Partnership on Sustainable
Low Carbon Transport

TRANSPORT AND CLIMATE CHANGE 2018

GLOBAL STATUS REPORT

Transport and Climate Change Global Status Report 2018
Partnership on Sustainable, Low Carbon Transport (SLoCaT)

SLoCaT Secretariat Team
Karl Peet, Sudhir Gota, Cornie Huizenga, Nikola Medimorec, Angela Enriquez, Alice Yiu, Bente Verheul, Holger Dalkmann, Maruxa Cardama.

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Acknowledgments

Strategy Team
Barry Howe (Alstom), Harvey Scorcia (CAF), Bernhard Ensink (ECF), Andre Eckermann (GIZ and MobiliseYourCity Partnership), Daniel Bongardt (GIZ), Jacob Teter (IEA), Wei-Shiuen Ng (ITF), Nicholas Wagner (IRENA), Ahmed Al Qabany (IsDB), Ramón Cruz (ITDP), Rana Adib (REN21), Philip Turner (UITP), José Holguin-Veras (VREF), Bronwen Thornton (Walk21), Maria Cordeiro (World Bank), Carlos Dora and Thiago Hérick de Sa (WHO), Alyssa Fischer (WRI).

Section Authors and Contributors
Juan Carlos Muñoz (BRT Centre of Excellence); Diletta Giuliani (CBI); Carlosfelipe Pardo (Despacio); Richard Clarke and Sheila Watson (GFEI); Laura Merrill (GSI); Tyrrell Duncan (Independent); Bernhard Ensink (ECF); Sacha Scheffer (IEA); Jacob Mason (ITDP); Phil Sayeg (Policy Appraisal Services Pty Ltd); Rana Adib, Flávia Guerra and Hannah Murdock (REN21); Cornie Huizenga, Angela Enriquez, Sudhir Gota, Nikola Medimorec, Karl Peet and Alice Yiu (SLoCaT); Daniel Sauter (Urban Mobility Research); Adam Cohen and Susan Shaheen (UC Berkeley); Andrea Braschi and Carole Escolan Zeno (UIC); Philip Turner (UITP); Marie Venner (Venner Consulting); Todd Litman (VTPI); Maria Cordeiro (WB); Thiago Herick de Sá and Regina Guthold (WHO).

Feedback Team Members
Mark Wenzel (California EPA); Sonia Yeh (Chalmers); Jakob Baum, Urda Eichhorst, Mathias Merforth, Christian Mettke and Friedel Sehlleier (GIZ); Yann Briand (IDDRI); Pierpaolo Cazzola, Marine Gorner, Sacha Scheffer and Jacob Teter (IEA); Nicholas Wagner and Gayathri Prakash (IRENA); Susanna Zammataro (IRF); Wei-Shiuen Ng (ITF); Markus Delfs (MobilseYourCity Partnership); Jan Brooke (Navigating a Changing Climate); Aage Jorgensen (NDF); Sharon Feigon (SUMC); Andrew Murphy (Transport & Environment); Lew Fulton (UC Davis); Tristan Smith (UCL Energy Institute); Valentin Foltescu (UN Environment); Bronwen Thornton and Martin Wedderburn (Walk21); Dario Hidalgo (WRI).

Senior Advisor
Tyrrell Duncan (Independent Consultant)

Special Advisor
Rana Adib (REN21)

Lead Consultant
Aileen Carrigan (Bespoke Transit Solutions)

Editing, Design and Layout
Lisa M. Ross (Editor)
Rayce Tugano, Billy Villareal, Rai O'Yek, Armie Decena, Ronald Eugenio, Mike Cortes (Design Muscle)

Cover Photos
Nikola Medimorec
Ryoji Iwata

Peer Reviewers and Other Contributors
Alexander Jung (Agora Verkehrswende); Barry Howe (Alstom); Bert Witkamp (AVERE); Emilie Prattico (Business for Social Responsibility); Bernhard Ensink (ECF); Zoltán Szabó (EERL); Jakob Baum; Dennis Knese, Mathias Merforth, Christian Mettke, Martin Schaefer, Friedel Sehlleier, and Tali Trigg (GIZ); Cristiano Façanha (ICCT); Yann Briand (IDDRI); Sacha Scheffer (IEA); Laetitia Dablanc (IFSTTAR); Gayathri Prakash and Nicholas Wagner (IRENA); Cristian Gonzalez and Susanna Zammataro (IRF); Clarisse Linke and Jacob Mason (ITDP); Markus Delfs (MobilseYourCity Partnership); Jan Brooke (Navigating a Changing Climate); Aage Jorgensen (NDF); Holly Parker (Noa); Caley Johnson (NREL); Flávia Guerra and Hannah Murdock (REN21); Hutch Hutchinson (Rocky Mountain Institute); Ellen Partridge and Kevin Karner (Shared Use Mobility Center); Holger Dalkmann (Sustain 2030); Andrew Murphy (T&E); Philippe Stefanos (UIC); Bert Fabian (UN Environment); Herrie Schalekamp (University of Cape Town); Edna Ohiambo (University of Nairobi); Kara Kockelman (University of Texas); Marie Venner (Venner Consulting); Roger Behrens (VREF CoE - Cape Town); Todd Litman (VTPI); Bronwen Thornton (Walk21); Patricia Ferrini (WHO); Maria Cordeiro (World Bank); Ben Welle (WRI); Fernando Rangel Villasana (WWF); Stefan Bakker (Independent); Tyrrell Duncan (Independent); David Leipziger (Independent); Margarita Parra (Independent); Xumei Chen (Independent).

Foreword

A recently-released special report from the Intergovernmental Panel on Climate Change underscores the urgency of reducing emissions significantly and rapidly to achieve the 1.5 degree Celsius scenario (1.5DS) called for in the Paris Agreement, to avoid potentially catastrophic climate impacts by mid-century. The transport sector contributes roughly one quarter of global energy related GHG emissions and one sixth of total emissions and is the fastest growing emissions sector. Without rapid and ambitious mitigation action, transport emissions could more than double by 2050; thus, it is evident that any path to a 1.5DS must include low carbon transport as a central element.

This inaugural edition of the Transport and Climate Change Global Status Report (TCC-GSR) is intended to help ensure that low-carbon transport is a central strategy in climate action at global, regional, national, and sub-national levels. The report describes recent trends in transport demand emissions, illustrates recent policy targets and measures across a number of transport sub-sectors, and sets a baseline from which to demonstrate the potential of transport to make a proportional contribution to the 1.5DS. The TCC-GSR is intended primarily as a resource for policy-makers to raise ambition on climate mitigation and adaptation in sustainable transport plans and programs by countries, cities, states and provinces, and private sector companies; thus, the report provides a central repository on transport and climate change data which can help to support policy-makers in setting transport planning targets. In addition, the report offers trends analyses supported by peer examples to help increase coherence among low carbon transport policies for actors at different levels of government.

The TCC-GSR opens with a Key Findings section, which synthesizes report outputs and offers a set of broad trends observed in the past year. Part I of the report consists of a Global Overview comparing current trends in transport and climate change across three dimensions: passenger and freight transport, international aviation and shipping, and global regions with respect to transport demand, transport emissions, and low-carbon transport policy measures. Part II describes recent trends in transport demand and transport emissions and illustrates potential Paris Agreement-compliant mitigation pathways. Part III of describes frameworks for transport and climate change planning through the UNFCCC mitigation and adaptation planning processes, along with low carbon transport policy targets and measures across eight major policy areas, which are illustrated by recent examples from a range of global regions including extensive case studies from the Global South. Part IV describes avenues to scale up and accelerate implementation of low-carbon transport measures, which include financing strategies to achieve transformational change in the transport sector and ongoing stakeholder efforts to support such a transformation at global, regional, national and sub-national levels.

While the TCC-GSR offers a snapshot of recent progress on transport and climate change, it is not intended to make policy recommendations, nor does it advocate the use of any particular low carbon transport measure, mode, or technology. Data are drawn from the most recent publicly-available source to populate a set of key indicators, which are to be refined and expanded in the future. As available data are not consistently robust for each of the eight policy areas, the report maintains indicators to highlight existing gaps with the goal to support future data collection efforts. Mode shift and emission reduction impacts for implemented measures in each of the eight policy areas are quantified where possible, data sets are currently limited for most of this policy areas.

The eight policy areas described in Part III provide an illustrative subset of transport sub-sectors to complement summaries in the Global Overview, which are to be expanded in future iterations of the TCC-GSR. Future editions of the report are envisioned to have increasing emphasis on quantifying the results of policy targets and measures relative to the baselines established in the current report, and to assess these trends relative to the transport sector emission gap. To accomplish this, the TCC-GSR will seek to establish in-country networks to help compile more current and comprehensive transport data.

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Amy Kenyon
SLoCaT Board Chair

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°C	Degree Celsius
1.5DS	1.5°C scenario
2DS	2°C scenario
4DS	4°C scenario
6DS	6°C scenario
A-S-I	Avoid-Shift-Improve
ADB	Asian Development Bank
AfD	Agence française de développement (French development agency)
AR4	Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change
AR5	Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change
ASEAN	Association of Southeast Asian Nations
AV	Autonomous vehicle
B2DS	Beyond 2°C Scenario
BAU	Business-as-usual
BC	Black carbon
BRT	Bus rapid transit
CAF	Development Bank of Latin America
CBI	Climate Bonds Initiative
CDM	Clean Development Mechanism
CFI	Climate finance instruments
CH4	Methane
CHF	Swiss Franc
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
COP	Conference of Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CTF	Clean Technology Fund
CTR	Commute trip reduction
E-bike	Electric bike
EBRD	European Bank for Reconstruction and Development
ECF	European Cyclists' Federation
EDGAR	Emissions Database for Global Atmospheric Research
EEA	European Environmental Agency
EERL	Ethanol Europe Renewables Ltd.
eGSE	Electric ground support equipment
EIB	European Investment Bank
EPA	Environmental Protection Agency
ETS	Emissions trading scheme
EU	European Union
EUR	Euro
EV	Electric vehicle
EVI	Electric Vehicle Initiative

F-gases	Fluorinated gases
FAME	Faster Adoption and Manufacture of (Hybrid and) Electric Vehicles
gCO_2/kWh	Grams of carbon dioxide equivalent per kilowatt-hour
GCAS	Global Climate Action Summit
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GFEI	Global Fuel Economy Initiative
GGFAP	Global Green Freight Action Plan
GHG	Greenhouse gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German development agency)
GPAQ	Global physical activity questionnaire
GPS	Global positioning system
GSE	Ground support equipment
Gt	Gigatonnes
HDV	Heavy-duty vehicle
HLPF	United Nations High Level Political Forum on Sustainable Development
HOV	High occupancy vehicle
HSR	High-speed rail
HVO	Hydrotreated vegetable oil
IADB	Inter-American Development Bank
ICAO	International Civil Aviation Organization
ICCT	International Council on Clean Transportation
ICE	Internal combustion engines
ICT	Information and communications technology
IEA	International Energy Agency
IKI	International Climate Initiative
IMF	International Monetary Fund
IMO	International Maritime Organization
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IRF	International Road Federation
IsDB	Islamic Development Bank
ITDP	Institute for Transportation and Development Policy
ITF	International Transport Forum
ITS	Intelligent transport system
JCM	Joint Crediting Mechanism
JI	Joint Implementation
km	Kilometer
kWh	Kilowatt hour
L	Liter
LC2RTI	Low Carbon Road and Road Transport Initiative

LCV	Light commercial vehicles
LDC	Least developed countries
LDV	Light-duty vehicles
LEDS GP	Low Emissions Development Strategies Global Partnership
LEZ	Low emissions zone
LNG	Liquefied natural gas
LRT	Light-rail transit
LT-LEDS	Long-term low-emission development strategy
MaaS	Mobility as a service
MDB	Multilateral development bank
MOU	Memorandum of understanding
MPGCA	Marrakech Partnership for Global Climate Action
MRT	Mass rapid transit
Mt	Million tonnes
N_2O	Nitrous oxide
NACTO	National Association of City Transportation Officials
NAMA	Nationally Appropriate Mitigation Actions
NAP	National adaptation plan
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contributions
NDF	Nordic Development Fund
NEDC	New European Driving Cycle
NEV	New energy vehicles
NGV	Natural gas vehicles
Nm^3/h	Normal Meter Cubed per Hour
NMVOC	Non-methane volatile organic compounds
NOx	Nitrogen oxides
NUA	New Urban Agenda
NUMP	National urban mobility policy
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OHD	Off-hour deliveries
OICA	Organisation Internationale des Constructeurs d'Automobiles
P2X	Power-to-X
PIARC	World Road Association
$PM_{2.5}$	Particulate matter less than 2.5 micrometers
PPI	Private participation in infrastructure
PPMC	Paris Process on Mobility and Climate
PPP	Public-private partnership
RFP	Requests for proposals
RTR	Rapid transit to resident
RTS	Reference technology scenario
SAV	Shared automated vehicle

SDG	Sustainable Development Goal
SGD	Singapore Dollar
SLoCaT	Partnership on Sustainable, Low Carbon Transport
SMP	Shared mobility principles
SOV	Single-occupancy vehicle
SOx	Sulfur oxides
SO2	Sulfur dioxide
SuM4All	Sustainable Mobility for All
SUMC	Shared-Use Mobility Center
SUMP	Sustainable Urban Mobility Plan
SUV	Sports utility vehicle
TCC-GSR	Transport and Climate Change Global Status Report
TDA	Transport Decarbonisation Alliance
TDM	Transport demand management
TEN-T	Trans-European transport network
TNC	Transportation network company
TOD	Transit-oriented development
TUMI	Transformative Urban Mobility Initiative
U.S.	United States
UCL	University College London
UEMI	Urban Electric Mobility Initiative
UIC	International Union of Railways
UITP	International Association of Public Transport
ULEZ	Ultra-low emission zone
UN	United Nations
UNCRD	United Nations Centre for Regional Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Programme
USD	United States Dollar
V2G	Vehicle-to-grid
VKT	Vehicle kilometer traveled
VNR	Voluntary national review
VOC	Volatile organic compounds
VTPI	Victoria Transport Policy Institute
WB	World Bank
WBCSD	World Business Council on Sustainable Development
WCA	World Cycling Alliance
WHO	World Health Organization
WRI	World Resources Institute
ZEV	Zero emission vehicle

Key Findings

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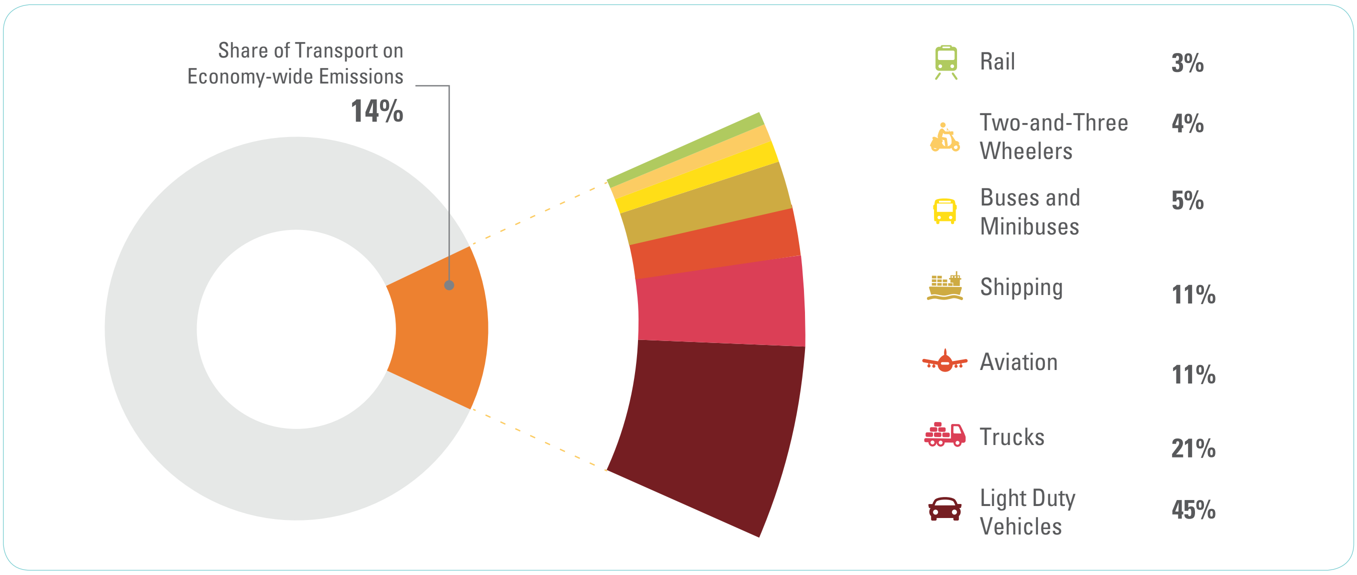
A. Transport and Climate Change Findings

Considering the implementation of the Paris Agreement on climate change, transport must inevitably play its part if global targets are to be met. This report highlights five core questions on transport emissions trends, emissions drivers, mitigation potential, policy responses, and transport's contribution toward the beyond 2°C scenario (B2DS) target.

Transport emissions are increasing in various regions and sub-sectors.

- Transport sector carbon dioxide (CO_2) direct emissions increased 29% (from 5.8 Gt to 7.5 gigatonnes (Gt)) between 2000 and 2016, at which point transport produced about 23% of global energy-related CO_2 emissions, and (as of 2014) 14% of global greenhouse gas (GHG) emissions.[1]
- Transport is the third-largest source of CO_2 emissions after the power sector and other industrial combustion.[2]
- Transport CO_2 emissions in non-Organisation for Economic Co-operation and Development (non-OECD) member countries increased from 1.5 Gt in 2000 to 2.9 Gt in 2016, which equals a share of 27% to 41%, respectively. The share of emissions from OECD countries[3] decreased from 58% to 43%, and the total transport CO_2 emissions decreased by 50 million tonnes CO_2 from 2.99 Gt in 2000 to 2.94 Gt in 2016.[4]
- Growth in absolute transport CO_2 emissions between 2000 and 2016 was highest in Asia (92%), Africa (84%) and Latin America (49%), driven by growth in passenger and freight transport activity in these regions, though starting from lower baselines than Europe and North America, where transport per capita is a lot higher than in the other regions.[5]
- Regional shares of global emissions are rising in Asia, Northern Africa, and Latin America and the Caribbean; falling in Europe and North America and remaining roughly level in Oceania.[6]
- Passenger and freight transport emissions increased by 36% and 75%, respectively, between 2000 and 2015. Freight emissions are now growing much faster than passenger transport emissions, and the freight emission share in total transport CO_2 emissions increased from 35% in 2000 to 41% in 2015.[7]
- Road transport is the largest contributor to global CO_2 emissions from transport, accounting for three-quarters of transport emissions in 2015. Passenger cars, two-and-three wheelers and mini buses contribute about 75% of passenger transport CO_2 emissions, while public transport (bus and railways) generates about 7% of the passenger transport CO_2 emissions despite covering a fifth of passenger transport globally.[8]
- Railways account for about 8% of passenger transport activity, and 28% of surface freight transport activity, while producing about 3% of global transport CO_2 emissions.[9]
- International aviation emissions increased by 47% from 2000 to 2016 and reached 523 million tonnes (Mt) CO_2 in 2016; international shipping emissions grew by 33% and reached 656 Mt CO_2 in the same year.[10] Together, international aviation and shipping produce more transport CO_2 emissions per year than any country in the world except the United States.

Figure 1: Share of Transport Sector GHG Emissions by Mode (2015)[11]



Growth in transport activity and demand is driving an increase in transport emissions.

- From 2000 to 2017, the global **population** increased by about 1.4 billion people to a total of 7.5 billion people, with 82% of that increase concentrated in middle and low-income countries. China and India alone contributed about 30% of the population increase from 2000 to 2017.[12] Population growth has a direct impact on transport demand, and an indirect impact on other demand drivers (i.e. per-capita income, urbanization).[13]
- From 2000 to 2016, **GDP growth** among regions was highest in Asia (106%) and Africa (98%).[14] Since 2008, global GDP and transport emissions have grown at annual rates of 2.7% and 1.1%, respectively, showing potential to decouple transport CO_2 emissions from income in both developed and developing countries.[15]
- From 2005 to 2015, **passenger transport energy intensity** has reduced by 27%, while freight transport energy intensity reduced by only 5% across all regions. All modes of passenger transport show improvement in terms of energy intensity reductions, with light-duty vehicles (LDVs) showing the least progress. Energy intensity of road freight vehicles has not shown reductions due to vehicle attributes, payloads, and lack of policy frameworks.
- **Passenger transport activity** has plateaued in the OECD, showing indications that motorized travel did reduce, while passenger transport in non-OECD countries grew almost threefold since 2000.
- **Public transport passenger activity** (bus and railways) has stabilized to 2000 levels in OECD countries, and has not increased in the past decade despite supportive policies and investments, whereas in non-OECD countries, absolute public transport passenger activity has doubled from 2000 levels, yet as it trails behind urban population growth it thus records a decline on a per-capita basis.
- **Global freight activity** grew from about 64 trillion tonne-kilometer (km) in 2000 to about 108 trillion tonne-km in 2015.[16] **Maritime shipping** is the main transport mode for long-distance trade, accounting for around 70% of global trade value.[17] **Surface freight activity** (road and rail) increased 40% from 2000 to 2015.
- **Air passenger-km** traveled increased 145% from 2000 to 2015, with growth in non-OECD countries nearly 3 times larger than the global average (425%), and 10 times larger than in OECD countries (44%).[18]

Transport has the potential to make a significant contribution to Paris Agreement targets.

- The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C shows that limiting global average temperature increase to 1.5°C is possible, but it requires unprecedented changes and far-reaching transitions in all sectors. CO_2 emissions would need to be reduced by at least 45% from 2010 levels by 2030 and reach net-zero by around 2050, which would also require existing CO_2 to be removed from the atmosphere.[19]
- Available evidence suggests that transport CO_2 emissions would need to be restricted to about 2 to 3 Gt in 2050 (1.5°C scenario (1.5DS), B2DS), or about 70 to 80% below 2015 levels to meet the targets set in the Paris Agreement.[20]
- A 1.5DS pathway for the transport sector is possible using a mix of stringent policy actions to reduce the need for transport trips, encourage shifts toward more efficient transport modes, and improve vehicle efficiency through low-carbon technologies. [21]
- The mitigation potential of transport requires emission reductions in all regions, sub-sectors and modes. Mitigation from passenger and freight show similar potential,[22] while the road sector offers the largest magnitude of mitigation potential. The main sources of emission savings in both OECD and non-OECD country groupings are scaling up the use of electric vehicles, implementation of **'Avoid'** and **'Shift'** policies (see definitions below), improved vehicle efficiency, and use of biofuels.
- Mitigation effects in emerging and developing countries require significantly less investment than achieving such effects in industrialized countries.

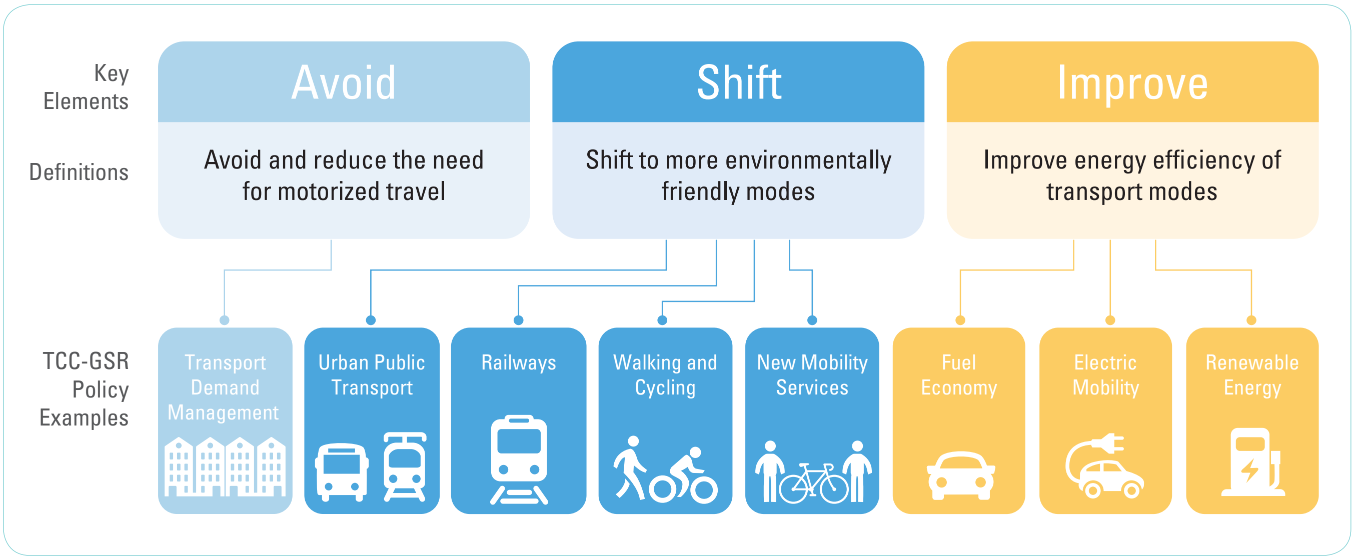
Countries and cities are formulating initial plans to reduce transport emissions and to increase resilience of transport systems.

- Key transport mitigation responses can be structured by the Avoid-Shift-Improve (A-S-I) framework:
    - **Avoid** passenger trips and freight movement or reduce travel distance by motorized modes of transport through regional and urban development policies, integrated transport and spatial planning, logistics optimization and travel demand management. (See *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management*).
    - **Shift** passenger and freight travel to more environmentally- and socially-sustainable modes, such as public transport, walking and cycling (in the case of passenger transport), and railways or inland waterways (in the case of freight transport). (See *Sections III.B.1 Sustainable Mobility Planning and Transport Demand Management, III.B.2 Urban Public Transport, III.B.3 Railways, III.B.4 Walking and Cycling, and III.B.5 New Mobility Services*).
    - **Improve** the energy efficiency of transport modes through low carbon fuel and vehicle technologies,

increased vehicle load factors, and better managed transport networks, with non-petroleum, low carbon fuels playing a more significant role, particularly before 2030. (See *Sections III.B.6 Fuel Economy, III.B.7 Electric Mobility, and III.B.8 Renewable Energy in Transport*).

- An analysis of all submitted 166 Nationally Determined Contributions (NDCs) representing 193 countries shows that 76% highlight transport as a mitigation source, but only 8% of NDCs have established transport sector emission mitigation targets.[23] In addition, there are 20 NDCs with indirect targets (e.g. targeting public transport mode share, renewable energy share, fuel consumption reduction, fuel efficiency) among all NDCs submitted, and in some cases NDCs do not reflect transport targets included in national plans (e.g. Germany).[24]
- NDCs do not outline clear pathways to decarbonizing transport. Most NDCs do not consider important interlinkages with other sectors (e.g. linkages between electric mobility and renewable energy, or implications of electric mobility on energy supply and networks).[25]
- NDCs focus more on passenger transport than freight. 64% of the NDCs highlighting transport refer to passenger transport, and only 21% refer to freight.[26]
- Transport adaptation to climate change appears in 29 NDCs (16%), and only 10 NDCs (4%) identify specific transport adaptation measures (e.g. infrastructure resilience projects).[27]
- Adaptation plans, especially those in developing countries, are often limited by a lack of reliable information on future climate impacts and current inventories of transport assets and services. With more reliable and up-to-date inputs, transport sector adaptation and mitigation plans can include more science-based targets.
- There are significant discrepancies in terms of levels of implementation of low carbon transport measures among developed and developing regions, countries and cities.

Figure 2: Avoid-Shift-Improve Framework



Transport plans and actions to date are insufficient to make a proportional contribution to the well-below-2 degrees Celsius scenario.

- Policy responses expressed within the United Nations Framework Convention on Climate Change (UNFCCC) framework fall short of what is needed for the transport sector. Instruments such as NDCs do not fully serve their purpose in structuring action; transport adaptation is largely absent in national adaptation plans (NAPs) and National Adaptation Programme of Actions (NAPAs); and few long-term low-emission development strategies (LTS) have been submitted to the UNFCCC to date.
- On mitigation, the sector is falling behind on the 2020-2030-2050 trajectory. The main shortfalls include: lack of progress on key technologies; high share of motorized private travel in OECD countries; passenger travel in non-OECD countries,[28] rising urbanization and motorization in Africa and Asia; projected continued growth in surface freight in all regions (with little change in market share of road and rail), with a projected trebling in the Asia-Pacific region to account for two-thirds of surface freight by 2050;[29] and a continued dominance of road transport and aviation emissions in the sector.

- If the economy-wide 2030 targets are translated to the transport sector, assuming the current transport share in economy-wide emissions, the 2030 NDC transport trajectory would be above the B2DS trajectory (emission gap) by 16%.[30]
- The IPCC Fourth Assessment Report[31] in 2007 estimated that the share of non-OECD countries in the total transport emissions will increase to 46% by 2030. However, by 2015, the non-OECD share in transport emissions had already increased to 48% (15 years ahead of the forecast).[32]
- In conclusion, mitigation commitments and actions in the transport sector to date are insufficient to achieve a B2DS target, highlighting the need to accelerate action and potentially increasing the need for ambitious adaptation efforts.

B. Transport and Climate Change Trends and Developments

The following statements provide context for the recent trends and developments in transport that helped shape the response of the transport sector to climate change.

Technology is playing an increasing role in low carbon transport plans and targets from countries, states and provinces, cities, and companies.

- Improvements in **vehicle standards** and **fuel economy** are also significant for transport emission reductions. The average fuel economy improved by 1.5% between 2005 and 2015,[33] and fuel economy standards saved 9.7% of fuel consumption in road transport in 2015.[34]
- **Electric mobility** (especially for passenger light-duty vehicles (LDVs) and two-wheelers) is proliferating the global market, helped in part by supporting policies, lower costs and larger capacity of batteries. After the electric car stock grew to 1 million in 2015, it surpassed 2 million in 2016 and reached 3 million in 2017; however, electric cars still account for just 0.3% of total passenger LDVs globally.[35]
- **Electric bike** (e-bike) sales outnumbered four-wheeled electric vehicles (EVs) globally by a more than 30:1 ratio, and worldwide around 32 million e-bikes were sold in 2017, the majority in Europe and China.[36] In the Netherlands, one of three bikes sold in 2017 was an e-bike.[37]
- In 2017, low carbon technologies played an increasing role for **electric buses**, with rapid scaling up of production and deployment. Cities in Europe, Latin America, Africa and Asia announced and executed plans to electrify their bus fleets. By 2017, there were around 375,000 electric buses[38] in operation in more than 300 cities, with more than 98% deployed in China.[39]
- In 2015, the **renewable energy** share in transport was estimated at 3.1%, while renewable electricity represented approximately 0.3% of energy use in the sector.[40]
- Links between **transport electrification** and **renewable energy** are still tenuous. While there are limited examples of countries with explicit policy linkages between EVs and renewable electricity,[41] implicit linkages exist in 43 countries that have targets (at the national or sub-national level) for both EVs and for shares of renewable electricity.[42] The CO_2 savings of EVs were in total 29.4 Mt in 2017, mostly contributed to by e-bikes in China.[43] As EV uptake continues, more explicit policy linkages and utility support of transportation electrification will be required to reduce emissions.[44]
- Several announcements related to **alternative fuels** for long-distance freight, shipping, and aviation were made in 2017. Prototypes of electric planes, ships, and heavy-duty vehicles (HDVs), as well as fuel-cell heavy duty trucks were released.[45] While over 100,000 commercial flights have used sustainable aviation fuels to date,[46] challenges remain to decarbonizing the aviation and shipping subsectors. Mitigation potential in these sectors may depend on efficiency improvements, along with replacement of fossil fuels with advanced biofuels (including biodiesel and ethanol produced from biomass feedstock and non-food energy crops), synthetic fuels, and transport electrification powered by renewable energy.
- **Micromobility services**, such as shared bikes, electric kick scooters and e-scooters, emerged in recent years and had accelerated growth in 2017. Bikesharing is constantly expanding since a decade ago, and new dynamics have been recorded through the introduction of dockless bikesharing systems.
- The number of **carsharing** vehicles grew globally by 51% between 2014 (104,060) and 2016 (157,357).[47] Asia accounts for 58% of worldwide carsharing membership, and 43% of global fleets deployed.[48]
- Through 2017, **autonomous vehicles (AVs)** were being tested in 82 cities in 26 countries across the globe.[49] Public and private-sector investments in AVs proliferated, with a path to rollout becoming clearer, and the timeframe to rollout shortening.[50]
- **Fuel cell driven trains**, which are powered by carbon-free produced hydrogen, have been implemented, and are designed to replace diesel trains on non-electrified lines.[51]

Transport is playing a more central role in global processes on climate change and sustainable development, but holistic solutions are still needed.

- In 2015, the United Nations (UN) adopted the **2030 Agenda for Sustainable Development** and established 17 Sustainable Development Goals (SDGs) and 169 targets. Transport is linked to direct and indirect targets of 8 SDGs. In the Voluntary National Reviews (VNRs) submitted to the High-Level Political Forum (HLPF) in 2017, nearly all countries (98%) reporting on their contributions to the SDGs referenced transport, and 35% provided specific examples for transport actions.[52] The **New Urban Agenda** (NUA) commits to the use of sustainable and efficient transport infrastructure and services where possible.[53]
- In 2017, transport strengthened its position under the **Marrakech Partnership on Global Climate Action (MPGCA)** through the launch of six new initiatives on topics including walking, low-carbon fuels, and sustainable urban mobility, among others. There are now 22 MPGCA Transport Initiatives that include both passenger and freight transport and touch on all major transport sectors and modes.[54]
- The **Sustainable Mobility for All (SuM4All)** Initiative brings together a diverse group of transport stakeholders to act collectively to implement the SDGs and transform the transport sector. In 2017 the Global Mobility Report was released by SuM4All to assess the performance of the transport sector regarding their four main objectives: universal access, efficiency, safety and green mobility.

Political and corporate leadership on transport and climate change is growing in scope and intensity, within and outside of global agreements.

- Some countries/sub-national entities are setting deadlines to phase out internal combustion engines (ICEs), and targets to ramp up electric vehicles. In some cases, these are more isolated announcements without direct policy follow-up. In 2017, six countries (France, Ireland, The Netherlands, Slovenia, Sri Lanka and United Kingdom) as well as the subnational entities California and Scotland announced phase-out targets for fossil fuel vehicles between 2030 and 2040, to join Norway, which set a target on ban of sales for diesel and petrol vehicles by 2025 in 2016.[55]
- In 2017, 13 countries announced specific targets on EV uptake, for a total of 60 countries to date.[56] **China** announced in 2017 that car makers will need to have a 10% share of new-energy vehicles' sales by 2019 and 12% by 2020.[57] Vehicle manufacturers are responding to city/company plans by setting more ambitious internal targets to phase out fossil fuel vehicles, and expand (hybrid and) electric models.
- The **Transport Decarbonisation Alliance (TDA)** is composed of entities committed to ambitious action on transport and climate change, around public commitments to decarbonize transport before or by 2050, and providing up-to-date public information about relevant objectives, actions, progress and experiences.[58]
- In April 2018, **the International Maritime Organization (IMO)** agreed to its first long-term emissions reduction plan, with a target of reducing carbon emissions 50% compared to 2008 by 2050 by optimizing operations and capacity, increasing energy efficiency, and transitioning the sector to low or zero-carbon fuels.[59]
- By 2017, 660 companies had pledged more than 1,000 commitments related to climate change. Transport-related commitments under **We Mean Business**, include **below50** (sustainable fuels) and **EV100** (electric mobility); 38 companies have signed these transport commitments to date.
- In 2018, the **World Health Organization (WHO)** published the Global Action Plan for Physical Activity, which aims for a 15% reduction (vs. 2016) in physical inactivity in adults and adolescents by 2030, with a strong emphasis on walking and cycling.[60]
- The Global Climate Action Summit (GCAS) in September 2018 concluded with new commitments and alliances on transport and climate change: 26 states and regions, major cities and businesses committed to 100% zero emission vehicle targets; **World Business Council on Sustainable Development (WBCSD)**, **CALSTART** and companies created low-carbon freight initiatives, and a pledge for USD 4 billion was made by a group of 29 philanthropists.[61]

No major breakthroughs in financing for low-carbon transport in 2017.

