECD Pacific shows the largest relative response to decarbonisation policies, reducing 2050 passenger-kilometres by 18% under a *Reshape+* scenario.

Figure 2.4. Demand for passenger transport by world region to 2050

Under three different scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover, Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. International aviation demand is attributed to the origin country. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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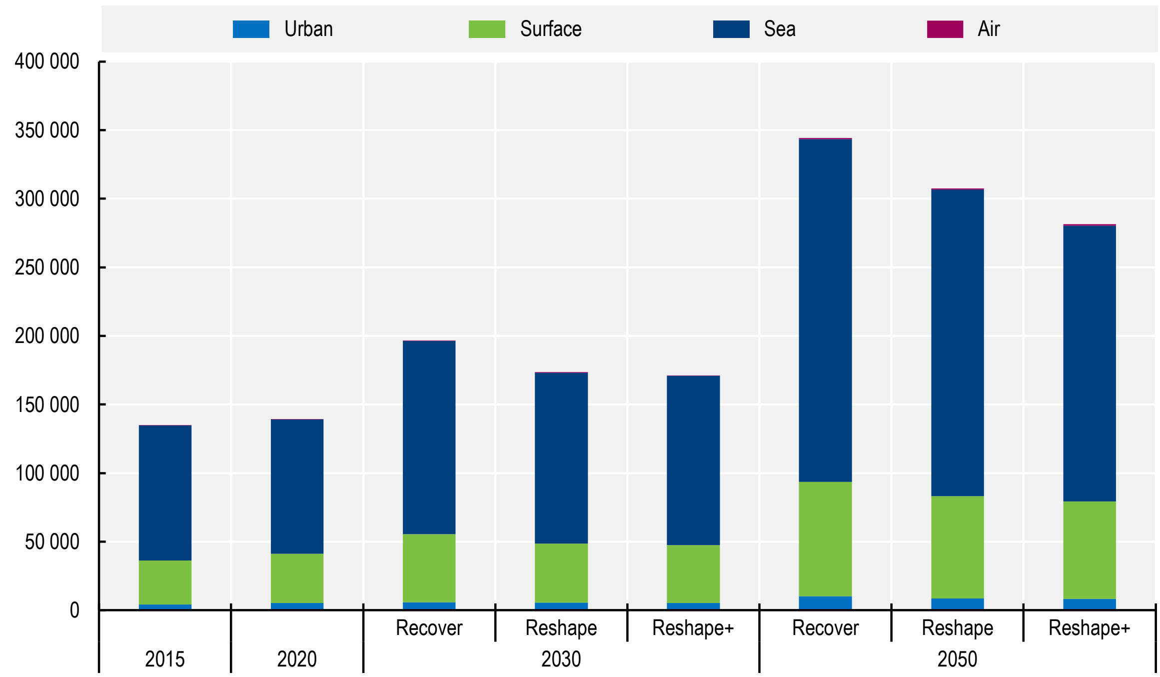
Freight transport demand

Freight demand continues to grow, but at a slower pace due to economic impacts from the Covid-19 crisis (Figure 2.5.) In *Reshape* and *Reshape+,* the global drop in fossil fuel consumption reduces the demand for transport of these resources. The impact of 3D printing in these scenarios is smaller but nevertheless causes some drop in demand. The materials required for 3D printing are primarily raw materials that can be transported at higher load factors compared to finished products (Wieczorek, 2017[10]; Chen, 2016[11]). The exogenous factors of trade regionalisation assumed in *Reshape+* slow freight growth even further.

Sea-based transport continues to dominate freight activity with more than 70% of tonne-kilometres, regardless of scenario (Figure 2.5). In *Reshape+,* the mode share of maritime trade drops slightly due to the drop in import/export transport activity, and particularly in longer distance inter-regional trade. Air and rail activity increases in all scenarios. The share of airfreight remains very small, however, with less than 1% of total tonne-kilometres. Lighter but higher-value goods tend to be transported by air. Urban freight activity growth follows the same overall pattern: it grows in all scenarios compared to 2015 values, but its growth slows in *Reshape* and even more in *Reshape+*. Parcel deliveries, such as those in urban freight, can seem small when measured in tonne-kilometres but can account for a large number of trips and vehicle-kilometres given their low weight-to-volume ratio. Parcels are expected to grow more than other commodities in the urban freight commodity mix.

Figure 2.5. Global demand for freight transport by mode to 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Surface includes freight transport by road and rail, as well as inland waterways, excluding urban freight. Air transport accounts for less than 1% of total demand.

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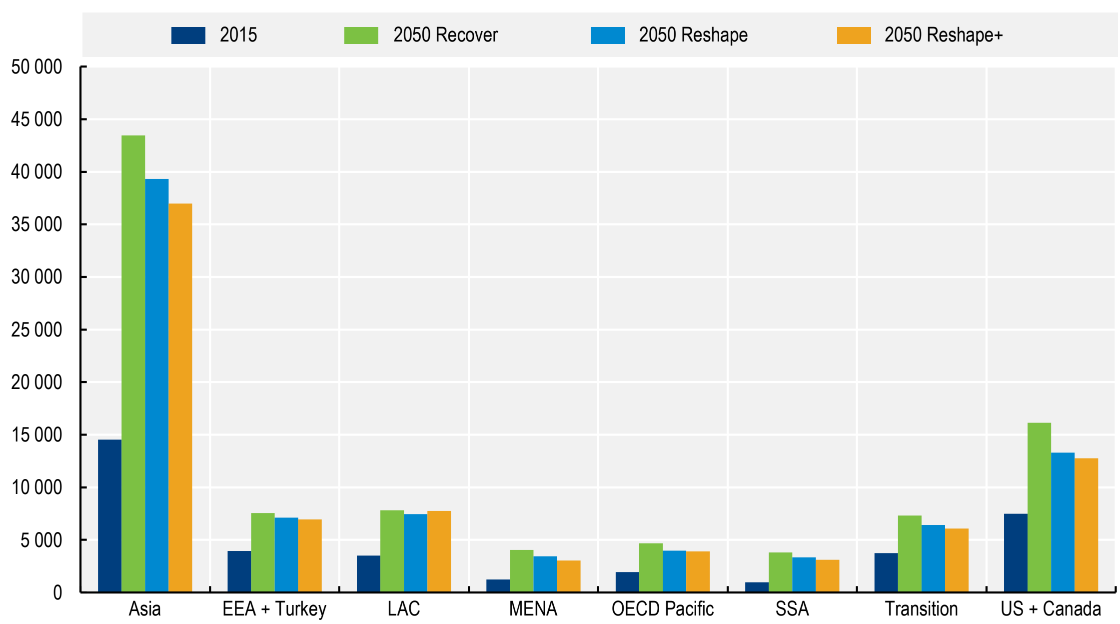
The share of fossil fuels movements among all international transport activity drops from 29% in 2015 to as little as 8% by 2050. Under the conditions of the *Recover* scenario, its share in 2050 is 17%. Under *Reshape*, that share is halved to 8%. Under *Reshape+,* it falls even more compared to 2015 levels but keeps the same 8% share because other commodities also grow at a slower pace. Lower fossil fuel use will have significant impacts on imports and exports in different regions. In 2015, fossil fuels made up nearly half of import-related transport in the European Economic Area (EEA) and Turkey. In *Reshape,* fossil fuel imports drop 51% by 2050 and 53% in *Reshape+*. Worldwide, total imports grow 129% in *Reshape*, and 108% in *Reshape+*. Transition countries (made up of the Former Soviet Union and non-EU south-eastern European countries) and MENA, which rely heavily on fossil fuel exports, have their export-elated transport activity drop by 21% and 27%, respectively, in a *Reshape* scenario from 2015 to 2050. In *Reshape+* the drop is 26% and 32% respectively.

Figure 2.6 shows the distribution of surface freight demand by region. While tonne-kilometres generated by surface transport (less than 30% of total demand in all scenarios) are attributed to regions, tonne-kilometres completed by sea or air are particularly challenging to attribute to specific countries. In international waters, freight activity is under the jurisdiction of the International Maritime Organisation (IMO). The International Civil Aviation Organization (ICAO) governs international airfreight. Airfreight is responsible for less than 1% of total tonne-kilometres. Figure 2.7 shows the sea regions where maritime activity occurs.

Asia has the greatest demand for surface freight, which could triple under current policies reflected in the *Recover* scenario. The largest relative increase in freight transport by road, rail, and inland waterways is expected in Sub-Saharan Africa (SSA), where freight demand could quadruple. However, in absolute figures, the region generates the least demand. *Reshape+* policies achieve a 15% to 24% decrease in most world regions compared to *Recover* by 2050, except for Latin America and the Caribbean (LAC) and EEA and Turkey. EEA and Turkey could limit demand by 8% in 2050. LAC experiences a slight increase in surface freight in *Reshape+* for *Reshape*. The assumptions on trade regionalisation in *Reshape+* favour trade within the region, leading to an increase in surface tonne-kilometres. However, the total impact when sea-based import and export activity is considered is a reduction in freight activity.

Figure 2.6. Demand for surface freight transport by world region to 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Surface freight includes road, rail and inland waterways. It does not include international maritime and airfreight. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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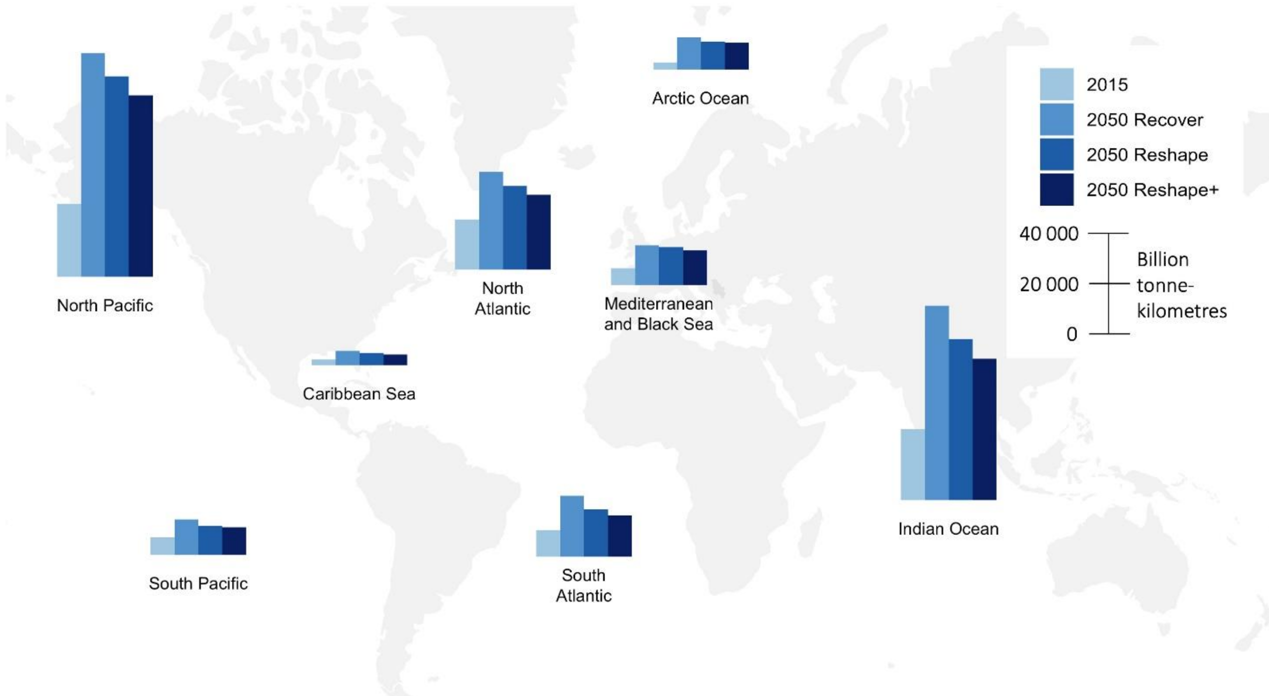
The North Pacific and Indian Ocean have the highest levels of freight activity which is expected to more than double in all scenarios, as shown in Figure 2.7. The North Atlantic had similarly high levels of freight activity in 2015 but will not grow to the same extent. The IMO is responsible for setting measures and targets concerning decarbonising freight activity in maritime regions. However, the international nature of shipping requires greater co-ordination and collaboration amongst operators, owners, flag states and port states. Individual countries are often reluctant to act alone in case more ambitious restrictions impact their competitiveness.

Figure 2.7. Projected demand for maritime freight transport by world region to 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport.

Transport emissions and climate goals: Can we still get there?

Limiting global temperature increases to "well below 2°C" and pursuing efforts to limit the increase to 1.5°C in line with the Paris Agreement (UN, 2015[12]), means restraining cumulative greenhouse gas (GHG) emissions to below a limited 'carbon budget'. Since GHG emissions accumulate in the atmosphere, the earlier measures are put in place, the higher the chances of limiting climate change. As part of the latest IPCC special report on 1.5°C, some academic institutions modelled high ambition, decarbonisation scenarios across all sectors of the global economy. The results of these 'whole system' models suggest that annual emissions from the transport sector must drop to approximately 5.9 gigatonnes CO_2 by 2030 and 2.6 gigatonnes CO_2 by 2050 to limit temperature increases to 1.5°C and avoid overshooting carbon budgets (IPCC, 2018[13]). While there continues to be a large degree of uncertainty about the magnitude of remaining carbon budgets, these median estimates can serve to gauge the levels of ambition required to meet climate targets.

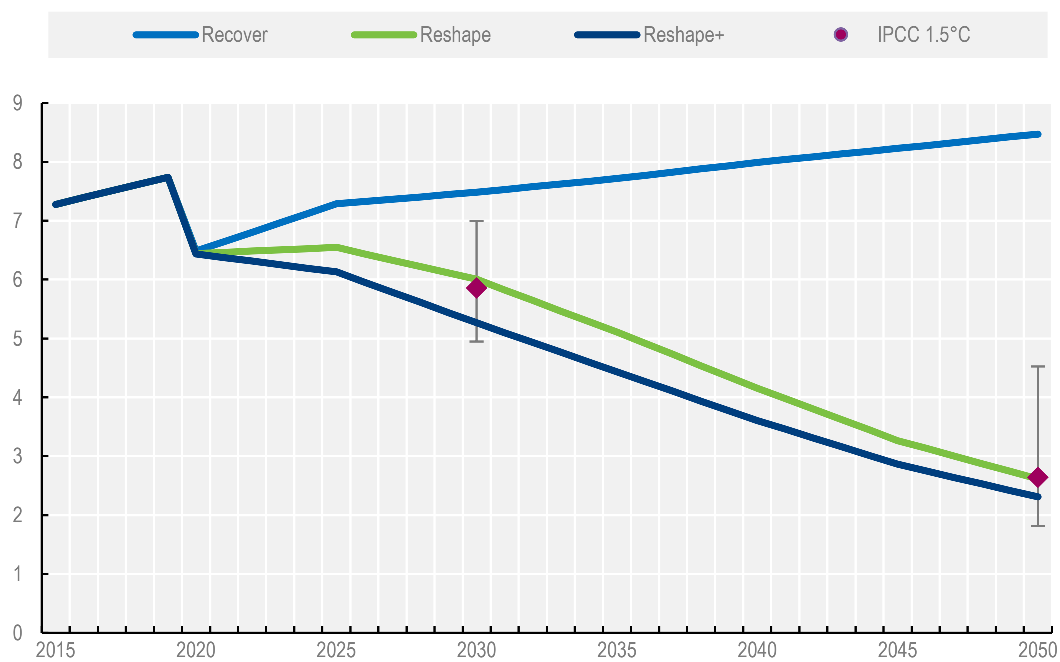
CO_2 emissions under a *Recover* policy agenda will not meet climate targets. Annual transport CO_2 emissions in the three *ITF Transport Outlook 2021* scenarios are presented in Figure 2.8. In the *Recover* scenario, transport emissions continue to grow, driven by increasing travel demand, a limited shift to more energy-efficient modes, and limited adoption of low carbon vehicle technologies without further stimulus from policy makers. Annual emissions produced in the years 2030 and 2050 would be 7.5 $GtCO_2$ and 8.5 $GtCO_2$ respectively, meaning the *Recover* scenario would be insufficient to meet Paris climate goals.

A policy agenda based on *Reshape+* gives the world greater certainty of meeting its climate targets. Both the *Reshape* and *Reshape+* scenarios offer the possibility of meeting the targets of the Paris

Agreement. The decisive policy action that underpins the *Reshape* scenario succeeds in shifting transport activity to more sustainable modes, improving energy efficiency, and rapidly upscaling the use of electric vehicles and low-carbon fuels. *Reshape+* policies further limit emissions by harnessing the momentum created by post-pandemic economic stimulus packages for accelerating the impact of emission-reductions technologies and measures.

Figure 2.8. Three scenarios for future transport CO_2 emissions

Gigatonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. ITF models used in this Outlook are typically run by five-year increments, therefore the 2020 to 2025 recovery trend may not necessarily be linear despite being shown as such in the figure. The shape of this "recovery curve" will depend on policy implementation and economic trajectories. IPCC 1.5˚C represents the emissions levels needed to limit warming to 1.5˚C as introduced by the IPCC (2018[13]) *IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C*, https://www.ipcc.ch/sr15/. The levels were calculated based on data sourced from https://data.ene.iiasa.ac.at/iamc-1.5c-explorer similarly to ICCT (2020[14]), https://theicct.org/sites/default/files/publications/ICCT_Vision2050_sept2020.pdf Transport sector emissions pathways with low or no overshoot were selected before estimating the median emissions in each year, error bars represent the 25th and 75th percentiles of scenarios. Emissions of black carbon are excluded as these are not estimated in the ITF or IEA MoMo models.

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Urban passenger transport has the greatest potential to decarbonise. Annual GHG emissions for each transport sector in the *Recover* and *Reshape+* scenario are presented in Figure 2.9. In the *Recover* scenario, emissions from freight and non-urban passenger travel continue to grow while urban emissions remain relatively constant. In contrast, emissions in the *Reshape+* scenario reduce in all transport sectors over time. The fastest reductions could occur in the urban passenger sector if highly ambitious policies are implemented; annual emissions in 2050 could be approximately 79% lower than 2015 levels.

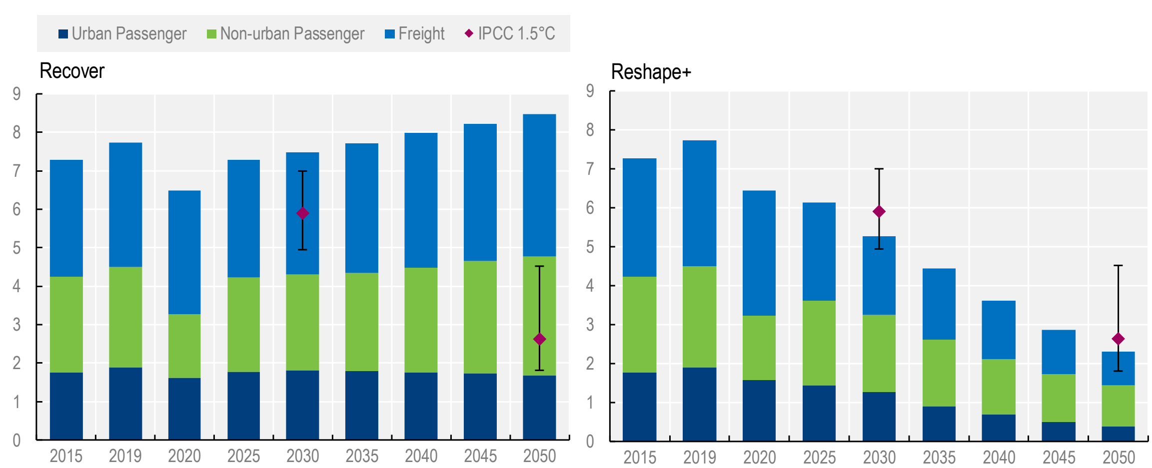
Many ways exist to decarbonise urban mobility and make rapid emissions reductions possible. The greening of city transport is driven by measures that shift travel away from private cars to other modes, stimulate the adoption of low-emission vehicles and tilt fuel demand towards low-carbon sources of energy such as electricity from renewable sources. Densification of cities through land-use policies and increased teleworking also reduce demand.

Improving energy efficiency is essential to reduce emissions from freight and longer-distance passenger travel

Longer-distance passenger travel and freight face great obstacles to reduce their emissions. Both offer fewer opportunities to shift demand on these modes to more sustainable alternatives, and low-carbon alternative fuels are still not available at scale. Electrifying aviation and maritime shipping remain limited by the relatively lower energy density of batteries compared to fossil fuels. Other alternative fuels such as hydrogen, ammonia and synthetic fuels are still at early levels of technological maturity (ITF, 2020[15]). Therefore improving energy efficiency is essential to reduce emissions from freight and longer-distance passenger travel. Under ambitious *Reshape+* policies, efficiency improvements would help bring emissions from non-urban passenger transport down 57% by 2050 and freight emissions by 72% from 2015 levels. Without a strong steer from policy action, emissions in both sectors will continue to increase over the coming decades, rapidly consuming the remaining carbon budget.

Figure 2.9. CO_2 emissions for urban passenger, non-urban passenger and freight transport to 2050

Under *Recover* and *Reshape+* scenarios, Gigatonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover* and *Reshape+* represent the most conservative and the most ambitious scenarios modelled. Graph depicts tank-to-wheel emissions for urban and non-urban passenger and freight transport in the *Recover* (left) and *Reshape+* (right) scenarios. IPCC 1.5˚C represents the emissions levels needed to limit warming to 1.5˚C as introduced by the IPCC (2018[13]) *IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C*, https://www.ipcc.ch/sr15/. The levels were calculated based on data sourced from https://data.ene.iiasa.ac.at/iamc-1.5c-explorer similarly to ICCT (2020[14]) https://theicct.org/sites/default/files/publications/ICCT_Vision2050_sept2020.pdf. Transport sector emissions pathways with low or no overshoot were selected before estimating the median emissions in each year, error bars represent the 25th and 75th percentiles of scenarios. Emissions of black carbon are excluded as these are not estimated in the ITF or IEA MoMo models.

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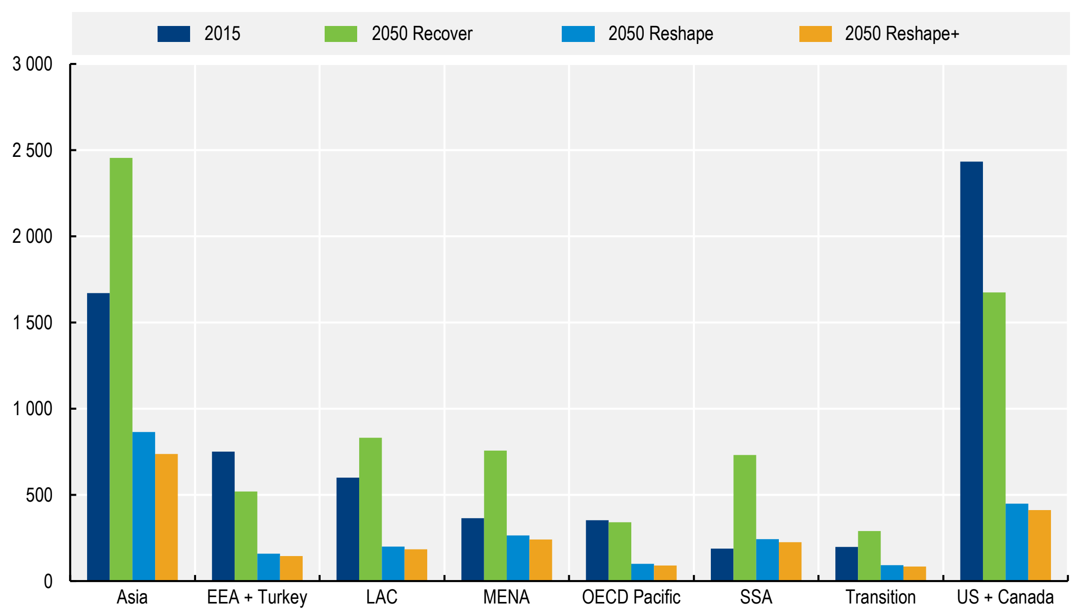
Policy measures play a key role in the adoption of low-carbon technologies in more ambitious scenarios. Vehicle technologies are adopted most rapidly in developed economies represented by OECD countries in the model and other fast-growing economies such as the People's Republic of China. They proceed at a slower pace in developing economies. Countries that pursue net-zero emissions as their official policy or that have made other ambitious national mitigation pledges achieve decarbonisation objectives more rapidly than others. The uptake of electric vehicles, for example, is stimulated by firm commitments to phase out internal combustion engines. Conversely, vehicle fleets in countries without fuel economy standards or similar regulations are likely to pocket fewer efficiency gains.

The United States and Canada plus the EEA and Turkey produced more transport emissions than the rest of the world combined in 2015 despite accounting for just 13% of the world's population. Future trends suggest that developing economies will account for a larger share of emissions in the coming decades. Under *Recover* policies, only regions with relatively high income – EEA and Turkey, OECD Pacific and the United States and Canada – are expected to see reductions in annual emissions between 2015 and 2050 due to the relatively constant demand for transport and slight improvements in vehicle technologies. Conversely, emissions in non-OECD countries are likely to increase rapidly under a *Recover* policy agenda due to growing levels of income and population. In higher ambition scenarios, emissions levels could drop significantly in all regions. Figure 2.10 presents annual CO_2 emissions for the years 2015 and 2050 in each scenario by region.

Figure 2.10. Transport CO_2 emissions by world region to 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Excludes emissions from international sea and airfreight. International aviation demand is attributed to the origin country. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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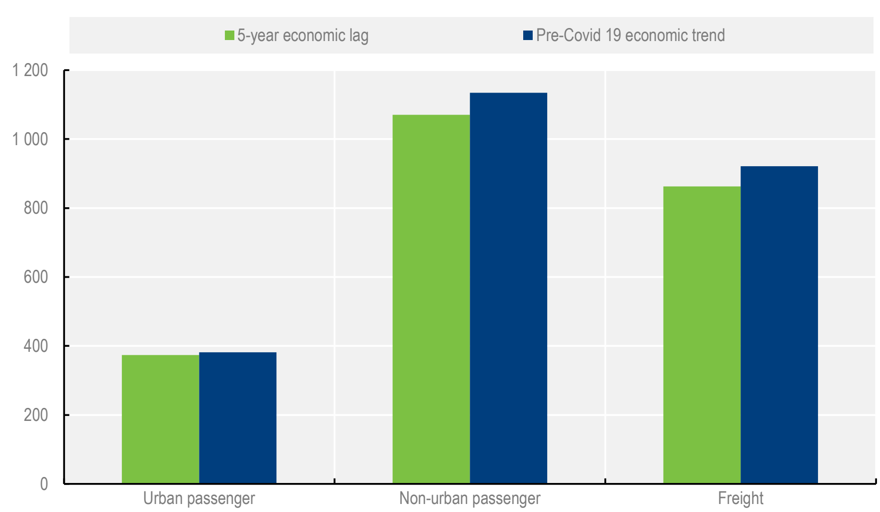
The impact of an economic lag on CO_2 emissions

To account for the economic impact of the Covid-19 pandemic, GDP and trade projections in this *Transport Outlook* are adjusted from pre-pandemic forecasts by including a five-year time lag for years after 2020. For example, GDP estimates in the year 2030 are assumed to be at pre-pandemic levels of the year 2025. There are various projections for what economic recovery will look like, ranging from the more optimistic bounce-back scenarios to dampened recovery expectations. The true demand and CO_2 emissions observed in the years to come will depend on the actual economic recovery pathway.

To better understand the magnitude of the impact of the five-year lag in GDP growth and trade, the *Reshape+* scenario was assessed assuming pre-Covid-19 economic projections. The impact of this five-year GDP time lag assumption on 2050 CO_2 emissions under a *Reshape+* scenario is shown in Figure 2.11. The pre-pandemic economic growth trends lead to 6% higher CO_2 emissions from non-urban passenger transport and 7% higher CO_2 emissions from freight. The lag in economic growth has a limited impact on urban passenger emissions: they are 2% lower than without the lag. The impact of GDP is more pronounced in the freight and non-urban passenger sectors, which are more sensitive to income, as demonstrated by the elasticities in Figure 2.2. Although urban passenger transport in non-OECD countries is more coupled with GDP when looking at the growth between 2015 and 2050 (as is done in Figure 2.2), its effect is not linear. By 2050 the difference in the elasticity of demand to GDP between non-OECD and OECD countries is much less. As countries become wealthier and latent demand is realised, the sensitivity to GDP decreases. Therefore, by 2050, under highly ambitious decarbonisation policies (as described by a *Reshape+* scenario*)*, urban passenger transport, globally, is less affected by GDP assumptions.

Figure 2.11. The impact of different post-pandemic recovery paths on transport CO_2 emissions in 2050

Under alternative *Reshape+* scenario assumptions, million tonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. The ITF Transport Outlook 2021 assumes a five-year lag in economic activity from 2020 onwards to simulate the economic impacts of the pandemic. To demonstrate the impact of economic assumptions on transport emissions, this figure shows the CO_2 emissions under the most ambitious of the three scenarios modelled for this *Transport Outlook* in terms of decarbonisation measures, the *Reshape+* scenario, juxtaposing results for the assumed five-year lag and also assuming the pre-Covid-19 economic trend.

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Transport emissions and social equity: Who pays for decarbonisation?

The uncertainty of whether technologies under development will be able to contribute on a large scale to reverse the rise of CO_2 emissions creates an imperative for impactful near-term mitigation. The simulations presented in this Transport Outlook demonstrate that the right policies can deliver progress in transport decarbonisation and also towards sustainable development in a broader sense. The modelling results demonstrate that decarbonisation policies can narrow regional differences in per capita CO_2 emissions due to action in all regions. However, the responsibility to pay or fund these initiatives is not equally borne. Inequalities between and within countries for emission contributions, climate change consequences, and economic opportunities mean that the responsibility to act and fund change is also not evenly divided.

Given transport's strong contribution to individual well-being, all decarbonisation efforts must not apply CO_2 mitigation measures at the expense of access to opportunities. This is especially true for vulnerable groups whose access has not been a priority for most transport systems in the past.

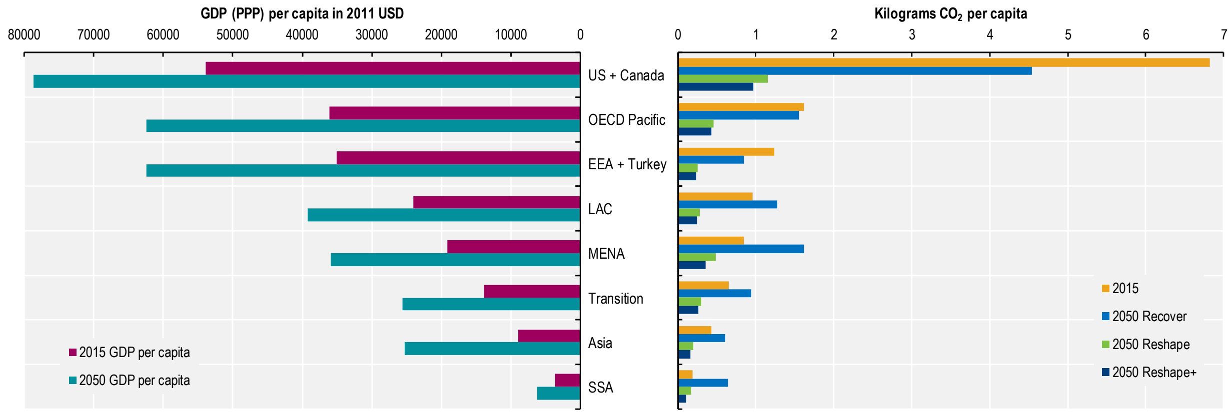
Ambitious decarbonisation policies will narrow emissions imbalances between regions. Per-capita CO_2 emissions for the United States and Canada region are at least four times, and up to 36 times, higher than for inhabitants of any other world region. Yet under a *Reshape+* scenario, this multiplier could be lowered to between 2.3 and 9.4 times. With the most ambitious policy agenda, the United States and Canada could by 2050 emit approximately the same amount of CO_2 per capita as the Latin America and the Caribbean (LAC) region in 2015. As the region with the highest GDP per inhabitant, the United States and Canada have the means to fund a low-carbon transition that could achieve the largest relative reduction in per capita emissions of all regions: a cut in transport CO_2 by 86% to 2050. Figure 2.12 juxtaposes transport CO_2 contributions in 2015 per capita, and the evolution of these emissions in regions under the different policy scenarios, alongside estimates for GDP per capita for 2015 and 2050.

Sub-Saharan Africa remains the region with the lowest per capita emissions from 2015 to 2050 despite its population growth. It also generates the lowest GDP per inhabitant. The region comprising the EEA and Turkey could reduce per capita emissions to 20% of its 2015 level by 2050 under *Reshape+* policies, while LAC and OECD Pacific could reduce it to 25%. The LAC region could reduce their 2050 emissions to approximately 20% of those in 2015. The MENA region and the Transition countries reduce their per capita emissions less significantly but could still reach 40% of their 2015 level by 2050. Without additional policy interventions, Asia, LAC, MENA, SSA and the Transition countries are all expected to increase per capita emissions over the next 30 years.

Responsibility for the global costs of decarbonisation is linked to cumulative emissions. The regions that have long-standing fossil-fuel-based industries have emitted the most cumulative emissions and gained the greatest economic benefits during the age of oil and coal. The latter now gives them privileged access to capital and technologies and thus the means to invest in decarbonisation. They can support climate action in regions that contribute less to global CO_2 emissions. Capital investment and technology transfer could enable these regions to leapfrog transport systems that historically led to excessive emissions in developed regions (Kosolapova, 2020[16]). The United Nations conclude there are sufficient global assets to finance sustainable development. However, the available capital is currently not channelled towards these goals at the scale and within the timeframe necessary to meet the Paris Agreement targets and SDGs (United Nations, 2019[17]). Mobilising capital to fund cleaner transport and support regions where it is most needed and most crucial for global climate action is an opportunity to bridge economic and social inequalities and set the world on a cleaner, more equitable path.

Figure 2.12. Per-capita transport CO_2 emissions and GDP by world region to 2050

Under three scenarios, emissions in tonnes per capita (tank-to-wheel), GDP per capita in 2011 USD at purchasing-power parity



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Graph depicts tank-to-wheel emissions. Emissions from international maritime or airfreight emissions are not attributed to countries and are therefore excluded. Emissions from international passenger movements are attributed to origin countries. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Greater decarbonisation ambition can mean more equitable and resilient urban transport – if implemented well. There is considerable room to align environmental sustainability and well-being goals in urban transport. A passenger transport system that allows users to access their needs affordably, reliably, conveniently and safely without owning a car is not only more sustainable but more equitable than what is commonplace today. While cars will have an important role, transport systems should not plan for them as the default option for all. It also addresses important negative externalities of congestion, air pollution and road safety while at the same time reducing the amount of space currently required to accommodate privately-owned vehicles.

Chapter 3 discusses in greater detail how higher ambition decarbonisation policies such as those underpinning the *Reshape* and *Reshape+* scenarios can improve the accessibility and resilience of urban transport systems. It also details the equity considerations policy makers will need to address to ensure policies are implemented fairly. In urban contexts, measures to reallocate road space and pricing schemes, as well as investments in affordable and safe public transport, shared mobility, active and micromobility may facilitate a shift away from private car use and support development patterns that can reduce urban sprawl. Such initiatives better serve the needs of lower-income populations, women, older and younger people who all tend to be more reliant on modes other than the private car. The travel patterns of women in particular will benefit considerably from better accommodating active travel (Miralles-Guasch, Melo and Marquet, 2015[18]).

Improved vehicle and fuel technology decarbonises transport and drives economic growth through innovation. Measures to incentivise the development of cleaner technologies in shared and public transport fleets are particularly important to support a transition away from private car dependency (Buckle et al., 2021[19]). These fleets are more intensely used than private vehicles, and therefore cleaner technologies have a bigger impact. They also have higher rates of turnover, which makes them ideal candidates to adopt new technologies, which can be accelerated with the right policy incentives.

Incorporating digital technology into vehicle operations, e.g. for optimal routing or real-time user feedback can boost energy efficiency, reduce congestion, increase safety and all the while foster economic growth.

Citizens with lower incomes should not pay high prices for decarbonising. Carbon and road pricing mechanisms to reduce the use of more polluting modes, such as private vehicles, can be implemented in a manner that does not unfairly burden lower-income populations. Pricing plays a significant role in managing non-urban passenger transport demand, and Chapters 3 and 4 offer a detailed discussion of this aspect. In some areas of the world, households are forced to own cars or motorcycles due to the lack of alternative transport options. Those who cannot afford newer vehicles may face higher costs than those who can buy cleaner vehicles that are exempt from charges or for which reduced rates apply. Pricing mechanisms also have a strong effect in aviation. Since a tiny and affluent share of the world population is responsible for most air travel, pricing flights to better reflect their carbon footprint shifts costs to those responsible (Gössling and Humpe, 2020[20]).

Policies that would impose new financial burdens on citizens warrant an analysis of distributional impacts first. Who is affected by additional costs and by how much will differ. Factors that play a role are the spatial distribution of origins and destinations, the transport options available, the cost and reliability of these alternatives, and constraints on households. Complementary measures to reduce the overall financial burden on these groups can be a help. For example, Sweden simultaneously lowered the income tax rate as it increased the levy on energy products (Speck, 1999[21]). Concerning world regions, pricing policies could have a more pronounced impact on developing economies than developed ones. The difference in per capita travel demand is greater between regions in the *Reshape+* scenarios than the *Recover* scenario. However, even with the implementation of pricing policies, the difference in non-urban activity between regions narrows (improves) between 2015 and 2050. Ultimately, economic measures will not successfully reduce CO_2 emissions while simultaneously maintaining or improving accessibility levels unless more sustainable, reliable, and affordable alternatives are provided. The focus should be on providing viable alternatives and designing land use in a way that supports these alternatives.

Delaying decarbonisation will increase freight costs. Under *Reshape* and *Reshape+* policies, supply chains shorten and carbon pricing increases freight transport costs where higher-emitting modes are used. Regions located at a distance from the main global consumption centres or that have not decarbonised their freight sector enough see the average transport costs of their exports rise under *Reshape+.* This is the case notably for the MENA and SSA regions. Global freight transport will risk being perceived as unfair if the decarbonisation in these regions is not accelerated or their negative cost impacts for the concerned countries mitigated. Technology transfer and investment in regions with lesser means must be prioritised to avoid imposing prohibitive costs and ensure that the regions with the most capacity to decarbonise are not the sole winners who gain all the cost benefits of such measures.

Transport export costs drop most in the EEA and Turkey by 2050 in the *Reshape* scenario. Some of the most ambitious policies are deployed in the European region, reducing emissions but also bringing greater efficiency and lower costs. A stronger modal shift towards rail than in other regions also contributes to this.

Key takeaways

- Transport demand will grow under all three scenarios, but far less under ambitious decarbonisation policies. The greater the decarbonisation ambition, the more transport demand decouples from GDP growth.
- Implementing more ambitious decarbonisation policies in the wake of the pandemic would bring the Paris climate goals into reach. Continuing with pre-pandemic policies will miss them.
- Developed countries have the highest CO_2 emissions but also the best access to capital to fund the decarbonisation of their transport systems. To avoid imbalances, they should ensure developing countries with lower per capita emissions can also transition to clean transport.
- Decarbonisation policies must be implemented with care. They must consider potential distributional impacts and ensure measures are consistent with equity and well-being objectives.

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3 Urban passenger transport: Cities can make mobility sustainable, equitable and resilient

This chapter demonstrates that urban passenger transport plays a vital role in curbing greenhouse gas emissions, boosting access to opportunities and spurring economic recovery from the Covid-19 pandemic. It presents three scenarios for future urban passenger transport demand and resulting CO_2 and local pollutant emissions, as well as the impacts on accessibility for citizens. It also discusses how decarbonisation initiatives can help to reduce inequalities and make urban transport systems more resilient.

In Brief

Continued urbanisation demands sustainable, accessible and resilient transport

Urban travel is responsible for 40% of all greenhouse gas emissions from passenger transport. Between 2015 and 2050, demand for urban passenger transport is poised to more than double after a temporary dip due to Covid-19. Unless cities succeed in cutting their transport emissions, the increase in urban mobility could jeopardise the climate goals of the Paris Agreement.

Urban passenger transport emissions could be cut nearly 80% by 2050 if more ambitious actions are taken than those foreseen under current commitments - despite the growing mobility demand cities will have to accommodate in the face of continuing urbanisation. Under ambitious scenarios, citizens will travel in smarter and more sustainable ways while enjoying better access to their desired destinations. By contrast, under current policies urban transport emissions would be at about the same level 30 years from now, decreasing by only 5%.

Avoiding unnecessary trips, shifting to more sustainable transport and improving vehicle and fuel technologies will prove decisive. Reducing our reliance on cars in cities is pivotal to decarbonise urban mobility. Three-quarters of all emissions from urban passenger transport come from private vehicles. In 2015, they accounted for half of global urban travel, or 2.6 times all public transport activity. The economic, environmental, and social costs are significant: excessive car use causes health problems, increases social inequalities, cements our dependence on fossil fuels, and perpetuates congestion.

Improved public, shared and active transport services, coupled with fewer incentives to use private vehicles in cities, would accelerate decarbonisation and make the opportunities cities offer more accessible for a greater number of citizens. Integrating land-use planning with transport policy will support less costly, less emitting and less space-consuming ways to travel around cities than cars.

Our urban transport systems would also become more resilient under stringent climate policies. A greater variety of travel choices for citizens means less reliance on one form of transport and thus flexibility to absorb disruptions. The pathways to sustainable, equitable and resilient urban transport lie before us. Now we need ambitious policies in place that steer us in the right direction.

Policy recommendations

- Empower cities to decarbonise urban mobility and enhance accessibility to improve well-being.
- Prioritise funding for sustainable urban transport over investment in city roads.
- Improve the quality of public transport to create more inclusive and reliable services.
- Pursue integrated land-use and transport planning for sustainable, neighbourhood-based urban development.
- Create incentives for greening urban vehicle fleets.
- Nurture transport innovation and collaborate with providers of new urban mobility services to maximise benefits and minimise costs.
- Combine transport decarbonisation and resilience measures now to meet future demand in sustainable ways and withstand disruptions.

As the world becomes progressively more urban, passenger transport faces growing demand in cities across the globe. Urban trips far outnumber all other passenger trips worldwide. Under current policies, ITF estimates a 163% global increase in travel activity by 2050 compared to 2015 levels. Cities have long been hubs for creativity and innovation, thanks to their density of infrastructure, people, and services. Despite the uncertainties of pandemic recovery, they are uniquely positioned to be at the forefront of equitable climate mitigation solutions that meet increasing demand sustainably. Under the right conditions growing urbanisation could be an opportunity, instead of a challenge, for decarbonising transport

Urban passenger transport is responsible for 40% of all passenger transport greenhouse gas (GHG) emissions. ITF scenarios show that by adopting highly ambitious decarbonisation policies and leveraging pandemic recovery to focus on decarbonisation efforts, urban passenger transport-related CO_2 emissions could be reduced by nearly 80% by 2050, compared to 2015. Integrated transport and land-use planning to create denser neighbourhoods with transit-oriented development (TOD) and provisions for safe active and micromobility are vital to reducing trip lengths and making sustainable modes a convenient choice. Estimates suggest that disruptions such as shared mobility and micromobility have an increasingly important role in the sustainable mobility landscape, if well integrated with public and active transport. Improving vehicle technologies in private and public fleets, as well as reallocating and redesigning road space to better support sustainable modes is also imperative.

Covid-19 had an unprecedented impact on urban transport. Cities saw public transport use, road traffic and everyday mobility collapsing to record low levels due to containment measures. However, the suppression of demand will probably not last in the long term. Travel by private vehicles recovered considerably in many cities worldwide between containment efforts while public transport did not. It may suffer longer-term losses without policy intervention. Despite the challenges of the pandemic, recovery does present potential opportunities to reshape our future trajectory. The ability to capitalise on these opportunities will depend on local governments' initiatives and funding support from national stimulus packages.

Cities are at a crossroads. They are striving to recover economically from the pandemic. They face the ever-mounting consequences of climate change. They are on the front line in the fight to tackle rising social inequality. Urban transport has a vital role in economic recovery, climate change mitigation and reducing social inequalities. But economic, environmental and social policies must align. Such alignment will also enhance public support and cost-effectiveness of the required policies. A change in perspective is needed to align policy goals: away from a siloed approach with a single objective and negative externalities; towards system-wide thinking that analyses the impacts of policies on multiple objectives and considers the interdependencies between them.

So what does this shift in perspective mean for transport policy-making?

Policy should shift from accommodating increasing traffic growth and transport volumes to improving access to opportunities. Authorities can do so by supporting integrated approaches to land-use and transport planning and prioritising demand-side policies that reduce the need for travel or shift travel to more sustainable modes. A more equitable system that allows residents to access a variety of opportunities and services via sustainable modes, conveniently, affordably, and over shorter distances is central to meeting environmental objectives as well. Authorities face massive challenges as they develop new policy agendas under the added uncertainty of pandemic recovery. This *Transport Outlook* assesses what urban transport might look like under three different global policy scenarios. The results show potential changes in transport activity, CO_2 emissions, and local pollutants under different policies. CO_2 emissions represent total GHGs as CO_2 equivalents. The results provide a starting point for these decisions.

Decarbonising urban passenger transport: The state of play

Three-quarters of all urban transport GHG emissions came from passenger transport in 2015, according to ITF estimates. The high density of infrastructure, people and services in cities provides greater potential for non-motorised, shared, and public-transport-based mobility compared to non-urban areas. Yet many urban areas are dominated by individual motorised transport with associated problems of GHG emissions, air pollution, noise, traffic injuries and congestion. These externalities lead to adverse health outcomes, social inequalities and affect the overall well-being of urban dwellers. The related economic, environmental and social costs are too big to overlook.

Authorities around the world are paying increased attention to urban transport decarbonisation within their broader transport policy commitments. Almost 40% of countries mention some form of urban passenger transport-related measures in their nationally determined contributions (NDCs) under the 2015 Paris Agreement (ITF/OECD, 2018[1]). They include 54 developing and fast-growing economies (GIZ, 2017[2]). Measures proposed by local authorities in select urban areas worldwide further add to their countries' commitments. For instance, 167 cities across the planet have committed to collaborating on actions to reduce GHG emissions in all major sectors, including transport. Out of these, 54 have developed climate action plans compatible with the Paris Agreement (C40, 2020[3]).

Urban transport systems are at risk of disruption due to climate change and other events like pandemics. Resilient systems designed to resist, absorb and adapt to disruptions' impacts without halting delivery of transport services become increasingly important as the planet faces a rise in extreme natural events due to climate change (Ahmed and Dey, 2020[4]). Floods, rainstorms, droughts or higher-than-normal variations in urban temperatures have immediate and long-term negative impacts on transport infrastructure and services (Zhou, Wang and Yang, 2019[5]; CDP, 2020[6]). Furthermore, transport is more dependent than ever on Information and Communication Technologies (ICT). Disruptions in transport, communication or power systems could reduce or even temporarily eliminate access for inhabitants of affected urban areas.

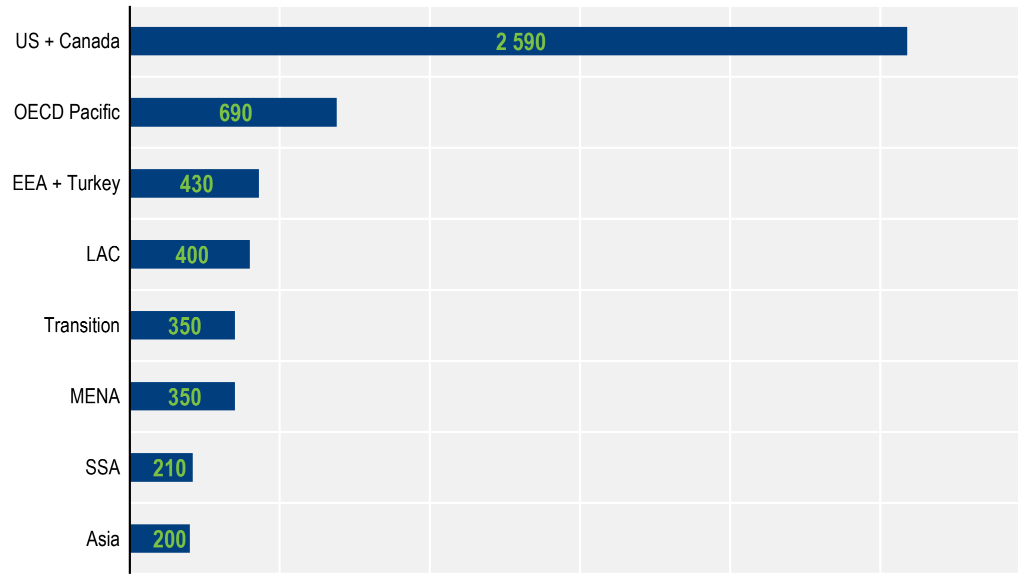
In an equitable transition to sustainable transport, environmental ambitions go in hand with promoting wider well-being. Any efforts to decarbonise the sector must not unfairly burden certain groups over others. A shift from traditional mobility-focused planning to one that prioritises accessibility will be instrumental in promoting both goals. Mobility is not an end in itself but rather a means to an end. It provides adequate access to jobs, education, health centres and other essential, thus improving citizens' well-being. (OECD/ITF, 2019[7]; OECD, 2019[8]). Vulnerable populations are already the most disadvantaged in terms of transport access and climate impacts, shouldering disproportionate costs from the travel decisions of others (Banister, 2018[9]; Sustainable Development Commission, 2011[10]; Gough, 2011[11]). Cities should take special care to reverse, not exacerbate, this trend with decarbonisation policies.

Routes to decarbonisation will differ between countries and cities. The challenges of developing equitable, sustainable, and resilient urban transport systems vary from country to country, from city to city. Current levels of per-capita emissions differ dramatically between OECD and non-OECD countries, and urbanisation patterns that drive demand for transport also differ between world regions.

City-dwellers in OECD countries have the largest transport carbon footprint. The highest emitting cities produce 28 times those in the least emitting. Urban inhabitants of OECD countries emit the most CO_2 per person, while people living in cities across Africa and some parts of Asia emit the least. Measures in OECD and some fast-growing economies will need to decrease urban transport-related emissions per capita. Non-OECD economies will need to focus on limiting the increase of per capita emissions while meeting growing transport demand. Figure 3.1 shows the average levels of CO_2 per capita generated by urban passenger transport worldwide in 2015, split into eight categories.

Figure 3.1. CO_2 emissions per capita of urban passenger transport in 2015

Kilograms CO_2 emissions per capita



Note: Figure depicts ITF modelled estimates. Averages by region are calculated as averages across all urban areas.

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A growing world population combined with fast-paced urbanisation will inevitably increase transport demand in cities. By 2050, almost seven billion people will live in cities, approximately the entire world population of 2015 (UN, 2018[12]). Cities in developing countries will grow most over the next thirty years. Sub-Saharan Africa's urban population will increase at the fastest pace, almost tripling between 2020 and 2050. In Asia, the urban population will nearly double in the same period. Authorities in these regions will be hard-pressed to meet this growing demand in sustainable ways.

Individual motorised transport dominates most cities. In 2015, more than a third of passenger trips were made by private vehicles, 2.5 times those made with public transport. These trips accounted for more than half of all urban passenger-kilometres in that year. The adverse health effects, social inequalities, fossil fuel dependence and congestion caused by excessive car use entail high economic, environmental and social costs. Yet projections see the global private passenger vehicle fleet growing by more than 30% between 2020 and 2030, reaching 1.4 billion vehicles by 2050 (IEA, 2020[13]). Already in 2015, private vehicle use generated three-fourths of all urban passenger transport-related GHG emissions worldwide (Figure 3.2). This is mostly the result of continued growth in both private vehicle ownership and increasing average vehicle size. The United States and Canada, taken together as one region, have 733 vehicles per 1 000 inhabitants and the highest share of emissions from private car use in international comparison (OICA, 2020[14]). The growing demand for larger sports utility vehicles (SUVs) is further challenging emission reduction. Nearly half of all cars sold in the United States in 2018 were SUVs, and worldwide the share of new SUVs has doubled compared to a decade ago. (IEA, 2019[15]).

How can cities handle growing mobility demand?

Policies to avoid unnecessary travel or shorten trips are crucial but must still provide good access. Some urban decarbonisation strategies rely heavily on the development and uptake of zero-emission technologies. To achieve the climate objectives of the Paris Agreement targets, avoid and shift policies must be equally central if the aim is to establish an equitable as well as a sustainable transport system. Shifting necessary travel to less carbon- and space-intensive modes reduce environmental, social and economic side effects. Cities will also need to foster the adoption of improved technologies and increase average vehicle fuel efficiency. These policies are complementary and should be applied in a balanced manner (Gota et al., 2019[16]) based on what is most appropriate for the region.

Integrated planning of transport and land use is essential to making journeys shorter and sustainable. Compact urban development patterns co-ordinated with public transport planning prevents inefficient and costly patterns of development. Mixed land-uses and compact development allow residents to access their needs without travelling long distances**.** Transit-oriented development (TOD), commonly defined as mixed-use urban development within close proximity (walking distance) to mass-transit facilities, can deliver on this goal. It concentrates higher-density, mixed development near access points for public transport. This makes using public transport convenient, encourages ridership and decreases car dependency.

> The amount of space given to different transport modes does not match their relative importance for sustainable transport

Cars should be allocated less urban space. The amount of space given to different transport modes does not match their relative importance in a sustainable transport offer. Cars are the most space-intensive mode of transport, and space in many cities is devoted mainly to cars. As an example, around 60% of road space in Freiburg (Germany) was dedicated to cars in 2016, while they made only 30% of trips. Cycling also accounted for around 30% of trips, but cycling infrastructure only made up around 4% of all road infrastructure (Gössling et al., 2016[17]). This brings negative environmental but also social and economic consequences. For instance, they are fast and heavy, making them potentially dangerous for more vulnerable road users such as pedestrians, cyclists and, increasingly, users of micromobility (ITF, 2021[18]). Reallocating road space to active modes, installing priority lanes for public transport and limit parking space can help cities to shift the mode share away from cars. The rising popularity of micromobility is putting pressure on existing roads and limited cycling infrastructure. Successfully integrating them with the transport network makes space reallocation even more important. Shared mobility will also change the way cities manage pavement space. Increasingly, pavements will resemble flexible, multi-use spaces that allow for pick-up and drop-off of passengers as priorities shift away from parking for private cars in dense city areas (ITF, 2018[19]).

Managing road space depends on evolving passenger and freight transport needs. Deliveries by light commercial vehicles are growing. Bicycle couriers and growing micromobility put additional pressure on urban space. However, jointly managing urban passenger and freight transport offers an opportunity for better allocating road space and reducing congestion. At the same time, it improves the distribution of transport flows (Pimentel and Alvelos, 2018[20]). The main trends in urban freight transport across the globe are discussed in Chapter 5. A better understanding of the linkages between passenger and freight urban transport activities and measures will come from more research into these issues.

Car users must pay the real cost of parking and driving. Most drivers only pay a fraction of the costs associated with urban car traffic; car use thus greatly exceeds the optimum (ITF, 2021[18]). This inefficiency will persist as long as prices are not equal to the marginal social costs or other measures constrain traffic. Various economic instruments and regulatory measures can optimise demand and mitigate congestion. These include different forms of road charges, parking pricing, vehicle restriction schemes and others. Carbon pricing would apply to all CO_2-emitting modes but particularly target private cars with internal combustion engines, which emit most CO_2 per passenger-kilometre. All efforts to reduce car use should be accompanied by investments in low-carbon alternatives to car travel.

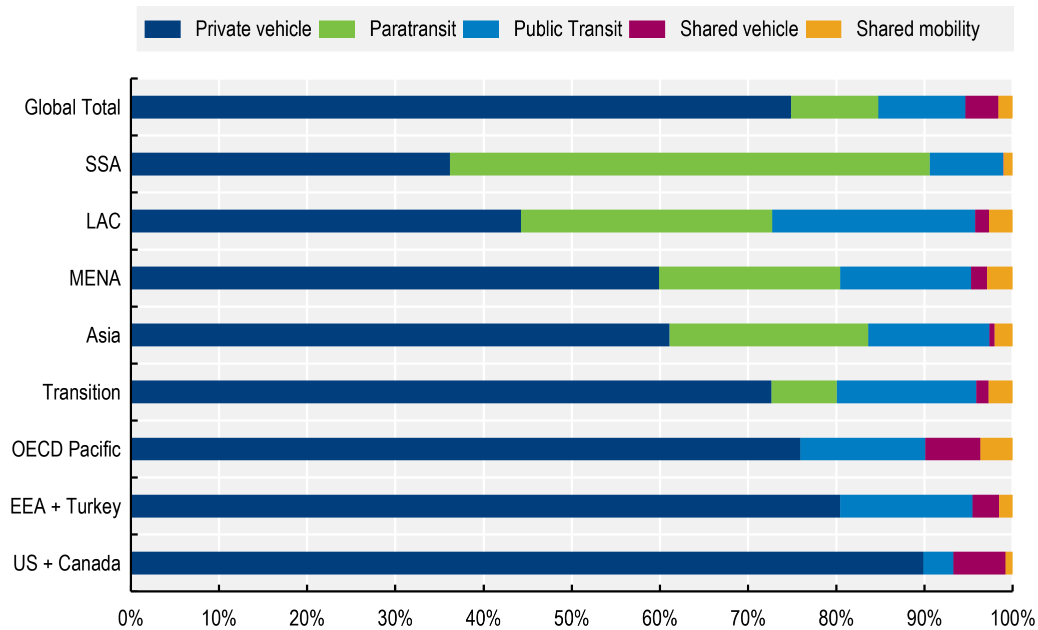
Uptake of new technologies requires investment and incentives. Policies to promote technologies that offer alternatives to private vehicles include purchase incentives for electric and other low-carbon vehicles, investment in charging infrastructure, fuel economy standards (GIZ, 2019[21]). New services such as shared mobility can operate more efficiently than private vehicles through optimised routing, increased load factors and better capacity use.

Self-driving cars and electric vehicles are no panacea for curbing emissions. Future transport emissions will not fall to the required levels through automation and electrification alone (Fulton et al., 2017[22]). Automated and electrified cars are only a part of the solution, not the solution, because of implementation challenges and the externalities they create. For example, the fast-growing share of electric vehicles in some developed and fast-growing economies do not address the negative externalities from congestion, regardless of their energy efficiency. Also, electric vehicles reduce local emissions and improve air quality, but they will only contribute to decarbonisation if powered with clean electricity. Automated cars bring the risk of increasing congestion in cities, among others by facilitating empty runs. Because of their limitations, technical improvements like automation and electrification will only yield sustainable gains in transport decarbonisation if combined with other measures in a holistic approach. This includes policies aimed at reducing demand and a shift to sustainable modes.

Fleet improvements in mass passenger transport systems will be particularly important in developing nations. In 2015, Latin America and the Caribbean and Sub-Saharan Africa were the only two global regions where public transport was responsible for most GHG emissions, given the technologies used in both formal and paratransit services (see Figure 3.2). The average fleet age in these regions varies from city to city but can be as high as 20 years in cities such as Lima in Peru and Conakry in Guinea (Salazar Ferro, 2015[23]). Fleet improvement and electrification programmes are essential in these regions to decrease emissions in the future. However, the current regulatory ambiguity of paratransit service operations poses challenges to fleet renewal (The World Bank, 2019[24]).

New shared mobility services have great potential to reduce the need for private vehicles. In combination with alternative fuels, such innovative services could achieve significant emission reductions. A lot of uncertainty surrounds the widespread adoption of shared mobility, however (Fulton et al., 2017[22]). It will require solid supportive policies and financial incentives to ensure that services with higher load factors are succeeding, rather than services that create additional traffic (ITF, 2020[25]; ITF, 2016[26]). Currently, shared mobility services are offered mainly by private-sector operators. Examples of collaboration with local authorities exist, however. In Mexico City, shared mobility operator Jetty was working with the city to fill service gaps in public transport. This contributed to a shift from private cars to Jetty's vanpooling service, particularly among higher-income users. Other forms of "agile mobility", for instance, electrified two- and three-wheelers, have appeared in urban areas in developing countries such as Nepal and Colombia. These services can often complement existing public transport services for the last mile (ITF, 2019[27]).

Figure 3.2. Mode share of urban passenger CO_2 emissions by world region in 2015



Note: Figure depicts ITF modelled estimates. Active mobility and micromobility include walking, biking, scootersharing, and bikesharing. Public transport includes PT rail, metro, bus, LRT, and BRT. Paratransit includes informal buses and PT three-wheeler. Shared vehicle includes motorcycle and carsharing. Private Vehicle includes motorcycles and cars. Shared mobility includes taxis, ridesharing, and taxi buses. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Public authorities must manage urban transport innovation so it will deliver the maximum social and environmental benefits (ITF, 2019[28]). This requires digital integration that facilitates ticketing, fare and routing co-ordination with existing public transport, as well as the integration of schedules and physical urban space that allow for seamless modal transfers. Mobility as a Service (MaaS) solutions show promise and could serve as an example for this, but no implemented best practices exist yet. An unregulated approach could result in adverse environmental impacts. Forms of shared mobility could bring about between 28% and 62% reductions of CO_2 emissions, respectively, for the Helsinki and the Lisbon metropolitan areas, if integrated and in co-operation with existing public transport services, ITF simulations show (ITF, 2020[25]).

Implementation of some of the transport policy measures during recovery from the Covid-19 pandemic will prove difficult. In contrast, others may be easier to put into place due to changes in behaviour during the pandemic and the substantial investment into the recovery. The following section details the impact of the Covid-19 pandemic on urban transport and revisits policy interventions from the context of recovery.

Mastering the pandemic: Challenges and opportunities for urban mobility after Covid-19

The global response to the Covid-19 pandemic ranged from limits on gatherings to strict national lockdowns. As a result, passenger transport activity in cities almost came to a halt. In April 2020, cities such as Milan, New York City or London registered less than 10% of typical mobility levels (Citymapper, 2020[29]). The ITF estimates overall urban transport activity in 2020 at 19% of previously anticipated annual demand. As the pandemic lingers, many uncertainties about its impact on urban mobility remain. Public transport has become a major casualty of Covid-19. Walking, cycling and micromobility are enjoying a surge, on the other hand, supported by many city authorities. The pandemic will likely leave a legacy of transformative change and policy makers will need to channel that impetus towards outcomes that set the planet on the right trajectory. The policies implemented as part of the pandemic recovery will determine whether decarbonisation is thwarted or tacks to the fast lane. A list of opportunities for and challenges to, decarbonisation in the long term is given in Table 3.1, together with a summary of the short-term impacts of Covid-19 on urban transport.

Table 3.1. Potential challenges and opportunities for decarbonising urban transport post-Covid-19

Impacts	Potential opportunities for decarbonisation	Potential challenges for decarbonisation
Short-term impacts	• High levels of teleworking, reducing commuting trips • Increased use of active and micromobility • Rapid implementation of active mobility lanes/reallocation of road space • Reduction of private-vehicle use, congestion, and pollution	• Reduction in public transport and shared mobility ridership due to health concerns • Shift to private-vehicle use
Long-term/structural changes	• Increased teleworking, reducing commuting trips and increasing local trips • Focus on local trips and land use may favour land-use policy to densify neighbourhood centres. • Deployment of permanent active mobility infrastructure and reallocation of road space • Stimulus packages to aid green recovery • Change in public transport funding systems to a more sustainable model • Technologies in response to policy signals and investments spurred by stimulus packages	• Increase in private-vehicle use due to health concerns • Reduction of public transport ridership due to change in habits or sanitary concerns • Lack of funds in private and public sector for research of sustainable fuels • Lack of funds to finance public transport • Stimulus packages that support a return to the status quo • Unmanaged urban sprawl if people move out of cities due to teleworking • Delays in the adoption of cleaner technologies due to lack of investment by private and public sector (e.g. slower the renewal of fleets, deployment of new infrastructure)

Note: Short-term impacts are based on observed changes in travel behaviour during the pandemic that hurt or hinder decarbonisation efforts. Most long-term and structural opportunities rely on well-designed recovery policies, while challenges add constraints to future decarbonisation.

Cities at a standstill

Teleworking became the new norm" during the lockdown". In the United States and European Union, approximately 48% and 42% of the workforce, respectively, was working from home (Sostero et al., 2020[30]; Bloom, 2020[31]). Confinement measures led to drastic declines in commuting and leisure trips (Google LLC, 2020[32]). For those unable to telework, economic consequences have been significant. In developing economies, where informal work is more prevalent, stay-at-home orders had particularly adverse impacts on incomes.

Lower traffic volumes rapidly reduced air pollution in cities from Manchester to Mumbai. Lockdowns resulted in a 60% reduction in NO_2 and a 31% reduction in particulate matter levels in a study of 34 countries. The NO_2 reductions, in particular, are credited to the dramatic drops in traffic (Venter et al., 2020[33]). Congestion and its externalities were virtually eliminated in cities like Beijing and Mumbai. Other urban centres recorded substantial reductions at least during the height of lockdown measures (TomTom, 2020[34]).

Public transport was a primary casualty of the pandemic. Typically the backbone of a sustainable and efficient urban transport system, passenger numbers on public transport fell drastically and have not yet recovered. To curb the spread of Covid-19, authorities urged citizens to use alternative modes to enable better social distancing. Many cities observed a 70-95% drop in ridership, while some faced as much as a 97% loss (Puentes, 2020[35]). The corresponding decrease in revenue is severe, and in some cases, public transport services were drastically cut as a result. Routes were suspended, schedules reduced, and occasionally mass transport was completely suspended (Dormer, 2020[36]; de la Garzia, 2020[37]; BBC, 2020[38]).

Reductions in public transport services hit essential workers and vulnerable groups particularly hard. According to a US-based study, 36% of public transport commuters under normal conditions are essential workers, and 67% of them are from ethnic minorities (TransitCenter, 2020[39]). Privately owned paratransit services shut down because of a lack of riders. This eliminated a connectivity option, notably for poorer neighbourhoods in many developing countries, and left many low-income workers with no choice but to walk or cycle long distances (IGC, 2020[40]).

Public transport operators have pivoted and adapted their operations to maintain services during the Covid-19 crisis. Measures aimed at ensuring essential services, especially for essential workers. In many cities, buses and trains continued to operate with reduced capacity limits, often only 15% of the maximum. They quickly installed plastic barriers to ensure separation and protection of transport personnel. Ending on-board ticket sales and front-door boarding and adding markings to communicate distancing requirements were other popular measures (McArthur and Smeds, 2020[41]; UITP, 2020[42]).

Shared mobility was also hit by the pandemic. Demand for ridesharing and vehicle sharing programmes fell substantially, leading to a temporary suspension of services in most cities at the height of the pandemic. Many have since resumed operation with enhanced sanitary and barrier measures in place. Some ridesharing companies have introduced new services such as food delivery to regain lost revenue (Ibold et al., 2020[43]).