- Current financial flows in the transport sector are estimated to be between USD 1.4 and USD 2.1 trillion.[62]
- Transport represented 36% of **private-sector investment** commitments in developing countries (USD 44 billion) in 2010.[63]
- The position of transport is gaining prominence in **green and other climate-themed bonds**, building upon historic trends in transport bond financing. With a multitude of rail and urban metro deals, green bond allocations to low carbon transport almost doubled in volume (from USD 13 billion to USD 24 billion) in 2017, accounting for 15% of total green bond issuances.[64]
- There were only 12 transport projects in 2017 supported by **climate-finance instruments** (CFIs),[65] down from a

peak of 41 CFI-funded transport projects in 2012. The 12 projects received a total of USD 111 million for low carbon transport in Africa, Asia and Latin America.[66]

- Transport is still largely marginalized in discussions on **carbon pricing**, though countries such as **India, Indonesia, Mexico,** and **United Arab Emirates** have made recent progress. **California** updated its cap-and-trade scheme in July 2017, which indirectly includes the transport sector, and **China** launched the world's largest carbon market by approving the national emissions trading scheme (ETS) in December 2017.[67]
- **Multilateral Development Banks** (MDBs) continue to be a major external source of funding for low carbon transport in the developing world. The eight MDBs that comprise the MDB Working Group on Sustainable Transport provided in 2016 more than USD 20 billion of new funding for more sustainable transport projects, staying on target to meet the Rio+20 Commitment goal of providing more than USD 175 billion for transport in developing countries from 2012-2022.
- **Fuel subsidies** still promote unsustainable forms of transport, although progress was made in 2016 as the G7 decided to end most fossil fuel subsidies by 2025.[68] **Mexico** ended oil subsidies in 2017, leading to an increase in prices and more efficient use of fuels.[69] International aviation remains exempt from kerosene taxation, which is partly driving the increase in emissions.[70]
- Significant barriers remain to financing sustainable, low-carbon transport, including a constrained fundable project pipeline with project selection criteria overlooking the co-benefits of low-carbon transport projects, and therefore favoring other sectors. The establishment of the **Green Climate Fund** in 2015 has not yet led to an increase in transport adaptation and mitigation projects; only 3 of 76 projects to date focus on transport.[71]
- Climate change is often not the main driver of transport policy reforms, as decision-makers often prioritize investments in transport infrastructure and services to address immediate externalities such as environmental pollution, road safety, and congestion.[72] Therefore, prioritizing sustainable transport investments addressing both climate and development agendas can draw resources from a broader set of stakeholders.[73]

Adaptation in the transport sector continues to lag behind mitigation action.

- Transport infrastructure still lacks physical and organizational resilience to address the implications of climate change.[74] The transport sector will be challenged by phenomena such as sea-level rise, temperature changes and increased rainfall, which can increase rail buckling, cause damage to bridges and ports, and speed pavement deterioration.[75] Drought and low water flow have impacts on inland waterway transport.
- The initial focus of climate change actions and financing on mitigation is slowly shifting towards more adaptation measures. The **European Environment Agency (EEA)** reported that 25 of the 28 European Union member states had adopted a national adaptation strategy by late 2017, and 15 had developed a national plan.[76]
- **The Global Center on Adaptation (formerly Global Center of Excellence on Climate Adaptation)**, launched formally at 23rd session of the Conference of Parties (COP 23) in November 2017, highlighted new momentum for the need for climate adaptation.[77] Infrastructure and transport is one of the center's focus areas.

Photo credit: Carlos Felipe Pardo

Dashboard I: Key Findings

Dashboard I outlines the most relevant transport demand indicators and how transport activity and emissions have developed between 2000 and 2017, on a global basis and among OECD and non-OECD countries.

	Years	World	OECD	Non-OECD	Data Sources
Transport Demand					
Population Size (billion people)	2000	6.12	1.16	4.96	United Nations, (2017). 2017 Revision of World Population Prospects. Available at: https://esa.un.org/unpd/wpp/
	2017	7.52	1.29	6.23	
	%Δ	23%	12%	26%	
Urban Population (billion people)	2000	2.83	0.88	1.95	
	2017	4.08	1.05	3.03	
	%Δ	44%	19%	55%	
GDP (Constant 2010 USD in trillion)	2000	49.25	38.18	11.07	World Bank, (2018). GDP (constant 2010 US$). Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD
	2016	74.91	49.42	25.49	
	%Δ	52%	29%	130%	
Transport Activity					
Passenger Travel Activity (trillion passenger-km)	2000	32.3	18.2	14.1	EA and WBCSD, (2004). IEA/SMP Model Documentation and Reference Case Projection. Available at: http://www.libralato.co.uk/docs/SMP%20model%20guidance%202004.pdf; IEA, (2016). Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems. International Energy Agency. Available at: http://www.iea.org/etp2016/
	2015	56.3	18.3	38	
	%Δ	74%	1%	169%	
Freight Travel Activity (trillion tonne-km)	2000	64	8	6.4	
	2015	107.6	15.7	24.2	
	%Δ	68%	96%	279%	
Motorization Rate (per 1,000 People)	2005	136	549	42	SLoCaT calculations based on OICA, (2015). Motorization Rate 2015 - worldwide. Available at: http://www.oica.net/category/vehicles-in-use/
	2015	173	591	85	
	%Δ	27%	8%	99%	
Transport Emissions					
Transport CO_2 Emissions excl. international aviation and shipping (Mt CO_2)	2000	4506	2990	1516	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016
	2016	5923	2943	2980	
	%Δ	31%	-2%	97%	
Transport CO_2 Emissions per Capita (tonnes CO_2)	2000	0.74	2.59	0.31	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016; United Nations, (2017). 2017 Revision of World Population Prospects. Available at: https://esa.un.org/unpd/wpp/
	2016	0.80	2.29	0.48	
	%Δ	8%	-11%	59%	

Dashboard I: Key Findings (continued)

	Years	World	OECD	Non-OECD	Data Sources
Transport Emissions *(continued)*					
Passenger Transport CO_2 Emissions (Mt CO_2) *(Difference in values due to different methodology than Transport CO2 Emissions by EDGAR above)*	2005	4311	3095	1216	IEA, (2016). Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems. International Energy Agency. Available at: http://www.iea.org/etp2016/
	2015	5295	2987	2308	
	%Δ	23%	-3%	90%	
Freight Transport CO_2 Emissions (Mt CO_2) *(Difference in values due to different methodology than Transport CO2 Emissions by EDGAR above)*	2005	3120	1369	1751	
	2015	3783	2017	1766	
	%Δ	21%	47%	1%	
International Aviation CO_2 Emissions (Mt CO_2)	2000	64	8	6.4	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016
	2015	107.6	15.7	24.2	
	%Δ	68%	96%	279%	
International Shipping CO_2 Emissions (Mt CO_2)	2005	136	549	42	
	2015	173	591	85	
	%Δ	68%	96%	279%	

Part I. Global Overview

Photo credit: Matthew Nolan

Addressing climate change is one of the major global challenges of our time. The transport sector is a major contributor of greenhouse gas (GHG) emissions; responsible for 23% of global energy-related carbon dioxide (CO_2) emissions.[78] The rate of emissions from transport is increasing faster than from any other sector.[79] This section provides a global overview of the current trends within the transport sector, with examples of policy measures to mitigate emissions, and approaches to strengthen resilience to climate impacts from the various regions.

A. Passenger and Freight Transport Trends

Global passenger and freight transport, respectively, accounted for about 59% and 41% of transport energy consumption and transport emissions in 2015. However, policy measures to date for passenger and freight transport have not been proportional to their relative impact. Light-duty vehicles (LDVs)[80] and air transport together account for 78% of passenger transport activity, and 93% of passenger transport CO_2 emissions. Road freight (light-commercial vehicles, freight vans and heavy-duty vehicles (HDVs)) represent 21% of freight transport activity (in tonne-kilometer (km)) but produce over half of transport CO_2 emissions.[81] Nationally Determined Contributions (NDCs) transport measures are highly skewed towards passenger transport, which represent 64% of NDCs that highlight transport mitigation; in contrast, freight is relatively neglected, included in just 21% of NDCs highlighting transport mitigation.[82] To illustrate, by 2017 only five countries (**Canada**, **China**, **India**, **Japan** and the **United States**) had adopted fuel economy standards for HDV, compared to LDV standards, which had been adopted in the 28 countries of the European Union and ten other countries.[83]

1. Passenger Transport

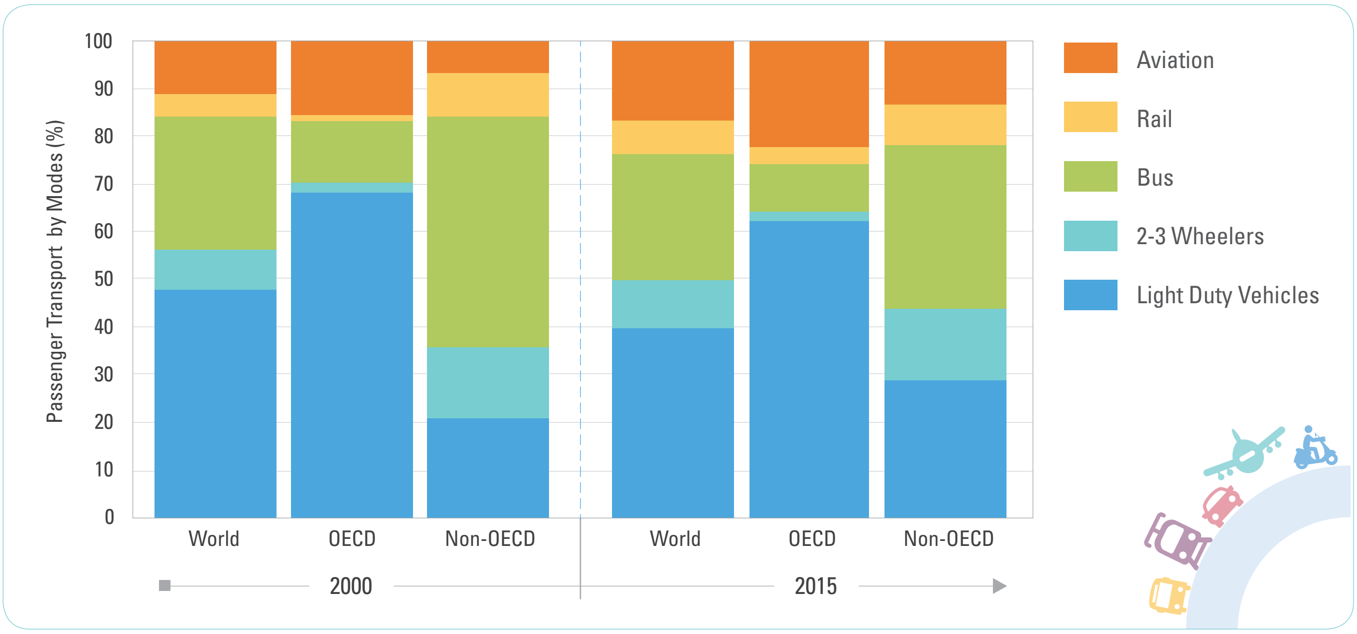
Transport Demand

Motorized passenger transport activity reached over 56 trillion passenger-km in 2015, due to increasing urbanization, gross domestic product (GDP) growth and other factors. Passenger transport in Organisation for Economic Co-operation and Development (OECD) member countries stayed at the same level between 2000 and 2015, while it increased by 169% in non-OECD countries. While the greatest rates of increase are seen in non-OECD countries, they are coming from a low baseline compared to OECD countries. The global share of non-OECD[84] passenger demand increased from 44% in 2000, to 68% in 2015, with passenger activity in **China** nearly quadrupling in the same period, from 2.6 to about 11 trillion passenger-km.[85] By modes, 40% of the global passenger transport demand is served by LDVs, and a quarter by buses, 15% by air, 10% by two- and three-wheelers, and 9% by rail. LDVs and aviation grew strongly in non-OECD countries, while other passenger modes stayed relatively constant, except for buses (Figure 3).

Global passenger demand increased significantly for passenger rail (156%), two- and three-wheelers (150%) and passenger aviation (145%), with demand for passenger aviation in non-OECD countries leaping 425%. Passenger transport demand grew more modestly for LDVs (45%) and mini-buses (59%), with demand for each of these sub-sectors decreasing in OECD countries.[87]

Though not included in Figure 3, walking and cycling remain the principal mode of transport in most developing cities, particularly in **Africa** and **Asia**,[88] with more than one-third of all passenger trips globally made on foot or by bicycle.[89]

Figure 3: Motorized Passenger Transport Demand in 2000 and 2015[86]



In some cities combined walking and cycling mode share is between 50% and 70%; while global level research has not historically split these modes, some research indicates that the vast majority of this mode share is by foot.[90]

Transport Emissions

In 2015, passenger transport accounted for 59% of total global transport emissions. Passenger transport emissions decreased by 2% between 2000 and 2015 in OECD countries, while increasing by 143% in non-OECD countries. Global passenger transport emissions increased by 36% from 2000 to 2015. Transport emissions by passenger transport reached 5.5 gigatonnes (Gt) CO_2 in 2015. Global passenger transport emission intensity reduced moderately by 29% from 2000 to 2015, through a range of policy measures (e.g. fuel economy standards, public transport implementation, railway electrification when combined with renewable power).

Policy Measures

Major steps were taken in 2017 to begin to reduce emissions from passenger transport across a range of sub-sectors and regions. Among **'Avoid'** measures, vehicle restriction measures were implemented in **China**, **Europe**, and **Latin America**; eight cities (**Antwerp**, **Balingen**, **Barcelona**, **Gent**, **Grenoble**, **Lille**, **Overath** and **Oslo**) implemented low emission zones (LEZs) in 2017, and London announced the world's first ultra-low emission zone (ULEZ) to be put in place in 2019,[91] bringing the global total to 241 cities.

Among **'Shift'** policy measures, public transport continued to expand in many cities around the world. In 2016, bus rapid transit (BRT) systems were launched in 11 cities, as well as in **Hanoi** and **Multan** in 2017, bringing the total number of global BRT systems to 169 covering a total length of 5,017 km, [92] and new tram and light rail lines were inaugurated in **Aarhus**, **Abuja**, and **Samarkand** in 2017 and 2018. High-speed rail (HSR) activity grew further, as **China** saw a nearly 10-fold increase in high-speed rail passenger travel from 2010 to 2016, compared to the global average growth of 180%. In 2017, **China**, **France**, **Germany** and **South Korea** opened new HSR lines, bringing the global total to more than 36,000 km.[93] Bikesharing systems saw dramatic growth in Asia and North America (as well as Europe), with nearly 450 bikeshare programs introduced in 2017, exceeding the previous two years combined.[94]

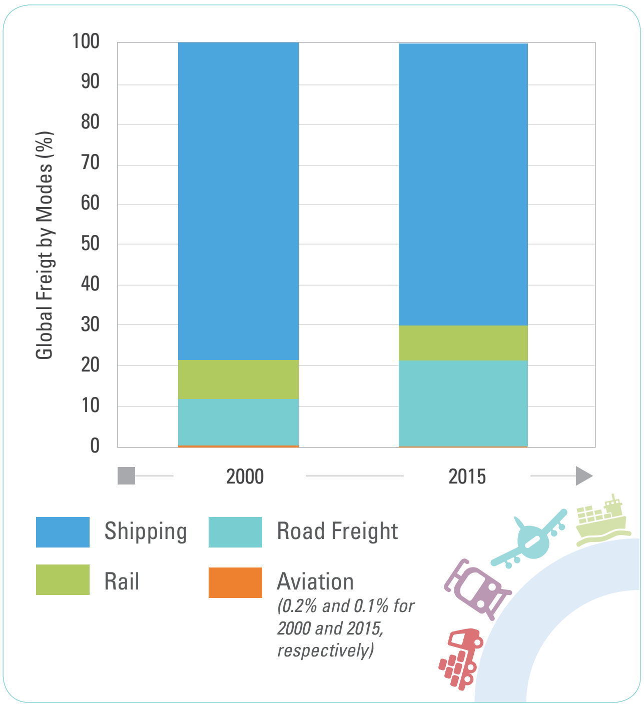
Among **'Improve'** measures, in 2017, more than 17 countries and 16 cities or regions worldwide announced specific electric vehicle (EV) uptake targets, bringing the total to 61 countries and 51 cities to date. Following an initial announcement by **Norway** in 2016 to phase out fossil fuel vehicles by 2025, six countries (**France, Ireland, Netherlands, Slovenia, Sri Lanka** and **United Kingdom**) announced in 2017 similar phase-out targets between 2025 and 2040 (electric cars, buses and two-wheelers are discussed in detail in *Section III.B.7 Electric Mobility*).[95] Railway electrification expanded in **India** by 4,000 km in 2017, equivalent to 6% of their national railroad network.[96] By 2017, autonomous vehicles (AVs) had been tested in 82 cities across 26 countries and preparations for trials is being conducted in 22 cities.[97] Yet, the impact of AVs is still uncertain as it can even double energy use of cars.[98]

2. Freight Transport

Transport Demand

Global freight mobility increased from about 64 trillion tonne-km in 2000, to about 108 trillion tonne-km in 2015. The highest per-capita demand growth was recorded in **China** (457%), **India** (239%) and **Mexico** (115%). Among modes, from 2000 to 2015, the global freight road fleet (i.e. light commercial vehicles, medium- and heavy-duty trucks) doubled from 93 to about 186 million, during the same period, the rail-freight mode share stagnated to 2000 levels.[99] It is associated with an increase of freight transport by road freight from 12% of total freight demand in 2000 to 22% in 2015 (Figure 4).

Figure 4: Freight Transport Demand in 2000 and 2015[100]



In 2014, the rail mode share in tonne-km of surface freight reached 70% in **Russia**, and topped 35% in India and **China**, but fell short of 15% in **Brazil**, **Mexico**, and the **European Union**, and accounted for just 1% in countries that are members of the Association of Southeast Asian Nations (ASEAN) countries.[101] In 2015, urban freight accounted for about 5% of surface freight activity, but generated about 50% of freight road vehicle kilometers.[102]

Transport Emissions

In 2015, freight transport accounted for 41% of global transport CO_2 emissions (up from 35% in 2000). The highest share of freight demand was in **India** (53%) and **China** (43%), exceeding the global average of 40%, and freight transport in many landlocked countries (e.g. **Afghanistan**, **Kazakhstan**, **Uzbekistan**) exceeded 50% of total surface transport demand.[103] While rail accounted for 10% of global freight activity in 2015,[104] it contributed just 4% of freight emissions due to modal efficiencies, rail electrification and vehicle improvements. Urban freight accounted for about 16% of surface freight CO_2 emissions in 2015.[105]

Policy Measures

Freight responses were less ambitious than passenger responses in 2017 and were disproportionately low compared to freight's global emissions share.[106] Among **'Avoid'** measures, new LEZs in eight cities, and vehicle restrictions helped to keep road freight emissions in check. Among **'Shift'** measures, regional freight corridors were launched in Africa,[107] and inter-regional corridors in Europe,[108] with emissions benefits to be determined. Among **'Improve'** measures, five countries in Asia and North America have heavy-duty vehicle (HDV) fuel economy standard programs. Companies such as **Deutsche Post DHL Group** announced long-term 2050 decarbonization plans, and introduced such technology solutions as electric-drive trucks, electric scooters, and cargo bicycles.[109] By November 2017, **Deutsche Post DHL Group** had introduced 5,000 StreetScooters in service, with an annual reduction of more than 16,000 tonnes of carbon emissions after 13.5 million kilometers driven.[110] Electric heavy truck models were announced by **Nikola** and **Tesla** in 2017.[111] **Amazon's Prime Air** service introduced a drone freight delivery pilot in the **United Kingdom** in 2016,[112] and other autonomous freight delivery options are under development in Europe and elsewhere.[113]

More detail on policy measures are given in *Section III.B*, which provides market trends, policy landscapes and key indicators in eight different policy areas.

B. Transport and Climate Change Trends in Global Regions

Transport demand among global regions is driven by a combination of factors, including population growth and rising GDP. Population growth rates from 2000 to 2017 were highest in Africa (54%), whose urban population nearly doubled from 277 million to 504 million in the same period. GDP growth was highest in Asia (106%) and Africa (98%) in the period from 2000 to 2016.[114] Rising GDP drove a two- to five-fold increase in private motorization in countries in Africa and Asia that have recently reached middle-income status (e.g. **China, Ghana, India, Indonesia, Kyrgyzstan, Sri Lanka** and **Vietnam**).[115] From 2000 to 2015, surface freight activity nearly doubled in OECD countries, and nearly tripled in non-OECD countries.

Transport activity in turn drives transport emissions, which grew by 31% from 2000 to 2016.[116] Growth of absolute transport emissions between 2000 and 2016 was highest in Asia (92%), Africa (84%) and Latin America (49%), driven by growth in prosperity and in passenger and freight transport activity in these regions. In 2011, Asia overtook North America as the largest transport CO_2 emitter. Regional shares of global emissions rose in Asia, Africa, and Latin America and the Caribbean, while falling in Europe and North America, and remaining at roughly the same level in Oceania (Figure 5).

Policy measures to address rising transport demand and emissions also varied among regions in 2017. Urban public transport and transport demand management measures were a primary focus in Asia (led by China), Europe, and Latin America; railway expansion and electrification - combined with increasing use of renewable power – were led by Asia and Europe; walking and cycling measures were emphasized in Europe and Latin America. Electric mobility grew rapidly in China, Europe (led by Norway) and North America; carsharing grew rapidly in Asia in 2016, and bikesharing exploded in Asia and North America in 2017; and renewables in transport were seen in Europe and Latin America.

More detailed discussions of trends in transport demand, transport emissions and policy measures within each of these global regions are found in the following sections.

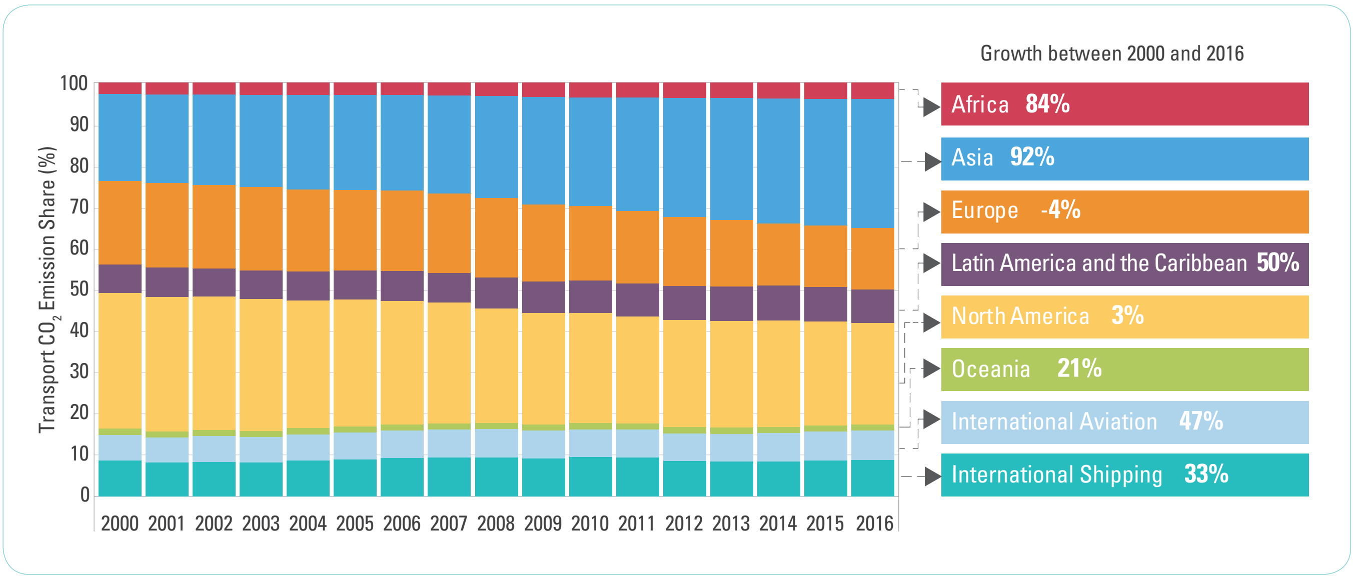
1. Africa

Africa's contribution to global transport demand has historically been low, and remained so relative to other regions in 2017, though rapid growth in demand was seen in some African countries, and latent demand is likely to be significant, especially in the face of rapid urbanization. In 2018, nine African cities (**Accra**, **Addis Ababa**, **Cape Town**, **Dakar**, **Dar es Salaam**, **Durban**, **Johannesburg**, **Lagos**, and **Tshwane**) have committed to cutting carbon emissions to zero by 2050, yet low-carbon transport policy measures in Africa trail other regions (despite a few emerging BRT systems and freight corridors). 13% of transport climate finance instrument projects are in the region. By the end of 2017, only three regional low carbon transport studies had been completed for Africa, and only six of 54 African countries had completed low carbon estimates for transport.[118]

Transport Demand

Countries in Northern Africa account for a large portion of transport activity, due in part to the relatively high motorization rate of 85 vehicles per 1,000 people, compared to 27 vehicles per 1,000 people in Sub-Saharan Africa in 2015. Between 2005 and 2015 the motorization rate grew

Figure 5: Regional Share of Transport CO_2 Emissions[117]



by 50% in Northern Africa, which is twice the magnitude of Sub-Saharan Africa's motorization rate development (27%). In 2015 the share of combined share of walking and cycling trips was 49% in **Nairobi**, 45-70% in **Dar es Salaam**, and 34% in **Cape Town**, with the clear majority (99%) of these being walking trips.[119]

Transport Emissions

Compared with other regions, Africa experienced the second highest growth of absolute transport emissions (84%) between 2000 and 2016, driven primarily by increases in passenger and freight transport activity. Transport emissions in Sub-Saharan Africa increased 75% from 2000 to 2016 to a level of 156 million tonnes (Mt) CO_2, while transport emissions in Northern Africa increased 95% during the same period (though at a lower absolute level of 135 Mt in 2016). Total transport CO_2 emissions increased in major economies of Africa between 2000 and 2016, including 161% in **Algeria**, 153% in **Ghana**, 123% in **Kenya**, 73% in **Egypt**, 40% in **South Africa** and 19% in **Nigeria**.[120] For example, in **Algeria** and **South Africa**, per capita emissions increased respectively by 100% and 13%, reaching levels of 1.0 and 0.89 tonnes CO_2 per capita in 2016.[121] Railway share in total transport emissions exceeds 5% in **South Africa**.

Policy Measures

Africa trailed other regions in 2017 in mitigation measures, such as managing transport demand, implementing urban rail systems, and establishing EV phase-in and internal combustion engine (ICE) phase-out targets. Africa has only 353 km of BRT, light-rail transit (LRT), and metro across the continent, summing to only 1.5 km per million urban residents (cities over 500,000 population).[122] 70% of this was built since 2007. 'Shift' measures included BRT systems emerging in several African cities in recent years, including **Dar es Salaam**, **Cape Town** and **Johannesburg**, as an option to increase capacity in urban public transport, with **Dar es Salaam** carrying 160,000 passengers daily in 2017.[123] In 2017, Kenya opened a 480 km-long rail line connecting **Nairobi** to **Mombasa**. In 2016, **Marrakech** became the first African city with a bikesharing system, and in 2017, **El Gouna**, Egypt launched Africa's first electric bike (e-bike) share system.[124] In 2017 **Mobike** and **UN Environment** announced plans for a dockless bikesharing system in **Nairobi**, which was launched in May 2018.[125] The Northern Corridor Master Plan was launched in 2017 to improve logistics and ease cargo congestion in East Africa, by connecting the port of Mombasa in Kenya, to landlocked **Uganda**, **Rwanda**, **Burundi** and **D.R. Congo**.[126] Among 'Improve' measures, in 2017, **South Africa** committed to having more than 2.9 million electric cars on their roads by 2050 to meet their Paris Agreement goals.[127] **Mauritius** and **South Africa** have also implemented various tax and rebate schemes to encourage the purchase of low emission vehicles.

2. Asia

Asia's ability to meet Paris Agreement targets will depend to a large extent on whether low carbon, sustainable transport is rapidly and broadly implemented. Most additional transport demand has been added in Asia, with absolute transport emissions increasing rapidly since 2000, and reaching 2.3 Gt CO_2 in 2016. Yet, the Asian region (led by **China**) also registered some of the strongest transport mitigation responses of any region, leading global growth in such areas as HSR, urban public transport (especially metro and BRT), fuel economy standards and (chiefly dockless) bikesharing. Every day, 50,000 vehicles are being registered in India but nevertheless, the country has the potential to leapfrog to more sustainable transport systems.[128] Asia is therefore poised to set the pace for sustainable transport paradigms that can be replicated across both global North and South.

Transport Demand

Asia's population reached 4.48 billion in 2017, with high annual growth in urbanization (2%) and GDP (1.5%). Transport demand in Asia grew significantly, with **China's** share of passenger transport activity increasing from 8% to 19% of the global total from 2000-2015. Railway passenger mode share reached 12% in **China**, and 27% in India in 2014; well above the world average of 8%.[129] HSR activity rose sharply in **China** since 2000, and expanded in other Asian markets including **South Korea**, which opened a 61-km HSR service at the end of 2016.[130] In 2016, **China's** HSR network carried 464 billion passenger-km over 25,000 km of railway.[131] Passenger vehicle ownership ballooned more than 1300% in China, and 300% in India since 2000, and in 2016, China remained the largest vehicle market in Asia and second largest in the world, with a total of 185 million vehicles.[132] 2014 railway freight mode share approached 40% in China, well surpassing the world average of 28%.[133] From 2000 to 2015, surface freight activity increased six-fold in China and four-fold in India, and per capita surface freight activity increased more than 500% in China and more than 300% in India in the same period,[134] reaching a total of 9.53 and 2.28 trillion tonne-km in 2015, respectively.

Transport Emissions

Asia accounted for 2.3 Gt of transport CO_2 emissions in 2016, contributing 39% of the global total. Between 2000 and 2016, absolute transport emissions in Asia grew 92%, driven by growth in passenger and freight transport activity in the region. Per capita transport emissions in Asia grew at the fastest rate (61%) among all regions in the same period, with increases of 312% in **Vietnam**, 193% in **China**, 184% in **India**, and 52% in **ASEAN** countries, compared to a global average of 31%. 2016 per capita transport emissions in Asia (0.5), including China (0.6) and India (0.2), remained below the global average of 0.8 tonnes per capita, and below Europe (1.5), Latin America (0.9) and North America (5.1).[135]

Policy Measures

Among 'Avoid' measures, transit-oriented development (TOD) is being promoted at new mass transit stations across Greater **Kuala Lumpur**,[136] and in 2017, **China** launched a pilot program to help seven major cities incorporate TOD principles into transit and urban plans, helping to eliminate the need for motorized trips.[137]

Policy measures across Asia to address rising transport demand and emissions focused primarily on 'Shift' and 'Improve' measures. There was significant investment in transport infrastructure aimed at shifting trips to public transport, biking and walking. Asia is home to over half the world's km of metro, with 50% of the metro kms built in the last 10 years. 70% of Asia's metro growth occurred in **China**. In the same period, the region went from having 5.4 km of rapid transit per million urban residents to over 9 km per million urban residents, even as urban populations grew substantially.[138] **China** further expanded its 25,000 km HSR network by opening two new lines (400 and 1300 km long) in 2017. Metro rail infrastructure in Asia also expanded sharply, led by Shanghai (adding 48.8 km to its network),[139] while **Seoul** and **Samarkand** launched light rail lines. **Hanoi** opened one of the world's three new BRT system corridors in 2017. Asia overtook Europe in 2017 as the region with the largest number of bikesharing services; **China** launched 123 new bikeshare programs in 2017, bringing its total to nearly 600 systems, led by private companies opening dockless bikesharing systems.[140] Among 'Improve' policy measures, railway electrification rose in Asian countries, topping 80% in **Korea**, 60% in **Japan**, and **India**, and reaching nearly 50% in **China** in 2015.[141] **Shenzhen** became the first city worldwide with a fully electric bus fleet at the end of 2017.[142] In 2017, **China** implemented the first national zero-emission vehicle policy with a target of 5 liter (L)/100 km in 2020. **India** became the third country in Asia and the fifth in the world with HDV fuel economy regulations, which were announced in 2017, and took effect in April of 2018 (see *Section III.B.6 Fuel Economy* for other examples).[143]

3. Europe

With level-to-negative population growth, and only slowly increasing motorization rates, transport demand in Europe is beginning to stabilize. Europe's per capita transport emissions remain higher than in most other regions, though still well below North America's, and continue to rise. Provisional data from 2016 indicated that GHG emissions from transport (excluding maritime shipping) were higher than in 1990.[144] Europe's transport mitigation responses are well developed, with a rich set of public transport systems, walking/cycling infrastructure and demand management policies, and transport adaptation policies also taking shape.

Transport Demand

Per capita passenger transport activity in the **European Union** increased slightly (7%), as passenger activity per unit GDP decreased by 6% from 2000-2015. Motorization in Europe increased by 17% from 2005 to 2015, though it remained around half the world average of 27%, with an average of 500 vehicles per thousand residents in 2015.[145] In 2010, public transport mode share reached 27% in OECD European countries, and 44% in non-OECD European countries; and in 2015 cycling activity in Europe led the world, with cycling mode shares approaching 26% in **Denmark** and 27% in the **Netherlands**.[146] Freight transport activity per capita increased 3%, while freight activity per GDP decreased 10% in the same period. In 2014, **Russia's** railway freight mode share exceeded 70%, more than double the global average of 33%.[147]

Transport Emissions

Although GHG emissions from transport continue to increase, transport CO_2 emissions per capita in Europe decreased 6% from 2000-2016 to 1.08 tonnes CO_2 per capita, with emissions per GDP decreasing 20% to 0.38 tonnes per USD 10,000 in 2016; demonstrating the potential to decouple transport emissions from economic growth. An outlier is **Russia**, where per-capita emissions grew to 1.5 tonnes per capita (16% growth) between 2000 and 2016. Europe's share of total global transport emissions decreased by 30%, and reached 13% in 2016, exceeding the overall OECD decrease of 22% of transport emissions relative to non-OECD countries. Nearly three-quarters of **European Union** transport CO_2 emissions resulted from LDVs and HDVs, and slightly more than a quarter of emissions were attributed to aviation and maritime shipping.[148]

Policy Measures

Vehicle restriction measures included plans for the world's first ultra-low emissions zone (ULEZ) in **London**. European cities continued to invest in expanding their public transport, cycling and walking infrastructure. Europe account for only 9% of the world urban population but 28% of its rapid transit. The ratio of rapid transit km to (million) urban residents is the highest in the world at 33,000. From 2007-2017, the region increased the km of rapid transit by 12%, even as urban population grew by only 6%.[149] In 2017, **Dublin** embarked on a redesign of their urban bus network,[150] while **Aarhus, Denmark** opened its first modern light rail line (6.5 km).[151] **Madrid** and **Oslo** announced plans to make all or part of their city centers car free, and to instead prioritize space for public transport, cycling and walking. Some European countries and cities set aggressive targets to phase out diesel and petrol engines, and European automakers responded by targeting higher shares of electric and hybrid vehicles in their fleets. European Union countries implemented more than 2000 low emissions zones (LEZs) from 2002-2013 and implemented congestion pricing in five major cities since 2007.