Walking and cycling are booming. For citizens uncomfortable using public transport for fear of exposure to the Coronavirus, active mobility became the transport option of choice. Large numbers of people made use of empty streets to run errands and exercise. Since the start of the pandemic, 1 800 cities have deployed temporary cycling and pedestrian infrastructure, closed roads, changed signalling and introduced other measures to support this shift (Goetsch and Quiros, 2020[44]). Bicycle suppliers, bikeshare operators, repair shops and cycle-to-work schemes have reported strong demand increases (BBC, 2020[45]). Data for walking is lacking.

Recovery risks – and opportunities

Orchestrating the recovery from a global pandemic is new territory. Uncertainty abounds about how long the pandemic threat will last and what life will look like as we learn to live with the virus. Covid-19 has introduced substantial risks for cities' sustainable transport agendas, as witnessed by the hit taken by public transport. Yet there are also opportunities to seize, notably to lock in positive behavioural change adopted by citizens, for now, by the pandemic.

Teleworking and its interdependence with transport dominates the discussion about post-pandemic cities. Much debate currently centres on telework's potential to bring down commuting levels and thereby decrease urban emissions. It is not yet certain what the net impact of teleworking will be. An increase in non-work trips often accompanies a drop in commuting, which may offset any gains (Hook et al., 2020[46]; Zhu et al., 2018[47]). Similarly, it is unclear whether the increase in energy use at home associated with teleworking will also cancel out some CO_2 reductions (IEA, 2020[48]). Even if teleworking has net CO_2 savings, it is still limited disproportionately to well-educated individuals in higher-paying jobs in developed economies which typically have a greater share of knowledge-sector workers (Dingel and Neiman, 2020[49]). The negative impact on social equity became clear during the pandemic when only those enjoying the privilege of working from home did not suffer income losses (Bloom, 2020[31]; Guyot and Sawhill, 2020[50]).

The pandemic is the opportunity to adopt a more sustainable funding model which properly reflects the social and environmental benefits that only public transport provides

Public transport operators are reeling at the loss of fare revenues during the pandemic. These losses will continue for the immediate future as operators comply with distancing rules that keep ridership down and operating costs up. The situation has prompted a massive budget crisis in public transport. Transport for London estimated a GBP 6.4 billion (USD 8.9 billion) funding shortfall between 2020 and 2022. Hong Kong's Mass Transit Railway estimates losses during the first half of 2020 to be HKD 400 million (USD 51.6 million) (McArthur and Smeds, 2020[41]). In Brazil, the National Association of Transport Companies was predicting daily losses of over BRL 1 billion (USD 184 million) across its members (Ibold et al., 2020[43]). Bailouts have been negotiated. Beyond the emergency, the crisis highlights fundamental issues in public transport funding, specifically the overreliance on fare revenues. The pandemic is the opportunity to adopt a more sustainable funding model, which properly reflects the social and environmental benefits that only public transport provides.

Reverting to pre-Covid-19 funding schemes will not be possible if the networks are to maintain an acceptable level of service. Cities are already announcing cuts to services due to the lack of fare revenues (CBC, 2020[51]; de la Garzia, 2020[37]). The current funding usually is a mix of ticket revenues, government funding, some form of taxes and other sources depending on the city. In developing countries with large shares of paratransit, these operators rely solely on fares. Transitioning from over-reliance on fares to more stable revenue sources will be necessary as public transport builds back from the crisis (McArthur and Smeds, 2020[41]). Land-value capture provides a potential mechanism. It seeks to monetise the windfall gains landowners can realise from land in proximity to newly developed public transport and to use it to pay for the network (Medda, 2012[52]; Transport for London, 2017[53]). Support from the national level for local governments to fund good public transport is another mechanism that will also benefit the economy by creating and connecting people to jobs, enabling better labour force participation (Sclar, Lönnroth and Wolmar, 2016[54]).

Cuts to public transport services now would roll back years of progress. Regaining pre-pandemic levels of public transport ridership will be difficult. If lack of funding forces operators to cut services or increase fares, this may become impossible (Steer, 2020[55]). It would undo years of progress in shifting urban mobility to sustainable transport options (McArthur and Smeds, 2020[41]). Efforts to renew public transport fleets with cleaner vehicles may be at risk, as they slip down the priorities list in the face of severely squeezed funding.

Public transport funding needs new prioritisation, not new money. Savings from building fewer new roads, car ownership and energy costs will exceed public transport investment needs (Fulton et al., 2017[22]). The patterns of public transport use will change, but its role in society remains the same: as an essential service and one of the most environmentally sustainable forms of transport (ITF, 2020[56]). It offers individuals with no access to a private vehicle the freedom to satisfy their needs. Disproportionately, regular public transport users are women, younger or older people, have lower incomes, face mobility restrictions, and come from minority backgrounds (Banister, 2019[57]).

Adapting to new travel patterns is an opportunity for better-integrated and equitable land-use and transport planning. There is much uncertainty about what travel, commuting, and urban development patterns will look like in the future. The rise of teleworking has raised concerns that commuting to central business districts will plummet. The current peak-hour, commuter-based public transport planning approach will need to adapt to remain relevant for the off-peak neighbourhood-based trips that may replace the traditional commute. Such a shift could result in a more equitable public transport system than before. An all-day public transport schedule and a system that connects neighbourhood centres would enhance public transport's role as the backbone of a transport system that aims to provide access to opportunities for all. Often, users from more marginalised groups are off-peak users, but traditional public transport planning does not prioritise their needs (Sustainable Development Commission, 2011[10]). Serving neighbourhood based trips throughout the day would enable a worker to access a shift job at odd hours, a senior citizen to visit the doctor mid-afternoon, or a mother to run errands between her job and picking up her child without having to wait for the bus for 20 minutes.

Spatially decentralised cities could lead to increased car dependency – but not necessarily. If teleworking becomes more accepted, citizens could choose to relocate from city centres to suburbs, possibly suburbs less serviced by public transport. The result could be more reliance on cars, exacerbating by growing urban sprawl. Required office trips would be longer, and running errands in a less dense neighbourhood would necessitate car travel. That said, a decentralisation of urban areas is not incompatible per se with the goal of a sustainable city. A well-managed decentralisation process that successfully shifts certain behaviours could pave the way for an even more equitable urban transport system (Chu, 2020[58]). The city of Paris has publicly announced their goals of a "15-minute city", which aims to give all residents access to their needs within a 15-minute walk from home (Moreno, 2020[59]; Paris en Commun, 2020[60]). The idea of the neighbourhood centre is not new, but recovery from the pandemic may be a unique opportunity to fast-track such initiatives. Shifts in land use to create neighbourhood centres in traditionally residential areas could start supporting new businesses and services around public transport hubs that increasingly connect neighbourhoods rather than primarily shuttling people in and out of the centre. Encouraging transit-oriented development will help keep public transport the first choice for trips unsuited to walking, cycling or scootering.

Linking transport modes will boost public transport. Integrating different transport options will be crucial to increasing public transport use again. Bus and rail can provide a strong backbone, with shared mobility services and micromobility covering the first and last mile and providing affordable alternatives to public transport during times of low demand. Mobility-as-a-Service (MaaS) platforms that use digital technologies to offer integrated scheduling and ticketing across different mobility options to simplify transfers could become increasingly important.

Protecting and promoting trust in public transport will be a challenge. A Swiss study found that between 22% and 28% of people plan to use public transport and shared modes less than before the pandemic (Deloitte, 2020[61]). An Ipsos (2020[62]) poll in the People's Republic of China found that approximately half of the respondents who had used bus and metro before the pandemic no longer do. Prioritising sanitation and protection is one way to regain some public trust in the short term (UITP, 2020[42]). In the long run, it will be crucial to maintain or improve service levels despite funding pressures and to increase the attractiveness of the public transport offer, notably through good integration with other modes.

Urban car use is recovering rapidly, at the expense of public transport. According to the study from Switzerland cited above, up to a quarter (24%) of people surveyed plan to use their private car or motorcycle more in future (Deloitte, 2020[61]). In China, where the peak of the pandemic occurred months before it reached other parts of the world, traffic in March 2020 surpassed average 2019 traffic in Beijing, Shanghai, and Guangzhou, while user numbers for metro systems were 29% to 53% below pre-Covid levels (Bloomberg News, 2020[63]). The intention to purchase new cars is also on the rise, and 77% of potential purchasers are doing so due to health concerns (Ipsos, 2020[62]). Providing public transport in the wake of the pandemic that users perceive as safe, efficient and affordable will be a key to preventing further motorisation of city traffic.

Government investment in clean technologies remains vital. Mainstreaming clean technologies and lowering entry costs for consumers requires research and development (IEA, 2020[64]). With lower private-sector R&D budgets due to the pandemics' impact on businesses, government stimulus packages offer a lifeline. Government spending that gives clean energy technologies a boost provides a good return on investment for taxpayers and correlates with employment growth (Calvino and Virgillito, 2018[65]; Dowd, 2017[66]). Incentives and subsidies for automotive technologies will primarily benefit higher-income consumers looking to purchase a cleaner car (PWC Strategy, 2020[67]). Adding conditions to recovery measures to encourage sales and investment in charging infrastructure and shared fleets would better align with the overall social and environmental goals of equitable mobility (Buckle et al., 2020[68]; Goetz, 2020[69]).

Cities have made a head start on infrastructure for active and micromobility – now is the time to make it permanent. Many cities had ambitious long-term plans for active mobility pre-pandemic. Now, where they have demonstrated success during the pandemic, cities need to capitalise on the opportunity and make temporary installations permanent in order to fast-track pre-pandemic plans.

Recover, Reshape, Reshape+: Three possible futures for urban passenger transport

This section explores potential development paths for urban passenger mobility to 2050. Its projections, presented in subsequent sections, are based on three different policy scenarios: *Recover*, *Reshape*, and *Reshape+*. These scenarios represent increasingly ambitious efforts by policy makers to reduce CO_2 emissions in cities and decarbonise urban travel.

The definition of policies within these scenarios are based on ITF research, input from experts in the form of a policy scenario survey disseminated to policy experts from all regions of the world in early 2020, and from ITF workshops held for projects under the ITF Decarbonisation Initiative in 2020. Table 3.3 details the assumed uptake of policy measures in the scenarios. All scenarios include the same baseline economic assumptions to reflect the impact of the Covid-19 pandemic: a five-year delay in GDP and trade projections compared to pre-Covid-19 levels.

The results are based on the ITF Urban Passenger Transport Model, which simulates the development of transport activity and mode shares in cities as well as emissions of transport CO_2 and local pollutants in urban areas to 2050 from the base year 2015. Box 3.1 offers a detailed description of the ITF Urban Passenger Transport Model and changes to previous versions.

Box 3.1. The International Transport Forum urban passenger transport model 2020

The International Transport Forum (ITF) urban passenger transport model assesses transport supply and demand in all regions in the world. It does so for more than 9 200 macro Functional Urban Areas (FUA). It estimates trips, mode shares, passenger-kilometres, vehicle-kilometres, energy consumption and CO_2, SO_4, NOx and PM emissions for 18 modes[1] for the period from 2015 to 2050 in five-year increments. The current version enables an assessment of the impact of 23 policy measures and technology developments which are specified for each of the 19 regional markets included in the model. The model developed at ITF was first presented in 2017 and is constantly updated and improved. Some of the key features that were updated since 2019 are described below. These changes are partially responsible for differences in model assumptions and baseline values between the 2021 and 2019 editions of the *Transport Outlook.*

Where available, socio-economic and mobility data, including GTFS data, have been collected for the FUAs. Where unavailable, the model replaces missing data with synthetic data estimated using regression analysis from similar FUAs. Inputs such as GDP per capita, geographic area and energy costs are updated for each model iteration.

In each iteration, the model first updates transport supply characteristics, which includes information on vehicle ownership, the availability of road infrastructure, public transport and other mobility services. Second, it generates trips. Third, a mode split module calculates mode shares using a discrete choice model that accounts for cost, time and accessibility attributes of the different modes. Last, transport emissions are estimated based on vehicle load factor and average vehicle emissions depending on the local vehicle fleet composition.

Table 3.2. Summary of urban model updates

	2019 version	2021 version
Urban population and cities	3.3 billion people in 11 099 cities	3.6 billion people in 9 234 macro Functional Urban Areas[2] (FUA) (United Nations, 2019[70]; OECD/European Commission, 2020[71])
Demographic model	External input	Internal demographic urban model representing population evolution for 36 age and gender groups[3] (WorldPop, 2020[72]) for each macro FUA
Land-use evolution	For each FUA, a growth rate is estimated.	For each macro FUA, different growth rates are estimated for the macro FUA centre and for its suburbs
Environmental performance	Average tank-to-wheel vehicle emissions based on the ICCT Roadmap Model (ICCT, 2019[73]) for local pollutants and the IEA Mobility Model (IEA, 2020[13]) for CO_2.	Include both tank-to-wheel and well-to-tank CO_2 emissions based on the IEA Mobility Model (IEA, 2020[13]). Includes local pollutants based on the ICCT Roadmap Model (ICCT, 2019[73]).
Trip generation model	Average trip rates	Trip rate calculated based on five distances, five ages and two gender categories
Estimation of car and motorcycle demand	Over-estimation of car and under-estimation of motorcycle passenger kilometres particularly in Asia and Latin America and the Caribbean	Reduction of car passenger kilometres and increase of motorcycle passenger kilometres, resulting in similar total demand but lower CO_2 emissions in the related world regions.
Walk access and egress trip legs	Not considered	Non-active modes include an additional walking component for access and egress.

1. The 18 modes included in the model are: walk, bike, private motorcycle, private car, taxi, public transport (PT) rail, PT metro, PT right rail transit, PT bus rapid transit, PT bus, informal bus, informal three-wheelers, scooter sharing, bikesharing, ridesharing, motorcycle sharing, carsharing, and taxi-bus.
2. Macro FUAs are aggregations of FUAs defined by the joint EC-OECD Cities in the World project and identified in the UN DESA World Urbanization Prospect 2018 project
3. Disaggregation of the city population in 36 age and gender categories

Urban mobility in the Recover scenario

In the *Recover* scenario, pre-pandemic thinking in terms of policies, investment priorities and technologies shapes urban mobility in the coming decade. Governments prioritise and reinforce primarily established economic activities to buttress the recovery. The main objective is the return to a pre-pandemic "normal". *Recover* is a more ambitious version of the *Current Ambition* scenario in the *ITF Transport Outlook 2019*.

The pandemic's impact on urban travel during 2020 gradually disappears by 2030 in the *Recover* scenario. On the positive side, policies are implemented to ensure public transport ridership returns to earlier levels. On the negative side, climate-friendly behaviours also revert to pre-pandemic practices by 2030: the shift to active mobility which helped lower CO_2 emissions during the pandemic, proves to have been temporary, for instance.

CO_2 mitigation policies in place by the start of the pandemic or about to be implemented are honoured. Pre-pandemic policies to reduce private car use continue, for instance. Carbon pricing is in place for all modes and ensures that the cost of use reflects their CO_2 emissions. No further efforts to decarbonise transport are made, however.

Technological progress in the *Recover* scenario occurs at a moderate rate. Changes in the electrification of vehicle fleets follow the Stated Policies Scenario (STEPS) of the International Energy Agency (IEA, 2020[13]).

Some cities continue to implement policies to reduce excessive car use, but change does not happen on a grand scale. Some cities and suburbs densify while others sprawl. Neighbourhoods around public transport hubs experience a modest increase in density and diversity of use. On some city streets, new bicycle and pedestrian infrastructure, speed limits, and the prioritisation of public transport help to continue a shift away from car use. Yet this remains exceptional. Some cities also restrict car use through urban vehicle restriction schemes, parking pricing and regulations, and road pricing mechanisms. Again, implementation is not widespread.

A few cities encourage low-emission vehicles through incentives and infrastructure investment. Carsharing, carpooling and shared transport modes are encouraged as alternatives to private vehicles. Public transport receives moderate investment. On average, there is little change to existing rail corridors. Bus and paratransit services improve slightly. Some cities increase their service network but do not integrate it efficiently with other modes.

Paradigm change: urban mobility in the Reshape scenario

In the *Reshape* scenario, the impacts of Covid-19 on urban travel also gradually disappear by 2030, as under *Recover*. *Reshape* differs in that policy makers set ambitious climate goals and implement stringent policies in their pursuit. Also, these more ambitious policies are put in place worldwide to different extents depending on the region. *Reshape* is a more ambitious version of the *High Ambition* scenario in the *ITF Transport Outlook 2019*.

Carbon prices are higher under *Reshape* than in the *Recover* scenario across all regions and modes.

Urban sprawl is stopped. The density of cities is maintained or increases, both in city centres and suburbs. Transit-oriented development is more pronounced than under *Recover*, increasing density and diversity around transport hubs.

Car travel is deprioritised. Street space in cities is reallocated away from cars more radically. Speed limits are reduced further. Dedicated lanes or signalling gives priority to at least parts of the public transport networks in all cities. Infrastructure for cyclists and pedestrians expands and improves dramatically in more cities. Urban vehicle restriction schemes, road and parking pricing and regulations reduce car use considerably more than in *Recover*.

Existing transport capacity is used more efficiently. Incentives for carpooling, carsharing and ridesharing have a more noticeable impact on average load factors and the availability of shared mobility.

The infrastructure for electric and other low-emission vehicles improves thanks to targeted incentives and investments, resulting in a marked reduction of average CO_2 emissions in some cities. The vehicle fleet composition follows the technology evolution assumptions of the IEA Sustainable Development Scenario (SDS) (IEA, 2020[13]).

Public transport offers a highly integrated service with seamless transfers between other modes through Mobility as a Service (MaaS) applications. Paratransit services are gradually regulated and integrated with formal public transport or shared-mobility systems, resulting in cleaner fleets in developing regions.

Reshape+: Reinforcing Reshape

In the *Reshape+* scenario, positive decarbonisation trends from the pandemic are locked in through policies that lead to permanent change. As in the other two scenarios, the negative impacts of Covid-19 on urban mobility transport are overcome by 2030. As in the *Reshape* scenario, governments set ambitious decarbonisation targets and implement policies that can deliver them. However, governments further seize opportunities for decarbonisation that emerged during the pandemic. By aligning economic stimuli with climate and equity objectives, they leverage economic recovery for environmental and social sustainability. They do so by implementing some *Reshape* policies more strongly or on a faster timeframe.

More teleworking reduces the number of commuting trips while supporting economic productivity.

Transit-oriented development on a large scale fosters positive attitudes towards public transport and counteracts any potential impact from people moving away from city centres.

Bicycle and pedestrian infrastructure is widely available. Temporary "pop-up" infrastructure for active mobility initiated during the pandemic is made permanent.

Increased incentives for the purchase of low-emission vehicles are funded from stimulus packages. The benefits of *Reshape* are moved forward, allowing the cities to reach decarbonisation sooner and with more certainty.

***Reshape* and *Reshape+* are optimistic scenarios that show what could be done if we harness the opportunity to transform transport in a pandemic recovery.** The policies are technically feasible, but ITF recognises some constraints that may limit regions from implementing every one of the measures. ITF does not seek to be prescriptive in the combination of policies. It highlights opportunities for economic stimulus packages to prioritise the creation of equitable cities while mitigating emissions.

Table 3.3. Scenario specifications for urban passenger transport

Shading denotes policies with stronger implementation in *Reshape+*

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Economic instruments				
Carbon pricing	Pricing of carbon-based fuels based on the emissions they produce.	Carbon pricing varies across regions: USD 150-250 per tonne of CO_2 in 2050	Carbon pricing varies across regions: USD 300-500 per tonne of CO_2 in 2050	
Road pricing	Charges applied to motorised vehicles for the use of road infrastructure.	0% to 7.5% increase of non-energy related car use costs by 2050, half for motorcycles.	2.5% to 25% increase of non-energy related car use costs by 2050, half for motorcycles.	
Parking pricing and restrictions	Regulations to control the availability and price of parking spaces for motorised vehicles.	5% to 50% of a city area subject to parking constraints, and 0% to 60% increase in parking prices by 2050.	7% to 75% of a city area subject to parking constraints and 20% to 150% increase in parking prices by 2050.	
Enhancement of Infrastructure				
Land-use planning	Densification of cities.	Density variation of -10% to +20% for the city centre of urban areas over 300 000 inhabitants. Density variation of -10% to +10% for cities under 300 000 inhabitants and for suburbs of urban areas over 300 000 inhabitants.	Density variation of 0% to +40% for the city centre of urban areas over 300 000 inhabitants. Density variation of 0% to +20% for cities under 300 000 inhabitants and for suburbs of urban areas over 300 000 inhabitants.	

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Transit-Oriented Development (TOD)	Increase in mixed-use development in neighbourhoods around public transport hubs.	Increases the land-use diversity mix and increases the accessibility to public transit by 5% by 2050.	Increases the land-use diversity mix and increases the accessibility to public transit by 7.5% by 2050.	Increases the land-use diversity mix and increases the accessibility to public transit by 10% by 2050.
Public transport priority measures and express lanes	Prioritising circulation of public transport vehicles in traffic through signal priority or express lanes.	0% to 40% of bus, light rail transit and bus rapid transit network prioritised by 2050.	10% to 60% of surface public transport network prioritised by 2050.	
Public transport service improvements	Improvements to public transport service frequency and capacity.	-10% to +10% service improvement for rail or corridor based public transport systems resulting in a -1% to +1% speed variation by 2050. 10% to 30% service improvement for bus and paratransit transport systems resulting in a 0.25% to 0.7% speed variation by 2050.	10% to 15% service improvement for rail or corridor based public transport systems resulting in a 1% to 1.5% speed variation by 2050. 20% to 50% service improvement for bus and informal public transport systems resulting in a 0.5% to 1.25% speed variation by 2050.	
Public transport infrastructure improvements	Improvements to public transport network density and size.	0% to 100% growth increase for the public transport network by 2050.	0% to 200% growth increase for the public transport network by 2050.	
Integrated public transport ticketing	Integration of public transport ticketing systems.	1.5% to 4.5% reduction of a public transport ticket cost, and 2.5% to 7.5% reduction of public transport monthly subscription cost by 2050.	1.5% to 7.5% reduction of a public transport ticket cost, and 2.5% to 12.5% of public transport monthly subscription cost by 2050.	
Bike and Pedestrian infrastructure improvements	Increase in dedicated infrastructure for active mobility.	20% to 300% increase in road space available to active modes by 2050 and a simultaneous increase in the speed of active modes, including micromobility	40% to 500% increase in road space available to active modes by 2050 and a simultaneous increase in the speed of active modes, including micromobility.	50% to 600% increase in road space available to active modes by 2050 and a simultaneous increase in the speed of active modes, including micromobility.
Speed limitations	Traffic calming measure to reduce speed and dominance of motor vehicles through low-speed zones or infrastructure.	2% to 30% reduction of speed on main roads, by 2050	5% to 50% reduction of speed on main roads, by 2050	
Regulatory instruments				
Urban vehicle restriction scheme	Car restriction policies in certain areas and during certain times to limit congestion. Typically applied in the city centre.	0% to 17.5% reduction of car ownership by 2050, Reduction of the car and carsharing speeds while increasing the car and motorcycle access time.	3.5% to 25% reduction of car ownership by 2050, Reduction of the car and carsharing speeds while increasing the car and motorcycle access time.	
Low-emission vehicles incentives and infrastructure investment	Financial incentives for the purchase and use of alternative fuel vehicles and investment in charging infrastructure.	Decreases average vehicle-kilometres made with diesel, gasoline and methane fuels between 0% and 4% by 2050.	Decreases average vehicle-kilometres made with diesel, gasoline and methane fuels between 0% and 36% by 2050.	Decreases average vehicle-kilometres made with diesel, gasoline and methane fuels between 0% and 45% by 2050.

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Stimulation of innovation and development				
Electric/alternative fuel vehicle penetration	Degree of uptake of electric/alternative vehicles in an urban vehicle fleet	Follows the IEA STEPS Scenario	Follows the IEA SDS Scenario	
Carsharing incentives	Incentives to encourage car rental schemes where members have access to a pool of cars as needed, lowering car ownership	0% to 15% increase in shared car availability per capita, and 0% to 40% increase in shared motorcycle availability per capita, by 2050.	5% to 30% increase in shared car availability per capita, and 10% to 60% increase in shared motorcycle availability per capita, by 2050.	
Carpooling policies	Carpooling policies encourage consolidating private vehicle trips with similar origins and destinations.	3.5% to 8.3% increase in average load factor by 2050.	7.6% to 16.7% increase in average load factor by 2050.	
Ridesharing/shared mobility	Increased ridership in non-urban road transport (car & bus)	25% to 200% increase of ridesharing vehicles per capita growth by 2050. Load factor evolution from -50% to +25% by 2050.	25% to 300% increase of ridesharing vehicles per capita growth by 2050. Load factor increase from 0% to 100% by 2050.	
Mobility as a Service (MaaS) and multimodal travel services	Improved integration between public transport and shared mobility (app integration, as well as physical infrastructure, ticketing and schedule integration). Increase in availability and load factors of shared mobility	1.7% to 10% reduction of a public transport ticket cost, and 1.0% to 6.0% reduction of shared mobility cost by 2050. Increase in the number of shared mobility vehicles and stations	3.3% to 20% reduction of a public transport ticket cost, and 2.0% to 12.0% reduction of shared mobility cost by 2050. Significant increase in the number of shared mobility vehicles and stations	
Exogenous factors				
Autonomous vehicles*	Introduction of vehicles with level 5 autonomous capabilities	The percentage of autonomous vehicles in use varies across regions: for car 0% to 3%, for bus 0% to 1.5%, for shared vehicles 0% to 6%.		
Teleworking	Reduces business and commuting trips, while increasing short non-work trips.	2.5% to 20% of the active population could telework by 2050.	3.5% to 30% of the active population could telework by 2050.	5% to 40% of the active population could telework by 2050.

Note: Range of values reflect the varying degrees of implementation of policy measures across the different world regions in each scenario. Unless otherwise specified, a % change indicates an alteration of a certain variable in a given year compared to the absence of a policy. For example, PT ticket costs are endogenously calculated for each city and year by the model, indexed to GDP, assuming no policy action. An X% decrease would be applied to the ticket price of the specific city and year.*Autonomous vehicles are considered but are not a primary factor in any of the scenarios. All scenarios assume a constant level of introduction of vehicles with Level 5 autonomy. The *ITF Transport Outlook 2019* focussed more specifically on transport disruptions, including autonomous vehicles, and assessed related scenarios.

Demand for urban travel: Managing mobility in growing cities

Demand for urban mobility depends on several factors. The most significant are population size, economic activity and land-use patterns. Population growth increases total mobility volumes (measured in passenger-kilometres), while travel per capita tends to grow as incomes increase (Rodrigue, Comtois and Slack, 2009[74]). How this travel is undertaken – by which transport mode and to which destinations – will influence total travel volumes and their associated emissions, as well as other outcomes relevant for human well-being.

The actual distances travelled are primarily influenced by land-use patterns and the density of mixed developments. Cities, where jobs are located close to residences and commercial areas will result in fewer kilometres travelled than those with sprawling, segregated patterns of development. More transport activity, therefore, is not an indicator of greater well-being. What influences the quality of life is accessibility, which considers individual needs, the locations of opportunities and the transport services between them.

Higher transport volumes are often due to limited accessibility, which results in longer trip distances and higher costs both in terms of time and budget. It also increases CO_2 emissions and air pollution.

Total urban passenger demand is projected to grow by 59% to 2030 and 163% by 2050 from the base year 2015 under the *Recover* scenario. This is higher than previously projected (ITF, 2019) due in part to improvements to the model (see Box 3.1.), such as a higher urban population and accounting for active access/egress components of motorised trips. These changes increase passenger-kilometres, while lower economic growth projections due to the Covid-19 pandemic and new policy commitments made by governments in the past two years reduce demand.

The increase in urban travel demand would be limited to 116% under *Reshape* and 104% under *Reshape+,* if even more ambitious policies were put in place between 2015 and 2050. A combination of shorter trips due to land-use changes and fewer work trips as a result of more teleworking are behind this result. These changes increase accessibility, well-being and economic growth despite lower overall transport volumes. *Reshape+*, in particular, assumes the most ambitious land-use changes and rates of telework. Some work trips are replaced by an increase in local non-work trips, but in a well-managed land-use scenario, they are assumed to be shorter in nature and are expected to have a net reduction on urban kilometres travelled.

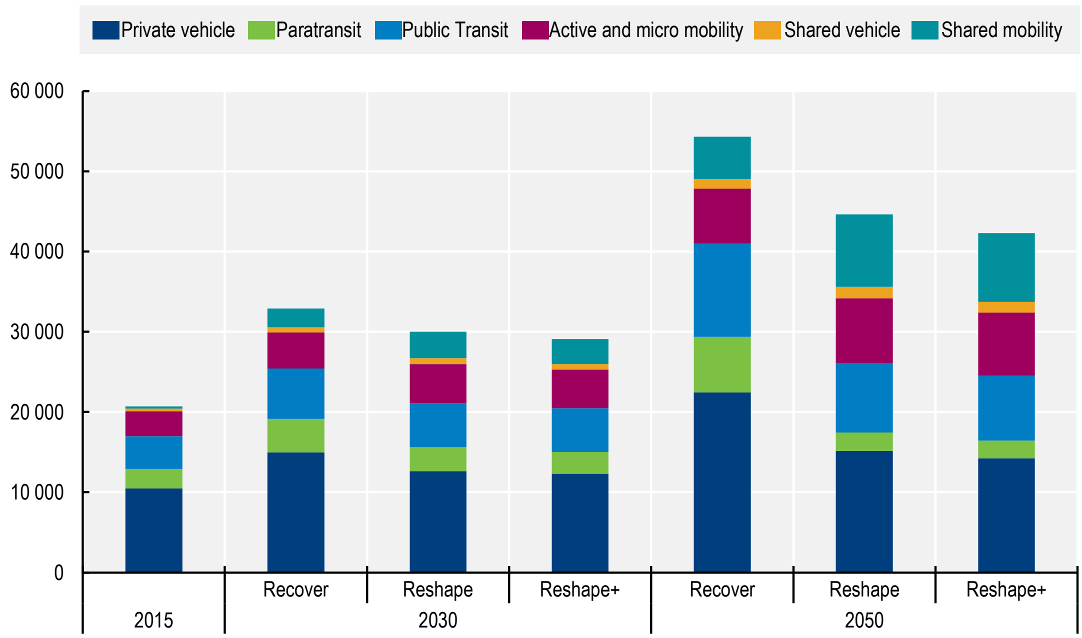
Shortening travel distances is key to curb car use in cities. More than half of global urban passenger-kilometres travelled in 2015 were made with private vehicles. By 2050, however, the more ambitious policies simulated in the *Reshape+* scenario could limit demand for private vehicle passenger-kilometres to one-third of 2050 global totals (Figure 3.3). Policies to limit private vehicle use and decrease car ownership achieve the most pronounced mode shift away from private vehicles. Car restriction schemes, pricing mechanisms for parking, road use and carbon, and the reallocation of road space away from cars all decrease the relative attractiveness of private car use vis-à-vis active mobility, public transport and shared mobility.

Changes in land use and transit-oriented development (TOD) allow for shorter travel distances and may determine whether citizens choose to drive or not. Private vehicles are more attractive to those with inferior alternatives and those travelling longer distances or linking several destinations.

In the *Reshape+* scenario, integrated land-use planning and TOD have particularly positive results in shifting shorter trips away from private cars. For distances between one and ten kilometres, private vehicle shares are 7 to 9 percentage points lower in 2050 under the *Reshape+* scenario than under the *Recover* scenario (Figure 3.4). Private vehicle use is replaced mainly by forms of active and micromobility for shorter distances and shared transport for longer trips.

Figure 3.3. Demand for urban passenger transport by mode to 2050

Under three scenarios, billion passenger-kilometres

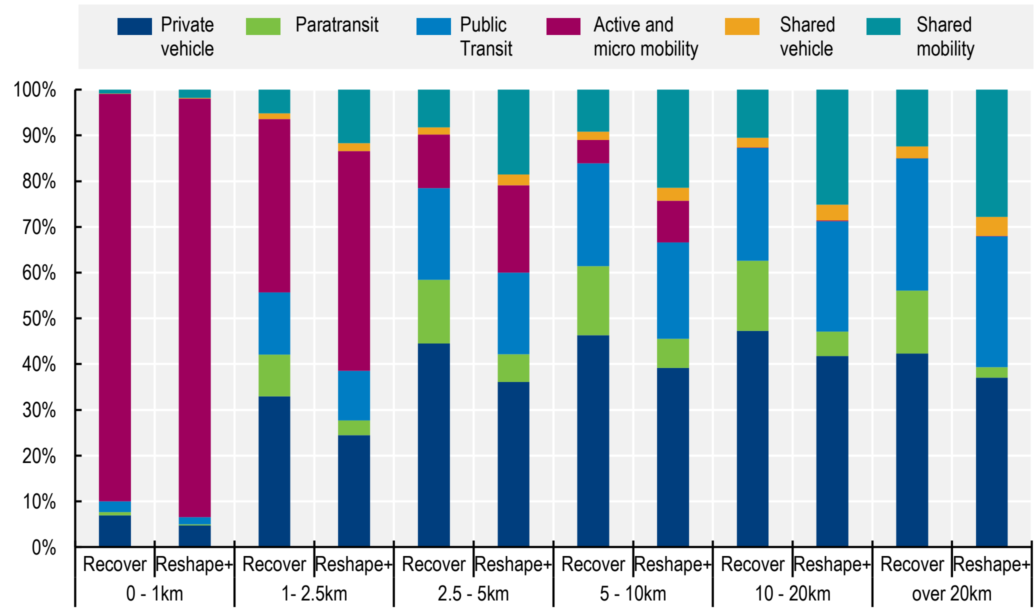


Note: Figure depicts ITF modelled estimates. *Recover, Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Active mobility and micromobility include walking, biking, scootersharing, and bikesharing. Public transport includes PT rail, metro, bus, LRT, and BRT. Paratransit includes informal buses and PT three-wheeler. Shared vehicle includes motorcycle and carsharing. Private Vehicle includes motorcycles and cars. Shared mobility includes taxis, ridesharing, and taxi buses.

StatLink https://doi.org/10.1787/888934238603

Figure 3.4. Mode shares for urban trips of different length in 2050

Under three scenarios, percentage of trips



Note: Figure depicts ITF modelled estimates. *Recover* and *Reshape+* refer to two scenarios modelled, represent current ambitions and much increased ambitions with regard to post-pandemic policies to decarbonise transport. The third scenario modelled, *Reshape,* is not shown as it results in very similar shares as *Reshape+*. Active mobility and micromobility include walking, biking, scootersharing, and bikesharing. Public transport includes rail, metro, bus, Light Rail Transit, and Bus Rapid Transit. Paratransit includes informal buses and public transport with three-wheelers. Shared vehicle includes motorcycle and carsharing. Private vehicles includes motorcycles and cars. Shared mobility includes taxis, ridesharing, and taxi buses.

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Active modes, shared mobility and public transport gain ground in ambitious scenarios. Trips by private car primarily shift to taxi, ridesharing and taxi-bus as well as shared vehicle ownership schemes for longer distances. Shared mobility grows from 1% of passenger-kilometres in 2015 to 10% in 2050 in the *Recover* scenario. Shared vehicles maintain a 2% share between 2015 and 2050. Under *Reshape* and *Reshape+*, shared vehicles account for 3% of passenger-kilometres, shared mobility accounts for one-fifth of passenger-kilometres by 2050. Public transport use grows by 184% by 2050 in *Recover*. Its share of total demand remains steady in 2050, as more of the shorter trips use active modes, especially with more ambitious decarbonisation policies in place. Walking, cycling and micromobility increase more than 2.5-fold and make up 18% of total passenger-kilometres by 2050 in both *Reshape* and *Reshape+*, growing from 15% in 2015.

Paratransit will likely be absorbed by shared mobility and public transport. Paratransit is informal collective transport. It dominates urban mobility in many developing countries. Under the *Recover* scenario, the share of paratransit grows to 13% of total passenger-kilometres by 2050. Yet in *Reshape* and *Reshape+* it plummets to only 5%, largely due to the formalisation of paratransit options in developing nations.

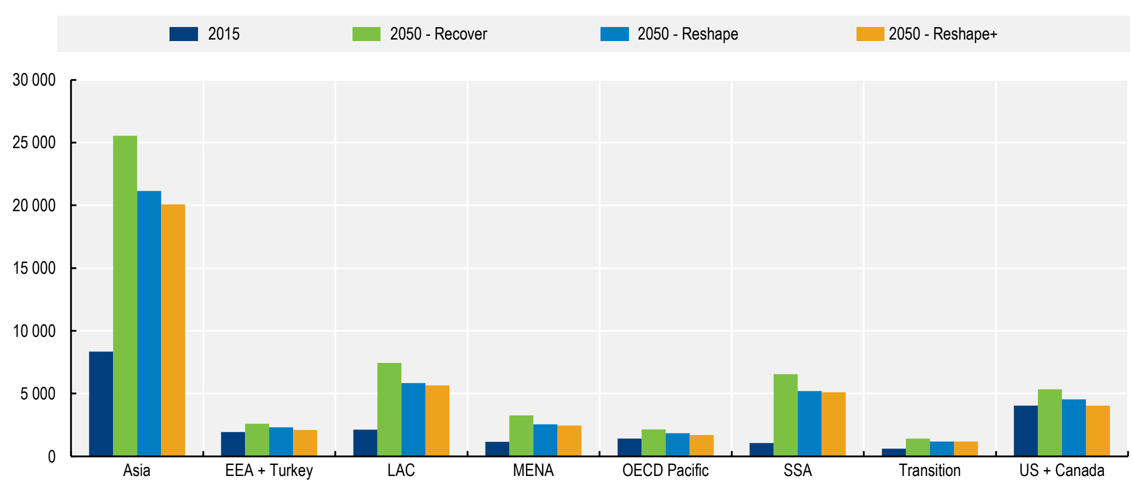
Asia remains the highest generator of urban transport demand. Total urban passenger transport demand varies considerably by region but is projected to grow in all regions under all policy scenarios (Figure 3.5). Asia contributed 40% of transport activity in 2015, the largest share of all regions. Strong economic growth, rapid urbanisation and fast motorisation of China and, to a lesser extent, India drive total urban passenger activity, which triples by 2050 in the *Recover* scenario. Policies in line with the *Reshape* scenario would cut 17% of demand compared to *Recover* in 2050 and *Reshape+,* 21%.

Significant scope exists to restrain urban mobility growth in North America. The United States and Canada were responsible for 20% of the global urban passenger-kilometres in 2015 due to low-density urban developments and longer travel distances. Cities in the region are often decentralised, requiring long commutes. *Reshape* policies would limit the growth of travel demand in cities to 13% above 2015 levels in 2050. Under *Reshape+* policies, demand growth could be frozen at close to 2015 levels. The region comprising the European Economic Area (EEA) and Turkey, as well as the Middle East and North Africa (MENA) region, also show considerable potential to limit demand growth under higher ambition policies. Compared to 2015 totals, 2050 demand growth could be 19% and 30% under *Reshape* policies, but 8% and 20% with a *Reshape+* agenda, respectively.

Population growth and economic development drive urban mobility demand in other regions. The highest relative growth in transport activity is projected for Latin America and the Caribbean (LAC) and Sub-Saharan Africa (SSA), driven by high economic growth in LAC and significant urban population growth in SSA. Under current policies, LAC's urban transport activity is estimated to be 3.5 times higher by 2050 than in 2015 and 6.2 times higher in SSA. Mitigation potential is more limited in the region due to financial constraints, urbanisation patterns, and rising living standards. However, *Reshape+* policies would enable these regions to achieve an 18% to 25% reduction in 2050 compared to a *Recover* scenario. A shift to sustainable options could allow these regions to leapfrog developed countries which are locked into unsustainable transport systems based on private vehicle ownership. Under *Reshape+,* LAC could see growth limited to 2.7 times 2015 values by 2050 and SSA 4.9 times.

Figure 3.5. Demand for urban passenger transport by world region to 2050

Under three scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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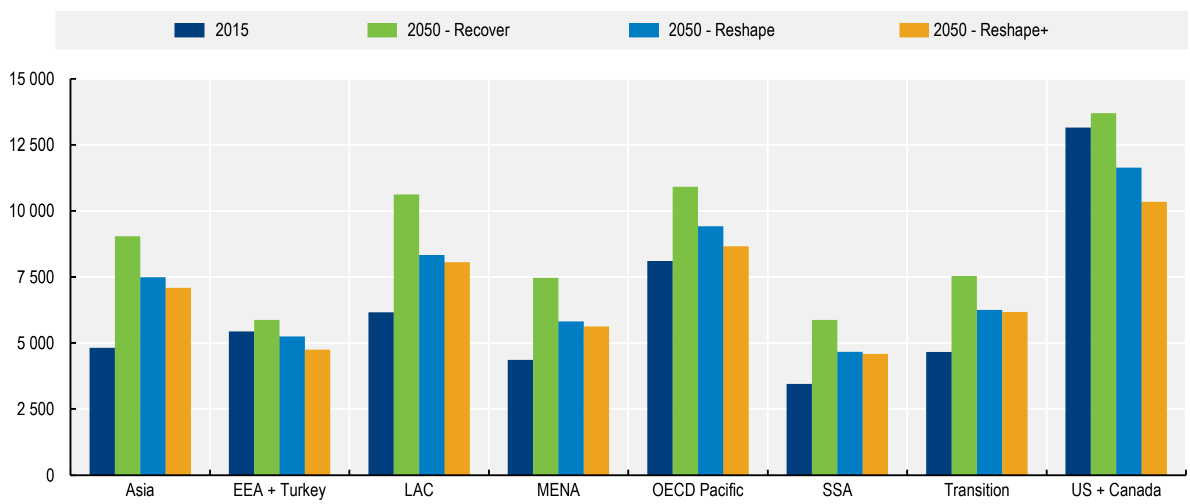
Per capita, transport demand is highest in the United States and Canada. In 2015, the United States and Canada generated 2.7 times more passenger-kilometres per person on average than individuals in Asia, the region with the largest total urban passenger demand (Figure 3.6). Urban mobility per inhabitant in the OECD Pacific region (Australia, Japan, Korea and New Zealand) is also significantly higher than in Asia, by a factor of 1.7. Compared to Sub-Saharan Africa (SSA), the region with the lowest urban travel per inhabitant, the average city-dweller in the United States and Canada generates 3.8 times as much demand, and individual travel in the OECD Pacific region is 2.3 times higher. This gap will narrow by 2050, but even then, the United States and Canada still generate 2.3 times the per capita travel demand of SSA, and the OECD Pacific region 1.9 times. The United States and Canada reduce per capita demand by 21% by 2050 under *Reshape+*, compared to 2015. The region comprising the European Economic Area (EEA) and Turkey achieves the second-highest reduction of 13%. By 2050, most other regions generate more travel activity per capita even under *Reshape+* compared with 2015 levels.

Figure 3.6. Per capita demand for urban passenger transport by world region to 2050

Under three scenarios, passenger-kilometres per capita



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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CO_2 emissions from urban mobility: Improved services, smaller carbon footprint

Tank-to-wheel CO_2 emissions from urban passenger transport are expected to decrease by 5% between 2015 and 2050 in the *Recover* scenario. This represents a drop from 1 755 million tonnes of CO_2 to 1 674 million tonnes. Total urban passenger CO_2 emissions in the baseline year 2015 are less than estimated in the *ITF Transport Outlook 2019* due to model improvements with additional calibration data (see Box 3.1). If more ambitious policies are enacted, expected emissions by 2050 could fall to 394 million tonnes in *Reshape* and 373 million tonnes in *Reshape+*, a 78% and 79% drop from 2015.

***Reshape+* policies help decarbonise faster.** The *Reshape+* scenario frontloads transport decarbonisation measures and assumes more significant behavioural change compared to *Reshape*. By 2030**,** *Reshape+* achieves a 28% decrease in CO_2 emissions from urban mobility compared to 2015, while under *Reshape* emissions fall by 25% compared to 2050. At that stage, both achieve similar reductions from 2015 emission levels of 78% and 79% respectively. What matters when comparing with climate emission targets, is the cumulative emissions. Under the policies of a *Reshape+* scenario, the sector would emit 1.25 Gigatonnes CO_2 less compared to a *Recover* trajectory by 2050.

Increases in load factors and fuel efficiency result in lower emissions. In addition to motorised passenger demand, emissions depend on how many people share a vehicle trip, known as the vehicle load factor, and the fuel efficiency of the vehicle. The preceding section describes the projected growth in demand from 2015 to 2050. In *Recover*, motorised travel holds 87% of the passenger-kilometre share by 2050, while in *Reshape* and *Reshape+* it is responsible for 82% of travel thanks to mode shift to active modes. Figure 3.7 shows the CO_2 emissions generated by mode for each scenario. In *Recover*, vehicle efficiency improves so that, on average, vehicles emit 57% less CO_2 in 2050 compared to 2015, over the same distance. In *Reshape* and *Reshape+*, emissions per vehicle-kilometre are 86% lower in 2050 than in 2015. In addition, measures to increase vehicle load factors by shifting to mass and well-integrated shared transport, and carpooling incentives, mean that average vehicle load factors are 22% higher in 2050 than in 2015 in the *Recover* scenario, and 28% to 29% higher in the more ambitious scenarios. Therefore, CO_2 emissions generated per passenger-kilometre drop by 65% by 2050 in *Recover* and by 89% in *Reshape* and *Reshape+*.

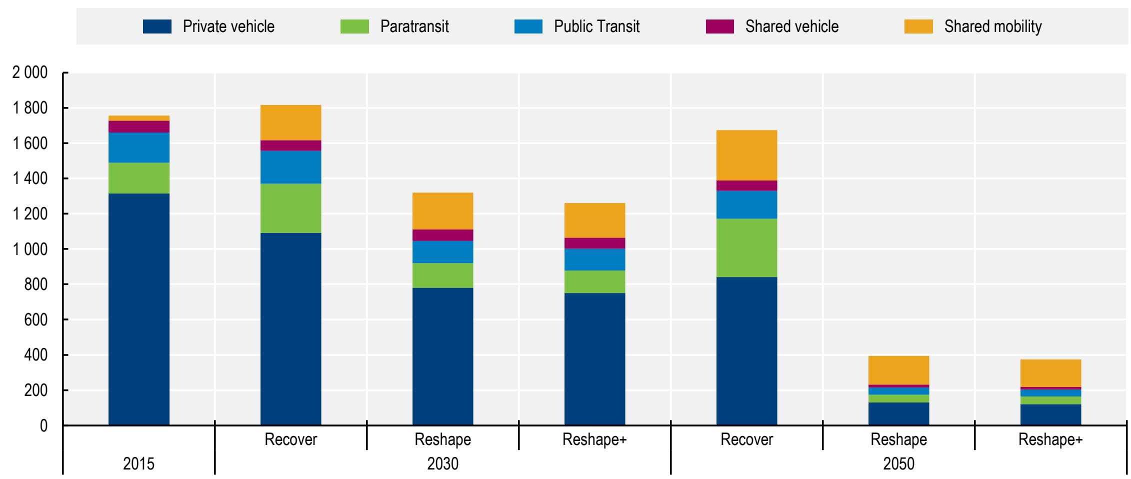
Emissions from private vehicles in cities can be more than halved. In 2015, emissions from private vehicle use made up three-quarters of urban passenger emissions. The share drops to 50% in *Recover*, primarily because of technological improvements and mode shift. In *Reshape* and *Reshape+,* they drop 56% and 57% by 2050 thanks to more pronounced mode shift, higher load factors and more ambitious expectations of new technology penetration in the vehicle fleet.

Well-integrated shared mobility is much less emitting. Most motorised modest reduce emissions by 2050 compared to 2015, in all scenarios. Shared mobility and paratransit are exceptions. The market penetration of shared mobility is very low in 2015, and as it gains mode share, its emissions appear to grow. With only minimal integration and management of shared mobility services in the *Recover* scenario, shared mobility emissions increase ten-fold between 2015 and 2050. However, in scenarios where shared mobility is well-managed and fully integrated into the transport system, its emissions grow only a little more than half as much (57% and 55% respectively for the *Reshape* and *Reshape+* scenarios compared to the *Recover* outcome). Paratransit under a *Recover* scenario also emits more due to demand growth but fall under the more ambitious policies as these informal services are integrated into the official networks.

Shared vehicles and shared mobility allow faster adoption of clean technologies. Both have higher utilisation than a typical private car, and vehicles thus need to be replaced more often. In a well-integrated system, shared mobility fills gaps in the public transport network and augments the overall offer. Swaying users to give up private cars for shared mobility requires integrated fares, routing and schedules with existing public transport via mobile phone applications. The targeted reconfiguration of urban space to make transfers seamless will also help considerably. Its potential to offer a sustainable travel alternative depends on how well it is integrated with public transport, acting as a complement to, rather than replacement of, public transport. A poorly managed system that leads to the substitution of public transport could easily have the reverse effect on emissions as seen by the higher 2050 emissions by shared mobility in *Recover*. Box 3.2 indicates some of the factors which can contribute to having higher or lower GHG emissions from shared and micromobility services.

Figure 3.7. CO_2 emissions from urban passenger transport by mode to 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Active mobility and micromobility include walking, biking, scooter sharing, and bike sharing. Public transport includes rail, metro, bus, Light Rail Transit, and Bus Rapid Transit. Paratransit includes informal buses and public transport with three-wheelers. Shared vehicle includes motorcycle and carsharing. Private vehicles includes motorcycles and cars. Shared mobility includes taxis, ridesharing, and taxi buses.

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Box 3.2. Lifecycle impacts of micromobility

The International Transport Forum (ITF) (2020[56]) report *Good to Go? Assessing the Environmental Performance of New Mobility* assessed energy and greenhouse gas (GHG) emission impacts of new mobility forms, including personal and shared electric kick-scooters, bicycles, e-bikes, electric mopeds and ridesourcing, i.e. for-hire vehicle services with drivers that use smartphone apps to connect drivers with passengers.

Key findings indicate that energy use and GHG emissions from shared are comparable in magnitude to those of metros and buses if lifetime mileage of micromobility vehicles is sufficiently high and if energy use and GHG emissions from operational services are effectively minimised.

The report also highlights that, unless ridership is increased, empty vehicle travel is reduced and vehicles are switched to energy and GHG emission saving technologies, ridesourcing (like taxis) has the highest energy and GHG emission impacts per passenger kilometre of all urban mobility options.

To ensure that the deployment of new mobility comes with net benefits for transport decarbonisation, the report recommends the following solutions:

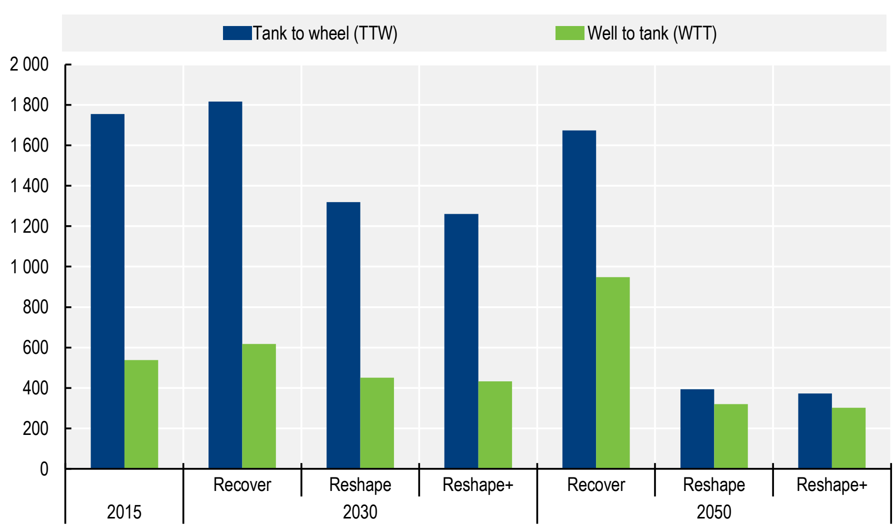
- Maximise ridership, minimise deadheading and transition towards energy-efficient and low-emission vehicles for ridesourcing (along with taxis).
- Get this started from vehicles with high lifetime mileage, not just because of the highest impacts, but also because of better economics and positive spillovers to scale up and reduce costs for technologies that have a major role to play to decarbonise transport and diversify its energy mix, like electric vehicles.

- Ensure greater transparency and access to info allowing the assessment of life-cycle impacts of micromobility.
- Adopt sound design and operational practices to service micromobility vehicles.
- Seize opportunities to help decarbonise transport from a better integration of public transport and shared micromobility (including through urban planning and Mobility as a Service).

Well-to-tank (WTT) emissions make up a larger portion of the total vehicle emissions as vehicles transition to alternative fuels. Even vehicles with low- or zero tailpipe, or tank-to-wheel, emissions cause indirect WTT emissions upstream during the production, processing and delivery of fuel. As the vehicle fleet's direct CO_2 emissions fall, the share of CO_2 emitted from well-to-tank increases. In 2015, one quarter (23%) of total urban transport emissions were indirect tailpipe emissions. By 2050, their share could increase to more than one-third (36%) under *Recover*, and to almost half (45%) under the more ambitious scenarios. If electric mobility gains ground, indirect emissions depend on how clean or dirty the electricity grid in a region or country is. Thus, shifting to alternative fuels like electricity is not a panacea to reach climate goals. A green vehicle fleet by definition requires clean energy production, and the transport and energy sectors need to work together to achieve this. Figure 3.7 presents the simulation results for the direct tank-to-wheel emissions across the three scenarios. These do not include the energy for generating electricity, extracting fuels or transporting them. Figure 3.8 illustrates the split between indirect well-to-tank and tank-to-wheel emissions.

Figure 3.8. Evolution of tank-to-wheel vs. well-to-tank CO_2 emissions from urban passenger transport to 2050

Under three scenarios, million tonnes CO_2 emissions



Note: Figure depicts ITF modelled estimates. *Recover, Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel emissions are emissions produced by using a vehicle (i.e. from the vehicle fuel consumption). Well-to-tank emissions are created during energy production. For instance, well-to-tank emissions for electric vehicles includes the emissions produced during electricity production, while tank-to-wheel emissions are null.

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Reducing regional emissions requires a two-fold strategy. A look at the differences in urban emissions between different world regions by mode reveals two patterns. Developed regions will reduce urban passenger emissions even under a *Recover* trajectory, albeit not sufficiently to reach their climate objectives. Developing regions, on the other hand, would increase CO_2 emissions by 2050 if action is not taken, due to fast-growing populations and economies.

Nearly half of the world's urban passenger transport emissions came from the United States and Canada in 2015 (Figure 3.9). However, they could achieve a more than 90% reduction by 2050 under *Reshape* and *Reshape+* policies. These would cut more than 730 million tonnes of CO_2 in 2050, the largest absolute reduction of any region. In terms of the breakdown of emissions, those from private vehicles are expected to dominate under any scenario due to high car dependence in both countries.

Asia had the world's second-highest urban transport emissions in 2015. While Asia generated more demand for mobility in cities than the United States and Canada, the related CO_2 emissions were less than half the share of the North American countries, with 20% compared to 45%. Citizens in Asia use more active travel and micromobility to get around, as well as shared and public transport options. Not least, Asia has a high proportion of relatively low-emitting motorised two- and three-wheelers making up their private vehicle fleet, in contrast with the heavier vehicles in the United States and Canada.

The largest relative reduction in CO_2 emissions under current policies to 2050 would happen in the EEA and Turkey, based on the *Recover* scenario assumptions. Under *Reshape* and *Reshape+*, the European Economic Area (EEA) and Turkey would generate the least CO_2 of all world regions, with emissions 95% to 96% lower in 2050 than in 2015. The United States and Canada region and the OECD Pacific are also the only other parts of the world projected to decrease emissions even under a *Recover* policy agenda.

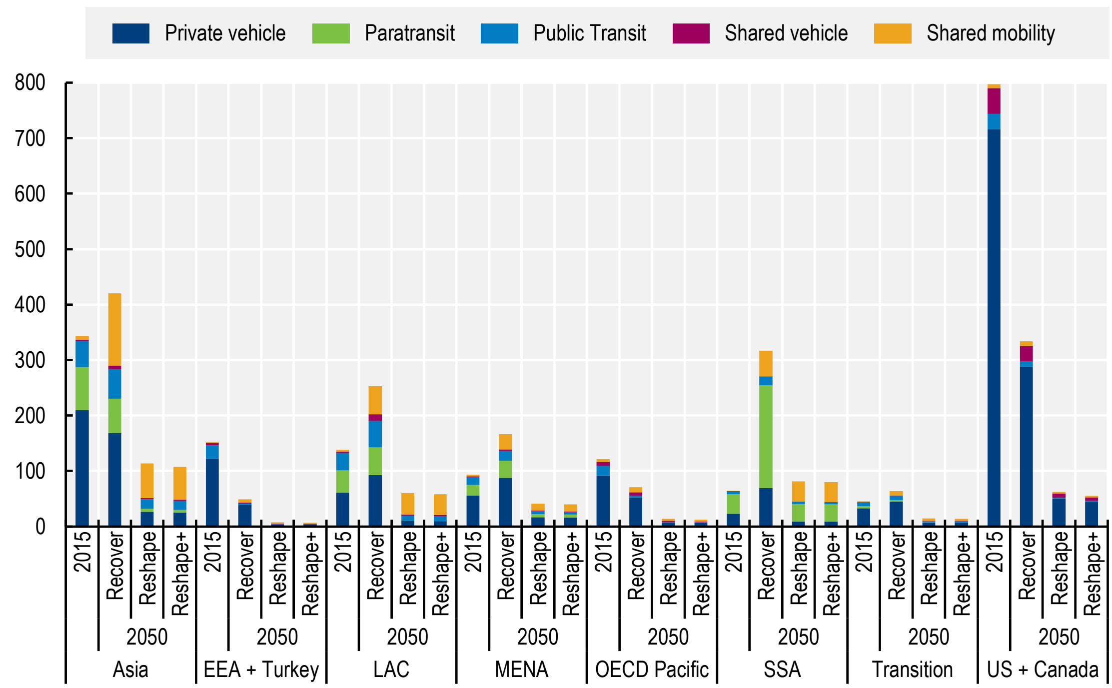
Sub-Saharan Africa will see the most substantial increase in urban emissions over the coming decades. Motorised travel demand there is projected to increase six-fold by 2050 in the *Recover* scenario as a result of rapidly-growing urban populations and economies. As a consequence, regional CO_2 emissions from urban transport would be about five times 2015 levels. *Reshape* and *Reshape+* policies would sharply reverse the trend and reduce emissions by 87% compared to *Recover* in 2050. LAC, MENA, Asia and Transition countries could also see significantly different decarbonisation outcomes depending on policies. Transition economies include countries of the former Soviet Union and non-EU south-eastern Europe. Under a *Recover* scenario, these regions will increase CO_2 emissions by 2050, but with policies closer to a *Reshape+* scenario, emissions could be 82% to 90% less than the *Recover* outcome in 2050. Asia could reduce emissions by more than 230 million tonnes CO_2 in 2050 under *Reshape* and *Reshape+* policies.

As shared mobility gains a greater mode share in *Reshape* and *Reshape+*, its share of urban emissions increase. This is the result of the desired effect, as shared mobility gains popularity when users shift from private car use to a shared system. It is particularly responsible for decreasing the share of private car emissions EEA and Turkey, OECD Pacific, and Transition countries.

The formalisation of paratransit helps drive urban emissions down in some world regions under the *Reshape* and *Reshape+* scenarios. The LAC region, in particular, sees an almost complete formalisation of paratransit, as well as a shift to shared mobility, significantly decreasing emissions. Formalisation allows regulation of vehicle standards and the adoption of cleaner fleets which can successfully decarbonise the sector. Aside from the environmental benefits, formalisation raises some equity considerations that must be taken into account and are discussed later in the chapter.

Figure 3.9. CO_2 emissions from urban passenger transport by world region in 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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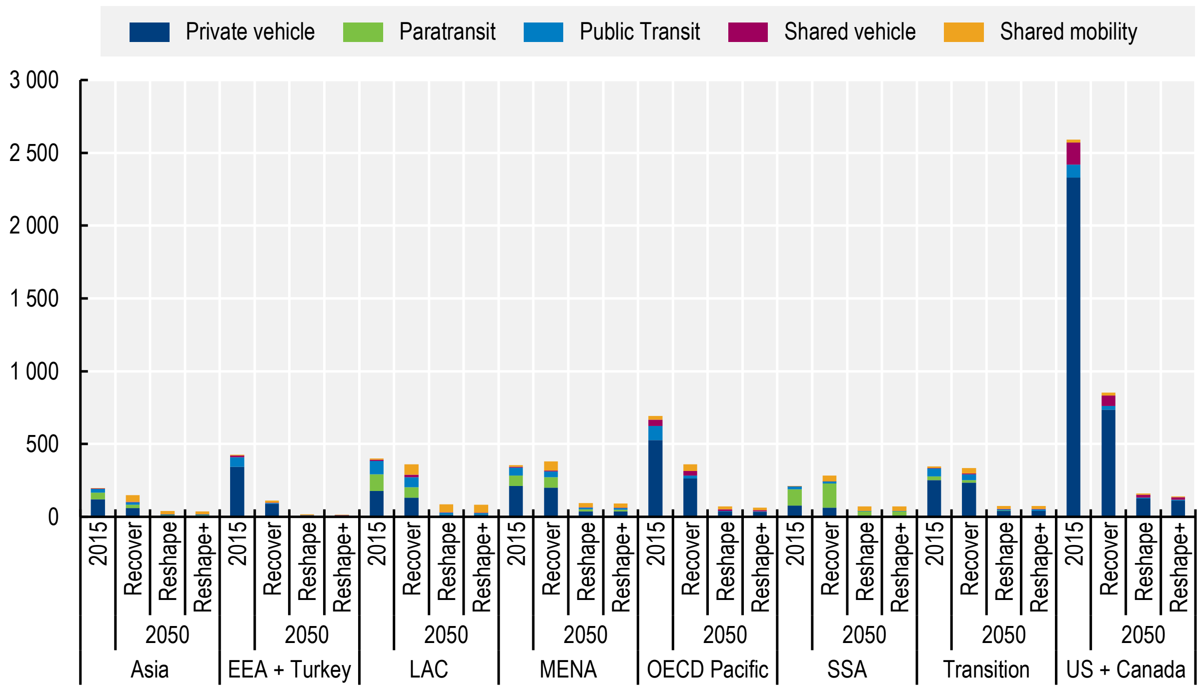
The United States and Canada could achieve big absolute urban emissions cuts per capita. All world regions reduce their per capita urban transport emissions between 2015 and 2050, under all scenarios (Figure 3.10). The emissions per person reveal a striking contrast between the United States and Canada as a region and the other world regions. The average city-dweller there generated 19 times as much CO_2 in 2015 from moving around cities as did the average individual in a city in Asia, which had the second-highest total emissions in that year. By 2050, Asian emission will have grown, but the United States and Canada region will still generate 12 times as much CO_2 per person from urban transport. That said, the reduction is still massive and represents the largest absolute drop in per-capita emissions of any region at 2 500 kg per person.

Ambitious policies could reduce per capita emissions by more than 90% in some regions by 2050, notably the EEA and Turkey region**,** followed by the United States and Canada and OECD Pacific. Under *Reshape+* policies, the EEA and Turkey region could reduce its per capita emissions to the lowest of the world regions. The SSA region has the lowest urban transport emissions per capita and will likely also reduce them the least – but it could still eliminate two-thirds of them by 2050.

Figure 3.10. Per capita CO_2 emissions from urban passenger transport by world region in 2050

Under three scenarios, kilograms direct CO_2 emissions per capita (tank-to-wheel)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Motorised transport is a significant source of local pollutants from fuel exhaust and non-exhaust mechanisms, such as brake, tyre and road wear. Urban transport contributes to the emission of nitrogen oxides (NOx), sulphates (SO4), and particulate matter of 2.5 microns or less (PM2.5). Local pollutants have acute negative health impacts. Cities can capitalise on synergies between reducing CO_2 and improving air quality to combat these.

Air pollution has a massive health impact and a massively unequal one. In 2016, 4.2 million premature deaths due to cardiovascular disease, respiratory disease and cancers resulted from exposure to PM2.5. Of these premature deaths, approximately 91% were in developing countries (WHO, 2018[75]), exposing a glaring global inequality. Transport has a co-responsibility to address this issue, as one contributor to ambient air pollution along with power generation, waste management and industry.

Air pollution from transport is most serious in cities. The concentration of people exposed to elevated pollution levels and concentration of the pollution sources themselves is high (Slovic et al., 2016[76]). Communities with higher proportions of ethnic minorities, children and lower incomes are exposed to substantially more air pollution than white and wealthier cohorts of the population (Reichmuth, 2019[77]; Barnes, Chatterton and Longhurst, 2019[78]). This is the case even within cities in developed nations because poorer communities everywhere in the world tend to be found next to large motorways and other polluters.

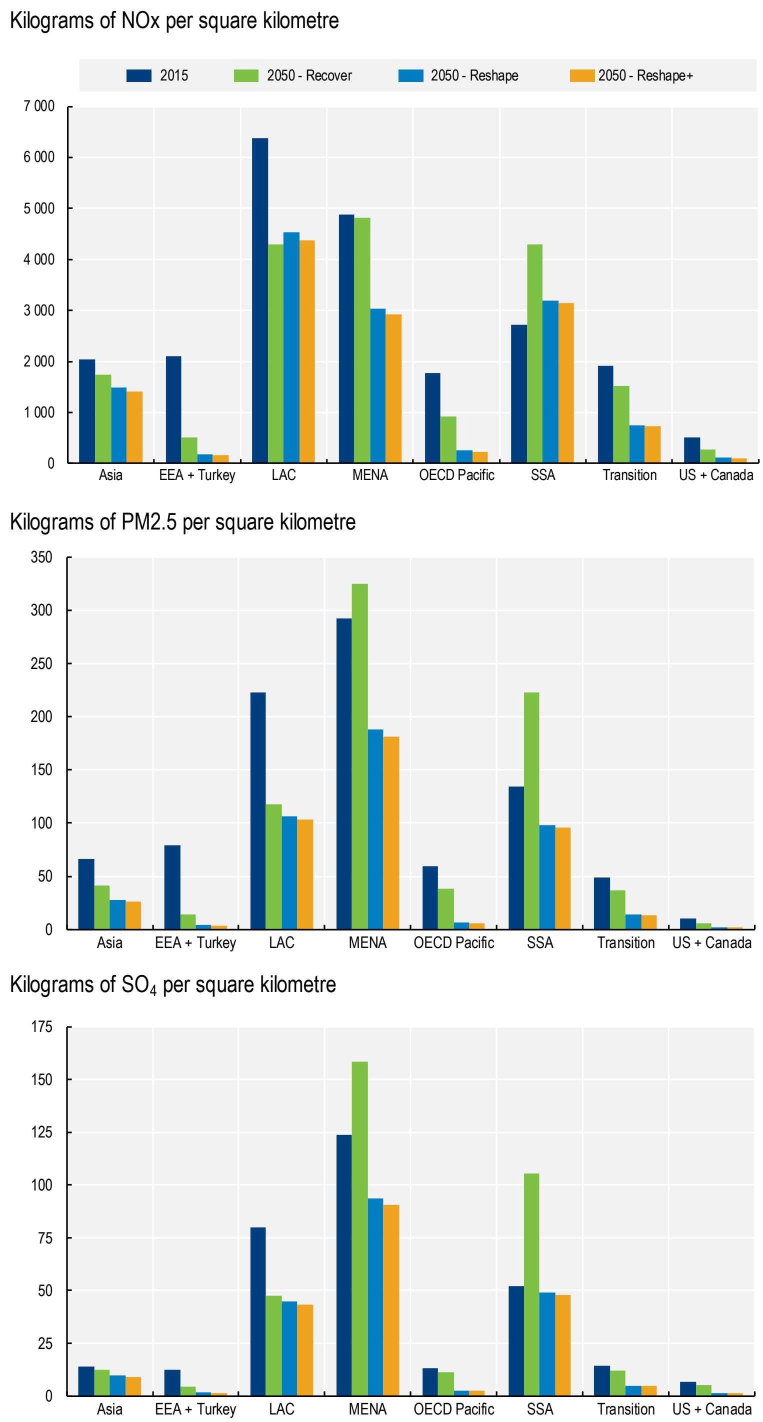
Fuel technology is a major determinant for emissions of both CO_2 and local pollutants. In the recent past, a preference for diesel cars in some regions helped to reduce CO_2 emissions but also raised concerns over urban air pollution. Reducing the consumption of fossil fuels through low-carbon alternatives in transport also reduces exhaust-based pollutants. However, that cannot be the extent of change. PM2.5 is also derived from non-exhaust sources such as brake, tyre and road wear (Panko et al., 2019[79]; Amato et al., 2014[80]). Vehicle weight is a significant factor in determining the level of such emissions levels. As electric vehicles are typically heavier than traditional cars, their benefits with regard to reducing non-exhaust particulate matter appear to be negligible (Soret, Guevara and Baldasano, 2014[81]). Figure 3.11 shows the pollutant emission results for NOx, PM2.5 and SO_4, by world region. The MENA region has the highest levels of PM2.5 and SO_4 emissions and is exceeded by LAC for NOx emissions. Projections from all future scenarios estimate dramatic drops due to newer fleets and reductions in motorised traffic share. Under *Reshape+*, the EEA and Turkey region achieves the largest improvement in NOx, PM2.5 and SO4 levels, dropping to 7%, 5% and 12%, respectively, of 2015 levels by 2050.

Some of the most significant improvements in air quality in LAC and SSA are due to the formalisation of paratransit services in the more ambitious scenarios. Formalisation allows for closer regulation of vehicle fleets. In Bogota, it led to the introduction of newer technologies which reduced pollutant emissions by 40% overall. The difference is most apparent in low-income neighbourhoods, which suffer from the worst air quality and are particularly reliant on paratransit (Bocarejo and Urrego, 2020[82]).

The averages for pollutant emissions presented in Figure 3.11 do not provide a complete picture of the exposure for individuals on the ground. Exposure risk is very localised and can vary drastically even within a city. More detailed in-situ evaluations are needed to determine the impacts and potential of individual interventions. Furthermore, the actual health impacts of local pollutant exposure depend on several factors, including geography and climate, which are not considered here.

Figure 3.11. Pollutant emissions from urban passenger transport by world region to 2050

Under three scenarios



Note: Figure depicts ITF modelled estimates. *Recover, Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Equity and well-being: Accessible cities and resilient networks

This section attempts to answer the following questions: How do transport decarbonisation policies affect accessibility and well-being? How does shifting away from private vehicles and improving public transport and shared mobility affect equity? How do land use and prioritisation of urban space affect different groups? And, how resilient are low-emission transport systems?

Measures to decarbonise transport should not undermine equity objectives. It is vital to align decarbonisation with well-being to ensure fairness while improving access for those whose needs have been historically neglected. Highly ambitious policies will only be acceptable to the public if they are perceived to improve quality of life, not hinder it. Policy makers will also need to consider how equitably costs and benefits of these measures are distributed across different socioeconomic groups.

Urban transport systems are inextricably linked to human well-being and social equity. Economically disadvantaged groups also face transport inequalities and poor access. By increasing access to opportunities – goods, services and people – transport services can increase social and economic well-being (OECD, 2019[8]). For instance, studies have shown that increasing access to public transport for lower-income communities could increase their access to formal job opportunities in Latin America (Moreno-Monroy, 2016[83]), Asia and the Pacific (Baker and Gadgil, 2017[84]) and Africa (Chen et al., 2017[85]).

Ambitious decarbonisation and accessibility for all

Improving access sustainably means improving the accessibility and quality of public transport and sustainable modes while shifting users away from less sustainable options. In its broadest sense, this means prioritising public transport and active mobility improvements while disincentivising car use. The goal is to provide more affordable, lower emission and less space-consuming ways to travel that do not come at the expense of accessibility and, therefore, well-being.

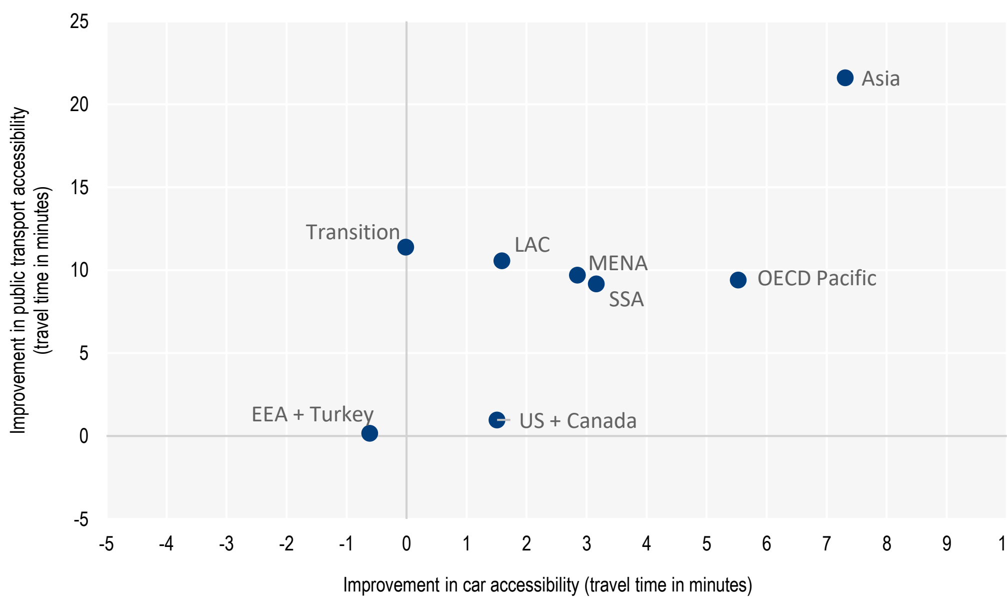
There are several ways to measure accessibility. Typically accessibility indicators take into account travel times or distances between locations representing desired opportunities. The ITF Urban Passenger Transport Model calculates a simplified measure representing the average time it would take to reach a city's edge from its centre, both by car and by public transport. A lower travel time indicates greater access opportunities. The indicator is very simplified and does not take into account the actual spatial distribution of people and opportunities (ITF, 2019[86]; Geurs and van Wee, 2004[87]). However, it helps provide a global indicator comparing the evolution of access between car and public transport in cities.

Public transport becomes more competitive vis-à-vis cars as an access provider under *Reshape*+ policies. Public transport generally costs less than private cars, providing a more affordable mode for all users. However, it can be less attractive due to generally higher travel times than private vehicles, among other reasons. Figure 3.12 plots the improvement in accessibility, or the reduction in average travel time, by car and public transport in 2050 for all world regions under a *Reshape*+ scenario compared to *Recover*. Points above the dotted line indicate that travel times improve more for public transport than for cars. The figure shows that in most world regions, under *Reshape*+, public transport travel times improve more than car travel times. Travel times by car generally still improve under higher ambition policies, albeit at a lower pace than for public transport, because of reductions in private car use and therefore congestion. The EEA and Turkey region is the exception; here travel times by car worsen, and public transport accessibility remains unchanged.

Developing countries show high gains in access by public transport under *Reshape*+ policies*.* Policies to increase public transport investments have a greater impact on accessibility in developing countries. In the Asia, MENA, LAC, SSA and Transition countries, travel times by public transport are between 17% and 21% lower under *Reshape*+ than under *Recover*. In developed countries, improvements are more modest. In European cities, low time improvements could be due to an already high provision of public transport infrastructure. In cities in the United States and Canada, on the contrary, low changes could indicate the large travel distances, which hamper efforts to increase public transport use beyond the values considered for the scenario. These changes in the relative accessibility of public transport and private vehicles are partially due to pricing mechanisms to disincentivise private vehicle use and simultaneous improvements to public transport. Equity considerations of both are discussed in the following subsections.

Figure 3.12. Potential accessibility improvements for public transport and car travel in different world regions by 2050

Difference between the average travel time from the centre to the edge of a city, for cars and public transport, in the *Reshape+* scenario compared to *Recover* scenario



Note: Figure depicts ITF modelled estimates. *Recover* and *Reshape+* refer to two scenarios modelled, representing current ambitions and much increased ambitions with regard to post-pandemic policies to decarbonise transport. Accessibility is represented by the average time required to travel the radius of an urban area. Improvement in accessibility (or travel time) is the difference between values under a *Reshape+* scenario and a *Recover* scenario. Values are averaged across urban areas in a region. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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The cost of car use is artificially low. Pricing schemes can internalise the negative social, economic and environmental externalities from driving cars (Litman, 2020[88]) and transfer the cost to the drivers if implemented in the right way. Pricing policies could encourage shifting trips to more sustainable travel options as well as to non-peak hours. Distributional impacts of these measures depend on the socio-spatial characteristics of cities, the travel behaviours of residents, and how obtained funds would be used (Taylor, 2010[89]). Measures will need to balance effectiveness in mode shift and time of travel with potential negative equity impacts. In lower-income areas with low public transport availability, measures can force lower-income citizens to not use private vehicles, but also decrease access to opportunities (Di Ciommo and Lucas, 2014[90]). Schemes that determine pricing tiers based on income levels could be a more equitable solution. However, this may limit the effectiveness of reducing car use in areas where these users make up the majority (TransForm, 2019[91]).

Policy should focus on providing alternatives to cars and not reducing access for disadvantaged groups. In regions with poor public transport, private vehicles can be the main, or even the only, means for accessing essential opportunities. This disproportionately affects lower-income groups, who are forced to maintain a private vehicle, although the high costs limit their budget for other essentials, such as housing or health care (Mattioli, 2017[92]). The only way to change this reality is to combine disincentives for private vehicle use with measures that improve access to opportunities by sustainable modes. Simply putting an additional price on car use without offering alternative transport options is likely to run into opposition, as middle- and low-income groups see their access reduced. In contrast, higher-income groups enjoy congestion-free roads and shorter travel time. Good public transport and shared mobility alternatives as a complement to pricing measures, on the other hand, could distribute the benefits across income groups (Crozet and Mercier, 2018[93]).

Improving public transport is key to affordable, sustainable access for all. Tackling transport inequalities means improving access to opportunities for marginalised groups. Often, this requires extending high-quality public transport services towards peripheral areas of cities. A recent ITF study analysed differences in access to opportunities between urban centres and wider commuting zones for 121 European cities, for different modes. It found that access by public transport is lower in the wider commuting zone of European cities than in their urban centres. Yet, these are the areas with the largest populations of lower-income households. In the twelve worst-performing cities, less than 20% of people living in city peripheries have public transport services close by. Infrastructure investments could help provide faster and more reliable access to the city (ITF, 2019[94]).

Affordability of public transport is a core component of accessibility. Spatial proximity to public transport is useless unless users have the means to use the services. In Bogota, Colombia, access to opportunities can decrease by up to 54% when considering transport fares and budgets of lower-income households (Peralta Quiros and Rodríguez Hernández, 2016[95]). Many governments provide subsidies to users to prevent barriers for lower-income groups (Li, 2019[96]). Targeted subsidies based on income, household status, and other socio-economic criteria often provide the best balance between the system's affordability and financial sustainability. Granting general subsidies based on age, for example, are not always an indicator of financial need. However, subsidies for students, for example, can have other benefits, such as helping to establish more sustainable transport behaviour from a young age.

Improvements in technology, such as smart cards and data management tools, improve targeting vulnerable users. In Colombia's capital, Bogota, local authorities started granting fare subsidies to public transport users based on data derived from the System for Selecting Beneficiaries of Social Spending (SISBEN). The SISBEN is a stratification instrument already in use for water, electricity and health care subsidies. Through this particular scheme, SISBEN beneficiaries in Bogota increased their monthly trips by more than 50% compared to non-beneficiary users (Peralta Quiros and Rodríguez Hernández, 2016[95]). The subsidy has also increased access to opportunities for citizens living on urban peripheries and thus contributed to reducing spatial inequalities (Guzman and Oviedo, 2018[97]).

Service quality improvements help to improve access. Increases in capacity, reliability and service hours would make public transport more convenient and attractive for all users, especially those who rely solely on the system. Beyond these general improvements, tailored measures can enhance levels of public transport use and satisfaction for specific groups whose needs are generally ignored or less considered by universal policies (van Lierop and El-Geneidy, 2016[98]). For instance, measures specifically targeting safety and safety perceptions would be crucial for increasing patronage among women (Shibata, 2020[99]; Badiora, Wojuade and Adeyemi, 2020[100]; Chant and McIlwaine, 2016[101]).

Integrated shared mobility could boost sustainable mobility for all. To harness the environmental and social benefits from shared mobility, services should be integrated with existing public transport in terms of infrastructure, service schedules, ticketing and fares. Mobility as a Service (MaaS) applications could facilitate integration. Currently, however, no examples exist where MaaS best practices have been implemented. The highest societal benefits will come from having a regulatory framework that aligns policies on pricing, land use and infrastructure design, as well as for allocating concessions and overseeing activities (ITF, 2018[102]). Particular attention needs to be paid to the role of MaaS in improving the mobility of disadvantaged groups, and how services could be designed to specifically respond to those needs (Pangbourne et al., 2020[103]).

Shared mobility can provide last-mile solutions that enhance accessibility in lower-density urban and suburban areas

Shared mobility can better connect the outskirts of cities. Vanpooling services could be the most cost-efficient way to link peripheral areas to major public transport stations. ITF simulations found that in Lyon, France, a system with integrated van-based ridesharing could double the area with good access to employment opportunities. Accessibility gains are most noticeable in the periphery of the city (ITF, 2020[25]). Forms of shared micromobility could enhance access in denser urban areas and, to a certain extent, lower-density suburban areas by providing last-mile solutions. In Chicago and Philadelphia, well-planned bikesharing services enhance access to employment opportunities for lower-income communities to a higher degree than for other income groups (Qian and Niemeier, 2019[104]).

Shared mobility and micromobility solutions can only be equitable if lower-income groups can afford to use them. In San Francisco, dockless bikesharing services provide better access for lower-income neighbourhoods than dock-based services due to a larger service area and frequent repositioning practices (Qian, Jaller and Niemeier, 2020[105]). City authorities will need to ensure interventions do not overlook these areas. For instance, in Denver, the Department of Public Works requires car-share companies to have infrastructure in "opportunity areas", i.e. where at least 30% of the population lives in poverty (Kodransky and Lewenstein, 2014[106])

Lack of access to the internet, smartphones and online payment services can limit access to shared mobility. Mobile phone penetration is around 90% in both developing and developed countries (Deloitte, 2019[107]). Yet individual characteristics such as gender, employment, literacy or age can negatively affect people's access to smartphones (ITU and UNESCO, 2019[108]). Other barriers exist for mobile payments. In the United States, 17 million people are unbanked, equalling one in twelve households (Kodransky and Lewenstein, 2014[106]). Shared mobility services will need to take these inequalities into account to leave no citizen behind (Cohen and Shirazi, 2017[109]).

Affordability of shared mobility services is a concern for operators, as it needs to be for authorities. In most countries, it is private initiatives that have created new forms of app-based shared mobility. These services require high initial capital investments, and their digital payment systems have high transaction costs. Because of this, many business models target higher-income segments for these new services, especially in developing countries. Extending the benefits of shared mobility in these conditions towards lower-income groups can be challenging for private operators, despite their environmental and equity benefits. In Mexico City, Jetty, a ridesharing startup, tried to offer its services to lower-income groups, reaching beyond their usual mid-to-high income market. They sought to decrease prices to bring them closer to MXN 5 (USD 0.23), the average cost of a bus ride in the city. One of the difficulties of implementation was the high cost of electronic payment commissions (Flores, 2020[110]). When individual transactions are very small, the commission eats into profits quite substantially. Developing new business models that address these difficulties by adapting to user income characteristics and needs is part of the solution (Wiprächtiger et al., 2019[111]). Given their potential accessibility and environmental benefits, increasing collaboration with public authorities for the expansion of these services towards lower income segments could be beneficial.

New regulatory frameworks could boost the affordability of shared mobility services for users. Shared mobility services could enhance access to opportunities in underserved areas where traditional transport offer has limited reach. In such cases, this raises the question of whether certain services, such as vansharing, could benefit from public transport-exclusive subsidies (ITF, 2019[112]). This would require brokering agreements with private operators, and in many cases, broadening the legal definition of which services can receive subsidies. Shared mobility services in many countries are not yet regulated or fall into grey legal areas. Relevant authorities will need to work together with shared mobility operators to develop new frameworks and regulations if they are to be part of a multi-modal, affordable and sustainable transport offer. These relationships will be essential during recovery from the Covid-19 pandemic.

Paratransit services provide valuable connectivity to lower-income groups in peripheral areas, especially in developing countries (IDB and ITF, 2020[113]). They also pose regulatory challenges. Paratransit services operate under different frameworks from those for official public transport systems. Some operate outside any regulatory supervision, some under unclear rules agreed formally or informally with the authorities (Salazar Ferro, 2015[23]). Integrating informal paratransit into regulated shared mobility can reap some of the largest decarbonisation reductions from shared mobility, according to ITF modelling results. Examples show that such a process brings other benefits, such as increased service quality standards, improved road safety and air quality (Bocarejo and Urrego, 2020[82]). It can also make mobility more affordable if tariff integration and subsidies are part of the formalisation process (Salazar Ferro, 2015[23]; Bocarejo and Urrego, 2020[114]). Without this, travel costs may go up (Bocarejo and Urrego, 2020[82]). Tensions may arise when moving from cash to digital fare systems: digital payment systems charge high commissions; also drivers may perceive payments to be delayed and feel they are less in control (Flores, 2020[110]).

Urban densification in pursuit of shorter travel distances must not extend to the point of overcrowding. Whether land-use policies and transit-oriented development will create more healthy, sustainable and equitable neighbourhoods depends mainly on two factors: the population density and the liveability and affordability of housing units in these neighbourhoods. Density and diverse land-uses mean short distances and the potential for less carbon emission from mobility. It can also make public transport more efficient. When density turns into overcrowding, however, the result can be detrimental to health and the quality of urban life in general. The Covid-19 pandemic was associated with a rapid spread of the Coronavirus around overcrowded lower-income neighbourhoods. This is partly linked to lower quality living conditions, making it harder for people to take precautionary measures. High rent prices also contribute to high concentrations of people in smaller spaces. Affordable and decent quality housing is a vital antidote to overcrowding.

Unbridled transit-oriented development can make housing less affordable. Proximity to good public transport can raise rents and land value in the neighbourhoods where investments occur. Gentrification may displace less well-off citizens to parts of the city with poorer service and less access. Investments in public transport might not serve the residents of an area targeted by transit-oriented development unless displacements are prevented. It is vital to support existing residents by ensuring rent-controlled and mixed-income housing in these developments. Working with local residents during the planning process will help.

Less road space for cars makes cities safer and fairer. Much of urban space is devoted to cars. Prioritising cars on city streets unfairly favours drivers and limits other traffic participants in utilising street space for their own travel needs. The users of more sustainable modes are more likely to be young people or seniors, women, earn lower incomes and come from ethnic minorities. There is also a significant opportunity cost linked to the excessive allocation of road space for cars instead of urban amenities and housing developments that benefit a greater portion of society. This is particularly true in cities where urban land and affordable housing is increasingly scarce.

Allocating road space to sustainable mobility has significant social benefits, particularly by increasing road safety. The *Reshape* and *Reshape+* scenarios integrate measures that seek to enlarge road space allocated for sustainable mobility to increase the mode share of these modes. These include lengthening of priority lanes for public transport and extensions and widening of pedestrian roads and cycling lanes. Studies show that driving cars and motorcycles in urban areas is associated with, respectively, a three and eleven times higher fatality risk than riding a bicycle (ITF, 2020[115]).

Active mobility users will continue sharing road space with heavy vehicles, even with mode shift. Almost 40% of the world's population will be either children below the age of 15 or elderly citizens over 65 years of age by 2050. Active mobility or micromobility offers these and other groups independence and an affordable travel option. Guaranteeing safe trips for them will not least depend on the availability of safe, protected infrastructure for pedestrians, cyclists and users of micromobility. Lowering speed limits will also be essential for increasing safety in urban areas (Box 3.3).

Box 3.3. Best practice for urban road safety

Road safety has become a priority in cities that aim to become more liveable. Reducing the risks of urban traffic not only saves lives, it makes people feel safer and enables a shift towards walking and cycling. Such sustainable forms of transport reduce pollution, congestion and public health issues. Safety is an essential part of sustainable urban mobility plans.

One should learn from individual cities that have achieved large reductions in road casualties. In *Best Practice for Urban Road Safety*, the ITF (2020[116]) provides examples of relevant policies. They include developing reliable traffic injury data, enforcing speed limits, implementing safer street design, and predicting and preventing road crashes.

London, one of the cities showcased in the report, aims to eliminate fatal and serious traffic injuries by 2041. Reaching this goal is facilitated by the Mayor's Transport Strategy which includes the reallocation of street space towards people walking and cycling, a policy which results in lower car use. This policy thus reduces greenhouse gas emissions. It also reduces local air pollution and tackles an obesity epidemic, two issues that affect deprived communities the most. By reducing car use, the strategy gives priority to the most efficient uses of public space – walking, cycling and public transport – thereby enabling the city to envisage growth without gridlock. Giving priority to more affordable means of transport also makes for a more inclusive city. Last, reducing car use makes the streets safer, in turn enabling a further shift towards active travel, closing a virtuous circle and accelerating change.

Another city featured in the report is Fortaleza, one of the very few cities which have cut by half the number of road deaths in the last decade. The Brazilian city expanded its cycling and bus priority networks, invested in traffic calming, redesigned pedestrian crossings and lowered speed limits on arterials. Such measures address road danger and reduce car dependence at the same time.

Gender shapes travel patterns; it should also shape transport planning. Gender heavily influences the way people travel. The types of jobs undertaken by women in the workforce are less likely to involve typical commutes. Women are overrepresented in the service and care industries, for instance, and also assume more roles within the household than men. Their trip patterns are thus typically more complicated, chaining together multiple trip purposes and destinations. Women tend to travel shorter distances, perform more inter-modal trips, combine several modes in one journey, and travel at off-peak hours. They also tend to use active mobility, generally walking (Miralles-Guasch, Melo and Marquet, 2015[117]). Thus, women tend to value public transport services' reliability higher than men. This highlights the importance of transport service resilience from a gender perspective (Ng and Acker, 2018[118]; ITF, 2019[119]). The same is true for safety. Women also tend to face higher risks in public spaces than men, despite having higher walking shares. This is especially true in developing countries, making active mobility less safe for women than men (Chant and McIlwaine, 2016[101]).

A gender-based approach to transport policies can contribute to adapting public spaces and infrastructure to serve the mobility patterns and needs of women. Mode share inequalities can be higher depending on the mode, income segment and area of the world (Gauvin et al., 2020[120]). In Latin American cities, at most, 30% of cycling trips are done by women, while in some European urban areas female users have a higher cycling mode share than men (Montoya-Robledo et al., 2020[121]). Even in urban areas with a higher female cycling share, there can be difficulties for women to use active mobility infrastructure because they have been developed without considering the needs of female users. One potential barrier, for example, could be the lack of cycling infrastructure allowing to carry a child along with the main rider (Montoya-Robledo et al., 2020[121]).

The higher the decarbonisation policy ambition, the higher the resilience of the system

Increasing the resilience of transport systems to external impacts is a growing requirement in cities around the world. Resilience is the ability for a transport system to function despite shocks where one mode may be more affected than others. External shocks can be linked to natural disasters and extreme weather phenomena that might make it impossible for vehicles to export. In 2018, in a study of more than 500 cities around the world, more than half indicated that transport systems are some of the most vulnerable public services to climate change in the short and medium term (Ahmed and Dey, 2020[4]). Shocks can also include unexpected events, such as global pandemics, where shared forms of transport may not be ideal. Disruptions in fuel distribution or energy production can further affect a component of transport systems, thereby requiring that systems develop ways to be resilient to these possibilities.

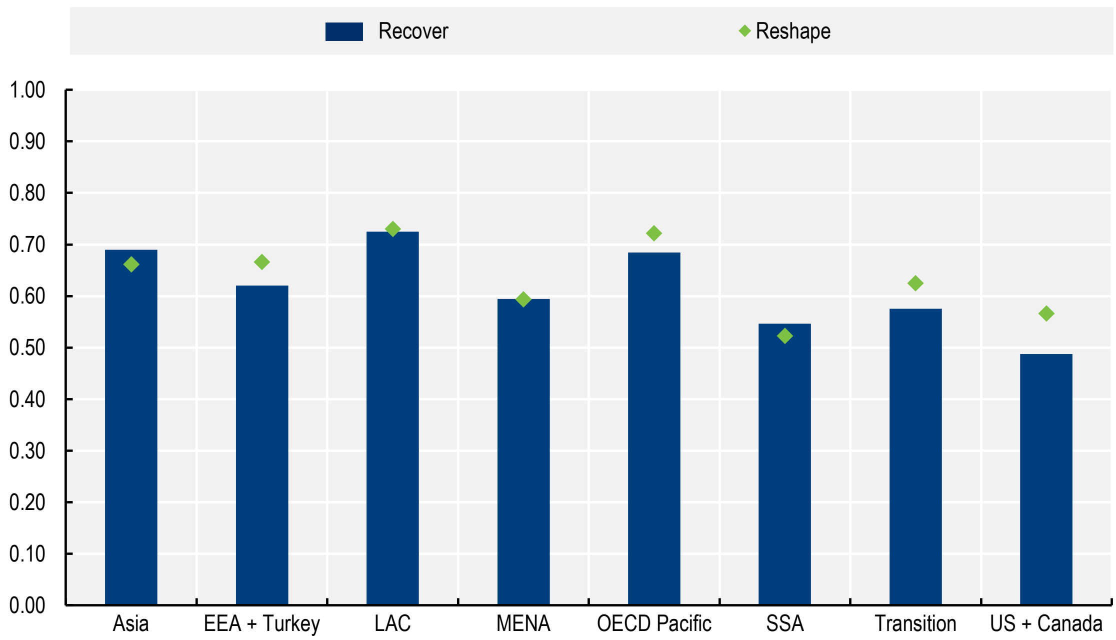
Mode availability is a useful proxy to quantify the resilience of urban transport networks. The ITF Urban Passenger Transport Model calculates how likely it is for travellers to use another mode when one mode is disrupted in a given urban area. The model takes into account mode shares for each city and gives an indicator between 0 and 1. In an urban area with a resilience level of one, all modes in the city have the same share or are used to the same extent. A resilience level of zero indicates that a single mode is responsible for all transport activity, therefore if disrupted, the entire system fails to function. This methodology provides a simplified metric for measuring transport resilience across time that is comparable for various world regions. It adds to other measures and methodologies to quantify levels of resilience (Ahmed and Dey, 2020[4]; Jaroszweski, Hooper and Chapman, 2014[122]; Arup, 2018[123]; Temmer and Venema, 2017[124]). These can include looking at the similarity between components of the transport system, the efficiency and dependency between modes in one system, the capacity of the system to recover from shocks, and the level of co-ordination between stakeholders (Ahmed and Dey, 2020[4]).

Highly ambitious decarbonisation policies promote a variety of modes and improve resilience of the transport ecosystem

Higher decarbonisation ambition increases the resilience of transport systems by promoting a greater variety of modal choice. For most world regions, mode resilience is the highest under *Reshape+* policies. This is particularly the case in developed countries. As Figure 3.13 shows, by 2050 resilience improvements in *Reshape* are the highest in the United States and Canada, EEA and Turkey, and OECD Pacific. These are the world regions where, under a *Recover* scenario, urban passenger transport activity is concentrated in private vehicle use. Highly ambitious decarbonisation policies bring about diversification of mode choice and improve resilience in these markets. This is a positive development, which could go in hand with other more direct measures to increase infrastructure and service resilience.

Even when promoting sustainable modes, resilience could be higher when the transport system depends on a variety of modes, rather than just a few. As reflected in Figure 3.13, in developing countries improvements in resilience are limited, and in some cases such as Asia and SSA, mode resilience even decreases under the *Reshape* scenario. In these two regions, under the *Reshape* scenario transport activity is more concentrated in forms of shared mobility than in other regions. This is particularly the case due to integration of paratransit services in the shared mobility offer. From a decarbonisation perspective, this could be positive. Nonetheless, from a resilience point of view, these results highlight the importance of modal diversity for having a resilient system that can respond and adapt to external shocks.

Figure 3.13. Resilience of urban transport systems by world region in 2050



Note: Figure depicts ITF modelled estimates. Resilience of transport systems describe its ability to withstand shocks. Mode availability is a useful proxy to quantify the resilience of a transport system. The indicator depicted is calculated based mode shares in each city and is between 0 and 1. A value of 1 means that all modes are available and used equally, while a value of 0 means that is single mode is relied on for all travel in the city. A disruption to one mode would have a lower impact in more resilient cities than one that depended fully on it to serve all transport needs. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Policy recommendations

The findings of this *Transport Outlook* should be seen as a call to action: simply following current commitments on a *Recover* trajectory will not be enough. Urban transport shows great promise to significantly reduce its carbon footprint. With the right policy tools, its emissions could be cut by almost 80%. Yet, this will require increased ambition in cities' climate action plans. National governments can empower cities to do that, by providing the funding and policy levers to respond to the decarbonisation challenge. To this end and for effective implementation of measures, good metropolitan-wide transport governance will be essential (ITF, 2018[125]). The Covid-19 pandemic is a double-edged sword for decarbonising passenger transport in cities. The following recommendations can support authorities in reshaping their urban transport systems in a way that cuts down emissions equitably once and for all during recovery from the pandemic.

Empower cities to decarbonise urban mobility and enhance accessibility to improve well-being

National governments need to make sure that local authorities have the right tools and capacities for increasing the ambition of their measures for decarbonising and increasing the resilience of their transport sector. They can empower local authorities by providing additional funding for inclusive and sustainable transport policies. National governments can also ensure that city authorities can legally implement measures for their wider urban area. At the local level, city authorities should take complementary measures that align with, or exceed, national targets set as part of the revision of Nationally Determined Contributions (NDCs) under the Paris Agreement. Cities need to shift their mobility policies from maximising individual mobility to increasing access to opportunities for all people to meet their needs. This shift is the prerequisite to ensure that decarbonisation policies will also deliver lasting gains for social and economic well-being.

Prioritise funding for sustainable urban transport over investment in city roads

Cities must fund the future they want for themselves. Sustainable, inclusive, liveable cities will invest a larger share of their budget into improving public transport and active mobility rather than build more infrastructure for private cars. They will also support other shared mobility options where these provide efficient alternatives to private vehicle use. Increased and consistent funding structures for sustainable transport will make sure that cities emerge from the Covid-19 pandemic with the tools to build a more sustainable and equitable system. Lack of funds for public transport and shared mobility could put sustainability at risk and dramatically reduce mobility options for citizens with no access to cars. Over-reliance on passenger fares can hurt public transport services, especially during disruptions like the pandemic. Funds can come from road pricing and fuel taxes, but also from land-value capture mechanisms. Potential gentrification issues from land-value capture will require attention.

Improve the quality of public transport to create more inclusive and reliable services

Better public transport will attract more users. More public transport users mean more sustainable urban mobility. An expanded route network and more frequent services would improve access to the opportunities cities offer. A focus on reliability, safety and security will raise the attractiveness of public transport for users, as will integrated ticketing and service schedules, easily accessible stations and clean vehicles. This will also play a role in gaining back users' trust in the systems, partially lost during the

Covid-19 pandemic in many cities around the world. Good quality public transport also makes urban mobility more equitable– if authorities ensure at the same time that fares can remain affordable.

Pursue integrated land-use and transport planning for sustainable, neighbourhood-based urban development

The rise in teleworking has created the spectre of increased urban sprawl. The ability to work remotely makes commuting less of an issue, which could induce citizens to move further away from downtown office districts. Managed well, this could be an opportunity for pursuing development approaches that put neighbourhoods and public transport corridors at their heart.

Integrating transport, and land use and planning will be vital for managing urban growth sustainably. Mixed-use areas, densification and transit-oriented development shorten residents' travel distances to essentials, making it more attractive to walk or cycle for local trips and use public transport for longer journeys.

At a micro level, integrated transport and land-use planning should ensure an allocation of urban space that serves all citizens and reconsider, for example, the societal benefits of providing public space for parking private cars. Cities have the opportunity to permanent the temporary reallocation of street space for walking and cycling made during the crisis. Seizing this opportunity could fast-track plans to expand infrastructure for safe, simple, affordable mobility.

New development patterns will also be an opportunity for making public transport services less commuter-centric and more equitable. Neighbourhood-based developments would allow transport services to adapt to the needs of user groups with shorter, though more complex mobility patterns than those of commuters travelling to cities' central business districts. This includes women, the elderly and children.

Create incentives for greening urban vehicle fleets

At least one-third of urban travel will still be made by private vehicles in 2050. Reducing emissions from these car trips requires technology improvements that increase fuel efficiency. Making these new fuel technologies affordable will be essential for decarbonising passenger activities, especially in areas where inhabitants do not have options other than using private vehicles. Vehicle improvements will also be important for public transport bus fleets in developing nations. Governments should design Covid-19 recovery packages that fund research and development of these new technologies, while simultaneously encouraging their uptake in private, shared and public vehicle fleets by providing more charging infrastructure and financial purchase incentives.

Nurture transport innovation and collaborate with providers of new urban mobility services to maximise benefits and minimise costs

Well-managed shared mobility solutions can complement and expand the reach of public transport, offering substantial benefits such as reduced transport emissions and improved access to opportunities. Where, on the contrary, shared mobility competes against public transport, it could affect sustainability negatively.

Authorities and operators must work together to ensure affordable services, especially in areas where public transport service is insufficient. Emerging shared mobility services might be considered for subsidies usually limited to public transport, for certain areas or user groups, where shared mobility offers last-mile solutions. Shared mobility can also provide cost-effective solutions in low-density areas or at off-peak times. Combined service offers with public transport can be co-ordinated through a Mobility-as-a-Service (MaaS) platform.

Combine transport decarbonisation and resilience measures now to meet future demand in sustainable ways and withstand disruptions

Ambitious decarbonisation policies for urban mobility can increase the resilience of cities' transport systems against disruptions. Climate mitigation policies will reduce overdependence on private cars and create a multimodal network. Multimodal systems are more agile at adapting to future changes in travel demand and unexpected disruptions like extreme weather events or pandemics. Beyond modal diversity, authorities need to consider the capacity of the transport system to adapt and recover its functions after external events. The resilience of operations and infrastructure should also be considered.

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4 Non-urban passenger transport: A pivotal sector for greening transport

Non-urban passenger transport is characterised by longer distances and fewer passengers than urban mobility. This chapter examines the decisive role of regional and intercity travel for reducing overall transport emissions. It outlines the challenges and opportunities of decarbonising the sector during Covid-19 recovery and presents projections for the future of non-urban passenger activity and emissions under three different scenarios. The chapter also discusses the social impacts of decarbonisation policies and highlights important considerations for equitable implementation.

In Brief

The fight to lower passenger transport emissions could be won or lost outside cities

Non-urban transport contributes 60% of all CO_2 emissions from the movement of people. Decarbonising the air, road and rail traffic between cities or rural areas is also more challenging than reducing emissions from urban travel because of the longer distances travelled by fewer passengers. Low-carbon alternatives to fossil fuels for powering long-distance mobility remain elusive.

The non-urban passenger transport sector has reached a crossroads. We must choose between a path on which demand and emissions continue to march in lockstep or one where they decouple. The second path ensures citizens have access to opportunities and supports economic development while drastically reducing emissions.

If non-urban passenger transport remains on its current trajectory (as described by the *Recover scenario*), its emissions in 2050 will be 25% higher than in 2015 and surpass 3 000 million tonnes CO_2. Aviation will drive most of this growth, with a share of almost 60% of all non-urban emissions by 2050.

However, a different path exists. Carbon emissions from non-urban passenger could be as much as 57% lower in 2050 than 2015. This path requires ambitious policies that leverage the decarbonisation opportunities of the Covid-19 recovery (the *Reshape+* scenario). Among the measures that will make this scenario a reality are taxing carbon, greening the electricity grid to power electric vehicles with clean energy, and economic recovery packages that prioritise environmental sustainability.

The Covid-19 pandemic has shaken the passenger sector to the core. Travel volumes in non-urban transport have dropped nearly 40%. Much international business travel has been replaced by video conferencing. The economic downturn was accompanied by a temporary drop in CO_2 emissions. For a sustainable recovery, policies should stimulate economic activities that also reduce emissions from long-distance travel: supporting investment in cleaner aircraft, for instance, or travelling less for business.

People will continue to travel in the future. Even with stringent decarbonisation policies, non-urban transport demand will grow by just over 100% to 2050, based on the ambitious *Reshape* and *Reshape+* scenarios. This is only marginally less than under current policies, with 114% growth projected in the *Recover* scenario. But under ambitious policies, emissions fall drastically due to shifts to more sustainable options and improvements in technology. On the current trajectory, they continue to rise.

Policy recommendations

- Increase the price of high-carbon non-urban transport to encourage clean alternatives.
- Create Covid-19 recovery packages that boost sustainable non-urban transport.
- Align decarbonisation policies across the transport and energy sectors to reflect the reliance of zero-carbon transport on clean energy.
- Mandate the use of alternative fuels in aviation to encourage long-term innovation.
- Incentivise the transition to low-emission non-urban road transport by making it more affordable and through measures that increase consumer confidence in cleaner options.
- Invest proactively in technological developments beyond the transport sector to ensure wide-scale availability of new technologies for a comprehensive decarbonisation roll out.

Non-urban transport refers to all transport activity outside urban areas. Its two main components are regional and intercity travel. Regional travel is domestic transport activity that includes peri-urban and rural travel. Intercity travel encompasses trips between urban areas, whether domestic or international. In ITF's modelling framework, the available modes for intercity travel are road (car, bus, and motorcycle), rail, air, and ferry. For regional travel, the options are only road and rail transport. Non-urban passenger transport is responsible for 34% of all transport emissions and 60% of passenger transport CO_2 emissions. Its total emissions in 2015 amounted to 2 482 million tonnes of CO_2 from 32 trillion passenger-kilometres travelled.

The fight to lower emissions from passenger transport will be won or lost in the non-urban sector. Regional and intercity transport is highly reliant on fossil fuels. Overall non-urban passenger activity and therefore emissions are likely to continue to grow, rebounding from a sharp reduction due to the Covid-19 pandemic. ITF projections for 2050 show that non-urban passenger activity could more than double and emissions increase by as much as 25%, even if growth will not be as strong as expected before the pandemic due to lingering economic impacts on demand.

The pandemic reduced non-urban passenger transport demand by more than a third in 2020. The travel restrictions and strict lockdowns imposed in response to the crisis reduced demand for regional and intercity travel by an estimated 38% in 2020 compared to pre-pandemic projections. The impact has been heavier on international travel than on domestic trips. This fall in demand has also led to a significant reduction in CO_2 emissions. However, this drop is likely to remain temporary: In all three scenarios modelled, non-urban travel will recover rapidly from the impact of Covid-19.

Ambitious policies could drive down CO_2 emissions from regional and intercity transport by 57% to 1 070 million tonnes in 2050 compared to 2015

More stringent policies could lock in decarbonising gains from the pandemic and help curb CO_2 emissions for non-urban transport. Ambitious policies could drive down CO_2 emissions from regional and intercity transport by 57% to 1 070 million tonnes in 2050 compared to 2015 in the *Reshape+* scenario. Recovery from the pandemic could become a catalyst for decarbonising regional and intercity travel. Policy makers should take this opportunity to design recovery plans that will also accelerate climate change mitigation.

Equity considerations need to be addressed when considering economic, environmental, and social trade-offs in making non-urban transport more sustainable. Reducing transport emissions cannot come at the price of leaving the less affluent behind. For example, tax refunds and similar incentives for purchasing electric vehicles do not benefit all consumers equally, as the less wealthy will not be able to afford them even with rebates. Similarly, carbon taxes are regressive and hit low-income groups harder. Transport policy should seek to avoid such unequal outcomes.

Decarbonising non-urban passenger transport: The state of play

Non-urban passenger transport is one of the most challenging transport sectors to decarbonise. It often involves long distances and lower passenger numbers, making it difficult to apply many of the decarbonisation solutions in other settings. Aviation, in particular, currently has no commercially viable alternative energy options. Much of rail transport has no tailpipe emissions but requires expensive infrastructure and high load factors to justify the investment. Availability of recharging points and the limited range of batteries remain obstacles to the broader adoption of electric vehicles for long-distance travel.

Vehicles using alternative fuels such as hydrogen face similar challenges. Nonetheless, ambitious new measures, infrastructure developments, and technological innovations can help the sector to decarbonise.

The traditional approach to meet increasing travel demand has been to add to boost capacity with new infrastructure. This has increased congestion, harmed air quality, and increased CO_2 emissions. A better approach to meet growing transport demand in sustainable ways is known as "Avoid-Shift-Improve". This paradigm aims to reduce congestion, emissions and energy consumption as well as improving air quality while providing travellers with greater accessibility.

***Avoid* policies aim to reduce the need to travel or induce shorter trips**. Within cities, land-use planning integrated with transport planning can achieve this. Non-urban travel does not typically present such opportunities. Nonetheless, the Covid-19 pandemic demonstrated that many business trips could be entirely avoided and replaced by teleconferencing. Similarly, the pandemic led to a growth in local tourism could reduce holiday-makers' trip distances. Such temporary changes in travel patterns due to Covid-19 could become more permanent if promoted by the tourism industry and businesses.

***Shift* policies seek to improve the carbon footprint of trips by transitioning to cleaner alternatives**, such as travelling by rail rather than aircraft. In the case of non-urban transport, avoid and shift go hand in hand since reducing the length of a trip also allows switching to a cleaner mode.

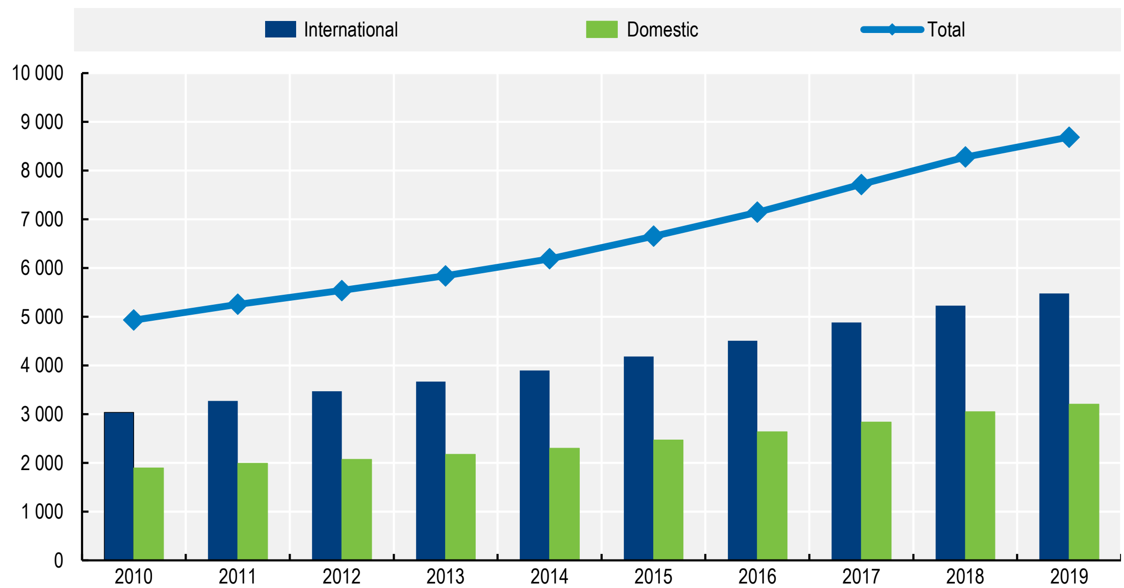
***Improve* policies aim to increase energy efficiency and to enhance environmental performance via technological upgrades.** In aviation, this includes cleaner aircraft technology and the use of sustainable aviation fuel. In road transport, engine and conventional powertrain developments and technologies for vehicle mass reduction could improve the fuel efficiency of vehicles.

Aviation has embraced the need to reduce its emissions. The International Civil Aviation Organization (ICAO) has adopted a new aircraft CO_2 emissions standard (ICAO, 2017[1]). ICAO is also implementing the Carbon Offsetting and Reduction Scheme for International Aviation, known as CORSIA (ICAO, 2016[2]). Under CORSIA, aircraft operators will collectively offset CO_2 emissions that exceed a threshold based on the average level of CO_2 emissions in 2019/2020. CORSIA will become mandatory in 2026, following a trial phase between 2021 and 2023 and a voluntary phase between 2024 and 2026. A few exceptions will be made, for instance for least-developed countries. Following the massive reduction in demand caused by the Covid-19 pandemic, CORSIA has been amended to use CO_2 emissions in 2019 as a base barring a swift recovery from the pandemic, CORSIA contributions will likely remain limited in its first years.

Rapid growth in air travel has outpaced significant environmental gains in aviation as newer, more fuel-efficient aircraft took to the skies. Before the hiatus caused by the pandemic in 2020, airline passenger traffic increased at a compound annual growth rate of about 6.5% between 2010 and 2019 (6% for domestic, 6.8% for international), according to data from ICAO (2020[3]). Aviation will become the leading mode of travel in the intercity segment by 2050, growing by almost 210% compared to 2015.

Figure 4.1. Evolution of world air passenger traffic, 2010-19

International and domestic flights, billion passenger-kilometres



Source: ICAO (2020[3]), *Annual Report of the Council 2019*, https://www.icao.int/annual-report-2019/Documents/ARC_2019_Air%20Transport%20Statistics.pdf

StatLink https://doi.org/10.1787/888934238812

The benefits and consequences of flying are inequitably distributed. One percent of the world population generates 50% of CO_2 emissions from commercial aviation (Gössling and Humpe, 2020[4]). While this small group is responsible for a large share of aviation emissions, the adverse effects are borne by all. The study also showed that close to 50% of global air transport occurs in North America and Europe, followed by the Asia-Pacific region (32%). The remaining world accounts for only 19% of air transport but is home to a much larger share of the world population. The fall in emissions from aviation due to Covid-19 can be an opportunity for policy makers to make the sector more equitable by shifting more of the environmental costs to frequent flyers.

Rail is often considered the cleanest non-urban transport mode, but electrification needs to continue. This has been a priority for many governments worldwide, yet the task is far from complete (UIC, 2019[5]). Significant progress has been achieved in Europe, the region with the most intercity rail activity globally. In other world regions much remains to be done. Furthermore, rail travel's lifecycle emissions, including those associated with rail infrastructure, need to be accounted for (IEA, 2019[6]).

Road vehicles have the greatest potential to decarbonise but face significant obstacles. Cars and motorcycles have been the subject of a technological revolution during the past decade, with hybrid-electric and electric engines replacing internal combustion engines (IEA, 2020[7]). Progress is still slow because of the low sales share of cleaner vehicles. Non-urban transport presents two main challenges for electric vehicles: driving range and charging infrastructure. The driving range of electric vehicles is still much shorter than that of conventional vehicles, and rapid-charging infrastructure is scarce outside cities. Charging infrastructure is being installed along main intercity corridors. But until other roads also have them, electric vehicles' usability in non-urban transport will be limited. Strategic placement of such infrastructure is thus necessary for the faster adoption of electric vehicles (Wang et al., 2019[8]; Xie et al., 2018[9]). The same limitations exist for electrified bus travel, which faces even more significant challenges. Other clean fuels for road vehicles, such as hydrogen, show promise but require substantial investments in research and development as well as broader acceptance from users.

Regional transport is slow to decarbonise. Services connecting citizens in rural areas face similar challenges to road and rail links between cities. However, the smaller passenger flows make infrastructure development expensive and less likely. Vehicle fleets in rural regions also tend to be older and less fuel-efficient than those in urban areas.

Box 4.1. Electrifying aviation

Commercial aviation has always relied on hydrocarbon fuels for energy. It has been and still is the only readily available power source with enough energy density to allow aircraft to take off. That will likely change in the next decades. Anticipated technological developments in aircraft and engine design as well as battery capacity and density will allow the use of electricity in aviation (Sehra and Whitlow, 2004[10]). The exact nature of how electricity will be used in aviation is still unknown, but hybrid-electric aircraft and all-electric aircraft show the most potential.

Hybrid-electric aircraft combine fuel combustion and electric assistance. Electricity is used to assist engines to operate under optimal conditions at all flight stages. This results in lower overall fuel consumption despite increased weight due to engine complexity and battery storage. Generally, energy savings have a higher relevance for short-haul flights where the more fuel-intensive flight stages (take-off, climb and descent) make up a larger share of the total flight. Recent studies place the potential fuel-burn (and consequently emissions) savings of hybrid-electric aircraft at up to 28% for regional and short-haul flights (Zamboni, 2018[11]; Voskuijl, van Bogaert and Rao, 2018[12]).

All-electric aircraft rely exclusively on electricity stored in batteries to fly. All-electric aircraft require batteries with high energy density and low weight to be suitable for a reasonable range and aircraft size. An all-electric aircraft for use in commercial aviation with an operating range of 750 km to 1 100 km and a capacity of 150 passengers would require battery cells with more than triple the density of current lithium-ion batteries (Schäfer et al., 2019[13]). Despite the many challenges, many companies have been working on developing all-electric aircraft of different sizes.

The ITF non-urban passenger model makes certain assumptions regarding the technological development and characteristics of electric aviation. Hybrid-electric aircraft that provide CO_2 emission savings of 28% are available starting in 2030 for distances under 1 000 km. All-electric aircraft are also available from the year 2030 but with a range of only 330 km. The range of both types of aircraft increases over time. The cost of electric aviation (for all-electric and for the electric component of hybrid-electric aircraft) is indexed to conventional fuel costs. In 2030, it is 2.5 times more expensive. This cost reduces throughout the study period to include expected technological developments but never becomes cheaper than 1.2 times that of conventional fuel (the final value depends on the scenario).

More information on hybrid-electric and all-electric aircraft, as well as other technological developments for the decarbonisation of air transport, can be found in the ITF's *Decarbonising Air Transport: Acting Now for the Future* report (forthcoming[14]).

Mastering the pandemic: Challenges and opportunities for non-urban mobility after Covid-19

The Covid-19 pandemic has disrupted mobility everywhere, but especially non-urban passenger transport. Border closures, stay-at-home orders, and quarantine requirements for international arrivals created unheard-of barriers to citizens' mobility. The ITF model for non-urban passenger transport has been adapted to account for these changes to calculate demand for regional and intercity travel and the associated and emissions for 2020. The results were validated against empirical data, where possible. Compared with pre-pandemic projections of non-urban passenger demand in 2020, they show a significant decline in travel of around 40% (measured in passenger-kilometres). Some transport modes experienced more significant drops than others, all saw a reduction of at least 30%, according to these estimates.

The decline in air travel was particularly steep. Passenger numbers for aviation plunged by 60% in 2020, the biggest year-to-year drop ever observed (ICAO, 2021[15]). International air travel fell by 75%. Domestic aviation was less affected, but passenger numbers still halved. Border closures and quarantine on international arrivals were the main factors, but fear and uncertainty also put many people off travelling (UNWTO, 2020[16]). A lack of universal guidelines also reduced the willingness to fly.

Aviation was particularly exposed to shifting regional peaks and troughs of the pandemic. By its nature, international air travel was highly vulnerable to the fact that different waves of the pandemic struck different parts of the world at different times, and that countries reacted with different responses. As a result, passenger demand for air travel came to a virtual standstill in April 2020, falling by 94% compared to April 2019 (IATA, 2020[17]). Some restrictions on travel and quarantine were lifted slowly in the following months, and some flight activity resumed, mainly on domestic routes. Several countries created temporary international travel corridors through air bubble agreements. An air bubble is an arrangement between two or more countries under which airlines can operate international flights between them with few or no restrictions. The aim behind such agreements is to safely resume air passenger services while regular international flights are suspended due to the pandemic.

Rail travel was affected disproportionately by the pandemic. Overall surface transport activity slumped by 32% compared to ITF's pre-pandemic projections. Rail and bus require travellers to share space with others and became particularly unpopular in the pandemic. Private road transport, on the other hand, offering relative protection against the virus, saw a more limited decline. Exact numbers on the global demand reduction for private cars do not exist; the ITF estimates the drop at about 30%. The numbers of vehicles passing through toll roads offer some insights. Various toll operators in the United States recorded 25-50% fewer cars throughout the pandemic (SmartBrief, 2020[18]). In India, the National Highway Authority estimated in May 2020 that the national lockdown during that spring would lead to a 17% reduction in intercity highway traffic for the year (CRISIL, 2020[19]). The actual reduction is likely to be more significant as states imposed their own rules and restrictions in the following months.

Intercity rail carried significantly fewer passenger in 2020 compared to 2019. According to the United Kingdom's Office of Rail and Road,35 million passenger rail journeys were made between April and June 2020 – a mere 6.4% of the journeys in the same period in 2019 and the lowest level recorded since the mid-19th century (ORR, 2020[20]). Data from Washington State in the United States show similar trends in intercity rail travel. On the day a stay-at-home order was issued, passenger rail services had 95% fewer users than on the same day in 2019 (WSDOT, 2020[21]). The order was lifted in June 2020, but on 1 January 2021, ridership was still 90% less than the same day a year before.

The demand for intercity bus travel has seen a large drop due to the pandemic, with bus activity falling by 36%, according to ITF estimates. Actual data is difficult to obtain, as the bus sector is less regulated and more fragmented than aviation or rail. New vehicle registrations provide some insights, however. In Western Europe, coach registrations fell by 82% between April and June 2020, compared to the same period in 2019. In individual countries, the numbers range from a 69% reduction in France to

92% in Belgium (Sustainable Bus, 2020[22]). Beyond reduced demand from bus operators, factory closures likely also played a role, however.

Box 4.2. A low-carbon pathway for tourism's resilience post Covid-19

In December 2019, on the occasion of UNFCCC COP25, the World Tourism Organization (UNWTO) and the ITF released the report "Transport-related CO_2 emissions from tourism" (UNWTO, 2019[23]), providing insights into the evolution of tourism demand and emissions globally and across regions from 2016 to 2030. Domestic and international and domestic tourism arrivals were forecast to reach 15.6 billion and 1.8 billion by 2030 respectively (from 8 billion and 1.2 billion in 2016), and so were CO_2 emissions, which were set to increase at least by 25% by 2030 (from 1597 Mt CO_2 to 1998 Mt of CO_2) against a current ambition scenario, making it challenging for the sector to stay aligned with international climate goals.

One year later, the sector is going through the worst crisis in its history. International tourist arrivals have dropped by 74% given the widespread travel restrictions and socio-economic challenges, representing an estimated loss of USD 1.3 trillion in export revenues with 120 million direct jobs at risk. Travel restrictions started being introduced gradually since the beginning of the pandemic. Yet, by May 2020, 75% of destinations worldwide had their borders completely closed to international tourism. Since then, destinations started easing travel restrictions, with November 2020 registering the lowest number of complete border closures (27% of destinations worldwide) before the trend reversed. As of February 2021, 32% of borders are again completely closed, making it difficult to foresee when tourism operations will fully recover. The implications of Covid-19 in transport-related CO_2 emissions from tourism are still pending to be measured.

Despite the circumstances, there is a growing consensus among tourism stakeholders as to how the future resilience of tourism will depend on the sector's ability to embrace a low carbon pathway, cut emissions in half by 2030 and achieve climate neutrality by 2050. The One Planet Vision for a Responsible Recovery of the Tourism Sector from Covid-19, released by UNWTO in June 2020, stresses the importance to monitor and report CO_2 emissions from tourism operations regularly and transparently, as well as the need to accelerate the decarbonisation of tourism operations, including through investments to develop low-carbon transportation options and greener infrastructure (One Planet Sustainable Tourism Programme, 2020[24]).

In countries like the People's Republic of China, one of the largest markets for domestic tourism, investments in developing high-speed rail connections throughout the country, appear to have contributed to an earlier restart of tourism in some normally less-visited destinations such as Nanjing and Changsa (McKinsey & Company, 2020[25]). For destinations like Scotland, the plans to reduce emissions and focus marketing efforts to encourage responsible tourism, including the promotion of public transport and active travel, have been made public in the context of the recovery from Covid-19 (VisitScotland, 2020[26]). In Colombia, the government recently adopted a National Tourism Policy which gives priority to measuring CO_2 emissions from tourism as a way to plan in alignment with the goals of the Nationally Determined Contribution to the Paris Agreement (Mincomercio, 2020[27]).

Less travel resulted in lower CO_2 emissions in 2020. Evidence suggests that the fall in emissions during the pandemic will be temporary. Some preliminary reports show a significant drop. In the United States, CO_2 emissions from the transport sector fell by 15% (Rhodium Group, 2021[28]). ITF estimates a drop of 36% in CO_2 emissions for non-urban passenger travel.

If policies continue on the pre-pandemic pathway, CO_2 emissions from non-urban passenger transport will rise by 45% between 2020 and 2025

Travel in regions and between cities emitted substantially less CO_2 in 2020, but this drop was temporary. The ITF estimates that CO_2 emissions from non-urban passenger transport fell by 36% in 2020. Overall, the reduction may well have been more significant than in other areas of the transport sector given the particularly dramatic fall in aviation activity. It will remain almost inconsequential to climate goals, however, unless decisive policy actions follow. If policies continue on the pre-pandemic pathway (the ITF *Recover* scenario), total CO_2 emissions from non-urban passenger transport will rise by 45% between 2020 and 2025.

How Covid-19 has changed travel behaviour

Covid-19 could lead to positive changes in the way we travel and work. These changes could further reduce emissions from non-urban passenger transport with the right policy support. Many businesses remained profitable and productive by embracing information and communication technology solutions and cutting business travel during the pandemic. Similarly, changes in international leisure tourism could also lead to major emission reductions as local options gain popularity.

Some business travel could be replaced by teleconferencing and virtual meetings. This could lead to long-term business trip reductions, especially in air travel, currently the highest emitter of CO_2. At the end of July 2020, flights booked by corporations were down 97% from a year earlier (Sindreu, 2020[29]). The reduction in business travel will remain temporary unless policies support this change to make it permanent. Changes in working culture (for instance increased teleworking and teleconferencing) or changes in business models (such as diversifying or compressing of global supply chains and the growth of digital businesses and e-commerce) may help curb emissions in the long term (OECD, 2020[30]). Fewer business trips, however, do not automatically translate into fewer emissions. Provided a minimum load factor is maintained, airlines would likely continue to serve routes at a similar frequency. This is expected to lead to an increase in economy fares, to maintain airline profitability.

Long-distance leisure tourism could shift to more travel closer to home. In mid-2020, while tourism made a temporary recovery, many people chose to travel to domestic or nearby destinations. This was due to safety concerns and travel restrictions. It was also due to promotions and advertisements to travel locally (Forbes, 2020[31]). Policies that boost such behavioural changes could reduce long-distance passenger travel by 15-22% by 2030, depending on the region.

Rebound in travel not out of the question. It is also possible that there will be a significant rebound. If people consider travelling safe again, they might overcompensate for the year of restrictions. One such example is the flights-to-nowhere that have appeared in some parts of the world (The New York Times, 2020[32]). While the impact of these flights is minimal globally, it shows that many people are looking forward to being able to travel again. This might cause a spike in non-urban activity and consequently CO_2 emissions.

The pandemic reduced the popularity of bus and rail travel. While the pandemic could lead to sustained reductions in emissions from aviation, the same cannot be said for road and rail transport. The need for physical distancing reduced the popularity of bus and rail transport, with private vehicles a viable alternative for some. This short-term adaptation could become permanent. Increased travel in privately owned vehicles could dent the drive to decarbonise non-urban passenger travel. Restoring the confidence of travellers in bus and rail will be crucial to decarbonisation once the pandemic ends.

The pandemic could speed up the retirement of older aircraft. Ageing aircraft not only have higher operating costs but also have higher fuel consumption. The reduction in demand caused by the spread of Covid-19 has led to the permanent grounding of some older aircraft. This has not only happened due to Covid-19. Similar periods of low demand, such as the 2008 financial crisis and the 9/11 attacks, also resulted in early retirements as well as mergers in the industry (Russell, 2020[33]). Air France, for example, initially planned to retire its Airbus A380s by 2022, but it announced in May 2020 that it would immediately retire its entire A380 fleet. This will be replaced by the smaller Airbus A350 and Boeing 787 aircraft, which have a smaller environmental footprint (Air France KLM Group, 2020[34]). The pandemic could act as a catalyst for airlines moving to more modern and less polluting aircraft. The policies devised in the aftermath of Covid-19 should support technological innovations to reduce the CO_2 emissions from the aviation industry (ITF, 2020[35]).

Table 4.1 gives an overview of the short-term and long-term impacts of Covid-19 that may act as challenges or opportunities in the drive to decarbonise non-urban passenger transport.

Table 4.1. Potential challenges and opportunities for decarbonising non-urban transport post-Covid-19

Impacts	Potential opportunities for decarbonisation	Potential challenges for decarbonisation
Short-term impacts	• Increased teleworking, reduced business travel trips • Increase in fuel efficiency due to the early retirement of older and less fuel-efficient aircraft • Reduction in air travel • Increase in localised leisure tourism due to health concerns	• Higher usage of private vehicles due to health concerns, leading to a reduction of cleaner shared modes (bus, rail)
Long-term/structural changes	• Paradigm shift for businesses reducing business travel trips • Increased localised leisure tourism due to travel behaviour changes • Accelerated transition to cleaner technologies in response to policy signals and investments spurred by stimulus packages	• Higher usage of private vehicles and reduced usage of bus and rail modes due to changes in preferences • Delays in the adoption of cleaner technologies due to lack of investment by private and public sector (e.g. slower renewal of fleets, deployment of new infrastructure) • Stimulus packages that support a return to the status quo

Note: Short-term impacts are based on observed changes in travel behaviour during the pandemic that hurt or hinder decarbonisation efforts. Most long-term and structural opportunities rely on well-designed recovery policies, while challenges add constraints to future decarbonisation.

The impact of Covid-19 on the decarbonisation of non-urban passenger transport

The pandemic has spurred aircraft fuel efficiency and more direct routes. While air travel recovers, fewer aircraft are required to cover the demand. The older, less fuel-efficient aircraft remain grounded. Even when demand reaches pre-pandemic levels, airline fleets will consist of newer, more fuel-efficient planes currently under construction. Likewise, a smaller number of aircraft in operation reduces congestion. This allows flights to minimise detours and fly more direct routes. As traffic returns to pre-pandemic levels, the latter gain may be short-lived.

Financial recovery after Covid-19 can support the transition to cleaner transport. If carbon pricing remains low, the stimulus packages designed by governments will turn out to be less environmentally effective. Governments could take recovery as an opportunity to encourage investment in low carbon alternatives for transport infrastructure. Carbon pricing can be used for that purpose. It can also provide revenue to balance public finances. The Aviation Tax Tool developed by the Transport & Environment advocacy group calculates the potential revenue and the avoided emissions if a country or a group of countries applies taxes on jet fuels. The tools show that starting in 2021 if taxes were applied in the EU and the United Kingdom at the rate of EUR 0.33 per litre of kerosene, it would avoid 99.3 million tonnes of CO_2 emissions over 2021-2030 and raise EU 7.2 billion in revenues in 2021 (Bannon, 2020[36]).

Recovery packages and bailouts need to bind airlines to environmental goals. The Covid-19 pandemic provides opportunities for governments to attach climate conditions to the bailout packages offered to the airlines. Several governments have done so. France's bailout of Air France-KLM requires that the carrier reduce its domestic flights by 40%, particularly short-haul routes where train-travel alternatives take less than two-and-a-half hours (Cirium, 2020[37]). The country's overall aerospace-sector aid package has set aside EUR 1.5 billion for research and the development of cleaner aircraft; a carbon-neutral plane by 2035 (Morgan, 2020[38]). Similarly, in Austria, the bailout requires Deutsche Lufthansa AG to impose minimum ticket prices and add extra fees on shorter routes to discourage avoidable flights (Schwarz-Goerlich, 2020[39]). More governments could similarly design aviation bailout packages, turning the crisis into an opportunity to reduce the threat of climate change.

Enhanced safety, sanitation and flexibility are central to encourage the return of passengers to bus and rail travel. As demand recovers after the pandemic, governments will need to prioritise measures to ensure that passengers feel confident choosing more sustainable shared long-distance travel options. Communicating safety protocols and sanitisation procedures will help consumers feel safer sharing spaces with other travellers. Introducing additional digital services that analyse travel data and identify lower demand times for travel during the day will help individuals travel more safely on mass transport. Additionally, dynamic pricing and collaboration between operators may help. Flexible booking options could also be used to increase the attractiveness of bus and rail compared to private cars.

Decarbonising private vehicles is key to decarbonising non-urban passenger travel. A large share of non-urban travel is by private vehicle. The use of electric vehicles has been lower in non-urban travel due to their low range and the limited availability of charging points. Policies and investments to address this can be part of economic recovery plans to support both decarbonisation and the economy. Germany, Spain, Austria, Italy and France all have recovery packages that include special concessions for electric vehicles for the consumers (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2020[40]) (Service-Public.fr, 2020[41]). The impact of such incentives has already been felt. Sales of battery-electric and plug-in hybrid electric vehicles in Western Europe have more than doubled in 2020, while sales of gasoline and diesel cars have plummeted (The New York Times, 2021[42]).

Economic stimulus packages prioritising decarbonisation of transport could help strengthen the pace of economic recovery after Covid-19. Manufacturing incentives coupled with tax benefits for the consumer can accelerate demand for electric vehicles. In the short term, maintaining policy requirements for clean mobility would help to reduce risks to existing investments in e-mobility. Continuing exemptions could also offer advantages for stakeholders waiting on the sidelines. In the long term, e-mobility, like other energy efficiency enhancements, can improve economic productivity by reducing travel costs and driving innovation (ITF, 2020[43]).

Recover, *Reshape*, *Reshape+*: Three possible futures for non-urban passenger transport

This section explores potential development paths for regional and intercity mobility to 2050. It is based on three different scenarios: *Recover*, *Reshape*, and *Reshape+*. These scenarios represent increasingly ambitious efforts by policy makers to reduce CO_2 emissions and decarbonise regional and intercity transport. The definition of policies within these scenarios was based on ITF research, input from experts in the form of a policy scenario survey disseminated to policy experts from all regions of the world in early 2020, and from ITF workshops held for projects under the ITF Decarbonisation Initiative in 2020. Table 4.3

details the assumed uptake of the measures for each scenario. All three include the same baseline economic assumptions to reflect the impact of the Covid-19 pandemic: a five-year delay in GDP and trade projections compared to pre-Covid-19 levels.

The scenarios are based on the ITF Non-Urban Passenger Transport Model, which simulates the development of transport activity, mode shares, and CO_2 emissions for intercity and regional transport to 2050 from the base year 2015. Box 4.3 offers a detailed description of the ITF non-urban passenger transport model and changes to previous versions.