Large European cities recorded increase in cycling in recent years, with bike mode shares increasing three- or four-fold between 1990 to 2015 and currently being at 3% for **London** and **Paris**, 6% in **Vienna**, 8% in **Sevilla**, 13% in **Berlin**, 32% in **Amsterdam** and 33% in **Copenhagen**.[151] One hundred and eleven bikeshare services were launched in European cities in 2017, more than double the average of the previous five years, with cities in **France**, **Germany**, **Italy**, **Poland** and **United Kingdom** experiencing an increase of bikesharing services on their streets. Several European countries are undertaking an energy transition in transport.[153] By 2015, railway electrification reached 60% in **Russia**, although may not be running on 100% renewable power, [154] while the railways of **Austria**, **Denmark**, **Finland**, the **Netherlands**, **Norway**, **Sweden** and **Switzerland** are running on 100% renewable electricity, either purchased from renewable energy providers, or produced in renewable energy plants owned and operated by the rail companies.[155] **Denmark** mandated in 2016 that advanced biofuels comprise 0.9% of transport fuel consumption by 2020 [156] and **Norway** agreed in 2017 for E20 biofuel mandate by 2020.[157] The first fuel cell driven passenger trains were homologated in **Germany** in 2018.[158]

Several sector and government networks have emerged to foster stakeholder coordination and mainstreaming of implementation approaches., e.g. within the European Union's flagship **CIVITAS** which is predominantly for European Union member states, or the **MobiliseYourCity Partnership** supported by European Union, France and Germany for stakeholders outside the European Union.

4. Latin America and the Caribbean

Latin America has the highest urban population of any continent, which is driving transport demand (and in many cases urban congestion and emissions, in combination with rising motorization rates). Though per capita transport emissions have risen, the region has high urban bus mode shares, a broad rollout of bus rapid transit (BRT) systems and walking and cycling infrastructure. Latin America's high renewable energy share has sparked efforts to launch low-carbon mobility through transport electrification.

Transport Demand

Per capita transport passenger activity increased 39% in **Brazil**, and 22% in **Mexico** from 2000-2015, trailing the world average of 45% during the same period. 2010 urban public transport shares in **Brazil** (44%), **Mexico** (42%) and other Latin American countries (59%) exceeded the global average (38%).[159] Despite high public transport shares, private motorization growth in **Brazil** (69%) and **Mexico** (49%) well exceeded the world average (27%), reaching levels of 208 and 297 vehicles per thousand inhabitants in 2015. In **Brazil**, this was a result of federal government economic policies that subsidized private vehicle purchases. **Mexico's** growth in passenger activity was exceeded by its 115% growth in surface freight per capita, reaching a level of 5,147 tonne-km per person in 2015.

Transport Emissions

After Asia and Africa, Latin America and the Caribbean recorded the highest growth rate of transport CO_2 emissions among all regions, with emissions growing by 50% between 2000 and 2016, and reaching 598 Mt CO_2 in 2016. Per-capita transport CO_2 emissions growth varied greatly in Brazil (38%) and Mexico (6%) from 2000 to 2016, against an average growth rate of 23% in Latin America during the same period. Emissions per unit GDP in Brazil increased by 12%, and decreased in Mexico by 6% from 2000-2016, while world averages fell by roughly 15% during the same period. Grid emissions factors in 2015 (grams of carbon dioxide equivalent per kilowatt-hour (gCO_2/kWh)) for Argentina (384.2), Brazil (156.6), and Mexico (459.6) showed varying potential for low-carbon electrification.[160]

Policy Measures

In 2017, **Mexico City** introduced a major parking policy reform, limiting the number of parking spaces allowed in city construction codes, potentially leading to less auto-oriented land use. In the last 10 years, Latin American countries have added over 1200 km of rapid transit, 78% of which was BRT.[161] Latin America led world regions in BRT implementation, with systems in 54 cities totaling 1,757 km at the end of 2017 (following the addition of new systems in **Acapulco** and **Cartagena**, and system expansions in **Buenos Aires**, **Mexico City**, **Rio de Janeiro**, **Belo Horizonte** and **São Paulo** in 2016), accounting for roughly a third of global totals for each (relative to 8.5% of global population).[162] The share of cycling in urban trips increased in several Latin American cities from very low baselines. In **Buenos Aires** the cycling share grew from 0.8% in 2002 to 3.3% in 2015 and in Bogota it grew from 0.5% to nearly 6%.[163] Among 'Improve' measures in Latin America and the Caribbean in 2016, **Chile** announced that as of 2018, **Santiago's** subway system– the second largest in Latin America after **Mexico City** – would be powered by solar photovoltaic (42%) and wind energy (18%).[164]

5. North America

Transport accounted for the largest portion (28%) of GHG emissions in 2016 in the **United States**.[165] The United States' motorization rate well exceeds world and OECD averages, but after peaking at 827 vehicles per 1,000 people in 2007, it declined to 800 vehicles/1000 population in 2013 and began growing again in recent years. In addition, drivers in the United States drove nearly twice the distance (21,500 km per year) than the average European driver (12,000 km per year).[166] While United States. per capita transport emissions were nearly five times higher than the world average in 2015, they are now on a downward trend, reaching a 2016 level of 5.1 tonnes per capita. **Canada** released a climate action plan, including carbon pricing, adaptation and resilience, and clean technology measures to help meet its target of reducing national emissions 30% by 2030.[167]

The Trump Administration's announced intent to withdraw from the Paris Agreement has intensified climate action among transport and other sectors in states and cities in the **United States**, as seen by the launch of the United States Climate Action Center at 23rd session of the Conference of Parties (COP 23) in late 2017. While growth of public transport options in North America remains halting, interest in shared and electric mobility is on the rise. As of 2017, the **United States** had the second largest fleet of electric passenger vehicles, with 700,000 cars. **California** reached a zero-emission vehicles market share of 4.5% in 2017 and is responsible for 49.5% of total EV sales in the United States.[167]

Transport Demand

Passenger vehicle ownership in the **United States** remained roughly level (+1%) from 2000-2015, after a steadily rising historic trend. Likewise, passenger transport activity in the **United States** declined in both per capita (-11%) and per unit GDP (-22%) terms during the same period, exceeding average decreases for OECD countries (-9% and -20%, respectively). Combined urban public transport shares in **Canada** and the **United States** (6%) were the lowest of any region, and well below the global average (38%).[169] Per capita **United States** freight demand decreased during this period, reaching a level of 27,805 tonne-km per capita in 2015.

Transport Emissions

United States was the largest transport CO_2 emitter in 2016, generating 1,648 Mt, more than twice the level of the second-largest polluter, **China**, which has more than four times as many citizens. United States' transport CO_2 emissions per capita decreased 4% from 2000-2016, to 5.11 tonnes per capita, and emissions per unit GDP decreased at an even sharper rate (-28%), to a level of 1 tonnes per USD 10,000 in 2016. This leads world and OECD averages, and demonstrates the potential to decouple transport CO_2 emissions from economic growth. However, in 2016 transport became the biggest single source of CO_2 emissions in the United States.[170] Urban freight in the **United States** accounted for only 4% of surface freight activity, but 58% of surface freight CO_2 emissions in 2015, showing the greatest discrepancy between these indicators for any country or region.[171]

Policy Measures

Despite positive trends in transport demand and emissions, mitigation responses in North America trailed other regions. In the past 10 years, North American cities have added 556 km of rapid transit, nearly 70% of which was light-rail transit (LRT). While the ratio of transit to million urban residents has grown slightly, it is offset by very low population densities.[172] The **Alberta** government committed significant funding to LRT in **Calgary**[173] and **Edmonton**.[174] Various cities (e.g., **Houston**, **Columbus**, **Los Angeles**, **San Francisco**, **Richmond**, **Omaha**, **Jacksonville**, **Orange County**, **Baltimore** and **Portland**) have redesigned their public bus network in recent years to increase connectivity, equity and efficiency.[175] **New York City's** 2017 Climate Action Plan committed to moving 80% of trips to walking, cycling and public transit by 2050. North America recorded 150 new bikesharing services, tripling the 2016 growth rate and raising the number of bikesharing systems to 291 by the end of 2017. The growth was driven by the expansion of dockless bikesharing to North America, with 98% of new systems launched in the United States.[176] The United States experienced a 25% growth in bikesharing trips between 2016 and 2017, attributable to the launch of new systems.[177] The United States has also heavily promoted investment in vehicle technologies towards electrification. Around 0.7 million EVs (23% of the global EV fleet) drive on roads in the United States, but the CO_2 reductions are marginal.[178] At the end of 2017, a bill was proposed in **California** to ban the sales of new fossil fuel cars by 2040.[179]

Transportation network companies (TNCs) (e.g. Uber, Lyft) have offered an affordable mobility option for many and have been on the forefront of local policy discussions in the United States and Canada. With the increase in demand for these ridesharing services, cities are faced with challenges of balancing the positive and negative impacts of the industry by establishing rules and regulations. **Seattle** initially capped the number of ridesharing vehicles on the road; however, this ordinance was repealed in 2014.[180] **Edmonton** legalized operation for Uber in 2015; however, in 2016 Uber ceased operations due to the company's inability to comply with the city's stringent regulations requiring necessary insurance and licensing of drivers.[181] Approximately 5.7 billion miles were added by TNCs in the United States' largest metro areas (**Boston**, **Chicago**, **Los Angeles**, **Miami**, **New York**, **Philadelphia**, **San Francisco**, **Seattle**, and **Washington DC**) and have contributed to worsening traffic congestion.[182] More detailed discussion on TNCs is given in *Section III.B.5 New Mobility Services.*

'Improve' policy measures in North America included several focused on advancing renewable fuels. The Pan-Canadian Framework on Clean Growth and Climate Change, which prioritizes vehicle emission standards and cleaner fuels, zero emission vehicles, public transport and cycling infrastructure, and optimized freight corridors, was agreed upon by most provinces and territories in December

2016, with details developed further during the course of 2017.[183] **Los Angeles** acquired 95 new electric buses and committed in July 2017 to transitioning its 2,220 buses to zero emission electric buses by 2030.[184] In 2016, the United States launched a Biofuels Innovation Challenge to catalyze development of advanced fuels, providing funding for pilot production of renewable diesel and jet fuels from industrial waste gases.[185]

6. Oceania

Oceania's contribution to global transport demand and per capita emissions remained low compared to other regions in 2017. **Australia** has continued to invest in expanding its urban public transport network, and carsharing continued to grow throughout the region.

Transport Demand

Vehicle ownership in Oceania increased 9% from 2000-2015, to a total of 540 vehicles per 1000 inhabitants, roughly comparable to European Union levels. By mid-2018, the region had BRT systems in four cities, representing small shares of the global BRT infrastructure length (1.9%) and daily passengers (1.3%).[186]

Transport Emissions

Oceania's regional share of around 2% of global transport emissions remained at the same level for the period 2000-2016, while total emissions increased from 87 Mt in 2000 to 107 Mt in 2016. Following the trend of other OECD regions, Oceania had a 23% decrease of transport CO_2 emission per unit GDP from 2000 to 2016. Transport CO_2 emission per capita reached roughly 2.7 tonnes per capita in 2016, exceeding levels in Europe (1.5), but still well below levels in North America (5.1).

Policy Measures

Despite some additions to urban rapid transit networks, the ratio of transit to urban residents in Oceania is the same as it was in 2007.[187] Policy measures in the region primarily included 'Improve' measures aimed at increasing transport energy efficiency. Oceania's mitigation responses focused on advancing renewable energy and sustainable fuels and demonstrated innovations in energy efficiency of transport fuels. **New South Wales**, Australia, released a renewable energy tender for **Sydney's** light rail system.[188] The Australian government invested USD 1.75 million towards biofuel and biocrude production, with the aim of producing plant-based renewable diesel and jet fuel.[189] An Australian rail company restored a 3-km section of abandoned track and launched the world's first fully solar powered passenger train.[190]

C. International Aviation and Shipping Trends

1. International Aviation

The international aviation sector remains exempt from fuel taxation, and also receives subsidies for aircraft design and production, and airport design and operation; there have been limited efforts to cut these subsidies to date. In the European Union, the aviation industry receives about EUR 3 billion in subsidies. However, because the industry is exempt from the basic consumer tax and fuel tax, European Union member states miss out on the potential tax revenue of EUR 20 to EUR 38 billion per year.[195] Limited incentives remain to curb emissions in the face of rising demand. [196] While participation in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from 2021 to 2035 is voluntary, by August 2017, 73 countries, accounting for nearly 88% of international aviation activity, had confirmed their intention to participate. CORSIA requires airlines to procure offsets to cover all emission increases; however, by setting a baseline at 2020 levels, CORSIA is expected to cover less than 30% of total international aviation emissions from 2020 to 2030.[197]

Transport Demand

International passenger aviation demand grew 145% from 2000 to 2015, with growth in non-OECD countries nearly 10 times greater than in OECD countries. Air travel accounted for 15% of global passenger demand (passenger-km traveled) in 2015, with the share from OECD countries roughly double that of non-OECD countries.[198] International freight aviation demand has also increased significantly; since 2000; air cargo activity has increased by 65% and is projected to grow rapidly over the next two decades.[199] The size of the global airline fleet has increased 6% since 2015, reaching 25,368 aircrafts in 2017, with the strongest growth in Asia (13.9%) and Africa (7.7%).[200]

Transport Emissions

International aviation accounts for roughly 11% of total energy used in transport;[201] if international aviation were a country, it would be the third largest emitter after China and the United States. 2016 emissions from international aviation reached a record high of 523 million tonnes CO_2, accounting for roughly 7% of human-produced GHG emissions.[202] Air freight has a much higher CO_2 intensity than surface transport and shipping freight. At only 0.1% of global tonne-km of freight carried, the contribution of aviation is currently too small to significantly influence global freight emissions, however, observed and projected growth is likely to shift this equation.

Policy Measures

With few close substitutes for international passenger aviation (with the exception of modal shift to passenger and freight rail services in Europe), recent policy measures have focused on measures to 'Improve' (rather than 'Avoid' or 'Shift') airline trips. Since 2016, policy support for aviation biofuels has increased. In 2016, ICAO announced that 66 nations, comprising 86% of international aviation activity, had committed to reducing the sector's greenhouse gas emissions beginning in 2021 through a combination of technical and operational improvements, and support for the production and use of sustainable aviation fuels.[203] Aviation has a high potential for power-to-fuel technologies because it requires fuels with high energy densities.[204] Production of bio-jet fuels advanced with the certification of two new technical production processes (bringing the total available to five); aircraft manufacturers **Airbus** and **Boeing** are leading efforts in bio-jet fuel development.[205] Airlines are increasingly experimenting with biofuels. **Qantas** announced in October 2017 that all Los Angeles-based flights will be powered by biofuels from 2020.[206] United States carrier **JetBlue** signed one of the largest renewable jet fuel purchase agreements to date, agreeing to buy some 33 million gallons of blended bio-jet fuel a year for 10 years (or roughly 20% of fuel consumption at **New York's** John F. Kennedy Airport).[207] Airports in **Stockholm** and **Los Angeles** also made bio-jet fuel available to selected airlines,[208] while in 2016, **Oslo's** airport became the first airport globally to offer biofuels to all air carriers.[209] However, these activities represent only a minor share of global fuel consumption.

Aviation operational efficiency programs have been mostly introduced in **China**, **Europe** and the **United States**,[210] and new airports took steps to reduce the carbon footprints of ground operations (e.g. **Galapagos**),[211] though these account for only a small fraction of the impact of global airline activity. In 2016, a solar-powered aircraft, the Solar Impulse 2, successfully completed a 16-month, around-the-world flight,[212] and prototype development for short-range electric flights continued.[213] Improvements in airplane design by manufacturers were also among 2017 policy measures, though slow fleet turnover makes this a longer-term emissions reduction strategy. At the Global Climate Action Summit (GCAS) in September 2018, **United Airlines** became the first North American airline to commit to GHG reductions of 50% from 2005 levels by 2050, and to introduce a 30% biofuel blend on its flights.[214]

2. International Shipping

International shipping vessels carry close to 70% of global freight activity, but emit roughly one-quarter of freight emissions.[215] With low diesel prices and a continued lack of international agreements in force, there were limited incentives in 2017 to deviate from business-as-usual approaches, and shift to more low-carbon shipping paradigms. In 2016, the IMO set a limit for sulphur levels of 0.05% m/m (mass by mass) for fuels (currently 3.5%) used in vessels by 2020.[216]

Policy Measures

In April 2018, the IMO adopted the goal to peak international shipping's GHG emissions as soon as possible, and to mitigate annual GHG emissions by at least 50% by 2050 compared to 2008 levels, while aiming for further efforts to decarbonize.[223] As with aviation, there are few close substitutes for maritime freight transport, and thus, policy measures focused largely on 'Improve' measures. "Slow steaming" can reduce emissions by reducing travel speeds (10% less average speed results in around 19% less emissions),[224] but was not widely used in 2017, with relatively low diesel prices. Although the potential of biofuels in the shipping sector has been long discussed, few pilot projects have been seen to date.[225] In 2016, several liquid natural gas (LNG)-fueled ships were deployed in **Australia**, and the industry's agreement to cap sulfur emissions by 2020 may catalyze more interest in LNG for shipping. However, while LNG is effective for reducing sulfur oxides (SO_x), nitrogen oxides (NO_x) and particulate emissions, issues such as emissions of unburnt methane mean that LNG is not a climate friendly option and unlikely to be a long-term solution for the shipping industry.

Research and development of electric and wind-powered ship propulsion technologies that decrease emissions has continued. **China** deployed the first all-electric cargo ship in December 2017, which reached speeds of 13 km/hr with 2,200 tonnes freight.[226] Rotor sails, being developed by companies such as **Magnuss** and **Norsepower**, can decrease fuel consumption by up to 10% (or 1,100 tonnes per vessel per year).[227] In March 2017, **Maersk** announced plans to trial two rotor sails on a cargo tanker.[228] While promising, these measures have had limited implementation (and therefore limited impact) to date. **India** also launched a Green Port Initiative, aimed at installing wind and solar power systems at the country's ports,[229] while in 2016 **Singapore's** Jurong Port completed solar power facilities to save 5,200t CO_2 per year.[230] In 2018, 7 ports (**Antwerp**, **Barcelona**, **Hamburg**, **Los Angeles**, **Long Beach**, **Rotterdam** and **Vancouver**) launched the World Port Climate Action Program to address climate change and reduce GHG emissions in line with the Paris Agreement, as announced during GCAS.[231]

Photo credit: Carlos Felipe Pardo

Dashboard II: Global Overview

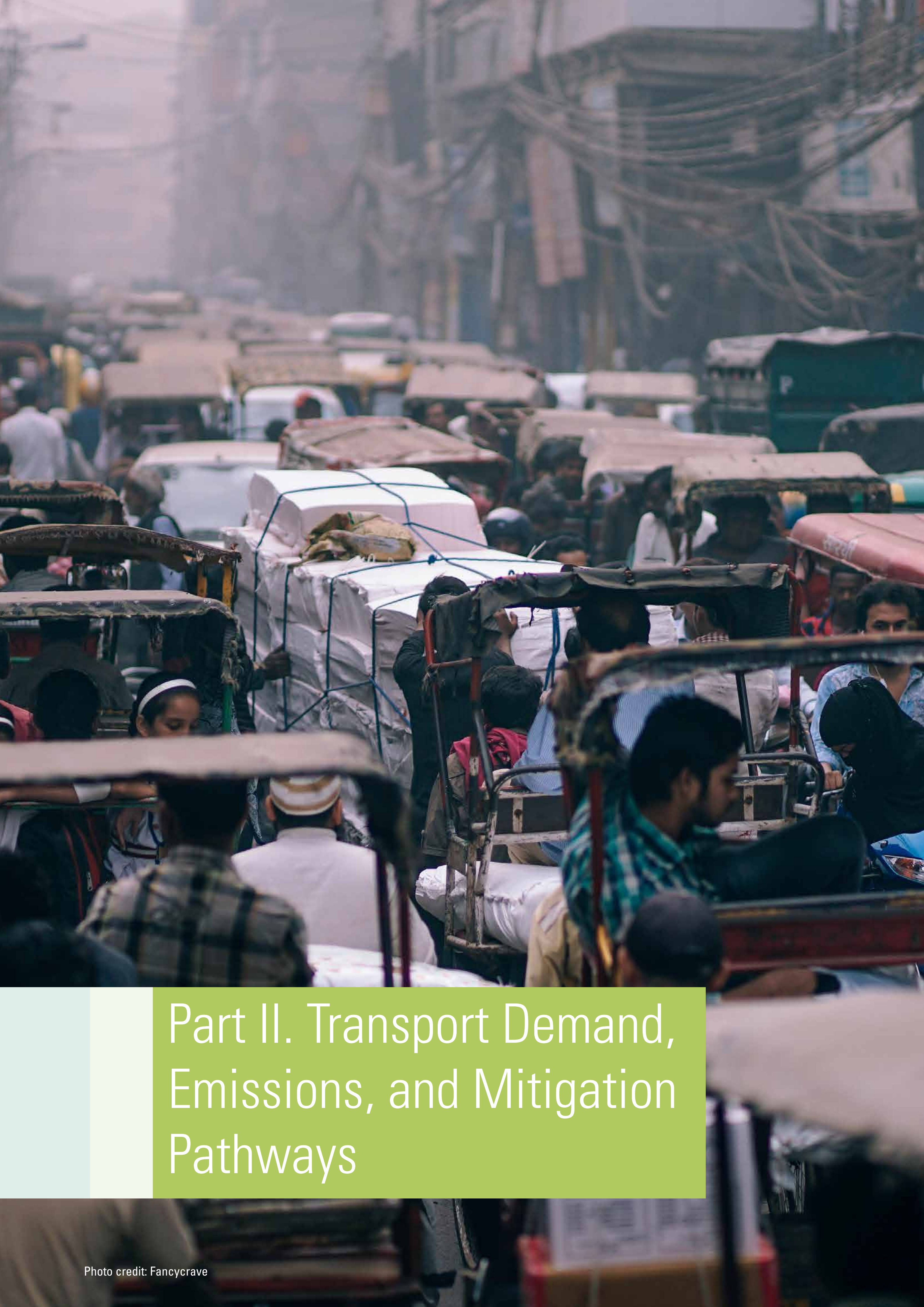
The second dashboard breaks down the major aspects of Dashboard I into regions and a selected number of countries as well as the European Union as major economic group.

It shows transport demand through the passenger and freight activity in absolute and per capita values, general motorization level and the development of passenger and

	Years	Global	Africa	South Africa	Asia	China	India	Europe
Transport Demand								
Passenger Activity (trillion passenger-km)	2000	32.3	N/A	0	N/A	2.6	2.2	N/A
	2015	56.3	N/A	0.4	N/A	10.8	4.4	N/A
	% Δ	74%	N/A	/	N/A	315%	100%	N/A
Surface Freight Activity (trillion tonme-km)	2000	64	N/A	N/A	N/A	1.57	0.54	N/A
	2015	107.6	N/A	0.43	N/A	9.53	2.28	N/A
	% Δ	70%	N/A	/	N/A	507%	321%	N/A
Passenger Activity per Capita (passenger-km per capita)	2000	5281	N/A	N/A	N/A	2096	2124	N/A
	2015	7653	N/A	6526	N/A	7878	3374	N/A
	% Δ	45%	N/A	/	N/A	276%	59%	N/A
Surface Freight Activity per Capita (tonne-km per capita)	2000	10465	N/A	N/A	N/A	1217	514	N/A
	2015	14637	N/A	7820	N/A	6782	1740	N/A
	% Δ	40%	N/A	/	N/A	457%	239%	N/A
Motorization Rate (vehicles per 1,000 people, excl. two- and three-wheelers)	2005	139.03	28.15	140.76	49.64	23.78	9.03	468.88
	2015	170.72	37.56	173.63	93.17	115.91	22.05	499.80
	% Δ	27%	33%	23%	88%	387%	144%	7%
Passenger Vehicle Motorization Rate (passenger cars per 1,000 people)	2005	102.62	19.16	93.71	35.02	16.05	6.67	410.60
	2015	125.62	25.83	115.46	72.75	96.67	17.16	433.77
	% Δ	22%	35%	23%	108%	502%	158%	6%
Commercial Vehicle Motorization Rate (commercial cars per 1,000 people)	2005	36.41	9.00	47.05	14.62	7.73	2.37	58.29
	2015	45.11	11.73	58.18	20.42	19.25	4.88	66.03
	% Δ	24%	30%	24%	40%	149%	106%	13%
Transport Emissions								
Transport CO_2 Emissions (Mt)	2000	4506	157.82	36.03	1201.25	263.57	95.26	1,150.32
	2016	5923	291.01	50.24	2310.29	772.45	270.62	1,104.04
	% Δ	31%	84.39%	39.46%	92%	193.07%	184.09%	-4.02%
Transport CO_2 Emissions per Capita (tonnes CO_2 per capita)	2000	0.74	0.19	0.79	0.32	0.20	0.09	1.58
	2016	0.80	0.24	0.90	0.52	0.55	0.20	1.49
	% Δ	8.00%	23.04%	13.85%	60.67%	167.92%	125.92%	-5.70%
Transport CO_2 Emissions per 10,000 USD (tonnes CO_2 per 10,000 USD (constant 2010 USD))	2000	0.91	1.36	1.35	0.96	1.18	1.19	0.69
	2016	0.78	1.27	1.20	0.89	0.81	1.10	0.52
	% Δ	-14.00%	-6.92%	-11.25%	-7.29%	-31.02%	-7.48%	-24.64%

commercial vehicles. The second part gives information on absolute transport CO_2 emissions and per capita as well per GDP for better comparison between the regions.

EU	Germany	Russia	Latin America	Brazil	Mexico	North America	United States	Oceania	Data Sources
5.9	0.98	0.9	N/A	1.1	0.6	N/A	8.3	N/A	IEA and WBCSD, (2004). IEA/SMP Model Documentation and Reference Case Projection. Available at: http://www.libralato.co.uk/docs/SMP%20model%20guidance%202004.pdf, IEA, (2016). Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems. International Energy Agency. Available at: http://www.iea.org/etp2016/
6.6	1.1	1.4	N/A	1.8	0.9	N/A	8.4	N/A	
12%	13%	56%	N/A	64%	50%	N/A	1%	N/A	
3.12	0.44	2.34	N/A	N/A	0.24	N/A	9.12	N/A	
3.35	0.50	3.02	N/A	1.88	0.65	N/A	8.90	N/A	
7%	15%	29%	N/A	/	166%	N/A	-2%	N/A	
12106	11965	6255	N/A	6258	5917	N/A	29285	N/A	IEA and WBCSD, (2004). IEA/SMP Model Documentation and Reference Case Projection. Available at: http://www.libralato.co.uk/docs/SMP%20model%20guidance%202004.pdf, IEA, (2016). Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems. International Energy Agency. Available at: http://www.iea.org/etp2016/, United Nations, (2017). 2017 Revision of World Population Prospects. Available at: https://esa.un.org/unpd/wpp/
12963	13467	9429	N/A	8682	7229	N/A	26063	N/A	
7%	13%	51%	N/A	39%	22%	N/A	-11%	N/A	
6399	5387	15969	N/A	N/A	2399	N/A	32330	N/A	
6591	6168	21001	N/A	9114	5147	N/A	27805	N/A	
3%	14%	32%	N/A	/	115%	N/A	-14%	N/A	
530.69	602.70	217.33	123.92	123.17	198.67	783.73	805.40	494.43	SLoCaT calculations based on OICA, (2015). Motorization Rate 2015 - worldwide. Available at: http://www.oica.net/category/vehicles-in-use/, United Nations, (2017). 2017 Revision of World Population Prospects. Available at: https://esa.un.org/unpd/wpp/
579.74	592.69	356.91	196.12	207.53	296.71	807.60	825.79	540.14	
9%	-2%	64%	58%	68%	49%	3%	3%	9%	
521.81	564.34	178.04	87.24	98.28	131.83	461.29	450.34	402.45	
504.59	551.61	307.55	144.44	172.22	213.97	405.73	382.34	429.57	
-3%	-2%	73%	66%	75%	62%	-12%	-15%	7%	
69.04	38.36	39.28	36.01	24.89	66.84	322.44	355.06	91.97	
75.15	41.07	49.36	50.45	35.31	82.74	401.88	443.45	110.57	
9%	7%	26%	40%	42%	24%	25%	25%	20%	
892.38	173.06	189.12	399.62	125.45	106.57	1,867.80	1,717.83	88.15	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016
810.95	146.39	216.30	598.03	205.78	141.46	1,820.07	1,647.93	107.01	
-9.12%	-15.41%	14.37%	49.65%	64.04%	32.74%	-2.56%	-4.07%	21.40%	
1.83	2.12	1.29	0.77	0.72	1.05	5.97	6.09	2.89	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016, United Nations, (2017). 2017 Revision of World Population Prospects. Available at: https://esa.un.org/unpd/wpp/
1.60	1.79	1.50	0.94	0.99	1.11	5.08	5.11	2.72	
-12.85%	-15.85%	16.30%	22.93%	38.47%	5.86%	-14.99%	-16.04%	-5.79%	
0.60	0.55	1.99	1.06	0.82	1.21	1.33	1.35	0.91	EDGAR, (2017). EDGAR v4.3.2_FT2016. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Available at: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016, World Bank, (2018). GDP (constant 2010 US$). Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD
0.44	0.39	1.33	1.13	0.92	1.14	0.97	0.98	0.70	
-26.36%	-29.83%	-33.15%	6.60%	12.27%	-5.56%	-27.07%	-27.69%	-22.83%	



Part II. Transport Demand, Emissions, and Mitigation Pathways

Photo credit: Fancycrave

This section is divided into three parts: Part A discusses the various drivers of transport demand, considering recent trends in passenger and freight transport demand, and reports on global development of transportation infrastructure; Part B reviews transport emissions growth by mode and region, and explores transport energy intensity, carbon intensity of fuel, and other impacts; and Part C discusses transport emissions projections and mitigation potential.

A. Transport Demand[232]

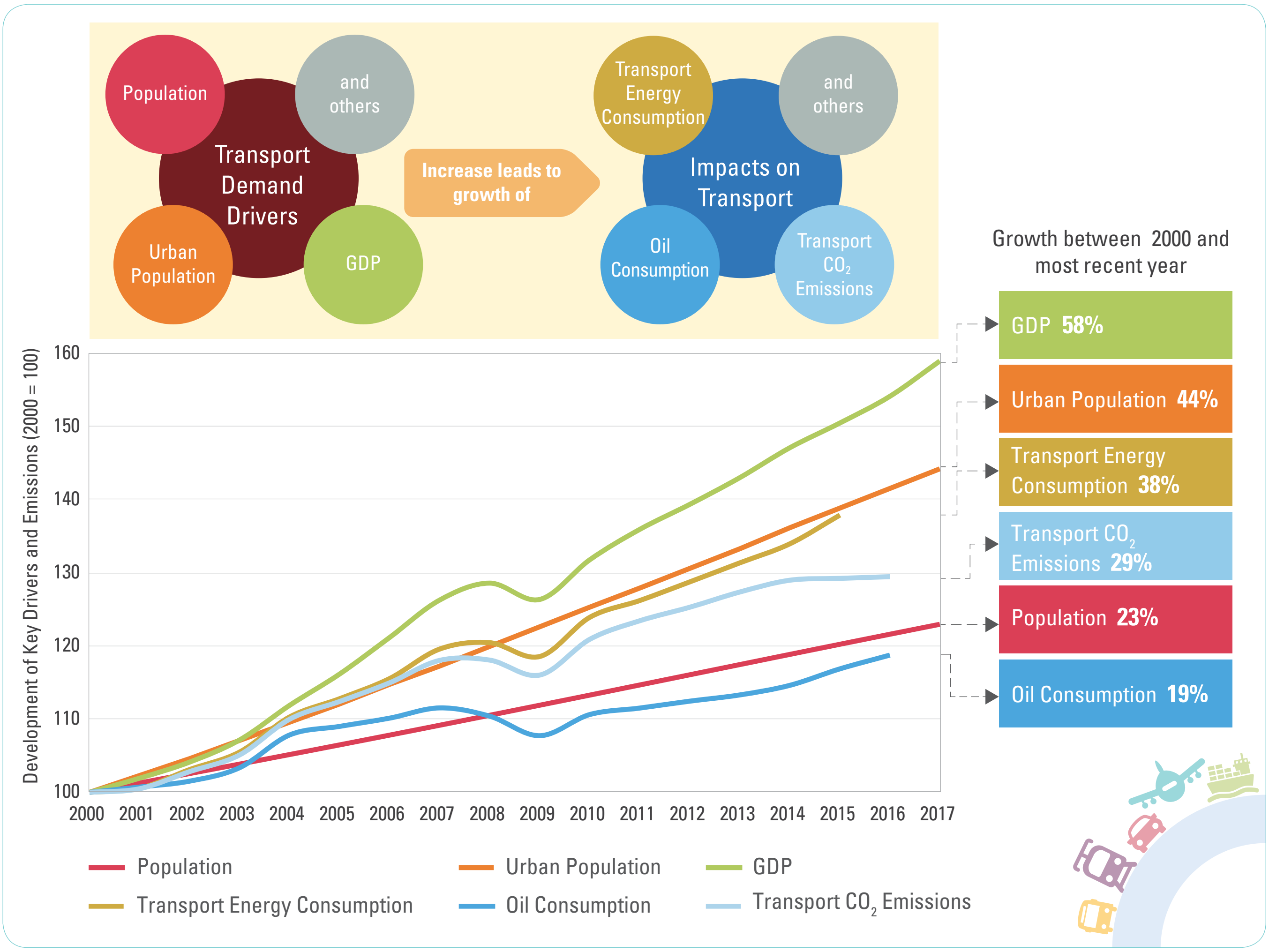
1. Drivers of Transport Demand

Opportunities for mitigating emissions will depend on providing low carbon solutions to meet the major elements of transport demand. Similarly, the problem of growing climate vulnerability of transport infrastructure and services is closely related to the type and location of transport networks built and needed to serve this demand. Therefore, a sound understanding of the composition of transport demand around the world is an essential starting point for examining the global status of transport and climate change. The mobility of goods and passengers is influenced by several external factors (i.e. developments that are not part of transport, such as population growth, economic growth etc.). Historically, growth in the demand for passenger and freight transport has been closely correlated with growth in population, urbanization, sprawl, economic activities, and fluctuating oil prices, which in turn create impacts such as increased oil and energy consumption, and CO_2 emissions (Figure 6).

Population Growth

Each person added to the **population** creates additional transport demand. However, population growth in and of itself should not be a major driver of growth in personal transport demand. Population growth significantly influences many other drivers of transport demand, such as per-capita income, urbanization, sprawl/suburbanization, average age of the population, and regional population growth. From 2000 to 2017, the global population increased by about 1.4 billion people and reached 7.5 billion, with 82% of the increase concentrated in middle and low-income

Figure 6: Transport Demand Drivers and Impacts (2000 to 2017)[234]



countries. The global population passed 7 billion in 2011 and has grown by 8.5% between 2010 and 2017. China and India alone contributed a third of the population increase from 2000 to 2017.[233]

Rapid Urbanization[235]

Urban population growth exceeds the rate of global population growth. In 2017, more than half of the world's population (54%) lived in urban areas. **Urbanization** is more concentrated in high-income countries (with an 81% urban population share), than in middle- and low-income countries (51% and 30% urban population share, respectively). Asia, home to nearly 60% of the world's population, has almost 2.2 billion urban citizens and a share of 49%. But the most urbanized region is North America with 83% of people living in cities, followed by Latin America and the Caribbean (79%), and Europe (74%). Low-income countries are catching up; between 2000 and 2017, low-income countries experienced the highest rate of urbanization (94% increase), with Africa (81%) and Asia (59%) leading over other regions.[236] The number of large and mega-cities doubled between 1995 and 2015.[237] By 2016, 24 of the world's 31 megacities were located in developing countries, as are all 10 of the cities projected to become new megacities by 2030.[238]

Urbanization can improve mobility efficiency because it is in less urbanized regions that travel distances can be much longer and less efficient due to less public transport and more personal vehicle travel. Rising urban populations increase mobility demand within cities that are already often congested and accommodating various types of transport users within cities with limited space that were likely planned in a way that prioritizes cars. While there are negative externalities associated with increased urbanization, such as congestion and local air and noise pollution, there are also potential benefits.[239] If transport and spatial planning are well coordinated in cities, the increased population density can support higher capacity urban public transport systems, and a mixture of land uses within walking and biking distance from transport. (See *Sections III.B.1. Sustainable Mobility Planning and Transport Demand Management, III.B.2. Urban Transport, and III.B.4. Walking and Cycling* for discussions of policy responses that encourage sustainable urban development and shifting trips to low-carbon modes.)