Box 4.3. The ITF non-urban passenger transport model 2021

The International Transport Forum (ITF) non-urban passenger model estimates non-urban passenger demand around the world. It splits the world into almost 1200 zones, using an airport or all the airports of a city as their centre. Each zone generates two types of transport activity, regional and intercity, and their corresponding externalities. Regional transport activity refers to activity happening within the zone but outside urban areas (if any). Intercity transport activity refers to activity happening between different zones. The model estimates the number of passengers, passenger-kilometres, mode combination, energy consumption and CO_2 emissions by mode for each area and each route between them. The modes analysed are air, rail, road (car and motorcycle), bus and ferry[1]. The current version of the model estimates the impact of 17 policy measures, technological developments and trends. These are specified for each of 19 regional markets of the world.

The model was developed and first presented by ITF in 2019. It represents as a continuation of the ITF International Passenger Aviation Model. It is constantly updated and improved. New features of the current edition are described in Table 4.2 below.

The model was also adapted to address the drop in demand resulting from the Covid-19 pandemic in 2020. Observed data from the aviation sector are used as a benchmark to calibrate the estimated demand reductions across modes and regions. The demand follows the projected recovery of the aviation sector in a post-pandemic as projected by IATA and ICAO. A number of Covid-19 related aftereffects are also included as trends.

Table 4.2. Summary of non-urban passenger model updates

	2019 version	2021 version
Full integration of multimodal travel	Multimodal travel was only an option for aviation trips, with a surface mode leg at the start or the end of the trip	Multimodal travel is an option for all trips, regardless of mode combination
Passenger ferry	-	The mode of passenger ferry is added in the intercity part of the model
Carbon-pricing policies	Carbon-pricing policies are applied only in aviation	Carbon-pricing policies are applied across all modes
Integration of new aircraft technology	All-electric aircraft are an alternative to conventional aircraft after 2040	Hybrid electric aircraft is an alternative after 2030 All-electric aircraft is an alternative after 2040
Updated rail infrastructure plans	Rail infrastructure developments happen if beneficial following a Cost-Benefit Analysis	TEN-T network infrastructure developments are also included in the model

1: Air and ferry modes are only available for intercity activity

Non-urban passenger transport in the Recover scenario

In the *Recover* scenario, pre-pandemic thinking in terms of policies, investment priorities and technologies shapes non-urban passenger transport in the coming decade. Governments prioritise and reinforce primarily established economic activities to bolster the recovery. The main objective is the return to a pre-pandemic "normal". *Recover* is a more ambitious version of the *Current Ambition* scenario in the *ITF Transport Outlook 2019*.

Technological progress for the non-urban road vehicle fleet is moderate. Overall, vehicle fleets and fuel-efficiency standards in regional and intercity travel follow the IEA's Stated Policies Scenario (STEPS) assumptions (IEA, 2020[44]). Hybrid-electric and battery-electric vehicles become more common outside cities, but their use is still limited. Vehicle sharing increases but remains marginal for non-urban travel.

Conventional and high-speed rail projects currently under construction or planned are completed. Governments also invest in service improvements, which leads to increased frequencies and an improved offer for passengers.

There is no quick breakthrough in the decarbonisation of aviation. Aircraft fuel-efficiency improves in line with past trends, albeit reinforced by the retiring of older, more polluting aircraft. Technological step changes such as all-electric aircraft or wide use of synthetic aviation fuel occur only towards mid-century. Hybrid aircraft with electricity-assisted jet propulsion start to appear by 2030 and represent a small but significant share of (mostly domestic) aviation by 2050. Peoples' propensity to fly falls slightly in some regions, primarily due to environmental concerns.

Carbon pricing is gradually implemented across all transport modes, reaching USD 150-250 per tonne of CO_2 by 2050. In aviation, moderate ticket taxes are introduced, and the use of sustainable aviation fuel mandated. Developed regions make more use of these mechanisms than other world regions. Finally, the liberalisation of air travel ("open skies") follows pre-pandemic trends, while better airspace management enables aircraft to use more efficient flight paths.

Paradigm change: Non-urban transport in the Reshape scenario

In the *Reshape* scenario, the impacts of Covid-19 on non-urban passenger transport also gradually disappear by 2030, as under *Recover*. *Reshape* differs in that policy makers set ambitious climate goals and implement stringent policies in their pursuit. Also, these more ambitious policies are put in place worldwide, not only regionally. *Reshape* is a more ambitious version of the *High Ambition* scenario in the *ITF Transport Outlook 2019*.

Government policies make non-urban travel less attractive by adding to cost, particularly in aviation. Carbon prices reach USD 300-500 in 2050. Similarly, higher ticket taxes of up to 30% is set for air travel. The use of sustainable aviation fuel increases due to the adoption of strict fuel mandate standards but also adds to costs.

Electrification of non-urban surface travel makes progress. The higher share of low-emission vehicles in the fleet makes regional and intercity travel more sustainable; it also minimises the impact of carbon-pricing policies. Electrification and fuel efficiency of surface vehicles improve in line with IEA's Sustainable Development Scenario (SDS) assumptions (IEA, 2020[45]).

Shared travel gains more traction in a non-urban setting, taking a bigger share of total activity.

Heavy public and private investment in rail transport improves infrastructure, service and operating speed. New ultra-high-speed rail lines (Maglev) further boost demand for intercity rail.

The decarbonisation of aviation picks up speed. The fuel efficiency of aircraft increases faster following an accelerated adoption of new aircraft designs. Government support for research and development lowers the cost of synthetic aviation fuels and all-electric aircraft. Technological advances allow the deployment of hybrid planes with higher battery capacity compared to the *Recover* scenario. A propensity to fly falls further, with people all over the world reducing their air travel. As aviation's carbon footprint falls towards mid-century, this trend loses in importance.

Reshape+: *Reinforcing Reshape*

In the *Reshape+* scenario, positive decarbonisation trends from the pandemic are locked in through policies that lead to permanent change. As in the other two scenarios, the negative impacts of Covid-19 on non-urban passenger transport are overcome by 2030. As in the *Reshape* scenario, governments set ambitious decarbonisation targets and implement policies that can deliver them. However, governments seize opportunities for decarbonisation that emerged during the pandemic. By aligning economic stimuli with climate and equity objectives, they leverage economic recovery for environmental and social sustainability.

Several exogenous trends shape non-urban transport under the *Reshape* scenario. Long-distance tourism decreases, for example, as holiday-makers choose nearer destinations and thus to shorter-distance travel. Teleconferencing remains common practice after the pandemic, reducing the need for business travel. These trends are positive effects of the pandemic. Yet, in a comprehensive analysis, it is hard to argue that they are entirely positive, as they correlate strongly with the difficult economic situation of countries and individuals. They do, however, have a supporting effect on the decarbonisation efforts of the non-urban passenger sector.

Fuel mandates are strict. In many countries, eligibility for Covid-19 support packages is tied to the mandatory use of a minimum share of sustainable fuels, notably for aviation. This accelerates the widespread use of alternative fuels.

Governments earmark Covid-19 recovery funds for rail infrastructure investments, which accelerates improvements in frequency and operating speed for regional and intercity services. It also creates more alternatives to air travel for longer-distance trips, both national and international.

Covid-19 stimulus packages target the decarbonisation of road transport. Subsidies and other benefits for electric and other low-emission vehicles remain in place for longer. Additional funds enable the roll-out of charging infrastructure in more regions, supporting a faster and increased penetration of non-urban travel with electric and low-emission vehicles. By 2050, *Reshape+* assumes that their share grows 1-5% extra compared to the *Reshape* assumptions.

Table 4.3. Scenario specifications for non-urban passenger transport

Shading denotes policies with stronger implementation in *Reshape+*

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Economic instruments				
Ticket taxes (air travel)	Percentage tax applied on the cost of airfare	Ticket taxes vary across regions: 3% - 15% in 2050	Ticket taxes vary across regions: 8% - 30% in 2050	
Carbon pricing	Charges applied on tailpipe CO_2 emissions	Carbon pricing varies across regions: USD 150-250 per tonne of CO_2 in 2050	Carbon pricing varies across regions: USD 300-500 per tonne of CO_2 in 2050	
Enhancement of infrastructure				
Development of ultra-high-speed rail	Introduction of new ultra-high-speed rail routes, such as Maglev	No development of new ultra-high-speed rail	Development of Maglev routes where economically feasible	

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Improvements in rail infrastructure	Investments in existing rail infrastructures leading to frequency and speed increases	Frequency increases by 50% (year of improvement varies across regions)	Frequency (50%) and speed (20%) improvements across regions	Earlier frequency (50%) and speed (20%) improvements across regions
Regulatory instruments				
Synthetic fuels (aviation)	Decrease of synthetic aviation fuel cost relative to conventional fuel as a result of technological developments	Synthetic fuels cost is 3.3 times more expensive than conventional fuel	Synthetic fuels cost is three times more expensive than conventional fuel	
Mandates in aviation for sustainable aviation fuels (SAF)	SAF should constitute a minimum percentage of total fuel used	Minimum SAF percentage varies across regions 5% - 10% in 2050	Minimum SAF percentage varies across regions 10% - 25% in 2050	Minimum SAF percentage varies across regions 15% - 30% in 2050
Operational instruments				
Optimise aircraft movements	Flights are closer aligned to greater circle paths	Deviations are reduced by 50% in 2030	Deviations are reduced by 50% in 2020	
Simulation of innovation and development				
Electric/alternative fuel vehicle penetration	Increased penetration of electric vehicles in non-urban road transport due to financial incentives for the purchase and use of alternative fuel vehicles and investment in charging infrastructure.	Follows the IEA STEPS Scenario	Follows the IEA SDS Scenario	Increased penetration on top of IEAs SDS Scenario
Hybrid-electric planes	Development of new hybrid-electric aircraft.	Hybrid-electric aircraft are available from the year 2030. They provide 5% - 7.5% of total energy required reaching up to 20% - 30% in 2050 depending on the region.	Hybrid-electric aircraft are available from the year 2030. They provide 7.5% - 10% of the total energy required reaching up to 30% - 40% in 2050 depending on the region.	
Ridesharing/shared mobility	Increased ridership in non-urban road transport (car and bus)	The percentage of shared trips of total trips by car equals 6.7%	The percentage of shared trips of total trips by car varies across regions 13.3% – 20.0%	
Mobility as a Service (MaaS) and multimodal travel services	Improved integration between different transport modes. Integration of ticketing and increase of intermodal terminals/stations	Switching between different modes is twice as penalising as between the same mode	Switching between different mode is no more penalising than between the same mode	
Improvement in range and cost of all-electric planes	Development of all-electric aircraft	Flying range of all-electric planes increases by 2050 up to 1 000 km Cost of all-electric aviation is 1.5 times that of conventional aircraft	Flying range of all-electric planes increases by 2050 up to 1 500 km Cost of all-electric aviation is 1.2 times that of conventional aircraft	
Exogenous factors				
Autonomous vehicles*	Introduction of vehicles with level 5 autonomous capabilities The percentage of autonomous vehicles in use varies across regions: for car 0% - 2.5%, for bus 0% - 1.25%			

Measure/Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Reduction in long-distance leisure-tourism	Reduced tendency to take long-distance leisure trips as a consequence of Covid-19 pandemic	none	none	Long distance trips are reduced by 15% to 22% (compared to demand without this factor) between 2020 and 2030. The impact reduces linearly reaching 0% in 2050.
Reduction in business travel due to teleconferencing	Replacement of business trips with teleconferencing as a consequence of Covid-19 pandemic	none	none	Air trips are reduced by 12.5% (compared to demand without this factor) between 2020 and 2030. The impact reduces linearly reaching a 2.5% reduction in 2050.
Reduced propensity to fly	Segments of the population avoid flying due to climate considerations	10% - 15% fewer people fly in some regions in 2050	5% - 30% fewer people fly in most regions in 2050	

Note: Range of values reflect the varying degrees of implementation of policy measures across the different world regions in each scenario. *Autonomous vehicles are considered but are not a primary factor in any of the scenarios. All scenarios assume a constant level of introduction of vehicles with Level 5 autonomy. The *ITF Transport Outlook 2019* focussed more specifically on transport disruptions, including autonomous vehicles, and assessed related scenarios

Demand for non-urban passenger transport: Quick recovery and continued growth

Non-urban passenger transport demand, measured in passenger-kilometres, is the sum of regional (peri-urban and rural) and intercity transport. In 2015, demand was around 32 trillion passenger-kilometres, with a little more than half of travel (54%) taking place between cities and the rest in the regional segment. The share of non-urban passenger transport is projected to fall slightly over the next three decades, from 61% of all passenger activity in 2015 to 56% by 2050.

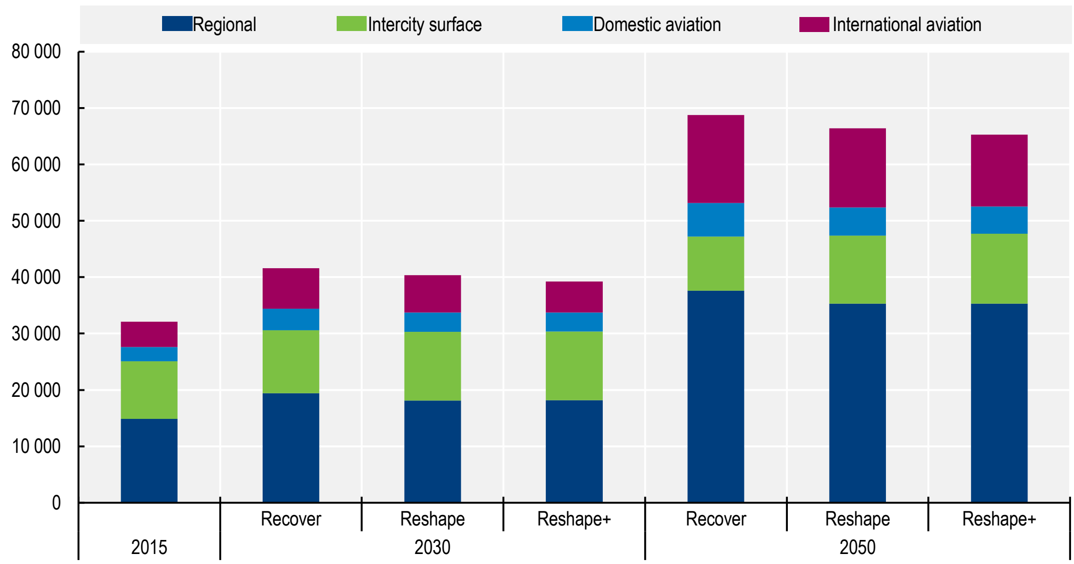
In absolute terms, non-urban passenger activity should more than double by 2050 compared to 2015. In the *Recover* scenario, it grows by 114% and under *Reshape* 107%. *Reshape+* will limit demand growth by an extra four percentage points to 103%, aided by policies that encourage teleconferencing and leisure tourism in nearby destinations to continue after the pandemic.

Regional transport and aviation grow strongest in all three scenarios, especially international aviation (Figure 4.2). Demand for surface modes linking cities will remain relatively stable. *Recover* policies would reduce demand for surface intercity transport both in absolute and relative terms, primarily due to carbon pricing. In *Reshape* and *Reshape+*, improved vehicle technologies, electrification, and carbon-pricing policies reverse this trend. Population growth and the economy affect both regional and intercity movements, while the availability of transport infrastructure and the supply and cost of travel primarily impact the intercity segment.

Under the assumptions of *Recover*, non-urban passenger transport activity will reach almost 70 trillion passenger-kilometres in 2050, with an almost even split between intercity and regional. The *Recover* scenario assumes that policy makers and stakeholders adopt measures and policies intending to return to a pre-pandemic "normal". That, however, cannot be reached without additional actions. Regional demand grows faster, increasing by 150% compared with 80% for intercity travel. Despite continuing urbanisation, the non-urban population will grow in absolute numbers and generate transport activity. However, hardly any policies target regional travel; in contrast with the intercity segment, where various measures are directly or indirectly reducing demand.

Figure 4.2. Demand for non-urban passenger transport by sub-sector to 2050

Under three scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Regional refers to daily local transport activity that happens outside of urban areas (peri-urban, rural); intercity surface refers to transport movements by private road vehicles (two- and three-wheelers, cars), buses, and rail between urban areas.

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The policies adopted in the *Reshape* scenario curb the growth of regional travel slightly. The more ambitious policies reduce the growth of regional activity by 1ercentage points in 2050, with demand for regional transport growing by 2.5 trillion passenger-kilometres less than under *Recover* policies. In contrast, demand for intercity travel stays almost the same as in *Recover*. The modal composition of *Reshape* is different, however, with "greener" modes playing a more prominent role.

The implementation of *Reshape+* policies reduces the growth of intercity travel. Under the assumptions of *Reshape+*, demand for intercity travel increases by 1.6% annually, for a total increase of 74%, seven percentage points less than *Recover* and *Reshape*. This is the consequence of a more pronounced drop in business travel and long-distance leisure tourism, aided by slightly higher fuel mandates, which increase the cost of air travel and further suppress demand. On the other hand, demand for regional travel has a similar growth as in *Reshape.*

Air travel will dominate intercity trips

Aviation becomes the main transport mode for intercity travel under all three scenarios. In 2015, cars (and motorcycles) generated more passenger-kilometres than aviation, with a 44% share compared with 40% for aviation. Bus and rail had smaller shares with 12% and 3% respectively. In all three scenarios, aviation recovers the losses from the 2020 Covid-19 pandemic quite quickly, establishing its dominance in the intercity market by 2030, with 50% of the total mode share in *Recover*, 45% in *Reshape* and 42% in *Reshape+*.

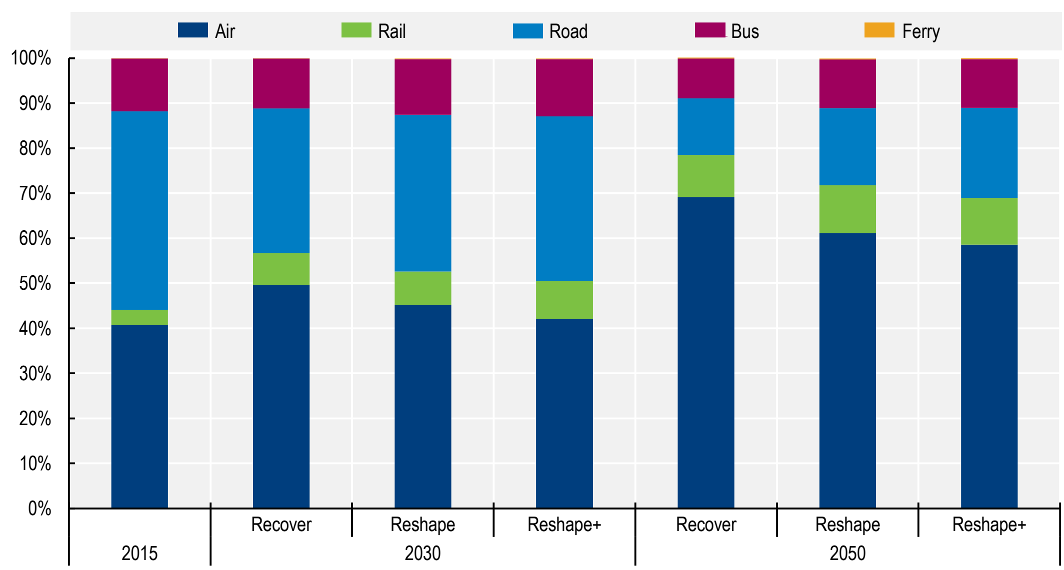
Demand for intercity travel grows considerably in the *Recover* scenario, led by aviation. Overall, demand is set to grow by 1.7% annually for a total increase of 81% by 2050. Aviation represents a massive 69% of the total intercity activity in passenger-kilometres. Compared to 2015, aviation demand more than triples in 2050, reaching almost 21.6 trillion passenger-kilometres. The policies implemented under *Recover* are unable to reign in the growth of aviation and especially international air travel.

***Recover* demonstrates how low levels of pricing mechanisms such as carbon pricing or ticket taxes will not significantly alter the growth path of air travel**, especially if the world economy recovers from the pandemic as assumed. The improved fuel efficiency of new aircraft reduces airfares and counters the imposed extra costs. International aviation is the primary driver of growth, with a compound annual growth rate of 3.6%. This growth assumes that the pandemic does not affect future Open Skies agreements.

Surface transport in regions and between cities shifts towards rail. Road transport becomes less important in the intercity segment, with only 21% of the mode share in 2050. Private vehicles make up 12%, with the remaining 9% covered by bus. The share of intercity rail increases, reaching 9% by 2050, buoyed by its reliance on electricity. It is not affected by carbon-pricing mechanisms, while the slow adoption of electric road vehicles means road travel becomes more expensive over time.

Figure 4.3. Mode shares for non-urban passenger transport to 2050

Under three scenarios, mode share in passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Road vehicles include two- and three-wheelers and cars. Ferry activity accounts for less than 1% of total demand.

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The right policies can keep rising aviation demand in check. Under the more ambitious policies in *Reshape*, especially the ones that increase the cost of emitted carbon and flights in general, aviation grows 36 percentage points less by 2050 than under *Recover* assumptions. Nevertheless, aviation still grows significantly, by 172%. The reduction effect is more evident in domestic aviation, which grows with a compound annual growth rate of 2% under *Reshape* compared to 2.5% in *Recover*. International aviation also grows slower, but the difference between the two scenarios is smaller, with 3.3% growth in *Reshape* versus a 3.6% increase under *Recover*. Overall, intercity demand in *Reshape* in 2050 is 81% higher than the base year, one percentage point less than *Recover*.

Forgone aviation growth under *Reshape* policies is shared between the surface modes. Private road transport demand still declines both in share and absolute passenger-kilometres representing only 17% of total passenger-kilometres by 2050. Intercity rail sees significant increases, growing more than five times compared to 2015. In 2050, rail represents 11% of all intercity activity. Bus demand remains stable, growing slightly in absolute numbers but reducing in share. The main factors behind this shift are the increased presence of low- and zero-emission road vehicles and the rail infrastructure developments in *Reshape* are. As carbon-free mobility becomes widespread, the effect of carbon-pricing mechanisms on surface transport is smaller.

***Reshape*+ policies and changes further reduce the growth of air travel.** Aviation growth is a further 21 percentage points lower in *Reshape+* compared to *Reshape*, and 57 percentage points lower than *Recover*. Despite this relative containment, demand for air travel is still more than 2.5 times higher in 2050 than in the base year 2015, growing at an annual compound rate of 2.7% (1.9% for domestic and 3% for international aviation). Aviation thus covers 59% of all passenger-kilometres even under *Reshape+* *co*nditions, with 20% remaining for private road vehicles, 11% for buses, and 10% for rail.

Ferry passenger transport does not play a significant role in any scenario. Ferry services are common only in the few region with many islands located close to each other and calm seas. Most of the ferry activity in the modelling results comes from the European Economic Area (which includes island-rich coastal states such as Norway, Sweden or Croatia) and Turkey.

Commercial electric aviation develops in all three scenarios. Both hybrid-electric and all-electric aircraft come into use due to the technological developments and policies assumed in the three scenarios (see Box 4.1 for details). Hybrid-electric aircraft enter the market in 2030 in all cases, but with different levels of penetration. All-electric aircraft become commercially viable towards mid-century. Domestic routes and short international connections see earlier and more widespread use of electric aircraft regardless of scenario, due to the constraints posed by aircraft size and weight.

One in five flight routes will use some hybrid-electric aircraft within the next decade in the *Recover* scenario. While hybrid aircraft will operate on 18% of air links by 2030, only 0.6% of aviation demand will be covered by hybrid planes' electric propulsion in that year.[1] By 2050, three out of five routes see some part of the activity carried out with hybrid-electric planes. Still, electricity provides only 8% of the total demand in passenger-kilometres 40 years from today under *Recover* policies. All-electric aircraft appear only in 2045 and by 2050 are used only on 3% of all routes, corresponding to 0.8% of all total aviation activity.

Airlines switch to hybrid-electric aircraft faster because of higher carbon prices and reduced energy costs in *Reshape*. Hybrid-electric aircraft fly on a higher share of routes by 2030, but their share in terms of passenger-kilometres is still only 1.7%. Higher battery capacity and lower weight favour the adoption of hybrid-electric aircraft in the two following decades. By 2050, the electric component of hybrid-electric aircraft powers 14% of all aviation passenger-kilometres under *Reshape* conditions. Hybrid-electric aircraft operate on 85% of all short- and medium-haul routes, which corresponds to almost two-thirds of all flights. All-electric aircraft have greater range limitations than hybrids and are used only on 7% of all routes, serving 2.6% of the total demand. There is no significant difference concerning hybrid-electric and all-electric aircraft between *Reshape* and *Reshape*+ as the policy environment is the same in both. Long-lasting Covid-19 impacts reduce overall demand for air travel. This leads to lower hybrid-electric and all-electric aviation numbers in absolute terms but similar in shares.

Regional transport grows faster than intercity travel. As regional transport services, rural areas and areas surrounding urban agglomerations (peri-urban), private road vehicles, buses, and rail are the only available modes. Regional movements represent the daily movements of the people living in the area, so they depend highly on GDP and population changes. In *Recover*, regional passenger-kilometres grow by 152% between 2015 and 2050. Private road vehicles represent 39% of those, four percentage points lower than the base year. Rail activity grows significantly, tripling in absolute numbers and reaching 42% in 2050 from 34% in 2015. Bus travel, on the other hand, drops to 19%, from 23%.

Under *Reshape, the use of* private cars for regional mobility recedes further. The share of private road vehicles drops a further two percentage points in the face of more ambitious decarbonisation policies, reaching 37% in 2050. Rail transport is less affected by carbon prices and caters for this demand, increasing its mode share to 44%. Total regional demand grows 15 percentage points less to 2050 under *Reshape* compared to *Recover*. Regional transport outcomes in *Reshape*+ are similar to *Reshape*, as the assumed trends and policy changes do not significantly affect regional travel.

Global transport activity is shifting to Asia

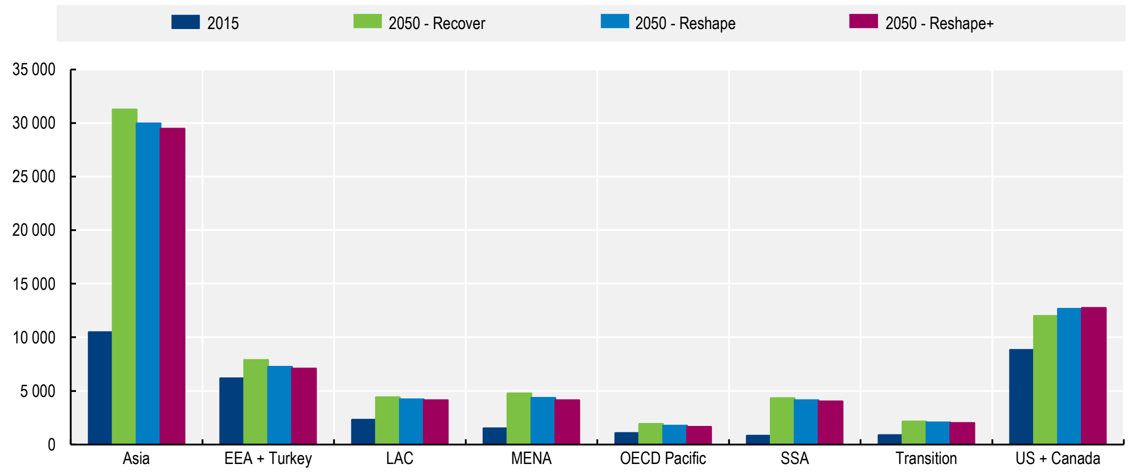
The global centre of gravity in transport activity is shifting. Most non-urban transport activity happened in OECD countries in the past. Over the past decade, this has started to change, and by 2050, a reversal of roles will happen. In 2015, the OECD's mostly developed nations accounted for 51% of all non-urban activity despite being home to only 20% of the world's population. By 2050, 67% of non-urban travel will occur in non-OECD nations. Of all world regions, Asia generated the most demand for non-urban transport in 2015, followed by the United States and Canada region, and the European Economic Area (EEA) and Turkey region. At the other end of the spectrum, Sub-Saharan Africa, Transition countries, and OECD Pacific were the world regions with the lowest non-urban transport activity in 2015. Transition economies include countries of the former Soviet Union and non-EU south-eastern European countries. OECD Pacific countries are Japan, South Korea, Australia and New Zealand. This shift continues through to 2050. In all three scenarios, non-urban transport grows strongest in Sub-Saharan Africa, the Middle East-North Africa (MENA) region and Asia. In the *Recover* scenario, demand in Asia will triple by 2050. The assumptions of the other two scenarios slightly reduce this growth, but Asia remains the biggest player.

Most OECD regions will see lower growth in regional and intercity travel. The lowest growth rates will occur in the United States and Canada, the EEA and Turkey and in the OECD Pacific. Overall, growth in the *Reshape* and *Reshape*+ scenarios is lower for all regions than in *Recover*, regardless of economic development. The United States and Canada region is the only one that defies this trend. In *Recover*, it has the second-lowest growth of transport activity behind the region of EEA and Turkey. In *Reshape,* however, the United States and Canada is the only region that has more activity than in *Recover*. This happens due to the planned and announced high-speed rail (HSR) projects of the region. These investments could increase non-urban transport activity more than in any other region.

Regional and intercity travel develops differently in OECD and non-OECD countries. Regional transport represents daily activity such as commuting or shopping trips. These trips are less affected by GDP growth in developed economies such as the OECD's compared to emerging or developing countries. The population covered under this segment also remains relatively stable or even decreases for most OECD countries. As a result, the total regional activity remains steady. Non-urban passenger demand growth in OECD countries thus comes primarily from intercity transport. The growing populations and economies of non-OECD countries, by contrast, will see massive growth in both regional and intercity transport activity.

Figure 4.4. Demand for non-urban passenger transport by world region to 2050

Under three scenarios, billion passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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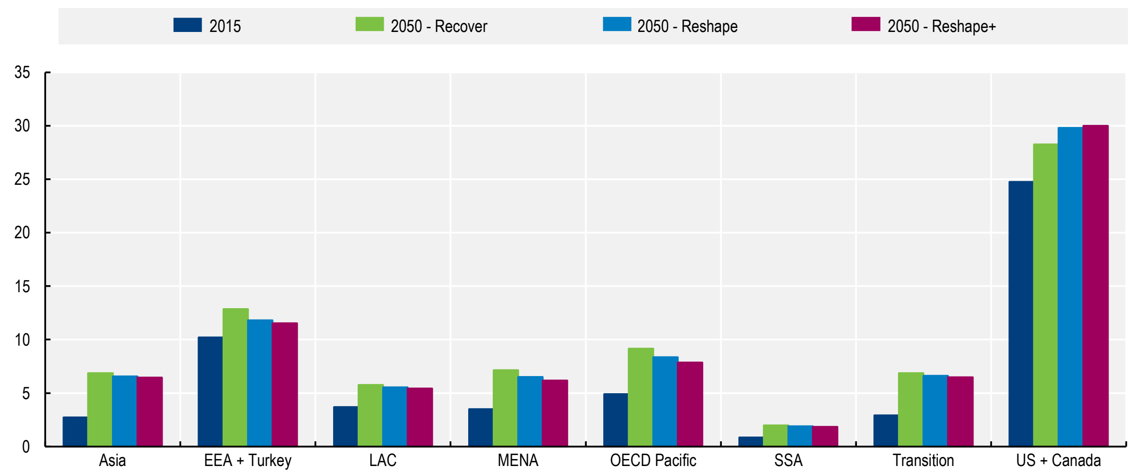
The most non-urban travel per person by far takes place in the United States and Canada. In this region, an average person travelled nine times as much as the average individual in Asia in 2015 (see Figure 4.5). The United States and Canada are both large countries; in both, most economic activity takes place on opposite sides of the country, generating considerable travel demand. Furthermore, their strong economic interdependence with the world and their geographic location implies that most international movements require crossing oceans. The EEA and Turkey region is a distant second in terms of per capita non-urban travel. Most of the other regions have a similar level of per capita demand. The only exception is Sub-Saharan Africa, where the average distance travelled by a person is significantly lower compared to all other regions. OECD Pacific is an interesting case, as it contains a mix of densely and sparsely populated, prosperous countries. They should produce low and high values of non-urban per-capita activity respectively, effectively cancelling each other out. Furthermore, the economic development of these countries would suggest high per capita values, but the geographically isolated countries included in this region, limit the number of international trips taken per person.

Per capita non-urban travel in passenger-kilometres increases in all three scenarios. In *Recover,* regional and intercity transport activity grows strongest in absolute terms for most regions. The only exception is the United States and Canada region, where activity grows more on a per-capita basis in the *Reshape+* scenario. The biggest relative growth occurs in Asia. Sub-Saharan Africa and the Transition regions also grow considerably in all three scenarios. The EEA and Turkey and the United States and Canada regions grow the least in all three scenarios, relative to 2015 levels.

Figure 4.5. Per capita demand for non-urban passenger transport by world region to 2050

Under three scenarios, thousand passenger-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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CO_2 emissions from non-urban passenger transport: Decoupling emissions from demand

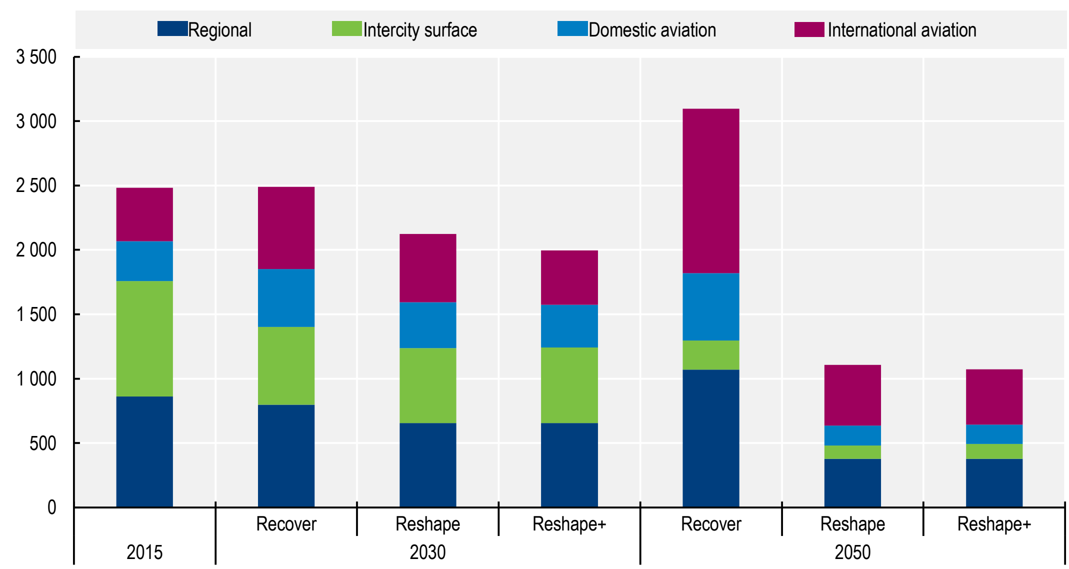
Non-urban passenger transport is at a crossroad. There are two possible paths ahead: one where emissions continue to grow in line with GDP, and one where the link between economic growth and emissions is severed. Despite the decline in non-urban transport and associated emissions as a result of the Covid-19 pandemic, the ITF simulations suggest that non-urban passenger emissions will rise again in the *Recover* scenario. Despite efficiency gains made on a per-kilometre basis, projected increases in demand far outpace these gains. Under *Reshape* and *Reshape+*, emissions could be drastically lower in 2050 than in 2015.

Non-urban passenger transport generated 2 482 million tonnes CO_2 in 2015. This represents 7.7% of all fuel-burn CO_2 emissions and 34% of all transport emissions. Of those, 70% were generated by road and rail, split evenly between regional and intercity travel. Aviation, both domestic and international, emitted 725 million tonnes of CO_2.

Emissions from non-urban travel rise by 25% if governments return to pre-pandemic policies as assumed in the *Recover* scenario. Regional transport and international aviation are the biggest CO_2 emitters, with 35% and 41% respectively by 2050. The rise in emissions is linked to growing demand, as decarbonising policies prove to be unsuccessful in curbing emissions. International aviation emissions grow almost in line with demand, reaching 1 300 million tonnes CO_2, a three-fold increase. This is far from the goal set by the aviation sector to reach 50% of 2005 emissions in 2050 (ATAG, 2019[46]), which would be a reduction of around 200 million tonnes of CO_2. Domestic aviation benefits more from the hybridisation of aircraft and increases by only 70%. As aviation becomes the main intercity travel mode, demand for surface modes will reduce. This fall in demand, combined with the increased fuel efficiency of surface vehicles, leads to a significant drop in emissions. Regional transport, on the other hand, will experience significant growth in demand, which leads to increased emissions. The emissions described for the *Recover* scenario are not a product of the absence of mitigation policies but rather what is expected under the current policies and measures. Further actions will be required from stakeholders to achieve even these targets.

Figure 4.6. CO_2 emissions from non-urban passenger transport by sub-sector to 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Regional refers to daily local transport activity that happens outside of urban areas (peri-urban, rural); intercity surface refers to transport movements by private road vehicles (two- and three-wheelers, cars), buses, and rail between urban areas.
Tank-to-wheel/wake emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Tank-to-wake is specifically used to refer to ships and aircraft.

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Accelerated technological progress and the wider use of electricity in aviation reduce emissions under *Reshape*. By 2050, non-urban passenger emissions fall by 55% compared to 2015. International aviation is the only segment where emissions grow compared to 2015, namely by 14%. Short- and medium-haul flights use hybrid-electric or all-electric planes almost exclusively, reducing domestic aviation emissions by 50%. Similarly, surface transport, both in the intercity and regional segments, benefits from the higher mode share of rail and the increased use of hybrid and electric vehicles on the road. The two segments combined produce 73% less CO_2 in 2050 compared to 2015.

***Reshape+* policies further accelerate emission reductions.** In 2050, total non-urban passenger transport CO_2 emissions would be 57% less than in 2015 under *Reshape+*. The difference between *Reshape* and *Reshape+* in 2050 stems almost exclusively from international aviation, which in *Reshape+* remains close to 2015 levels, increasing only by 4%. Domestic aviation emissions are also slightly lower under *Reshape+*, with two percentage points less than in *Reshape*. The reduction in aviation CO_2 emissions between the two scenarios comes from the reduced propensity of business travellers and long-distance leisure tourists to fly, as well as from the strengthened fuel mandates for aviation. Intercity surface transport is projected to reduce its CO_2 emissions by 87% compared to 2015.

Well-to-tank emissions become more important

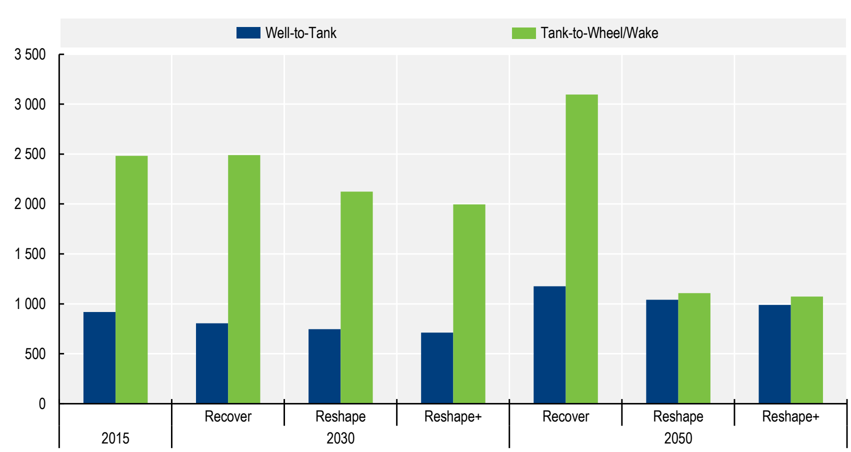
Upstream emissions play an important role in decarbonisation as fuel and electricity production is energy-intensive. These well-to-tank emissions accounted for 920 million tonnes of CO_2 in 2015, a time when most non-urban passenger transport relied on hydrocarbon fuels. These emissions are a combination of two main elements: the transportation of liquid fuels to consumption points and the emissions created from electricity production. These elements differ by country, year, and scenario.

The well-to-tank component becomes a larger share of total transport emissions. Well-to-tank emissions were responsible for 27% of total non-urban passenger transport emissions in 2015. Under a *Recover* scenario, this share remains stable throughout the next 30 years. But with more ambitious policies, as in *Reshape* and *Reshape+*, the share of well-to tank emissions reaches almost 50%. As the nature of transport emissions shifts and is shaped more by upstream factors, close collaboration between the transport and energy sectors will be increasingly critical for effective climate change mitigation.

The source of upstream emissions shifts from production and transport of fuel to production and transport of electricity. Well-to-tank emissions in 2015 stem almost entirely from the production and transport of fuels to their final consumption points. This is the case both for surface transport and aviation, with the biggest share of well-to-tank emissions in 2015 coming from the former. Regional and intercity surface activity taken together are responsible for 80% of the total upstream emissions of non-urban transport. Under the assumptions of the *Recover* scenario, a majority of well-to-tank emissions will come from the production and transport of electricity, and even more so with *Reshape* and *Reshape+* policies.

Figure 4.7. Evolution of tank-to-wheel vs. well-to-tank CO_2 emissions from non-urban passenger transport to 2050

Under three scenarios, million tonnes CO_2 emissions



Notes: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel/wake emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Well-to-tank emissions occur during energy production. Thus, well-to-tank emissions for electric vehicles (EVs) include emissions from electricity generation, while EVs tank-to-wheel emissions are zero. Tank-to-wake is specifically used to refer to ships and aircraft.

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OECD countries have the greatest potential to decarbonise

The lion’s share of non-urban passenger CO_2 emissions came from OECD countries in 2015. This also means these countries have the biggest potential to decarbonise. Two regions produced almost 55% of all well-to-tank CO_2 emissions, namely the United States and Canada region on the one hand and the EEA and Turkey region on the other. Asia generated only 22% of these emissions, despite having the largest population.

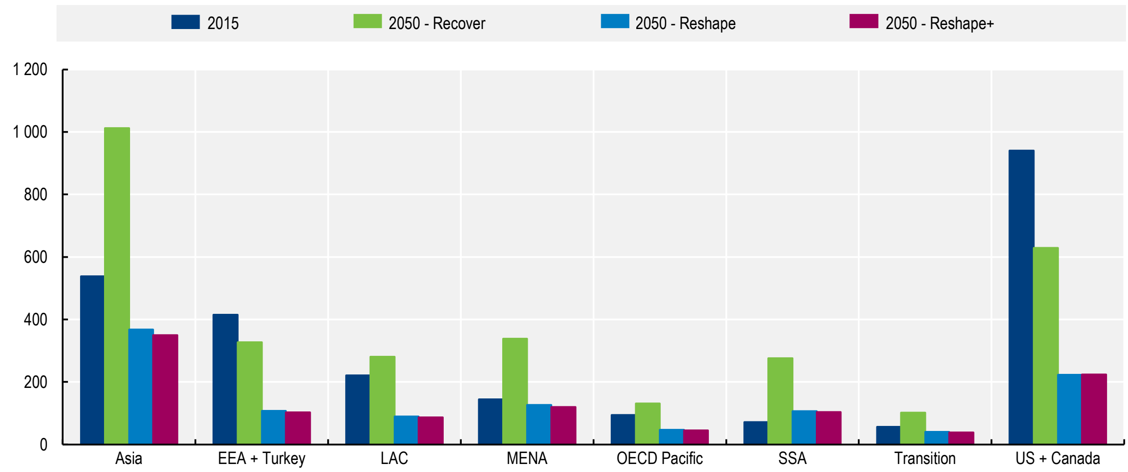
Different transport modes account for the highest non-urban travel emissions in the different regions. The OECD Pacific region, comprised mostly of island nations, is the only region where aviation produces a majority of emissions. In the Transition countries, aviation produces more emissions than other modes, but less than 50%. This is probably due to the region’s size and the increased use of rail. Road transport is the main driver of CO_2 emissions in all other regions. This is particularly true for the United States and Canada region and South-Saharan Africa, where private road vehicles, bus, train, and ferry services generate around 80% of the total.

***Recover* is the only scenario in which non-urban transport emissions rise by 2050.** Emissions grow in all but two regions, the United States and Canada and EEA and Turkey. These two generated the bulk of CO_2 emissions in 2015. They are two of the most economically developed regions and as such benefit the most from the increased efficiency and electrification of the surface vehicle fleets combined with the decarbonisation of the energy sector. All other regions register higher emissions in 2050, especially Asia, MENA, and Sub-Saharan Africa. The latter sees the biggest relative growth with almost four times the 2015 value, while Asia records the biggest growth in absolute terms, with nearly 475 million tonnes CO_2 more.

***Reshape* and *Reshape*+ policies reduce CO_2 emissions from non-urban travel across all regions.** In *Reshape*, the United States and Canada region and the EEA and Turkey region also register the biggest reductions. Pricing measures (carbon pricing, ticket taxes, etc.) are stricter in those regions and therefore shift demand more strongly to sustainable modes, favouring among other things the uptake of hybrid-electric aircraft. Emissions fall to 25% of the 2015 level. Sub-Saharan Africa is the only region that experiences growth in non-urban CO_2 emissions. The biggest reduction in absolute terms comes from the United States and Canada region, which reduce their projected WTW CO_2 emissions by 720 million tonnes. *Reshape*+ has similar numbers to *Reshape*, with all emission figures being slightly lower.

Figure 4.8. CO_2 emissions from non-urban passenger transport by world region to 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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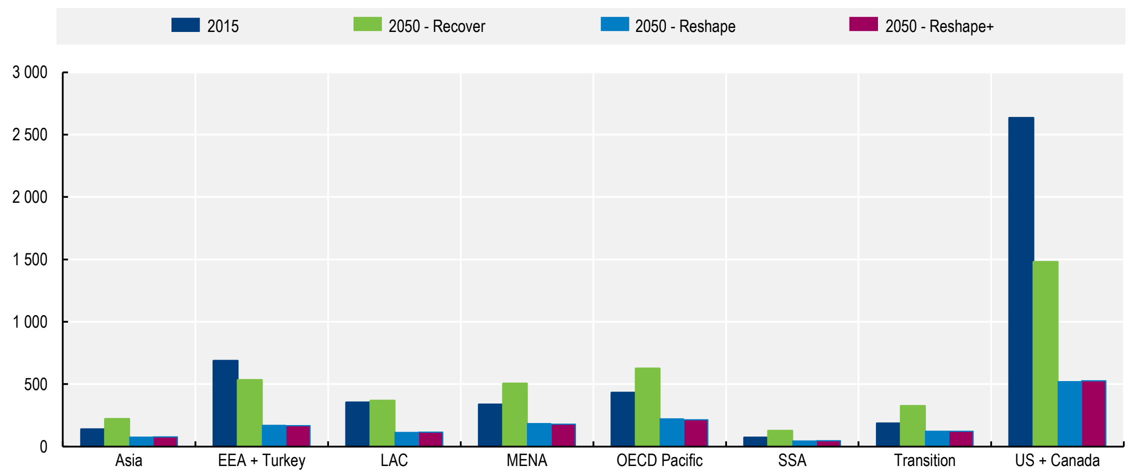
Travel patterns and emissions shift in all three scenarios. In 2050, aviation will be responsible for the majority of CO_2 emissions in all regions, with the exceptions of Asia and Sub-Saharan Africa. Emissions from Asia are evenly split between air and surface transport in the *Recover* scenario. In the other two scenarios, improved technologies and more ambitious policies shift the majority of emissions to the aviation sector. By contrast, Sub-Saharan Africa has an almost even split between air and surface transport in *Reshape* and *Reshape+*, whereas surface transport produces almost 60% of all non-urban emissions in *Recover*.

Wealthier world regions have much higher per capita CO_2 emissions as a result of more passenger-kilometres travelled. In 2015, the average inhabitant of the United States and Canada produced over 2.5 tonnes of well-to-wheel CO_2 emissions from non-urban passenger transport. An average inhabitant of EEA and Turkey generated almost 700 kg and citizens of OECD Pacific 430 kg. At the bottom end, the average inhabitant of Sub-Saharan Africa produced only 72 kg of CO_2 and Asians 140 kg.

The difference between regions is much higher in CO_2 emissions per capita than in passenger-kilometres. For example, in 2015, an average person in the United States and Canada travelled nine times more kilometres than an average person in Asia. In terms of CO_2 emissions, the difference between both is more than double: the North American traveller emitted 19 times the CO_2 of the Asian. This results from high volumes of non-urban activity by air and car in one region and rail and bus in the other. While this is one of the more extreme examples, similar discrepancies exist between most regions.

Figure 4.9. Per capita CO_2 emissions for non-urban passenger transport by world region to 2050

Under three scenarios, kilograms CO_2 per capita direct emissions (tank-to-wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape*+ refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

StatLink https://doi.org/10.1787/888934238964

In *Recover*, average per capita emissions grow in most regions. The two exceptions are the regions that had the highest emissions in 2015, the United States and Canada and EEA and Turkey. These regions reduce per capita emissions due to existing and planned rail infrastructure investments. Also, their high-income levels allow people to switch to lower-emission private vehicles. The lower growth of transport activity in those regions plays an important role as well. Other regions are unable to decouple activity from emissions. There, emissions grow on a per capita basis, most of all in Asia, the Transition countries and Sub-Saharan Africa.

***Reshape* and *Reshape*+ policies reduce per capita emissions from non-urban travel worldwide**. The drop is more pronounced in economically developed regions. In *Reshape,* the EEA and Turkey region manages to reduce per capita emissions to 17 kg of CO_2, below those from OECD Pacific and MENA (225 kg and 190 kg respectively), primarily because of its high connectivity with surface modes. The biggest drop, both in absolute and relative terms, happens in the United States and Canada, even if this region still has the highest per capita emissions of around 0.5 tonnes CO_2 annually. As road transport and the energy sector decarbonise, the biggest share of emissions comes from air transport, even if aviation is much less carbon-intensive than in 2015.

Fair decarbonisation: Reducing non-urban passenger emissions in equitable ways

Transport can be a catalyst for promoting social inclusion and well-being. Transport policies, including decarbonisation policies, impact equity by influencing accessibility and the distribution of costs and benefits between populations. They can influence the economic and social outcomes of individuals. It is vital to align economic, climate change and well-being goals. Covid-19 has had a drastic impact on mobility and hence on access to essentials such as jobs, services, and social networks. During the pandemic, car owners had a clear accessibility advantage over those reliant on other forms of transport. While shorter distances can be covered by walking or cycling, regional and intercity travel for low-income households was gravely disrupted. Even without a pandemic, the affordability of different modes of transport dictates the travel patterns of people. Lower-income households are less able to fly or use high-speed rail. They often depend on bus services and, in certain regions, trains for their non-urban travel needs.

Policy makers should protect and promote more efficient and affordable long-distance travel services. Transport providers are reeling from the financial losses of the pandemic. They are facing high operating costs and low user numbers. Policy makers will need to deal with funding shortfalls. Bailouts have been granted for aviation, but bus operators that serve lower-income travellers will also need government assistance to maintain service.

Transport projects often benefit more mobile travellers. In a traditional cost-benefit analysis of transport schemes, the value of travel time saved accounts for the majority of estimated benefit to users. Yet travel time savings offer benefit to groups that are already highly mobile but are less likely to provide benefits to groups with restricted mobility, such as non-drivers, the elderly, low-income households or the disabled. (Lucas, Tyler and Christodoulou, 2009[47]).

Environmental equity of transport decisions

Transport policy decisions must balance environmental and social goals. Sustainable transport planning often requires trade-offs between the economy, environment, and social justice. Substantial attention has been paid to trade-offs between economic development and the environment, as well as economic development and social equity. Interest in striking the right balance between environmental and equity goals has been much less pronounced. The trade-off between these two goals is often referred to as environmental justice (Mitchell, 2005[48]).Policies focussing on decarbonising the transport sector should entail an equitable implementation of measures. Environmental justice strives to ensure that the negative impact of transport decisions on health and the environment does not fall disproportionately on minorities and lower-income groups (Forkenbrock and Schweitzer, 1999[49]).

Advances in sustainable transport can offer benefits to all. Governments worldwide have focused on promoting electric vehicles to cut transport emissions. Despite incentives, electric vehicles will continue to be more expensive than equivalent internal combustion engine vehicles for the next four to six years (Soulopoulos, 2019[50]). Their high price makes them unaffordable for many consumers. Policy makers must ensure that environmental progress in transport does not leave anyone behind. Tax credits and other fiscal incentives to encourage the use of electric vehicles are often available equally to all consumers, regardless of income levels. This results in uneven social benefits. The social benefits of electric vehicles include increased energy security as well as reduced emissions of GHGs. While the social benefits of increased energy security are shared nationally, the benefits of improved air quality are more unevenly distributed (Skerlos and Winebrake, 2010[51]). If the tax credit for purchasing electric vehicles is adjusted by income level, it would increase adoption among lower-income groups and also lead to a more equal distribution of the social benefits of their adoption.

Improving shared vehicle fleets and charging infrastructure offers benefits to all. In the aftermath of Covid-19, recovery measures that encourage sales of low emission vehicles and investment in charging infrastructure should focus on shared rather than private fleets to achieve environmental and equity goals (Buckle et al., 2020[52]; Goetz, 2020[53]). Future transport will be shaped by shared, autonomous, and electric vehicles. The private sector will largely drive that change. Given the public and private benefits of that change, policy makers must ensure social equity is a priority for both the public and private sectors.

Carbon taxes must not harm the less well-off

Pricing mechanisms employed to promote the reduction of emissions can have adverse equity impacts. The equity effects of carbon taxes have been a subject of discussion since their conception as a policy instrument. Carbon taxes affect the cost of travel and lead to changes in passenger demand, mode choice and the flow of traffic on road networks. These are significant when it comes to low-carbon road transport (ITF, 2020[54]). However, theoretically, and empirically, carbon taxes and energy taxes are regressive and can cause inequity by affecting low-income groups relatively more than high-income groups. While there is strong evidence that carbon taxes contribute to mitigation of carbon emissions, the uptake of carbon pricing as an instrument to reduce emissions has been slow and hesitant. This can be traced to the opposition faced by carbon taxes due to their regressive distributional impacts (Büchs, Bardsley and Duwe, 2011[55]).

Lower-income groups bear the brunt of regressive taxation. Carbon taxes affect non-urban passenger transport more than other instruments because they are often determined and applied nationally. The regressive distribution impacts arise due to different reactions to a uniform policy that stem from differences in income, living conditions, consumption preferences and patterns, and different socio-economic groups (Liang, Wang and Wei, 2013[56]). Even if they are unlikely to be frequent flyers, lower incomes groups could bear a heavier burden of such taxes than higher incomes groups, depending on the alternatives available to them. How the revenues generated by carbon taxes are used can play a big role in ensuring that the burden on lower-income groups is reduced or eliminated.

A distributional impact analysis before adopting a carbon tax will highlight areas for concern as well as areas where equity impacts are perceived but not significant. For example, pricing measures on flights. Only a small share of the population takes a majority of flights. In the United States, 12% of the population took six or more flights in 2016, accounting for 68% of flights (Rutherford, 2019[57]). In England, only 1% of residents took almost 20% of international flights, and 10% took over half (Kommenda, 2019[58]). Across 26 EU countries, carbon footprints associated with air travel rise with expenditure and income (Ivanova and Wood, 2020[59]). Therefore, targeting flights with pricing mechanisms shifts the costs onto those responsible for the emissions, and are not likely to be regressive.

Carbon taxes can be implemented without negative distributional impacts. Successful examples have complemented the tax with preferential measures that safeguard lower-income groups from bearing the burden of the tax. These measures can be applied in different forms. Sweden, for example, reduced the income tax rate as it increased the levy on energy products (Speck, 1999[60]). In Denmark, the revenue generated from the carbon tax could be used by other sectors as labour subsidies or energy-saving investment (Wei et al., 2008). It is essential for policy makers to keep in mind such distributional impacts and the possible steps to avoid them. Revenue can be recycled to groups or individuals through direct transfers and subsidies. Exemptions and lower tax rates for specific groups can be offered from the outset. All these measures directly impact the effectiveness of carbon taxes.

Quantifying the equitability of non-urban transport

Annual per capita non-urban transport activity grows in all three tested scenarios, as seen earlier in this chapter. Growing per capita activity does not in itself mean that the situation becomes more equitable. An evaluation of equity impacts must examine the distribution of activity across regions. The Gini coefficient is an indicator that tests the distribution of income. A value of one means that all the income is concentrated in a single individual, while a value of zero means that income is evenly distributed across all individuals. A similar process is used to examine the per capita passenger-kilometres in the regions. In 2015, the Gini coefficient is 0.47. In 2050, it is lower for all three scenarios: 0.36 in *Recover*, 0.38 in *Reshape,* and 0.39 in *Reshape+*. *Reshape* and *Reshape+*, both assume more costly policies and measures that increase the cost of travel. Such increases affect regions with lower economic capabilities more. Therefore, the gap between per capita demand for travel between regions narrows between 2015 and 2050, but the pricing mechanisms in *Reshape* and *Reshape*+ mean they decrease less than in *Recover*.

Per capita CO_2 emissions from non-urban transport are more unevenly distributed across regions compared to per capita passenger-kilometres in 2015. The Gini coefficient for the base year is 0.52, compared to 0.47 for passenger-kilometres. The coefficient decreases in 2050 for all three scenarios, to approximately 0.35. However, in contrast with passenger-kilometres, *Reshape* is slightly more equitable. This is a result of the high impact decarbonising policies can have in the high-emitting regions.

Policy recommendations

Non-urban transport is an overlooked step-child of climate policy. Regional and intercity travel is responsible for more than one-third of all transport emissions and more than half of total passenger transport CO_2 emissions. Without addressing the carbon footprint of a growing number of rural commuters, city hoppers or tourists, it will be difficult to contain climate change.

The Covid-19 pandemic has temporarily reduced emissions from non-urban passenger transport, particularly from aviation. But regional and intercity transport is set to rebound and to at least double by 2050. Its emissions will increase by a quarter if the policies currently in the pipeline will not change.

A shift in policy would pave the way to more sustainable non-urban transport. Its emissions can be brought down by more than half over the next three decades if the decarbonisation windfall of the Covid-19 pandemic can be locked in. Making investment into decarbonisation a priority of economic recovery programmes will put non-urban transport on the right path. The following recommendations detail essential steps on that path.

Increase the price of high-carbon non-urban transport to encourage clean alternatives

Governments can tax the use of carbon and increase levies on transport options that are currently under low-tax regimes or exempt from taxes. For international transport, these pricing mechanisms need to be applied based on both the country of origin and destination. This will minimise loopholes and help ensure money raised can be used to decarbonise transport. The increased cost of travel may reduce demand marginally if alternative transport options do not exist and enable a change in behaviour. A price on transport carbon will also drive the availability of greener alternatives, however - for example by making blend-in aviation fuel or electric aircraft more attractive and encouraging other measures that make existing modes more sustainable and also affordable.

Beyond pricing carbon nationally, governments should aim to conclude bilateral or multilateral agreements on pricing mechanisms for international aviation. Introducing effective carbon pricing will require tough negotiations and encounter opposition. However, the cost of not acting will be much higher than the cost of implementing penalties for high-carbon transport and promoting low-carbon alternatives.

Create Covid-19 recovery packages that boost sustainable non-urban transport

Economic stimulus packages for Covid-19 recovery should contain environmental conditions that support sustainable transport. Governments need to privilege the manufacturing and use of electric vehicles over petrol and diesel vehicles. Such incentives could specifically target large vehicle fleets used in shared and public transport in the non-urban segment. This would extend the benefits of low-emission vehicles beyond cities and owners of private vehicles.

Bailouts for transport operators can be conditional on meeting certain climate-related goals. There are applications of this across the entire transport ecosystem, but some more specific examples for non-urban passenger transport include the following. Improvement in intercity and regional rail services frequency and operating quality. Incentivising bus and taxi operators to switch to low or zero-emission vehicles. Requiring airlines to limit short-haul flights to encourage rail travel. Finally, governments and enterprises could nudge employees to travel by rail on business, rather than fly or drive.

Align decarbonisation policies across the transport and energy sectors to reflect the reliance of zero-carbon transport on clean energy

Low- or zero-carbon transport is not possible without clean energy, and therefore without the decarbonising the energy sector. Recovery packages that focus on greening the electricity grid and improving battery technologies are vital to comprehensively decarbonise transport. A green grid is critical, as an ever-increasing part of non-urban transport will rely on electricity. Electric road vehicles, further rail electrification and hybridisation of aircraft will all play a part in reaching decarbonisation goals and rely on clean electricity.

Mandate the use of alternative fuels in aviation to encourage long-term innovation

Encouraging the adoption of alternative fuels in aviation would reduce emissions in the short term and encourage innovation over the longer term. Initially, a certain share of alternative fuel would come from sustainable sources, either as biofuel or as synthetic fuel from sustainable sources. Fuel mandates would stimulate innovation and adoption of new sustainable aviation fuel in the future, providing further incentives for improving aircraft efficiency. Such a measure would have direct and indirect impact on the cost of flying, which could reduce demand.

Incentivise the transition to low-emission non-urban road transport by making it more affordable and through measures that increase consumer confidence in cleaner options

Purchase subsidies, tax rebates and exemptions can ensure electric and other low-emission vehicles, become more affordable and interesting for consumers. The higher initial cost of low-emission vehicles and the lack of charging infrastructure are deterrents for potential users especially outside cities. Investing in rapid charging infrastructure along intercity routes would help to establish electric vehicles as a reliable longer-distance travel option. The public sector can lead by example by equipping public vehicle fleets with low-emission vehicles and making more public charging points available. Funding for research and development of cleaner vehicles and fuel technologies should be stepped up to help reduce costs and improve performance.

Invest proactively in technological developments beyond the transport sector to ensure wide-scale availability of new technologies for a comprehensive decarbonisation roll out

Policies to encourage the uptake of new vehicle and fuel technologies will not help decarbonisation efforts if the technological developments are not available at a wide enough scale to meet demand. Significant investments should be made in research and development of new technologies in existing and new industries to meet demand and fast-track adoption. These include developing new biofuels, designing more efficient aircraft, and increasing capacity while decreasing costs of batteries. The human capital necessary for these developments will need to be cultivated and planned for in advance.

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Note

[1] A simplification is made to display the impact of hybrid-electric aircraft in total aviation demand. The total distance of a trip completed by hybrid electric aircraft is split according to the equivalent distance powered completely by conventional fuel and equivalent distance powered by electricity. The sum is the total trip length. Therefore, the total passenger-kilometres completed by the electric component of a hybrid-electric aircraft can be assessed

5 Freight transport: Bold action can decarbonise movement of goods

This chapter highlights the significant role freight transport plays in a sustainable transport system and the challenges in decarbonising the sector. It presents estimates for freight activity and emissions for the next 30 years under three scenarios and gives recommendations for policies to set the movement of goods on a sustainable path. It includes a discussion of potential regional imbalances associated with decarbonisation and outlines important considerations for ensuring an equitable transition to cleaner freight transport.

In Brief

The carbon footprint from moving goods is as important as that from moving people

Freight transport receives less attention from policy makers than it deserves, given its cross-border complexities and commercial nature. Policy ambition has been relatively low compared to passenger transport, even though freight is responsible for more than 40% of all transport CO_2 emissions. Freight transport demand is projected to more than double in the next three decades, even with an ambitious policy agenda. Bold and fast action is crucial to decarbonise the sector.

The return to a pre-pandemic “normal” will mean rising freight emissions and missing climate change mitigation targets. However, with decisive decarbonisation actions, freight transport’s CO_2 emissions could be 72% lower in 2050 than in 2015. The introduction of low-carbon technologies across all modes, load consolidation, collaboration, and standardisation are among the critical levers to in get us there.

Road freight will be decisive for transport decarbonisation. Trucks currently emit 65% of all freight CO_2 and will remain the dominant mode of surface transport. Carbon-neutral solutions for long-haul heavy-duty trucks are not yet commercially available for widespread adoption. Further advances in vehicle technology, supply and distribution infrastructure are needed.

Maritime freight transport accounts for more than 70% of global goods movements. Maritime shipping’s carbon intensity is relatively low, but its emissions are not included in the National Determined Contributions of the Paris Agreement. The sector is under the purview of the International Maritime Organization, which has set targets, but not yet agreed on measures that would significantly reduce maritime shipping emissions. Close international co-operation is needed for a clean and equitable transition.

Opportunities for freight decarbonisation arise from the greater emphasis on resilient supply chains in the aftermath of the Covid-19 pandemic. Faster digitalisation and automation can help to optimise logistics and reduce its carbon intensity. Stimulus packages can include investments in alternative fuel production, distribution and supply infrastructure. They can also boost the availability of multimodal solutions and their competitiveness. The renewal of fleets with newer, cleaner vehicles is crucial.

Fossil fuels are being replaced by alternatives at an increasing pace. Historically low fuel prices provide an opportunity to phase out fossil fuel subsidies. Long-term interest rates close to zero in many developed economies mean that the social rate of return of such investments will likely exceed the financial costs of the projects. The world has an unprecedented opportunity to make bold policy choices that will enable a successful and equitable transition to clean freight transport.

Policy recommendations

- Design stimulus packages that align to support economic recovery, freight decarbonisation and supply chain resilience.
- Align price incentives with freight decarbonisation ambitions for carrier buy-in.
- Scale-up ready-to-adopt freight decarbonisation measures quickly to cut costs and emissions.
- Strengthen international co-operation to combat freight emissions.
- Accelerate standardisation procedures to speed up the adoption of new clean technologies.
- Tailor decarbonisation pathways to regional realities to address gaps in standard solutions.
- Broaden access to privately owned data to improve policy design.

This chapter covers all freight transport: by air, by sea and by the surface modes road, rail, and inland waterways. The analysis covers both international and domestic movements. Urban freight is covered as part of road freight unless specified otherwise. The chapter outlines the current state of freight transport and highlights challenges and opportunities for freight decarbonisation. It examines the impact of the pandemic on goods transport and reviews the immediate and potential long-term structural changes facing the sector. It also explores policies for a transition to cleaner and more equitable freight transport, based on three different scenarios for the sector's future development. The presentation of detailed results of the Recover, Reshape and Reshape+ scenarios is followed by a discussion about possible regional imbalances associated with decarbonising policies and changes in the structure of freight markets accentuated by the Covid-19 crisis. Policy recommendations are summarised at the end of the chapter.

Freight transport keeps the global economy moving but is a major emitter of CO_2. Total freight activity volume amounted to 145 229 billion tonne-kilometres in 2019. This resulted in CO_2 emissions of 3 233 million tonnes, according to ITF estimates. In that year, freight was responsible for 42% of all transport emissions. In 2020, freight accounted for 50% because of the much sharper fall in passenger transport due to Covid-19. Even in the most optimistic scenario, projections see freight transport demand more than double over the next three decades. If policies continue as before the pandemic, freight emissions will not be lower by 2050, but 22% higher than the 2015 period. By contrast, ambitious policies can drastically reduce freight emissions over the next 30 years.

Road freight will continue to dominate surface goods transport and play a decisive role in transport decarbonisation as it represents 65% of all freight emissions. Carbon-neutral transport solutions in long-haul heavy-duty trucking are not yet commercially available for widespread adoption. Further developments in vehicle technology, supply and distribution infrastructure are needed. This transition requires millions of small companies to renew their truck fleets and switch to vehicles powered by clean energy.

Maritime transport dominates freight activity with more than 70% of all tonne-kilometres, while its CO_2 emissions account for around 20% of all transport freight emissions due to its high capacity and low carbon intensity. But, it is the second-highest emitter after road freight.

Freight demand grows at a slower pace than previously estimated. Previous projections saw freight activity measured in tonne-kilometres more than triple by 2050 (ITF, 2019[1]) (ITF, 2017[2]). The current ITF estimates see freight grow less, but still more than double by 2050 (Figure 5.1). The fall in GDP and drop in trade due to the pandemic are the main drivers of this change. As a result, the annual compound growth rate in freight activity between 2015 and 2050 is 2.7% in the *Recover* scenario, instead of the pre-pandemic 3.4% projection. Even before considering the impacts of Covid-19, the updated GDP and trade projections indicated slower growth than expected at the time of modelling for the 2019 Outlook. Covid-19 introduced a further slowdown. In addition, average distances are also lower than modelled in 2019, including for the *Recover* scenario, where there is less reliance on long-distance trade.

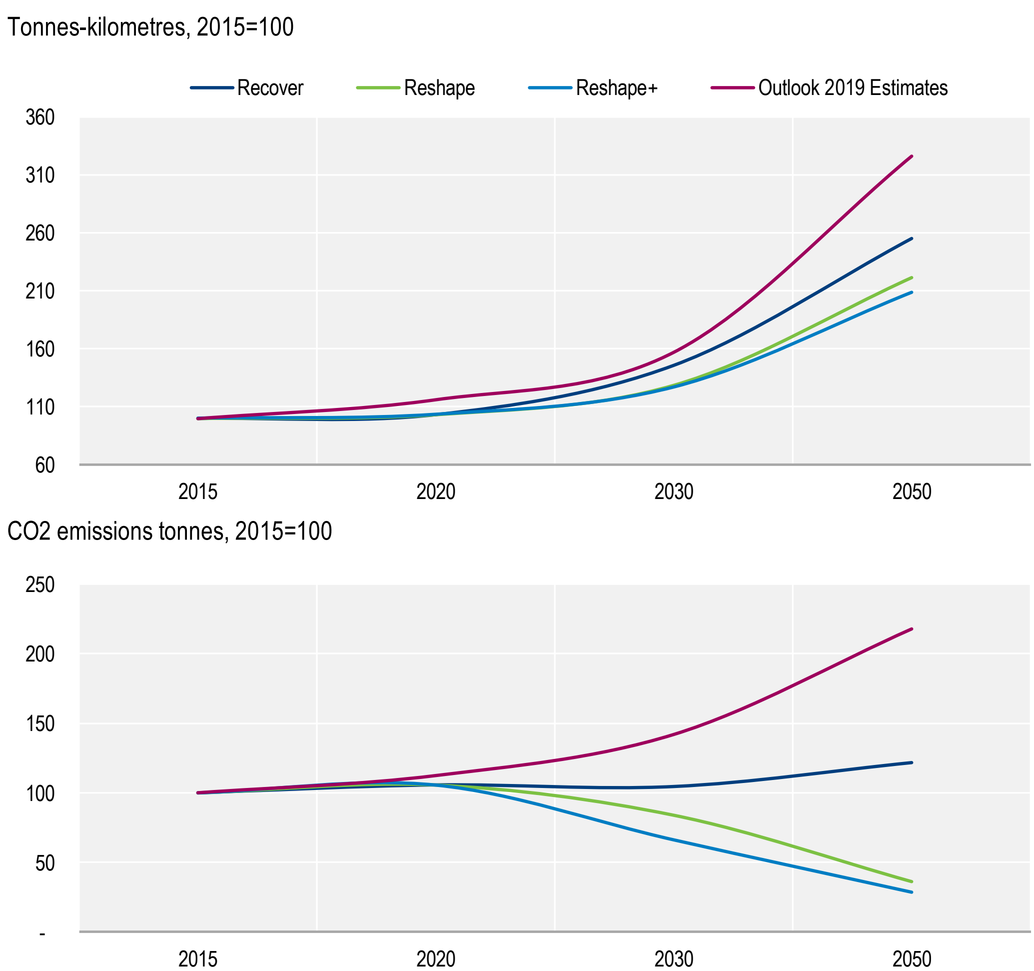
In the *Reshape* scenario, freight demand growth further decreases due to lower fossil-fuel consumption and, to a lesser extent, increasing 3D printing. These trends intensify for *Reshape+*. When coupled with trade regionalisation, this leads to even slower growth. Compared to *Recover*, freight transport activity drops 11% in *Reshape* and 18% in *Reshape+* by 2050. Transport activity still doubles between 2015 and 2050 in *Reshape+*, however.

Substantial emission reductions are within reach but require bold action. In the *Recover* scenario, carbon emissions will grow in the long-term, rising by 22% by 2050 compared to 2015, even considering that this scenario does include stated policies by countries and does not follow a do-nothing approach. Still, the drop in this scenario compared to the 2019 edition of the *Transport Outlook* is substantial, both due to lower demand and new mitigation commitments made since 2019.

Freight currently accounts for about 42% of total transport emissions and will be responsible for 44% of emissions by 2050. More ambitious policies will make reductions possible. Freight can remain in lockstep with other transport sectors to reduce emissions and contribute to achieving climate targets. In the *Reshape* scenario, emissions from goods transport would be 70% less by 2050 than in *Recover,* and 64% less than in 2015. The reductions in *Reshape+* are even greater, 77% below *Recover* in 2050 and 72% less than in 2015. The share of freight in total transport emissions will remain stable in *Reshape,* but drops to below 37% in *Reshape+* (see Figure 2.8 in Chapter 2).

Reshape envisages significantly stronger leadership and accelerated technological transitions. A wide array of economic, regulatory, technological and operational measures must converge for freight transport carbon intensity to drop by 84% between 2015 and 2050. Even then, this pathway's success also relies on a slowdown in freight transport demand growth caused by exogenous factors. The Covid-19 pandemic was a shock, economically and socially. The *Reshape+* scenario assumes policy makers leverage it as an opportunity to "build back better" by reinforcing the positive trends and measures emerging from the pandemic to push emissions down further.

Figure 5.1. Freight transport demand and emission trends



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Decarbonising freight transport: The state of play

Most freight transport activity takes place at sea. The maritime sector accounts for more than 70% of freight activity and around one-fifth of freight emissions. Demand for maritime freight has approximately doubled over the last two decades, growing 3.7% annually on average (Figure 5.2).

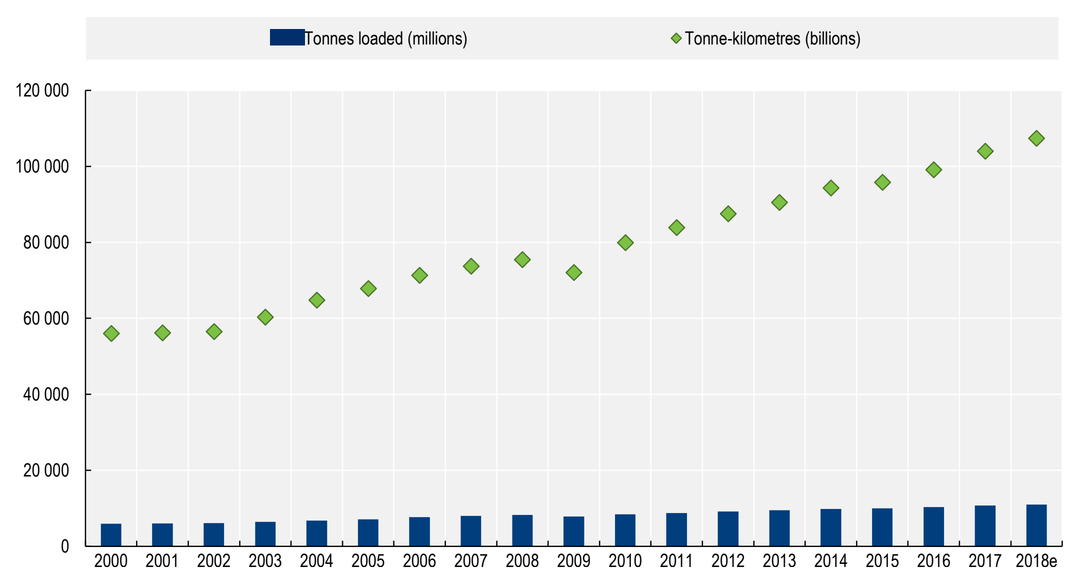
Road freight represents 15% of total freight activity but emits 44% of the sector´s CO_2 (see Figure 5.8 and Figure 5.11). It is the predominant surface mode with 60% of global activity for road, rail, and inland waterways combined. Road freight will retain this position in the future, even though its share will tend to fall.

> Urban delivery trips account for around 20% of all freight emissions – the same as maritime shipping. But shipping covers 70% of all freight activity, urban deliveries only 3%.

Urban freight transport covers short distances, involves many trips and small loads. These movements represent only about 3% of total freight activity but are very carbon-intensive. Urban delivery trips account for roughly the same emissions as global maritime shipping, with around 20% of all freight emissions.

Rail and inland waterways are the least carbon-intensive surface modes. Rail accounted for 30% of the global surface transport in 2015, with ambitious decarbonisation policies it will be around 35% by 2050. However, rail freight demand fell in the OECD, the European Union countries and the United States in 2019, after growing for three consecutive years (Figure 5.4). China has seen growth in all surface freight modes and makes far more use of inland waterways than any other country

Figure 5.2. Development of total maritime freight demand, 2000-18

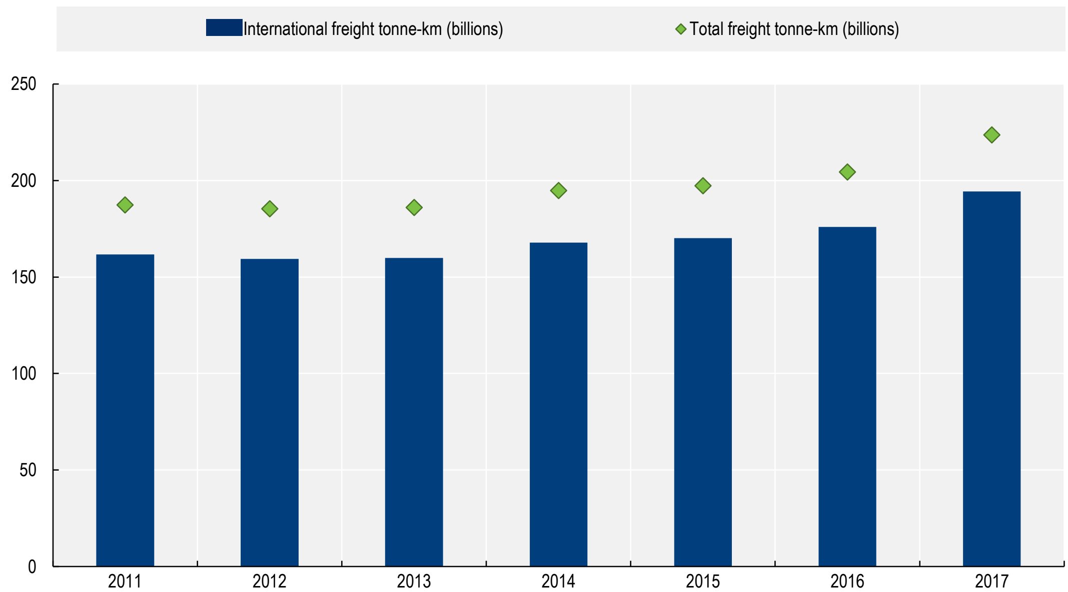


Note: Data for 2018 are estimates.
Source: Data on tonnes for 2000 to 2018 are from UNCTAD (2020[3]), *World seaborne trade database*, http://stats.unctad.org/seabornetrade(accessed 7 August 2020). Data on tonne-kilometres are from UNCTAD (2020[4]) *Review of Maritime Transport 2019*, https://unctad.org/system/files/official-document/rmt2019_en.pdf, based on data from Clarksons Research Services.

StatLink https://doi.org/10.1787/888934239002

Airfreight accounts for less than 1% of global freight activity measured in tonne-kilometres. The reason is that most goods moved by air are high-value and lightweight. Air cargo is by far the most carbon-intensive freight mode: it emits 20 times more than the freight sector average per tonne-kilometre, according to ITF estimates based on International Energy Agency (IEA) data. Airfreight demand remained relatively steady between 2011 and 2016, increasing by 9% in 2016/17 (Figure 5.3).

Figure 5.3. Development of global airfreight traffic 2011-17

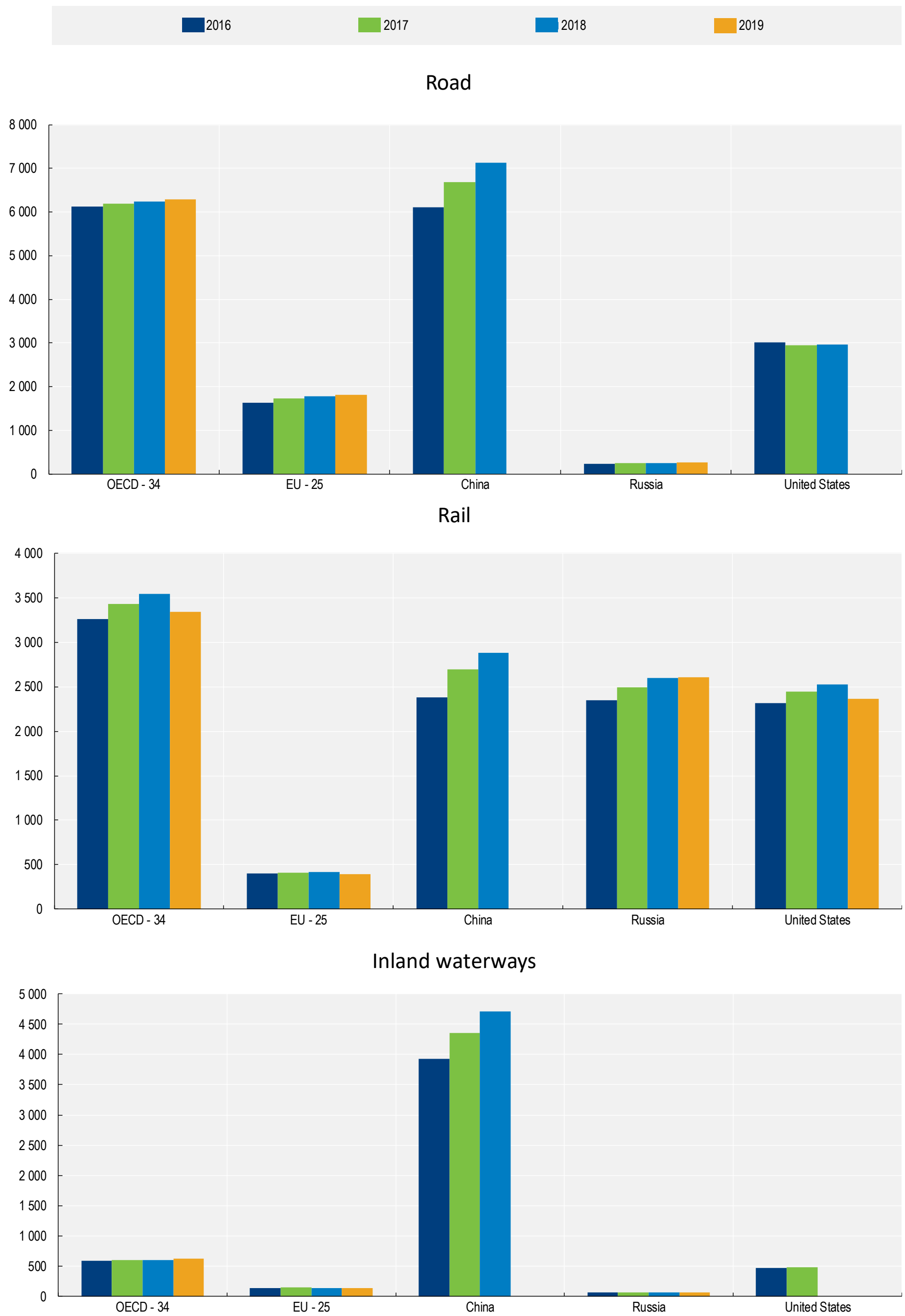


Source: Data from the ICAO (2018[5]) *ICAO Annual Report of the Council 2017*, https://www.icao.int/annual-report-2017/Pages/default.aspx.

StatLink https://doi.org/10.1787/888934239021

Figure 5.4. Surface freight demand by transport mode, 2016-19

Billion tonne-kilometres



Note: Aggregates for road do not include Chile, Columbia, Cyprus, Israel or Malta. Rail aggregates do not include Australia, Belgium, Columbia or Cyprus. Inland waterway aggregates do not include Canada, Chile, Columbia, Cyprus, Estonia, Latvia, or Portugal. Data for 2019 were estimated for the following countries: Canada, Denmark, Iceland, South Korea, Switzerland, the United Kingdom, and the United States for road, Denmark, Spain and the United Kingdom for rail, and the United Kingdom and the United States for inland waterways. Data for 2018 were estimated for the United States inland waterways.

StatLink https://doi.org/10.1787/888934239040

Fast-growing and emerging economies have the highest share of surface transport activity. In 2015 Asia accounted for 39% of the world's surface freight transport tonne-kilometres. By 2050 nearly half will be concentrated there. Sub Saharan Africa (SSA), Asia and the Middle East and North Africa (MENA) are the regions with the highest growth rates of surface activity. On the other hand, the European Economic Area (EEA) and Turkey region, the United States and Canada, and the OECD Pacific region have the lowest growth.

Asia's share of import-related transport movements will grow significantly, from 28% in 2015 to more than 40% by 2050. Import transport activity to Latin America and the Caribbean (LAC) and MENA will also grow faster than in other world regions. In the developed world, import driven transport will still increase, but at annual rates below 1% for the *Reshape* and *Reshape+* scenarios. In the EEA and Turkey, in particular, this is associated with the decrease in fossil-fuel trade. Export activity in regions like MENA and Transition countries (includes part of the Former Soviet Union and non-EU south-eastern European countries). In the more ambitious scenarios, exports from these regions will be a quarter to one-third lower in 2050 than in 2015. Regions that rely on fossil-fuel exports today will face a challenging transition to a decarbonised world. Those dependent on fossil-fuel imports have a greater incentive to decarbonise.

Regions with more ambitious decarbonising policies will increase their competitiveness in the world market. Europe adopts bolder measures in the scenarios and sees its export-related transport costs drop the most compared to 2015 in a *Reshape* scenario. On the other hand, regions that are distant from the main consumption centres (such as OECD Pacific) or that slower to decarbonise, such as MENA and SSA, see average transport costs for their exports rise. The latter will bear the greatest increases in transport cost due to a combination of factors that include rising GDP per capita but also some of the decarbonising measures, such as carbon taxes. Efforts for global transport decarbonisation risk being perceived as unfair if the deployment of measures in these regions is not accelerated or their negative cost impacts mitigated.

> We need to pay as much attention to the carbon footprint from the movement of goods as the carbon footprint from the movement of people

Freight's main challenges

The slow pace of technological progress is a major challenge for freight transport. Technological advances allowing carbon-neutral transport for long-haul heavy-duty trucks remain mostly confined to experimental trials. Road freight will remain the dominant mode of surface transport and is responsible for the largest share of freight transport emissions. The development of batteries, other alternative fuels, supply and distribution infrastructure and vehicles have not matured yet to the point of having readily available commercial solutions for widespread adoption.

The shortcomings of global rules for international freight modes also poses a challenge. International maritime and aviation emissions are not included in the National Determined Contributions (NDCs) of the Paris Agreement. Efforts and regulations aimed at decarbonising these sectors are not bound to a specific country or regional body; they fall under the purview of international organisations; the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO). Enacting bold measures is particularly difficult and time-consuming in such a context.

A lack of policy action is holding back freight decarbonisation. Traditionally, more attention has been paid to the movement of people than the movement of goods in the fight against climate change. Freight is mainly a private business, less subjected to public service obligations and has not been as central in policy making as passenger transport. This has implications that include a lack of monitoring, data, and even mature methodological tools to evaluate policies.

The lack of commercially viable carbon-neutral technologies for long-haul freight transport must be overcome. It needs to be attractive for carriers to invest in zero-carbon fleets and zero-carbon fuels. Few carriers will invest in low-carbon fleets or low-carbon fuels if they have to pay more than conventional vehicles or fuels. This price difference arises partly because negative externalities such as greenhouse gas emissions and climate change are not reflected in the price of conventional vehicles or fuels. In fact, some parts of freight transport, such as maritime transport, receive generous fuel tax exemptions. These are an obstacle to any attempt to move to low-carbon transport.

Tax exemptions for fossil fuels must be phased out to decarbonise freight transport successfully. Freight transport emissions inclusion in carbon-pricing schemes at regional, national, supra-national or global levels can help pave the way to a low-carbon transition. Although global industries, like international shipping, should ideally be subject to global rules, supra-national initiatives could serve as the second-best options when there is no international agreement on carbon pricing.

Carbon-pricing schemes present significant equity challenges. The added costs of this type of measures can fall unequally on different population groups, economic sectors, and regions of the world. Taxation designed to eliminate pollution and inefficiency must take a fair distribution of its costs and benefits into account. Perceptions of injustice risk creating a backlash.

Three steps towards decarbonising freight

There are many low-hanging fruits to pick in freight decarbonisation. Available solutions ready to implement for road freight include aerodynamic retrofits, reduced-rolling resistance of tyres, vehicle weight reduction, increased engine efficiency and hybridisation. Ambitious fuel economy and CO_2 emission standards will help the widespread deployment of these measures. For urban freight operations, alternative fuels already provide a viable commercial solution, or shortly will. Policy must foster measures such as the adoption of alternative fuels for urban logistics operations through pricing mechanisms and other incentives, stricter emission standards, zero-emissions zones, recharging infrastructure and policies geared towards the adoption of alternative fuels by large fleets. Other prime examples include eco-driving training and fewer restrictions on truck length and weight to maximise efficiencies from the introduction of high-capacity vehicles (HCVs) on certain corridors. Further measures include the adoption of common standards for new equipment and processes, promoting off-peak deliveries, creation of collection points, route optimisation or voluntary emissions reduction programmes with set targets. These and other measures are outlined in various ITF reports and resources such as the *Transport Climate Action Directory* (ITF, 2020[6]), *Towards Road Freight Decarbonisation Trends, Measures and Policies* (ITF, 2018[7]), *Decarbonising Maritime Transport Pathways to zero-carbon shipping by 2035* (ITF, 2018[8]), *How Urban Delivery Vehicles can Boost Electric Mobility* (ITF, 2020[9]).

More collaboration between logistics companies can reduce emissions and save costs. So far, inter-company collaboration in surface transport has only taken place to a limited extent. Scaling up collaboration will be critical to unlocking its significant decarbonisation potential. Yet antitrust legislation sometimes hinders horizontal collaboration, and legal risk has already prevented some trials (ITF, 2018[7]). Digital collaboration platforms, operated by neutral, trusted third parties, offer a promising pathway to overcome these barriers and offer the prospect of a pathway towards the Physical Internet. The shock induced by the pandemic provided a push to increase asset sharing between companies and fill otherwise empty return trips. The aftermath of the crisis can lead to market consolidation, which can in some fragmented freight transport sectors – such as trucking - lead to more opportunities to share assets and allow the scale economies that favour fleet renewals and more rapid deployment of clean technologies. A renewed emphasis on resilience with a relaxation of the just-in-time paradigm in favour of a just-in-case approach provides more opportunities for consolidating loads and shipments. Consolidation favours the adoption of intermodal solutions that include lower carbon intensity modes such as rail or inland waterways.

To reach climate targets, freight transport must achieve the transition to low- or zero-carbon energy sources. Currently, only rail offers a mature and readily available solution for widespread use in zero-emissions transport. Even if some modal shift can be expected, the result is still far from what is necessary to achieve meaningful emission reductions. A significant share of road freight trips simply cannot shift to rail, not to mention intercontinental trade, which relies on sea transport and to a lesser degree on airfreight. For long-haul heavy freight trucks, shipping or aviation, the widespread use of zero-emissions technology remains some way off. For now, it remains unattractive for carriers to invest in low-carbon fleets and alternative fuels. To meet climate goals, zero-emissions technologies will need to be available and attractive to ensure adoption. Direct supply of electric energy to road vehicles ("electric roads"), hydrogen and electric batteries already hold the potential to transform heavy-duty long-distance haulage. This, however, does not include emissions from electric power generation and the availability of green hydrogen.

It is unlikely that a single alternative will replace the internal combustion engine. Even if electric roads can efficiently power long-haul road freight, they will not cover all trips. Hydrogen, electric batteries, or advanced biofuels could complement them where electric road infrastructure is not in place. Strategic policy choices are likely to be needed to decide which set of alternative fuels will be scaled up for general use. They will involve significant funding, especially for supply infrastructure. Scaling up solutions implies prioritising, yet some flexibility can be maintained in the short term. Trial and error are part of the prioritisation process, and further research and pilot projects must be highly encouraged. Breakthroughs in low-carbon liquid fuels, such as advanced biofuels or synthetic renewable fuels (e-fuels), or an acceleration in the deployment of carbon capture and sequestration (CCS) should not be ruled out even if not foreseeable at present. A useful resource to further explore the range of policy options and type of parameters influencing freight transport decarbonisation is the logistics decarbonisation framework proposed by Alan McKinnon is (McKinnon, 2018[10]). Recent ITF work on this topic is highlighted in Box 5.1.

Box 5.1. Recent International Transport Forum work on freight transport

Electrifying Postal Delivery Vehicles in Korea

ITF (2020[11]) evaluated the costs and benefits of replacing postal delivery motorcycles with electric vehicles in eight Korean cities. It accounted for operating costs, safety performance and environmental impacts based on data from a field trial involving both vehicle types. The study recommended that the replacement scheme be continued as its combined benefits exceeded costs by 243%. Insights from focus groups of trial participants further demonstrated the importance of pilot studies and consultations with drivers to understand the local context. Driver education and adjustment of delivery routes to better suit the comparatively larger EVs were identified as key to gaining driver confidence in the programme.

Vietnam Logistics Statistical System

The ITF has been contributing to the establishment of a Logistics Statistical System for Vietnam (VLSS) since May 2018. The main motivation behind creating the VLSS was to house all relevant transport and logistics data within a single institute, which can then facilitate the management and dissemination of the data so that it can be used most effectively. To fill the most urgent data gap identified, the ITF created a survey to collect provincial level origin-destination data on movements of goods in tonnes and Vietnamese dong, by transport mode and commodity type for the year 2018. The study generated the first data for Vietnam on freight flows by province.

Impact Analysis of Improving Transport Connectivity in the North East Asia Region

The main goal of this study is to provide a methodology to assess freight cargo potential within North East Asia under particular infrastructure development scenarios. The existing ITF freight model (ITF, 2020[12]), was adjusted and applied to obtain quantitative indicators on the current connectivity levels as well as the connectivity and network performance under two different what-if scenarios for border crossings between the Republic of Korea (ROK), the Democratic People's Republic of Korea (DPRK), and China. The scenarios differ in terms of the intensity and efficiency of the border activity between ROK, DPRK, and China.

Regulations and Standards for Clean Trucks and Buses

This ITF (2020[13]) report reviews progress on technical standards for heavy vehicles that could enable trucks and buses with zero or near-zero emissions. It focuses on plug-in and fuel cell electric vehicles that use technologies at the forefront of green and inclusive economic development. It includes information on technical standards on charging and refuelling infrastructure and identifies remaining barriers and opportunities for their future development.

Mastering the pandemic: Challenges and opportunities for freight after Covid-19

The downturn in freight activity caused by the pandemic has no precedent in recent decades. Freight volumes in the second quarter of 2020 were lower than during the peak of the 2008 financial crisis (ITF, 2020[14]). The ITF estimates that global freight transport dropped by 4% in 2020 on the previous year. Global GDP and trade, two critical underlying drivers of freight demand, have fallen drastically. For the first time since the Great Depression of the 1930s, world GDP will shrink year on year. The latest available projections are for a 4.2% drop according to the OECD, 4.9% for the IMF and 5.2% for the World Bank (The World Bank, 2020[15]; IMF, 2020[16]; OECD, 2020[17]). Global trade values will go down 20% according to the United Nations Conference on Trade and Development (UNCTAD, 2020[18]) and by 9.2% according to the World Trade Organisation (WTO, 2020[19]). These drops will be in line with, or surpass, the dramatic fall registered in 2008/9. The crisis affects all regions simultaneously, unlike the 2008 financial crisis when effects were concentrated in developed countries while having minor impacts on fast-growing and emerging economies. Even by the standards of systemic crises, this is a once in a century, global – truly global – crisis (Reinhart and Reinhart, 2020[20]).

Crises of the magnitude of the Covid-19 pandemic always spark or accelerate changes in the production and movement of goods

The pandemic will prompt long-term changes in freight transport and logistics. Crises of this magnitude always spark or accelerate qualitative changes in the production and movement of goods. The 2008 financial crisis marked the decoupling of GDP and trade growth. It also ushered in the rise of the gig economy. From 2008 to 2018, trade grew only at half the rate of the preceding decade, and the elasticity of trade to GDP dropped (ITF, 2017[2]). Airbnb and Uber were created during the last crisis. Services based on digital platforms have expanded with new options for how people move and shop. The current shock to our economy and societies will likely be even greater, reinforcing current trends like e-commerce and trade regionalisation or leading to a new balance between supply chain resilience and efficiency.

Freight activity decreased less than passenger transport. The fall in consumption and disruptions to the transport network at border crossings, ports and airports affected freight transport. Nevertheless, the lockdowns and mobility restrictions introduced to contain the pandemic had a more direct impact on the movement of people than goods. Home deliveries and e-commerce actually increased. In the United Kingdom, they increased by more than 50% compared to pre-pandemic levels (Office for National Statistics, 2020[21]). In August 2020, air passenger activity volumes (passenger-kilometres) were down 75% compared to the previous year, while freight activity (tonne-kilometres) was down 13% (IATA Economics, 2020[22]). In March and April 2020, passenger vehicle-kilometres in the United States decreased by 46% and 13% for trucks (Pishue, 2020[23]). While people had to stay put, goods had to keep moving (see Box 5.2).

Box 5.2. Covid-19 response for road passenger and freight transport in Europe

In March 2020, the ITF launched a *Covid-19 Information* webpage collecting the road transport and border crossing measures introduced by each of the ITF/ European Conference of Ministers of Transport (ECMT) member countries (https://www.itf-oecd.org/road-transport-group/covid-19-road-group). It also contained relevant communications from the Observer organisations, European Commission (EC) and International Road Transport Union (IRU). At the time of publication, this information is still constantly updated and comes directly from the member country governments. At a time when each European country was adopting their own rules, this webpage consolidated information on what was happening across the continent. The initial motivation for the page was to provide support to drivers who had to navigate the myriad of rules. Resources for truck drivers included documents required to enter each country, quarantine rules and exceptions. Policy makers also found it extremely useful to monitor developments in other countries.

The economic impact of the pandemic has been patchy. Total trade values for 2020 fell significantly, but some sectors were harder hit than others. Energy trade decreased by 40% in April. Automotive products fell by a whopping 50%, according to UNCTAD. Car sales in 2020 will shrink 20% year-on-year, at least (IHS Markit, 2020[24]). Projections have oil consumption down 9% in 2020, with consumption in April falling to levels last seen in 1995, driven mainly by the sharp decrease in transport activity (IEA, 2020[25]). The 2020 decline for coal is 8% from 2019, driven by cuts to electricity generation and greater availability of renewables.

In contrast, trade in agriculture products and food grew by 2% in the first quarter of the year with cereal production expected to grow by 2.6% (FAO, 2020[26]). Not surprisingly, the goods and commodities most related to mobility suffered the most. Essential products like food and medical equipment did not fall or even grew. Telecommunications equipment saw increases in the second quarter, rising above 2019 levels. Other types of electronics also showed resilience. Digitalisation and virtualisation of processes are gathering pace.

Public awareness of the vital role played by freight and logistics has increased. The pandemic was a potent reminder of the essential functions required to keep societies running. Logistics and supply chains work in the background of our lives. Warehouses, delivery vans, trucks, cargo planes, freight trains, container ships, and ports are mostly either disregarded or considered a nuisance. But perceptions change. During the pandemic, societies discovered that these companies and workers were on the frontlines of the fight against the virus. They moved vaccines, critical medical equipment and supplied the essential goods people needed. This boost to the sector's public profile can help move it higher up the list of public policy priorities and towards an equitable, inclusive, and clean mobility transition.

The freight sector suffered severe losses of revenues and jobs during the pandemic. Global road freight annual losses for 2020 are expected to exceed EUR 550 billion, with revenues down 18% compared to 2019 (IRU, 2020[27]). The U.S. Bureau of Labor Statistics reported that 88 300 trucking jobs were lost in April 2020, more than the total job loss in the industry in 2008. These negative impacts extended to air and rail freight, although the container shipping sector made record profits in 2020. Trucking and the freight transport sector more generally are major employers (Eurostat, 2020[28]) (RTS, 2017[29]). The decrease in transport capacity adds to the social and economic impacts of these losses and can jeopardise economic recovery. Job creation and economic revival will necessarily be a significant concern for policy makers moving forward. This will also offer a unique opportunity for public policy to shape the sector, accelerate a green transition and enhance the profile and competence levels of the sector workforce. For instance, wider training in eco-driving and fleet management skills for Small and Medium-Sized Enterprises (SMEs) would help reduce emissions among companies that make up the bulk of the road freight sector. These measures can help address the driver shortage afflicting the road freight industry (IRU, 2019[30]), also aided for instance by measures to increase safety and security for truck drivers,

Policy decisions that will shape the future must be taken in a highly fractured and uncertain environment. Short-term economic and transport developments depend on the evolution of the health crisis. It is not possible to overstate how uncertain this time is. Though all regions are affected, WTO data from the first semester of 2020 (WTO, 2020[31]) shows the impacts on Europe and North America are higher than in Asia. In the former regions, exports fell more than 20%, while in the latter they decreased 6.1%. Uncertainty can freeze new investments into construction or fleet renewals as well as consumer spending, leading to lower growth in the medium-term. But, companies are rapidly adapting, increasing the pace of digitalisation and automation, reallocating resources with even traditional sectors harnessing new technologies. In this time of global crisis, public policy will play a prominent role in shaping the future and the trends that will take hold (for a discussion focused on emerging economies see Box 5.3).

Box 5.3. The ITF Decarbonising Transport in Emerging Economies project

One of the biggest challenges for climate change mitigation is to enable emerging economies to continue lifting people out of poverty while at the same time reducing greenhouse gas emissions. The ITF's *Decarbonising Transport in Emerging Economies* (DTEE) project helps governments of emerging nations to identify ways to reduce their transport CO_2 emissions and meet their climate goals, https://www.itf-oecd.org/dtee.

The DTEE project supports transport decarbonisation in Argentina, Azerbaijan, India, and Morocco. It is designing a common assessment framework for transport emissions that will cover several transport sub-sectors and transport modes. Country-specific modelling tools and policy scenarios will help the participating governments to implement ambitious CO2-reduction initiatives for their transport sectors. Stakeholder workshops, training sessions, briefings for policy makers and mitigation action plans will stimulate further research and the development of policies beyond the duration of the project.

The DTEE projects conference "Decarbonising transport in an unprecedented global crisis: A virtual conference" explored how transport decarbonisation policies can promote low-carbon economic growth and increased resilience of Argentina's and Latin America's transport systems following the Covid-19 crisis. Some of the questions addressed were: How can a transport decarbonisation agenda be adapted to this period of severe crisis? More specifically, how can transport decarbonisation, economic recovery and added resilience in transport systems be combined? In the short-medium term, what are the greatest challenges and opportunities to jointly address climate change mitigation and sustainable economic development?

Notes: Outputs of the virtual conference *Decarbonising Transport in an Unprecedented Global Crisis* are available at https://www.itf-oecd.org/dtee-output

The pandemic is accelerating several trends that affect freight transport. Digitalisation and e-commerce, trade regionalisation and decreased fossil-fuel consumption are the most noticeable trends to emerge from the pandemic. The crisis has hastened the faster adoption of technologies and business models that were already emerging. This was led by trends where it was possible to scale up quickly, becoming a standard or even the only alternative to stay in business. On the other hand, the vulnerabilities of older systems were highlighted by the crisis and provoked dramatic downsizing.

> Digitalisation and e-commerce, trade regionalisation and decreased fossil-fuel consumption are the most noticeable trends to emerge from the pandemic

Digitalisation, automation, virtualisation, e-commerce, and home deliveries are picking up steam. To keep freight and essential supplies moving across borders safely and expediently, initiatives promoting paperless processes and documentation gained traction (UNCTAD, 2020[32]), (European Commission, 2020[33]). Companies, particularly large multinationals, are also making efforts to make supply chains more data-driven to manage their assets better. Accelerated automation is also likely, including for health and sanitary reasons, particularly at logistical terminals, ports, and other critical nodes of the supply chain (Rodrigue, 2020[34]). With much of bricks-and-mortar retail closed or facing restrictions, consumer goods companies were forced to step up their online presence to reach customers. Likewise, restaurants had to start or ramp up home deliveries to keep operating. The movement towards online retail and home delivery was widespread and included traditional mom-and-pop stores in small cities or the countryside as well as large franchises and shops in big cities.

The focus has shifted to more resilient and diversified supply chains. Supply chain vulnerabilities experienced during Covid-19 coupled with increased automation of production (e.g. through 3D-printing), trade tensions and rising wages in China are all pushing companies to build more resilience into their supply chains (Economist Intelligence Unit, 2020[35]) to gain an edge against any future shocks. This includes relocating parts of their activities, moving production closer to consumption centres and sourcing more of their products from suppliers in closer proximity. Such strategies will lead to less trans-continental transport with more regional or local supply chains that have shorter average transport distances (Friedel Sehlleier, 2020[36]), a phenomenon known as trade regionalisation (World Economic Forum, 2020[37]). Since supply chains are difficult to set up and move, as more industries take this decision, the shift in trade patterns will have long-lasting consequences. The transition to a more regionalised trade system was already underway before the crisis. In 2019 the Association of Southeast Asian Nations (ASEAN) overtook the United States as China's second-largest trading partner (Huang and Smith, 2020[38]) (Nikkei Asia, 2020[39]). Emerging and fast-growing economies have gained a larger share in global trade and increasingly trade with each other as trade tensions between the two largest economies remain.

> The transport of fossil fuels account for 30% of global international freight activity in tonne-kilometres

The energy transition and the phasing-out of fossil fuels accelerate. The current crisis severely affected fossil-fuel trade, with the largest drop in coal consumption since World War 2 (IEA, 2020[40]) and an unprecedented year-on-year fall in oil demand (IEA, 2020[41]). This shock will likely accelerate the phase-out of fossil fuels required to achieve the goals outlined in the Paris Agreement. Reaching the climate targets implies major shifts in energy demand. Projections by the ITF (ITF, 2018[42]) suggest that coal needs to be phased out by 2030 in OECD countries, by 2040 in China, and the rest of the world by 2050. Oil consumption would need to decline up to 22% by 2040. This would have a major impact on freight transport demand. According to ITF estimates, fossil fuels account for 30% of global international freight activity (in tonne-kilometres). In 2016, oil and gas represented 30% of the total international seaborne trade (in terms of millions of tonnes loaded), and coal represented 11% (ITF, 2018[42]). Ambitious plans in major economies to confront climate change and diversify energy supply are already underway (European Commission, 2019[43]). These efforts will increase as the competitiveness of renewable energy increases and economic recovery programmes invest in the transition towards cleaner energy and mobility.

Market concentration can open the door to increased asset sharing and faster adoption of cleaner technologies in surface transport. Scale can improve the ability to cope with disruptions. Larger logistics firms are showing greater resilience in the current crisis. Small companies with low-profit margins dominate domestic freight markets and trucking in general. Many of these companies do not have the financial buffers required to overcome the current shock that can lead to a greater concentration of the sector in the future. This, in turn, can increase logistic efficiency and the industry's decarbonisation. Larger fleets tend to use more of their loading capacity, having more opportunities to consolidate loads and fill return trips. Larger companies also have more resources to invest in fleet renewals and uptake of cleaner technologies. Nonetheless, the shipping sector provides a cautionary tale. Consolidation has progressed over the last decades with no benefits to decarbonisation, particularly where large shipping companies are concerned.

Greater emphasis on the resilience of transport systems offers opportunities for decarbonisation. Relaxing the just-in-time paradigm allows for more widespread adoption of slow steaming in maritime shipping and lower speeds for trucks, including via stricter speed limits. Lower speeds require less energy and emit less CO_2. Additionally, reduced pressure to meet strict schedules will allow increased load consolidation, i.e. the fullest use of available vehicle capacity. This will also favour multimodal solutions that include less carbon-intensive modes especially suited to moving larger-scale shipments. Rail and inland waterways have much more capacity and run on dedicated, more controlled infrastructure. Hence they offered some advantages in the context of the pandemic, specifically at border crossings. The sharp growth for rail transport between Europe and China in 2020 is a sign of how greater modal and route diversity is a critical feature of more resilient transport systems (Knowler, 2020[44]; RailFreight.com, 2020[45]).

Table 5.1. Potential challenges and opportunities for decarbonising transport post-Covid-19

Impacts	Opportunities	Challenges
Short-term impacts	• An overall decrease in demand and transport activity • Reduction in consumption and transport of fossil fuels • Faster deployment of automation and digital solutions (e.g. at port terminals or border crossings) • Greater resilience of less carbon-intensive modes (rail and inland waterways)	• Increase in e-commerce and home deliveries • Companies delaying vehicle fleet renewals and other investments, including cleaner technologies
Long-term or structural	• Slower growth rate due to delay in economic recovery • Faster decline of fossil fuels demand and need to move them • Greater focus on resilience, not just efficiency, move from "just-in-time" to "just-in-case". Favours cargo consolidation, higher average loads and multimodal solutions • Faster deployment of digital technology and automation that increase efficiency • More suitable environment for logistical collaboration and share assets • Greater market concentration can speed up the adoption of greener tech and operations • Trade regionalisation can shorten supply chains and decrease transport activity (tkm) even if total volume (tonnes) remain the same • Stimulus packages to aid green recovery with greater political will and opportunity to foster greener technologies and operations	• Financial constraints can delay the adoption of cleaner technologies, both private companies ability to renew fleets and equipment's and government´s ability to deploy new infrastructure • Lower costs of fossil fuels reducing the commercial attractiveness of cleaner technologies. New technologies tend to have higher initial costs but can have lower total ownership costs (TOCs) mostly due to lower fuel costs and consumption. With lower fuel costs the commercial break-even for new greener technologies is longer • Even faster growth in e-commerce and home deliveries, increasing congestion, emissions and decreasing consolidation and average loads • Stimulus packages that support a return to the status quo

“Build back better” stimulus packages will accelerate transport decarbonisation. Public policy has taken centre stage in the pandemic. Only governments have the means to bailout and restart the economy. The political opportunity and tools available to policy makers to make bold choices that reshape the economy and move it towards a clean and equitable transition is unprecedented. Long-term interest rates close to zero in many developed economies increase the likelihood of the social rate of return exceeding the financial costs of projects (OECD, 2020[46]). Historically low fuel prices provide an opportunity to phase out fossil-fuel subsidies (IEA, 2020[47]). Stimulus programmes can include investment in alternative fuel production, distribution and supply infrastructure while also improving the competitiveness and availability of multimodal solutions. Incentives can be offered to encourage ready-to-implement decarbonisation solutions and fleet renewals. Regulatory changes, which do not have direct costs for taxpayers in many instances, can be rolled out. These measures include the increased deployment of high-capacity vehicles, zoning restrictions in urban areas and stricter fuel economy standards.

Lower fossil-fuel costs due to the pandemic undermine the competitiveness of cleaner technologies. New cleaner technologies tend to have higher initial costs than legacy solutions. Even improvements and add-ons to increase the efficiency of existing internal combustion engine (ICE) vehicles imply some initial costs. However, these solutions decrease operational costs in the longer term and can lead to lower total ownership costs (TOCs). They are more efficient, lowering the consumption of fuel and respective costs, while in some cases they use cheaper energy sources and have lower maintenance requirements (e.g. electric engines). With lower fossil-fuel costs, the commercial break-even period for cleaner technologies increases, discouraging their adoption without changes to regulation and incentives.

Many companies will cancel or postpone investments in the face of uncertainty, slower demand growth and high debt (OECD, 2020[48]). This will slow down fleet renewal and the deployment of new infrastructure, including for the distribution of alternative energy. Thus decarbonisation will slow down unless public policy counteracts this trend, for instance by making bailouts conditional on decarbonisation commitments. Pressing short-term concerns about employment and the economy might move decarbonisation further down the policy agenda, with delays to implementation. A “build back better” policy that can jointly address employment, growth, equity, and decarbonisation concerns faces several challenges. These challenges include the need to stimulate the economy quickly, increasing the temptation to simply shore up incomes and prop up existing industries to the detriment of decarbonisation.

The rise of e-commerce and online retailing could also increase freight emissions. More e-commerce and home deliveries lead to increased congestion, more empty runs, less capacity use and higher emissions in urban areas. Short time windows for deliveries and free returns policies can exacerbate this. Also, 80% of cross border e-commerce is transported by air (IATA, 2020[49]), by far the most carbon-intensive mode. Air cargo capacity is severely constrained because much of the belly capacity is not available; cargo moved under the plane belly on passenger flights. Demand for passengers has contracted much more than freight, and many passenger flights that used to also carry cargo were cancelled or suspended. In fact, freight movements are increasingly important sources of income for the aviation industry. Several routes have reopened for cargo flights only, and passenger aircraft have been converted for freight purposes (FreightWaves, 2020[50]). Policy can steer these developments. In urban areas, the use of collection points, off-peak deliveries, zero-emissions zoning and incentives for low- to zero-emission vehicles will mitigate emissions (World Economic Forum, 2020[51]). Distance-based charges and carbon taxes could nudge operators to make better use of vehicle capacity and make multimodal solutions attractive. Table 5.1 lists further short and long-term impacts of the pandemic on freight transport decarbonisation.

Recover, Reshape, Reshape+: Three possible futures for freight transport

This section explores potential development paths for freight transport to 2050. Its projections, presented in subsequent sections, are based on three different policy scenarios: *Recover*, *Reshape*, and *Reshape+*. These scenarios represent increasingly ambitious efforts by policy makers to reduce freight CO_2 emissions and decarbonise freight transport.

The definition of policies within these scenarios was based on inputs from experts in the form of a policy scenario survey disseminated to policy experts from all regions of the world in early 2020, ITF research – e.g. *Decarbonising Maritime Transport Pathways to zero-carbon shipping by 2035* (ITF, 2018[42]), *Towards Road Freight Decarbonisation Trends, Measures and Policies* (ITF, 2018[7]), *Enhancing Connectivity and Freight in Central Asia* (ITF, 2019[52]) – and from ITF workshops held for projects under the ITF Decarbonisation Initiative in 2020 – namely, *Modelling International Transport and Related CO_2 Mitigation Measures Expert Workshop* (ITF, 2019[53]) and *Setting Scenarios for Non-Urban Transport and Related CO_2 Measures Workshop* (ITF, 2020[54]). Table 5.3 details the assumed uptake of policy measures in the scenarios.

All three include the same baseline economic assumptions to reflect the impact of the Covid-19 pandemic: a five-year delay in GDP and trade projections compared to pre-Covid-19 levels.

The results are based on the ITF freight model, which simulates the development of goods transport activity, freight's mode shares and CO_2 emissions to 2050 from the base year 2015. The underlying average carbon intensities of each mode follow the IEA's Stated Policies Scenario (STEPS) in *Recover* and Sustainable Development Scenario (SDS) in *Reshape* and *Reshape+*. Box 5.4 offers a detailed description of the ITF freight transport model and changes to previous versions.

Box 5.4. Improvements to the International Transport Forum freight transport model

The ITF freight model assesses all freight activity in all regions of the world. It estimates freight transport activity (urban, domestic non-urban activity and international) for 27 commodities for all major transport modes including sea, road, rail, air, and inland waterways. The underlying network contains 8 437 centroids, where consumption and production of goods take place. Of these, 1 134 represent the origins and destinations (ODs) for international trade flows, and 7 303 represent the ODs of domestic flows. Each of the 156 737 links of the network is described by several attributes. These include length, capacity, travel time (including border crossing times), and travel costs (per tonne-kilometre). The network also represents 102 404 nodes, encompassing 2 810 ports, 3 118 airports, 7 441 intermodal logistic platforms. It estimates tonne-kilometres, mode shares, vehicle-kilometres, energy consumption and CO_2 emissions from 2015 to 2050. The current version models the impact of 18 policy measures and technology developments, which are specified for each of the 19 regional markets included in the model. The key drivers of demand for freight transportation are GDP and trade, though, particularly for the domestic component, several other factors are accounted for. The methodological paper (ITF, 2020[12]) explains how these two critical elements and these other factors influence transport activity in the ITF freight model. The model was developed by ITF and first presented in 2015. It is constantly being updated and improved. New features are described in the table below.

The model was also adapted to address the drop in demand resulting from the Covid-19 pandemic in 2020 and subsequent recovery in the following years. Observed data from the freight sector and trade activity – e.g. (WTO, 2020[31]), (UNCTAD, 2020[18]) – are used as a benchmark to calibrate the estimated drops across commodities and regions. The demand follows the projected recovery of the trade activity and economic activity in a post-pandemic as projected by IMF (2020[16]). ITF approximates this economic trajectory by introducing a 5-year delay in global trade activity compared to pre-2020 estimates. Several potential Covid-19 related aftereffects are also included as trends.

Table 5.2. Summary of freight model updates

	2019 version	2021 version
Spatial resolution (centroids)	International: 404 centroids Domestic: 7 303 centroids	International:1 134 centroids Domestic:7 303 centroids Hierarchical structure with 493 regional hubs
Domestic freight modes	Road, rail and inland waterways	Road, rail, inland waterways, air and coastal shipping
Intermodal network and infrastructure plans	Links: 156 102 Nodes: 101 701 Port expansion plans by sea region Alternative sea route (Arctic route) Some Infrastructure development plans for Central Asia	Links: 156 737 Nodes: 102 404 Infrastructure is the same as previous, plus greater network detail and incorporation of infrastructure plans in some regions (e.g. Europe – TEN-T network, Central Asia and North-East Asia)
Network attributes	Travel time, border crossing time, cost and capacity	Greater resolution on pre-existing attributes, mainly on differentiating energy costs or additional charges (distance charges or carbon taxation)
Network assignment	Equilibrium assignment, with route choice model for maritime routes and shortest path for other modes in each iteration	Same assignment as before, incorporating a route choice model for airfreight as well
Environmental performance	Average tank-to-wheel vehicle CO_2 emissions based on the IEA mobility model (IEA, 2020[55])	Includes both tank-to-wheel and well-to-tank CO_2 emissions based on the IEA mobility model (IEA, 2020[55])
Tracking of freight performance (exports/imports)	Not included	Links freight activity and externalities and to generator (exporter/importer)

Freight transport in the Recover scenario

In the *Recover* scenario, pre-pandemic thinking in terms of policies, investment priorities and technologies shapes freight transport in the coming decade. Governments prioritise and reinforce primarily established economic activities to buttress the recovery. The main objective is the return to a pre-pandemic "normal". *Recover* is a more ambitious version of the *Current Ambition* scenario in the *ITF Transport Outlook 2019*.

Distance-based charges and carbon taxes are introduced. They increase transport costs, favour efficiency, and encourage a shift towards cleaner technologies.

Infrastructure improvements increase capacity and mode choice while lowering costs and travel times. Among these investments is the full deployment of the European Union's planned TEN-T network.

Infrastructure and incentives for low-carbon road freight are set up, preparing the ground for the energy transition of carbon-intensive long-haul road freight. Enhancements of terminals and operations increase the attractiveness of intermodal solutions that include rail and inland waterways. Operational changes raise average loads, for instance, asset sharing.

Regulatory policies are pursued to lower the carbon intensity of freight transport, such as fuel economy standards, incentives to low energy fuels, heavy capacity vehicles and lower speed limits. Innovations in Intelligent Transport Systems (ITS) and eco-driving, particularly for road freight, are deployed leading to lower costs and higher efficiency.

Paradigm change: Freight transport in the Reshape scenario

In the *Reshape* scenario, the impacts of Covid-19 on freight transport also gradually disappear by 2030, as under *Recover*. *Reshape* differs in that policy makers set ambitious climate goals and implement stringent policies in their pursuit. Also, these more ambitious policies are put in place worldwide, not only regionally. *Reshape* is a more ambitious version of the *High Ambition* scenario in the *ITF Transport Outlook 2019*.

The transition towards low-carbon energy sources for long-haul road freight vehicles accelerates under the *Reshape* scenario, as charging and refuelling infrastructure is made available more widely.

Autonomous road freight transport comes into play and enables efficiency and cost gains in the freight sector. In general, technology and fuel efficiency standards advance in much bolder steps. While in *Recover*, they follow the IEA´s Stated Policies Scenario assumptions (IEA, 2020[56]); *Reshape* bases them on the IEA's more activist Sustainable Development Scenario.

The transport network improvement plans (e.g. TEN-T and developments in Central Asia) are applied equally in all scenarios.

Important factors outside the transport sector such as fossil-fuel consumption shape freight decarbonisation. Whereas consumption of oil and coal remains roughly constant under *Recover*, it declines under *Reshape*. Falling demand for fossil energy will change overall transport volumes and patterns since fossil fuels account for almost one-third of all international tonne-kilometres. New manufacturing techniques such as 3D printing will, to a degree, affect the trade of some manufactured commodities and therefore demand for freight transport.

Reshape+: *Reinforcing Reshape*

In the *Reshape+* scenario, positive decarbonisation trends from the pandemic are locked in through policies that lead to permanent change. As in the other two scenarios, the negative impacts of Covid-19 on freight transport are overcome by 2030. For instance, although e-commerce is very likely to expand, it is assumed policies are put in place to mitigate negative impacts. As in the *Reshape* scenario, governments set ambitious decarbonisation targets and implement policies that can deliver them. However, governments seize opportunities for decarbonisation that emerged during the pandemic. By aligning economic stimuli with climate and equity objectives, they leverage economic recovery for environmental and social sustainability.

Trade becomes less global and more regional. An increased focus on resilience sparks more near-shoring. Shorter supply chains mean shorter distance, intra-regional goods movements rather than longer-distance inter-continental movements leading to a decrease in activity measured in tonne-kilometres

Other policies and measures are deployed more aggressively under *Reshape+* than under *Reshape*. They have an array of effects from changing demand volumes, costs, travel times, average loads, carbon intensities, perceptions of the attractiveness of specific modes and the transport network itself. The latter influences mode availability, capacity, travel times and costs too. These dynamics combine to determine transport activity, routing, mode choice and, ultimately, freight emissions.

Table 5.3. Scenario specifications for freight transport

Shading denotes policies with stronger implementation in *Reshape+*

Measure/ Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Economic Instruments				
Distance charges	Distance based charges for road freight.	Charges introduced in 2030 growing to 1 cent per tonne-kilometre by 2050.	Charges introduced in 2030 growing to 2.5 cents per tonne-kilometre by 2050.	Charges introduced in 2025 growing to 6 cents per tonne-kilometre by 2050.
Port fees	Differentiated port fees depending on environmental performance of vessels, i.e. ships with no clean technologies have higher port fees.	Port fees grow an additional 1% by 2050 decreasing the carbon intensity of shipping by 0.5%.	Port fees grow an additional 20% by 2050 decreasing the carbon intensity of shipping by 10%.	Port fees grow an additional 30% by 2050 decreasing the carbon intensity of shipping by 15%.
Carbon pricing	Pricing of carbon-based fuels based on the emissions they produce.	Carbon pricing varies across regions: USD 150- 250 per tonne of CO_2 in 2050.	Carbon pricing varies across regions: USD 300-500 per tonne of CO_2 in 2050.	
Enhancement of infrastructure				
Rail and inland waterways improvements	Increase in attractiveness of intermodal solutions, namely trips with a rail or inland waterway component.	The penalty for mode transfers at intermodal terminals is decreased and alternative specific constant of rail and inland waterways increases. The rate of change varies by world region, e.g. in Western Europe it grows from 2% in 2020 to 20% in 2050.	The penalty for mode transfers at intermodal terminals is decreased and alternative specific constant of rail and inland waterways increases. The rate of change varies by world region, e.g. in Western Europe it grows from 4% in 2020 to 40% in 2050.	The penalty for mode transfers at intermodal terminals is decreased and alternative specific constant of rail and inland waterways increases. The rate of change varies by world region, e.g. in Western Europe it grows from 10% in 2020 to 80% in 2050.
Transport network improvement plans	Construction and upgrade of new infrastructure, e.g. new roads, railways or port expansion.	The transport network is updated with planned new infrastructure and upgrades (e.g. increases in port capacity, developments in Central Asia, TEN-T European projects) expected to become operational between 2020 and 2050.		
Energy transition for long-haul heavy-duty road freight vehicles	Includes a range of solutions to achieve zero emissions for long haul heavy duty road vehicles, including: Electric Roads (ERS), hydrogen fuel cells, advanced batteries, or low carbon fuels (for more check (ITF, 2019[1]))	Very low, marginal implementation	14% of heavy trucks tkm are on these systems by 2050. Costs begin higher than conventional fuels but by 2050 become lower. Differences in uptakes and costs by regions.	37% of heavy trucks tkm are on these systems by 2050. Costs begin higher than conventional fuels but by 2050 become lower. Differences in uptakes and costs by regions.
Operations management				
Asset sharing and the Physical Internet	Sharing assets (e.g. vehicles or warehouses) to make resource management for logistics activities more efficient.	Less than 1% Increase in average loads of road freight by 2020 growing to 2% in 2050.	4% Increase in average loads of road freight by 2020 growing to 10% in 2050.	Less than 4% Increase in average loads of road freight in 2020 growing to 20% in 2050. Accelerated increase between 2020 and 2030.

Measure/ Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
Regulatory instruments				
Slow steaming and speed reduction for maritime and trucks	Reduction of the average speed of ships or trucks to reduce emissions.	Decrease in the speed of road and maritime transport is less than 1% in 2020, growing to a 10% decrease by 2050.	Decrease in the speed of road and maritime transport is 1% in 2020, growing to a 20% decrease by 2050.	Decrease in the speed of Road and Maritime modes by more than 1% in 2020, growing to a 33% decrease by 2050.
Fuel economy standards for internal combustion engine (ICE) vehicles and fuel	Increase in fuel efficiency of ICE road freight vehicles.	Carbon intensity per tkm of ICE trucks reduces by less than 1% in 2020 up to 10% by 2020.		Carbon intensity per tkm of ICE trucks reduces by 2% in 2020 up to 15% by 2020.
Low emission fuel incentives (including electric vehicles) and investment in distribution/supply infrastructure	Increases the share of low emission vehicles km (e.g. electric, hydrogen, clean biofuels, biogas) in commercial vehicle fleets, lowering the average carbon intensity of road freight.	Increases in low emission fuels vehicle shares vary by world-region, in faster adoption regions (e.g. Western Europe) there is an increase of 1% by 2025, growing to 10% by 2050.	Increases in low emission fuels vehicle shares vary by world-region, in faster adoption regions (e.g. Western Europe) there is an increase of 2.6% by 2025, growing to 20% by 2050.	Increases in low emission fuels vehicle shares vary by world-region, in faster adoption regions (e.g. Western Europe) there is an increase of 4% by 2025, growing to 30% by 2050.
Heavy Capacity Vehicles (HCV)	Road vehicles that exceed the general weight and dimension limitations set by national regulations. Truck loads increase 50% and costs fall 20% per tonne-kilometre where HCVs are adopted.	By 2050 2% of non-urban road freight transport activity (tkm) is done with high capacity vehicles.	By 2050 5% of non-urban road freight transport activity (tkm) is done with high capacity vehicles.	By 2050 10% of non-urban road freight transport activity (tkm) is done with high capacity vehicles.
Stimulation of innovation and development				
Autonomous Vehicles and Platooning	Simulates the adoption of autonomous trucks (platooning and full autonomy) in road freight. The adoption of this technology reduces costs for road freight, but also its CO_2 intensity, on the other hand it can induce demand and reverse modal shift.	Adoption varies by sector (urban and non-Urban) and world-region. Very low to marginal adoption in this scenario.	Up to 45% uptake on non-urban in some regions by 2050 (Europe, North America, China, Japan and South Korea). Uptake on urban freight is lower. Decrease of 14% on carbon intensity and 45% on costs.	Up to 90% uptake on non-urban in some regions by 2050 (Europe, North America, China, Japan and South Korea). Uptake on urban freight is lower. Decrease of 14% on carbon intensity and 45% on costs.
Electric/alternative fuel vehicle penetration and increases in efficiency for all transport modes	Electric/alternative fuel vehicle penetration and increases in efficiency for all transport modes (including average loads and vehicle capacity).	Follows the IEA STEPS Scenario.	Follows the IEA SDS Scenario.	
Intelligent Transport Systems (ITS) and eco-driving	Development of ITS to provide better quality, real-time, automatic data collection and processing to improve fleet management, routing and assist driving.	Implemented with regional variations, in regions with faster deployment (e.g. Western Europe) reductions of 4% in carbon intensity in 2020 and close to zero in 2050.	Implemented with regional variations, in regions with faster deployment (e.g. Western Europe) reductions of 10% in carbon intensity in 2020 and 1% in 2050.	Implemented with regional variations, in regions with faster deployment (e.g. Western Europe) reductions of 15% in carbon intensity in 2020 and close to 2% in 2050.

Measure/ Exogenous factor	Description	*Recover*	*Reshape*	*Reshape+*
		Exogenous factors		
3D Printing	Enables manufacturing closer to the point of consumption, leading to drop in long distance trade for several commodities compared to estimated values, namely manufactured goods.	Negligible impact on trade.	International trade shrinks 10% by 2050. Values differ by commodities, electronic and manufactured goods have higher falls.	
Decarbonisation of energy	Decreases in trade and consumption of oil and coal as societies decarbonise, directly impacting freight transport demand for fossil fuels.	Oil and Coal grow less than other commodities (following ENV-Linkages model (ENV-OECD), (Chateau et al., 2014)	Yearly decrease of 3.35% for coal and 2.1% for oil. By 2050 coal trade has reduced 65% and oil close to 50%, compared to 2020 estimates.	Yearly decrease of 10% for coal and 2.1% for oil. By 2050 coal trade has reduced by 96% being almost phased-out globally and there is close to a 50% decrease in oil consumption compared to 2020 estimates.
Trade regionalisation	Simulates increased trade exchanges within regions or trade blocks, while decreasing longer distance trade between regions.	No additional fees compared to baseline.		5% increase in penalty fees for inter-regional trade.
E-commerce	Simulates the impact of growth in e-commerce and home deliveries. Increases the estimated demand of goods over time in addition to the projected values.	Urban freight with an additional 5% demand increase by 2050, smaller impacts on non-urban freight.		

Note: There is an overlap between the "Energy transition for long-haul heavy-duty road freight vehicles", "Low emission fuel incentives (including electric vehicles) and investment in distribution/supply infrastructure" and "Electric/alternative fuel vehicle penetration" measures. But they apply differently to different regions of the world and vehicle types, the adoption rate implemented in the scenario matches the highest value between this three measures for each world region and vehicle type/operation.

Demand for freight: Substantial growth at a slower pace

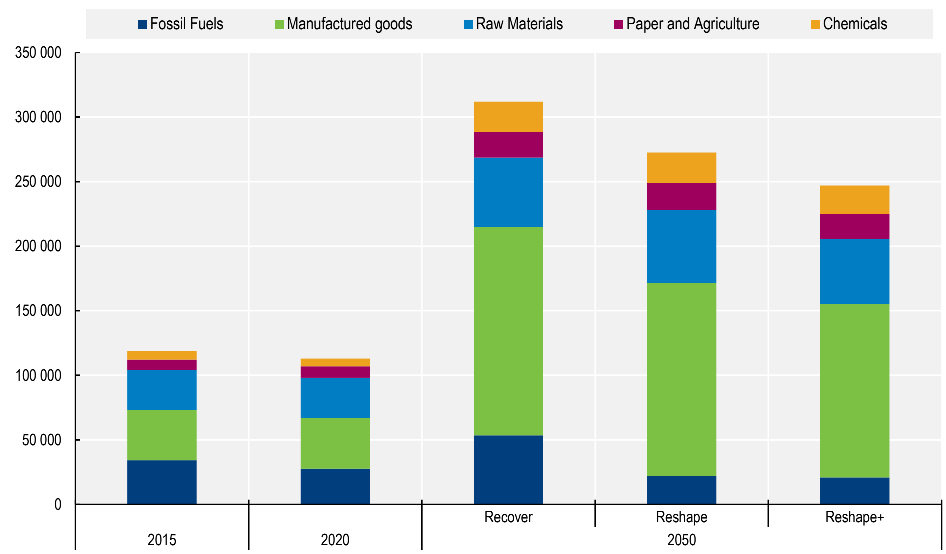
Demand for freight transport will grow more slowly than previously estimated. Its compound annual growth rate between 2015 and 2050 is adjusted down to 2.7% in the *Recover* scenario, from 3.4% in the ITF's previous baseline estimate (ITF, 2019[1]). Freight activity in 2020 decreased by 4% compared to 2019 in the ITF simulation. Meanwhile, moderate adoption of 3D printing and an accelerated shift away from fossil fuels in the *Reshape* scenario bring the growth rate of freight movement down further to 2.4% annually. In *Reshape+*, an even quicker substitution of fossil fuels, more prevalent trade regionalisation and, to a lesser extent, 3D printing combine to further reduce the annual growth rate to 2.1%.

A drop in consumption of fossil fuels will significantly affect trade flows. In 2015, the shipment of fossil fuels accounted for 29% of all international freight activity. By 2050, that share drops to 17% in *Recover* and 8% in *Reshape* and *Reshape+* (see Figure 5.5). However, absolute movements of fossil fuels increase in *Recover*, decline in *Reshape*, and fall further in *Reshape+*. Europe depends heavily on fossil fuels from other regions and will see related import activity decline below 2015 levels by 51% in *Reshape* and 53% in *Reshape+* by 2050. Meanwhile, regions that rely heavily on fossil-fuel exports see related freight activity decline. In Transition countries, fossil fuel export activity falls by 21% in *Reshape* and 26% in *Reshape+* between 2015 and 2050. MENA exhibits a similar pattern, with drops of 27% in *Reshape* and

32% in *Reshape+* over the same period. On the other hand, the EEA and Turkey region, as well as the United States and Canada region, are poised for growing export activity across all scenarios. *Reshape+* generally tempers export activity, although Europe sees its export activity grow faster in this scenario.

Figure 5.5. Import-related freight transport by type of goods to 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport.