Economic Growth

The relationship between **economic growth** and transport is reciprocal. Transport is a key enabler of economic activity and trade; higher incomes lead to higher demand for goods and services that need to be transported. Better transport systems enhance access to income generating activities which in turn lead to economic growth and can drive demand for personal travel and tourism due to infrastructure growth and more affordable fares.

Global GDP increased by 58% between 2000 and 2017 and reached a global value of USD 78 trillion in 2017.[240] Economic growth is the transport driver with the strongest growth in the last two decades. Growth in per capita incomes in various countries and regions has also led to increased ownership and use of private vehicles. Car ownership continues to be a status symbol for many people, even in lower income levels in which lower fuel efficiency has a larger financial impact. This trend can continue for many years before eventually slowing due to saturation of private vehicle ownership.

Freight transport demand reflects the combined effects of economic growth and the changing industry composition of the economy. Countries at an early stage of economic development are more dependent on the production and high-volume transport of low-value primary products. As they move up the global value chain, services and higher-value, lower-volume goods become more important, leading to lower freight intensity per unit of GDP.

Oil Consumption and Prices

As a result of the growing transport activity and demand, oil consumption is on the rise, recording a growth of 18% between 2000 and 2016. Per day, 98.5 million barrels of oil were consumed in 2017.[241]

The price of oil is an underlying determinant of GDP growth, trade, and the demand for transport. In oil-importing countries, lower oil prices boost growth in GDP and trade by improving competitiveness. The retail price of gasoline and diesel, which are largely affected by a country's fuel taxes, may lower oil prices which in turn reduce the ownership costs for personal vehicles. As a result, consumers are more likely to purchase a personal vehicle and drive longer distances. In 2017, crude oil prices were at USD 51 per barrel,[242] showing a slight increase from 2016 levels, but still far below 2011-2014 levels. There is considerable uncertainty about future prices, particularly as alternative fuels come on line. The International Energy Agency (IEA) forecasts that oil prices may rise to USD 72 to USD 97 per barrel by 2025.[243]

2. Passenger Transport Demand Trends

- Since 2000, global passenger transport activity (passenger-km) has increased 74%, with most of this increase concentrated in non-OECD countries.
- Between 2000 and 2015, modal share in most countries shifted towards private automobiles and air travel, and away from public transport services.

Passenger Transport Activity

Global passenger mobility increased from 32 trillion passenger-km in 2000 to about 56 trillion passenger-km in 2015 (Figure 7). However, not all populations and geographic regions contributed evenly to this growth. In fact, the increase in passenger mobility was fully concentrated in non-OECD countries, in which the global share of passenger mobility increased from 44% in 2000, to about 66% in 2015.[244]

Among all countries, the magnitude and intensity of passenger mobility growth in **China** is unparalleled. From 2000 to 2015, passenger mobility in China increased fourfold, from 2.6 trillion passenger-km to about 11 trillion passenger-km.

Public transport passenger activity (bus and railways) has on average stabilized to 2000 levels in OECD countries, and has not increased in the past decade despite supportive policies and investments, whereas in non-OECD countries, public transport passenger activity has doubled from 2000 levels. Currently, transport activity is still closely correlated with economic development (GDP growth) in low-and middle-income countries, while in OECD countries, there could be a slight weakening of this coupling of passenger transport demand with GDP. For example, in the **European Union** the GDP increased by about 30%, while per-capita passenger mobility only increased by 9%.[246]

Passenger Transport Demand by Mode

Global passenger transport demand comprises several segments. About half (51%) of the global passenger-km traveled in 2015 occurred in urban areas. Among motorized modes, passenger cars represented about 40% of global passenger transport activity, land-based public transport about 35%, aviation about 15%, and two-and-three wheelers about 11% of total passenger transport demand.[247]

However, great diversity exists in the mobility patterns among different geographical and income regions. For example, passenger cars contributed about 62% of the motorized passenger mobility demand in OECD countries, while its share in non-OECD countries was about 29% in 2015 (Figure 8).

There is also significant variation among countries. For example, among non-OECD countries, railways contribute about 27% of motorized passenger mobility demand in **India**, while its share is only 1% in the countries of the **ASEAN** region.

Between 2000 and 2015, modal share shifted towards private automobiles and airplanes, and away from public transport services in most countries. Passenger car activity has been persistently falling or stalled in many European countries and North America for the past decade, reflecting such factors as: the high rate of urbanization; the availability of good quality public transport; and the adoption of policies discouraging car use in favor of public transport *(See Part III.B.1 Sustainable Mobility Planning and Transport Demand Management and III.B.2 Urban Transport).* In non-OECD countries - where urban public transport and non-urban rail, bus transport, and walking and cycling facilities are often inadequate - growth in travel is principally driven by growth in private vehicle ownership. Air travel recorded nearly 4 billion passengers carried in 2017, an increase of 145% from 2000 (Figure 9).[249]

Figure 7: Status of Passenger Mobility (2000 and 2015)[245]

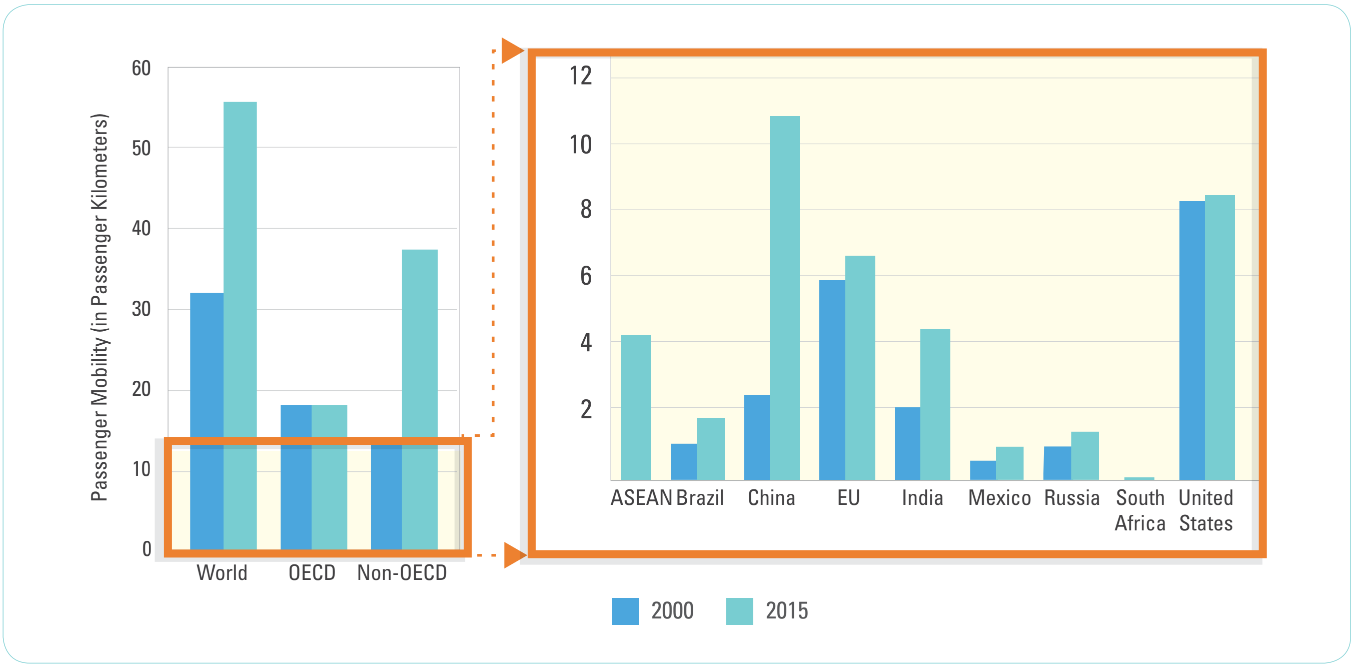


Figure 8: Motorized Passenger Transport Mode Share in OECD and non-OECD Countries (2015)[245]

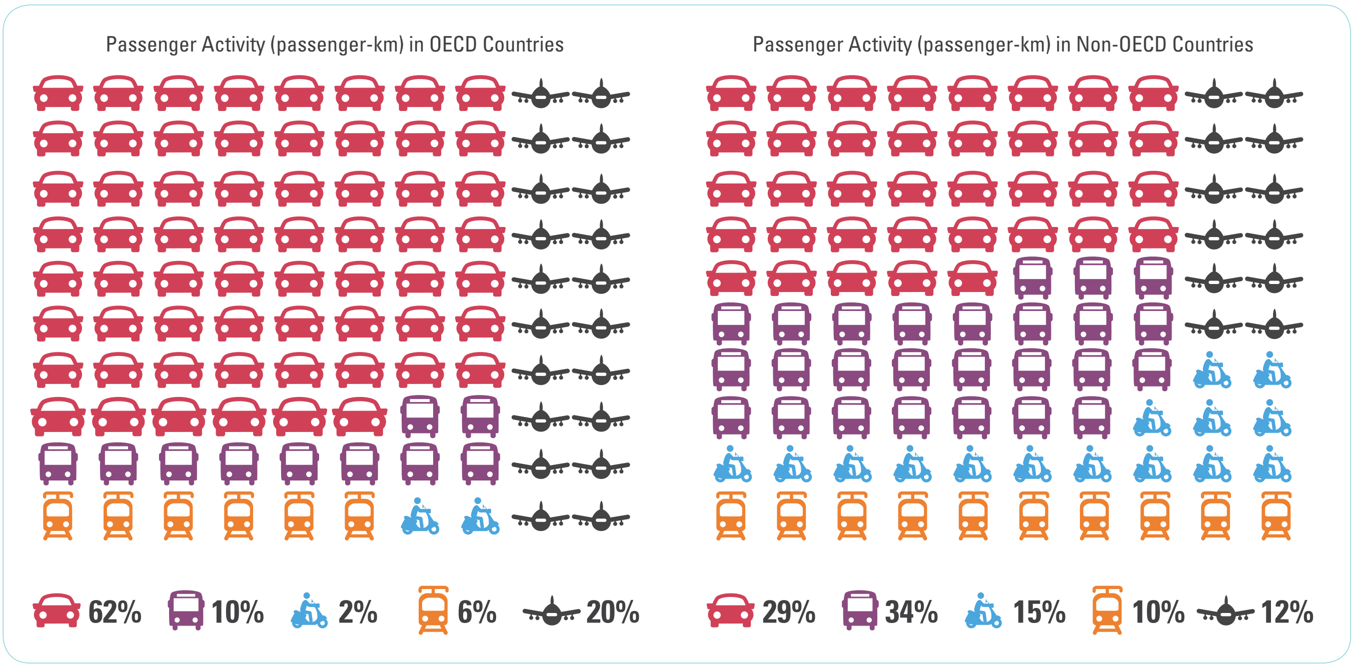
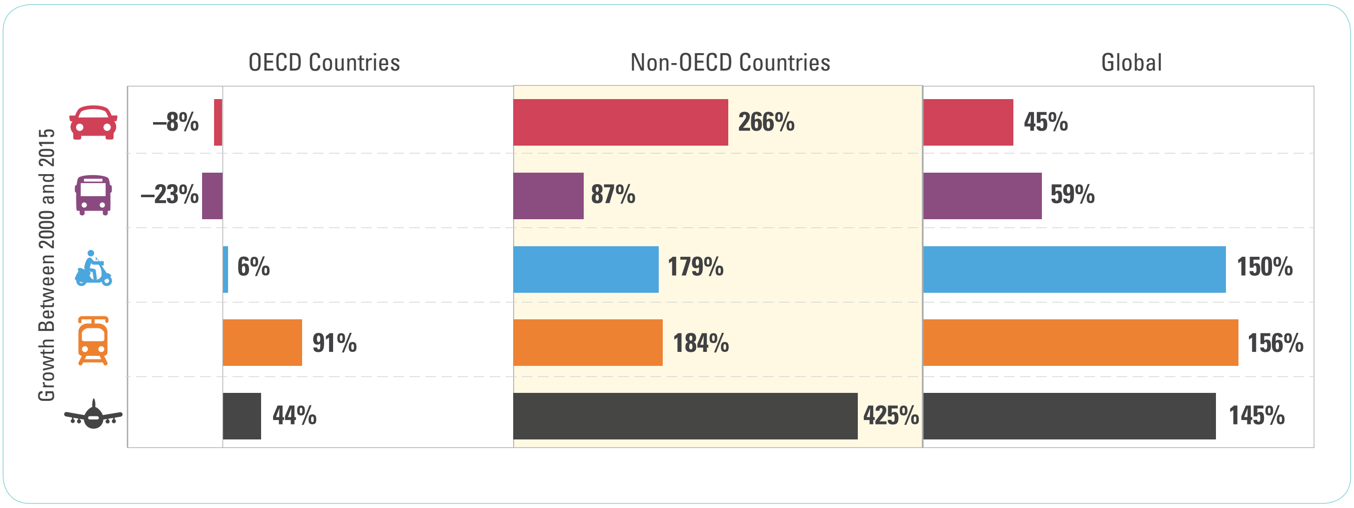


Figure 9: Growth of Passenger Activity for Motorized Transport Modes[250]



Private Vehicle Ownership

Motorization generally follows an S-shaped curve, with private vehicle ownership rising slowing when average incomes remain low, accelerating when middle-income level is reached, and slowing again when incomes become high. Current vehicle ownership levels are 487 and 69 passenger vehicles per 1000 population in OECD and non-OECD countries, respectively.[251] In countries that have more recently reached middle-income levels, such as **Botswana**, **China**, **India**, **Indonesia**, and **Sri Lanka**, average annual ownership growth rates were typically in the range of 6–17% from 2005 to 2015.[252] Some of these middle income countries, like **India** and **China**, support the growth of their automobile industry; as a result, these countries are likely to experience high growth rates of motorization. Private vehicle ownership levels do not stagnate in high-income countries. In 2017, the sales of private vehicles increased by 3% in the European Union. The same year, 15.1 million vehicles were registered in the **European Union**; the highest number of registered vehicles since 2007.[253]

Experience suggests that, if economic growth continues in the absence of sustainable transport measures, rapid motorization may continue in these countries for many years until eventually per capita car ownership approaches levels seen in high-income countries (as highlighted in *Part III: Responses to Transport and Climate Change Impacts*). Many lower-income developing countries have yet to achieve the GDP growth that would trigger the onset of rapid motorization, but some may be expected to do so in the coming years. A consequence of rapid motorization, especially in the absence of sustainable alternatives including walking and cycling, is a reduction in physical activity levels, which negatively impacts public health and contributes to climate change *(See Sidebar: Public Health Impacts of Passenger Transport Demand).*

Photo credit: Justin Raycraft

Public Health Impacts of Passenger Transport Demand

Direct Public Health Impacts

Transport has major impacts on health. For example, by encouraging physical activity, such as walking and cycling, urban transport systems can also positively influence health outcomes.[254] Urban transport can also create direct, negative impacts on public health through its contributions to local air and noise pollution, and road injuries and fatalities. Additionally, a well-functioning (uncongested) transport system allows the population to better access health care services.[255] Most of the global top-ten causes of death (e.g. heart attack, stroke, pneumonia, chronic respiratory disease, lung cancers, diabetes, road injuries) are strongly linked to externalities such as local air pollution and physical inactivity.[256] (See *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management and Part III.B.4 Walking and Cycling*).

Indirect Public Health Impacts

Less well known are the indirect health impacts of urban transport infrastructure, as seen through changes in the design and social interaction of neighborhoods. Such impacts include access to public and green space, social cohesion, and protection from crime and violence. Improved mobility for those who have less access to private vehicles—women, children, the elderly and the poor—also enhances health equity.[257] Moreover, transport has a decisive influence on more upstream determinants of health and health equity, by enabling access to education, decent jobs, healthcare, leisure and clean water. Transport emissions impact natural ecosystems and drive climate change, which have indirect health effects.[258]

Linking Transport Climate Action and Public Health

Global growth in transport demand and emissions will further deepen the health and equity impacts of transport systems. These impacts will particularly affect low- and middle-income countries and cities that are experiencing rapid urbanization, weak transport regulation and enforcement, and poor infrastructure, Climate action in the transport sector that advances cleaner fuels and vehicles (See *Section III.B.7 Electric Mobility* and *Section III.B.8 Renewable Energy in Transport*), more active transport (See *Section III.B.4 Walking and Cycling*), and safer streets can yield significant, immediate public health benefits, while reducing the transport sectors' GHG emissions contributions.[259,260,261]

3. Freight Transport Demand Trends

- Since 2000, global freight transport demand (in tonne-km) has almost doubled.
- Freight demand is growing faster than GDP, with surface freight activity increasing by 177% from 2000 to 2015.
- Urban freight constitutes about 12% of road freight demand (in tonne-km), but generates about 50% of road freight vehicle km, a majority of freight activity done within an urban area.

Freight Transport Activity

Global freight transport demand increased by 68% from about 64 trillion tonne-km in 2000, to about 108 trillion tonne-km in 2015.[262] **Maritime freight** carried by far the largest portion of freight tonne-km (69%), followed by road (22%) and railways (9%), with much lower volumes for **air freight** (less than 1%). Road freight increased its share from 12% in 2000 to 22% in 2015 (see Figure 4). Maritime shipping is the main transport mode for long-distance trade, accounting for around 70% of global trade value.[263] For many commodities, it offers significant cost and convenience advantages compared with other modes.

Freight demand is growing faster than GDP, with surface freight activity (e.g. road and rail) increasing by 177% from 2000 to 2015.[264] It has been estimated that for every 1% increase in GDP per capita, per-capita road freight activity increases by an average of 1.07%.[265] However, this figure masks considerable national disparities. From 2000 to 2015, surface freight activity nearly doubled in OECD countries, nearly tripled in non-OECD countries, increased fourfold in India, and increased six-fold in China. This rapid increase in freight activity in Asia is mainly due to the export-oriented nature of its economic growth, the rapid change in economic structure from agriculture to industrialization, and the globalization of production activities and supply chains across Asian countries.

Freight Transport Demand by Mode

Surface freight accounts for about 31% of global freight volume, with the majority carried on the road, followed by rail. Surface freight activity (road and rail) increased 40% from 2000 to 2015. Due to its competitiveness and convenience for door-to-door delivery, road freight transport plays a leading role across global regions. There has been tremendous mode-shift towards road freight, with total road freight increasing to 22% in 2015. In the same period, the global road freight fleet (i.e. light commercial vehicles (LCVs), medium- and heavy-duty trucks) doubled from 93 to about 186 million. Currently, 70% of the freight vehicle fleet is LCVs, with 17% medium- and 13% heavy-duty trucks.

Rail freight is important in geographically large countries—such as **China**, **India**, **Russia** and the **United States**—where the railway's lower per-km transport operating costs can outweigh its fixed and handling costs. However, data for 65 countries from 1990–2010 indicates that nearly 55% of countries had negative growth rates in rail tonne-km. Among possible explanations for this are: continued investment in road infrastructure improvements; shortfalls in railway investment; trends toward just-in-time deliveries; shifts toward higher-value products; and shortcomings in the commercial orientation of railway institutions. While there has been a tremendous increase in road-freight activity since 2000, the rail-freight mode share has stagnated to 2000 levels.

Urban freight constitutes only about 1% of total freight activity in tonne-km (or about 12% of road freight activity) but generates about 50% of road freight vehicle kilometer travel,[266] as final products get delivered in low volumes and at high frequencies in congested conditions.

In line with developments in the world economy, demand for **shipping services**—represented as millions of tons loaded—increased, with an annual growth rate of 3.4% from 2000 to 2016. The share of the major bulk commodities (e.g. coal, iron ore, grain) amounted to about 31% of total volume (increasing from 16% in 1980). In contrast, the share of oil and gas reduced from 51% in 1980, to 30% in 2016. In 2016, global shipping activity reached 88 estimated trillion of tonne-km, increasing by an annual growth rate of 3.7% from 2000.[267]

Aviation contributed only about 0.1% of global freight transport demand; however, this demand is growing rapidly (see Figure 4). Since 2000, air cargo movement has increased by 65%,[268] and now represents more than 35% of global trade by value (i.e. about 7.4% of global GDP).[269]

4. Transport Infrastructure Supply

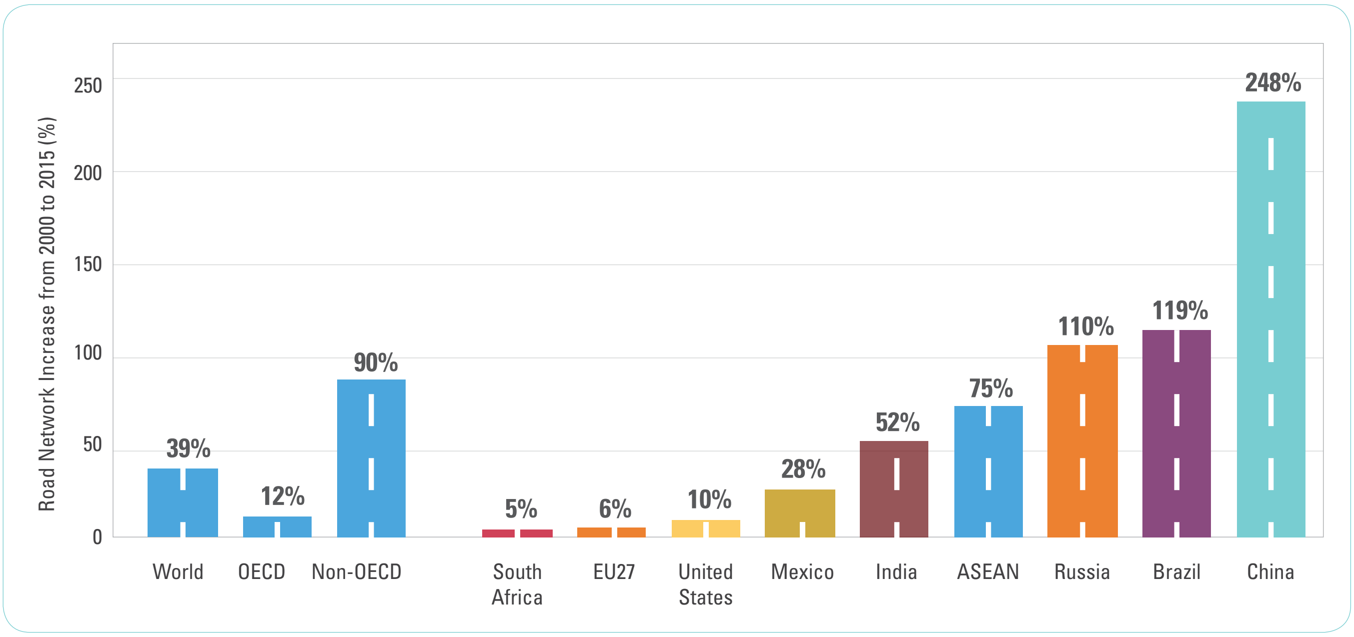
- Since 2000, global roadway length increased by about 40%. While conventional railway infrastructure stagnated at 2000 levels, high-speed railway infrastructure increased by nearly 12 times from 1990 levels.
- Since 2000, there has been significant expansion of BRT (835%), light rail (88%), and metro system (67%) infrastructure.

Transport infrastructure supply drives transport activity demand patterns, depending on whether that infrastructure is concentrated in roadways, railways or public transport. **Paved roads** (without any explicit distinctions in car lanes, bus lanes or cycling lanes) constitute roughly 97% of the global surface land transport infrastructure. Since 2000, the global roadway network length increased by about 40%, from 35 million kilometers to about 49 million kilometers, to meet the growing demand by passenger and freight transport. Since 2000, about 90% of road infrastructure growth occurred in non-OECD countries (Figure 10).[270]

Global railway development provides a contrasting picture when compared with road development. Railway infrastructure has remained stagnant at 1990 levels. Overall, roughly 120,000 rail track-km were removed or retired since 1990. Railway infrastructure density shows significant reductions in many OECD countries (e.g. **Austria**, **Germany**, **Ireland**, **Latvia**, **United States**). While conventional railway infrastructure stagnated at the global level, HSR infrastructure increased to nearly 12 times the 1990 level, passing an estimated 35,000 km in 2017.[272] Over the last two decades, **China** has led high-speed railway infrastructure development, accounting for nearly 60% of global high-speed rail infrastructure (*See Section III.B.3 Railways for further discussion of high-speed railway* expansion trends).

Air transport infrastructure expanded further in recent years to accommodate the growth in passengers and freight carried. In 2017, 35.8 million registered air carrier departures were recorded. 60% of the departures have been in OECD countries but departures in non-OECD countries (e.g. **China**, **Kazakhstan**, **United Arab Emirates** and **Vietnam**) are increasing, and grew threefold (320%).[273]

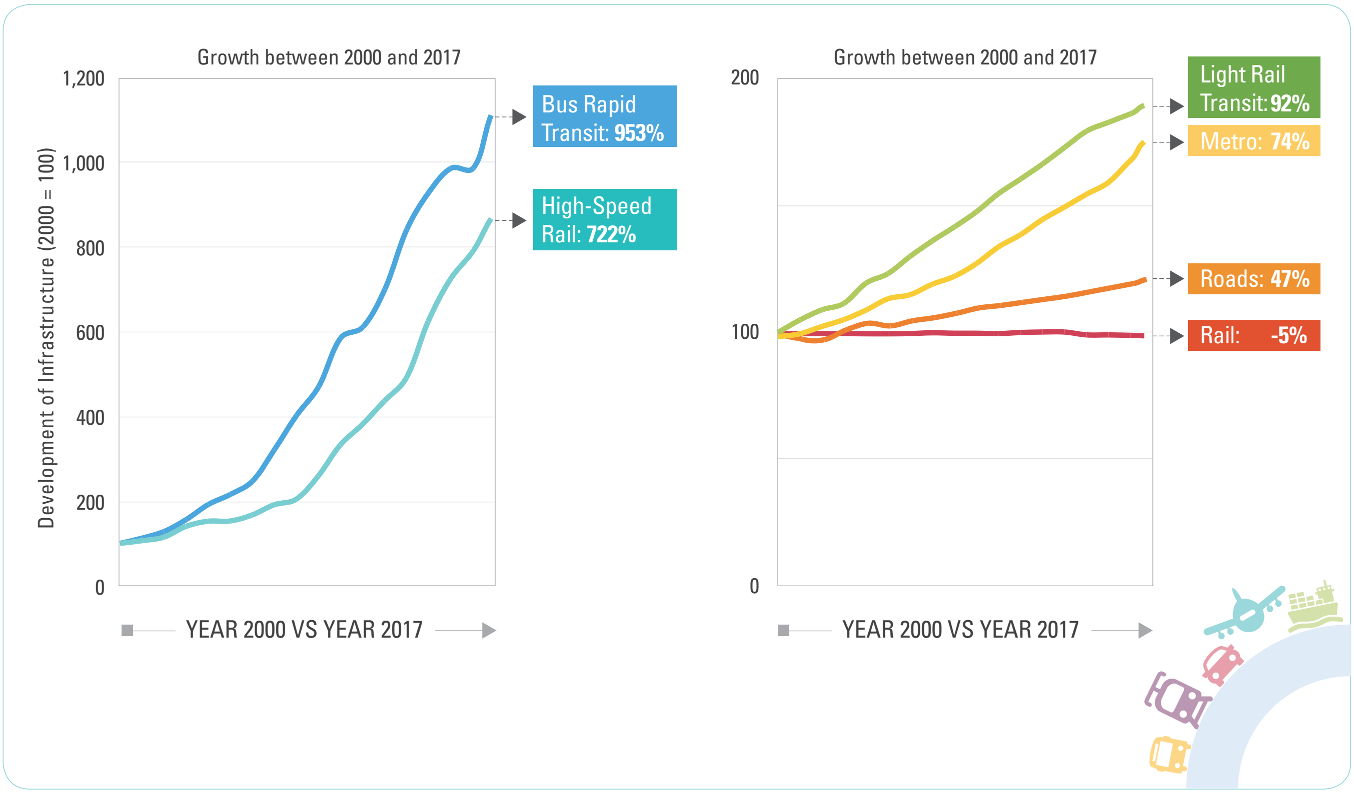
Figure 10: Paved Road Infrastructure Growth (2000 to 2015)[271]



The Rapid Transit to Resident (RTR) Ratio indicator by the **Institute for Transportation and Development Policy (ITDP)**, which compares a country's urban population with the length of **rapid urban transit** lines (including light rail, metro, and BRT) that serve them, has shown significant improvement in both OECD and non-OECD countries (e.g. **Colombia**, **China**, **France**, and **Indonesia**).[274] Globally, between 2000 and 2017, BRT, light rail and metro system infrastructure expanded by 952%, 91% and 74%, respectively (Figure 11).[275]

In 2017, 26 cities in eleven countries added 703.8 km of metro rail, six cities added 62.4 km of BRT, and 17 cities added 135.2 km of light rail.[277] Globally, however, the RTR ratio has increased only marginally, from about 10.9 km to 11.1 kilometers per million population (in cities with more than 500,000 people) (See *Section III.B.2 Urban Transport* for further discussion of metro rail, BRT and light rail policies and infrastructure expansion.).

Figure 11: Transport Infrastructure Increase (2000 to 2017)[271]



B. Transport Emissions and Other Impacts[278]

Global growth in CO_2 emissions from the transport sector has been driven by increasing demand for transporting passenger and goods, and the corresponding growth in the levels of activity served by the various modes of transport.

Emissions in the transport sector are dependent on four factors, as captured in the 'ASIF' formula: the product of travel demand in passenger-km and/or freight activity (A) (in tonne-km travel) across all modes; the mode share (S); the fuel intensity (I) of each mode in liters per passenger-km (or tonne-km for freight); and the carbon content of the fuel or emission factor (F), in grams of carbon or pollutant per liter of fuel consumed. These components are not assumed to be independent, but interconnected, and each component may directly or indirectly influence the other components (positively or negatively). The 'ASIF' formula is the foundation for the 'A-S-I' strategy framework.

1. Economy-Wide CO_2 Emissions

- Since 2000, economy-wide and transport-sector emissions have increased by 37% and 29%, respectively.

- Transport is the third-largest CO_2-emitting sector after the power industry and other industrial combustion.

Total GHG emissions (excluding those from land use) increased from 36.1 Gt in 2000 to about 49.3 Gt in 2016 in CO_2 equivalent, i.e. an increase of about 37%. About 72% of these emissions are CO_2 emissions, 19% are methane (CH_4), 6% are nitrous oxide (N_2O), and 3% are fluorinated gases (F-gases), calculated using Global Warming Potentials for 100 years.[280] The top six CO_2 emitters (i.e. **China**, **United States**, **European Union**, **India**, **Russia** and **Japan**, in decreasing order of emissions) constitute about 51% of the global population, 65% of global GDP, and 65% of total global GHGs. The CO_2 emissions from the energy sector[281] account for the largest share of global anthropogenic GHG emissions, representing about 68% of global emissions in 2014.[282] Since the industrial revolution, global CO_2 emissions from fossil fuel combustion, a major source of anthropogenic GHGs, have dramatically increased from near zero to about 23.7 Gt in 2000, and to about 32.3 Gt in 2015, an increase of about 36%.

The power industry (i.e. the generation of electricity and heat) is the largest source of global fossil CO_2 emissions,[283] with a 38.5% share in 2016, followed by other industrial combustion (i.e. combustion for industrial manufacturing and fuel production) with a share of 21.2%, and transport is the third largest source with a share of 20.9% (Figure 13).

Figure 12: ASIF Formula [279]

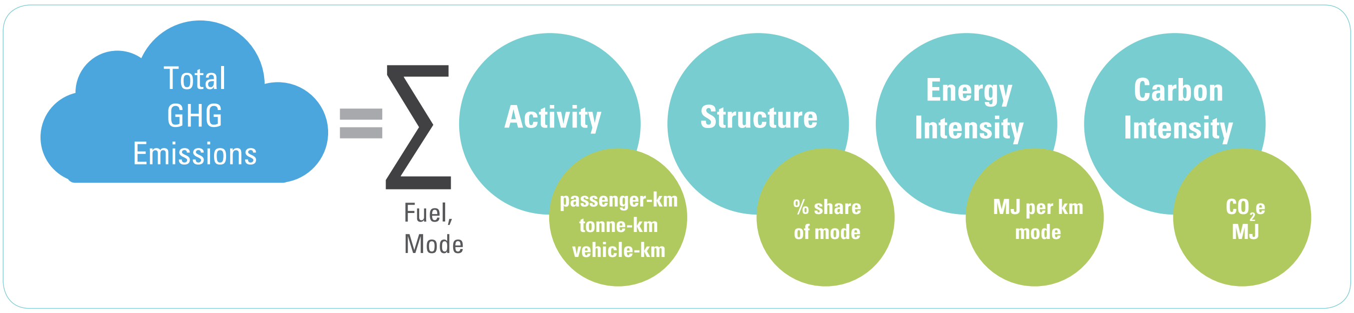
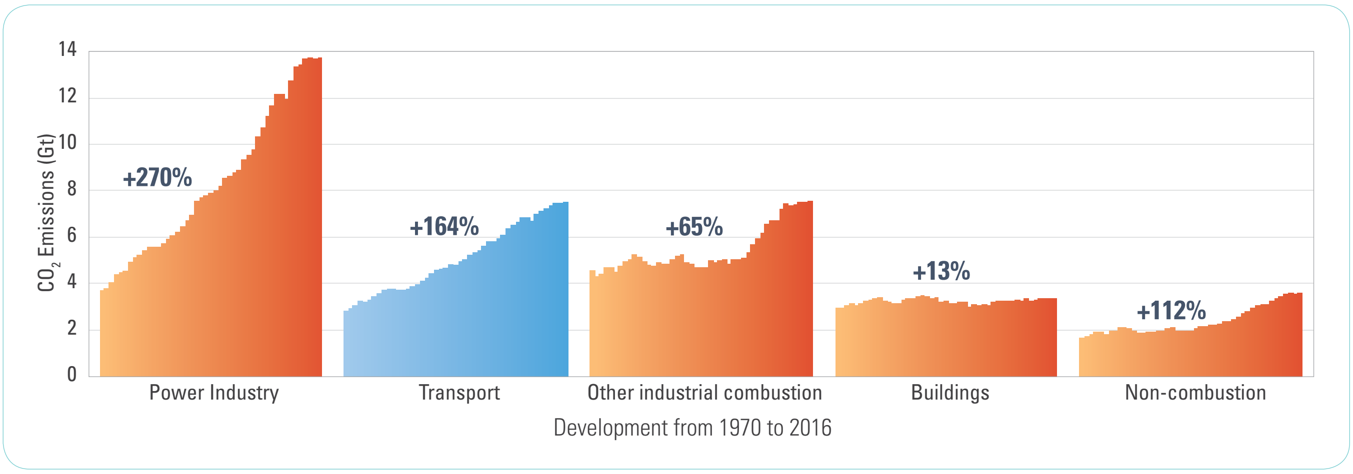


Figure 13: Fossil CO_2 Emissions by Sector (1970 to 2016) [284, 285]



2. Transport CO_2 Emissions Trends

- In 2014, transport produced about 14% of global GHG emissions.
- From 2000 to 2016, GDP and transport CO_2 emissions increased by 52% and 29%, respectively.

Transport sector CO_2 emissions increased from 5.8 Gt in 2000 to 7.5 Gt in 2016, an increase of 29%. Transport produced about 14% of global GHG emissions as of 2014.286 Transport was also the largest growing sector between 2000 and 2016 in 40 countries, among which are 29 non-OECD countries from all regions.[287]

Incremental improvements in transport fuel efficiency and carbon intensity of fuels have kept global growth in transport CO_2 emissions (29%) lower than the growth in transport demand (i.e. growth in passenger traffic (74%) and freight traffic (68%) volumes.[288] Ethanol and biodiesel blends implemented in numerous countries have lower lifecycle GHG emissions. However, there have been no large-scale changes in transport technology capable of disrupting the CO_2 emissions growth trend.

As discussed in Section II.A, economic growth has been a key enabler to higher demand of the transport of passengers and goods. The growth in transport demand produced contributed to the increase in CO_2 emissions from the sector. From 1970 to 2000, global GDP increased with an annual average growth rate of 3.3%, while transport CO_2 emissions increased with an annual growth rate of 2.4%. Since the 2008 financial crisis, GDP and transport emissions have grown moderately at an annual rate of 2.7% and 1.1%, respectively, indicating a weakening of this coupling of transport sector CO_2 emissions with GDP (Figure 14). Good examples for decoupling of transport CO_2 emissions from economic growth are **Singapore** and **Uzbekistan**. From 2010 to 2015, the GDP has increased in these countries by 22% and 189%, respectively, while the transport CO_2 emissions have decreased by 6% and 38%, respectively.[289]

Transport Emissions Growth by Region and Country

For many years, global growth in transport CO_2 emissions was mainly attributable to increases in travel activity in OECD countries. However, by the 1990s, growth in travel in these countries began to slow. Between 2000 to 2016, transport carbon emission patterns changed in significant ways. With continuing incremental improvements in vehicle efficiency, by the mid-2000s the transport CO_2 emissions of OECD countries stopped growing.

Albeit starting from a small base, transport demand began to grow rapidly in non-OECD countries in the early 2000s. The share of non-OECD countries in total transport CO_2 emissions also increased from 27% in 2000 to 41% in 2016, while the share of OECD countries reduced from 58% to 43% (Figure 15).

The **United States**, **European Union**, **China**, **India** and **Russia** (in decreasing order) collectively constitute close to 60% of total transport CO_2 emissions (excluding international aviation and shipping emissions). Due to high growth in travel activities and the slow pace of fuel efficiency improvements, international aviation and shipping emissions have increased by 47% and 33%, respectively, and now constitute about 16% of total transport emissions (Figure 15).

Figure 14: Transport Emissions Relative to Economic Growth (1990 to 2016)[290]

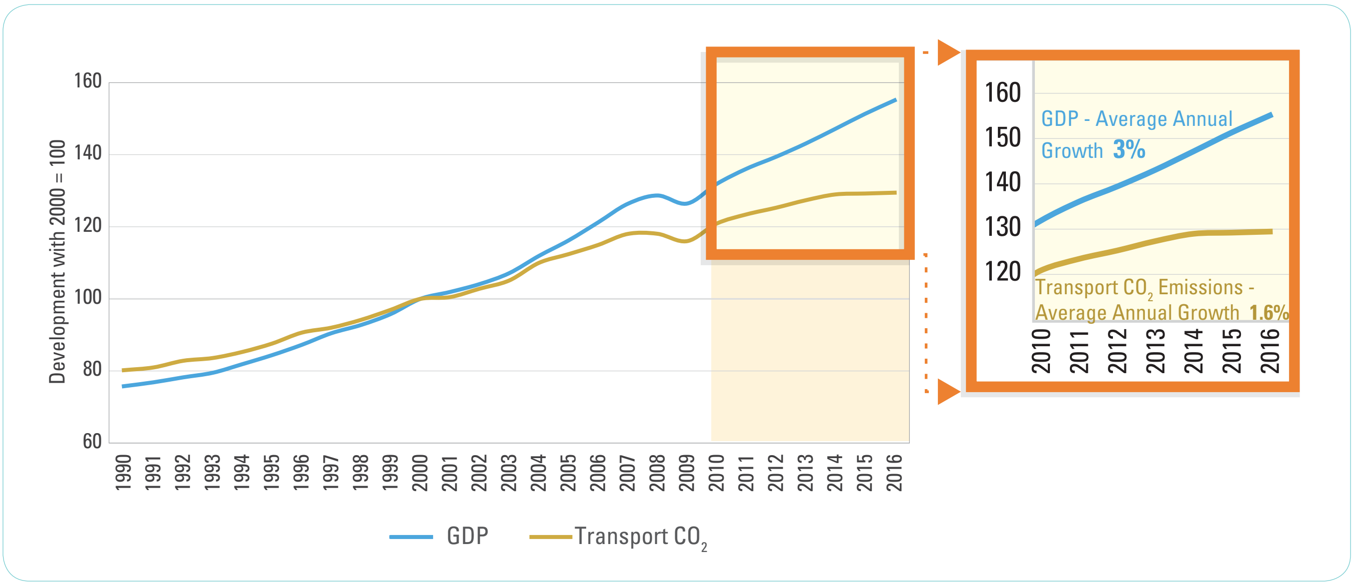
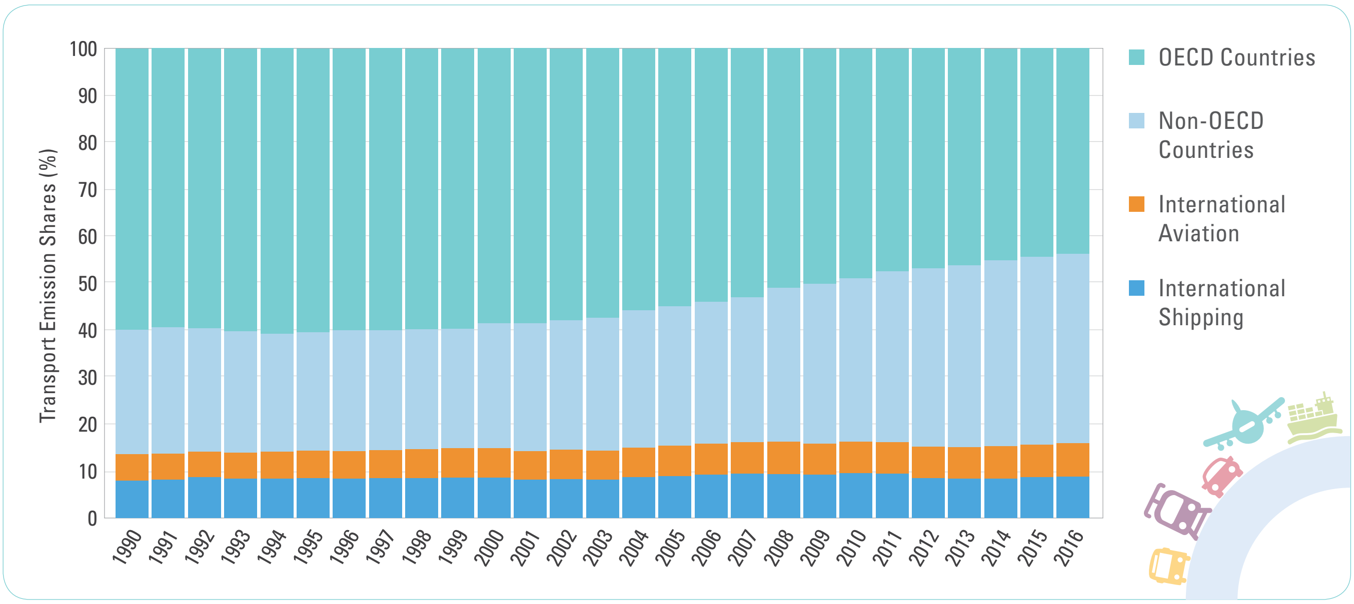


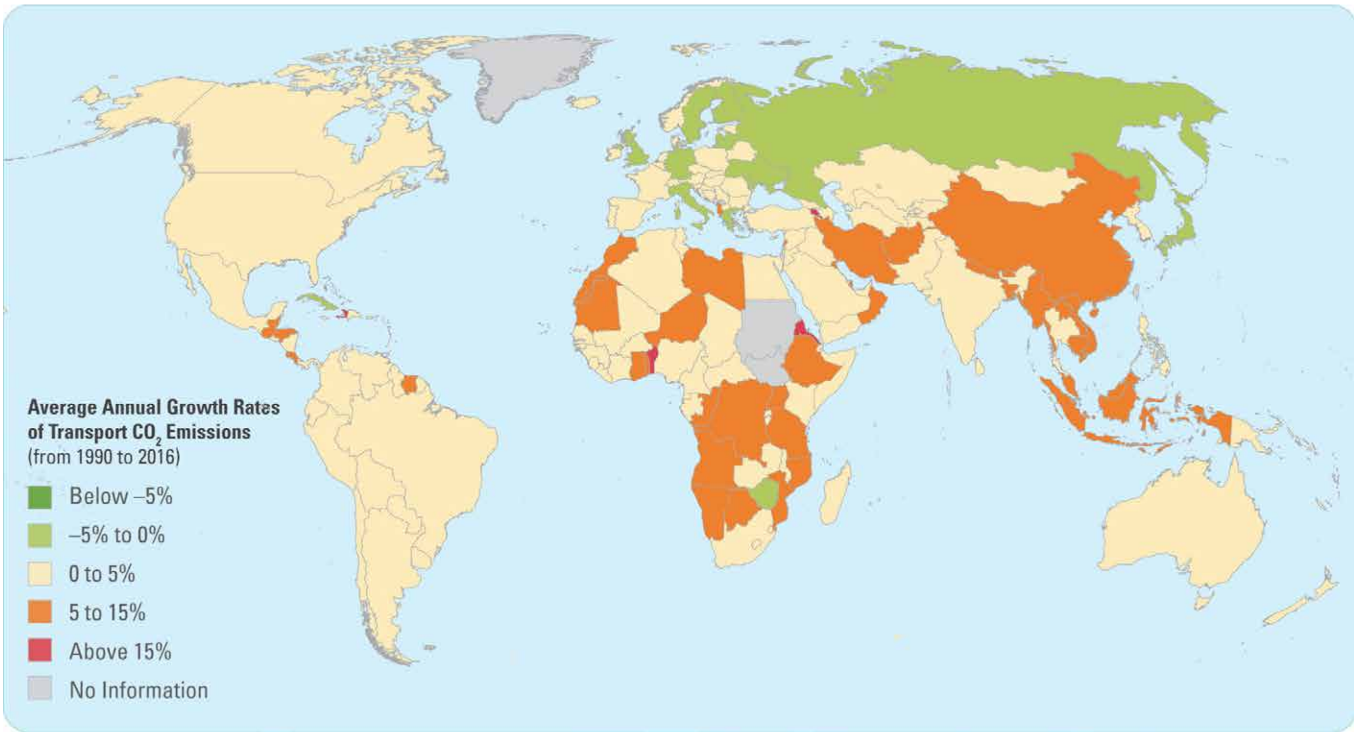
Figure 15: Transport CO_2 Emissions Share of OECD and non-OECD Countries (2000 to 2016)[291]



Transport emissions growth rates are decreasing in OECD countries. Transport CO_2 emissions decreased marginally from 2.99 Gt in 2000 to 2.94 Gt in 2016. From 1990 to 2000, about 13% of OECD countries had an annual growth rate of transport emissions of less than 0%. In 2000 to 2016, the share of OECD countries with an annual growth rate of transport emissions below 0% increased to 77%. By contrast, non-OECD countries show an increasing trend in transport growth rates and emissions grew from 1.5 Gt in 2000 to 2.9 Gt CO_2 in 2016. Alone from 2010 to 2016, nearly 31% of non-OECD countries had transport emission annual growth rates exceeding 5%.

In examining the transport CO_2 emissions trends by country, recent growth is led by countries in East Asia, Southeastern Asia, Central Asia and Africa. To a lesser extent, Latin America and the Caribbean show a growth trend, with only Cuba showing a reduction of transport CO_2 emissions (Figure 16).

Figure 16: Average Annual Growth Rates of Transport CO_2 Emissions (1990 to 2016)[292]



3. Disaggregating Transport CO_2 Emissions

- Since 2000, public transport mode share (in passenger-km travel) has remained stagnated at 2000 levels, whereas railways and shipping freight mode share (in tonne-km) has reduced from 87% to 78%.

Transport Emissions by Country Grouping

Since 2000, the aggregated modal share (i.e. road, railways, shipping, aviation) in transport emissions has been similar across OECD and non-OECD countries. However, there are significant variations among countries. For example, road share in transport emissions (in 2015) varied from 63% in **Russia** to 97% in **Mexico**. Railway share in total transport emissions is negligible in Southeast Asia countries, whereas it is above 5% in **South Africa**, **India** and **Russia.**

Further, within the road sector, there are significant variations in magnitude and intensity of growth of different sub-modes. For example, light-duty vehicles constitute about 49% of transport CO_2 emissions share in OECD countries, but only 39% in non-OECD countries. Since 2000, the emissions share of light-duty vehicles has reduced in OECD countries, but increased in non-OECD countries. Two-and-three-wheelers constitute only about 1% and 8% share in total transport emissions in OECD and non-OECD countries, respectively. Two- and three-wheeler emissions have grown globally the fastest among all modes, with about 260% growth from 2000 to 2015 due to their high relevance in India and in **ASEAN** as a major mode of transport. Between 2000 and 2015 the activity of motorized two- and three-wheelers increased from 2.8 trillion passenger-km to 8.5 trillion passenger-km.[293] The increase was fully concentrated in non-OECD countries, where its share increased from 3% to 8% from 2000 to 2015 (Figure 17).

Transport Emissions by Mode and Sub-Sector

Passenger and freight CO_2 emissions growth have followed transport activity growth trends, but with much lower intensity. Since 2000, passenger and freight activity have increased by 74% and 68%, respectively. However, **passenger and freight transport** emissions have only increased by 36% and 75%, respectively. Freight emissions are now growing much faster than passenger transport emissions with freight emissions share in transport CO_2 emissions increasing from 35% in 2000 to 41% in 2015.

The main passenger modes contribute to global passenger CO_2 emissions roughly in proportion to their share of global passenger activity. Passenger cars, two-and-three wheelers and mini buses constitute 65% of passenger transport activity and contribute about 75% of passenger transport CO_2 emissions. However, public transport services (e.g. heavy road, rail, bus and railways), which accommodate about 22% of passenger activity, generate only about 7% of passenger transport CO_2 emissions (Figure 18).

Comparing **maritime freight** and **surface freight**, there is an inverse relationship between market share and emissions. Surface freight using road and rail produces about 75% of freight CO_2 emissions carrying about 30% of tonne-km, while maritime shipping produces 24% of freight CO_2 emissions, carrying 69% of tonne-km.[296] This reflects the much lower CO_2 intensity of maritime shipping compared with surface freight modes. **Air freight** has a much higher CO_2 intensity

Figure 17: Transport CO_2 Emissions Share (Mode) (2000 and 2015)[294]

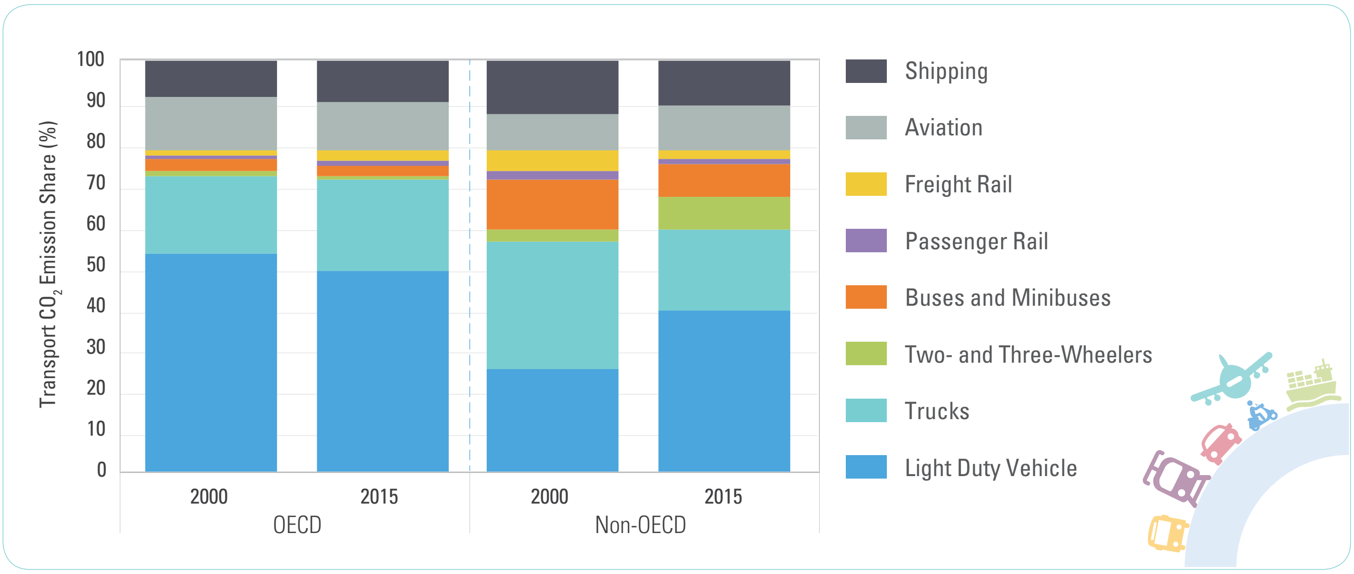
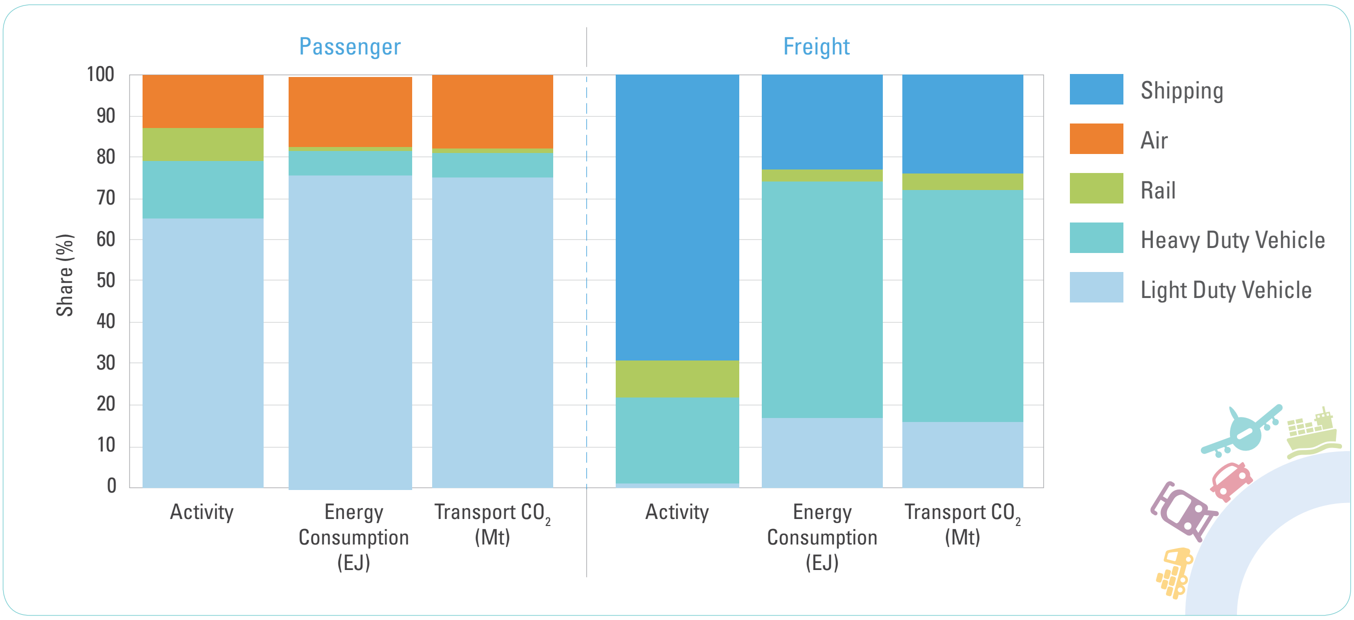


Figure 18: Passenger and Freight Modal Shares: Activity, Energy Consumption and CO_2 Emissions (2015)[295]



than surface transport and shipping; at only 0.1% of global freight in terms of tonne-km, is currently too small to significantly influence global freight emissions.[297] However, since 2000, air cargo movement has increased by 65%, and is set to grow very fast over the next two decades.[298]

Urban freight constitutes only about 1% of total freight activity in tonne-km (or about 5% of surface freight activity), but causes about 16% of the surface freight CO_2 emissions.[299] Among transport sub-sectors, **road transport** is by far the largest producer of global CO_2 emissions from transport, accounting for three-quarters of transport emissions in 2015. This reflects road transport's relatively high CO_2 emission intensity, and its leading role in the major market segments for urban and non-urban passenger transport and surface freight. **Rail**, which has a lower CO_2 emission intensity and a much smaller market share (i.e. about 8% of passenger transport activity, and 28% of surface freight transport activity), only produces about 3% of transport CO_2 emissions.

4. Transport Energy Intensity

- Since 2000, passenger and surface freight transport energy intensity have decreased by 29% and 15%, respectively.

Energy use for the transport sector is the product of total travel, the modal shares, and the energy intensities of each mode. Any change in any variable will significantly impact the total energy consumption. **Energy intensity**, or the ratio between energy consumption and passenger activity (in passenger-km) and freight activity (in tonne-km), varies significantly among modes and regions. For example, globally, two-and-three-wheelers and large passenger cars provide similar transport output in terms of passenger-km (large cars have 8% lower passenger-km when compared with two-and-three-wheelers), but the energy consumption of large cars is more than four times the energy consumption of two-and-three-wheelers.[300]

Energy Intensity by Transport Mode

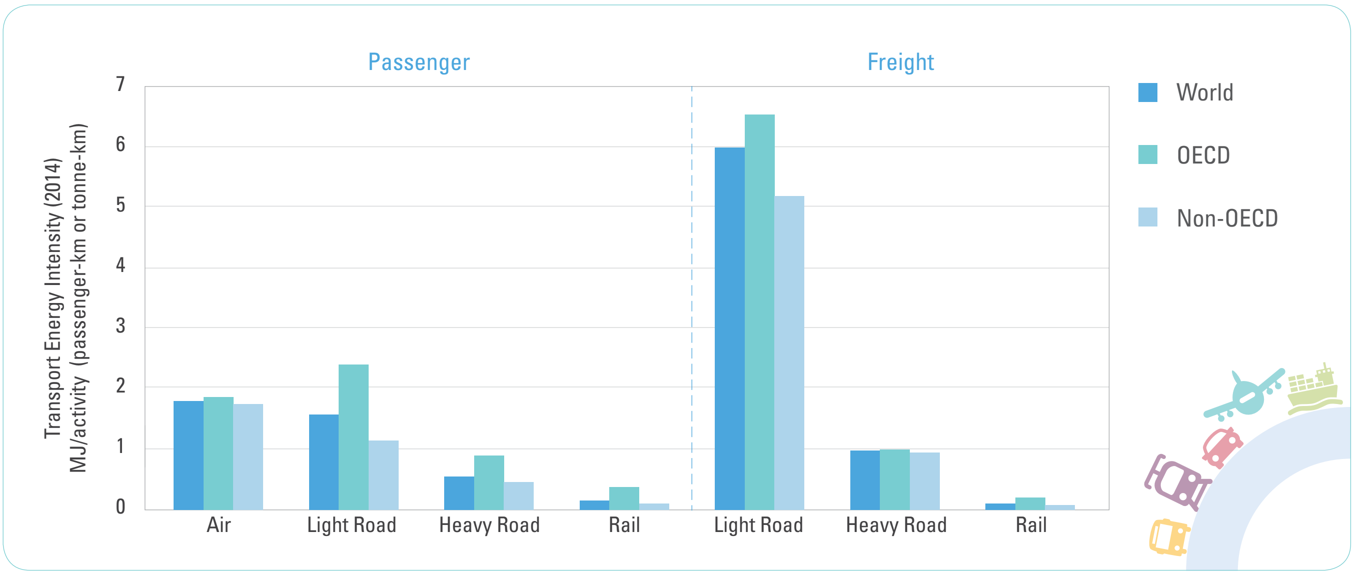
From 2005 to 2015, **passenger transport** energy intensity reduced by 27%, while **freight transport** energy intensity reduced by only 5%. All modes of passenger transport show improvement, with light-duty vehicles showing the least progress. However, significant heterogeneity exists among LDVs in relation to fuel economy in **OECD countries**, with **Europe** and **Japan** having greater fuel economy than **Australia**, **Canada** and the **United States**.[301]

Road freight vehicles show no reduction in energy intensity due to several factors, including vehicle attributes, payloads, and lack of policy frameworks, among others. In surface freight, activity in the **European Union** is only 10% higher than in Russia, but the energy consumption in surface freight is more than five times that of **Russia.** One of the main reasons for such a wide gap in energy intensity of surface freight is the role of railways. In Russia, rail constitutes about 70% of the surface freight activity, while in the European Union it is only 12% (tonne-km).

Energy Intensity by Country Grouping

Transport energy intensity is much higher in OECD countries when compared with non-OECD countries, mainly due to mode split in favor of private vehicles, aviation and trucks (non-OECD countries have a higher share of public transport

Figure 19: Transport Energy Intensity (2014)[302]



and railways) (Figure 19). Other reasons include low occupancy and loading, due to use of less energy-efficient vehicles (fleet composition, vehicle size), or due to lower penetration of alternative transport energy (biofuels, electric two-wheelers).

Among OECD countries, the **United States** and **European Union** have similar total passenger transport activity levels. United States passenger activity is higher than the European Union by about 6%, but the passenger transport energy consumption in the United States is twice the European Union level. One factor driving this gap in energy intensity is the mode share of buses and railways in the passenger transport activity (passenger-km); United States public transport mode share is 9% versus 16% in the European Union.

Between 2000 to 2015, changes in travel demand, mode share, and energy intensity interacted to determine increases in per-capita transport energy consumption of 27% globally, 1% in OECD countries, and (98%) in non-OECD countries.[303]

5. Carbon Intensity of Transport Fuels

- Since 2000, oil demand in the transport sector has increased by about 25%; transport remains extremely dependent on oil.
- Transport accounted for about two-thirds of global oil consumption in 2015, with road transport alone accounting for half of oil consumption from transport.
- Electricity share in transport energy consumption has increased marginally from 0.7% in 2000 to 1% in 2015.

Currently, the transport sector is the least diversified energy end-use sector. The principal source of transport carbon emissions is the combustion of fossil fuels, and transport lags behind other energy sectors in its use of renewable energy. Globally, about 50% of **renewable energy** is used in the residential, commercial and public sectors, while in OECD countries a similar proportion is used to generate electricity.[304]

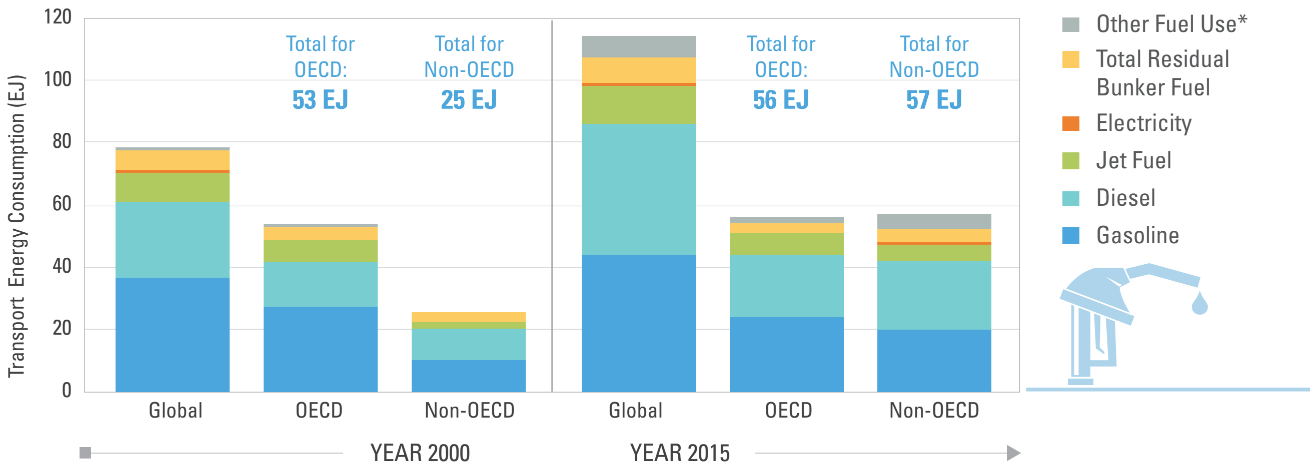
Oil is the predominant fuel used for passenger and freight transport by road, water and air, and accounted in 2016 for 94% of global transport fuel combustion.[305] **Gasoline** and **diesel** remain the dominant transport sector fuels, comprising roughly 75% of total transport energy consumption in 2015 (Figure 20). Overall, transport accounted for about two-thirds of global oil consumption in 2015, with road transport alone accounting for half.[306] The reliance of transport on oil also means that a sizeable portion of international freight consists of movements of oil for end-use in transport. Trade in crude oil and petroleum products (including gas) accounted for about 30% of global maritime freight tonnage in 2016.[307]

Electricity share in transport energy consumption has increased marginally over 15 years (i.e. from 0.7% in 2000 to 1% in 2015). The main exception is railways, which are powered by a significant share of electricity (39%) compared to 56% by oil products.[308] Further electrification of transport must come along with decarbonization of the power sector.

6. Other Climate-Related Transport Impacts

Climate change is often not the main driver of changes to transport policies; other negative externalities of transport activities, such as local air pollution and black carbon

Figure 20: Total Transport Energy Consumption by Fuel Source (2000 and 2015)[309]



*Ethanol, Biodiesel, CNG, LPG, Hydrogen

emissions, often give rise to policy change. Addressing these transport impacts is essential to achieving most of the proposed Sustainable Development Goals (SDGs), which contains climate change targets along with the Paris Agreement.

Local Air Pollution

While most GHG emissions from transport take the form of CO_2, other transport GHGs include CH_4, volatile organic compounds (VOC), NO_x, sulphur dioxide, carbon monoxide (CO), F-gases, non-absorbing aerosols, and black carbon (BC).[310] These pollutants from transport degrade local air quality and are detrimental to public health. Outdoor air pollution was estimated to cause 4.2 million premature deaths globally in 2016.[311]

The global aggregated data on transport externalities indicate a possible weakening of the coupling of externalities such as transport air pollutant emissions with income. However, this figure masks considerable national disparities and contrasts between the improvement in high-income countries with the lack of improvement or worsening in middle and low-income economies. OECD countries have demonstrated more progress in reducing air pollutants from transport than non-OECD countries, which are facing a faster rate of increased transport demand. It is therefore more urgent for non-OECD countries to address the issue to save lives and improve health for citizens. For example, Europe significantly reduced emissions of certain air pollutants the transport sector between 1990 and 2015: CO and non-methane volatile organic compounds (NMVOCs) (both by around 85%); SO_x (by 49%); and NO_x (by 41%).[312] By 2015, emissions of $PM_{2.5}$ had decreased by 42% from 2000 levels. In **India** by comparison, from 2000 to 2010 transport sector NO_x emissions increased by 44%.[313]

Black Carbon

Black carbon (BC) from transport consists of airborne soot particles left from incomplete combustion of fossil fuel, especially diesel.[314] This is typically due to low vehicle emissions standards, inadequate vehicle engine maintenance and high sulfur content in diesel fuel. Although the climate effects of BC are complex and not fully understood, they may be second only to CO_2 in terms of potency. [315] In addition to climate effects, BC is a leading cause of human mortality and morbidity, as it is emitted in the form of $PM_{2.5}$ (particulate matter less than 2.5 micrometers).[316] The human body cannot protect against exposure to ultra fine particles like $PM_{2.5}$, which is associated with a range of respiratory and cardiovascular diseases and with premature death.[317]

Among transport modes, road transport and shipping are the largest producers of BC. According to the IPCC, in North and South America and in Europe, over half of BC emissions result from combustion of diesel and other heavy distillate fuels (including marine oil) in vehicle engines. The IMO sulphur cap is expected to significantly reduce such emissions from international shipping form 2020. BC emissions from road transport are also significant and rising in Asia and Africa.[318] They are one of the main causes of chronic smog in cities such as **Beijing, Delhi, Dhaka, Karachi** and **Lagos**. Thus, climate change mitigation strategies in the transport sector can result in many co-benefits. While selecting mitigation options, opportunities for potential health and environment synergies need to be identified.

Transport Sector Adaptation and Resilience

In addition to impacts *from* the transport sector on local air pollution and black carbon emissions, there are also climate change impacts *to* the transport sector from extreme weather events and natural disasters. Slow onset changes such as sea level rise and changes in seasonal rainfall can also cause major problems for transport infrastructure, requiring often costly and sometimes complex adaptation measures *(See Sidebar: Climate Impacts and Vulnerability in the Transport Sector).*

Climate Impacts and Vulnerability in the Transport Sector

Transport infrastructure and services are **vulnerable to the impacts of natural disasters and climate change.** This is especially true in high-risk locations, such as coastal areas, flood plains, or along deforested mountain slopes, where exposure to natural hazards and disasters like extreme heatwaves, hurricanes, storm surges, flooding and landslides is higher. Climate change is expected to further increase the risks of natural disasters, whose impacts may vary significantly by region, with coastal areas expected to be most impacted due to high exposure to sea-level rise and coastal storms. Incidentally, coastal areas are frequently where much of transport networks and infrastructure are located.

Damage to transport assets from natural disasters and extreme weather events often requires costly repairs and reconstruction, with longa-term implications. Disruptions to the transport network cause delays, and impairs access to markets, products and services, affecting the whole fabric of society and the economy for extended periods of time. Well-being losses are often felt beyond the immediate event, and the extent of the impact depends on the level and speed of connectivity restoration.

Climate Impacts in the Transport Sector

The transport sector will be directly and indirectly impacted by climate change. Sea level rise, increased storm intensity, changes in extreme temperatures – both increase in the average temperature across the year and increase in the number of heatwaves – and precipitation have direct impacts on transport infrastructure, operations and user behavior. Climate change may also impact the demand for products and services that will indirectly impact the transport sector, shifting infrastructure needs. It is worth noting that not all impacts will be negative; for instance, warmer winters in cold regions are likely to reduce delays, improve reliability and decrease need for winter maintenance.

Climate change is expected to impact the infrastructure and services of all transport sub-sectors and modes:

- **Road and rail transport** are sensitive to high temperatures and pavements can rut and buckle. Intense precipitation and longer periods of sustained precipitation have the most pronounced effect on road infrastructure through flooding. Increase in temperature and humidity or prolonged dry spells can raise potential for asphalt deterioration. For inland waterways, changes in seasonal precipitation as well as in extremes mean that both high flow and low flow can cause problems. Drought conditions can severely restrict inland waterway activities
- **Ports** and any transport infrastructure along coast lines, are particularly vulnerable to sea-level-rise and storm surges. Heavy rain and winds can disrupt port and **airport** operations.
- **Underground transit** facilities and tunnels are particularly susceptible to extreme heat as some systems have had to close on hot days and flooding from heavy periods of precipitation, storms or sea-level-rise.