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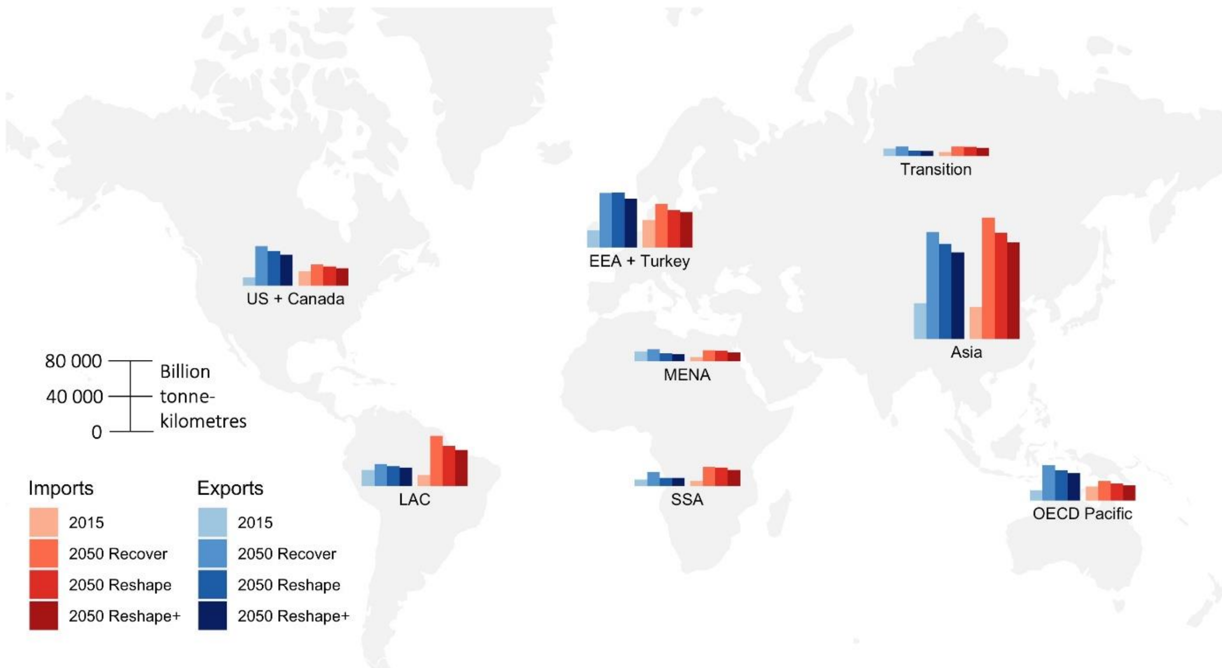
Trade movements are shaped by a set of often opposing forces. Macroeconomic forces beyond the purview of transport policy makers strongly determine trade volumes but are moderately elastic for shipping costs. Carbon taxes and wage increases drive these up, but improved fuel efficiency, better infrastructure and adoption of cleaner technology may cause them to fall. Trade activity in 2050 is generally lower in *Reshape* than *Recover* in 2050. The exception is European exports, which benefit from the region's early adoption of low-carbon technologies. More trade regionalisation and, to a lesser extent, 3D printing further temper growth in trade movements in the *Reshape+* scenario.

Export-related transport will grow in OECD countries, but different policies affect regions differently. The United States and Canada will see the most significant increase in export-related transport across all scenarios. Exports from the OECD Pacific region will also grow, but at a lower rate in *Reshape* and *Reshape+* than in *Recover*. EEA and Turkey, benefitting from a central location and faster deployment of cleaner technologies, sees higher growth in the *Reshape+* scenario. Transition countries and MENA see exports grow moderately in *Recover* and decline below 2015 levels in the other scenarios (see Figure 5.6).

Import-related transport will grow at the highest rates in fast-growing countries in Latin America, Asia and Sub-Saharan Africa in all three scenarios. However, more ambitious decarbonisation will temper growth, leading to 20% less import activity in *Reshape* and 28% less in *Reshape+* by 2050 compared to *Recover* levels in LAC. With less dependence on fossil fuels and slower economic growth, the OECD Pacific, the United States and Canada, and the EEA and Turkey will see the lowest growth rates for import activity. For example, import activity to OECD Pacific will only rise 7% above 2015 levels in 2050 under *Reshape+*.

Figure 5.6. Import- and export-related freight transport by world region in 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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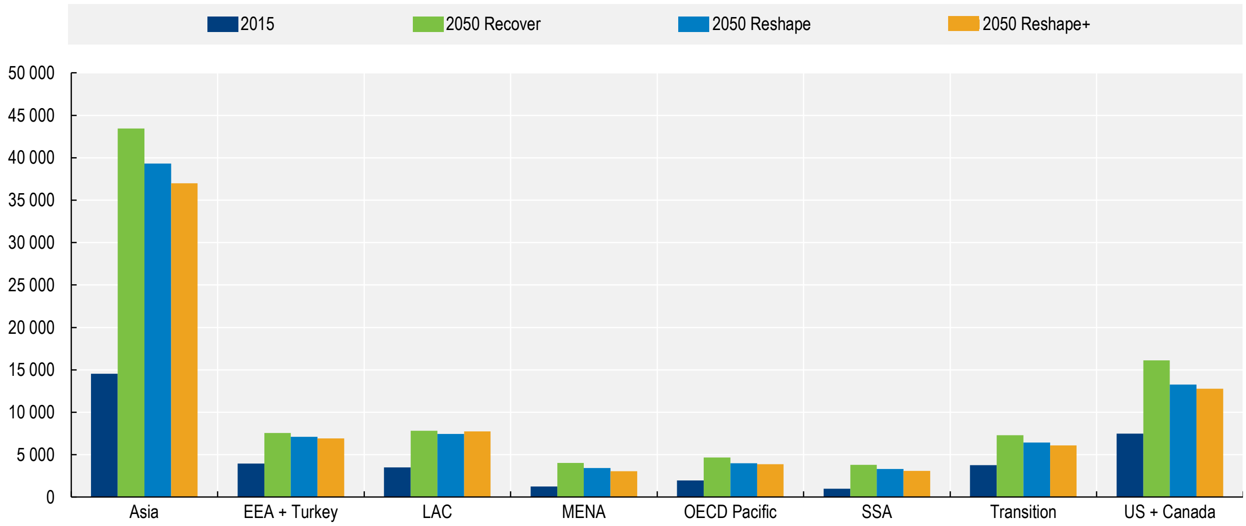
The non-OECD share of freight transport activity will grow, with 63% of surface and domestic air and shipping in non-OECD economies in 2015 increasing to 69% by 2050. Surface freight transport grows fastest in SSA, the region with low volumes to start with. Asia will see its share of activity increase, while that of the Transition countries will fall.

Asia has the highest level of freight activity by far, considering surface and domestic shipping and air transport. Thus, Asia could provide support for realising economies of scale for emerging low-carbon freight technologies and systems. On a per-capita basis, however, activity levels are roughly twice as high in Transition and three times as high in the United States and Canada. Surface transport and domestic sea and air will increase in all regions by 2050, although to a lesser extent in *Reshape* and *Reshape+* scenarios. *Reshape+* generally lightens activity further than *Reshape,* although there is a slight increase in LAC due to a shift to greater regional trade activity (see Figure 5.7).

Figure 5.7. Freight activity by world region to 2050

Under three scenarios, surface and domestic air and sea movements in billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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Road freight will continue to dominate future surface transport in all three scenarios

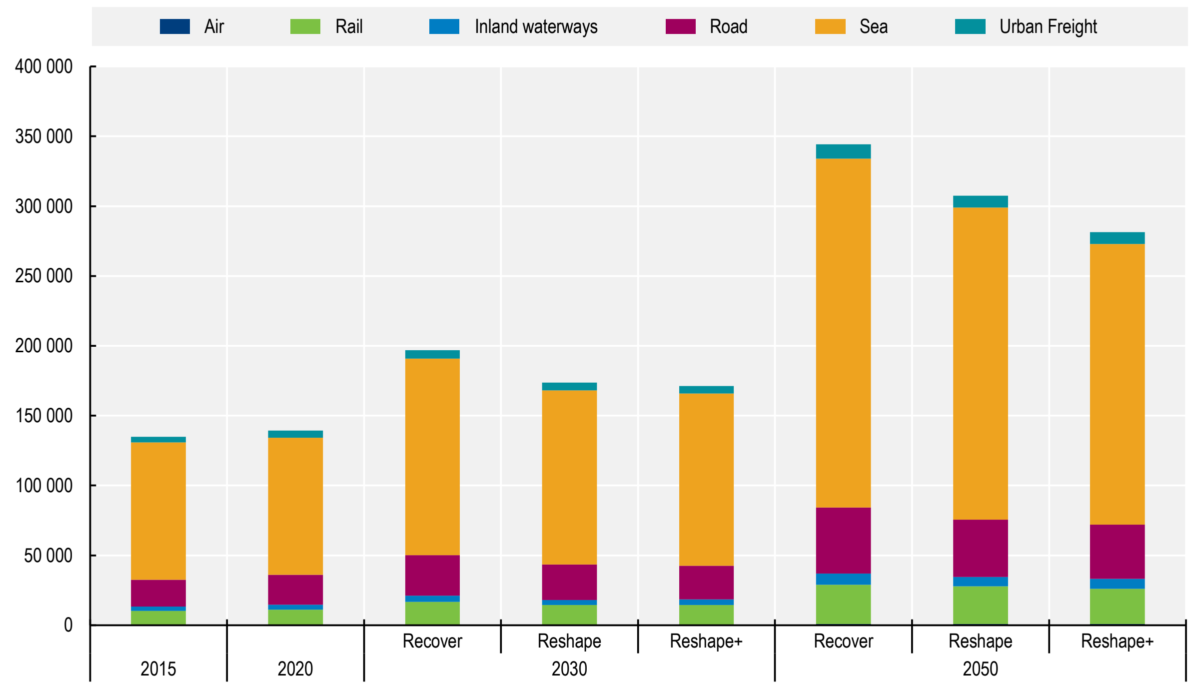
Maritime transport will continue to be the dominant freight mode. Sea transport offers high capacity, access to global markets at low cost and relatively low carbon-intensity, and more than 70% of total tonne-kilometres will take place by sea in all three scenarios (see Figure 5.8). Sea movements are even more dominant in longer distance import-export related transport where their share of the mode split is above 90%. Maritime's mode share is slightly lower in *Reshape+* as trade regionalisation, and climate measures discourage long-distance trade flows. While total freight activity is 18% lower in *Reshape+* than *Recover* in 2050, the difference for maritime is 20%.

Among surface modes, rail is forecast to account for an increasing share of non-urban freight activity. Since rail is less carbon-intensive than road freight, its share of activity grows even faster with more ambitious decarbonisation policies, despite the declining share of fossil-fuel transport, the main commodity moved by rail today. With 30% of non-urban freight activity in 2015, rail will capture 34% in *Recover* and 36% in *Reshape* and *Reshape+* by 2050. Even with this growth, road freight will continue to dominate future surface transport in all three scenarios. Airfreight's share of activity, measured in tonne-kilometres, also increases but does not surpass 1%.

E-commerce sparks growth in urban freight that has accelerated during the pandemic. Although this growth may appear moderate in terms of tonne-kilometres, e-commerce tends to incur higher levels of vehicle activity, which is more directly associated with carbon emissions, congestion, and other externalities. Because these side-effects are so significant and apparent, all policy scenarios assume that governments will implement a range of policies (e.g. carbon taxes, distance charges, zoning restrictions, dedicated pick-up locations) to manage parcel movements better. Urban freight activity is estimated to grow faster than non-urban trucking but can be addressed with more ambitious policies.

Figure 5.8. Freight activity by transport mode to 2050

Under three scenarios, billion tonne-kilometres



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Air transport accounts for less than 1% of total demand. Urban freight specifies road freight in urban areas.

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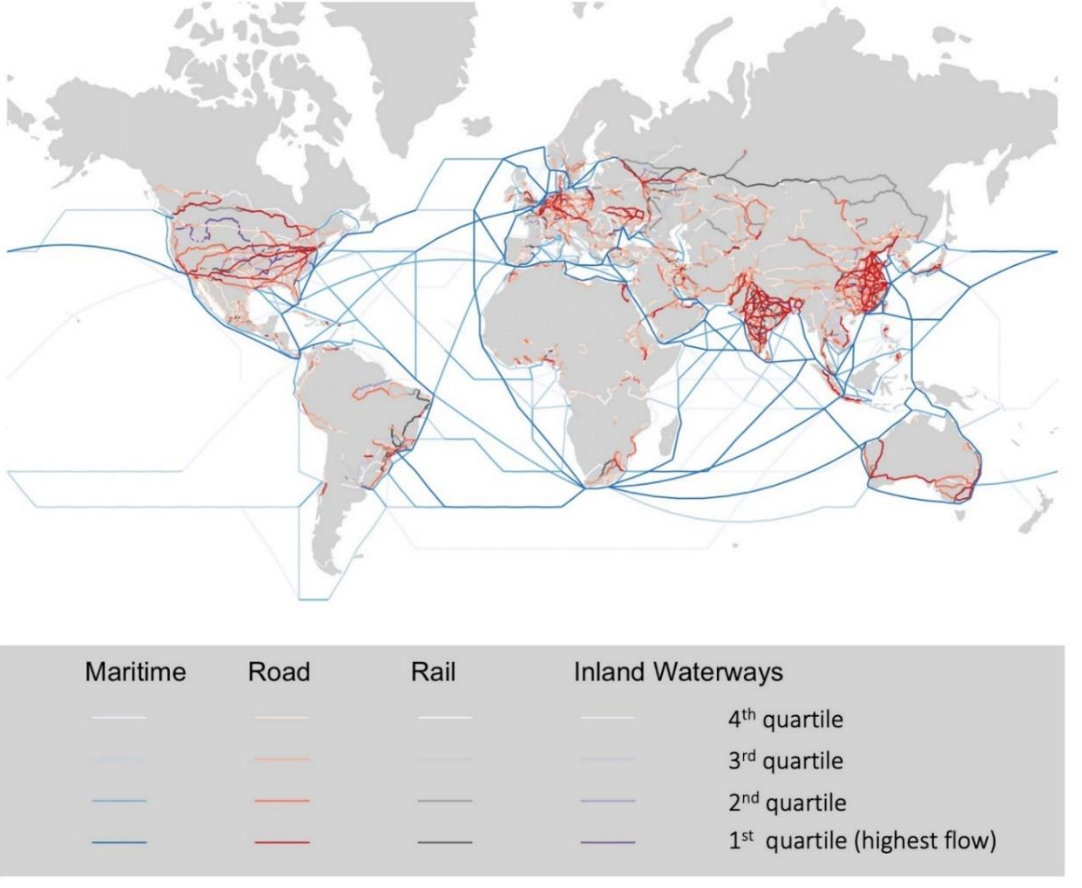
Some rail corridors stand out for their potential to increase traffic. Freight flow maps reveal patterns and opportunities that are less apparent in aggregate graphics. In alignment with the mode shares illustrated in Figure 5.8, the road and maritime freight networks are especially developed. A handful of rail corridors stand out for their potential to increase traffic, particularly freight lines connecting Asia to Europe through Transition countries and the coast-to-coast routes of North America. Dense and busy road networks in the United States and Canada, central Europe, China, and India could be fertile ground for collaborative decarbonisation measures, such as the transition to clean energies of heavy-duty long-haul trucks or shared logistics assets. A few inland waterways also carry considerable freight volumes, for instance, the Missouri and Mississippi rivers in the United States and the Amazon River in Brazil (see Figure 5.9 and Figure 5.10).

Today's policies will determine the distribution, routing, and mode shares of freight flow in 2050. In all scenarios, fast-growing countries will further develop their road freight networks, and global warming will open new maritime routes through the Arctic Ocean. However, more ambitious decarbonisation measures in *Reshape* favour flows between Europe and East Asian countries, which can take advantage of existing and developing rail corridors. Similarly, increased trade regionalisation in *Reshape+* encourages greater flows between the United States and Canada region and the nearby LAC region.

Figure 5.9. Global freight flows in the network by mode, 2015

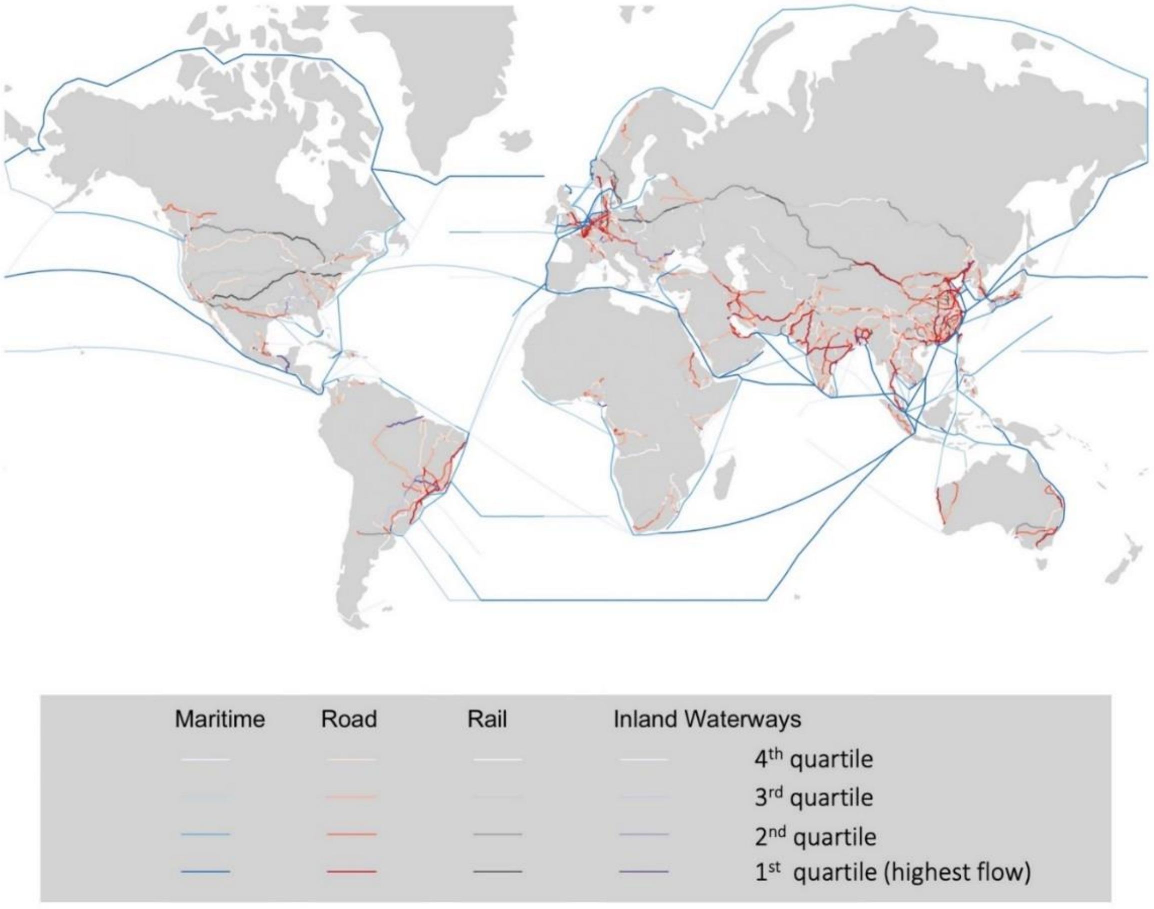
Quartiles based on weight of goods. Excludes airfreight.



Notes: Figure depicts ITF modelled estimates. Only the top 20% most active links in terms of weight of goods transported are depicted.

Figure 5.10. Variation in freight flows between 2015 and 2050

Quartiles indicate percentage change in weight of goods transported between 2015 and 2050 under the *Reshape* scenario. Excludes air freight.



Notes: Figure depicts ITF modelled estimates. Only the top 10% most active links in terms of weight of goods transported are depicted. 1st quartile includes routes with the highest increase in freight flows.

Box 5.5. Future maritime trade flows

Economic development and population growth will continue to drive future demand for maritime trade. However, the transition to non-fossil fuels and the regionalisation of trade patterns will likely have a substantial impact, according to the ITF (2020[57]) report *Future Maritime Trade Flows.*

The cost of maritime transport will increase as a result of expected regulations to decarbonise shipping. However, these cost increases will be small in relation to the total value of traded goods and the impact on global trade may be marginal. Trade routes to and from less-developed countries at the end of poorly serviced transport chains may feel significant repercussions but affected countries could be compensated for some of the adverse impacts on trade.

Increased ship size and industry consolidation, as well as other developments in liner shipping, have changed maritime trade patterns by reducing the number of calls to secondary ports. However, the trend towards marginalisation of secondary ports may have come to an end, as the movement of ever-larger ships seems to have run its course.

China's Belt and Road Initiative (BRI) will likely have a significant impact on maritime trade flows if fully implemented. The maritime part of the initiative has a stronger potential to impact overall trade than the terrestrial investments, focused on railway links and pipelines. Investment in the ports connecting China with other parts of the world could cut maritime trade costs, thereby reducing trade costs, and increasing imports and exports.

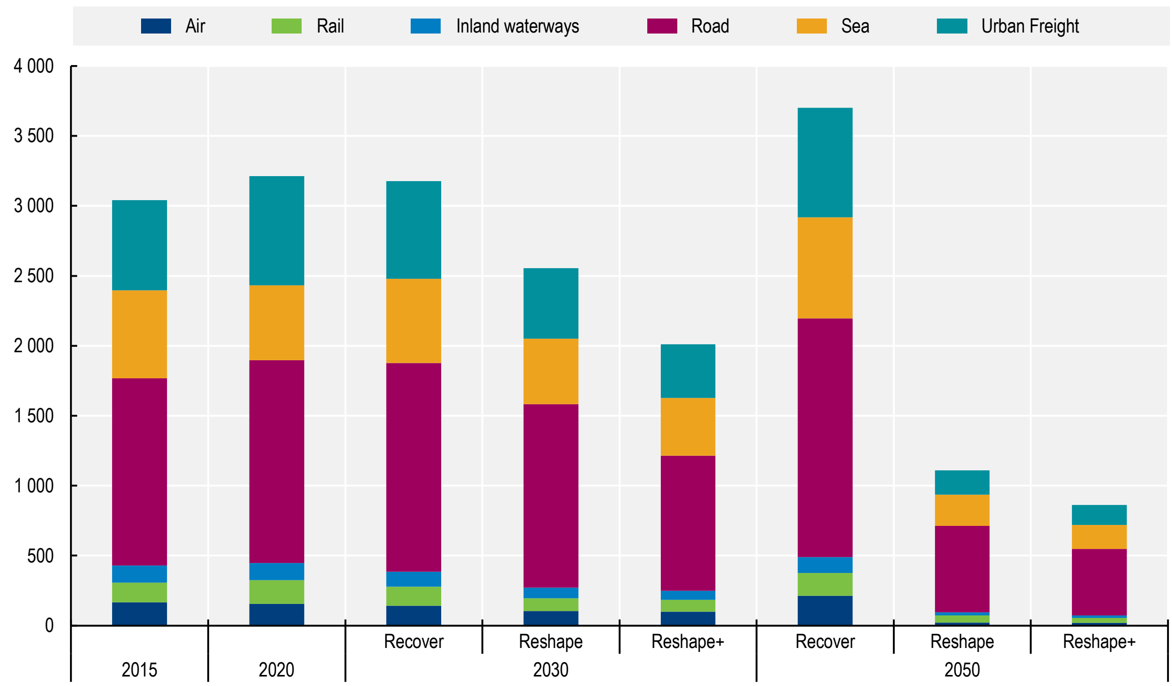
Modelling projections show that the share of global trade using the Northern Sea Route by the next century will be fairly small, at less than 5%, even in extreme climate change scenarios. Interest in developing relevant infrastructure in the Arctic Seas continues despite uncertainties, however. If a Central Arctic passage became feasible, it could trigger a considerable change in the configuration of maritime trade flows.

CO_2 emissions from freight transport: Reversing emission growth

Sharply falling freight emissions in the *Reshape* and *Reshape+* scenarios offer pathways to achieving the transport sector's climate targets. Freight emissions are poised to increase by 2050 under *Recover* assumptions but decline from 2015 levels by 64% in *Reshape* and 72% in *Reshape+*. A moderate shift to rail, which is less carbon-intensive, accounts for only a small share of the reductions. Most of the decarbonisation is due to the broad adoption of low-carbon technologies across all modes. By 2050, more ambitious measures in *Reshape* and *Reshape+* could reduce the overall carbon intensity of freight transport by 84% and 86% below *Recover* levels, respectively. There is also a 10% drop in activity in *Reshape* and 18% in *Reshape+* compared to *Recover*. Although the measures in the former two scenarios reduce emissions from trucking considerably, this transport mode proves particularly difficult to decarbonise.

Figure 5.11. CO_2 emissions from freight activity by transport mode in 2030 and 2050

Under three scenarios, million tonnes of CO_2 direct emissions (tank to wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel/wake emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Tank to wake is specifically used to refer to ships and aircraft. Urban freight specifies road freight in urban areas.

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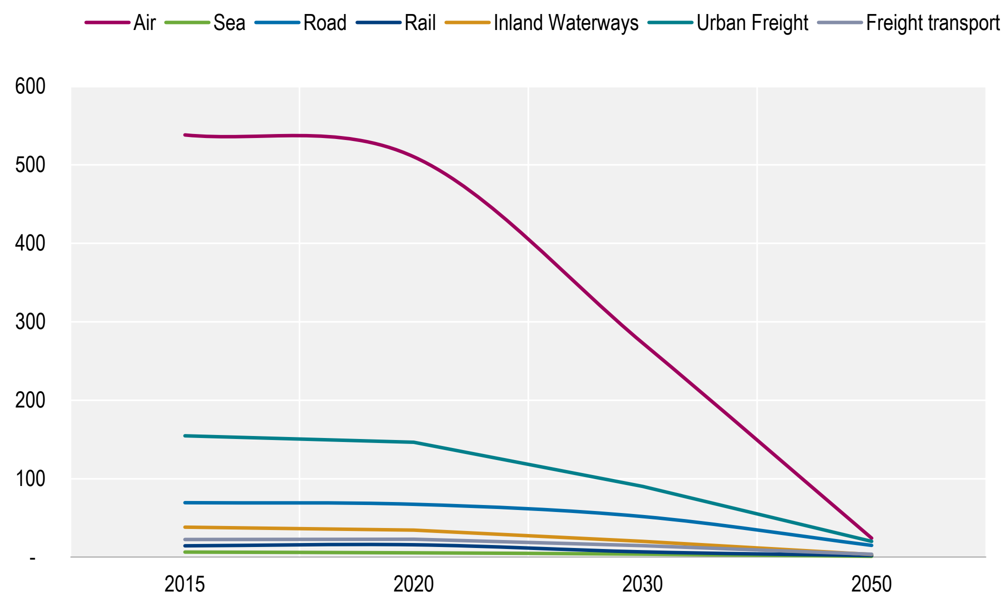
Global freight activity fell by 4% in 2020 due to the Covid-19 pandemic. Freight emissions only dropped by 1% because of the increase in high-emitting urban deliveries.

Freight emissions fell less than freight activity in 2020 due to the spike in urban delivery. Global activity volumes fell by 4% due to the pandemic in 2020 compared to 2019; emissions only dropped by 1% (see Figure 5.8 and Figure 5.11). The main reason is the growth in urban freight activity that increased by 7% from 2019 to 2020, driven by increased e-commerce and home deliveries. Urban freight has the highest carbon intensity of all modes except aviation (see Figure 5.12).

Figure 5.12. Carbon intensity of freight by transport mode to 2050

Under *Reshape* scenario, grammes of CO_2 per tonne-kilometre



Note: Figure depicts modelled estimates based on ITF and IEA Mobility Model (IEA, 2020[55]). Reshape is one of the three scenarios modelled. It assumes ambitious post-pandemic policies to decarbonise transport are put in place. Urban freight specifies road freight in urban areas. Freight transport specifies the sector average.

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Sharply falling freight emissions are driven by a steep decrease in carbon intensity across modes and by slower demand growth for freight in the *Reshape* and *Reshape+* scenarios (see Figure 5.12). A combination of measures acting on different levers of decarbonisation can significantly drive down the carbon intensity of road freight. The deployment of infrastructure to support an energy transition for long-haul transport and incentives for low emission fuels pushes the road sector to cleaner energy sources. Fuel economy standards, ITS solutions, autonomous vehicles and lower speed limits all push for greater energy efficiency. Asset sharing and heavy capacity vehicles drive up average loads, hence also energy efficiency. Carbon taxes are an incentive to pursue both greater efficiency and move to cleaner technologies. Nonetheless, despite a substantial fall in carbon intensity of 78% between 2015 and 2050, road transport will be responsible for more than half of all freight transport emissions in 2050 in the *Reshape* scenario (56%; 72% if urban freight is included, see Figure 5.11).

Rail transport can become even closer to being carbon neutral with zero tank-to-wheel emissions, assuming a significant push towards the electrification of networks and the deployment of other clean tail-pipe energy sources such as hydrogen, batteries or clean biofuels. Improved operations and enhanced commercial attractiveness coupled with new infrastructure also allows rail to increase its mode share. This contributes to the overall fall in freight transport emissions given rail´s relatively lower average carbon intensity – unlike other non-urban modes, rail can avail itself of readily available and mature low-carbon solutions.

In aviation, fuel efficiency gathers pace with the faster introduction of advanced aircraft designs. Alternative fuel solutions are adopted by the industry, with synthetic aviation fuels available in quantities and in a price range that allows their commercial adoption. Government support for research, innovation and supply infrastructure will be necessary to make this a reality.

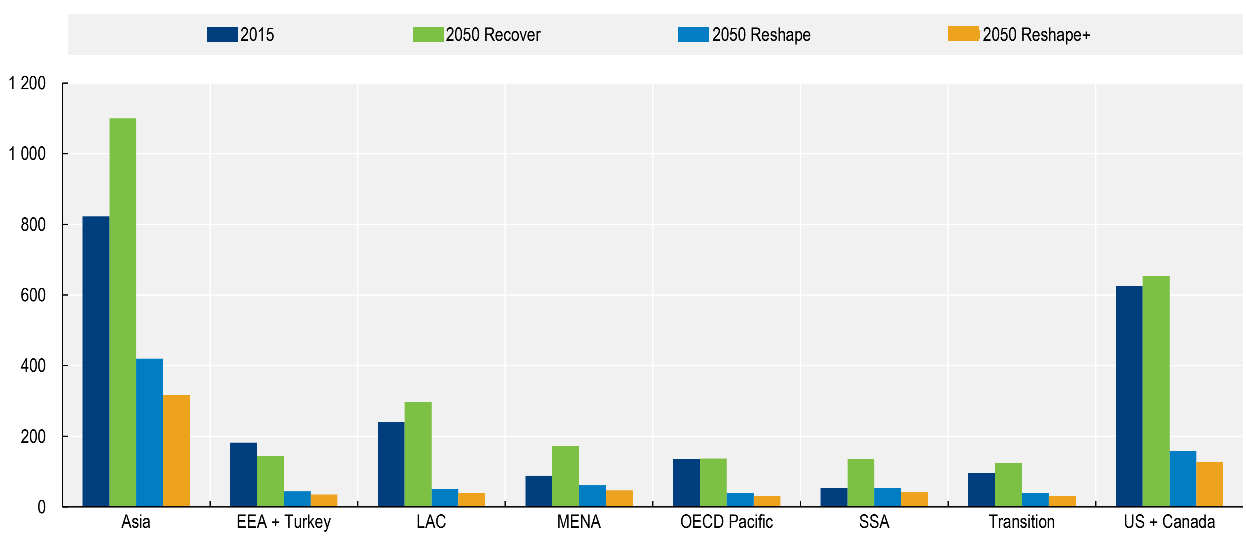
The emission factors in shipping also fall drastically in *Reshape*, a more aggressive deployment of slow steaming, port fees that favour clean ships and a wide array of technologies and operational changes contribute to this. A more in-depth exploration of the several technological options available to decarbonise this sector, along with the policy implication associated with their fast and mass adoption, are available in (ITF, 2018[8]) and (ITF, 2020[58]).

Freight emissions per capita in 2050 will still be around three times higher in the OECD than non-OECD countries

Surface freight emissions decrease more in OECD than non-OECD countries, but the per capita levels remain much higher. The share of emissions from non-OECD economies will grow from around 55% to 69%, but when looking at numbers per inhabitant, the values in 2015 for OECD economies are four times higher when compared to non-OECD economies. Even decreasing at a faster pace due to the deployment of more ambitious policies, the emissions per capita in 2050 will still be around three times more in OECD than non-OECD countries. This highlights the significantly higher carbon footprint of developed economies which largely persists in the three scenarios tested.

Figure 5.13. CO_2 emissions from surface freight transport by world region in 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel)



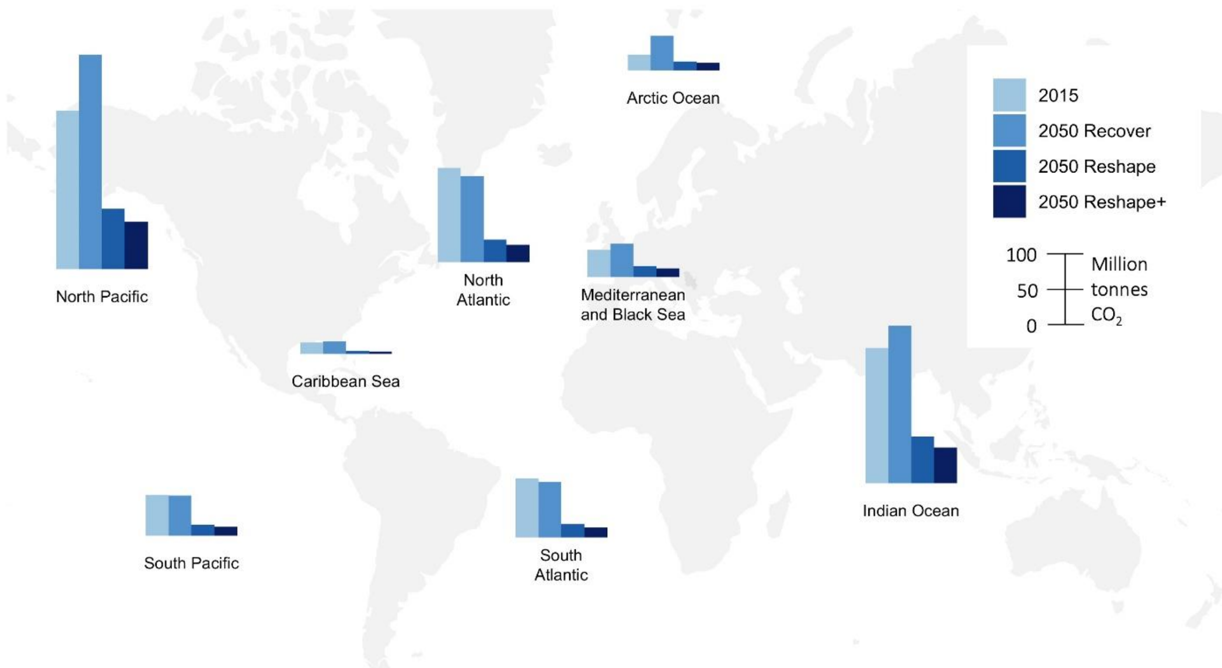
Note: Figure depicts ITF modelled estimates. *Recover, Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

StatLink https://doi.org/10.1787/888934239173

Europe is the only region where emissions from surface freight transport decrease from 2015 to 2050 under current policies (the *Recover* scenario)**.** In *Reshape* and *Reshape+*, several regions achieve sizeable reductions in surface transport emissions (see Figure 5.13). In the latter scenarios, the greatest reductions occur in LAC, followed by EEA and Turkey and the United States and Canada, which have similar decreases. The decarbonising measures tested have their highest impact on surface emissions in LAC, the region that presents a sharp contrast between the *Recover* and *Reshape* scenarios. The lowest impact and difference between scenarios are in SSA and MENA, where there is a greater delay in the adoption of measures and activity grows at a faster rate. A similar dynamic takes place in Asia. Here, too, activity will grow at a faster pace than the global average and the deployment of decarbonisation measures will vary widely between nations of this vast region.

Figure 5.14. CO_2 emissions from maritime freight transport in 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel/wake emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Tank-to-wake is specifically used to refer to ships and aircraft.

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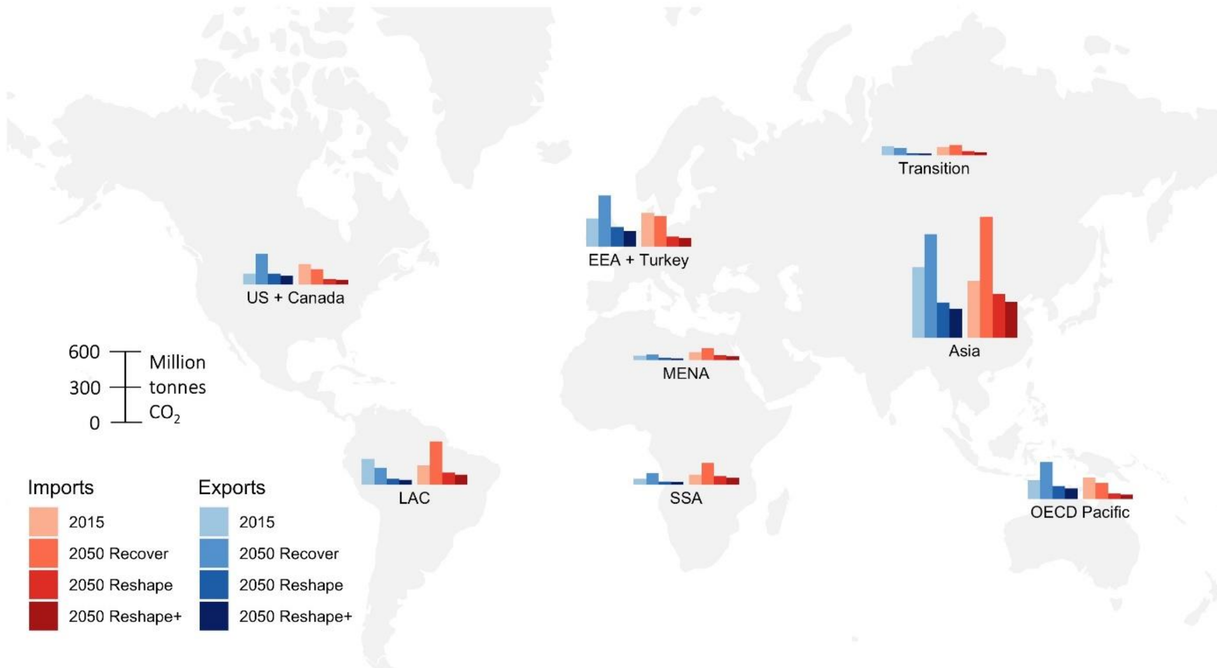
Most freight transport activity in tonne-kilometres comes from imports and exports. These often involve long-distance, inter-continental trips by sea. Nonetheless, most emissions are associated with surface transport, which tends to occur within the same country. The lower carbon intensity of maritime transport compared to road freight, which dominates surface transport, explains this result. Europe is an exception, mainly because import-export transport-related activity reaches much higher volumes than surface transport (see Figure 5.13, Figure 5.14, and Figure 5.15). Transport within the region covers relatively short distances, although there is considerable long-distance trade with other world regions. LAC and MENA are the only regions where export-related emissions decrease in the *Recover* scenario. They are also regions with some of the lowest growth in export-related transport activity.

Figure 5.15. CO_2 emissions from import- and export-related freight transport by world region to 2050

Under three scenarios, million tonnes CO_2 direct emissions (tank-to-wheel/wake)



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel/wake emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Tank-to-wake is specifically used to refer to ships and aircraft. EEA: European Economic Area. LAC: Latin America and the Caribbean. MENA: Middle East and North Africa. OECD Pacific: Australia, Japan, New Zealand, South Korea. SSA: Sub-Saharan Africa. Transition economies: Former Soviet Union and non-EU South-Eastern Europe.

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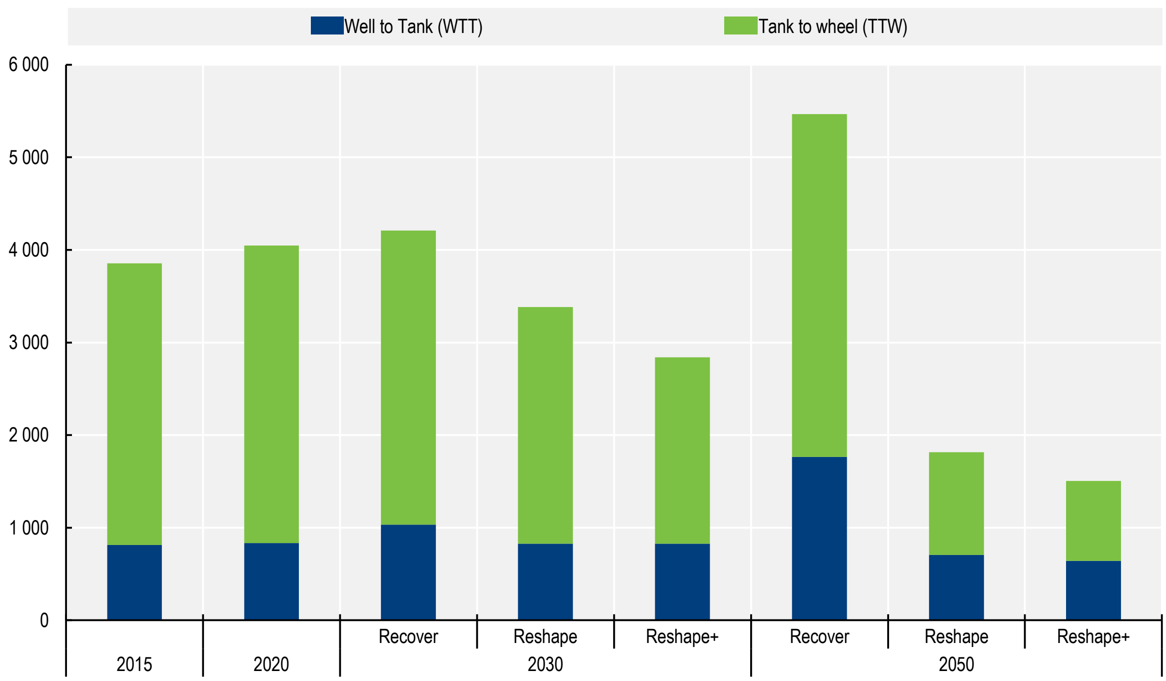
Well-to-tank emissions will decline but account for a larger share of all freight emissions. As the transport system shifts from fossil fuels to alternative energy, a part of tailpipe emissions will be simply displaced to other sectors (see Figure 5.16). Total well-to-wheel emissions decrease 53% to 2050 in *Reshape* and 61% in *Reshape+*, which is less than the reductions in tailpipe emissions. As a result, the share of well-to-tank to total well-to-wheel emissions grows from 21% in 2015 to 43% by 2050 in *Reshape+*.

Figure 5.16. Evolution of tank-to-wheel/wake vs. well-to-tank CO_2 emissions from freight transport to 2050

Under three scenarios, Million tonnes CO_2 emissions



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. Tank-to-wheel emissions are produced by using a vehicle (i.e. from vehicles' fuel consumption). Well-to-tank emissions occur during energy production. Thus, well-to-tank emissions for electric vehicles (EVs) include emissions from electricity generation, while EVs tank-to-wheel emissions are zero. Tank to wake is specifically used to refer to ships and aircraft.

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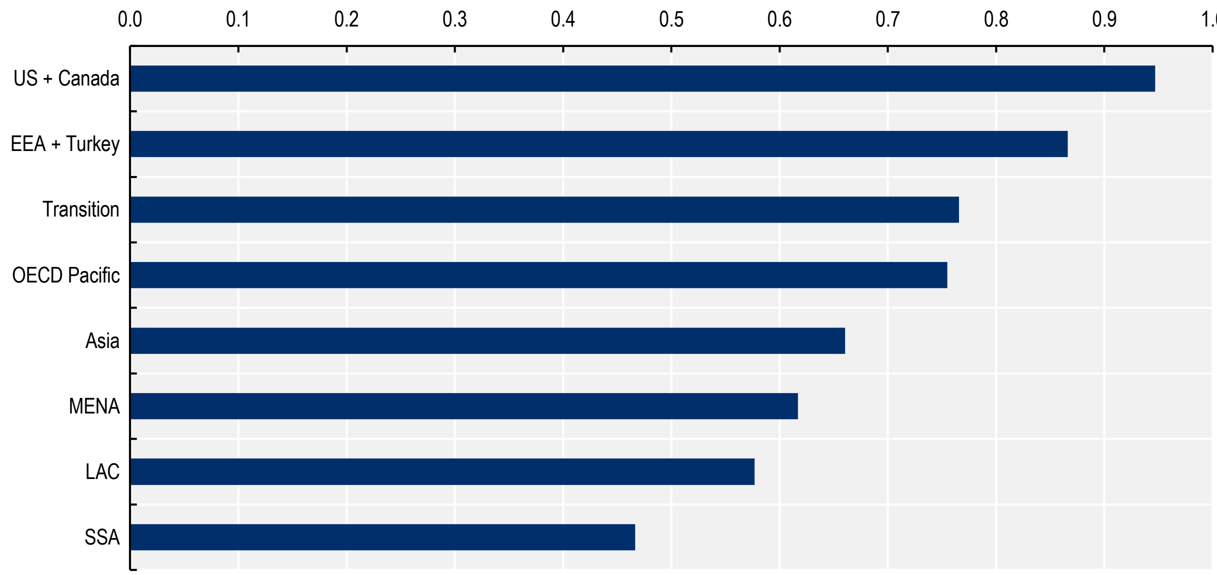
Equitable freight decarbonisation: Avoiding regional imbalances

The question of equity in the context of freight decarbonisation has two main dimensions. First, the unequal impacts that decarbonisation measures can have in different world regions. Second, decarbonisation could lead to market concentration in freight transport, as small companies that cannot afford to implement expensive technologies, for example, are replaced by fewer larger firms. Currently, domestic freight markets are dominated by small, often family-owned businesses. Maritime shipping, on the other hand, has been moving towards greater concentration over the last decades. The pandemic crisis is likely to accentuate this trend, extending it to the domestic market and other modes besides sea transport.

Measuring the connectivity of different world regions to global markets provides a preliminary insight into the current imbalances in freight transport and logistic infrastructure and networks. The freight connectivity indicator developed by the ITF primarily reflects the quality and density of the transport networks, the ease of border crossings, and the proximity to major consumption centres (i.e. areas with high GDP). The indicator ranges between 0 (lowest connectivity) and 1 (highest connectivity). The world regions with the highest freight connectivity are the United States and Canada region and the EEA and Turkey region (see Figure 5.17). Sub Saharan Africa (SSA) has the lowest connectivity. Thus, most developed economies, unsurprisingly, also are the best connected while developing nations lag behind. That said, the fact that the OECD Pacific region scores much higher on the index than Sub-Saharan Africa underscores that infrastructure development and administrative proficiency are relevant, even if the distance to global markets of course play a role.

Figure 5.17. Freight connectivity by world region, 2015



Note: Figure depicts ITF modelled estimates. 0 = lowest connectivity, 1 = highest connectivity

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The average transport cost of exports increases more in the *Recover* scenario than in *Reshape* and *Reshape+* (see Figure 5.18). By 2050, they will be 9% higher for *Recover*, remain at 2015 cost levels under *Reshape* and increase by 7% in *Reshape+*.

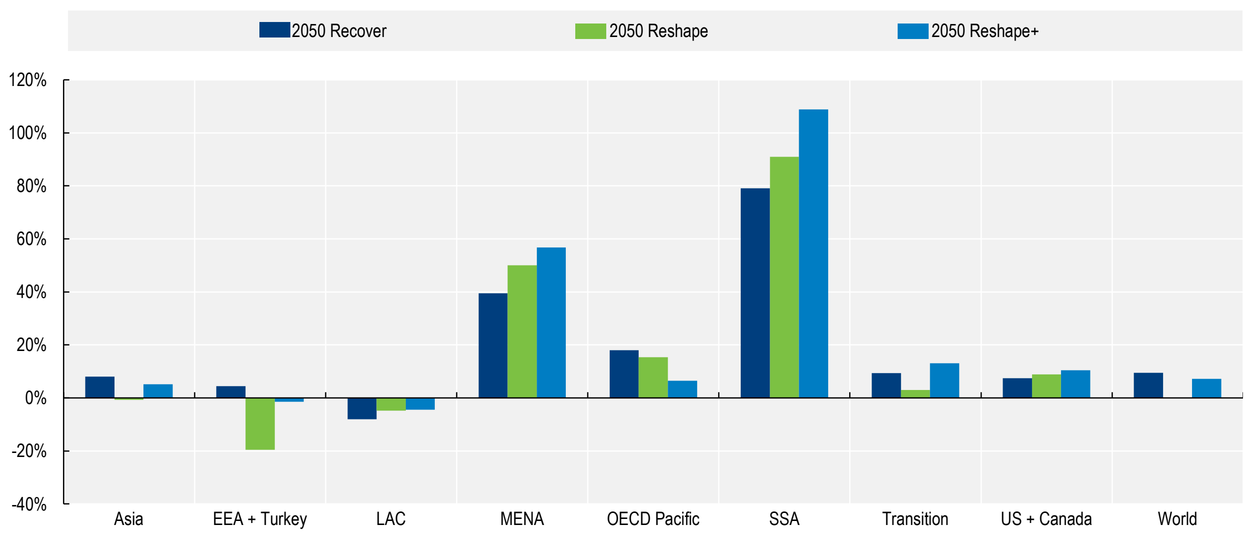
Carbon taxes or distance charges push freight costs up but other decarbonising measures drive them down. Asset-sharing, better intermodal solutions, heavy-capacity vehicles and autonomous trucks all help freight companies to cut costs. The extensive deployment of carbon-neutral fuels in *Reshape* decreases the costs due to carbon taxes. The initial costs of moving towards cleaner technologies are high. Still, in the long run, these solutions tend to be much more efficient and have lower operational costs than current technologies and operational practices. In *Reshape+*, the average cost per tonne-kilometre is higher than *Reshape* because there is relatively less long-distance maritime activity, the cheapest of all modes.

Exports become more costly for remote countries. Average transport cost of exports increases for countries situated far from the main consumption centres. The same is the case for countries lagging behind in terms of ambitious decarbonisation policies, such as MENA and Sub-Saharan Africa (SSA). The latter see costs progressively increase as their per-capita GDP grows and more ambitious decarbonisation policies are implemented globally. The implementation of some measures requires great attention to and equitable distribution of the costs and benefits of decarbonisation policies, such as carbon taxes that drive costs up and slow-steaming that increases travel times.

The costs of bolder transport decarbonisation must not fall disproportionally on less-developed regions of the world. There is a strong equity argument that developed economies need to pursue more ambitious transport decarbonisation targets, since their per-capita transport carbon far surpasses that in developing countries. Technology transfers and investments from developed countries in developing economies should be prioritised so that the latter are not left behind, shouldering prohibitive initial costs.

Figure 5.18. Changes in freight costs for exports by world region

Percentage change in operational and time costs for each scenario in 2050, compared to 2015



Note: Figure depicts ITF modelled estimates. *Recover*, *Reshape* and *Reshape+* refer to the three scenarios modelled, which represent increasingly ambitious post-pandemic policies to decarbonise transport. These results represent the user or operator perspective, as they are derived from the mode-choice function of the freight model. Thus, they mostly reflect operational costs. They do not include all of the costs associated with new infrastructure implemented as part of ambitious decarbonisation policies, whether for new transport solutions or alternative fuels.

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More resilience, less carbon and lower costs with the right policy mix

Average transport costs tend to increase with trade regionalisation. In logistics, the diversification or regionalisation of supply chains and the resulting growth in inventories will tend to push up the cost of goods. More resilience implies a greater diversity of suppliers, modes, and route choices. But relaxing the just-in-time paradigm also means keeping larger stocks and buffers for production. Hence, more warehousing and storage space is needed. This increased focus on resilience will imply adaptations and costs, some already underway.

Greater resilience can reduce transport costs by relaxing just-in-time requirements and more load consolidation, which reduces empty runs, increases capacity use, and facilitates multimodal solutions with lower unit costs. When coupled with digitalisation, automation and streamlined processes (e.g. single logistic windows type systems (UN, 2020[59])) any cost or time losses from resilience and decarbonisation inducing policies can be further offset (Sarkis et al., 2020[60]). Greater transparency and responsible business conduct can increase resilience and hedge risks (see Box 5.6). Nonetheless, some trade-offs are unavoidable between decarbonisation and resilience. More efficient fleet management and capacity use favours decarbonisation but can hinder system resilience and flexibility, e.g. by reducing the truck fleet size leading to less additional capacity available for transport.

Disruption resulting from climate change can be very costly for the economy. Natural disasters linked to climate change disrupt transport, and by extension the economy, with increasing frequency and severity. In future, infrastructure and operations could be disrupted even more, for even longer periods, and with even graver economic impacts. To manage such risks, companies would need to maintain larger stocks that tie capital. Protecting supply chains and transport infrastructure from extreme conditions would add further costs and make navigation in certain parts of the world increasingly challenging. According to some forecasts, global GDP would be 3% smaller in 2050 in a world where climate change has taken hold, compared to a scenario where global warming has been contained (Economist Intelligence Unit, 2020[35]).

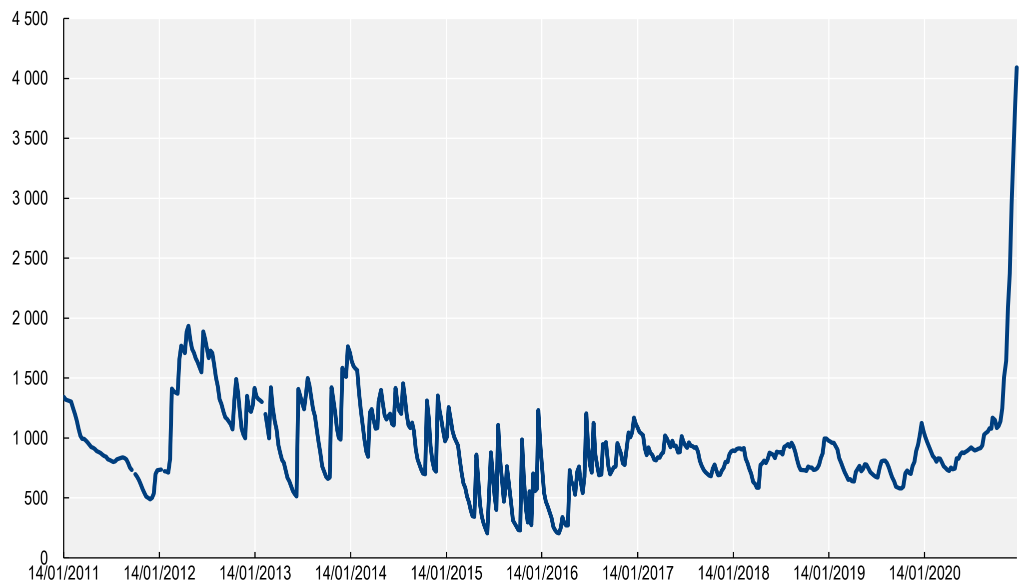
The role of smaller players in the freight transport market may decrease. The economic crisis, increased automation, expansion of online retail and investment in DT could lead to market consolidation giving less space to smaller players. The transition of the road freight industry from one where small family owned businesses play a prominent role to one where a few companies dominate the sector would have serious consequences. The sector employs a significant number of people, and many run their own businesses. However, consolidation could increase the pace of adopting cleaner technologies and operational solutions (e.g. alternative fuels and asset sharing). Another downside of consolidation could be decreased competition and increased monopoly power. This would be detrimental to consumers. Such trends have already taken hold in maritime shipping.

Maritime shipping has become highly concentrated over the last decades. This is the case for cruise shipping, car carriers and container shipping in particular. In addition, container carriers benefit from intensive co-operation via alliances and vessel-sharing agreements. This co-operation has made it possible to manage container ship capacity jointly (ITF, 2018[61]). During the Covid-19 pandemic, carriers collectively withdrew around one-third of their capacity. As a result, container freight rates went up despite a drop in demand (Figure 5.19). This has sparked action from regulators in China and the United States (Waters, 2020[62]) (Shen, 2020[63]), while the European Commission has not taken any action. Under EU regulations, liner shipping is granted exemption from competition rules applied to other sectors, on the premise that the exemption benefits the liners' clients (ITF, 2019[64]).

The shipping industry suffers from a moral hazard problem. The assurance that operators will be bailed out in combination with tax exemptions enables shipping firms to offload their risks to the public sector (ITF, 2020[65]). The Covid-19 pandemic has demonstrated the imbalance with regards to public and private risks of shipping companies. The shipping industry has a notoriously low effective corporate income tax rate of approximately 7% in comparison to the worldwide statutory tax rate of 24% (Merk, 2020[66]). This low rate is the result of tax avoidance by incorporating firms in tax havens and operating ships under flags of convenience. It is also the result of special, generous tax regimes for the shipping sector, such as the tonnage tax. The tonnage tax, based on a ship's internal volume, replaces the corporate income tax (ITF, 2019[67]). During the Covid-19 crisis, several shipping companies incorporated in tax havens received liquidity support from other states than those where they are incorporated (ITF, 2020[68]).

Figure 5.19. Container freight rates 2011-20

Shanghai Containerised Freight Index Asia-Europe (USD/TEU)



Note: The Shanghai Containerized Freight Index reflects the weekly spot rates of container transport exports from Shanghai to 13 world regions. This figure reflects the weekly spot rates of container transport exports from Shanghai to Europe.
Source: Shanghai Shipping Exchange (2021).

Box 5.6. Building resilience in the supply chain through responsible business conduct

The Covid-19 crisis has exposed significant vulnerabilities in company operations when it comes to disaster preparedness and supply chain continuity and resilience. Entire supply chains have come to a halt and placed millions of companies and workers at economic risk (OECD, 2020[69]), including already vulnerable populations, such as migrant workers (IOM, 2020[70]). Responsible business conduct (RBC) principles and standards, which are widely accepted in the global markets, can help build resilience in the supply chain without further destabilising them down the line (e.g. resurgence of forced or child labour in strategic sectors). Evidence is already showing that more resilient production networks can be achieved through better risk management strategies at the firm level, with the emphasis on risk awareness, greater transparency, and agility (OECD, 2020[71]).

The transport sector plays a critical role in this regard. As the underlying fabric for all global supply chains, the sector connects people to jobs, gets products to global markets, and is also a large employer itself. However, social, and environmental impacts across modes can vary. RBC instruments aim to unpack this complexity and look to a whole-of-supply chain perspective to address the responsibilities of different actors in the face of impacts that do not neatly fit within a specific country jurisdiction, sector, or even among business relationships. Consider, for example, that recent research has shown that just 100 companies have been the source of more than 70% of the world's greenhouse gas emissions since 1988 (CPD, 2017[72]).

The *OECD Guidelines for Multinational Enterprises* (https://mneguidelines.oecd.org/mneguidelines/) set out that all companies – regardless of their legal status, size, ownership, or sector – should 1) make a positive contribution to the economic, environmental, and social progress of the countries in which they operate and 2) avoid and address negative impacts of their activities. This includes their core business activities as well as the supply chain and business relationships. The Guidelines provide recommendations on information disclosure, human rights, environment, employment and industrial relations, bribery, consumer interests, competition, and taxation.

The OECD also recommends that businesses know and show they are addressing their most significant environmental and social impacts through risk-based due diligence - a process through which businesses identify, prevent, and mitigate their actual and potential negative impacts across all business operations and account for how those impacts are addressed over time. The *OECD Due Diligence Guidance for Responsible Business Conduct* (https://www.oecd.org/investment/due-diligence-guidance-for-responsible-business-conduct.htm), developed in close consultation with businesses, governments, civil society, and trade unions, explains how to do so in practice.

Policy recommendations

The freight sector is hard to decarbonise, but it can be done. Without low-carbon goods transport, the international community will fail to reach its climate objectives. Bold policy action to reshape freight transport can bring its CO_2 emissions down up to 72% by 2050. With business-as-usual policies, freight emissions will rise by almost a quarter, by 22%.

Two things need to change:

First, decarbonising freight has to move higher up on policy agendas. It can no longer take a back seat to passenger transport, in which public authorities have historically been more involved and which has been the focus of their attention.

Second, governments must create business cases for freight decarbonisation. Freight transport is a profit-driven sector dominated by private companies. Their buy-in is critical, as they will quickly adopt new practices if and where they see benefits. Policy must set regulatory frameworks that favour best practices.

The Covid-19 pandemic can become a turning point to accelerate the green transition of goods transport. The following policy recommendations will move us towards that goal.

Design stimulus packages that align to support economic recovery, freight decarbonisation and supply chain resilience

Public funding and financing of economic recovery programmes should prioritise green transport infrastructure. Targets for investment include the transport network itself, for instance, the electrification of rail lines, and the production, distribution and supply of alternative fuels. Digitalisation and automation of terminals and logistic hubs can bring efficiency gains. The same is true for the streamlining of processes at border crossings or for issuing permits. Such measures can increase efficiency, lowering freight emissions, and make supply chains more reliable and resilient. Governments need to create a coherent framework of economic and regulatory incentives and penalties to align economic objectives with sustainability goals. The toolbox could include carbon taxes, zoning restrictions, fuel mandates, and bailouts conditional on decarbonisation actions.

Align price incentives with freight decarbonisation ambitions for carrier buy-in

Few carriers will invest in low-carbon vehicles if they have to pay more than for conventional vehicles or fuels. The price of conventional vehicles or fuels generally does not reflect negative externalities such as greenhouse gas emissions. On the contrary, various parts of the freight sector receive generous fuel tax exemptions. These undermine the attractiveness of cleaner, more efficient alternatives. Phasing out tax exemptions for fossil fuels is a crucial step on the road to freight transport decarbonisation and the widespread adoption of cleaner technologies and systems.

Including freight transport emissions in carbon-pricing schemes is part of the toolbox policy makers have at their disposal to foster a green transition. Taxation reforms need to ensure a fair distribution of costs and benefits when they eliminate incentives that reward inefficiencies and pollution. The equitable distribution of impacts between different world regions also needs to be addressed. The costs of a bold transport decarbonisation agenda should not fall disproportionally on less-developed economies and regions further from the main production and consumption centres. Otherwise, perceptions of injustice risk generating a backlash against decarbonisation.

Scale-up ready-to-adopt freight decarbonisation measures quickly to cut costs and emissions

Many low-tech solutions and mature decarbonisation technologies could be quickly deployed and scaled up. Aerodynamic retrofits, tyres with reduced rolling resistance, lighter materials for weight reductions, more fuel-efficient engine and hybrid propulsion are technologies that exist. Tough standards for fuel economy and CO_2 emissions can drive their wider deployment, for which heavy freight trucks must be a priority target.

In urban freight, alternative fuels are becoming a viable solution. Carbon pricing, stricter emission standards, zero-emissions zones, more recharging points and incentives for greening whole vehicle fleets will spur this trend. Other low-hanging fruits include training for drivers (“eco-driving”) and fewer restrictions on high-capacity lorries on certain corridors. Promoting off-peak deliveries, creating collection points, optimising routes can limit emissions if widely adopted, as can voluntary emissions reduction programmes.

Collaboration between logistics companies, for instance sharing vehicles to reduce empty runs, can save costs and cut emissions. Legal, technical or other barriers must be addressed. Digital collaboration platforms run by trusted third parties offer a promising path.

Strengthen international co-operation to combat freight emissions

Transport decarbonisation needs greater international co-ordination than in the past. International aviation and shipping are not included in the Paris Agreement and need different mechanisms. For both, standards and regulations are set by international bodies that operate on a consensus basis. Implementing fuel standards and other decarbonisation measures for aviation and shipping will require political will to act jointly.

Accelerate standardisation procedures to speed-up the adoption of new clean technologies

Low- and zero-carbon solutions under development will require scale to make them economically viable. Setting international standards for new technologies, services, and practices will help mainstream them quickly by leveraging the global scale. Where global standards are hard to achieve, co-ordination at a regional level is the next-best solution.

Tailor decarbonisation pathways to regional realities to address gaps in standard solutions

Different geographic, economic, regulatory and infrastructure conditions around the world require different priorities and pathways. Decarbonising ageing second-hand vehicle fleets in developing countries requires other solutions than for the modern fleets in highly industrialised nations, for instance. Electric roads may become soon operational within a relatively short time in advanced economies. For many developing countries, improving the quality of diesel fuel and replacing old trucks are more immediate tasks. In some regions, biofuel production may be nearly carbon-neutral and cost-effective, in others, this is a vision for the far-off future. Technology transfers and cross-border investment may reduce such gaps and should be prioritised. International regulations and decarbonisation roadmaps must reflect that the per capita carbon footprint in developed countries far surpasses that of people in developing economies.

Broaden access to privately owned data to improve policy design

The importance of data to support decarbonisation policies for freight transport cannot be overstated. Data is critical for emissions accounting. It is also vital for evaluating the impact of innovative business models and new vehicle technologies. Relevant data for such purposes exist, but they are usually company-owned. Ensuring public-interest access to private data is imperative. Addressing privacy concerns and safeguarding legitimate commercial interests is possible and a critical requirement to enable access to corporate data for research and policy evaluation purposes. New modelling tools and more disaggregated approaches can use currently inaccessible data to provide important insights for policy makers and the freight transport (Office for National Statistics, 2020[21]) industry.