Resilient Transport

Transport can play a role in enhancing the resilience of communities and economies. Resilience in infrastructure depends largely on fundamental design assumptions which may be long out of date. Climate factors should be considered when making long-term decisions about transport infrastructure investment, location and design. For instance, resilient transport systems include adaptive construction designs and materials that can withstand climatic changes, or that can be retrofitted in a timely manner.

Climate change considerations can be incorporated into transport asset management lifecycles to avoid lock-in effects and to enhance adaptive capacity. Enhanced capacity of transport agencies, operators and users can help to minimize impacts on communities and economies. If a metro system is interrupted, for example, other options within the system can be accessed to quickly cover service. Other Climate Change impacts require investments over long periods, integrated with asset maintenance and replacement cycles, as most damage to roads and rail is from chronic conditions (e.g. many successive days above a temperature threshold) rather than extreme events.

continued next page

Climate Impacts and Vulnerability in the Transport Sector *(continued)*

Challenges for Mainstreaming Climate Adaptation in Transport

The 2010 UNFCCC Cancun Agreements established the national adaptation plan process and the 2015 Paris Agreement adopted a global goal to "enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change." The international agreements generated attention and efforts towards climate adaptation.

Countries developed Nationally Determined Contributions (NDCs) plans to increase resilience post-2020. Out of the 166 NDCs, 29 prioritized the transport sector for adaptation, and only 10 specified transport adaptation measures like vulnerability assessments and infrastructure resilience planning. In the NDCs, the focus on adaptation is low when compared to the focus on mitigation.[319]

Challenges to mainstreaming adaptation in the transport sector (even where data sets are sufficient) include the following:

- Decision making within uncertainty of the extent and strength of local impacts;
- Coordination and cooperation of agencies across sector mandates; and
- Lack of relevant and reliable data to support planning and decision making.

C. Transport CO_2 Emission Mitigation Targets and Potential

The transport sector is responsible for 23% of energy-related GHG emissions worldwide; with growing transport demand, transport emissions are increasing at a faster rate than from any other sector.[320] Based on current policies and practices, the emissions pathway for the transport sector is projected to increase by 50% by 2030, and to double by 2050, compared to 2010 levels.[321] However, transport stakeholders are working together in an effort to curb transport emissions in line with scenarios to keep temperature change below 2°C.

- By 2050, global transport sector CO_2 emissions could more than double, reaching 10 to 18 Gt.
- Non-OECD countries will be responsible for nearly all increases in transport emissions, with their share increasing from 40% in 2015, to a projected 56%-72% in 2050.

1. Transport Business-as-Usual Projections

To understand potential emission reductions within the transport sector, it is important to discuss future projected emissions alongside current policies and measures.

Transport Demand Business-as-Usual (BAU) Projections

Change in transport demand is a key driver of future trends in transport CO_2 emissions. Looking forward, global transport activity (passenger and freight) is expected to continue growing under current trends and policies, with faster growth expected for freight transport. The BAU[322] projections from 2015 to 2050 reveal that passenger and freight transport demand (in passenger-km and tonne-km) could grow by 90-160% and by 100%-230%, respectively, if no effort is made to manage transport demand.[323]

While most of the population in middle and low-income countries still do not have access to personal motorized vehicles, this situation is rapidly changing. The baseline global projections of global **light duty vehicle** (LDV) stock indicate an increase from around 0.85–1.1 billion LDVs in 2010, to 2.0–3.0 billion LDVs in 2050.[324] While total passenger travel in non-OECD countries was only slightly greater than in OECD countries in 2015, it is projected to be more than three times greater by 2050.[325]

Due to rapid urbanization in Asia and Africa, **urban passenger transport** activity could increase by about 84%, with a significant shift towards private vehicles.[326] From 2015–2050, non-urban passenger transport activity is projected to increase two to three times.[327]

Future projections of **surface freight** activity in 2030 and 2050 show continued growth in all regions of the world, with road freight remaining the leading mode in all regions, and little change in the market shares of road and rail freight. Striking is the projected trebling of surface freight in the Asia-Pacific region—driven by rapid growth in developing countries in Asia—to account for two-thirds of surface freight by 2050.[328]

Transport Emissions BAU Projections

Despite their inherent uncertainties, transport demand projections are instructive. The IPCC's Fourth Assessment Report in 2007 estimated that the share of non-OECD countries in the total transport emissions will increase to 46% by 2030.[329] However, by 2015, the non-OECD share in transport emissions had already increased to 48% (15 years ahead of the forecast).[330] Emissions growth rates are highest among Asian countries, where collectively CO_2 emissions could increase by more than 300% over the 2010-2050 period.[331] The top countries where the emission growth is projected to be very intense (roughly 300-1400%) from 2010 to 2050 are **Bangladesh**, **Cambodia**, **China**, **India**, **Lao PDR**, **Myanmar**, **Nepal**, **Philippines**, **Peru** and **Vietnam**.[332]

The projected growth in transport CO_2 emissions of the various transport market segments is quite similar to the projected growth in demand (See *Section II.A Transport Demand*). Globally, urban passenger transport, surface non-urban passenger transport, surface freight, and aviation and maritime shipping segments will each account for a quarter of emissions over the period until 2050.[333] The present trends reveal a continued dominance of road transport emissions, as well as an increase in aviation emissions.

Growth in transport activity does not necessarily result in a parallel growth in CO_2 emissions, due to the impact of existing low-carbon policy actions to reduce both the energy intensity of modes and the carbon intensity of fuel. However, BAU projections suggest that the global transport sector CO_2 emissions could still increase to 10 to 18 Gt (i.e., an increase of about 40% to 150% above 2015 levels) (Figure 21).[334]

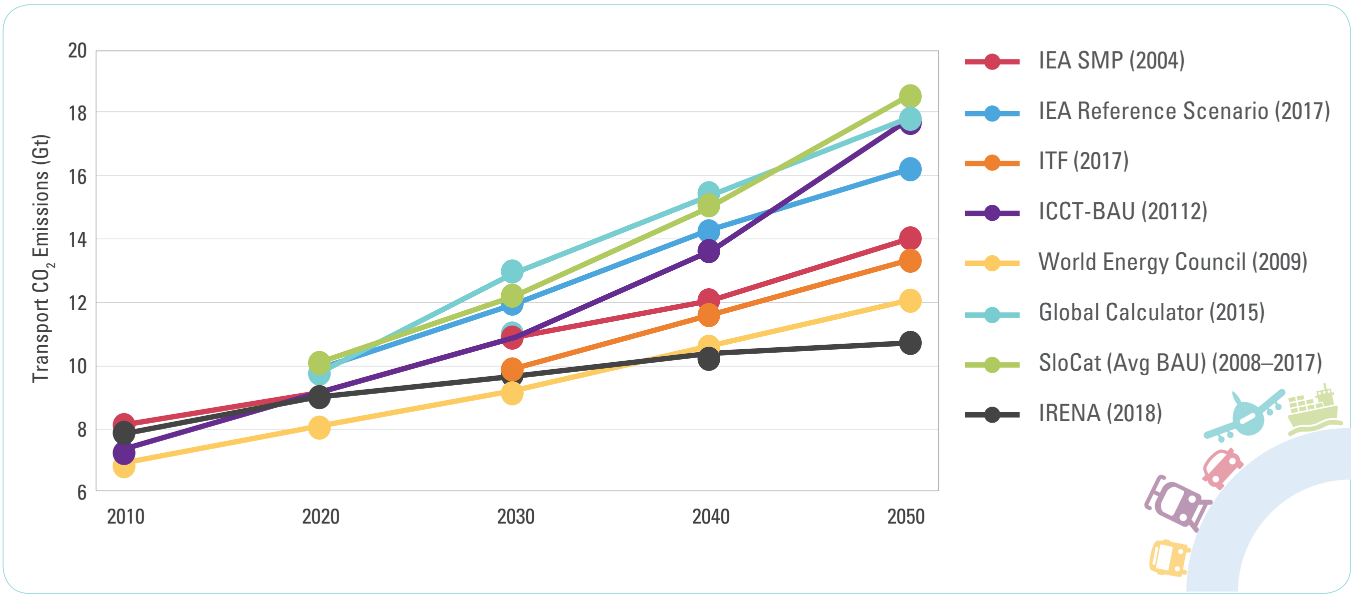
"Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."[336] It is also acknowledged that there is a need to *"reach global peaking of GHG emissions as soon as possible"* and arrive at net-zero global emissions in the second half of this century by achieving a balance between GHG emissions and removals by GHG sinks.

Scientists and researchers find the Paris Agreement commitment to be ambitious. It will be very challenging to end the world's centuries-old reliance on fossil-fuels within just a few decades. However, most also agree that the consequences of not doing so would be catastrophic.

Economy-Wide 2°C and 1.5°C Scenarios

Limiting temperature rises to not more than 2°C is expected to reduce the likelihood and severity of dangerous climate

Figure 21: Transport Business-as-Usual CO_2 Emissions Projections (2000 to 2050)[335]



2. Paris Agreement-Compatible Transport Emissions Pathways

- Global transport emissions will need to be reduced to 2 to 3 Gt CO_2 per year by 2050 to meet Paris Agreement mitigation targets.

By signing the Paris Agreement on Climate Change, 195 countries recognized that existing efforts and commitments to mitigate GHG emissions were insufficient and would need to be stepped up significantly. The countries pledged to work toward aggregate GHG emission pathways consistent with

impacts. The IPCC's Fifth Assessment Report estimated that without additional policies and investments to reduce GHG emissions beyond those in place today, future emissions growth would be largely driven by growth in population and economic activities. By 2100, this would result in global mean surface temperature increases of 3.7°C to 4.8°C, compared with pre-industrial levels; well above the 2°C limit.[337]

The idea of a 2°C limit has been part of the global dialogue on climate change for several decades. It was adopted as a global climate target in 2010 when 193 countries signed the Cancun Agreements committing governments to *"hold* *the increase in global average temperature below 2°C above pre-industrial levels."*[338]

The discussion is still very much evolving regarding a 1.5°C economy-wide scenario in the Paris Agreement.[339] Only a few scientific studies exist that chart out the degree of transformation required for a 1.5°C world. The IPCC Special Report on Global Warming of 1.5°C shows that limiting global average temperature increase to 1.5°C is possible, but it requires unprecedented changes and far-reaching transitions in all sectors. CO_2 emissions would need to be reduced by at least 45% from 2010 levels by 2030 and reach net-zero by around 2050, which would also require existing CO_2 to be removed from the atmosphere.[340]

Transport Sector 2°C and 1.5°C Scenarios

While climate policy objectives are often formulated on an economy-wide basis at international and national levels, in practice such objectives need to be implemented on a sectoral basis. In the transport sector, there are limited interpretations of Paris Agreement commitments, and the degree of transformation required in the transport sector. The available evidence suggests that transport CO_2 emissions would need to be restricted to about 2 to 3 Gt in 2050 (1.5°C, beyond 2°C scenario (B2DS)), or about 70 to 80% below 2015 levels.[341] For the 2-degree scenario (2DS), transport CO_2 emissions would need to be restricted to about 3 to 6 Gt in 2050, or about 40 to 70% below 2015 levels. Since transport infrastructure-related decisions "lock-in" transport demand for decades to come, Paris Agreement-compatible 2050 targets will be hard to realize if the transition is not started in earnest within the next two to five years.

Nationally Determined Contributions

The Nationally Determined Contributions (NDCs) provide an overview of national climate action plans for reducing transport sector emissions and adapting to climate change in transport. Among the 165 NDCs submitted to date (representing 192 countries, with all European Union member countries under a single NDC), 76% explicitly identify the transport sector as a mitigation source, and more than 63% of NDCs propose transport sector-specific mitigation measures; however, only about 8% of NDCs include a specific transport sector emission reduction target, and only about 12% of NDCs include assessments of country-level transport mitigation potential. (See *Section III.A Policy Frameworks for Transport and Climate Change*).[342]

Existing NDC targets for 2030 are largely economy-wide, not transport sector-specific. The current analysis shows that even if the economy-wide 2030 targets are translated to the transport sector, assuming the current proportional transport share in economy-wide emissions, there would be a projected 16% gap with the B2DS trajectory.[343] Overall, implementation of the first generation of NDCs would lead to lower economy-wide emission growth rates when compared with pre-NDC trajectories; however, current NDCs would likely result in warming of about 2.8°C above pre-industrial levels,[344] therefore falling well short of Paris Agreement targets.

These global mitigation scenarios inform mitigation imperatives at the sectoral level:

1. Faced with high and rising emissions, a dramatic transformation in energy use is needed to achieve a net-zero emissions economy by mid-century or soon after.
2. This transformation must scale up quickly, as a continuation of high emissions in the short-term will necessitate a more drastic and costly transformation in the long-term.
3. All sectors must decarbonize if temperature rise is to be contained, with exceptions limited by the extent to which other sectors can achieve negative emissions.
4. NDCs need to consider important interlinkages with other sectors (e.g. linkages between electric mobility and renewable energy, or implications of electric mobility on energy supply and networks).[345]

3. Transport Sector Mitigation Potential

- The transport emission gap between BAU and 1.5DS is 16 Gt CO_2 for 2050.
- Cumulative transport mitigation potential in absolute terms is about 60% greater in non-OECD countries than in OECD countries.

Assessing Transport Sector Decarbonization Potential

Despite the key role of transport in meeting Paris Agreement targets, many global multi-sectoral studies consider the transport sector difficult to decarbonize. The IPCC Fourth and Fifth Assessment Reports (AR4 and AR5) both suggest modest mitigation potential in the transport sector compared to many other sectors.[346] If present trends continue, the transport sector could potentially become a major roadblock to avoiding dangerous climate change.[347]

While there is a growing awareness of transport sector's role in energy sector decarbonization, globally, only about 42% of those countries that have pledged to reduce emissions in Paris have carried out long-term low carbon transport emission modeling (Figure 22).[348] However, these countries account for 85% of transport CO_2 emissions,[349] and thus implementation of low carbon transport measures in these countries holds significant mitigation potential. The identification of appropriate country-specific mitigation measures could inform the development of integrated, region-specific policy packages in a global roadmap for transport decarbonization.

Figure 22: Countries with 2050 Transport Low Carbon Estimates[350]

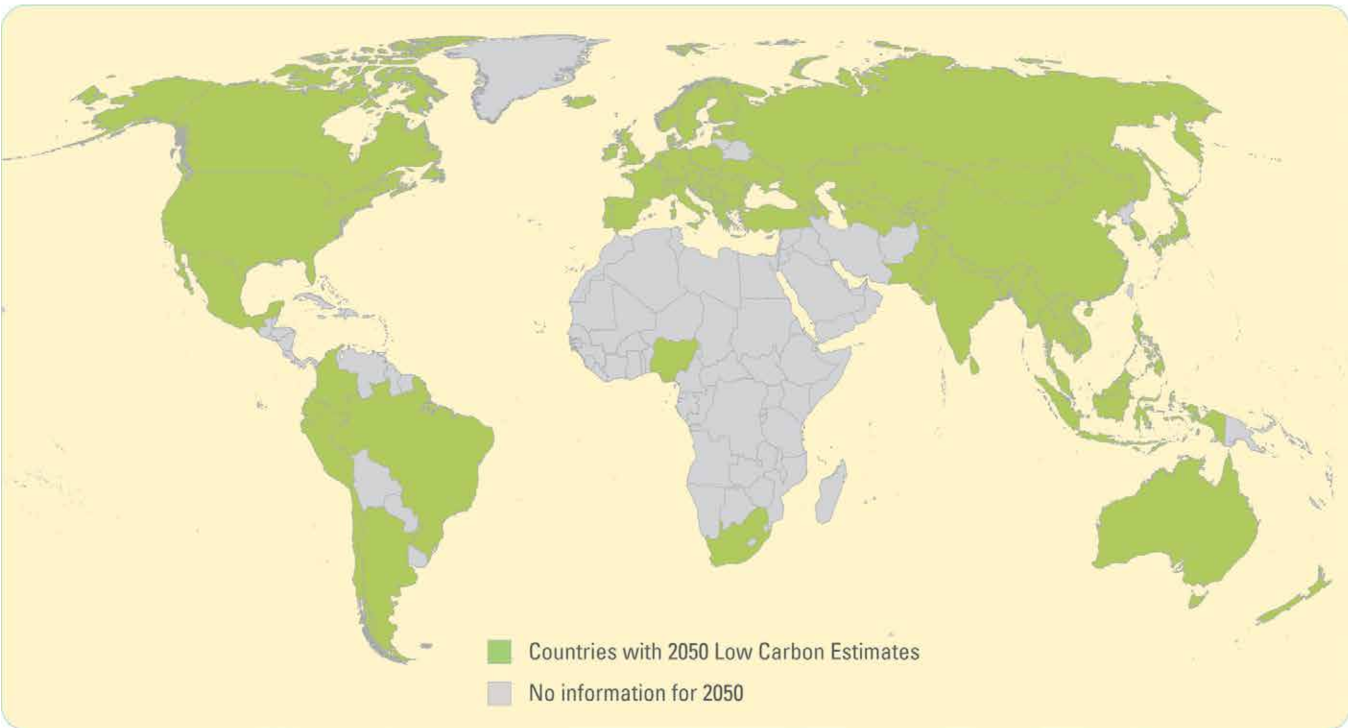
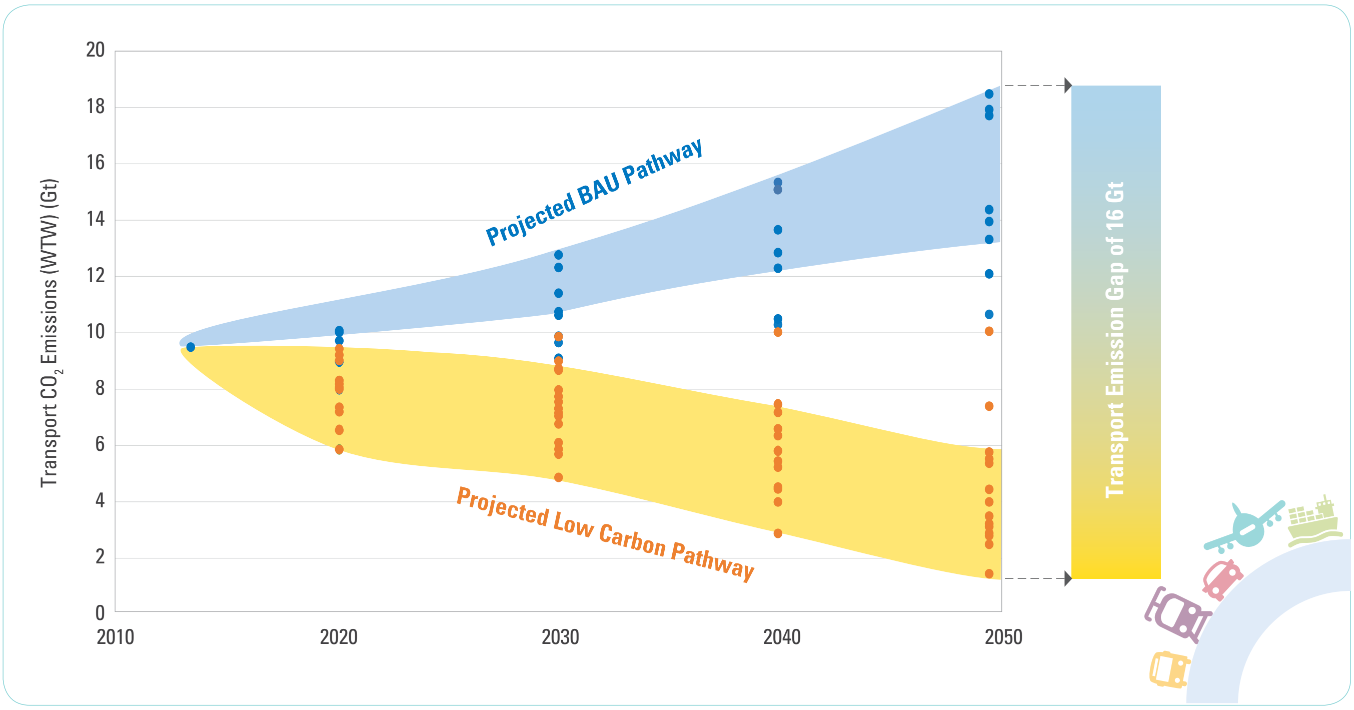


Figure 23: Projected Transport CO_2 Emissions: Business as Usual and Low Carbon Pathways (2010 to 2050)[335]



Recent global studies assert that the transport sector can provide a significant contribution to economy-wide decarbonization with 2050 emissions being 1.5 Gt to 10 Gt, with an average of 4.5 Gt, i.e. the emission gap of 44% with the B2DS trajectory (Figure 23). A number of these models suggest that emission reductions of 2°C or below are potentially feasible in the transport sector by 2050. Thus, global transport CO_2 emissions show reductions in the same order of magnitude as emissions from other sectors. This contradicts the more qualitative general assumption (as suggested in the IPCC AR4 and AR5) that the transport sector will lag behind in reduction, because reductions are more "challenging" in transport.[351]

Transport Decarbonization Potential by Region and Sub-Sector

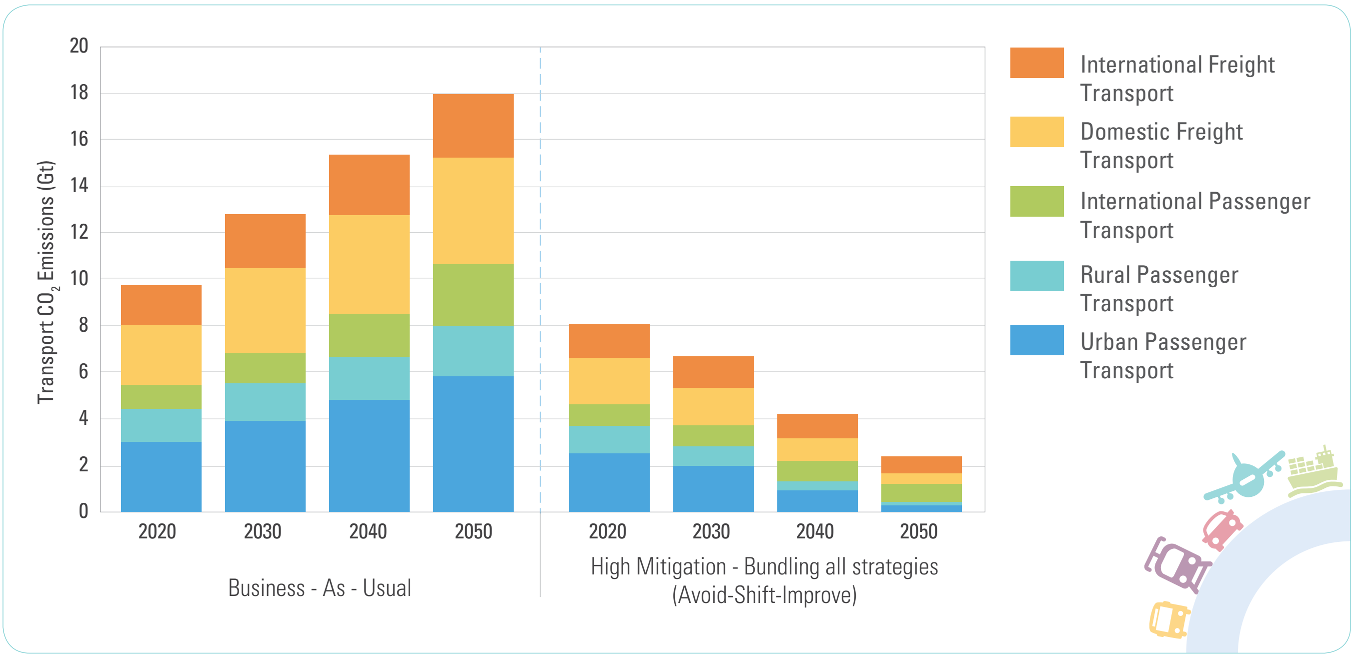
The potential to reduce GHG emissions in percentage terms is roughly the same in OECD and non-OECD economies. GHG emissions in the 2DS in 2050 are 60% to 70% lower than in both 4°C scenario (4DS) and 6°C scenario (6DS), but the cumulative abatement potential in absolute terms (in Mt CO_2 equivalent) is about 60% greater in non-OECD (i.e. generally middle- and low-income) countries than in OECD (i.e. generally high-income) countries.[353]

Among sub-sectors, various studies indicate mitigation potential proportionate to the size of the sector, with road sector providing the largest magnitude of potential mitigation. Decarbonizing **freight transport** is considered more challenging than **passenger transport** in the AR5.[354] However, mitigation potential for passenger and freight show a similar bandwidth (Figure 24). [355] Urban passenger transport must mitigate emissions to a large extent and rural passenger transport to follow in a smaller degree but reaching similar total emission levels by 2050.

efficiency improvement through 2050, and a carbon-neutral growth from 2020.[358] The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) seeks to stabilize CO_2 emissions from international aviation by requiring airlines to procure offsets to cover all emission increases above 2020 levels on routes between participating states. While participation during 2021–35 is voluntary, 73-member countries, accounting for 88% of international aviation activity, have confirmed their intention to participate from the outset.[359] However, by setting the baseline at 2020 emission levels, CORSIA will cover less than 30% of international aviation emissions during 2020–30.[360]

In **international shipping**, in October 2016, the IMO approved a roadmap to develop a comprehensive strategy for the reduction of GHG emissions from ships, with the prospect of an initial strategy being adopted in 2018, to be followed by a final GHG reduction strategy by 2023. In April 2018, IMO agreed to mitigate annual GHG emissions by at least 50% by 2050 compared to 2008 levels, while aiming for further efforts to decarbonize the shipping sector.[361] Given that international shipping emissions are already significant,

Figure 24: Transport Mitigation Potential across Sub-sectors (2020 to 2050)[356]



Within the global climate change process, GHG emissions from **aviation** and **shipping** may be addressed under the UNFCCC through inclusion in NDCs. Mitigation strategies may also be achieved unilaterally, through bilateral agreements between countries, or among member states of the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO).

In 2016, the member states of ICAO adopted a global market-based scheme to mitigate CO_2 emissions from **international aviation**.[357] ICAO's aspirational goals are a 2% annual fuel

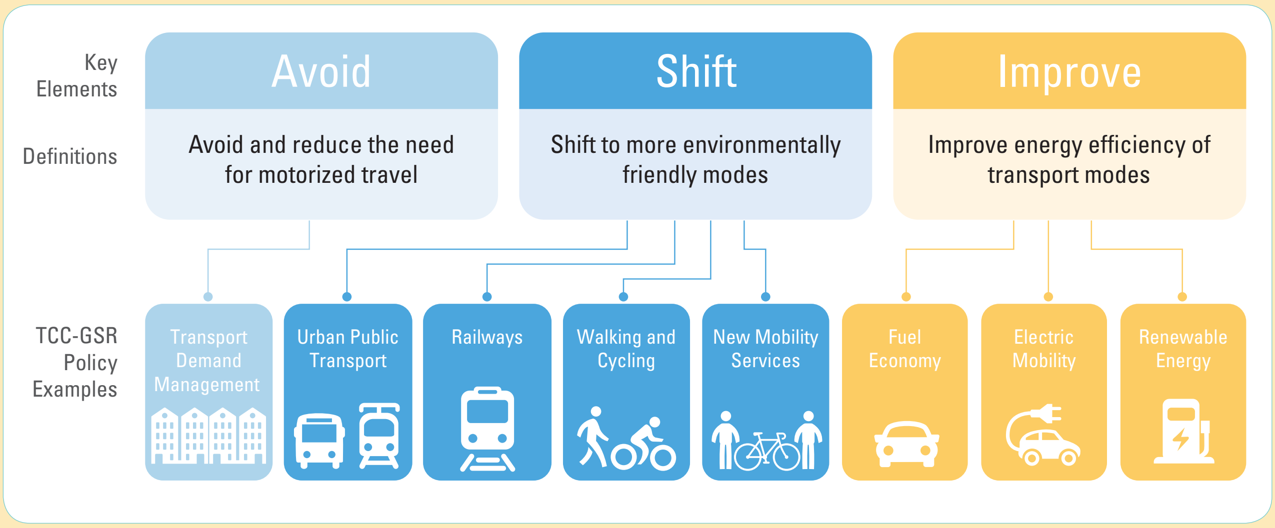
and growth in demand exceeds present trends in fuel efficiency improvements, maritime shipping may consider alternative fuels, renewable energy, carbon pricing and operational measures to yield a more significant reduction of emissions.[362]

A recent meta-analysis of mitigation measures in NDCs, mitigation studies, and technology needs assessments indicates a high prioritization of mitigation measures related to fuel efficiency and fuel decarbonization.[364] As seen in Figure 26, in terms of the "A-S-I" framework, nearly two-

Box 1: The Avoid-Shift-Improve Framework for Sustainable Transport Measures

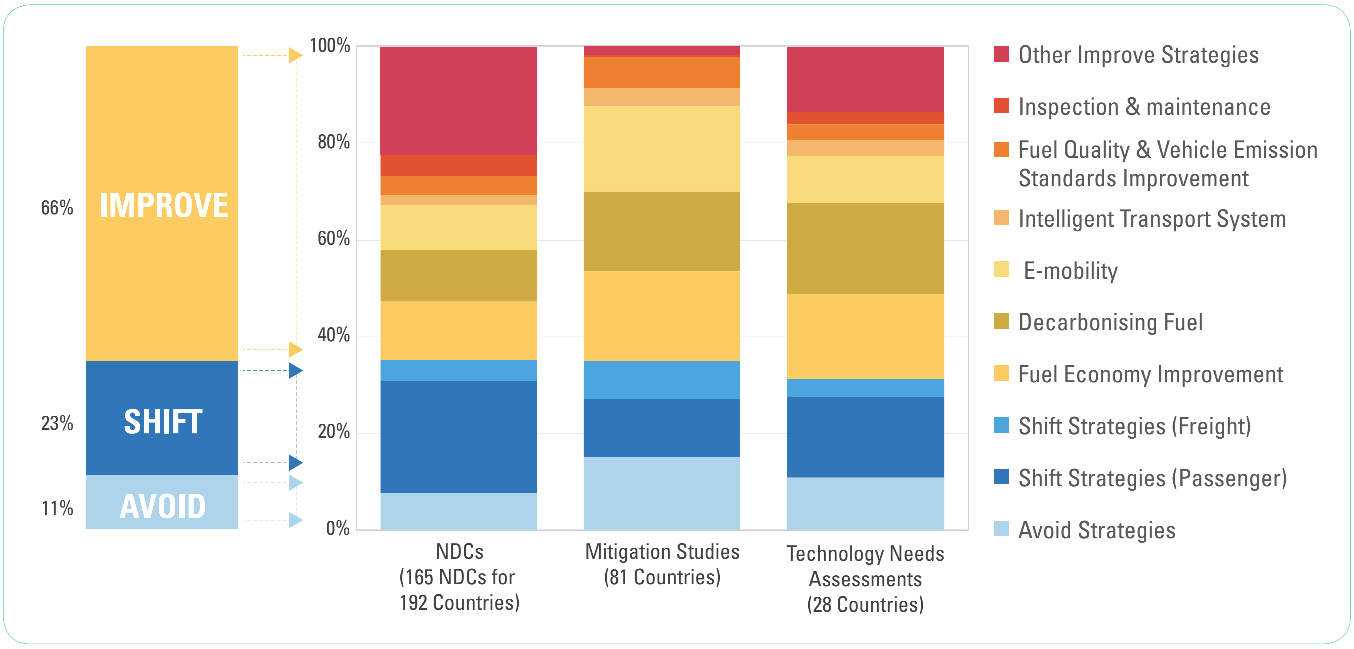
The Avoid-Shift-Improve (A-S-I) Framework[363] was developed to better categorize the measures and ambitions taken in the transport sector on climate change and sustainable development. 'Avoid' refers to avoiding and reducing the need for motorized travel with transport system efficiencies through integrated transport and spatial planning and transport demand management (See *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management*). 'Shift' seeks to improve trip efficiency by shifting use of private vehicles to the use of public transport, walking and cycling. 'Improve' refers to measures that improve vehicle and fuel efficiency as well as optimizing transport infrastructure (Figure 25).

Figure 25: Avoid-Shift-Improve Framework



Tackling climate change mitigation and improving the probability of reaching a 1.5DS target will require more ambitious and comprehensive measures in low-carbon transport plans including a balanced set of strategies to: 'Avoid' unnecessary transport trips; 'Shift' existing trips to more efficient, low carbon modes; and 'Improve' the technologies of transport to reduce emissions.

Figure 26: Typology of Transport Mitigation Strategies[366]



thirds of the measures are 'Improve'-related (i.e. vehicle and fuel technologies), and about one- third of measures are 'Avoid-' and 'Shift-' related (i.e. behavior based or infrastructure improvements). For example, NDCs submitted by OECD countries focus on transport electrification, energy efficiency measures and other technology-based measures, while non-OECD countries see 'Shift' strategies, especially public transport expansion and rail infrastructure development, as major mitigation strategies.[365]

The main sources of emission savings in OECD and non-OECD country groupings are improved vehicle efficiency, use of biofuels, scaling up the use of electric vehicles, and implementation of 'Avoid' and 'Shift' policies. In OECD countries, electrification of transport can reduce 32% of BAU emissions and improve vehicle efficiency by 24%. In non-OECD countries electrification, biofuels and vehicle efficiency can have 26%, 23% and 23% emissions savings, respectively. In both groups, 'Avoid' and 'Shift' policies add important shares of 18% (OECD) and 14% (non-OECD). The largest projected reductions in emissions will be for LDVs, trucks, aviation and shipping; with smaller changes for buses, rail and two- and three-wheelers. For LDVs and trucks, near-term vehicle efficiency improvements and longer-term electrification will be key; for short distance modes, electrification will be the major decarbonization pathway (See *Section III.B.7 Electric Mobility* and *Section III.B.8 Renewable Energy in Transport* for more discussion on optimizing synergies between vehicle electrification and renewable electricity supply).

By 2060, two- and three-wheelers, LDVs, and rail and road-based public transport will transition to electric or other ultra-low or zero emissions technologies. Longer distance modes—including trucks, shipping and aviation—are currently considered more difficult to electrify and may depend more on efficiency improvements together with the replacement of fossil fuels with biofuels until other alternatives are developed and mainstreamed. A shift from high to low carbon modes is also envisaged, with the use of LDVs, aviation and trucks shifting to rail and public transport.[367]

The intensity of transformation foreseen in many transport decarbonization technology pathways is ambitious. Most of these roadmaps illustrate that reaching 1.5°C climate targets depend on two crucial factors: the availability of technologies, and the availability and penetration of low- to zero-carbon fuels. For example, to achieve a 1.5DS pathway, studies indicate that passenger cars must be completely electrified by 2050. The IEA has estimated that to reach net-zero GHG emissions from transport shortly after 2060, the global EV stock must reach 25 million by 2020, and must exceed 200 million by 2030, and by 2060 EVs would need to account for 85% of global vehicle stock.[368] In general, modeled low-carbon scenarios will require much more aggressive market uptake of EVs than targeted by policy commitments to date (See *Section III.B.7 Electric Mobility*), indicating the need for policies supported with additional cross-sectoral optimization (e.g. decarbonizing electricity).

Part III. Policy Frameworks for Transport and Climate Change

Photo credit: Clayton Lane

Reducing emissions from the transport sector and adapting its infrastructure for greater resilience to climate change has become a global priority. This section summarizes the frameworks and mechanisms tracking low carbon transport measures and provides an overview of the international policy frameworks that include transport within their targets. Section B is divided into eight sections that offer an overview of progress on key indicators within various sub-sectors, as well as examples of policy targets and initiatives implemented across global regions.