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Annex A. Statistical Annex

Rail freight transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	25	23	40	23	9	25	20	43
Argentina	10 583	9 746	8 893	8 274	8 529	8 377	..	..
Armenia	867 e	851 e	786	640	658	690	..	..
Australia	290 570 e	319 000	367 700	401 600	413 490	..	..	..
Austria	19 499	19 564	20 746	20 814	21 361	22 256	21 996	21 736
Azerbaijan	8 212	7 958	7 371	6 210	5 192	4 633	4 492	5 152
Belarus	48 351	43 818	44 997	40 785	41 107	48 538	52 574	48 205
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	1 150	1 243	1 313	1 286	1 142	1 130	1 188	1 275
Bulgaria	2 908	3 246	3 439	3 650	3 434	3 931	3 792	3 902
Canada	368 297	386 266	414 069	412 985	396 806	420 143	445 546	433 139
Chile	4 090 p	3 981 p	4 104 p	4 086 p	4 077 p	3 770 p	3 816 p	3 079 p
China	2 918 709	2 917 390	2 753 020	2 375 430	2 379 230	2 696 220	2 882 100	..
Croatia	2 332	2 086	2 119	2 183	2 160	2 592	2 743	2 911
Czech Republic	14 266	13 965	14 574	15 261	15 619	15 843	16 564	16 180
Denmark	2 278	2 448	2 453	2 603	2 575	2 653	2 592	..
Estonia	5 129	4 722	3 256	3 114	2 339	2 325	2 594	2 155
Finland	9 275	9 470	9 596	8 468	9 455	10 362	11 175	10 270
France	32 539	32 230	32 596	34 252	32 569	33 442	32 039	31 829
Georgia	5 976	5 526	4 988	4 261	3 424	2 963	2 598	2 935
Germany	110 065	112 613	112 629	116 632	128 866 |	131 204	129 991	113 114 p
Greece	283 e	238 e	343 e	294	254	358	408	491
Hungary	9 230	9 722	10 158	10 010	10 528	11 345	10 584	10 625
Iceland	x	x	x	x	x	x	x	x
India	649 645	665 810	681 696	654 481	620 175 e	654 285 e	..	..
Ireland	91	99	100	96	101	100	73	72
Italy	20 244	19 037	20 157	20 781	22 712 |	22 335	22 070 p	21 309 p
Japan	20 471	21 071	21 029	21 519	21 265	21 663	19 369	20 117
Kazakhstan	..	..	..	..	..	..	..	..
Korea	10 271	10 459	9 564	9 479	8 414	8 229	7 878	7 357
Latvia	21 867	19 532	19 441	18 906	15 873	15 014	17 859	15 019
Liechtenstein	10	9	..	..	..	..	..	..
Lithuania	14 172	13 344	14 307	14 036	13 790	15 414	16 885	16 181
Luxembourg	231	218	208	207	201	214	223	191
Malta	x	x	x	x	x	x	x	x
Mexico	79 353	77 717	80 683	83 401	84 683	86 316	87 924	89 049
Moldova, Republic of	960	1 227	1 182	963	790	987	1 012	940
Montenegro, Republic of	73	105	94	112	112	169	..	..
Morocco	..	..	5 383	4 749	..	3 896	..	..
Netherlands	6 142	6 078	6 169	6 545	6 641	6 467	7 026	7 018
New Zealand	4 768	4 679	4 493	4 349	4 190	3 619	3 857	3 830
North Macedonia	423	421	411	278	222	277	305	350
Norway	3 582	3 513	3 682	3 631	3 823	4 040	3 970	3 903
Poland	48 903	50 881	50 073	50 603	50 650	54 797	59 388	54 584
Portugal	2 421	2 290	2 438	2 661	2 622	2 742	2 863	2 701 p
Romania	13 472	12 941	12 264	13 673	13 535	13 782	13 076	13 312
Russian Federation	2 222 389	2 196 217	2 300 532	2 305 945	2 344 087	2 493 428	2 597 778	2 602 493
Serbia, Republic of	2 769	3 022	2 988	3 248	3 087	3 288	3 932	2 861
Slovak Republic	7 591	8 494	8 829	8 439	9 111	8 486	8 691	8 480
Slovenia	3 470	3 799	4 110	4 175	4 360	5 128	5 151	5 292
Spain	9 390	9 366	10 303	10 812	10 644	10 507	10 792	..
Sweden	22 043	20 970	21 296	20 699	21 406	21 838	23 358 |	22 717
Switzerland	11 061	11 812	12 313	12 431	12 447	11 665	11 776	11 673
Turkey	11 670	11 177	11 992	10 474	11 661	12 869	14 478	14 707
Ukraine	237 722	224 434	210 157 |	195 054	187 557	191 914	186 344	181 844
United Kingdom	21 467	22 401	22 143	19 342	17 053	17 167	17 206	..
United States	2 500 300	2 541 355	2 702 743 |	2 537 845	2 314 699	2 445 138	2 525 224	2 364 144

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road freight transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	3 223 e	3 497 e	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	401	484	544	479	676	725	..	..
Australia	196 511	200 594	205 465	208 301	213 940	219 900	216 247 e	218 903 e
Austria	26 088	24 212	25 260	25 458	26 138	25 978	25 763	26 502
Azerbaijan	13 744	14 575	14 989	16 038	16 486	16 864	17 402	18 115
Belarus	22 031	25 603	26 587	24 523	25 239	26 987	28 082	28 516
Belgium	32 105	32 795	31 808	36 077	35 579	34 219	32 684	34 829
Bosnia-Herzegovina	2 310	2 739	3 125	3 405	4 015	4 280	4 303	4 375
Bulgaria	24 387	27 237	27 922	32 350	35 402	35 185	27 003	20 613
Canada	241 495	251 387	268 568	277 396	294 716	299 160	269 094	..
Chile	..	..	..	..	..	..	..	..
China	5 953 486	5 573 810	5 684 690	5 795 570	6 108 010	6 677 150	7 124 920	..
Croatia	8 649	9 133	9 381	10 440	11 337	11 833	12 635	12 477
Czech Republic	51 228	54 893	54 092	58 714	50 315	44 274	41 073	39 059
Denmark	12 292	12 222	12 950	12 324	12 943	15 515	14 988	..
Estonia	5 793	5 987	6 292	6 259	6 717	6 189	5 783	4 795
Finland	25 458	24 429	23 401	24 486	26 853	27 977	28 413	28 847
France	165 808	165 315	159 530	148 713	151 213	162 616	168 480	181 400 |
Georgia	637	646	655	664	674	683	693	702
Germany	307 106	305 781	310 142	314 815	315 769	313 143	316 766	311 869
Greece	20 416	19 203	19 223	19 763	24 560	28 418	29 279	28 197 p
Hungary	33 735	35 817	37 517	38 352	40 006	39 687	37 948	36 951
Iceland	786 e	808 e	850 e	907 e	1 052	1 150	1 195	..
India	1 508 000	1 653 600	1 824 300	2 026 100	2 226 570 e	2 435 870 e	..	..
Ireland	9 895	9 138	9 772	9 844	11 564	11 758	11 538	12 403
Italy	124 009	127 241	117 813	116 819	112 638	119 687	124 915	127 225 p
Japan	209 956	214 092	210 008	204 316	210 314	210 829	210 467	213 836
Kazakhstan	..	..	..	..	..	..	..	..
Korea	111 529	118 582	124 650	132 382	135 259	140 374	143 530	..
Latvia	12 178	12 816	13 670	14 690	14 227	14 972	14 997	14 965
Liechtenstein	281	318	..	..	..	..	..	..
Lithuania	23 449	26 338	28 067	26 485	30 974	39 099	43 591	53 117
Luxembourg	6 550	7 214	7 912	7 095	6 448	6 418	6 968	7 540
Malta	..	..	..	..	..	..	..	..
Mexico	233 464	235 427	239 710	245 136	251 122	256 136	260 642	258 684
Moldova, Republic of	3 954	4 423	4 306	4 217	4 693	5 008	5 290	5 567
Montenegro, Republic of	76	67	122 |	140	121	103	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	38 477	42 001	42 184	41 650	42 966	42 455	42 732	42 905
New Zealand	21 705	21 730	23 672	22 993 |	23 249	24 887	25 315	25 372 p
North Macedonia	8 965	7 466	10 622	10 192	10 590	10 850	10 639	10 267
Norway	18 086	19 712	20 297	19 730	19 676	20 075	19 982	20 526
Poland	233 310	259 708	262 860 |	273 107	303 560	348 559	377 778	395 311
Portugal	32 274	39 624	36 336	32 525	34 683	34 073	32 676	31 216 p
Romania	29 662	34 026	35 135	39 022	48 175	54 704	58 761	61 041
Russian Federation	248 862	250 054	246 784	241 512	240 715 |	245 818	248 990	263 878
Serbia, Republic of	2 474	2 824	2 959	2 973	4 299	4 980	6 443	8 175
Slovak Republic	29 504	30 005	31 304	33 525	36 106	35 362	35 590	33 888
Slovenia	1 849	1 889	2 062	2 069	2 135	2 311	2 256	2 306
Spain	199 205	192 594	195 763	209 387	216 993	231 105	238 991	249 555
Sweden	41 011 |	42 090	41 956	41 498	42 686	41 848	43 474	42 601
Switzerland	17 109	17 241	17 541	17 214	16 963	17 288	17 716	..
Turkey	216 123	224 048	234 492	244 329	253 139	262 739	266 502	267 579
Ukraine	57 453	58 683	55 964 |	53 293	58 030	62 297	72 068	64 953
United Kingdom	152 706	140 874	136 873	151 805	157 657	156 064	161 112	..
United States	2 660 295 |	2 926 454	2 856 882	2 899 252	3 008 681	2 955 442	2 969 468	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Inland waterway freight transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	x	x	x	x	x	x	x	x
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	x	x	x	x	x	x	x	x
Austria	2 191	2 353	2 177	1 806	1 962	2 022	1 489	1 715
Azerbaijan	5 062	4 632	4 125	2 896	3 002	4 420	4 576	3 351
Belarus	134	84	49	21	21	32	37	33
Belgium	10 420	10 365	10 451	10 426	10 331	11 098	11 357	10 816
Bosnia-Herzegovina	x	x	x	x	x	x	x	x
Bulgaria	1 397	1 196	971	1 081	1 255	1 202	939	988
Canada	26 300 e	26 600 e	..	..	..	..	..	..
Chile	x	x	x	x	x	x	x	x
China	2 829 548	3 073 028	3 683 960	3 753 650	3 926 380	4 352 720	4 712 580	..
Croatia	772	771	716	879	836	813	678	835
Czech Republic	669	693	656	585	620	623	554	569
Denmark	x	x	x	x	x	x	x	x
Estonia	..	..	..	..	..	..	..	..
Finland	124	121	136	130	103	120	120	122
France	7 830	7 912	7 752	7 461	6 836	6 715	6 702	7 358
Georgia	x	x	x	x	x	x	x	x
Germany	58 488	60 070	59 093	55 315	54 347	55 518	46 901	50 945
Greece	x	x	x	x	x	x	x	x
Hungary	1 982	1 924	1 811	1 824	1 975	1 992	1 608	2 120
Iceland	x	x	x	x	x	x	x	x
India	3 063	2 418	2 847	3 450	3 952	4 347 e	..	..
Ireland	x	x	x	x	x	x	x	x
Italy	81	89	64	62	67	61 p	67 e	65 e
Japan	x	x	x	x	x	x	x	x
Kazakhstan	..	..	..	..	..	..	..	..
Korea	x	x	x	x	x	x	x	x
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	2	1	1	1	1	1	1	2
Luxembourg	290	315	285	235	190	196	205	228
Malta	x	x	x	x	x	x	x	x
Mexico	x	x	x	x	x	x	x	x
Moldova, Republic of	1	1	1	0	0	0	0	0
Montenegro, Republic of	x	x	x	x	x	x	x	x
Morocco	..	..	..	..	..	..	..	..
Netherlands	47 520	48 600	48 535	49 425	48 799	48 998	47 244	47 581
New Zealand	x	x	x	x	x	x	x	x
North Macedonia	x	x	x	x	x	x	x	x
Norway	x	x	x	x	x	x	x	x
Poland	815	768	779	2 187	832	877	782	656
Portugal	..	..	..	..	..	..	..	..
Romania	12 520	12 242	11 760	13 168	13 153	12 517	12 261	13 957
Russian Federation	80 762 |	80 101	72 317	63 620	67 194 |	67 165	66 089	65 906
Serbia, Republic of	605	701	759	859	926	725	580	727
Slovak Republic	986	1 006	905	741	903	933	778	937
Slovenia	x	x	x	x	x	x	x	x
Spain	x	x	x	x	x	x	x	x
Sweden	..	..	..	..	16	14	43	49
Switzerland	50	49	43	47	30	41	33	43
Turkey	x	x	x	x	x	x	x	x
Ukraine	1 748	1 387	1 358 |	1 572	1 465	1 423	1 540	1 614
United Kingdom	157	211	169	120	108	99	93	..
United States	481 493	458 931	504 768	476 662	464 128	476 080	..	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Oil pipeline transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	2 876 e	2 750 e	2 837	2 624	2 550	2 835	..	..
Australia	x	x	x	x	x	x	x	x
Austria	7 146	8 392	8 259	8 475	8 473	8 396	8 577	8 567
Azerbaijan	63 172	63 734	67 039	67 515	65 924	65 879	66 452	62 768
Belarus	61 134	61 220	59 704	60 552	59 345	57 708	58 071	54 039
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	x	x	x	x	x	x	x	x
Bulgaria	573	633	583	661	710	706	671	735
Canada	165 000	175 400	192 400	213 600	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	321 100	349 600	432 800	466 500	419 600	478 400	530 100	..
Croatia	1 216	1 485	1 447	1 740	1 921	2 111	2 315	1 675
Czech Republic	1 907	1 933	2 063	2 023	1 588	2 165	2 107	2 050
Denmark	3 078	2 739	2 409	2 258	2 026	..	..	..
Estonia	x	x	x	x	x	x	x	x
Finland	x	x	x	x	x	x	x	x
France	15 151	11 521	11 055	11 443	11 373	11 973	12 449	11 819
Georgia	..	..	..	..	..	..	..	..
Germany	16 207	18 180	17 541	17 714	18 761	18 239	17 234	17 649
Greece	x	x	x	x	x	x	x	x
Hungary	5 802	5 694	5 801	5 305	5 850	7 430	7 589	8 901
Iceland	x	x	x	x	x	x	x	x
India	141 660	..	..	..	..	..	..	..
Ireland	x	x	x	x	x	x	x	x
Italy	10 066	10 024	9 555	9 213	9 977	10 194	10 329 p	10 528 p
Japan	x	x	x	x	x	x	x	x
Kazakhstan	..	..	..	..	..	..	..	..
Korea	x	x	x	x	x	x	x	x
Latvia	2 631	2 279	2 376	1 965	1 507	1 411	1 109	1 129
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	632	563	567	496	406	391	326	330
Luxembourg	x	x	x	x	x	x	x	x
Malta	x	x	x	x	x	x	x	x
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	x	x	x	x	x	x	x	x
Montenegro, Republic of	x	x	x	x	x	x	x	x
Morocco	..	..	..	..	..	..	..	..
Netherlands	5 572	5 405	5 837	6 044	6 047	6 143	5 535	5 840
New Zealand	x	x	x	x	x	x	x	x
North Macedonia	37	..	6 |	6	10	13	12	36
Norway	3 115	2 724	2 845	3 377	3 813	4 768	4 518	5 185
Poland	22 325	20 112	20 543	21 843	22 204	21 080	21 313	18 610
Portugal	360	350	371	391	392	415	440	..
Romania	785	829	984	1 029	1 131	1 087	1 080	1 168
Russian Federation	1 187 627	1 223 931	1 220 442	1 268 535	1 308 126	1 315 268	1 331 622	1 368 464
Serbia, Republic of	295	381	355	405	447	481	1 056	933
Slovak Republic	..	..	..	..	..	..	..	..
Slovenia	x	x	x	x	x	x	x	x
Spain	8 900	8 691	8 967	10 115	9 990	9 713	9 949	..
Sweden	x	x	x	x	x	x	x	x
Switzerland	183	228	234	113 |	109	107	112	105
Turkey	37 433	26 756	17 106	52 514	52 683	52 095	38 650	54 238
Ukraine	10 607	11 198	10 795 |	10 830	9 863	10 358	9 903	9 882
United Kingdom	9 914	..	..	..	..	..	..	..
United States	750 607 |	717 287	748 643	773 143	761 867	782 838	857 888	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total inland freight transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	3 248	3 520	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	4 144 e	4 085 e	4 167	3 743	3 883	4 256	..	..
Australia	487 081	519 594	573 165	609 901	627 430	..	..	..
Austria	47 778	46 129	48 183	48 078	49 461	50 256	49 248	49 953
Azerbaijan	90 190	90 899	93 524	92 659	90 604	91 796	92 922	89 386
Belarus	131 650	130 725	131 337	125 881	125 712	133 265	138 764	130 793
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	3 460	3 982	4 438	4 691	5 157	5 410	5 491	5 650
Bulgaria	29 265	32 312	32 915	37 742	40 801	41 024	32 405	26 238
Canada	801 092	839 653	875 037 |	903 981 p	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	12 022 843	11 913 828	12 554 470	12 391 150	12 833 220	14 204 490	15 249 700	..
Croatia	12 969	13 475	13 663	15 242	16 254	17 349	18 371	17 898
Czech Republic	68 070	71 484	71 385	76 582	68 141	62 904	60 298	57 859
Denmark	17 648	17 409	17 812	17 185	17 544	18 168 |	17 580	..
Estonia	10 922	10 709	9 548	9 373	9 056	8 514	8 377	6 950
Finland	34 857	34 020	33 133	33 084	36 411	38 459	39 708	39 239
France	221 328	216 978	210 933	201 869	201 991	214 746	219 670	232 406
Georgia	6 613	6 172	5 643	4 926	4 098	3 646	3 291	3 637
Germany	491 866	496 644	499 405	504 476	517 743 |	518 104	510 892 p	493 577
Greece	20 699 e	19 441 e	19 566 e	20 057	24 814	28 776	29 687	28 688 p
Hungary	50 749	53 157	55 287	55 490	58 359	60 454	57 729	58 596
Iceland	786 e	808 e	850 e	907 e	1 052	1 151	1 195	..
India	2 302 368	2 321 828	2 508 843	2 684 031	2 850 697 e	3 094 502 e	..	..
Ireland	9 986	9 237	9 872	9 940	11 665	11 858	11 611	12 475
Italy	154 400	156 391	147 589	146 875	145 394 |	152 277 p	157 381	159 127
Japan	230 427	235 163	231 037	225 835	231 579	232 492	229 836	233 953
Kazakhstan	..	..	..	..	..	..	..	..
Korea	121 800	129 041	134 214	141 861	143 673	148 603	151 408	..
Latvia	36 676	34 627	35 487	35 561	31 607	31 397	33 965	31 113
Liechtenstein	291	327	..	..	..	..	..	..
Lithuania	38 255	40 246	42 942	41 018	45 171	54 905	60 803	69 630
Luxembourg	7 071 e	7 747 e	8 405	7 537	6 839	6 828	7 396	7 959
Malta	..	..	..	..	..	..	..	..
Mexico	312 817	313 144	320 393	328 537	335 805	342 452	348 566	347 733
Moldova, Republic of	4 915	5 651	5 489	5 180	5 483	5 995	6 302	6 507
Montenegro, Republic of	149	172	216 |	252	233	272	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	97 711	102 084	102 725	103 664	104 453	104 063	102 537	103 344
New Zealand	26 473	26 409	28 165	27 342 |	27 439	28 506	29 172	29 202
North Macedonia	9 425	7 887 |	11 039 |	10 476	10 822	11 140	10 956	10 653
Norway	24 783	25 949	26 824	26 738	27 312	28 883	28 470	29 614
Poland	305 353	331 469	334 255 |	347 740	377 246	425 313	459 261	469 161
Portugal	35 055	42 264	39 145	35 577	37 697	37 230	35 979	33 917 p
Romania	56 439	60 038	60 143	66 892	75 994	82 090	85 178	89 478
Russian Federation	3 739 640 |	3 750 303	3 840 075	3 879 612	3 960 122 |	4 121 679	4 244 479	4 300 741
Serbia, Republic of	6 143	6 928	7 061	7 485	8 759	9 474	12 011	12 696
Slovak Republic	38 081	39 505	41 038	42 705	46 120	44 781	45 059	43 305
Slovenia	5 319	5 688	6 172	6 244	6 495	7 439	7 407	7 598
Spain	217 495	210 651	215 033	230 314	237 627	251 325	259 732	..
Sweden	63 054 |	63 060	63 252	62 197	64 108 |	63 700	66 874 |	65 367
Switzerland	28 402	29 330	30 131	29 805 |	29 549	29 101	29 637	..
Turkey	265 226	261 981	263 590	307 317	317 483	327 703	319 630	336 524
Ukraine	307 530	295 702	278 274 |	260 749	256 915	265 992	269 855	258 293
United Kingdom	184 244	163 486	159 185	171 268	174 818	173 332	178 411	..
United States	6 392 695 |	6 644 027	6 813 036 |	6 686 902	6 549 375	6 659 498	6 352 580 |	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata

at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Coastal shipping

National transport

Million tonne-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	102 577	104 462	105 404	105 244	110 380	107 830	..	..
Austria	x	x	x	x	x	x	x	x
Azerbaijan	5 062	4 632	4 124	2 937	3 002	4 418	4 576	3 351
Belarus	x	x	x	x	x	x	x	x
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	..	..	..	..	..	..	..	..
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	10 005 e	13 658 e	12 442 e
China	5 341 200	4 870 500	5 593 500	5 423 600	5 807 500	5 508 400	5 192 700	..
Croatia	222	211	205	217	212	208	195	197
Czech Republic	x	x	x	x	x	x	x	x
Denmark	..	..	..	..	..	..	..	..
Estonia	0	0	0	1	0	0	5	14
Finland	2 840	1 900	2 010	2 180	2 170	2 270	2 800	3 006
France	..	..	..	..	..	..	..	..
Georgia	..	..	..	..	..	..	..	..
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	x	x	x	x	x	x	x	x
Iceland	12	32	13	30	23	16	19	..
India	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	50 287 e	49 112 e	52 867 e	51 145 e	56 713 e	60 005 e	64 854 e	68 946 e
Japan	177 791	184 860	183 120	180 381	180 438	180 934	179 089	169 680
Kazakhstan	..	..	..	..	..	..	..	..
Korea	25 804	30 476	29 900	31 841	37 036	33 855	28 282	..
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	..	..	..	..	..	..	..	..
Luxembourg	x	x	x	x	x	x	x	x
Malta	..	..	..	..	..	..	..	..
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	x	x	x	x	x	x	x	x
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	..	..	..	..	..	..	..	..
North Macedonia	x	x	x	x	x	x	x	x
Norway	24 487	23 281	24 468	26 563	22 329	24 294	24 010	23 058
Poland	..	..	..	..	..	..	..	..
Portugal	..	..	..	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	12 138 |	12 133	13 126	14 956	12 944	16 596	28 334 |	20 981
Serbia, Republic of	x	x	x	x	x	x	x	x
Slovak Republic	x	x	x	x	x	x	x	x
Slovenia	..	..	..	..	..	..	..	..
Spain	41 761	40 773	41 848	44 536	47 488	49 698	50 293	55 716 p
Sweden	6 892	6 764	6 663	7 221 |	7 002	7 141	7 570	7 750
Switzerland	x	x	x	x	x	x	x	x
Turkey	17 158	19 725	18 553	19 189	19 492	22 087	21 779	20 520
Ukraine	1 702	..	..	..	..	..	..	..
United Kingdom	34 400	28 000	25 800	30 300	29 100	23 700	23 000	..
United States	229 349	239 158	251 801	256 376	250 690	256 955	253 451	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Rail container transport

Twenty-foot equivalent unit (TEU)

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	..	..	15 735	..	..	..	..	..
Australia	..	..	..	..	..	..	..	..
Austria	1 278 267	1 237 076 |	1 296 064	1 445 960	1 532 708	1 725 083	1 802 305	1 820 814
Azerbaijan	19 264	17 396	10 041	12 475	12 682	20 315	25 761	38 971
Belarus	..	..	..	..	333 484	524 020	635 886	732 906
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	53 272	63 725	35 419	37 807	46 527	35 580	36 261	39 090
Canada	3 559 595	3 686 321	3 897 973	4 071 322	4 170 821	4 534 111	4 654 397	4 184 417 p
Chile	..	..	..	..	..	..	..	..
China	..	..	..	..	..	..	..	..
Croatia	37 744	41 299	40 792	34 115	93 137	83 078	96 920	106 817
Czech Republic	1 157 228	1 274 125	1 336 973	1 476 907	1 548 782	1 492 392	1 803 175	1 791 675
Denmark	157 306	166 870	137 144	128 635	156 621	..	..	..
Estonia	48 863	62 014	72 019	42 995	53 947	40 058	52 432	76 755
Finland	43 105	42 211	41 137	33 434	33 552	40 987	56 136	50 332
France	..	..	..	..	..	..	..	..
Georgia	55 798	48 083	49 339	44 022	35 913	41 392	56 781	78 943
Germany	6 228 484	6 456 060	6 272 430	5 979 035	6 205 543	5 983 721 |	6 678 868 |	7 138 556
Greece	..	..	39 730	50 657	39 265	56 505	63 759	77 780
Hungary	386 746	519 480	448 166	651 093	736 798	721 233	707 524 e	401 290
Iceland	x	x	x	x	x	x	x	x
India	2 586 000	2 869 000	3 111 000	2 924 000	3 102 000	3 531 900	..	..
Ireland	13 776	14 784	15 330	14 910	15 876	17 009	15 537	8 532
Italy	752 433	767 503	789 217	710 969	730 452	811 785	2 466 147 |	2 587 850 p
Japan	..	..	..	..	..	..	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	..	..	..	..	..	..	..	..
Latvia	111 117	97 710	97 028	69 813	56 339	54 736	64 029	66 738
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	104 171	103 952	90 745	69 964	67 601	92 751	114 941	144 838
Luxembourg	35 000	47 000	65 000	84 000	56 629	63 010	70 234	74 283
Malta	x	x	x	x	x	x	x	x
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	1 463	2 015	1 883	365	1 080	807	625	665
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	1 539 810	1 300 000	1 406 000	1 441 000	1 600 000	1 377 000	1 686 000	1 653 000
New Zealand	..	..	..	..	..	..	..	..
North Macedonia	..	..	..	..	..	..	..	..
Norway	386 620	332 653	324 815	322 765	309 830	329 091	398 965	309 139
Poland	1 026 181	1 091 888	1 072 627	1 098 698	1 353 936	1 619 943	1 770 082	2 049 424
Portugal	191 895	183 583	262 337	367 905	416 171	441 818	451 396	..
Romania	91 465	61 474	54 995	99 737	95 561	102 468	102 879	100 777
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	..	..	..	..	..	..	..	..
Slovak Republic	526 643	593 281	636 652	621 315	618 227	610 941	679 871	692 990
Slovenia	395 945	390 507	398 621	458 449	477 693	509 652	537 298	533 919
Spain	..	..	..	..	..	..	..	..
Sweden	450 303	433 918	430 588	411 664	388 772	394 523	438 841 |	418 631
Switzerland	..	..	..	..	..	..	..	..
Turkey	707 989	814 981	891 605	713 504	789 761	856 856	990 992	1 081 740
Ukraine	262 455	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	..	..	..	..	..	..	..	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Maritime container transport

Twenty-foot equivalent unit (TEU)

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	87 909	109 054	99 350	104 060	118 828	118 270	134 526	145 762
Argentina	..	..	1 554 012	1 575 634	1 515 282	1 636 756	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	6 936 142 e	6 994 361 e	7 519 534 e	7 415 789 e	7 529 626 e	8 047 764 e	..	..
Austria	x	x	x	x	x	x	x	x
Azerbaijan	4 459	6 117	10 485	13 307	17 102	15 337	22 887	35 024
Belarus	x	x	x	x	x	x	x	x
Belgium	9 165 000	9 188 000	9 726 000	9 776 000	10 083 000	10 331 000	11 219 000	11 527 000
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	212 369	218 999	236 944	242 865	245 459	274 880	292 919	313 090
Canada	5 109 500	5 225 900	5 429 700	5 792 200	5 684 800	6 322 300	6 718 400	6 970 500 p
Chile	3 521 050	3 815 269	3 950 318	3 930 230	4 145 068	4 388 783	4 900 462	4 611 911
China	..	..	..	..	..	..	..	..
Croatia	144 041	130 236	138 278	181 912	208 133	245 559	264 445	331 303
Czech Republic	x	x	x	x	x	x	x	x
Denmark	763 000	747 000	743 000	750 000	764 000	..	..	..
Estonia	228 032	253 900	261 069	209 118	204 368	230 409	241 001	242 060
Finland	1 449 596	1 472 143	1 440 462	1 413 654	1 510 314	1 630 105	1 596 690	1 617 879
France	4 650 494	4 835 191	5 030 910	5 202 852	5 257 025	5 756 897	5 856 374	5 838 680
Georgia	357 654	403 447	446 972	379 816	329 805	394 787	453 938	647 816
Germany	15 325 000	15 552 000	15 905 000	15 181 000	15 205 000	15 129 000	15 130 000	15 061 029
Greece	3 220 371	3 620 126	3 928 785	3 744 380	4 131 533	4 512 982	5 300 026	6 093 956
Hungary	x	x	x	x	x	x	x	x
Iceland	..	..	..	..	..	..	..	..
India	7 714 000	7 453 000	7 960 000	8 148 000	8 442 000	9 139 000	..	..
Ireland	732 316	726 019	796 620	876 848	916 829	956 904	1 000 558	1 063 488
Italy	9 398 353	9 491 151	10 104 971	10 180 380	11 336 766	10 730 533	12 758 529	10 659 573
Japan	21 225 537	21 490 748	21 717 653	21 196 655	21 709 965	22 821 394	23 464 972	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	22 550 275	23 469 251	24 798 210	25 680 530	26 005 344	27 468 077	28 970 367	..
Latvia	366 824	385 665	391 218	359 756	388 484	450 071	474 451	470 075
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	381 371	402 733	450 183	350 393	441 664	474 209	749 067	705 222
Luxembourg	x	x	x	x	x	x	x	x
Malta	..	..	..	..	..	..	..	..
Mexico	4 878 097	4 875 281	5 058 635	5 506 488	5 680 483	6 371 628	6 987 387	7 105 882
Moldova, Republic of	x	x	x	x	x	x	x	x
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	12 133 471	11 818 300	12 621 088	12 543 230	12 727 674	14 047 511	14 865 101	15 574 369
New Zealand	2 414 660	2 503 739	2 672 032	2 777 811	2 869 420	3 120 030	3 176 020	3 238 319
North Macedonia	x	x	x	x	x	x	x	x
Norway	714 565	729 947	761 332	770 347	735 229	777 957	811 041	851 583
Poland	1 648 886	1 979 703	2 256 061	1 793 408	2 306 312	2 256 441	2 650 440	2 755 138
Portugal	1 994 327	2 418 743	2 706 975	2 752 614	2 919 806	3 167 199	3 189 352	2 913 478
Romania	675 414	659 375	663 271	689 489	706 157	692 032	667 986	664 695
Russian Federation	3 371 039	3 501 985	3 617 159	2 906 555	3 058 806	3 520 306	3 888 129	4 064 431
Serbia, Republic of	x	x	x	x	x	x	x	x
Slovak Republic	x	x	x	x	x	x	x	x
Slovenia	556 392	596 429	676 381	802 696	845 547	919 652	980 196	934 055
Spain	13 999 337	13 709 523	14 066 730	14 252 380	15 130 479	15 924 830	17 198 589	17 435 718 p
Sweden	1 150 775	1 147 065	1 155 418	1 115 992	1 157 348	1 180 740	1 219 998	1 237 228
Switzerland	x	x	x	x	x	x	x	x
Turkey	7 192 396	7 899 933	8 351 122	8 146 398	8 761 974	10 010 536	10 843 998	11 591 838
Ukraine	693 210	..	..	..	..	..	..	..
United Kingdom	8 013 000	8 273 000	9 540 000	9 799 000	10 230 000	10 259 000	10 324 000	..
United States	33 236 967	34 484 687	35 867 974	35 665 402	36 504 338	..	..	..

.. Not available; e Estimated value; p Provisional data; x Not applicable

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_GOODS_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Passenger transport by rail

Million passenger-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	16	12	8	7	3	2	3	2
Argentina	6 003	5 035	5 734	6 884	8 065	8 361	..	..
Armenia	53 e	55 e	52	44	50	55	..	..
Australia	15 569	15 544	15 571	16 017	16 504	17 039	17 586	..
Austria	11 323	11 915	12 092	12 208	12 578	12 657	13 205	13 350
Azerbaijan	591	609	612	495	448	467	466	544
Belarus	8 977	8 998	7 796	7 117	6 428	6 295	6 215	6 274
Belgium	10 857	10 595	10 974 e	10 333 |	10 025 e	10 167 e	..	..
Bosnia-Herzegovina	54	40	35	34	24	30	40	56
Bulgaria	1 876	1 826	1 702	1 552	1 458	1 438	1 479	1 524
Canada	1 376	1 365	1 327	1 422	1 482	1 601	1 685 p	..
Chile	934	862	663	584	583	596	677	721 p
China	981 233	1 059 560	1 124 190	1 196 060	1 257 930	1 345 690	1 414 660	..
Croatia	1 104	948	927	951	836	745	756	734
Czech Republic	7 265	7 601	7 797	8 298	8 843	9 498	10 286	10 931
Denmark	7 020	7 076	6 808	6 808	6 653	6 623	6 560	..
Estonia	236	225	282	289	316	367	417	392
Finland	4 035	4 053	3 874	4 113 |	3 868	4 271	4 534	4 924
France	105 956	105 215	104 589	104 849	104 207	110 469	107 920	112 614
Georgia	625	585	550	465	545	597	634	675
Germany	88 796	89 615	90 976	91 603	94 197	95 530	98 161 p	100 015
Greece	832 e	755 e	1 072	1 263	1 192	1 109	1 104	1 252
Hungary	7 806	7 843	7 738	7 609	7 653	7 731	7 770	7 752
Iceland	x	x	x	x	x	x	x	x
India	1 098 103	1 140 412	1 147 190	1 143 039	1 149 835	1 161 333 e	..	..
Ireland	1 578	1 592	1 863	1 917	1 990	2 121	2 281	2 399
Italy	46 759	48 739	49 957	52 207	52 178 |	53 231	55 493 p	56 586 p
Japan	404 396	414 387	413 970	427 486	431 799	437 363	441 614	446 711
Kazakhstan	..	20 625	23 750	20 345	17 322	17 961	18 509	..
Korea	70 079	66 353	67 860	68 371	86 871	89 964	92 285	93 887
Latvia	725	729	649	591	584	596	624	643
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	403	391	373	361	396	424	468	479
Luxembourg	373	394	409	418	418	438	442	463
Malta	x	x	x	x	x	x	x	x
Mexico	970	1 036	1 150	1 411	1 481	1 550	1 591	1 571
Moldova, Republic of	347	330	257	181	122	99	95	74
Montenegro, Republic of	62	73	76	81	84	60	..	..
Morocco	5 114	5 397	5 449	5 507	5 208	4 923	..	..
Netherlands	16 100	17 700	16 200	15 800	16 900	17 800	22 600	..
New Zealand	..	..	..	..	..	..	..	..
North Macedonia	99	80	80	178	83	59	64	62
Norway	3 092	3 260	3 440	3 555	3 695	3 584	3 722	3 715
Poland	17 826	16 797	16 015	17 367	19 175	20 319	21 043	22 056
Portugal	3 803	3 649	3 852	3 957	4 146	4 391	4 487	4 964
Romania	4 571	4 411	4 976	5 149	4 988	5 663	5 577	5 906
Russian Federation	144 612	138 517	130 027	120 644	124 620	123 096	129 542	133 589
Serbia, Republic of	540	612	453	509	438	377	347	285
Slovak Republic	2 459	2 485	2 583	3 411	3 595	3 873	3 915	4 093
Slovenia	742	760	697	709	680	650	656	698
Spain	22 476	23 788	25 072	26 142	26 670	27 487	28 434	27 263
Sweden	11 792	11 842	12 121	12 650	12 800	13 331	13 547	14 617
Switzerland	19 262	19 447	20 010	20 389	20 812	20 865	20 613	21 737
Turkey	6 361	6 225	7 401	8 326	7 829	8 465	8 938	14 259
Ukraine	49 329	48 981	35 865 |	35 367	36 839	28 075	28 685	28 413
United Kingdom	69 686	71 092	74 262	76 788	78 696	80 261	80 526	..
United States	34 126	36 047	36 393	36 044	35 892	33 256	31 963	32 483

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_PASSENGER_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Passenger transport by passenger car

Million passenger-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	6 654	7 587	..	..	..	..	..	..
Argentina	23 500	24 558	25 437	27 693	30 017	32 407	..	..
Armenia	2 450	2 457	2 537	2 396	2 437	2 403	..	..
Australia	267 183	269 623	273 498	278 752	285 559	290 380	291 368	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	1 095	1 217	1 296	1 370	1 413	1 455	1 494	1 550
Belarus	133	208	189	185	180	181	251	347
Belgium	110 141	105 360	108 190	107 070	105 967	106 940	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	..	..	..	..	..	..	..	..
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	..	49 664 e	..
China	..	..	..	..	..	..	..	..
Croatia	..	..	..	..	..	..	..	..
Czech Republic	64 260 e	64 650 e	66 260 e	69 705 e	72 255 e	74 327 e	77 971 e	81 179 e
Denmark	60 190	60 854	60 195	60 862	60 071	..	..	..
Estonia	..	..	..	..	..	..	..	..
Finland	65 270	65 115	65 520	66 295	57 007 |	66 600 |	66 800	66 800
France	780 865 |	776 643	781 027	786 867	795 367	801 452	801 206	798 682
Georgia	..	..	..	..	..	..	..	..
Germany	896 300	903 100	916 400	927 000	946 300	920 900 |	920 200 p	..
Greece	..	..	..	..	..	..	..	..
Hungary	51 793	51 823	52 722 e	54 603 e	57 354 e	60 645 e	63 947 e	67 034 e
Iceland	4 832 e	4 971 e	5 226 e	5 578 e	6 468	7 082	7 347	..
India	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	578 668	620 368	642 920	676 350	704 542 e	744 919 e	722 894	745 628 p
Japan	816 489	815 224	803 743	808 492	821 360	835 152	847 820	844 042
Kazakhstan	..	..	..	..	..	..	..	..
Korea	248 362	250 425	258 220	268 784	271 271	278 597	286 014	..
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	34 191	33 325	24 366	24 865	25 854	31 361	30 119	..
Luxembourg	..	..	..	..	..	..	..	..
Malta	..	..	1 607 p	1 615 p	1 623 p	1 631 p	..	..
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	..	..	..	..	..	..	..	..
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	139 600	145 400	145 000	139 500	140 800	138 700	144 700 |	..
New Zealand	3 072 e	3 101 e	3 157 e	3 259 e	3 393 e	3 480 e	3 545 e	3 545 p
North Macedonia	5 116 e	5 964 e	6 769 e	6 987 e	7 192 e	9 168	9 452	9 703
Norway	58 701	59 407	61 288	62 391	62 630	63 828	64 014	64 192
Poland	189 324 e	193 336 e	197 032 e	200 570 e	213 318 e	221 545 e	233 842 e	244 480 e
Portugal	..	..	..	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	338	337	263	351	450	499	387	..
Serbia, Republic of	..	..	..	..	..	..	..	..
Slovak Republic	26 935 e	27 155 e	27 251 e	27 531 e	27 836 e	28 125 e	28 460 e	28 616 e
Slovenia	..	..	..	..	..	..	..	..
Spain	321 045	316 539	308 704 |	317 553	329 880	332 858	340 556	..
Sweden	108 378	108 252	110 374	111 953	114 566	116 118	116 000	114 541
Switzerland	88 150	89 467	90 704	91 995	93 970	95 742	96 897	97 852
Turkey	..	..	..	..	..	..	..	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	647 332	641 845	654 335	655 127	665 500	669 843	672 713	..
United States	5 617 316	5 645 133	5 635 924	5 839 310	5 954 242	5 970 536	..	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_PASSENGER_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Passenger transport by bus and coach

Million passenger-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	983 e	1 063 e	..	..	..	..	..	..
Argentina	20 554	18 362	17 924	16 845	16 822	16 377	..	..
Armenia	..	..	..	..	..	..	..	..
Australia	20 413	20 775	21 168	21 301	21 633	22 094	22 533	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	18 939	20 663	21 696	22 455	23 016	23 431	23 782	24 400
Belarus	12 261	12 720	11 900	11 249	11 839	12 155	12 398	12 638
Belgium	17 905	16 170	15 790	15 170	13 533	..	..	..
Bosnia-Herzegovina	1 926	1 750	1 660	1 690	1 706	1 661	..	..
Bulgaria	9 233	8 916	10 145	10 231	9 757	9 179	8 588	9 175
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	..	..	1 099 680	1 074 270	1 022 870	976 520	927 970	..
Croatia	3 249	3 507	3 648	3 377 |	3 802	4 150	3 843	4 022
Czech Republic	9 015	9 026	10 010	9 996	10 257	11 178	10 950	10 547
Denmark	6 849	6 697	6 831	6 682	6 473	..	..	..
Estonia	2 490	2 619	2 569	3 315	2 995 |	2 929	2 924	3 240
Finland	7 540	7 540	7 540	7 540	8 255 |	8 200 |	8 000	7 900
France	55 421 |	56 008	57 505	58 374	59 646	60 150	60 738	60 685
Georgia	..	..	..	..	..	..	..	..
Germany	76 019	77 146	78 790	81 771	81 455	79 730	80 102 p	..
Greece	..	..	..	..	..	..	..	..
Hungary	16 868	16 965	17 441	17 618	17 623	18 100	18 660	18 722
Iceland	622 e	640 e	673 e	718 e	833	912	946	..
India	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	101 512	101 770	102 806	102 640	103 099	103 174 e	103 390	103 570 p
Japan	75 668	74 571	72 579	71 443	70 119	69 815	70 101	65 556
Kazakhstan	..	..	..	..	..	..	..	..
Korea	106 838	109 503	110 296	109 260	102 648	103 257	101 254	..
Latvia	2 358	2 325	2 345	2 232	2 187	2 146	2 156	2 191
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	2 387	2 521	2 672	2 457	2 361	2 474	2 583	2 646
Luxembourg	..	..	..	..	..	..	..	..
Malta	..	..	332 p	339 p	345 p	351 p	..	..
Mexico	480 690	484 776	494 128	508 498	518 368	528 694	538 603	535 699
Moldova, Republic of	2 835	3 004	2 720	2 834	3 006	3 132	3 375	3 512
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	24	24	25	26	27	29	31	32 p
North Macedonia	1 994	1 980	2 474	2 276	2 069	2 331	2 246	2 028
Norway	5 791	5 844	5 966	6 351	6 693	6 534 e	6 751 e	7 150 e
Poland	39 419 e	37 781 e	39 158 e	37 580 e	36 774 e	36 065 e	34 544 e	36 236 e
Portugal	5 850	6 023	5 657	6 575 |	7 612	7 415	7 926	..
Romania	12 584	12 923	14 061	17 471	18 744	18 177	19 937	20 553
Russian Federation	132 968	126 042	127 090	126 271	123 977	122 943	122 152	121 942
Serbia, Republic of	4 640	4 612	4 223	4 601	4 282	4 255	4 950	4 662
Slovak Republic	5 300	5 166	5 281	5 268	5 829	5 925	6 239	6 187
Slovenia	..	..	..	..	..	..	..	..
Spain	54 531	53 836	39 469	46 389	47 763	30 510	32 188	..
Sweden	10 101	10 316	10 290	10 439	10 507	10 647	10 730	10 865
Switzerland	6 837	6 895	7 016	7 163	7 306	7 363	7 435	..
Turkey	..	..	..	..	..	..	..	..
Ukraine	62 583	60 765	53 294 |	44 919	44 447	45 450	44 291	43 016
United Kingdom	42 226	40 382	39 618	39 367	34 364	37 979	35 267	..
United States	504 300	517 466	545 852	553 732	557 814	587 765	..	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_PASSENGER_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total passenger transport by road

Million passenger-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	7 637 e	8 650 e	..	..	..	..	..	..
Argentina	44 054	42 921	43 361	44 538	46 839	48 784	..	..
Armenia	2 450	2 457	2 537	2 396	2 437	2 403	..	..
Australia	287 595	290 398	294 665	300 053	307 192	312 475	313 901	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	20 034	21 880	22 992	23 825	24 429	24 886	25 276	25 950
Belarus	12 394	12 928	12 089	11 434	12 019	12 336	12 649	12 985
Belgium	128 046	121 530	123 980	122 240	119 500	..	..	..
Bosnia-Herzegovina	1 926	1 750	1 660	1 690	1 706	1 661	..	..
Bulgaria	9 233	8 916	10 145	10 231	9 757	9 179	8 588	9 175
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	1 846 755	1 125 090 |	1 099 680	1 074 270	1 022 870	976 520	927 970	..
Croatia	3 249	3 507	3 648	3 377 |	3 802	4 150	3 843	4 022
Czech Republic	73 275	73 676	76 270	79 701	82 512	85 505	88 921	91 726
Denmark	67 039	67 551	67 027	67 544	66 544	..	..	..
Estonia	2 490	2 619	2 569	3 315	2 995 |	2 929	2 924	3 240
Finland	72 810	72 655	73 060	73 835	65 262 |	74 800 |	74 800	74 700
France	836 286 |	832 651	838 532	845 241	855 013	861 602	861 944	859 367
Georgia	6 219	6 393	6 572	6 756	6 945	7 140	7 340	7 545
Germany	972 319	980 246	995 190	1 008 771	1 027 755	1 000 630 p	1 000 302 p	..
Greece	..	..	..	..	..	..	..	..
Hungary	68 661	68 788	70 163 e	72 221 e	74 977 e	78 745 e	82 607 e	85 756 e
Iceland	5 454 e	5 611 e	5 899 e	6 296 e	7 301	7 994	8 293	..
India	10 393 000	11 756 000	13 403 000	15 415 000	17 496 000 e	19 718 000 e	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	680 180	722 138	745 726	778 990	807 641	848 093	826 284	849 198 p
Japan	892 157	889 795	876 322	879 935	891 479	904 967	917 921	909 598
Kazakhstan	..	..	..	..	..	..	..	..
Korea	355 200	359 928	368 516	378 044	373 919	381 854	387 268	..
Latvia	2 358	2 325	2 345	2 232	2 187	2 146	2 156	2 191
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	36 578	35 846	27 038	27 322	28 215	33 835	32 702	..
Luxembourg	..	..	..	..	..	..	..	..
Malta	..	..	1 940 p	1 954 p	1 968 p	1 982 p	..	..
Mexico	480 690	484 776	494 128	508 498	518 368	528 694	538 603	535 699
Moldova, Republic of	2 835	3 004	2 720	2 834	3 006	3 132	3 375	3 512
Montenegro, Republic of	111	109	108	110	114	114	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	139 600	145 400	145 000	139 500	140 800	138 700	144 700 |	..
New Zealand	3 096 e	3 126 e	3 183 e	3 285 e	3 420 e	3 509 e	3 576 e	3 578 p
North Macedonia	7 110 e	7 944 e	9 243 e	9 263 e	9 261 e	11 499	11 698	11 731
Norway	64 492	65 251	67 254	68 742	69 323	70 362 e	70 765 e	71 342 e
Poland	228 743 e	231 117 e	236 190 e	238 150 e	250 092 e	257 610 e	268 386 e	280 716 e
Portugal	..	..	..	..	..	..	..	..
Romania	12 584	12 923	14 061	17 471	18 744	18 177	19 937	20 553
Russian Federation	133 306	126 379	127 353	126 622	124 427	123 442	122 539	121 942
Serbia, Republic of	..	..	..	..	..	..	..	..
Slovak Republic	32 235	32 321	32 532	32 799	33 665	34 050	34 699	34 803
Slovenia	..	..	..	..	..	..	..	..
Spain	375 576	370 375	348 173 |	363 942	377 643	363 368	372 744	..
Sweden	118 479	118 568	120 664	122 392	125 073	126 765	126 730	125 406
Switzerland	94 988	96 362	97 720	99 158	101 276	103 104	104 331	..
Turkey	258 874	268 178	276 073	290 734	300 852	314 734	329 363	339 601
Ukraine	62 583	60 765	53 294 |	44 919	44 447	45 450	44 291	43 016
United Kingdom	689 558	682 227	693 953	694 493	699 865	707 822	707 980	..
United States	6 121 616	6 162 599	6 181 776	6 393 042	6 512 056	6 558 301	..	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_PASSENGER_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total inland passenger transport

Million passenger-kilometres

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	7 653	8 662	..	..	..	..	..	..
Argentina	50 057	47 956	49 095	51 422	54 904	57 145	..	..
Armenia	2 503 e	2 512 e	2 589 e	2 440	2 598	2 666	..	..
Australia	303 164	305 942	310 236	316 070	323 696	329 514	331 487	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	20 625	22 489	23 604	24 320	24 877	25 353	25 742	26 494
Belarus	21 371	21 926	19 885	18 551	18 447	18 631	18 864	19 259
Belgium	..	132 125	134 954 e	132 573 |	129 667	..	..	..
Bosnia-Herzegovina	1 980	1 790	1 695	1 724	1 730	1 691	..	..
Bulgaria	11 109	10 742	11 847	11 783	11 215	10 617	10 067	10 699
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	2 827 988	2 184 650 |	2 223 870	2 270 330	2 280 800	2 322 210	2 342 630	..
Croatia	4 353	4 455	4 575	4 328 |	4 638	4 895	4 599	4 756
Czech Republic	80 540	81 277	84 067	87 999	91 355	95 002	99 207	102 657
Denmark	74 059	74 627	73 835	74 352	73 197	..	..	..
Estonia	2 726	2 844	2 851	3 604	3 311 |	3 296	3 341	3 632
Finland	76 845	76 708	76 934	77 948	69 130 |	79 071 |	79 334	79 624
France	942 242 |	937 866	943 121	950 090	959 220	972 071	969 864	971 981
Georgia	6 844	6 978	7 122	7 221	7 490	7 736	7 973	8 220
Germany	1 061 115	1 069 861	1 086 166	1 100 374	1 121 952	1 096 160 p	1 098 463 p	..
Greece	..	..	..	..	..	..	..	..
Hungary	76 467	76 631	77 901 e	79 830 e	82 630 e	86 476 e	90 376 e	93 508 e
Iceland	5 454 e	5 611 e	5 899 e	6 296 e	7 301	7 984	8 293	..
India	11 491 103	12 896 412	14 550 190	16 558 039	18 645 835 e	20 879 333 e	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	726 939	770 877	795 683	831 197	859 819 |	901 324	881 777	905 784
Japan	1 296 553	1 304 182	1 290 292	1 307 421	1 323 278	1 342 330	1 359 535	1 356 309
Kazakhstan	..	..	..	..	..	..	..	..
Korea	425 279	426 281	436 376	446 415	460 790	471 818	479 553	..
Latvia	3 083	3 054	2 994	2 823	2 771	2 742	2 780	2 834
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	36 981	36 237	27 411	27 683	28 611	34 259	33 170	..
Luxembourg	..	..	..	..	..	..	..	..
Malta	..	..	1 940 p	1 954 p	1 968 p	1 982 p	..	..
Mexico	481 660	485 812	495 278	509 909	519 849	530 244	540 194	537 270
Moldova, Republic of	3 182	3 334	2 977	3 015	3 128	3 231	3 469	3 586
Montenegro, Republic of	173	182	184	191	198	174	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	155 700	163 100	161 200	155 300	157 700	156 500	167 300 |	..
New Zealand	3 096 e	3 126 e	3 183 e	3 285 e	3 420 e	3 509 e	3 576 e	3 578 p
North Macedonia	7 209 e	8 024 e	9 323 e	9 441 e	9 344 e	11 558	11 762	11 793
Norway	67 584	68 511	70 694	72 297	73 018	73 946 e	74 487 e	75 057 e
Poland	246 569 e	247 914 e	252 205 e	255 517 e	269 267 e	277 929 e	289 429 e	302 772 e
Portugal	..	..	..	..	..	..	..	..
Romania	17 155	17 334	19 037	22 620	23 732	23 840	25 514	26 459
Russian Federation	277 918	264 896	257 380	247 266	249 047	246 538	252 081	255 531
Serbia, Republic of	..	..	..	..	..	..	..	..
Slovak Republic	34 694	34 806	35 115	36 210	37 260	37 923	38 614	38 896
Slovenia	..	..	..	..	..	..	..	..
Spain	398 052	394 163	373 245 |	390 084	404 313	390 855	401 178	..
Sweden	130 271	130 410	132 785	135 042	137 873	140 096	140 277	140 023
Switzerland	114 250	115 809	117 730	119 547	122 088	123 969	124 921	..
Turkey	265 235	274 403	283 474	299 060	308 681	323 199	338 301	353 860
Ukraine	111 912	109 746	89 159 |	80 286	81 286	73 525	72 976	71 429
United Kingdom	759 244	753 318	768 215	771 281	778 560	788 082	788 507	..
United States	6 155 742	6 198 646	6 218 169	6 429 086	6 547 948	6 591 557	..	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_PASSENGER_TRANSPORT&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic injury accidents

Number of accidents

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	1 870	2 075	1 914	1 992	2 033	1 978	1 718	1 498
Argentina	116 988	161 920	129 076	..	..	102 623 p	..	..
Armenia	2 602 e	2 824 e	3 156	3 399	3 203	3 535	..	..
Australia	..	..	..	..	..	..	..	..
Austria	40 831 |	38 502	37 957	37 960	38 466	37 402	36 846	35 736
Azerbaijan	2 892	2 846	2 635	2 220	2 006	1 833	1 817	1 870
Belarus	5 187	4 730	4 550	4 151	3 654	3 418	3 399	3 567
Belgium	44 259	41 347	41 474	40 300	40 123	38 025	38 455	37 699
Bosnia-Herzegovina	34 884	35 725	36 225	38 659	39 543	37 628	36 672	..
Bulgaria	6 717	7 015	7 018	7 225	7 404	6 888	6 684	6 730
Canada	124 682	122 143	116 293	119 541	118 271	114 408	110 114 p	..
Chile	34 591	39 301	38 476	38 734	42 285	41 743	39 194	39 246 |
China	204 196	198 394	196 812	187 781	212 846	203 049	244 937	..
Croatia	11 773	11 225	10 607	11 038	10 779	10 939	10 450	9 695
Czech Republic	20 504	20 342	21 054	21 561	21 386	21 263	21 889	20 806
Denmark	3 124	2 984	2 880	2 853	2 882	2 789	2 964	2 808
Estonia	1 383	1 364	1 413	1 376	1 468	1 406	1 469	1 406
Finland	5 725	5 334	5 324	5 185	4 752	4 432	4 312	3 984 p
France	60 437	56 812	58 191	56 603	57 522	58 613	55 766	56 016
Georgia	5 359	5 510	5 992	6 432	6 939	6 079	6 452	5 839
Germany	299 637	291 105	302 435	305 659	308 145	302 656	308 721	300 143
Greece	12 398	12 109	11 690	11 440	11 318	10 848	10 737	10 745 p
Hungary	15 174	15 691	15 847	16 331	16 627	16 489	16 951	16 627
Iceland	742	822	808	912	986	952	868	770
India	490 383	486 476	489 400	501 423	480 652	464 910	..	..
Ireland	5 610	4 976	5 796	5 831	5 877	6 019	6 119	5 862
Italy	188 228	181 660	177 031	174 539	175 791	174 933	172 344	172 183
Japan	665 157	629 033	573 842	536 899	499 201	472 165	430 601	381 237
Kazakhstan	..	..	..	..	..	..	..	..
Korea	223 656	215 354	223 552	232 035	220 917	216 335	217 148	229 600
Latvia	3 358	3 489	3 728	3 692	3 792	3 874	3 973	3 724
Liechtenstein	403	468	465	445	434	436	478	..
Lithuania	3 391	3 391	3 225	3 033	3 201	3 055	2 926	3 289
Luxembourg	1 019	949	908	983	941	955	947	..
Malta	14 546	14 070	14 473	15 504	15 017	15 003	..	..
Mexico	12 888	21 636	17 909	16 994	12 553	11 873	..	..
Moldova, Republic of	2 713	2 605	2 536	2 559	2 479	2 641	2 613	2 572
Montenegro, Republic of	1 217 |	1 266	1 334	1 554	1 698	1 831	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	4 968	9 522	13 358	18 523	18 749	18 706	..	..
New Zealand	9 678	9 453	8 922	9 782	10 185	11 245	11 689	11 737 p
North Macedonia	4 108	4 230	3 852	3 854	3 902	4 019	3 740	3 233
Norway	6 154	5 241	4 972	4 563	4 374	4 086	3 898	3 579
Poland	37 062	35 847	34 970	32 967	33 664	32 760	31 674	30 288
Portugal	29 867	30 339	30 604	31 953	32 299	34 416	34 235	..
Romania	26 928	24 827	25 355	28 944	30 751	31 106	30 202	31 146
Russian Federation	203 597	204 068	199 723	184 000	173 694	169 432	168 099	164 358
Serbia, Republic of	13 333	13 522	13 043	13 638	14 382	14 691	14 142	14 134
Slovak Republic	5 370	5 113	5 391	5 502	5 602	5 638	5 689	5 410
Slovenia	6 864	6 542	6 264	6 585	6 495	6 185	6 014	6 025
Spain	83 115	89 519	91 570	97 756	102 362	102 233	102 299	..
Sweden	16 458	14 815	12 926	14 672	14 051	14 849	14 233	13 684
Switzerland	18 148	17 473	17 803	17 736	17 577	17 799	18 033	17 761
Turkey	153 552	161 306	168 512	183 011	185 128	182 669	186 832	174 896
Ukraine	30 699	30 681	25 854 |	25 493	26 782	27 220	..	..
United Kingdom	151 346	144 426	152 407	146 203	142 846	136 063	128 207 p	..
United States	1 634 000 e	1 621 000 e	1 648 000 e	1 747 000 e	2 151 000 |	1 923 000 e	..	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata
at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_ROAD_ACCIDENTS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic casualties (injuries plus fatalities)

Number

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	2 569	2 798	2 617	2 692	2 779	2 611	2 291	2 044
Argentina	122 062	118 925	85 984	..	..	118 593 p	..	..
Armenia	4 050 e	4 310 e	4 776	5 084	4 718	5 458	..	..
Australia	35 391	36 246	36 703	38 286	40 238	..	..	..
Austria	51 426 |	48 499	48 100	47 845	48 825	47 672	46 934	..
Azerbaijan	4 165	4 112	3 800	3 159	2 762	2 469	2 433	2 523
Belarus	6 608	5 927	5 611	5 088	4 511	4 209	4 229	4 323
Belgium	57 146	53 876	53 982	52 593	51 928	49 081	49 354	47 793
Bosnia-Herzegovina	9 478	10 052	10 364	10 205	11 509	10 527	10 680	..
Bulgaria	8 794	9 376	9 299	9 679	10 082	9 362	9 077	9 127
Canada	168 802	166 476	158 399	162 950	160 690	154 628	154 769 p	..
Chile	54 746	61 209	59 505	59 588	65 227	63 644	59 442	59 462 |
China	284 324	272 263	270 405	257 902	289 523	273 426	321 726	..
Croatia	16 403	15 642	14 530	15 372	14 903	14 939	14 306	13 182
Czech Republic	26 257	25 942	27 046	27 704	27 692	27 656	28 336	26 663
Denmark	3 778	3 585	3 375	3 334	3 439	3 318	3 458	3 275
Estonia	1 794	1 761	1 790	1 792	1 917	1 773	1 899	1 785
Finland	7 343	6 939	6 934	6 678	6 169	5 812	5 542	5 205 p
France	79 504	73 875	76 432	74 263	76 122	76 832	73 135	73 734
Georgia	8 339	8 559	9 047	9 789	10 532	8 978	9 506	8 402
Germany	387 978	377 481	392 912	396 891	399 872	393 492	399 293	387 276
Greece	16 628	16 054	15 359	14 889	14 649	14 002	13 849	13 532 p
Hungary	19 584	20 681	20 750	21 543	21 936	22 076	22 632	22 198
Iceland	1 044	1 232	1 172	1 324	1 429	1 387	1 289	1 136
India	647 925	632 465	633 145	646 412	645 409	618 888	..	..
Ireland	8 105	7 068	8 271	8 002	7 955	7 937	8 150 p	..
Italy	270 617	261 494	254 528	250 348	252 458	250 128	245 946	244 557
Japan	829 830	785 880	715 487	670 140	622 757	584 544	529 378	464 990
Kazakhstan	..	..	..	..	..	..	..	..
Korea	349 957	333 803	342 259	355 021	336 012	327 014	326 818	345 061
Latvia	4 356	4 517	4 815	4 754	4 806	4 954	4 946	4 688
Liechtenstein	109	113	101	113	105	89	121	..
Lithuania	4 253	4 263	4 014	3 836	3 941	3 752	3 563	4 092
Luxembourg	1 412	1 297	1 261	1 384	1 235	1 307	1 254	..
Malta	1 599	1 582	1 796	1 711	1 852	1 873	..	..
Mexico	29 275	24 542	21 182	18 960	14 534	11 824	..	..
Moldova, Republic of	3 951	3 521	3 404	3 334	3 239	3 293	3 396	3 275
Montenegro, Republic of	1 768	1 886	1 900	2 224	2 423	2 711	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	12 528	12 187	11 595	12 665	13 106	14 417	15 073	15 079 p
North Macedonia	6 281	6 682	6 186	6 061	6 136	6 379	5 993	5 296
Norway	8 340	7 029	6 438	5 804	5 674	5 368	5 049	4 466
Poland	49 369	47 416	45 747	42 716	43 792	42 297	40 221	38 386
Portugal	38 823	39 390	39 653	41 549	41 668	44 495	44 005	..
Romania	36 251	33 325	34 152	38 790	41 475	42 162	40 576	41 533
Russian Federation	286 609	285 462	278 751	254 311	241 448	234 462	233 067	227 858
Serbia, Republic of	19 090	19 118	18 529	19 909	21 212	21 717	21 198	20 725
Slovak Republic	6 790	6 562	6 912	7 059	7 216	7 160	7 175	6 835
Slovenia	9 278	8 867	8 328	8 830	8 586	8 005	7 779	7 673
Spain	117 793	126 400	128 320	136 144	142 200	140 992	140 415	..
Sweden	23 110	20 522	17 795	19 902	18 933	19 914	18 825	17 940
Switzerland	22 557	21 648	21 764	21 791	21 608	21 643	22 064	21 467
Turkey	271 829	278 514	288 583	311 951 |	311 112	307 810	313 746	288 707
Ukraine	42 650	42 354	36 448 |	35 603	37 023	38 109	..	..
United Kingdom	204 733	192 693	203 865	195 926	190 975	180 177	169 098 p	..
United States	2 396 000 e	2 346 000 e	2 371 000 e	2 478 000 e	3 098 000 |	2 783 000 e	2 747 000 e	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_ROAD_ACCIDENTS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic injuries

Number

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	2 235	2 503	2 353	2 422	2 510	2 389	2 078	1 817
Argentina	116 988	113 716	80 705	..	..	113 173 p	..	..
Armenia	3 739 e	3 994 e	4 479	4 738	4 451	5 179	..	..
Australia	34 091	35 059	35 552	37 082	38 945	..	..	..
Austria	50 895 |	48 044	47 670	47 366	48 393	47 258	46 525	..
Azerbaijan	2 997	2 948	2 676	2 265	2 003	1 719	1 711	1 702
Belarus	5 569	5 033	4 854	4 424	3 923	3 620	3 680	3 818
Belgium	56 319	53 112	53 237	51 831	51 258	48 472	48 750	47 147
Bosnia-Herzegovina	9 175	9 718	10 067	9 864	11 188	10 229	10 403	..
Bulgaria	8 193	8 775	8 639	8 971	9 374	8 680	8 466	8 499
Canada	166 727	164 525	156 558	161 061	158 791	152 772	152 847 p	..
Chile	52 767	59 106	57 389	57 452	63 050	61 719	57 487	57 489
China	224 327	213 724	211 882	199 880	226 430	209 654	258 532	..
Croatia	16 010	15 274	14 222	15 024	14 596	14 608	13 989	12 885
Czech Republic	25 515	25 288	26 358	26 966	27 081	27 079	27 680	26 045
Denmark	3 611	3 394	3 193	3 156	3 228	3 143	3 287	3 076
Estonia	1 707	1 680	1 712	1 725	1 846	1 725	1 832	1 733
Finland	7 088	6 681	6 705	6 408	5 911	5 574	5 303	4 994 p
France	75 851	70 607	73 048	70 802	72 645	73 384	69 887	70 490
Georgia	7 734	8 045	8 536	9 187	9 951	8 461	9 047	7 921
Germany	384 378	374 142	389 535	393 432	396 666	390 312	396 018	384 230
Greece	15 640	15 175	14 564	14 096	13 825	13 271	13 149	12 836 p
Hungary	18 979	20 090	20 124	20 899	21 329	21 451	21 999	21 596
Iceland	1 035	1 217	1 168	1 308	1 411	1 371	1 271	1 130
India	509 667	494 893	493 474	500 279	494 624	470 975	..	..
Ireland	7 942	6 880	8 079	7 840	7 773	7 782	8 011 p	..
Italy	266 864	258 093	251 147	246 920	249 175	246 750	242 621	241 384
Japan	824 569	780 715	710 650	665 255	618 059	580 113	525 212	461 070
Kazakhstan	..	..	..	..	..	..	..	..
Korea	344 565	328 711	337 497	350 400	331 720	322 829	323 037	341 712
Latvia	4 179	4 338	4 603	4 566	4 648	4 818	4 795	4 553
Liechtenstein	108	111	98	111	105	87	121	..
Lithuania	3 951	4 007	3 747	3 594	3 749	3 561	3 390	3 908
Luxembourg	1 378	1 252	1 226	1 348	1 203	1 272	1 218	..
Malta	1 590	1 564	1 786	1 700	1 829	1 854	..	..
Mexico	24 736	20 693	17 408	15 470	11 163	8 905	..	..
Moldova, Republic of	3 510	3 220	3 080	3 036	2 928	2 991	3 122	3 001
Montenegro, Republic of	1 722	1 812	1 835	2 173	2 358	2 648	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	12 220	11 934	11 303	12 348	12 779	14 039	14 695	14 727 p
North Macedonia	6 149	6 484	6 056	5 913	5 971	6 224	5 860	5 164
Norway	8 195	6 842	6 291	5 687	5 539	5 262	4 941	4 358
Poland	45 792	44 059	42 545	39 778	40 766	39 466	37 359	35 477
Portugal	38 105	38 753	39 015	40 956	41 105	43 893	43 330	45 361 p
Romania	34 209	31 464	32 334	36 897	39 562	40 211	38 709	39 669
Russian Federation	258 618	258 437	251 793	231 197	221 140	215 374	214 853	210 877
Serbia, Republic of	18 406	18 472	17 993	19 308	20 606	21 139	20 656	20 194
Slovak Republic	6 438	6 311	6 617	6 749	6 941	6 884	6 915	6 565
Slovenia	9 148	8 742	8 220	8 710	8 456	7 901	7 688	7 571
Spain	115 890	124 720	126 632	134 455	140 390	139 162	138 609	..
Sweden	22 825	20 262	17 525	19 643	18 663	19 662	18 501	17 719
Switzerland	22 218	21 379	21 521	21 538	21 392	21 413	21 831	21 280
Turkey	268 079	274 829	285 059	304 421	303 812	300 383	307 071	283 234
Ukraine	37 519	37 521	32 009 |	31 600	33 613	34 677	..	..
United Kingdom	202 931	190 923	202 011	194 122	189 115	178 321	167 261 p	..
United States	2 362 000 e	2 313 000 e	2 338 000 e	2 443 000 e	3 061 000 |	2 746 000 e	2 710 000 e	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_ROAD_ACCIDENTS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic fatalities