A. Frameworks and Mechanisms for Tracking Low Carbon Transport Measures

At the 21st Conference of the Parties (COP 21) in Paris, Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future.[369] The Paris Agreement aims to strengthen the global response to the threat of climate change by keeping global temperature rise this century well below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to below 1.5 degrees Celsius. It calls for ambitious goals to be established: appropriate financial flows; a new technology framework; and an enhanced capacity-building framework to support actions taken by countries based on their own national objectives (also known as Nationally Determined Contributions (NDCs)).

To achieve the Paris Agreement targets, the transport sector must accelerate action towards decarbonization by mid-century. The Agreement entails supporting and empowering opportunities for the transport sector to contribute to its ambitious goals for GHG emission reductions through the NDCs submitted by Parties, and non-Party stakeholder involvement in the UNFCCC process (e.g. through the Marrakech Partnership for Global Climate Action (MPGCA)).

The UNFCCC provides other reporting mechanisms to describe intended measures and ambitions on climate change mitigation and adaptation, including the long-term low-emission development strategies (LT-LEDS), national adaptation plans (NAPs), National Adaptation Programme of Actions (NAPAs), and the Nationally Appropriate Mitigation Actions (NAMAs).[370] Both NAPs and NAPAs focus on adaptation, but the main difference is that NAPAs, established in 2001, are following a specific process and result in a list of adaptation projects and they are just compiled by developing countries, while NAPs (decided in 2011) emphasize an integrated, country-specific process resulting in medium- to long-term adaptation planning, and is done by developing and developed countries.[371]

1. Nationally Determined Contributions

Transport Mitigation and Adaptation Measures in Nationally Determined Contributions (NDCs)

The NDCs communicate intended mitigation and adaptation actions by UNFCCC Parties. The first NDCs were submitted as Intended Nationally Determined Contributions (INDC) by Parties in 2015 and, with the ratification of the Paris Agreement, the INDCs officially became NDCs[372]. The NDCs must be submitted in a five-year cycle, with the second generation due in 2020. The process is supported by the Global Stocktake (Paris Agreement Article 14), which will take place in 2023 and every five years thereafter, to take stock of the implementation of the Paris Agreement. As of July 2018, 195 Parties have signed (i.e. preliminarily endorsed) the agreement, with 179 of those having ratified (i.e. agreed to be legally bound by) the agreement.[373] Approximately 89% of global emissions are covered by the Parties that have ratified the agreement, with **China** (20%) and the **United States** (18%) accounting for a large share of global emissions.[374]

Of the submitted 166 NDCs representing 193 countries, 76% highlight the transport sector as a mitigation source, though only 8% include transport emission reduction targets. Passenger transport is well-represented in NDCs; included in 64% of those that highlight transport. Urban transport measures are mentioned in 38% of NDCs, while other areas receive less attention. Freight transport contributes around 40% of emissions but appears in only 21% of the NDCs with transport measures (Figure 27).[375]

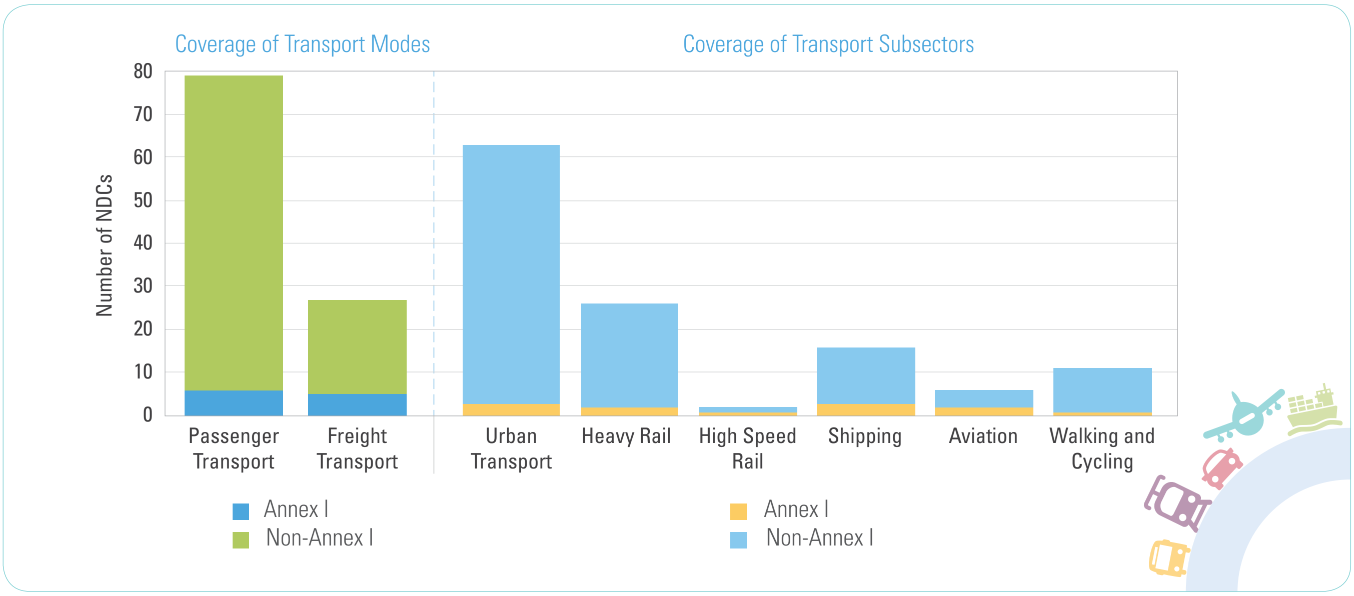
The majority (about 65%) of the 356 proposed mitigation measures in NDCs represent 'Improve' strategies. This focus on technological measures helps explain why NDCs do not fully optimize the mitigation potential of the transport sector, which can be achieved by implementing more holistic polices that include 'Avoid' and 'Shift' strategies (Figure 28).

Transport adaptation has received less attention than mitigation in NDCs. Though adaptation is included in some form in nearly every NDC, transport adaptation appears in 29 NDCs (16%), while 10 NDCs (4%) identify specific transport adaptation measures (e.g. infrastructure resilience projects), underscoring an opportunity to further emphasize transport adaptation in the NDC framework (See also *Box 2: Adaptation Policy Measures in the Transport Sector*).[378]

Transport CO_2 Reduction Targets in NDCs

There is an opportunity to improve the NDCs' commitments on transport through developing sectoral targets, identifying priority actions and increasing ambition. While about 76% of NDCs highlight transport sector mitigation, a much smaller share of NDCs (8%) propose transport sector emission

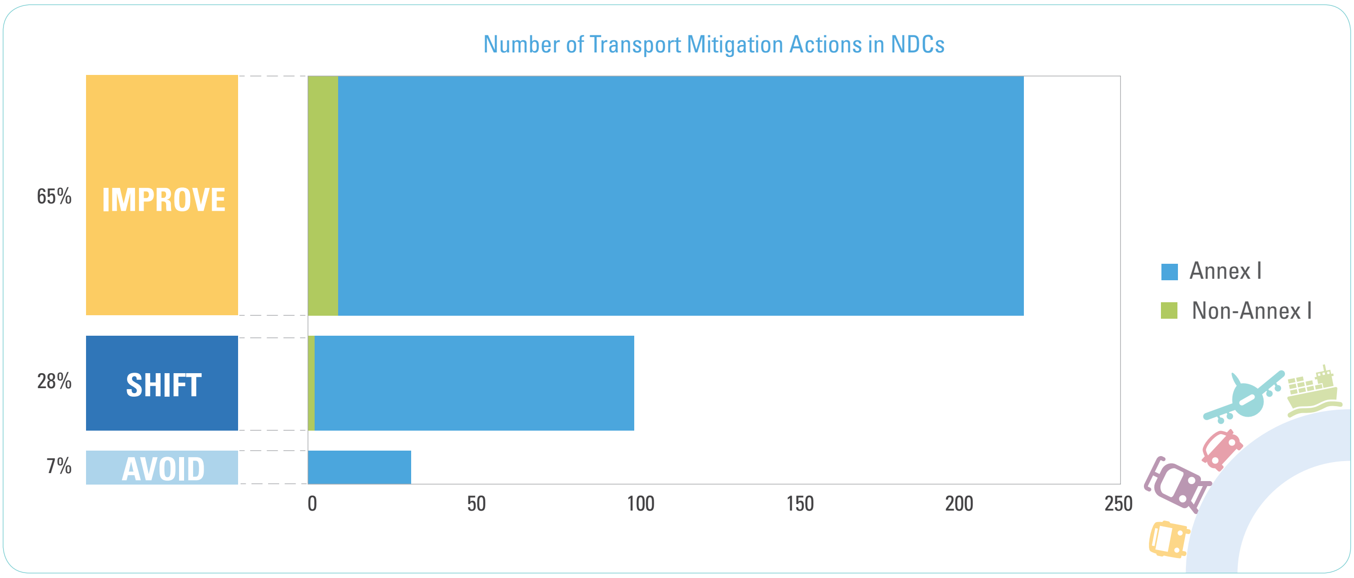
Figure 27: Number of NDCs Highlighting Modes and Sub-Sectors[376]



reduction targets, and those that do represent countries with only about 4% of the global transport emission share (e.g. **Burkina Faso** and **Trinidad and Tobago** have set ambitious transport reduction targets that are at least twice as ambitious as their economy-wide emission reduction targets). In addition, 8% of NDCs include national transport BAU emission projections, and 12% of NDCs include estimates of country-level transport mitigation potential (Reference Table 1).[379] Investments required for the transport sector to achieve desired mitigation goals are highlighted in about 9% of NDCs, and for countries with transport sector emission targets, 29% of NDCs provide investment estimates. Reference Table 2 provides examples of projected investment requirements to implement proposed transport mitigation measures noted in NDCs.[380]

Several countries highlighted progress towards implementation of NDC transport measures in the UNFCCC NDC Spotlight series (e.g. 20% of new cars sold in **Norway** in 2017 were electric vehicles, relative to an NDC target for 100% new passenger cars sold to be zero emission in 2025);[381] however, these updates do not follow a structured reporting format. In the next round of NDCs, to be submitted by 2020, experts are looking for parties to improve coordination with relevant ministries that are involved in decision-making for the transport sector to increase ambition and identify specific actions in order to prioritize those with the highest mitigation and development impacts. Further, individual country, city and company plans in many cases show higher levels of mitigation ambition than those reported in NDCs;[382] however, there is currently little clarity on how to incorporate these more ambitious plans in the UNFCCC process.

Figure 28: Share of Avoid, Shift and Improve Transport Measures in NDCs[377]



Linkage of NDCs to Other Global Processes

The transport sector is becoming more visible in other global processes on climate change and sustainable development. In 2015, the UN adopted the 2030 Agenda for Sustainable Development, and established 17 SDGs and 169 targets. Transport is linked to direct and indirect targets of 8 SDGs.[383] In the voluntary national reviews (VNRs) submitted to the High-Level Political Forum (HLPF) in 2017, nearly all countries (42 of 43 countries) reporting on their contributions to the SDGs referenced transport, and 35% provided specific examples for transport actions.[384] VNRs of **Costa Rica**, **Portugal** and **Sweden** include activities and programs on transport and climate change, ranging from air travel emission reductions, bike- and carsharing and renewable energy. In addition, the New Urban Agenda (NUA) emerging from the Habitat III conference commits to the use of sustainable and efficient transport infrastructure and services where possible.[385] There is potential to more closely link the NDC, VNR, and NUA processes through the coordinated efforts of actors at global, regional and national levels.

2. Long-term Low-emission Development Strategies

In addition to the NDCs, the Paris Agreement invites Parties to formulate and communicate long-term low emission development strategies (LT-LEDS), which are essential for setting low-carbon trajectories to 2050. Through the formulation of an LT-LEDS, the development and implementation of future NDCs can be guided.

Only 10 countries have submitted LT-LEDS to the UNFCCC, with submissions largely from the global North (except for **Benin** and the **Marshall Islands**).[386] Benin's LT-LEDS was developed with the support of the French Development Agency (AfD), Africa4Climate, and the United Nations Development Programme (UNDP) and others. All long-term strategies cover plans and actions in the transport sector, with most focusing heavily on mitigation and decarbonization, and only **Benin** and the **Marshall Islands** mentioning transport adaptation measures (Reference Table 3).

3. National Adaptation Plans and National Adaptation Programmes of Action

As the impacts of climate change on transport infrastructure and services are already taking place and will increase in the future, it is important for governments to recognize the value of adaptation plans and strategies within the global processes as well as local impacts (Box 2).

Box 2: Adaptation Policy Measures in the Transport Sector[387]

Transport systems worldwide are vulnerable to the increasing impacts of a changing climate, which increase the potential for catastrophic impacts. Resilient transport is an essential contributor to disaster recovery. Transport systems and services are already being severely disrupted by climate-related events, with an ever-growing number of incidents in both the developed and developing world. The systemic nature of transport means that disruption in one mode can severely impact another.

Adaptation in the transport sector is necessary for both developed and developing countries. Sustainable low-carbon passenger and freight transport systems must adapt to climate change with a view to strengthening resilience, ensuring business continuity, maintaining reliability and increasing market share (relative to high-carbon transport systems), all of which are vital for achieving the full mitigation potential of the transport sector. Despite this, transport adaptation has received much less attention than transport mitigation in submitted NDCs, specific measures for the transport sector are also not sufficiently highlighted in the NAPs and NAPAs submitted to date and most low- and middle- countries do not have a climate vulnerability and mapping study.

Steps to scale up actions for transport adaptation include the following:

- Building transport adaptation capacity at local, national and international levels is crucial and can be done through capacity building and support for more resources for climate adaptation;
- Promoting climate risk screening and vulnerability mapping, and assessments of existing transport systems, services, and all new projects;
- Recognizing the key role of integrating climate change into road asset management systems in enhancing adaptive capacity;
- Developing and adopting industry-relevant technical standards to ensure that transport infrastructures are climate resilient, with appropriate adaptive capacities to minimize future risk;
- Leveraging additional climate finance to shift public and private investments towards resilient transport systems and building technical adaptive capacity;
- Including climate risk in environmental impact assessments of major transport project and making risk and vulnerability part of design standards and norms.
- Integrating adaptation into infrastructure maintenance, replacement and improvement processes and incorporating incremental adjustments that adapt infrastructure to new standards;
- Cooperating with the broader adaptation community to integrate transport into adaptation programs, plans and activities;
- Develop strong connections between adaptation planning, disaster risk reduction and sustainable development; and
- Strengthening coordination across funding, implementing and operating agencies.

National adaptation plans (NAPs) are used to identify medium-/long-term adaptation needs, and to develop strategies to address those needs. NAPs aim to facilitate the integration of climate change adaptation into relevant new and existing policies, programs and activities to establish and develop planning processes and strategies across various sectors and levels of government.[388]

Adaptation plans, especially those in developing countries, are often limited by insufficient technical capacity, a lack of reliable information on future climate impacts, and current inventories of transport assets and services. With more reliable and up-to-date inputs, transport sector adaptation and mitigation plans can include more science-based targets.

By the end of 2017, 30 developed countries had prepared country adaptation plans and strategies registered with the UNFCCC.[389] The European Environmental Agency (EEA) reports that 25 of the 28 **European Union** member states had adopted a national adaptation strategy by late 2017, and 15 had developed a national plan.[390] By late 2017, only eight developing countries had prepared NAPs registered with UNFCCC.[391] Among these, six mention climate change impacts on transport, and five refer to specific transport adaptation measures (Reference Table 4).[392]

National Adaptation Programme of Action (NAPA) allow least developed countries (LDCs) to prioritize responses to urgent and immediate needs to adapt to climate change. NAPAs contain a list of ranked priority adaptation activities/projects, as well as short profiles of each activity, designed to facilitate the development of project proposals for implementation. The UNFCCC also established a Least Developed Countries Fund to assist the preparation and implementation of NAPAs, and an LDC Expert Group to provide technical support and advice to the LDCs.[393]

By 2017, 51 LDCs have completed NAPAs registered with the UNFCCC.[394] Among these, 34 included descriptions of climate change impacts on transport, and 18 included specific transport adaptation measures. Examples of transport adaptation measures included in the NAPAs are listed in Reference Table 5,[395] though there is no clear reporting process on the degree to which implementation has been achieved. In sum, we some progress in advanced countries but relatively little in other countries, which implies serious risks ahead on transport adaptation.

4. Nationally Appropriate Mitigation Actions

Nationally Appropriate Mitigation Actions (NAMAs), which refers to any action that reduces emissions in developing countries and is prepared under the umbrella of a national governmental initiative, were an outcome of the Bali Action Plan from COP 18 in Doha (2012).[396] NAMAs are supported and enabled by technology, financing, and capacity-building, and are aimed at achieving a reduction in emissions relative to BAU emissions in 2020. NAMAs also emphasize financial assistance from developed countries to developing countries to reduce emissions.

Transport NAMAs show potential for pre-2020 actions through various measures, including public transport development, green freight programs, scaling up of electric mobility, and better mobility management (i.e. TDM). A smaller but noticeable number of NAMAs focus on fuel economy and energy efficiency measures, improvement of data and modeling for the transport sector, cycling, urban rail, walking, improving fuel quality and vehicle emission standards, and land-use planning.

By November 2017, there were a total of 237 NAMAs under development and 22 at the implementation stage. 12% of the NAMAs focus on transport and three transport NAMAs have reached the implementation stage.[397] An analysis of 27 identified transport NAMAs registered to the UNFCCC shows that 78% cover passenger transport, and only 30% cover freight transport (five NAMAs cover both freight and passenger transport).[398] Though four additional transport NAMAs emerged between April 2017 and November 2017, there is little evident momentum that NAMAs are poised to make a significant contribution to transport sector decarbonization.

Photo credit: Kinsey

B. Policy Landscape on Transport and Climate Change

This section of the report contains eight sub-sections describing major policy areas for low carbon transport policy targets and measures. The eight policy areas in this initial version of the report were selected based on policy areas with abundant data and examples (e.g. urban transport, railways, walking and cycling) as well as areas of emerging interest and action (e.g. new mobility services, electric mobility, renewable energy in transport), with the goal to balance 'Avoid', 'Shift', and 'Improve' measures. Other sectors with significant emissions shares are described in the Global Overview at the beginning of the report (e.g. private motorized transport, freight transport, aviation and shipping) and are incorporated in existing policy landscape sections (e.g. green freight under electric mobility, aviation and shipping under renewable energy, intercity transport under passenger and freight railways). These eight policy areas are to be expanded in future iterations of the TCC-GSR.

Each policy landscape section consists of the following structure:

- *Overview:* Provides brief general background on the specific policy and an explanation of measures or transport modes
- *Policy Landscape*: Describes the status of implemented or planned policies and targets set by countries, cities, businesses and organizations through examples
- *Market Trends:* Outlines the growth of the policy area and its extension to new regions or sectors in recent years
- *Key Indicators:* Provides snapshot of trends in development of policy landscape and market development indicators (see further description below)
- *Emission Reduction Impacts and Modal Shift:* Provides evidence of GHG emission reductions and/or examples of modal shift from carbon-intensive transport modes to low carbon transport solutions affected the specific policy, where available
- *Global Initiatives Supporting Policy Area:* list of associated organizations and stakeholders working on the specific policy

Policy examples in each of these sections focus on policy targets set or measures implemented primarily in 2017 and 2018, with selected examples from prior years where more recent examples are not available. Examples are intended to showcase a broad array of representative and innovative examples from a range of global regions and developed and developing country contexts; at the same time, these examples are not intended to be exhaustive due to space limitations. Mode shift and emission reduction impacts for each of the policy areas are quantified where possible, but these data sets are limited in most policy areas.

Key indicators at the beginning of each section are representative indicators that show the progress of specific policies towards low carbon transport on a global level. In certain cases, robust data was impossible to collect, but indicators are nevertheless listed in these areas to show the importance of collecting relevant data over time. Key indicators are divided into *policy landscape indicators*, which provide quantitative information about applied policy *instruments and market development indicators*, which show quantitative information on market size of related transport modes and areas that may be expected to result from the policies described over time, though causal links between the two are not implied.

A subset of major indicators showing the status quo of transport and climate change are summarized in Dashboard III along with a brief summary of key findings from each policy landscape section. The indicators are to be refined and expanded in future iterations of the TCC-GSR.

Photo credit: Simon Smiler

1. Sustainable Mobility Planning and Transport Demand Management

Overview

Background

A comprehensive, integrated way to plan the mobility system serving people in cities is through sustainable mobility planning. The difference to traditional transport planning is that sustainable mobility planning not only focus on a coordinated transport system but also how the system impacts its users. This process involves various stakeholders in the planning process, aims for an interdisciplinary approach with the objectives of accessibility and quality of life, and addresses environmental concerns among other aspects.[399]

Transport demand management (TDM) refers to a large menu of options that encourage travelers to **'Avoid'** trips or **'Shift'** their trips to more resource-efficient travel options. TDM reduces total (i.e. personal and freight) vehicle travel and associated costs, and/or stimulates walking and cycling as well as more compact spatial development. The basic approach of TDM is that it allows cities to limit vehicle traffic to the roadway capacity, and rewards travelers who use resource-, space- and energy-efficient modes. Table 1 lists various types of TDM strategies for passenger transport, which tend to be most effective when implemented as packages. In recent years, TDM has received more attention from policymakers; however, implementation of such TDM measures as parking pricing, efficient road pricing or comprehensive smart growth policies remains limited (see city examples in below sections).

Policy Landscape: Policies and Examples

Policy Measures Implemented

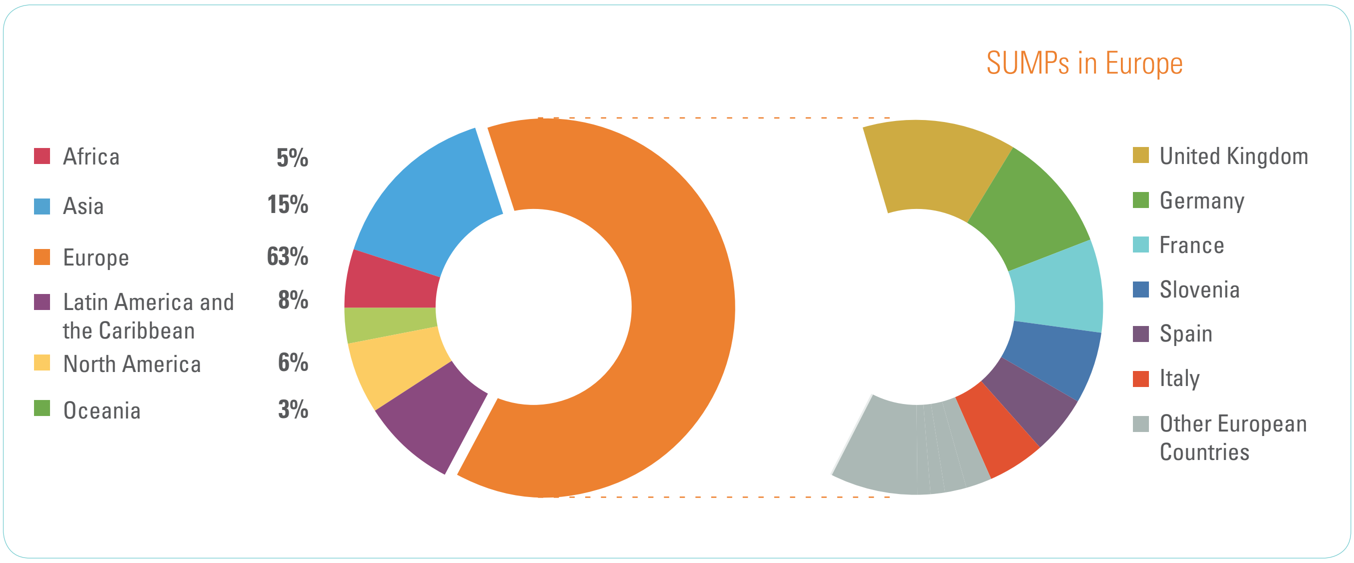
Sustainable mobility planning is a comprehensive, integrated approach to transport planning in cities (or at national levels), which may incorporate various TDM measures described below.

- **National urban mobility policies (NUMPs):** The **Philippines** implemented The Sustainable Transportation Act of 2017, which explicitly mentions several such TDM strategies as carpooling, congestion pricing measures, programs to promote telecommuting, and flexible work schedules. The bill further promotes a sustainable transport action plan, integrated spatial and transport planning, use of alternative fuels, walking and cycling and public transport.[401] Similarly, **India's** Ministry of Housing and Urban Affairs unveiled its Urban Green Mobility Scheme 2017, which aims to promote walking and cycling, alternative fuels and electric mobility, and improve road safety by the adoption and implementation of TOD and TDM measures. The scheme will provide USD 10.75 billion to 103 cities over a period of seven years. Major improvements are expected in the areas of pedestrian, cycling, and public transport facilities.[402]
- More than 800 sustainable urban mobility plans (SUMPs) have been identified to date, with the clear majority being applied in European cities (63%), and 10 countries represent 80% of European SUMPs (Figure 29). In 2017, the Romanian city **Turda** approved a SUMP,

Table 1: Transportation Demand Management Strategies[400]

Incentives to Use Efficient Modes	Smart Growth Development Policies	Implementation Programs	Complementary Mobility Strategies
• Efficient parking pricing • Parking regulations • Road/area tolls, congestion pricing, zero/ or low emission zones • Road space reallocation • Distance-based pricing • License plate policies (odd/ even plate restrictions) • Commuter financial incentives (parking cash out, subsidized or free transit)	• Smart Growth policies and planning practices • Transit-oriented development • More connected (e.g. ramp metering) and complete streets • Streetscaping, curb buildouts, landscaping features to reframe public space • Parking policies (on-street and off-street, efficient parking management • Social housing and transport policy integration	• Transportation Management Associations • Commute trip reduction programs • School and campus transport management • Freight transport management • Mobility management marketing • Transport planning reforms	• Flextime • Off-peak deliveries • Telework and delivery services that reduce vehicle travel • Pedestrian and bicycling improvements • Public transit and taxi service improvements • Multimodal trip planning and/ or payment tools • High occupancy vehicle (HOV) encouragement • Carsharing, ride sharing

Figure 29: Sustainable Urban Mobility Plans by Region and for Countries in Europe[404]



and was also the winner of the 6th SUMP award.[403] Many cities around the world have comprehensive transport planning that are not identified as SUMPs but are very similar and reflect a comprehensive strategy for sustainable transport.

- **Complete Streets** and **multimodal planning** practices ensure that walking, bicycling and public transport are safely and efficiently accommodated in roadway planning.[405] Several Indian cities in 2017 made substantial changes in their public spaces by building and planning Complete Streets Networks. **Chennai** has already completed more than 40 km, and in October 2017, invited tenders to redesign an additional 22 km of streets. **Pune** broke ground on its 100 km Complete Streets network and approved a Bicycle Plan that aims to create a 300 km bicycle-track network in the city.[406] In 2015, the Urban Redevelopment Authority in **Singapore** launched its 'Streets for People' program, supporting the transformation of streets into car-free, vibrant public spaces.[407]
- **Transit Oriented Development (TOD)** refers to mixed, dense urban development centered around or located near a transit station, which aims to create vibrant and connected communities and eliminate the need for some motorized trips. TOD can be encouraged by local governments through zoning laws, integrated transport, housing and spatial plans, new mobility services near residential developments, among other things[408] (New mobility services are discussed in *Section III.B.5 New Mobility Services*). **China** in 2017 launched China Sustainable Cities Integrated Approach Pilot Project to help seven major cities incorporate TOD principles into future transit and urban plans.[409] For example, **Shenzhen, China** is constructing new metro stops and lines following **Hong Kong's** successful 'Rail + Property' TOD business model. As of August 2017 there were 11 TOD projects in process in Shenzhen, where transport authority receives a cut of the profits from the commercial or residential buildings around the metro.[410] **Kuala Lumpur**, **Malaysia**, while extending its MRT network, aims to make several new stations future TODs.[411] The **Colombian** government initiated a new EUR 14.9 million project in 2016 with TOD as NAMA to transform the urban development model in several cities, shifting how and where public and private neighborhood infrastructure investments are made. The Mayor of **Cali**, for example, positioned the "Green Corridor" at the heart of Cali's transformation into a sustainable city.[412]

'Avoid' measures reduce the need to travel and/or the distance traveled:

- **Vehicle quota systems and vehicle restrictions** are implemented by local or national governments to control the number of new vehicles that can be registered and/or purchased to regulate the growth of vehicle ownership. Such a system proved successful in **Shanghai**, where it was introduced in 1990, as Shanghai had 66% fewer vehicles than Beijing in 2010.[413] In **Japan** all car owners need evidence of an off-street parking spot to be able to register a car, which supports low vehicle growth in larger cities.[414] In October 2017, the Land Transport Authority of **Singapore** announced that its vehicle growth rate would be reduced to zero (from 0.25%), effective February 2018, and that the government would instead invest approximately USD 20 billion in rail infrastructure and bus contracting subsidies.[415]
- **Vehicle use restrictions:** In **Delhi, India** the government installed an "odd-even" number plate policy again in November 2017. The policy is part of a larger response plan to the severe air pollution in the city, and could serve as a long-term remedy, together with the strengthening of public transport.[416] In March 2017, Pico y Placa

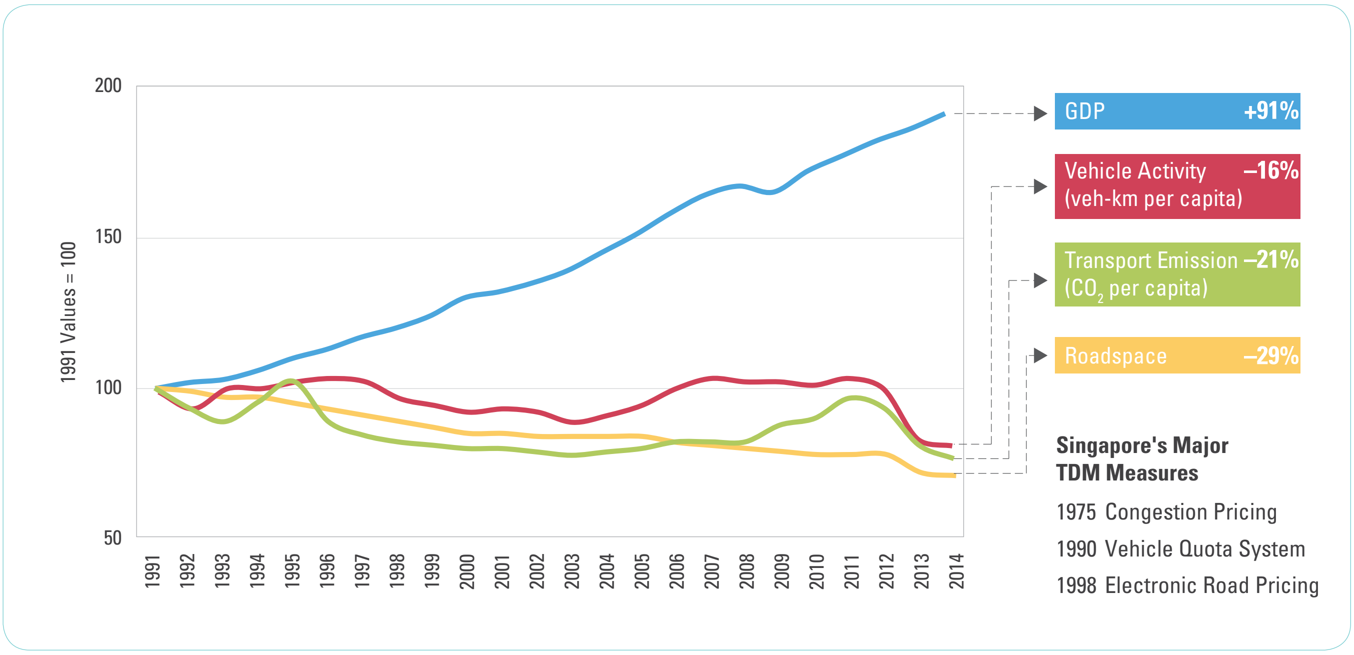
("rush hour and license plate") took place in **Medellin, Colombia**, which is designed to help regulate traffic during rush hours and reduce critical pollution levels.[417] In 2016, **China** adopted restrictions on internal combustion engine (ICE) vehicles, then implemented a trial in five cities with special number plate licenses for new energy vehicles (NEVs), to provide preferential policies (i.e. tax reductions). Following this pilot, the Ministry of Public Security announced in August 2017 that special plates for NEVs would be issued in every city nationwide.[418] **Jakarta, Indonesia** announced in August 2017 its intention to apply the odd-even license plate traffic policy, which began in 2016, in additional areas of Jakarta.[419] Vehicle use restriction policies can have unintended impacts and rebound effects if residents purchase additional vehicles to avoid days that an existing vehicle is prohibited from driving. Also, **Mexico City's** case has shown that the vehicle restrictions have so far not delivered the desired air quality improvements because those who could afford to have bought additional vehicles.[420]

- **Congestion charging** refers to variable road tolls that are intended to reduce peak-period traffic volumes to optimal levels. Tolls can vary based on a fixed schedule, or be dynamic, changing depending on real-time levels of congestion. Exemptions may be provided for zero-emission vehicles to drive electric mobility as a key mitigation strategy, or for high-occupancy vehicles to encourage a shift from single-occupancy vehicle (SOV) trips. This TDM measure can reduce the generalized cost of other SOV car users by easing congestion, and therefore can induce traffic in the same way as increasing road capacity could do. Additional research has shown that limited (e.g. highway only) and widespread applications of congestion charging (including credit-based pricing policies) can improve the welfare of all citizens.[421] Congestion charging has been implemented in seven cities in **Europe**. In the Asia region, **Singapore** successfully introduced congestion charging in the 1970's, as well as several other TDM measures contributed to reducing vehicle-km per capita by 16% between 1991-2014, and reducing transport CO_2 emissions per capita by 21% from 1991-2014 (Figure 30).

- **Car-free streets & banning internal combustion engines in cities:** Multiple cities worldwide plan to go car-free through a variety of mechanisms, and these bans on ICEs could be a critical tipping point for increased investment in urban public transport. For example, **Kigali, Rwanda** initiated a monthly car-free day, banning all motorized vehicles from the streets in 2016; the city is restricting street parking and planning several bus-only transport corridors.[423] **Oslo, Norway** announced plans to ban all cars from its city center by 2019, and will invest heavily in public transport and cycling infrastructure. **Madrid, Spain** plans to make 500 acres of its city center car free, and transform the roads into walking streets.[424] Nationwide bans of ICEs are discussed in *Section III.B.7 Electric Mobility.*

- **Fossil fuel subsidy reform** can be seen as an 'Avoid' strategy, as it disincentivizes travel by conventional motor vehicles, and as an 'Improve' strategy, as it incentivizes both manufacturers and consumers to increase uptake of fuel-efficient vehicles. (See *Section IV.A Financing for Transport and Climate Change* for discussion of recent country reforms.)

Figure 30: Singapore Economic vs. Transport Growth (1991 to 2014)[422]



'Shift'-focused TDM Measures shift passenger and freight trips that do happen to more energy efficient or environmentally friendly modes (i.e. walking, cycling, bus, rail). The examples below just show a few potential 'Shift' measures and other notable examples are off-peak fare discounts for public transport, fare integration with bike- or carsharing and incentives for car-pooling.