Number

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	334	295	264	270	269	222	213	227
Argentina	5 074	5 209	5 279	..	5 582	5 420 p	..	..
Armenia	311 e	316 e	297	346	267	279	..	..
Australia	1 300	1 187	1 151	1 204	1 293	1 223	1 137	1 195 p
Austria	531 |	455	430	479	432	414	409	416
Azerbaijan	1 168	1 164	1 124	894	759	750	722	821
Belarus	1 039	894	757	664	588	589	549	505
Belgium	827	764	745	762	670	609	604	646
Bosnia-Herzegovina	303	334	297	341	321	298	277	..
Bulgaria	601	601	660	708	708	682	611	628
Canada	2 075	1 951	1 841	1 889	1 899	1 856	1 922 p	..
Chile	1 979	2 103	2 116	2 136	2 178	1 925	1 955	1 973 |
China	59 997	58 539	58 523	58 022	63 093	63 772	63 194	..
Croatia	393	368	308	348	307	331	317	297
Czech Republic	742	654	688	738	611	577	656	618
Denmark	167	191	182	178	211	175	171	199
Estonia	87	81	78	67	71	48	67	52
Finland	255	258	229	270	258	238	239	211 p
France	3 653	3 268	3 384	3 461	3 477	3 448	3 248	3 244
Georgia	605	514	511	602	581	517	459	481
Germany	3 600	3 339	3 377	3 459	3 206	3 180	3 275	3 046
Greece	988	879	795	793	824	731	700	696 p
Hungary	605	591	626	644	607	625	633	602
Iceland	9	15	4	16	18	16	18	6
India	138 258	137 572	139 671	146 133	150 785	147 913	..	..
Ireland	163	188	192	162	182	155	139 p	140 p
Italy	3 753	3 401	3 381	3 428	3 283	3 378	3 325	3 173
Japan	5 261	5 165	4 837	4 885	4 698	4 431	4 166	3 920
Kazakhstan	..	..	..	..	..	..	..	..
Korea	5 392	5 092	4 762	4 621	4 292	4 185	3 781	3 349
Latvia	177	179	212	188	158	136	151	135
Liechtenstein	1	2	3	2	0	2	0	..
Lithuania	302	256	267	242	192	191	173	184
Luxembourg	34	45	35	36	32	35	36	..
Malta	9	18	10	11	23	19	..	..
Mexico	4 539	3 849	3 774	3 490	3 371	2 919	..	..
Moldova, Republic of	441	301	324	298	311	302	274	274
Montenegro, Republic of	46	74	65	51	65	63	..	..
Morocco	4 167	3 832	3 489	3 776	3 785	3 726	3 485	..
Netherlands	650	570	570	621	629	613	678	661
New Zealand	308	253	292	317	327	378	378	352
North Macedonia	132	198	130	148	165	155	133	132
Norway	145	187	147	117	135	106	108	108
Poland	3 577	3 357	3 202	2 938	3 026	2 831	2 862	2 909
Portugal	718	637	638	593	563	602	675	621 p
Romania	2 042	1 861	1 818	1 893	1 913	1 951	1 867	1 864
Russian Federation	27 991	27 025	26 958	23 114	20 308	19 088	18 214	16 981
Serbia, Republic of	684	646	536	601	606	578	542	531
Slovak Republic	352	251	295	310	275	276	260	270
Slovenia	130	125	108	120	130	104	91	102
Spain	1 903	1 680	1 688	1 689	1 810	1 830	1 806	..
Sweden	285	260	270	259	270	252	324	221
Switzerland	339	269	243	253	216	230	233	187
Turkey	3 750	3 685	3 524	7 530 |	7 300	7 427	6 675	5 473
Ukraine	5 131	4 833	4 439 |	4 003	3 410	3 432	..	..
United Kingdom	1 802	1 770	1 854	1 804	1 860	1 856	1 837 p	..
United States	33 561	32 719	32 675	35 485	37 461	37 133	36 750 e	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_ROAD_ACCIDENTS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic fatalities, per million inhabitants

Number

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	115.2	101.9	91.4	93.7	93.5	77.3	74.3	79.5
Argentina	121.6	123.4	123.7	..	128.1	123.1 p	..	..
Armenia	107.8 e	109.1 e	102.0	118.3	90.9	94.7	..	..
Australia	57.2	51.3	49.0	50.6	53.4	49.7	45.5	47.1 p
Austria	63.0 |	53.7	50.3	55.4	49.4	47.1	46.3	46.9
Azerbaijan	125.6	123.6	117.9	92.6	77.8	76.1	72.6	81.9
Belarus	109.8	94.4	79.9	70.0	61.9	62.0	57.9	53.3
Belgium	74.5	68.5	66.5	67.6	59.1	53.5	52.9	56.3
Bosnia-Herzegovina	84.1	94.3	85.3	99.4	94.8	88.9	83.3	..
Bulgaria	82.3	82.7	91.4	98.6	99.3	96.4	87.0	90.0
Canada	59.8	55.6	52.0	52.9	52.6	50.8	51.9 p	..
Chile	113.7	119.7	119.2	118.9	119.6	104.2	104.4	104.1 |
China	..	..	..	..	..	..	..	..
Croatia	92.1	86.5	72.7	82.8	73.5	80.3	77.5	73.0
Czech Republic	70.6	62.2	65.4	70.0	57.8	54.5	61.7	57.9
Denmark	29.9	34.0	32.2	31.3	36.8	30.4	29.5	34.2
Estonia	65.8	61.5	59.3	50.9	54.0	36.4	50.7	39.2
Finland	47.1	47.4	41.9	49.3	46.9	43.2	43.3	38.2 p
France	55.6	49.5	51.0	52.0	52.1	51.6	48.5	48.4
Georgia	162.2	138.3	137.4	161.6	155.9	138.7	123.2	129.3
Germany	44.8	41.4	41.7	42.3	38.9	38.5	39.5	36.6
Greece	89.5	80.2	73.0	73.3	76.5	68.0	65.2	64.9 p
Hungary	61.0	59.7	63.4	65.4	61.9	63.9	64.8	61.6
Iceland	28.1	46.3	12.2	48.4	53.7	46.6	51.0	16.6
India	109.2	107.4	107.8	111.5	113.8	110.5	..	..
Ireland	35.4	40.7	41.2	34.5	38.3	32.2	28.6 p	28.3 p
Italy	63.0	56.5	55.6	56.4	54.2	55.8	55.0	52.6
Japan	41.2	40.5	38.0	38.4	37.0	34.9	32.9	31.0
Kazakhstan	..	..	..	..	..	..	..	..
Korea	107.4	101.0	93.8	90.6	83.8	81.5	73.3	64.8
Latvia	87.0	88.9	106.3	95.1	80.6	70.0	78.4	70.6
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	101.1	86.6	91.1	83.3	66.9	67.5	61.8	66.0
Luxembourg	64.0	82.8	62.9	63.2	55.0	58.7	59.2	..
Malta	21.4	42.3	23.0	24.7	50.5	40.6	..	..
Mexico	38.7	32.4	31.4	28.6	27.3	23.4	..	..
Moldova, Republic of	154.2	105.3	113.4	105.1	111.0	109.6	101.3	103.1
Montenegro, Republic of	74.1	119.1	104.5	82.0	104.5	101.2	..	..
Morocco	125.4	113.7	102.0	108.9	107.8	104.7	96.7	..
Netherlands	38.8	33.9	33.8	36.7	36.9	35.8	39.3	38.1
New Zealand	69.9	57.0	64.7	69.0	69.7	78.9	78.1	71.6
North Macedonia	63.6	95.4	62.6	71.2	79.3	74.4	63.9	63.4
Norway	28.9	36.8	28.6	22.5	25.8	20.1	20.3	20.2
Poland	94.0	88.2	84.2	77.3	79.7	74.5	75.4	76.6
Portugal	68.3	60.9	61.3	57.3	54.5	58.4	65.6	60.5
Romania	101.8	93.1	91.3	95.5	97.1	99.6	95.9	96.3
Russian Federation	195.5	188.3	187.4	160.4	140.7	132.1	126.1	117.6
Serbia, Republic of	95.0	90.2	75.2	84.7	85.9	82.3	77.6	76.5
Slovak Republic	65.1	46.4	54.4	57.2	50.6	50.7	47.7	49.5
Slovenia	63.2	60.7	52.4	58.2	63.0	50.3	43.9	48.9
Spain	40.7	36.0	36.3	36.4	38.9	39.3	38.6	..
Sweden	29.9	27.1	27.8	26.4	27.2	25.1	31.8	21.5
Switzerland	42.4	33.3	29.7	30.5	25.8	27.2	27.4	21.8
Turkey	..	..	..	95.9	91.5	91.6	81.1	65.6
Ukraine	112.5	106.2	98.1 |	88.7	75.8	76.6	..	..
United Kingdom	28.3	27.6	28.7	27.7	28.3	28.1	27.6 p	..
United States	106.9	103.5	102.7	110.7	116.0	114.3	112.5 e	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INDICATORS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road traffic fatalities, per million motor vehicles

Number

	2012	2013	2014	2015	2016	2017	2018	2019
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	258.0	..	..	..
Armenia	..	..	..	..	..	..	..	..
Australia	77.7	69.1	65.3	66.9	70.3	65.1	59.3	61.3 p
Austria	85.7 |	72.2	67.3	74.1	66.0	62.2	60.4	60.3
Azerbaijan	..	..	..	..	..	..	..	..
Belarus	..	..	..	..	..	..	..	..
Belgium	119.5	109.2	105.3	106.2	91.8	82.1	80.2	..
Bosnia-Herzegovina	..	..	..	..	..	300.6	267.0	..
Bulgaria	178.3	171.6	181.2	184.7	184.6	198.6	176.5	..
Canada	92.8	84.8	78.2	79.0	78.2	75.5	76.7 p	..
Chile	509.2	504.5	473.6	459.6	448.7	379.0	363.2	..
China	..	..	..	..	..	..	..	..
Croatia	..	209.2	172.4	191.6	163.3	170.9	156.5	..
Czech Republic	119.6	102.7	108.2	113.6	89.0	81.2	88.8	80.9
Denmark	57.0	64.6	61.0	58.8	68.3	55.3	52.9	60.5
Estonia	121.1	107.9	99.8	85.5	83.8	54.6	73.8	..
Finland	61.7	60.9	52.8 e	61.0	56.7	51.1	50.1	43.3 p
France	86.4 e	77.2 e	79.7 e	81.1 e	80.8 e	79.4	74.4	..
Georgia	..	..	..	..	..	..	..	..
Germany	69.6	63.7	63.8	64.4	58.7	57.2	58.0	53.2
Greece	104.1	93.0	84.0	83.3	86.8	75.7	73.5	70.9 p
Hungary	169.6	160.1 |	165.7	165.7	150.9	148.4	143.3	130.2
Iceland	33.8	55.6	14.6	56.1	59.4	49.4	53.4	17.5
India	..	..	..	..	..	..	..	..
Ireland	67.8	75.7	76.3	63.0	69.3	57.9	51.1 p	49.9 p
Italy	73.2	66.3	65.4	66.0	62.3	63.1	61.3	57.7
Japan	58.4	57.0	53.2	53.5	51.4	48.5	45.5	42.9
Kazakhstan	..	..	..	..	..	..	..	..
Korea	246.1	227.3	207.5	195.3	174.7	164.7	140.8	..
Latvia	..	229.0	265.7	228.0	195.6	162.0	175.0	..
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	134.9	112.5	179.3 |	156.2	119.0	121.0	106.2	107.0
Luxembourg	79.1	101.8	81.2 |	81.2	70.5	75.0	74.7	..
Malta	..	56.0	30.0	31.9	64.4	51.3	..	..
Mexico	130.1	104.7	99.2	87.3	79.4	63.7	..	..
Moldova, Republic of	..	..	..	..	..	..	..	..
Montenegro, Republic of	..	..	..	..	315.7	291.6	..	..
Morocco	1 333.9	1 166.2	1 014.8	1 051.8	998.4	918.4	808.2	..
Netherlands	61.1	53.3	53.2	57.6	57.5	55.3	60.1	..
New Zealand	94.8	76.6	85.9	90.2	89.4	98.8	95.1	..
North Macedonia	..	475.5	..	339.6	366.5	335.3	280.5	..
Norway	40.3	50.9	39.3	30.7	34.8	26.8	27.1	..
Poland	143.8	130.7	121.0	107.2	105.8	95.5	92.9	..
Portugal	124.3	111.3	111.5	102.9	97.0	97.7	..	..
Romania	380.2	330.7	308.5	305.3	290.6	271.6	242.2	..
Russian Federation	..	..	525.8	443.8	..	337.6	318.9	..
Serbia, Republic of	343.4	315.3	257.1	279.3	270.8	237.6	219.2	..
Slovak Republic	..	108.6	123.3	124.1	105.9	101.7	91.9	..
Slovenia	96.2	92.7	79.9	87.4	93.2	73.0	61.6	67.3
Spain	57.0	50.9	51.1	50.5	53.1	52.4	50.6	..
Sweden	49.5	44.7	45.6	43.0	43.9	40.2	51.2	34.7
Switzerland	58.9	46.1	40.9	41.8	35.1	36.9	36.9	29.3
Turkey	..	..	..	411.5	377.8	364.4	318.2	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	50.6	49.0	50.5	48.0	48.5	47.7	46.7 p	..
United States	126.3	121.5	118.9	126.1	130.1	127.9	123.7 e	..

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INDICATORS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Investment in rail transport infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	0.9	0.5	0.7	0.7	0.5	0.0	0.0	0.3
Argentina	..	..	..	..	..	..	..	..
Armenia	26.4	23.9	11.7	12.0	12.4	5.6	..	..
Australia	5 164.9	6 602.3	4 975.6	4 320.3	2 796.3	2 563.9	3 825.3	5 025.6
Austria	2 143.0	1 688.0	1 648.0	1 567.0	1 549.0	1 523.0	1 552.0	1 682.0
Azerbaijan	2.7	3.0	3.8	3.8	1.8	1.1	1.0	3.5
Belarus	389.6	530.5	379.1	297.1	188.9	96.6	180.5	89.8
Belgium	1 295.1	1 333.4	1 200.8	1 108.0 |	1 006.0	959.1	880.0	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	90.0	114.0	123.7	167.2	301.2	153.4	92.0	96.1
Canada	869.4	1 044.5	1 011.4	962.6	1 065.2	796.5	918.5	1 081.6 p
Chile	..	..	..	..	..	..	..	..
China	65 833.8	75 538.5	81 347.4	94 554.3	111 893.1	105 447.9	105 083.8	97 308.3
Croatia	80.5	61.8	183.1	130.7	60.0	44.3	62.6	99.6
Czech Republic	446.8	381.5	334.7	454.2	1 164.9	681.5	565.6	741.1
Denmark	862.9	915.8	996.1	1 159.4	1 308.4	1 185.0	1 228.2	1 351.4
Estonia	94.0	47.7	26.5	15.5	13.1	15.4	14.0	27.0
Finland	355.0	450.0	605.0	643.0	567.0	537.0	521.0	491.0
France	7 060.0	7 991.7	10 364.6	8 921.9	8 576.2	8 614.7	9 334.8	9 901.6
Georgia	266.8	243.8	62.7	76.5	88.2	88.7	46.9	54.0
Germany	4 086.0	3 930.0	4 684.0 |	5 543.0	5 541.0	5 192.0	5 711.0	6 145.0
Greece	185.0	177.0	96.0	180.6 e	220.3 e	307.8 e	227.1 e	..
Hungary	348.8	472.4	623.2	626.7	701.3	323.2	556.1	803.1
Iceland	x	x	x	x	x	x	x	x
India	4 944.4	6 075.9	5 928.5	8 786.2	9 643.9	9 890.9	10 368.6	..
Ireland	..	..	..	..	..	..	..	..
Italy	4 466.0	4 238.0	4 103.0	4 742.0	2 861.0	3 524.0 p	..	..
Japan	10 208.8	11 803.1	9 192.0	8 644.3	8 880.2	9 174.7	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	4 937.8	5 964.5	5 838.4	6 175.6	8 589.3	..	..	..
Latvia	53.0	102.0	77.0	136.0	209.0	24.0	22.0	17.2
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	116.0	140.0	139.0	264.0	180.0	70.0	49.0	65.0
Luxembourg	150.4	124.9	145.9	191.5	277.7	317.2	290.0	263.9
Malta	x	x	x	x	x	x	x	x
Mexico	649.9	590.7	699.3	997.8	1 150.1	1 355.9	1 652.7	..
Moldova, Republic of	7.2	10.4	12.8	4.5	4.5	1.0	1.0	1.2 p
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	1 136.0	..	..	..	..	..	..	..
New Zealand	227.8	231.3	212.5	148.2	124.5	115.8	116.6	96.7
North Macedonia	..	..	..	..	..	..	..	..
Norway	561.1	675.8	838.7	1 218.3	1 281.4	1 460.6	1 345.2	1 400.2
Poland	925.3	430.9	262.8	53.1	340.4	326.6	510.3	461.9
Portugal	333.0	86.0	71.0	120.0	177.0	79.0	110.0	132.0
Romania	161.4	117.8	208.9	277.7	321.9	262.1	214.5	182.9
Russian Federation	9 872.1	11 194.2	9 786.8	6 474.6	5 022.3	4 830.4	3 609.3	4 355.2
Serbia, Republic of	7.0	2.9	9.3	11.8	83.1	73.3	45.0	68.3 p
Slovak Republic	289.0	216.0	324.0	276.0	295.5	131.6	231.1	279.4
Slovenia	106.0	72.0	140.0	270.0	376.0	84.4	100.0	153.0
Spain	7 553.0	5 350.0	2 710.0	3 042.0	2 613.0	1 657.0	2 215.0	2 102.0 p
Sweden	1 588.4	1 570.1	1 389.9	1 480.7	1 630.0 |	1 501.7	1 525.0	1 352.3
Switzerland	3 410.0	3 463.9	3 665.6	3 550.1	4 193.5	3 836.0	3 120.7	3 078.2
Turkey	1 526.2	1 508.5	2 254.4	1 380.6	1 081.0	1 718.2	1 732.7	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	7 532.7	8 765.9	8 426.4	10 306.7	14 665.9 |	13 511.1	13 055.1	13 711.3
United States	8 335.8	10 478.4	9 856.2	11 347.8	15 687.6	12 473.3	11 480.6	10 505.3

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Investment in road transport infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	210.2	180.8	234.2	192.7	179.2	89.1	159.1	169.3
Argentina	..	..	..	..	..	..	..	..
Armenia	30.5	26.5	23.2	66.8	77.7	90.4	..	..
Australia	13 802.0	15 900.9	12 734.4	10 438.9	10 457.1	11 863.4	13 676.3	14 717.9
Austria	303.0	327.0	363.0	453.0	455.0	444.0	515.0	463.0
Azerbaijan	1 561.8	1 484.2	1 913.6	1 411.3	873.2	498.1	557.1	695.0
Belarus	1 186.6	1 581.3	1 446.1	1 357.7	1 007.8	873.0	960.8	1 004.7
Belgium	248.0	553.0	587.0	417.0	778.0 p	810.0	655.9 p	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	511.8	585.9	505.2	563.5	839.0	163.1	115.0	882.5
Canada	15 066.2	14 756.4	13 086.1	5 108.7 |	7 214.8	7 042.7	7 481.3	6 578.8 p
Chile	1 003.6 |	1 211.6 p	1 392.7 p	1 330.0 p	1 273.2 p	1 313.6 p	1 310.4 p	928.8 p
China	154 221.3	215 276.5	249 280.0	300 735.3	414 199.5	448 260.9	528 997.0	558 506.4
Croatia	465.7	478.6	424.2	279.5	238.4	197.4	196.5	285.5
Czech Republic	1 293.2	876.3	647.5	604.0	885.4	849.2	984.2	1 044.8
Denmark	1 052.0	1 323.7	1 046.9	1 101.6	1 086.4	1 099.5	1 065.6	1 084.0
Estonia	158.0	198.4 |	214.5	147.7	185.1	148.6	197.0	219.0
Finland	973.0	1 128.0	1 148.0	1 238.0	1 243.0	1 178.0	1 235.0	1 526.0
France	12 604.3	13 173.7	12 866.2	10 807.2	10 011.2	9 169.0	9 084.0	9 630.1
Georgia	247.6	177.4	236.7	224.5	194.1	202.5	308.2	402.6
Germany	12 290.0	11 900.0	12 130.0	12 590.0	12 160.0	12 870.0	14 240.0	15 630.0
Greece	1 310.0	1 088.0	2 181.0	1 597.9 e	1 385.2 e	2 843.4 e	4 101.2 e	..
Hungary	298.0	152.7	400.6	1 238.4	1 247.7	802.7	1 280.4	1 780.3
Iceland	38.7 |	37.9	41.8	45.3	67.4	74.7	91.0	99.4
India	5 616.7	6 208.4	8 475.2	8 717.8	13 689.8	12 461.4	..	..
Ireland	1 017.0	886.0	594.0	638.0	612.0	..	..	..
Italy	4 129.0	3 107.0	2 841.0	3 860.0	5 151.0	3 511.0 p	3 409.0	..
Japan	35 812.5	37 300.8	33 129.2	29 831.9	28 143.4	33 274.8	31 577.9	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	9 243.6	10 780.7	11 337.2	10 904.6	13 174.2	..	..	..
Latvia	222.0	190.0	199.0	188.0	203.0	190.0	226.0	221.4
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	343.0	243.0	253.0	224.0	258.0	357.0	345.0	325.0
Luxembourg	222.0	213.4	219.9	215.1	226.6	214.6	207.8	180.4
Malta	17.3	26.7	11.1	38.5	..	..	..	..
Mexico	3 915.8	3 985.3	4 180.0	4 883.3	4 296.3	3 383.3	2 161.4	..
Moldova, Republic of	8.1	40.2	36.2	38.9	51.1	36.3	31.3	33.7
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	2 287.0	..	..	..	..	..	..	..
New Zealand	919.0	654.5	799.0	911.8	1 034.3	1 005.2	943.1	1 058.0
North Macedonia	103.9	70.5	87.5	174.3	166.3	228.6	195.1	157.0
Norway	2 811.6	3 301.1	3 844.3	3 804.0	3 559.2	3 383.3	3 717.7	..
Poland	8 323.3	4 382.8	2 464.8	1 721.1	2 170.8	3 075.4	3 209.6	2 668.6
Portugal	..	274.0 p	211.0 p	..	..	..	..	..
Romania	3 283.6	3 092.8	2 728.7	2 492.6	2 870.3	2 366.8	2 133.6	2 181.6
Russian Federation	8 423.7	9 281.4	9 836.0	8 283.7	6 117.2	7 597.0	8 201.5	7 298.2
Serbia, Republic of	339.0	256.6	279.3	337.0	505.1	493.8	506.7	442.5 p
Slovak Republic	432.0	311.0	360.0	550.0	1 133.8	751.4	749.6	768.8
Slovenia	112.0	102.0	104.0	128.0	102.0	100.0	120.0	219.0
Spain	5 966.0	5 316.0	4 646.0	4 358.0	4 259.0	3 880.0	3 690.0	3 512.0 p
Sweden	1 911.7	2 212.1	2 013.1	1 864.8	1 861.5	2 086.3	2 374.4	2 497.0
Switzerland	3 822.5	3 880.4	3 731.4	3 647.3	4 225.7	3 968.2	3 930.2	..
Turkey	5 204.6	4 801.9	6 226.1	6 643.9	9 056.8	7 329.6	6 138.7	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	5 565.0	5 557.5	6 029.9	7 845.6	9 067.9	8 561.4	9 082.1	8 697.0
United States	59 423.7	64 639.1	61 286.0	62 763.4	79 307.9	82 414.6	81 200.7	80 744.8

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Investment in inland waterway transport infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	x	x	x	x	x	x	x	x
Austria	2.0	3.0	11.0	10.0	2.0	2.0	3.0	3.0
Azerbaijan	..	..	..	..	..	..	..	..
Belarus	0.9	1.4	1.2	1.5	0.2	0.1	1.1	0.6
Belgium	152.0	152.0	167.0	103.0	291.0	225.0	237.5	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	0.0	0.0	0.0	0.5	1.3	0.0	0.2	0.0
Canada	..	..	..	..	..	..	..	..
Chile	x	x	x	x	x	x	x	x
China	..	..	..	..	..	..	..	..
Croatia	3.5	3.3	1.7	..	..	..	..	..
Czech Republic	22.3	17.2	7.2	9.6	15.1	9.8	7.2	2.8
Denmark	x	x	x	x	x	x	x	x
Estonia	..	..	..	..	..	..	..	..
Finland	1.0	2.0	3.0	2.0	2.0	2.0	4.2	8.1
France	264.3	236.0	224.4	180.0	164.1	192.3	35.1	226.3
Georgia	x	x	x	x	x	x	x	x
Germany	1 070.0	885.0	865.0	865.0	830.0	895.0	860.0	910.0
Greece	x	x	x	x	x	x	x	x
Hungary	0.2	0.0	0.1	0.0	0.0	10.3	0.2	1.0
Iceland	x	x	x	x	x	x	x	x
India	..	..	..	..	..	..	..	..
Ireland	x	x	x	x	x	x	x	x
Italy	36.0	52.0	136.0	358.0	509.0	48.0 p	239.0	..
Japan	x	x	x	x	x	x	x	x
Kazakhstan	..	..	..	..	..	..	..	..
Korea	x	x	x	x	x	x	x	x
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	2.0	0.0	1.0	3.0	1.0	0.0	0.0	0.0
Luxembourg	1.3	0.7	0.1	0.3	0.0	0.1	0.0	0.1
Malta	x	x	x	x	x	x	x	x
Mexico	x	x	x	x	x	x	x	x
Moldova, Republic of	0.7	0.2	0.1	..	0.0	0.0	0.0	0.1
Montenegro, Republic of	x	x	x	x	x	x	x	x
Morocco	..	..	..	..	..	..	..	..
Netherlands	263.0	..	..	..	..	..	..	..
New Zealand	x	x	x	x	x	x	x	x
North Macedonia	x	x	x	x	x	x	x	x
Norway	x	x	x	x	x	x	x	x
Poland	29.1	0.2	..	61.2	..	..	..	..
Portugal	1.0	3.0	0.0	..	..	..	..	..
Romania	519.0	279.5	268.1	314.1	505.9	236.9	105.1	189.7
Russian Federation	301.7	230.0	106.7	103.4	39.8	73.6	43.6	56.4
Serbia, Republic of	25.8	24.7	15.5	17.7	22.3	40.7	34.3	45.9 p
Slovak Republic	1.0	1.0	1.0	0.0	0.1	0.1	1.1	1.5
Slovenia	x	x	x	x	x	x	x	x
Spain	x	x	x	x	x	x	x	x
Sweden	..	..	..	..	..	..	..	..
Switzerland	..	..	..	..	..	..	..	..
Turkey	x	x	x	x	x	x	x	x
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	126.5	129.1	151.3	178.4	162.2	194.3	..	..

.. Not available; p Provisional data; x Not applicable

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total investment in inland transport infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	211.1	181.4	234.9	193.4	179.8	89.1	159.1	169.6
Argentina	..	..	..	..	..	..	..	..
Armenia	56.9	50.4	34.9	78.8	90.1	96.1	..	..
Australia	18 966.8	22 503.1	17 709.9	14 759.2	13 253.3	14 427.2	17 501.7	19 743.5
Austria	2 448.0	2 018.0	2 022.0	2 030.0	2 006.0	1 969.0	2 070.0	2 148.0
Azerbaijan	..	..	..	..	..	..	..	..
Belarus	1 577.1	2 113.2	1 826.4	1 656.3	1 196.9	969.7	1 142.3	1 095.1
Belgium	1 695.1	2 038.4	1 954.8	1 628.0 |	2 075.0 p	1 994.1	1 773.4 p	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	601.8	700.0	628.9	731.2	1 141.5	316.5	207.2	978.6
Canada	15 935.6	15 800.9	14 097.5	6 071.2 |	8 280.0	7 839.2	8 399.8	7 660.4 p
Chile	..	..	..	..	..	..	..	..
China	220 055.1	290 815.0	330 627.4	395 289.6	526 092.6	553 708.8	634 080.8	655 814.7
Croatia	549.7	543.8	609.1	410.2	298.4	241.7	259.1	385.1
Czech Republic	1 762.4	1 275.1	989.3	1 067.8	2 065.4	1 540.5	1 557.0	1 788.6
Denmark	1 914.9	2 239.4	2 043.1	2 260.9	2 394.8	2 284.5	2 293.8	2 435.3
Estonia	252.0	246.1 |	241.0	163.2	198.2	164.0	211.0	246.0
Finland	1 329.0	1 580.0	1 756.0	1 883.0	1 812.0	1 717.0	1 760.2	2 025.1
France	19 928.6	21 401.4	23 455.1	19 909.1	18 751.6	17 975.9	18 453.8	19 758.0
Georgia	514.4	421.3	299.4	301.0	282.3	291.2	355.0	456.6
Germany	17 446.0	16 715.0	17 679.0 |	18 998.0	18 531.0	18 957.0	20 811.0	22 685.0
Greece	1 495.0	1 265.0	2 277.0	1 778.5 e	1 605.5 e	3 151.2 e	4 328.3 e	..
Hungary	647.0	625.1	1 023.9	1 865.1	1 949.0	1 136.2	1 836.6	2 584.5
Iceland	38.7 |	37.9	41.8	45.3	67.4	74.7	91.0	99.4
India	10 561.1	12 284.2	14 403.7	17 503.9	23 333.8	22 352.3	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	8 631.0	7 397.0	7 080.0	8 960.0	8 521.0	7 083.0 p	..	..
Japan	46 021.3	49 103.9	42 321.3	38 476.1	37 023.6	42 449.5	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	14 181.4	16 745.2	17 175.6	17 080.1	21 763.5	..	..	..
Latvia	275.0	292.0	276.0	324.0	412.0	214.0	248.0	238.6
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	461.0	383.0	393.0	491.0	439.0	427.0	394.0	390.0
Luxembourg	373.7	339.1	365.9	407.0	504.4	531.9	497.8	444.4
Malta	17.3	26.7	11.1	38.5	..	..	..	..
Mexico	4 565.7	4 576.0	4 879.3	5 881.2	5 446.4	4 739.2	3 814.1	..
Moldova, Republic of	16.0	50.8	49.0	43.4	55.6	37.4	32.3	34.9 p
Montenegro, Republic of	15.0	18.0	20.0	9.0	12.0	16.0	11.0	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	3 686.0	..	..	..	..	..	..	..
New Zealand	1 146.8	885.8	1 011.6	1 059.9	1 158.8	1 121.0	1 059.7	1 154.7
North Macedonia	..	..	..	..	..	..	..	..
Norway	3 372.8	3 976.9	4 683.0	5 022.3	4 840.6	4 843.9	5 062.9	..
Poland	9 277.7	4 813.9	2 727.6	1 835.3	2 511.2	3 402.0	3 719.9	3 130.5
Portugal	..	363.0 p	282.0 p	..	..	..	..	..
Romania	3 964.0	3 490.1	3 205.7	3 084.4	3 698.1	2 865.8	2 453.2	2 554.1
Russian Federation	18 597.6	20 705.6	19 729.4	14 861.7	11 179.4	12 500.9	11 854.4	11 709.8
Serbia, Republic of	371.8	284.2	304.1	366.5	610.5	607.9	586.0	556.7 p
Slovak Republic	722.0	528.0	685.0	826.0	1 429.3	883.1	981.8	1 049.8
Slovenia	218.0	174.0	244.0	398.0	478.0	184.4	220.0	372.0
Spain	13 519.0	10 666.0	7 356.0	7 400.0	6 872.0	5 537.0	5 905.0	5 614.0 p
Sweden	3 500.0	3 782.2	3 403.0	3 345.5	3 491.5 |	3 588.0	3 899.4	3 849.3
Switzerland	7 232.6	7 344.2	7 397.0	7 197.4	8 419.2	7 804.2	7 050.9	..
Turkey	6 730.8	6 310.4	8 480.5	8 024.4	10 137.8	9 047.9	7 871.4	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	13 097.7	14 323.4	14 456.3	18 152.3	23 733.8 |	22 072.5	22 137.2	22 408.3
United States	67 886.0	75 246.6	71 293.5	74 289.6	95 157.7	95 082.2	92 681.3	91 250.1

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Investment in sea port infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	9.9	8.8	1.1	2.2	5.8	2.6	0.0	0.2
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	3 515.8	5 758.4	4 636.5	3 210.8	1 206.1	836.2	600.4	556.8
Austria	x	x	x	x	x	x	x	x
Azerbaijan	59.2	48.5	420.3	260.0	80.2	40.8	65.9	0.0
Belarus	x	x	x	x	x	x	x	x
Belgium	241.0	236.0	197.0	150.0	108.0	90.9	120.4	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	4.6	3.1	2.6	14.8	10.2	11.2	7.7	5.6
Canada	249.3	432.0 |	578.0	520.7	702.7	714.1	821.7	1 336.0 p
Chile	..	..	..	..	..	..	..	..
China	..	..	..	..	..	..	..	..
Croatia	62.6	95.9	74.3	69.7	..	..	..	..
Czech Republic	x	x	x	x	x	x	x	x
Denmark	62.3	64.9	150.8	68.0	73.6	81.0	47.3	..
Estonia	18.0	8.6 |	5.9	6.7	12.2	6.1	4.9	6.0
Finland	77.0	56.0	40.0	44.0	55.0	114.0	99.5	58.3
France	215.0	228.0	323.0	340.1	307.5	310.0	273.0 e	273.0
Georgia	6.3	20.5	27.2	22.4	10.5	10.6	13.7	4.2
Germany	925.0	890.0	780.0	450.0	460.0	430.0	410.0	435.0
Greece	25.0	24.0	33.0	24.8 e	20.4 e	8.8 e	4.9 e	..
Hungary	x	x	x	x	x	x	x	x
Iceland	16.9	15.2	15.5	15.2	20.0	35.2	36.1	29.7
India	61.0	62.2	39.5	34.0	66.3	79.7	..	..
Ireland	16.0	11.0	11.0	11.0	11.0	11.0	..	..
Italy	1 268.0	1 343.0	1 126.0	1 168.0	1 059.0	615.0 p	772.0	..
Japan	2 287.0	3 281.1	2 287.8	1 916.5	2 109.8	2 617.4	2 259.6	1 912.2
Kazakhstan	..	..	..	..	..	..	..	..
Korea	1 059.8	1 129.8	1 052.1	1 077.4	1 326.3	1 339.0	..	..
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	27.0	28.0	83.0	22.0	17.0	13.0	23.0	36.0
Luxembourg	x	x	x	x	x	x	x	x
Malta	6.0	8.0	4.0	5.0	..	..	..	..
Mexico	542.8	666.6	653.5	629.3	695.3	542.6	582.5	..
Moldova, Republic of	4.2	..	..	3.9	0.0	0.0	0.0	0.0
Montenegro, Republic of	3.0	1.0	25.0	19.0	7.0	1.0	1.0	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	..	119.9	137.1	186.0	151.4	200.5	150.3	211.9
North Macedonia	x	x	x	x	x	x	x	x
Norway	8.2	11.4	28.7	12.8	10.5	34.5	63.0	..
Poland	63.6	153.9	93.9	..	..	..	..	..
Portugal	83.0	62.0	34.0	87.8 |	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	326.6	86.4	147.6	138.8	49.3	178.2	141.5	299.8
Serbia, Republic of	x	x	x	x	x	x	x	x
Slovak Republic	x	x	x	x	x	x	x	x
Slovenia	6.0	5.0	8.0	23.0	16.0	25.0	14.0	3.0
Spain	1 789.0	1 245.0	830.0	873.0	904.0	847.0	920.0	927.0 p
Sweden	88.4	69.3	101.3	103.8	81.2	100.2	143.8	..
Switzerland	x	x	x	x	x	x	x	x
Turkey	35.4	73.2	45.1	10.3	8.4	53.6	91.2	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	..	..	..	..	..	..	..	..

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Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Investment in airport infrastructure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Argentina	..	..	..	..	..	..	..	..
Armenia	..	..	..	..	..	..	..	..
Australia	..	..	..	..	..	..	..	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	163.8	278.2	270.6	78.7	349.8	5.7	207.0	19.4
Belarus	18.2	2.2	1.8	52.4	5.2	105.6	18.8	82.9
Belgium	34.0	74.0	93.0	107.0	127.0	109.3	116.3	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	1.5	9.7	5.1	5.1	4.6	27.1	13.3	6.1
Canada	701.5	952.7	1 154.6	1 032.1	1 053.2	980.0	787.4	840.4
Chile	52.6 |	67.0 p	96.0 p	107.1 p	108.2 p	150.4 p	248.5 p	49.6 p
China	9 302.4	13 853.5	15 977.2	17 548.6	26 633.2	30 207.7	31 433.8	32 144.4
Croatia	18.6	15.6	16.1	77.9	139.7	175.9	65.8	98.4
Czech Republic	40.0	47.2	55.6	36.0	36.4	65.1	63.9	125.1
Denmark	31.1	30.8	79.6	22.5	9.9	5.9	2.8	..
Estonia	6.0	0.5	1.0	0.1	0.0	13.8	16.5	11.0
Finland	44.0	45.0	35.0	86.0	78.9	183.0	175.5	245.4
France	949.0	616.0 |	431.0	390.0	512.0	774.0	801.0	936.0
Georgia	9.8	38.5	12.8	6.3	11.0	55.9	36.3	18.2
Germany	1 815.0	1 390.0	930.0	770.0	850.0	900.0	1 110.0	1 370.0
Greece	49.0	60.0	49.0	52.9 e	43.5 e	48.8 e	27.0 e	..
Hungary	37.9	25.8	11.9	7.6	10.2	17.8	55.9	54.3
Iceland	1.7	1.9	1.1	0.3	0.5	0.6	0.6	0.1
India	188.9	875.6	781.5	718.9	475.1	241.6	..	..
Ireland	83.0	..	..	..	..	..	..	..
Italy	184.0	98.0	87.0	123.0	148.0	71.0 p	42.0	..
Japan	1 328.3	1 359.2	1 130.8	1 332.5	1 365.1	1 633.3	1 594.4	1 809.4
Kazakhstan	..	..	..	..	..	..	..	..
Korea	44.0	46.3	55.6	65.9	83.0	..	..	..
Latvia	6.0	9.0	38.0	50.0	42.0	14.0	6.0	10.0
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	14.0	3.0	7.0	6.0	6.0	2.0	29.0	6.0
Luxembourg	12.5	11.0	0.2	0.5	1.9	1.1	11.2	12.4
Malta	..	..	..	..	..	..	..	..
Mexico	226.3	202.0	197.0	222.2	1 573.1	2 081.6	1 058.0	..
Moldova, Republic of	1.8	..	0.1	0.0	..	..	..	..
Montenegro, Republic of	4.0	2.0	..	..	3.0	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	54.8	71.1	68.8	87.1	114.6	216.4	308.0	356.5
North Macedonia	101.5	0.4	3.4	0.5	0.6	1.1	1.0	1.3
Norway	158.2	475.7	484.8	296.5	265.3	872.3	662.8	..
Poland	205.6	146.3	153.4	236.8	302.4	69.9	43.9	55.4
Portugal	102.0 |	64.0	53.0	45.0	80.0	66.5	76.5	49.0
Romania	2.1	21.1	19.2	28.6	38.7	22.3	17.7	1.9
Russian Federation	435.0	666.5	783.0	877.8	851.7	594.5	386.2	271.2
Serbia, Republic of	0.3	0.3	3.0	1.1	0.2	3.6	0.3	0.2 p
Slovak Republic	33.0	31.0	4.0	5.0	4.2	4.8	3.5	2.9
Slovenia	3.0	4.0	4.0	1.0	1.0	0.0	1.0 e	1.0 e
Spain	1 235.0	943.0	585.0	363.0	293.0	378.0	445.0	617.0 p
Sweden	126.4	404.1	289.3	114.7	131.3	242.8	424.7	343.1
Switzerland	327.4	264.7	294.1	293.9	213.6	351.3	327.6	442.7
Turkey	430.9	433.9	519.2	503.4	1 437.7	2 250.4	2 539.7	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	..	..	..	..	..	..	..	..

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Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.
Source: ITF Transport statistics

Rail infrastructure maintenance expenditure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	0.0	0.0	0.0	0.0	0.0	0.0	..	..
Australia	..	..	..	..	..	..	..	..
Austria	451.0	480.0	497.0	504.0	503.0	535.0	552.0	560.0
Azerbaijan	19.1	24.8	29.8	34.5	33.5	21.5	16.5	22.4
Belarus	..	..	..	..	..	..	..	..
Belgium	312.0	311.0	329.0	333.0	313.0	311.0	317.0	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	32.7	37.3	41.9	49.6	32.7	34.3	32.2	35.8
Canada	706.4	755.8	739.4	851.2	957.2	800.4	831.2	800.0 p
Chile	..	..	..	..	..	..	..	..
China	..	..	..	..	..	..	..	..
Croatia	86.8	102.2	102.1	105.7	100.7	87.7	91.0	96.7
Czech Republic	364.5	353.0	377.6	423.6	661.1	576.9	547.8	671.3
Denmark	..	..	..	..	..	..	..	..
Estonia	..	..	..	..	..	..	..	..
Finland	197.0	181.0	201.0	194.0	206.0	216.0	233.0	221.0
France	3 804.0	3 983.0	3 884.0	3 115.0	3 245.8 e	3 329.6	3 502.8	3 496.4
Georgia	18.4	20.2	22.5	22.9	21.8	20.4	18.8	19.5
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	435.1	434.8	418.2	490.2	473.3	550.0	621.4	636.1
Iceland	x	x	x	x	x	x	x	x
India	15 326.7	16 388.7	16 900.3	17 805.6	20 958.4	21 595.2	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	7 675.0	7 477.0	7 205.0	7 194.0	1 741.0	..	..	..
Japan	..	..	..	..	..	..	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	836.9	981.8	1 036.3	1 153.4	1 455.1	..	..	..
Latvia	109.0	112.0	110.0	119.0	117.0	108.0	105.0	112.0
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	151.0	156.0	153.0	155.0	161.0	167.0	180.0	156.0
Luxembourg	124.4	132.4	139.5	142.7	152.6	153.0	150.4	158.3
Malta	x	x	x	x	x	x	x	x
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	..	..	..	..	..	..	..	..
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	1 798.0	1 798.0	1 798.0	..	..	..	..	..
New Zealand	178.2	86.2	53.9	55.0	69.8	75.1	73.5	72.0
North Macedonia	..	..	..	..	..	..	..	..
Norway	730.5	756.5	713.0	800.9	837.3	972.8	645.4 |	710.9
Poland	238.7	307.3	387.2	614.2	578.8	729.4	796.9	716.6
Portugal	..	..	..	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	17.4	15.8	9.0	9.2	8.8	7.0	12.4	16.3 p
Slovak Republic	6.0	9.0	7.0	8.0	10.5	9.5	13.1	15.1
Slovenia	81.0	87.0	71.0	101.0	110.0	89.8	133.0	123.0
Spain	..	..	..	..	..	..	..	..
Sweden	562.2	612.8	638.6	683.3	668.1	666.6	672.9	713.7
Switzerland	666.9	728.4	728.7	483.3	549.8	540.3	649.5	545.5
Turkey	208.6	209.1	188.7	173.0	174.1	171.7	198.5	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	1 840.2	1 951.6	2 046.9	1 069.6	5 471.1 |	5 170.8	5 182.1	6 457.0
United States	..	..	..	..	..	..	..	..

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Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Road infrastructure maintenance expenditure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	7.7	6.7	8.7	15.3	8.4	13.0	13.6	13.4
Argentina	..	..	..	..	..	..	..	..
Armenia	10.3	10.7	10.1	10.1	11.2	11.6	..	..
Australia	..	..	..	..	..	..	..	..
Austria	494.0	517.0	559.0	667.0	692.0	697.0	687.0	726.0
Azerbaijan	26.4	34.7	31.7	31.7	22.9	18.7	27.8	25.4
Belarus	..	..	..	..	..	..	..	..
Belgium	156.0	145.0	147.0	206.0	457.0	528.0	396.8 p	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	79.3	111.5	103.8	100.2	138.1	174.9	164.1	256.7
Canada	5 818.6	6 229.8	3 942.6 |	4 727.9 |	5 352.9	4 885.1	5 362.7	4 825.4 p
Chile	627.6 |	746.4 p	677.5 p	619.1 p	945.4 p	830.9 p	768.9 p	857.8 p
China	..	..	..	..	..	..	..	..
Croatia	212.1	186.5	209.0	257.4	245.1	234.4	172.4	193.3
Czech Republic	569.7	570.7	513.1	587.1	684.4	767.3	721.3	871.5
Denmark	880.9	944.5	920.1	795.9	807.8	919.8	1 117.5	1 151.5
Estonia	39.0	44.3	47.2	46.3	47.5	43.6	42.0	39.0
Finland	658.0	525.0	511.0	506.0	508.9	544.0	548.5	543.0
France	2 746.0	2 851.0	2 904.0	2 760.0	2 598.2	2 430.9	2 369.2	2 370.7
Georgia	13.4	15.1	14.1	15.6	15.5	17.9	30.4	30.3
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	256.5	295.8	370.2	272.8	282.2	292.6	369.4	379.7
Iceland	29.0	29.7	27.8	32.3	43.4	45.4	68.0	83.5
India	9 299.0	7 763.6	7 040.9	7 232.1	7 488.8	..	..	..
Ireland	159.0	139.0	128.0	85.0	82.0	..	..	..
Italy	6 220.0	7 196.0	9 134.0	9 564.0	9 066.0	8 446.0	8 803.0	..
Japan	15 681.5	17 611.0	16 256.9	14 088.9	14 437.4	14 060.6	17 221.8	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	1 499.5	1 605.6	1 665.0	1 647.8	2 206.6	..	..	..
Latvia	125.0	120.0	133.0	154.0	171.0	175.0	177.0	200.6
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	153.0	123.0	127.0	143.0	159.0	152.0	151.0	144.0
Luxembourg	36.9	33.7	36.7	35.2	34.8	45.7	53.6	67.0
Malta	27.1	24.2	24.9	17.2	..	..	..	..
Mexico	821.5	823.7	1 098.1	1 124.2	1 091.0	1 093.9	736.0	..
Moldova, Republic of	36.4	55.1	64.0	72.0	41.4	25.6	29.3	48.7
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	323.0	..	..	..	..	..	..	..
New Zealand	843.8	995.2	887.5	928.1	949.9	898.6	993.4	1 062.9
North Macedonia	..	..	..	..	..	..	..	..
Norway	1 615.4	1 746.6	1 841.0	1 990.0	1 948.3	..	..	..
Poland	2 679.5	428.0	438.2	383.1	415.5	418.7	516.6	464.7
Portugal	..	165.0	174.0	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	205.4	208.9	129.2	143.0	163.0	180.9	202.7	297.7 p
Slovak Republic	157.0	193.0	204.0	181.0	201.0	215.0	230.0	295.7
Slovenia	122.0	120.0	123.0	113.0	126.0	138.0	203.0	229.0
Spain	..	..	..	..	..	..	..	..
Sweden	856.5	958.8	1 043.6	1 017.5	1 183.6 |	1 130.0	1 081.1	1 089.4
Switzerland	2 235.0	2 413.5	2 402.3	2 420.5	2 761.3	2 699.5	2 708.7	..
Turkey	674.5	699.9	630.1	558.0	239.3	230.1	229.3	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	3 444.3	3 450.6	3 145.4	2 881.3	3 163.4	2 504.1	2 015.9	2 356.4
United States	29 892.2	33 972.5	34 208.0	35 252.1	39 639.5	44 054.8 p	..	..

.. Not available; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Inland waterway infrastructure maintenance expenditure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	x	x	x	x	x	x	x	x
Austria	11.0	12.0	17.0	19.0	14.0	12.0	13.0	12.0
Azerbaijan	..	..	..	..	..	..	..	..
Belarus	..	..	..	..	..	..	..	..
Belgium	58.0	71.0	66.0	27.0	82.0	103.0	87.5	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	1.5	1.0	1.0	1.0	1.0	1.3	1.4	3.4
Canada	..	..	..	..	..	..	..	..
Chile	x	x	x	x	x	x	x	x
China	..	..	..	..	..	..	..	..
Croatia	0.8	1.2	1.2	..	..	..	..	..
Czech Republic	1.8	2.9	4.6	4.5	7.5	6.2	6.5	7.5
Denmark	x	x	x	x	x	x	x	x
Estonia	..	..	..	..	..	..	..	..
Finland	20.0	15.0	16.0	17.0	16.3 |	18.0	16.0	17.7
France	61.0	61.0 e	61.0 e	60.0 e	59.8 e	59.6 e	62.2 e	59.0
Georgia	x	x	x	x	x	x	x	x
Germany	..	..	..	..	..	..	..	..
Greece	x	x	x	x	x	x	x	x
Hungary	1.6	0.8	0.9	1.3	1.4	2.7	2.2	2.1
Iceland	x	x	x	x	x	x	x	x
India	..	..	..	..	..	..	..	..
Ireland	x	x	x	x	x	x	x	x
Italy	78.0	77.0	113.0	125.0	106.0	127.0	122.0	..
Japan	x	x	x	x	x	x	x	x
Kazakhstan	..	..	..	..	..	..	..	..
Korea	x	x	x	x	x	x	x	x
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Luxembourg	0.2	0.3	0.2	0.2	0.1	0.2	0.2	0.2
Malta	x	x	x	x	x	x	x	x
Mexico	x	x	x	x	x	x	x	x
Moldova, Republic of	..	..	..	..	0.0	0.0	0.0	0.1
Montenegro, Republic of	x	x	x	x	x	x	x	x
Morocco	..	..	..	..	..	..	..	..
Netherlands	343.0	..	..	..	..	..	..	..
New Zealand	x	x	x	x	x	x	x	x
North Macedonia	x	x	x	x	x	x	x	x
Norway	x	x	x	x	x	x	x	x
Poland	16.5	7.6	21.0	5.5	..	..	..	..
Portugal	0.0	1.0	1.0	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	23.0	17.6	16.5	17.3	29.8	28.7	32.9	35.3 p
Slovak Republic	2.0	3.0	4.0	9.0	3.7	0.3	7.1	1.8
Slovenia	x	x	x	x	x	x	x	x
Spain	x	x	x	x	x	x	x	x
Sweden	..	..	..	..	..	..	..	..
Switzerland	..	..	..	..	..	..	..	..
Turkey	x	x	x	x	x	x	x	x
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	415.3	430.1	419.4	489.2	577.7	600.9	..	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Sea port infrastructure maintenance expenditure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	x	x	x	x	x	x	x	x
Australia	..	..	..	..	..	..	..	..
Austria	x	x	x	x	x	x	x	x
Azerbaijan	..	7.9	..	1.9	3.5	2.3	2.1	2.0
Belarus	x	x	x	x	x	x	x	x
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	0.5	0.5	1.0	2.0	1.5	1.5	0.5	0.5
Canada	263.9 |	1 167.5	1 173.6	1 038.4	1 376.2	1 280.6	1 378.1 |	1 523.2 p
Chile	..	..	..	..	..	..	..	..
China	..	..	..	..	..	..	..	..
Croatia	3.4	4.0	4.4	3.0	..	..	..	..
Czech Republic	x	x	x	x	x	x	x	x
Denmark	..	..	..	..	..	..	..	..
Estonia	..	..	..	..	..	..	..	..
Finland	122.0	101.0	112.0	101.0	76.0 |	91.0	94.0	122.7
France	53.0	53.0 e	53.0 e	53.0 e	53.5 e	50.7 e	49.5	46.6
Georgia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	x	x	x	x	x	x	x	x
Iceland	..	..	..	..	..	..	..	..
India	147.6	130.7	172.3	183.9	260.4	..	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	1 447.0	1 628.0	1 263.0	2 609.0	2 538.0	1 478.0	1 539.0	..
Japan	..	..	..	..	..	..	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	84.2	99.5	102.2	111.2	135.7	136.3	..	..
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	2.0	3.0	3.0	4.0	7.0	4.0	3.0	3.0
Luxembourg	x	x	x	x	x	x	x	x
Malta	1.0	1.0	0.0	2.0	..	..	..	..
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	..	..	..	..	..	..	0.0	..
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	..	310.2	318.9	348.8	363.1	344.8	372.1	392.5
North Macedonia	x	x	x	x	x	x	x	x
Norway	..	..	..	..	..	..	..	..
Poland	15.3	15.3	19.5	..	..	..	..	..
Portugal	4.0	3.0	3.0	2.6	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	x	x	x	x	x	x	x	x
Slovak Republic	x	x	x	x	x	x	x	x
Slovenia	3.0	3.0	2.0	3.0	2.0	4.0	2.0	3.0
Spain	..	..	..	..	..	..	..	..
Sweden	27.4	19.6	19.8	18.0	23.2	25.9	23.6	..
Switzerland	x	x	x	x	x	x	x	x
Turkey	..	..	..	..	..	..	..	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	..	..	..	..	..	..	..	..

.. Not available; e Estimated value; p Provisional data; x Not applicable; | Break in series
Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.
Source: ITF Transport statistics

Airport infrastructure maintenance expenditure

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Argentina	..	..	..	..	..	..	..	..
Armenia	..	..	..	..	..	..	..	..
Australia	..	..	..	..	..	..	..	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	7.3	7.9	9.6	9.6	7.9	5.7	5.1	5.0
Belarus	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	1.5	0.0	2.0	2.0	1.5	1.5	0.5	0.5
Canada	699.3	755.8 |	741.0	720.6	800.6	850.4	941.0	982.9
Chile	25.1 p	22.4 p	17.8 p	21.6 p	26.8 p	24.1 p	24.3 p	19.9 p
China	..	..	..	..	..	..	..	..
Croatia	3.5	3.5	4.5	4.5	3.5	4.0	6.3	6.6
Czech Republic	7.0	8.8	15.2	9.0	8.2	11.0	17.2	13.7
Denmark	..	..	..	..	..	..	..	..
Estonia	..	..	..	..	..	..	..	..
Finland	267.0	268.0	251.0	233.0	232.0	240.0	219.0	209.1
France	..	..	..	..	..	..	..	..
Georgia	1.0	1.6	1.4	1.2	1.2	1.2	1.2	1.4
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	8.5	8.1	7.6	7.1	7.5	7.7	18.6	22.9
Iceland	..	..	..	..	..	..	..	..
India	143.9	166.7	128.6	125.0	136.4	..	..	..
Ireland	29.0	..	..	..	..	..	..	..
Italy	95.0	115.0	109.0	93.0	90.0	170.0	141.0	..
Japan	..	..	..	..	..	..	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	15.1	19.0	20.1	36.5	49.6	..	..	..
Latvia	..	..	..	..	..	..	..	..
Liechtenstein	x	x	x	x	x	x	x	x
Lithuania	1.0	1.0	2.0	2.0	2.0	3.0	5.0	4.0
Luxembourg	7.0	9.7	9.6	7.5	11.0	9.6	7.5	12.0
Malta	..	..	..	..	..	..	..	..
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	..	..	0.1	0.0	..	..	..	..
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	112.3	148.1	155.1	168.8	182.3	154.2	166.4	169.4
North Macedonia	..	..	..	..	..	..	..	..
Norway	..	..	..	..	..	..	..	..
Poland	20.6	64.3	33.6	63.1	96.3	15.4	2.1	3.2
Portugal	16.0 |	..	..	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	0.0	1.3	0.0	0.1	0.1	0.0	0.5	0.0 p
Slovak Republic	2.0	3.0	1.0	1.0	1.9	2.4	2.7	2.2
Slovenia	..	..	..	..	..	..	0.0	0.0
Spain	..	..	..	..	..	..	..	..
Sweden	17.3	17.7	16.4	12.3	13.1	13.6	14.0	13.7
Switzerland	..	..	..	..	..	..	..	..
Turkey	2.6	44.5	32.0	9.6	44.0	25.1	34.5	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	..	..	..	..	..	..	..	..

.. Not available; p Provisional data; x Not applicable; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total spending on road infrastructure investment and maintenance

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	217.9	187.5	242.9	208.0	187.6	102.1	172.6	182.7
Argentina	..	..	..	..	..	..	..	..
Armenia	40.8	37.2	33.3	76.8	89.0	102.0	..	..
Australia	..	..	..	..	..	..	..	..
Austria	797.0	844.0	922.0	1 120.0	1 147.0	1 141.0	1 202.0	1 189.0
Azerbaijan	1 588.2	1 518.8	1 945.3	1 443.0	896.1	516.8	584.9	720.4
Belarus	..	..	..	..	..	..	..	..
Belgium	404.0	698.0	734.0	623.0	1 235.0 p	1 338.0	1 052.7 p	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	591.1	697.4	609.0	663.7	977.1	338.0	279.2	1 139.2
Canada	20 884.7	20 986.1	17 028.6 |	9 836.6 |	12 567.7	11 927.8	12 844.1	11 404.2 p
Chile	1 631.2 |	1 958.0 p	2 070.2 p	1 949.1 p	2 218.6 p	2 144.5 p	2 079.3 p	1 786.6 p
China	..	..	..	..	..	..	..	..
Croatia	677.8	665.2	633.2	536.9	483.5	431.7	369.0	478.8
Czech Republic	1 862.9	1 447.0	1 160.6	1 191.1	1 569.8	1 616.5	1 705.5	1 916.2
Denmark	1 932.8	2 268.2	1 967.0	1 897.4	1 894.2	2 019.2	2 183.2	2 235.4
Estonia	197.0	242.7 |	261.7	194.0	232.6	192.2	239.0	258.0
Finland	1 631.0	1 653.0	1 659.0	1 744.0	1 751.9	1 722.0	1 783.5	2 069.0
France	15 350.3	16 024.7	15 770.2	13 567.2	12 609.5	11 599.9	11 453.2	12 000.8
Georgia	261.0	192.5	250.8	240.1	209.6	220.4	338.5	432.8
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	554.5	448.4	770.8	1 511.2	1 529.9	1 095.3	1 649.8	2 160.0
Iceland	67.7 |	67.7	69.6	77.6	110.8	120.1	159.0	182.9
India	14 915.7	13 971.9	15 516.1	15 949.9	21 178.6	..	..	..
Ireland	1 176.0	1 025.0	722.0	723.0	694.0	..	..	..
Italy	10 349.0	10 303.0	11 975.0	13 424.0	14 217.0	11 957.0 p	12 212.0	..
Japan	51 494.0	54 911.8	49 386.1	43 920.8	42 580.8	47 335.4	48 799.7	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	10 743.0	12 386.3	13 002.2	12 552.4	15 380.9	..	..	..
Latvia	347.0	310.0	332.0	342.0	374.0	365.0	403.0	422.0
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	496.0	366.0	380.0	367.0	417.0	509.0	496.0	469.0
Luxembourg	258.9	247.1	256.5	250.3	261.4	260.3	261.4	247.4
Malta	44.5	51.0	36.0	55.8	..	..	..	..
Mexico	4 737.3	4 809.0	5 278.1	6 007.5	5 387.2	4 477.3	2 897.5	..
Moldova, Republic of	44.6	95.3	100.2	110.9	92.5	61.9	60.6	82.4
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	2 610.0	..	..	..	..	..	..	..
New Zealand	1 762.8	1 649.7	1 686.6	1 839.9	1 984.2	1 903.9	1 936.5	2 120.9
North Macedonia	..	..	..	..	..	..	..	..
Norway	4 427.0	5 047.7	5 685.3	5 794.1	5 507.5	..	..	..
Poland	11 002.7	4 810.8	2 903.0	2 104.2	2 586.3	3 494.1	3 726.2	3 133.4
Portugal	..	439.0 p	385.0 p	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	544.4	465.5	408.4	480.0	668.1	674.7	709.4	740.3 p
Slovak Republic	589.0	504.0	564.0	731.0	1 334.8	966.4	979.6	1 064.5
Slovenia	234.0	222.0	227.0	241.0	228.0	238.0	323.0	448.0
Spain	..	..	..	..	..	..	..	..
Sweden	2 768.2	3 170.9	3 056.7	2 882.3	3 045.1 |	3 216.3	3 455.5	3 586.4
Switzerland	6 057.5	6 293.9	6 133.7	6 067.8	6 987.0	6 667.7	6 638.9	..
Turkey	5 879.1	5 501.8	6 856.2	7 201.8	9 296.1	7 559.7	6 368.0	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	9 009.3	9 008.1	9 175.3	10 726.9	12 231.3	11 065.5	11 098.0	11 053.4
United States	89 315.9	98 611.5	95 493.9	98 015.5	118 947.4	126 469.4 p	..	..

.. Not available; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Total inland transport infrastructure investment as a percentage of GDP

Percentage

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	2.3	1.9	2.4	1.9	1.8	0.8	1.4	1.3
Argentina	..	..	..	..	..	..	..	..
Armenia	0.8	0.6	0.4	0.9	0.9	1.0	..	..
Australia	1.8	1.9	1.6	1.4	1.2	1.3	1.5	1.7
Austria	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Azerbaijan	3.3	2.7	3.4	2.5	1.8	1.5	1.5	1.8
Belarus	3.5	4.1	3.2	2.8	2.4	2.2	2.4	2.2
Belgium	0.5	0.5	0.5	0.4 |	0.5	0.5	0.4 p	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	1.5	1.7	1.5	1.7	2.5	0.7	0.4	1.7
Canada	1.2	1.1	1.0	0.4 |	0.6	0.6	0.6	0.5 p
Chile	..	..	..	..	..	..	..	..
China	4.1	4.4	4.6	5.0	5.3	5.5	5.8	5.6
Croatia	1.2	1.2	1.4	0.9	0.7	0.5	0.5	0.7
Czech Republic	1.1	0.8	0.6	0.7	1.2	0.9	0.8	0.9
Denmark	0.8	0.9	0.8	0.9	0.9	0.8	0.8	0.8
Estonia	1.5	1.4 |	1.3	0.8	1.0	0.8	0.9	0.9
Finland	0.7	0.8	0.9	0.9	0.9	0.8	0.8	0.9
France	1.0	1.0	1.1	0.9	0.9	0.8	0.8	0.8
Georgia	4.7	3.3	2.3	2.3	2.1	2.1	2.5	3.1
Germany	0.6	0.6	0.6 |	0.6	0.6	0.6	0.6	0.7
Greece	0.7	0.7	1.3	1.0 e	0.9 e	1.8 e	2.4 e	..
Hungary	0.6	0.6	1.0	1.8	1.7	1.0	1.5	1.9
Iceland	0.4 |	0.3	0.3	0.3	0.4	0.4	0.4	0.5
India	0.8	0.8	1.0	1.1	1.2	1.1	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	0.5	0.5	0.4	0.6	0.5	0.4 p	..	..
Japan	1.0	1.0	1.1	1.1	0.9	1.0	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	1.6	1.7	1.7	1.5	1.6	..	..	..
Latvia	1.4	1.3	1.2	1.4	1.7	0.9	0.9	0.8
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	1.5	1.1	1.1	1.3	1.2	1.1	0.9	0.9
Luxembourg	0.9	0.8	0.8	0.8	1.0	1.0	0.9	0.7
Malta	0.3	0.4	0.1	0.5	..	..	..	..
Mexico	0.5	0.5	0.5	0.6	0.5	0.5	0.4	..
Moldova, Republic of	0.3	0.7	0.7	0.6	0.8	0.5	0.4	0.4 p
Montenegro, Republic of	0.5	0.6	0.6	0.3	0.3	0.4	0.3	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	0.6	..	..	..	..	..	..	..
New Zealand	0.9	0.6	0.7	0.7	0.7	0.7	0.6	0.7
North Macedonia	..	..	..	..	..	..	..	..
Norway	0.9	1.0	1.2	1.3	1.4	1.5	1.4	..
Poland	2.4	1.2	0.7	0.4	0.6	0.8	0.8	0.6
Portugal	..	0.2 p	0.2 p	..	..	..	..	..
Romania	3.0	2.6	2.2	2.1	2.3	1.7	1.3	1.2
Russian Federation	1.3	1.2	1.1	1.0	0.9	1.1	0.9	0.8
Serbia, Republic of	1.0	0.8	0.8	1.0	1.7	1.7	1.5	1.3 p
Slovak Republic	1.0	0.7	0.9	1.1	1.8	1.1	1.2	1.2
Slovenia	0.6	0.5	0.7	1.1	1.2	0.5	0.5	0.8
Spain	1.3	1.0	0.7	0.7	0.6	0.5	0.5	0.5 p
Sweden	0.8	0.9	0.8	0.8	0.8 |	0.8	0.8	0.8
Switzerland	1.4	1.4	1.4	1.3	1.4	1.3	1.2	..
Turkey	1.1	0.9	1.2	1.1	1.3	1.2	1.0	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	0.7	0.7	0.7	0.8	0.9 |	0.9	0.9	0.9
United States	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5

.. Not available; e Estimated value; p Provisional data; | Break in series

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INDICATORS&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

Capital value of inland transport infrastructure assets

Million euros

	2011	2012	2013	2014	2015	2016	2017	2018
Albania	..	..	..	..	..	..	..	..
Argentina	..	..	..	..	..	..	..	..
Armenia	273	34	19	36	18	12	..	..
Australia	..	..	..	..	..	..	..	..
Austria	..	..	..	..	..	..	..	..
Azerbaijan	..	..	..	..	..	..	..	..
Belarus	19 066 e	18 425 e	20 508 e	19 267 e	16 676 e	13 239 e	14 141 e	13 984 e
Belgium	..	..	..	..	..	..	..	..
Bosnia-Herzegovina	..	..	..	..	..	..	..	..
Bulgaria	..	..	..	..	..	..	..	..
Canada	..	..	..	..	..	..	..	..
Chile	..	..	..	..	..	..	..	..
China	..	..	..	..	..	..	..	..
Croatia	..	..	..	..	..	..	..	..
Czech Republic	..	..	..	..	..	..	..	..
Denmark	..	..	..	..	..	..	..	..
Estonia	..	..	..	..	..	..	..	..
Finland	..	..	..	..	..	..	..	..
France	691 363	694 213	697 677	699 964	702 361	703 687	705 668	708 044
Georgia	..	..	..	..	..	..	..	..
Germany	..	..	..	..	..	..	..	..
Greece	..	..	..	..	..	..	..	..
Hungary	..	..	..	..	..	..	..	..
Iceland	..	..	..	..	..	..	..	..
India	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	..	..	..	..
Italy	..	..	..	..	..	..	..	..
Japan	..	..	..	..	..	..	..	..
Kazakhstan	..	..	..	..	..	..	..	..
Korea	..	..	..	..	..	..	..	..
Latvia	7 190	8 005	7 013	6 651	7 203	6 949	6 911	..
Liechtenstein	..	..	..	..	..	..	..	..
Lithuania	..	..	..	..	2 994	3 040	3 247	3 476
Luxembourg	..	..	..	..	..	..	..	..
Malta	..	..	..	..	..	..	..	..
Mexico	..	..	..	..	..	..	..	..
Moldova, Republic of	..	..	..	..	..	..	..	..
Montenegro, Republic of	..	..	..	..	..	..	..	..
Morocco	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..
New Zealand	21 514	22 324	21 096	22 920	24 282	25 366	27 071	..
North Macedonia	..	..	..	..	..	..	..	..
Norway	54 254	60 319	62 074	68 515	74 446	75 317	79 945	..
Poland	..	..	..	..	..	..	..	..
Portugal	..	..	..	..	..	..	..	..
Romania	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..
Serbia, Republic of	..	..	..	..	..	..	..	..
Slovak Republic	..	..	..	..	..	..	..	..
Slovenia	..	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..	..
Sweden	81 419	87 321	88 847	86 000	83 406	84 972	90 461	89 828
Switzerland	..	..	..	..	..	..	..	..
Turkey	..	..	..	..	..	..	..	..
Ukraine	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..
United States	2 514 479	2 833 930	2 808 237	2 836 394	3 421 593	3 534 972	3 596 387	3 578 163 e

.. Not available; e Estimated value

Note: Detailed metadata at: http://dotstat.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=ITF_INV-MTN_DATA&Lang=en&backtodotstat=false.

Source: ITF Transport statistics

ITF Transport Outlook 2021

The *ITF Transport Outlook 2021* provides scenarios for the development of transport demand up to 2050. It also models transport decarbonisation scenarios and their impacts on climate change. Based on this, the *ITF Transport Outlook 2021* identifies decisions that policy makers will need to take to ensure a transition to sustainable mobility that is effective as well as equitable. This edition includes a special focus on the impacts of the Covid-19 pandemic on transport systems, and models potential long-term changes with challenges and opportunities for decarbonisation.

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