- Through **commute trip reduction (CTR)** programs employers encourage their workers to use resource-efficient commute modes, share rides, or even telework. Incentives may include public transport benefits, charging for on-site parking, parking cash out,[425] and rideshare matching. For example, the **Egyptian** start-up company **Raye7** contributes to the reduction of individual motorized transport as drivers are encouraged to share their vehicles with others through a point system.[426] **Washington State** has a successful CTR program since 1991 including initiatives for mortgage discounts for places closer to work, financial support for home offices and vanpools.[427] The Eco-Mileage system, launched in 2017 in **Seoul**, **South Korea** rewards citizens who reduce their driving compared to km driven the year before.[428] **Los Angeles** Metro announced plans to introduce in fall 2018 its TAPforce account-based payment system, which incentivizes use of transit and other mobility services including bikeshare, electric vehicle sharing, and ride-hailing.[429]
- **Efficient parking pricing & policies** reduce or eliminate minimum parking requirements or establish upper limits for parking spaces in zoning codes, and price parking where possible so that motorists pay directly for use of parking spaces.[430] Parking management and pricing refers to restricting and directly (or even dynamically) charging for the use of a parking space. Efficient parking pricing can provide numerous benefits, including increased turnover and less parking search time, parking facility cost savings, reduced traffic problems, and increased revenues.

Many cities are implementing such policies.[431] **New York City** first introduced a Park SMART program in 2008 to price curbside parking in commercial areas at variable rates. Following the program's successes (i.e. decreased occupancy and parking duration) the city is currently planning an updated program.[432] It is important to note the trend of mid-sized cities are removing parking minimums (e.g. **Buffalo, Hartford, Cincinnati**) and of other cities setting parking maximum ordinances (e.g. London). In July 2017, the Mayor of **Mexico City** introduced a major parking policy reform and announced the limitation of parking spaces in city construction code, committing to improving spatial planning by limiting private vehicle parking spaces, as well as requiring mandatory bicycle parking spots and the creation of a fund to improve mass transit that developers must pay as they approach the maximum parking quotas in the central area.[433]

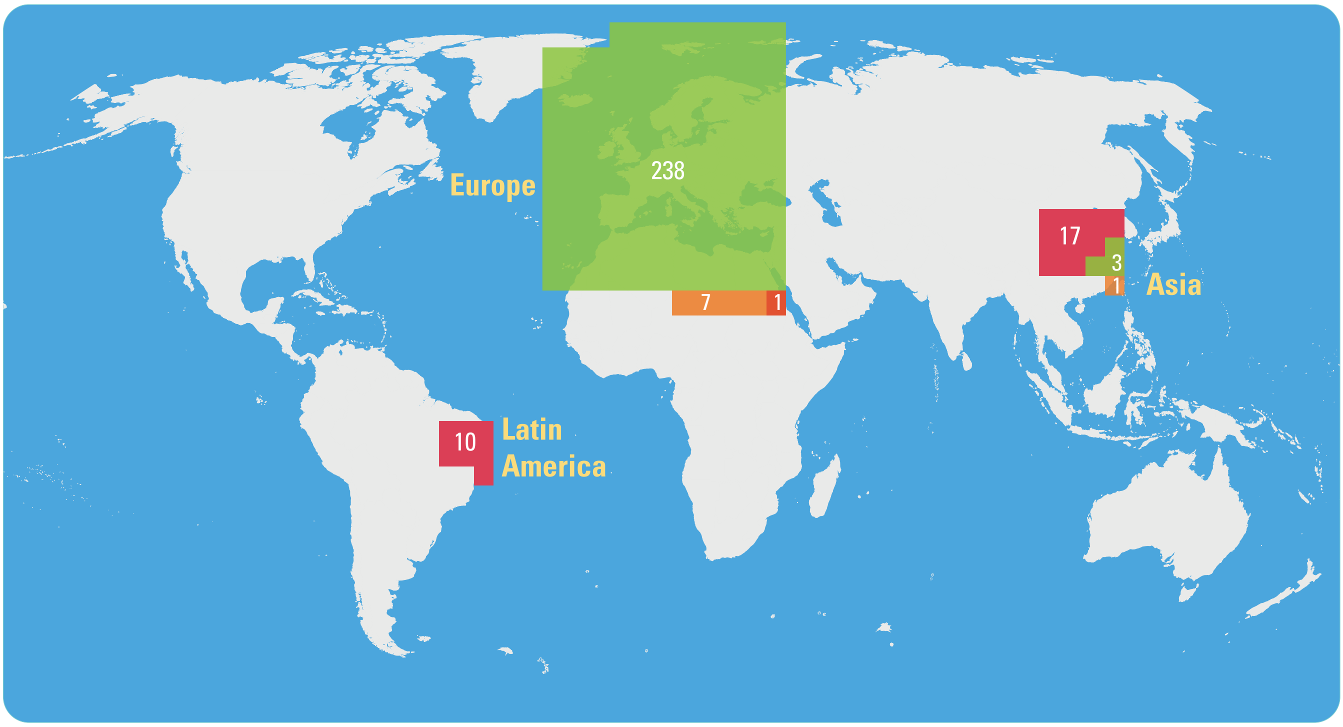
The most expensive parking can be found in cities in **Australia** and the **United States** (Table 2), though in many contexts high parking prices require complementary policies to significantly reduce motorized vehicle trips and traffic congestion.

- **Low Emission Zones (LEZs)** are a regulatory measure in which access within a defined area is restricted for polluting passenger and freight vehicles (i.e. vehicles with higher emissions cannot enter the area or must pay higher charges for access). The concept is well applied and documented for **Europe** but less so in other parts of the world:
    - Eight European cities (**Antwerp**, **Balingen**, **Barcelona**, **Gent**, **Grenoble**, **Lille**, **Oslo** and **Overath**) introduced new LEZs in 2017, bringing the global total to 241 cities.[435]
    - In addition, **London** announced the world's first ultra-low emission zone (ULEZ) to be put in place in 2019.[436] In preparation for the ULEZ a new Toxicity Charge (T-Charge) was introduced in central London in September 2017, to help deter the use of more polluting vehicles (including vans and other commercial vehicles) and encourage walking, cycling or using public transport.[437]
- **Off-hour deliveries (OHD)** refer to freight deliveries made outside of regular business hours (typically between 7:00 PM and 6:00 AM), with the goal of reducing deliveries that would have taken place during day hours and thus increasing daytime congestion and pollution. **London** created a "Retiming of Deliveries" office in 2015 to promote OHD; **New York's** OHD program had 400 confirmed participants in 2016; and **Copenhagen**, **Brussels**, **São Paulo** and **Bogota** have conducted successful pilots; with the private sector requesting expansion in each case.[439]

Table 2: Top 10 Cities with the Most Expensive Parking

Rank	1	2	3	4	5	6	7	8	9	10
City	Sydney	New York	Brisbane	Melbourne	Boston	Chicago	London	Tokyo	San Francisco	Washington, DC
Price for 2h Parking at PPP in USD	34.85	32.97	26.67	22.85	21.56	20.80	20.78	15.89	15.16	14.85

Figure 31: Overview of Major TDM Measures by Region[438]



Transport Demand Management Measures (Number of Cities)

- Vehicle Restrictions (covering measures limiting the number of vehicles entering the city or limiting the ownership of private vehicles)
- Low Emission Zones (restricting vehicles based on their pollution levels from certain areas)
- Congestion Charging (charging road users for driving within the city)

Policy Targets Set

- **New York** released a Climate Action Plan for the city in October 2017,[440] committing that by 2050 80% of passenger trips taken will be by foot, bike or on public transit. To achieve this goal, the subway and bus system will be improved, new miles of protected bike lanes will be built, in addition to expanding bike sharing systems. TDM measures included are an updated smart parking policy (PARK SMART), and possible low emission zones.[441]
- **London's** Mayor's Transport Strategy set out a target to increase the proportion of walking, cycling and taking public transport to 80% by 2041, meaning an average of 3 million fewer car trips in London every day. The Strategy uses a combination of several TDM measures: new densified developments around public transport stops; implementing more inclusive and safe walking routes, better cycling environment and improved public transport called 'Healthy Streets', restricting parking provision and car – free area; and keeping existing road charging schemes. The ambition is that 70% of Londoners will live within 400 meters of a high-quality, safe cycle route and for example on walking, the goal is to increase the number of walking trips by more than one million per day by 2024 (from 6.4 million to 7.5 million).[442]

Market Development

There is a global trend towards adoption of **low-emissions vehicle zones.** While this trend is dominated by European Union cities, more Asia and Latin American cities are adopting TDM policies as well.

Effect of minimum parking requirements: An analysis of 2011 United States household survey data concluded that minimum parking requirements lead to car-free households paying USD 142 per month on average, or if summed up to the total of the whole car-free population, USD 440 million per year for garage parking that they do not use for car storage.[443]

Unbundled parking: In the United States in 2012, the national average cost of constructing one below-ground parking space was USD 34,000, and one above-ground space was

USD 24,000.[444] The cost of constructing parking is high and generally passed on to renters and owners. A 2013 study of downtown **Los Angeles** that had been converted to housing after the city passed its Adaptive Reuse Ordinance, concluded that bundled parking raised the rent for an apartment by about USD 200 per month, and raised the price of a condo by about USD 43,000. Unbundling parking from the cost of housing allows renters and homeowners to choose whether or not they are willing to pay the additional cost of a dedicated parking space, depending on their travel behavior and mode choices.

Overview of Key Indicators

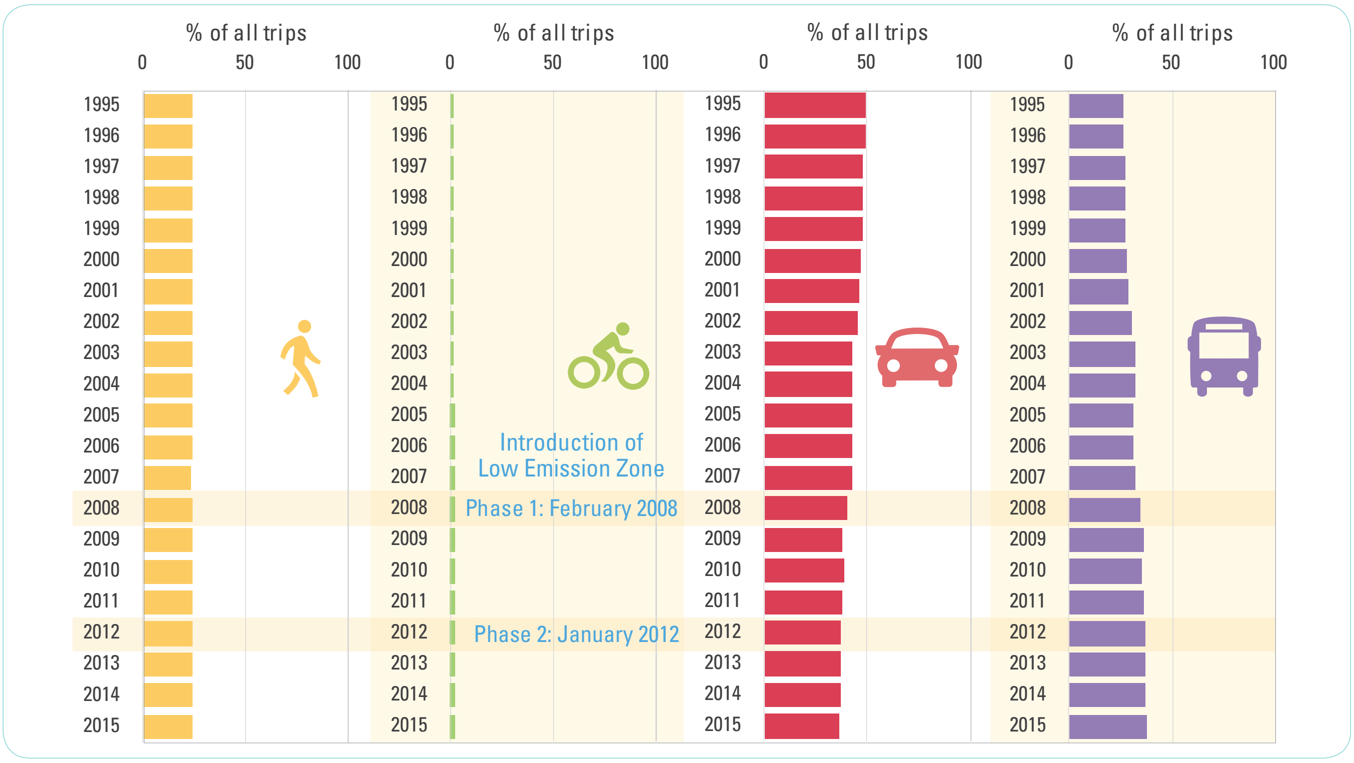
TDM takes a human-centered transport planning approach; it does not focus solely on infrastructure measures but aims to actively influence the behavior of citizens by using management measures such as congestion charging, or implementation of transport sector-wide carbon pricing (See *Section IV.A: Financing for Transport and Climate Change*). TDM indicators prescribe a wide range of phenomena, from the presence of LEZs, congestion charging and vehicle restriction policies to SUMPs.

Table 3: Overview of Key Indicators for Sustainable Mobility Planning and Transport Demand Management

KEY INDICATORS FOR TDM

	2017	2015	% CHANGE	Source/s
Policy Landscape Indicators				
Congestion charging zones *(# of cities)*	7	N/A	N/A	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb
Low emissions zones *(# of cities)*	241	189	28%	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb, Sadler Consultants Europe GmbH, (2018). Urban Access Regulations in Europe. Available at: http://urbanaccessregulations.eu/, Wang, Y. et al., (2017). Study on International Practices for Low Emission Zone and Congestion Charging. World Resources Institute. Available at: https://www.wri.org/sites/default/files/Study_on_International_Practices_for_Low_Emission_Zone_and_Congestion_Charging.pdf
Vehicle restrictions	28	N/A	N/A	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb
Sustainable Urban Mobility Plans *(# of plans)*	806	N/A	N/A	Based on SLoCaT calculations of GIZ, (2018). Urban Mobility Plans. Available at: https://www.google.com/maps/d/u/0/viewer?mid=1PnE9ux2r3BhcFGv2M_AZ1pD7SwU&ll=19.816856479523285%2C-1.4289565999999922&z=3
Countries with passenger mode shift plans *(# of countries)*	36	N/A	N/A	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb
Countries with freight mode shift plans *(# of countries)*	10	N/A	N/A	
	2016	**2014**	**% CHANGE**	**Source/s**
Market Development Indicators				
Diesel prices *(USD cents/liter)*	85.5	120.8	-29%	Data received by GIZ and based on GIZ, (2017). Non-Alternative Facts on International Fuel Prices in 2016. Available at: https://www.giz.de/expertise/downloads/giz2017-en-ifp2016-2017.pdf
Super (high grade) gasoline prices *(USD cents/liter)*	97.1	130.4	-26%	

Figure 32: London Trip Mode Share[445]



Emission Reductions Impacts and Modal shift

- Following implementation of congestion charging and complementary public transport improvements, **London's** public transport share increased from 25% to 37% from 1995-2015, while its private vehicle share decreased from 49% to 36% (Figure 32).
- **Washington State, United States** implemented the CTRtrips. In downtown Seattle, the City's CTR Alternate Plan has Law in 1991 to force employers to work with employeesdecreased commuters driving alone from 35% in 2010 to lessto reduce the amount and length of drive-alone commutethan 30% in 2017.[446]

Global Initiatives Supporting Sustainable Mobility Planning and TDM

- **C40's TOD Network** supports city efforts to deliver compact, walkable, mixed-use communities centered around high quality public transport. Cities participating in the network have prioritized four focus areas (financing, social equity, public engagement, active mobility) around which they are actively sharing knowledge.
- **Global Designing Cities Initiative** is a program of National Association of City Transportation Officials (NACTO), supporting the shift towards sustainable, safe and healthy cities through street transformation. Their Global Street Design Guide offers technical details about complete street design, and supports practitioners worldwide in redefining the role of streets.
- Institute for Transportation and Development Policy (ITDP) promotes socially equitable and environmentally sustainable transportation policies and projects worldwide. ITDP released version 3.0 of their **TOD Standard** in June 2017, which outlines eight core principles of urban design and spatial planning, each supported by specific performance objectives and easily measurable indicators, or metrics. In 2018, the **Pedestrians First: Tools for a Walkable City** was released to facilitate the understanding and the measurement of features that promote walkability in urban environments around the world at multiple levels
- The **Global Green Freight Action Plan (GGFAP)** aims to enhance the environmental and energy efficiency of goods movement in ways that significantly reduce the climate, health, energy, and cost impacts of freight transport around the world.
- **The MobiliseYourCity Partnership** supports local governments in developing countries plan sustainable urban mobility for more inclusive, livable and economically efficient cities, and to reduce GHG emissions. The MobiliseYourCity Partnership provides an introduction of national urban mobility policies and investment support programs that typically foster urban public transport.
- The European Union has implemented several urban freight knowledge-sharing initiatives that include information on green freight, co-modality, and e-freight, including the **"Best Practice Factory for Freight Transport" (BESTFACT)** and **Sustainable Urban Goods Achieved by Regional and local policies (SUGAR) initiative**. The CIVITAS Awards and SUGAR Awards recognize innovative green freight projects in cities in developing countries.

2. Urban Public Transport

Photo credit: Nikola Medimorec

Overview

Background

The benefit of public transport results from pooling more people than private cars in an equivalent unit of space, which can reduce the total number of vehicle kilometers traveled (VKT) by passengers who might otherwise travel in their own vehicles. By reducing VKT, public transit reduces congestion, urban space requirements, local and global pollution, crashes, and noise. High-quality transit, such as rail and BRT, can accelerate TOD and lead to a higher scale of the mentioned benefits, as well as to further positive impacts: less car ownership, more walking, cycling and public transport use.

The focus on public transport has been in extending metro networks, building segregated lanes for buses, and providing integration among urban transport services. It is important when planning for urban transport to acknowledge the role of other mass transport modes such as paratransit, tricycles and other informal transport options in cities as they provide services where there may be gaps within the public transport network. Public transport improvements are most effective when combined with TDM measures (See *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management*).

Policy Landscape

Policy Overview

Local governments worldwide aim to increase the mode share of public transport, or to maintain it at high levels by building new infrastructure such as metro, LRT, and BRT systems, and by ensuring high quality service (e.g. ticket, timetable and physical integration of modes). Seamless, synchronized transfers with easy (and smart) fare systems are crucial for intermodality, and for competing with private transport. Finally, financial incentives can further increase the attractiveness of public transport services and more effectively pull travelers out of their private vehicles.

Increasing Urban Public Transport Supply

- **Metro:** Bus priority and metro systems have grown steadily during the last few decades. Even though urban buses operate over many more kilometers than metros do worldwide, the number of kilometers of segregated busway is below that of metro. In 2016, the total length of metro lines in the world was over 10,000 km; more than twice the total length of bus lanes in priority corridors. 75 new metro systems opened since 2000, with 53,768 million passengers annually worldwide.[447]
- **Bus Priority Systems:** Bus priority corridors come in a variety of forms, and BRT has gained more popularity worldwide as a cost-effective alternative to far more expensive urban rail investments.[448] Between 2005-2017, **Mexico City** expanded their Metrobus BRT system to seven lines, totaling 140km and carrying 1.24 million passengers per day.[449] To completely redesign **Dublin's** public transport system, the National Transport Authority of **Ireland** in May 2017 proposed the 'BusConnects' plan consisting of 17 new bus routes, with all separate bus lines.[450]
- **Trams and Light Rail Transit:** Nearly all regions worldwide have seen growth in the number of LRT and tram systems serving their cities, with an ongoing renaissance in the tram since the 1980s. The first LRT in Sub-Saharan Africa was opened in 2015 in **Addis Ababa, Ethiopia**[451] and followed by a 45.2 km long light rail line in Abuja, Nigeria in 2018.[452] **Samarkand**, **Uzbekistan** inaugurated a newly built 6.4 km-long tram line in April 2017, and a second 5.3 km-long route beginning in 2018.[453] **Aarhus**, **Denmark** opened Phase I of its first modern light rail line that included 6.5 km and 10 stops in December 2017.[454]
- **Cable cars:** Cable cars are an emerging trend in public transport in cities with hilly terrain is the use of cable cars or gondolas. Because of their ability to traverse steep hillsides and cross rivers, cable cars can be cost-effective mass transport solutions in areas where other modes could not operate. **Medellin**, **Colombia** introduced its Metrocable line, which acts as a feeder to the city's metro system, and many other cities have looked to replicate Medellin's success. Numerous cable car projects have been completed since 2016 in Latin America (**Rio de Janeiro**, **Caracas**, **Guayaquil**, **Santo Domingo**, and **La Paz**), Asia (**Busan and Yeosu in South Korea**, **Taiwan**, **Hong Kong**), Africa (**Constantine**), and Europe (**London**, **Koblenz**, **Bolzano**).[455]
- Public bikeshare, carsharing and ridehailing systems: See *Section III.B.5 New Mobility Services* for further discussion.

Box 3: Urban Transport Indices

Indices by various organizations attempt to compare the mobility performance and development of cities. Here, four indices regarding urban mobility have been identified, and their Top 10 rankings summarized. Each index has a different set of indicators and sample of cities – for example, innovative transport schemes and level of public funding for transport. As shown, **Singapore**, **Stockholm**, **Amsterdam** and **Copenhagen** are regarded as those with the world's best urban transport environment.

Table 6: Overview of Top Cities in Urban Mobility Indices

Rank	1	2	3	4	5	6	7	8	9	10
Qualcomm, Urban Mobility Index (2017)	Oslo	London	Amsterdam	Copenhagen	Paris	Zurich	Tokyo	Berlin	Munich	Seoul
Arthur D. Little and UITP, The Future of Mobility 3.0 (2018)	Singapore	Stockholm	Amsterdam	Copenhagen	Hong Kong	Vienna	London	Paris	Zurich	Helsinki
Arcadis, Sustainable Cities Index (2016)	Zurich	Singapore	Stockholm	Vienna	London	Frankfurt	Seoul	Hamburg	Prague	Munich
Deloitte, City Mobility Index (2018) (Future of Mobility)	Singapore	Berlin	London	Helsinki	Tokyo	Barcelona	Seoul	Stockholm	Paris	Boston

The top-ranked cities are mainly from Europe and Asia, representing high-density urban areas. These cities invest in the expansion of public transport and have a well-established cycling network as well as a good walking environment. These cities prioritize sustainable transport modes, which leads to high modal shares of public transport, cycling and walking, safe roads and higher quality of public spaces. The levels of per- capita transport GHG emissions are lower in these cities than in other places around the world.

Intermodality

Intermodality, a key feature of integrated transport systems, aims to create more effective, efficient and convenient trips. A precondition of intermodality is cooperation among different transport operators (and private companies), which could involve a metropolitan or regional transport authority as an effective central institution. Intermodal systems incorporating informal and formal transport systems, with public transport services connected to shared transport, and walkable neighborhoods or walking networks, can allow cities - especially in developing countries and emerging markets - to leapfrog conventional models of car-centric development. Effective intermodality advances equity for vulnerable groups (e.g. women, children, elderly, disabled, poor) and ensures a people-centered approach to mobility and development more broadly. For example, the mobility needs of women, especially in developing countries, tend to be more heterogeneous, combining domestic and caregiving tasks with work trips. Intermodality serves the trip chaining phenomenon, where trips are short, multimodal, and frequent.[457] (See *Section III.B.3 Passenger and Freight Railways* and *Section III.B.5 New Mobility Services for further discussion.*)

- In recent years, several cities and regions have implemented smart ticketing systems, which provide seamless transfers between modes. For example, in **Taipei**, **Taiwan** travelers can use their EasyCard (smart card) to rent shared bicycles, with docking stations located at most metro stops. In the **Netherlands**, travelers can rent a bicycle for their last mile at any large train station with their (national) smart card. Since 2018, citizens in **Dublin** can use the smart card (LEAP Card) to access carsharing services.[458] Well-designed train stations, smart ticketing solutions, and synchronized transfers can all enhance intermodality and connect local public transport with regional and national rail transport (See *Section III.B.3 Passenger and Freight Railways*)

User Financial Incentives

Providing travelers with financial incentives, including free or discounted fares, can increase the attractiveness of public transport services. As an emergency response to critical air pollution levels, in 2017, several cities announced or implemented trials of free public transport. **Brussels**,

Belgium announced that public transport and bikesharing systems would be free on heavily polluted days, and expect to fully implement the measure by summer 2018.[459] In December 2017, **Kaohsiung**, **Taiwan** launched a three-month free public transport scheme to combat air pollution, and on its first day saw a 10% increase in subway passenger during the morning peak.[460] **Seoul**, **Korea** implemented similar emergency measures in January 2018, when air quality reached critical levels, providing free public transport during rush hour.[461]

National Urban Transport Funding

Urban transport funding is of equal importance to user incentives. Dedicated financial support of public transport from the national government is critical for cities to be able to provide high quality networks. In many cases, national funding is contingent on local governments meeting certain criteria, such as completion of sustainable urban mobility plans. National governments in **Colombia**, **Mexico**, **India**, **South Africa**, and **Brazil** have introduced programs to at least partially fund construction of new mass transit systems.[462] The MobiliseYourCity Partnership is supporting the development of new national public transport investment programs in Indonesia and Peru. The Ministry of Transportation in **Indonesia**, for example, provides 635 buses in 17 provinces to support the development of public transport by allocating USD 307 million in its 2018 budget for land transport. [463]

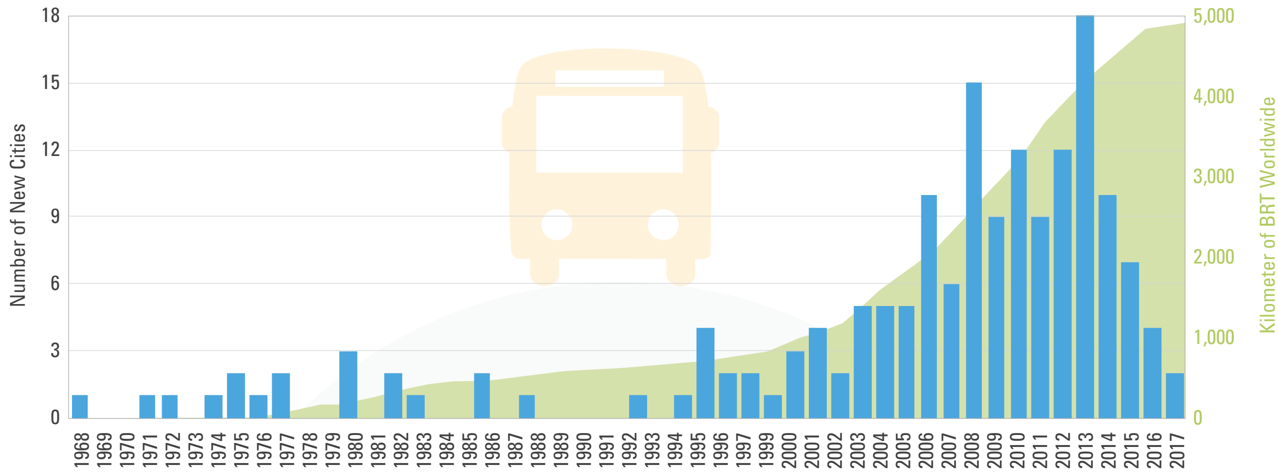
Policy Targets Set

- **Kuala Lumpur, Malaysia** opened a 51 km-long new mass rapid transit (MRT) line and 31 new stations in July 2017, resulting in a 3.7% increase in average daily ridership of public transport. The national government plans several other rail projects to meet a nationwide public transport modal share target of 40% by 2030.[464]
- **Kigali, Rwanda's** 2013 Public Transport Master Plan prioritizes public transport on five bus-only corridors totaling 92 km and plans to phase out the use of private transport by 2040.
- **Singapore** wants to increase its public transport mode share during peak period from 66% (2015) to 75% in 2030.[465]
- The **New South Wales** Government announced a renewable tender for **Sydney's** light rail system.[466]
- In 2016, **Chile** announced that as of 2018, **Santiago's** subway system – the second largest in Latin America after **Mexico City** – would be powered by solar photovoltaic (42%) and wind energy (18%).[467]
- **China** in its NDC submission of 2015 aims to promote the share of public transport in motorized travel in big-and-medium-sized cities, and to reach a share of 30% by 2020.[468]
- **Indonesia's** National Policy aims to increase public transport mode-share of 32% in 2019.[469]

Market Development

- **Rapid Transit to Resident (RTR):** The RTR ratio indicator, which compares a country's urban population (for cities with more than 500,000 people) with the length of rapid transit lines (including rail, metro, and BRT) that serve them, shows significant improvement in many countries such as **France**, **Colombia**, **China** and **Indonesia**.[470] Globally, since 2000, the BRT system, light rail transit and metro system infrastructure expanded by 835%, 88%, and 67%, respectively. Globally, in 2017, 26 cities in eleven countries added 703.8 km of metro rail; six cities added 62.4 km of BRT; and 17 cities added 135.2 km of light rail. By comparison, in 2016, more metro rail was added (37 cities, with 754.5 km), three times more BRT was added (12 cities, and 176.2 km), but less light rail was added (nine cities, with 81.5 km).[471] The growth is largely driven by transit expansion in Chinese cities.[472] The RTR ratio (for cities with more than 500,000 people) has only increased marginally, from 10.9 km in 2016, to 11.1 km in 2017 (2%) per million population.[473]
- **Metro System Expansion:** In 2017, the total length of metro lines in the world was over 14,000 km, which is nearly three times the total length of bus lanes in priority corridors.[474] The total length of metro lines is steadily increasing, with multiple cities introducing new lines in 2017. This rapid increase worldwide in metro systems and network lengths is mainly a reflection of developments in **China**. **Shanghai** opened additional lines and extensions to what is already the world's longest metro system, bringing the total length to 637 km.[475] **Shenzhen** plans to add another 148.9 km and five lines to its network after the National Development and Reform Commission approved the next phase of the system in July 2017, which should be finished by 2022 and will add five lines to the existing network.[476] In **New Delhi**, **India** a new 12.64 km-long metro line was inaugurated late 2017, significantly reducing travel times between **Noida** and south **Delhi**.[477] In November 2017, the West Metro was launched in **Helsinki**, **Finland**, a 14 km extension of the Helsinki metro line into the neighboring city of **Espoo**.[478] For **Qatar Rail**, 2017 was a year of important milestones: 69% of the Lusail Tram project was completed,[479] a network that will consist of 4 main tram lines that span 33 km, and 37 passenger train stations. The first line is scheduled to open in 2018.[480] At the same time, 77% of the Doha Metro project (a 300 km network consisting of four lines) was completed by Spring 2018.[481]
- **Bus Rapid Transit Growth:** By the end of 2017, BRT systems were implemented in in 169 cities with a total length of more than 5,000 km (Figure 33).[482] Several cities introduced new systems, for example **Multan**, **Pakistan**

Figure 33: Evolution of BRT Systems[484]



inaugurated its 18.5 km-long BRT system (Multan Metrobus) in January 2017, with 21 stations.[483] **Hanoi, Vietnam** launched its first 14.5 km corridor.

- **Minibus services:** Minibuses are owned by private operators and can be regarded as paratransit or informal public transport. They are a dominant public transport method in many African countries. For example, in **Dakar**, 3,000 minibuses provide around 80% of the public transport supply. In recent years minibus improvement schemes have been implemented whereby fleet renewal can lead to emission reductions.[485]
- **Trams and Light-rail transit development:** In 2014, 388 cities worldwide had trams and LRT in operation, representing over 2,300 lines and totaling more than 15,600 km of infrastructure.[486] **Alberta, Canada** committed USD 1.53 billion to **Calgary** Green Line LRT,[487] as well as USD 600 million to support Edmonton's Southeast Valley Line LRT.[488] Worldwide, many cities are reviving or introducing new tram systems. **Seoul, South Korea** opened an 11.4 km-long LRT line in September 2017 to improve accessibility in the northeast of Seoul, operated by 18 driverless two-car trains.[489] In December 2017 a new 3.1 km-long tram link between the Swiss city **Basel** and **French** town **St. Louis** in Alsace was opened, which revives a tram service that closed around 60 years ago.[490]

Emission Reduction Impacts and Modal Shift

- Modal shares in public transport in developed countries oscillate between 1% (**Stockton, United States**) and 43% (**Prague, Czech Republic**), whereas in developing countries, modal shares range from 8% (**Guayaquil, Ecuador**) to 83% (**Taichung, Taiwan**). The push from (local) governments towards public transport is also noticeable in historically car-oriented cities. For example, in **Dubai, UAE** metro became the most popular public transport mode in the city, capturing 36% of public transport ridership in 2017. Public transport mode share has grown from 6% in 2006 to 17% in 2017 largely due to changing attitudes in the city towards using public transport.[491] In the **United States**, however, ridership has declined nationally by 3% between 2014 and 2016.[492] This is likely attributed to the attractiveness of other mobility options (e.g. shared mobility, affordability of personal vehicles) and transit service supply issues.[493]

Overview of Key Indicators

When provided with viable, attractive public transport with seamless transfers and last-mile solutions such as walkable networks and bikesharing systems, travelers do not need to rely on private vehicles to reach their destinations (See *Part III.B.5 New Mobility Services*). The indicators summarized below show the current global urban public transport supply based on available data, noting there are qualitative as well as quantitative factors contributing to the effectiveness of these systems (e.g. quality of service and the degree to which systems are integrated with spatial planning policies to create TOD).[494] Several countries allocate a national fund to support local governments with public transport infrastructure costs.

Table 5: Overview of Key Indicators for Urban Public Transport

KEY INDICATORS FOR URBAN PUBLIC TRANSPORT	2017	2016	% CHANGE	Source/s
Policy Landscape Indicators				
Countries with national funding for urban transport *(# of countries)*	N/A	N/A	N/A	N/A
Market Development Indicators				
Bus Rapid Transit (BRT) *(# of systems)*	169	167	1.2%	BRT+ Centre of Excellence and EMBARQ, (2018). Global BRTData. Version 3.37. Available at: http://www.brtdata.org
Urban Rail (Metro and Modern Light Rail) *(# of systems)*	223	220	1.4%	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb
Rapid Transit to Resident Ratio *(for cities with population 500,000+)*	11.1	10.9	1%	ITDP, (2018). Rapid Transit Database. Institute for Transportation and Development Policy. Available at: https://docs.google.com/a/itdp.org/spreadsheets/d/1uMuNG9rTGO52Vuuq6skyqmkH9U5yv1iSJDJYjH64MJM/edit?usp=drive_web

Global Initiatives Supporting Public Transport

- **Transformative Urban Mobility Initiative** enables leaders in developing countries and emerging economies to create sustainable urban mobility. The initiative offers technical and financial support for innovative ideas. TUMI supports projects, leadership development, and career building for urban leaders, decision-makers, planners and students; connecting 1000 leaders worldwide.
- **UITP Declaration on Climate Change Leadership** launched in 2014, demonstrates the public transport sector's commitment to tackling climate change. The Declaration's goal is to double the market share of public transport by 2025. The Declaration is supported by more than 350 pledges to climate action, from over 110 members of the international public transport community in over 80 global cities.
- **EcoMobility Alliance** was created in October 2011, in Changwon, Korea. It is a transformation of the former Global Alliance for EcoMobility, which was launched in Bali on 10 December 2007, at COP 13. The common goal of the group of local governments is to create and implement urban mobility strategies that prioritize people and the environment.
- **CoMET and Nova Metro Benchmarking Groups** are comprehensive international urban railway benchmarking consortiums made up of 35 metro systems from 33 global cities. The groups are jointly owned by the members with the aim of providing a confidential forum for sharing best practices and improving performance.
- **BRT Centre of Excellence** was established in 2010 with funding from the Volvo Research and Education Foundation. Made up of a consortium of research organizations, the Centre aims to advance the latest research and practical knowledge about BRT planning, design, operations. The Centre led the development of BRTdata.org, a global database of BRT characteristics, performance metrics and costs.
- The **C40 Clean Bus Declaration** is led by the C40 Cities Climate Leadership Group (C40), and aimed at influencing manufacturers, public transport operators, leasing companies, multilateral development banks and other funding agencies to support city ambitions to decarbonize urban mass transport.
- The **MobiliseYourCity Partnership** supports local governments within developing countries to plan and implement sustainable urban mobility plans, by providing an introduction to national urban mobility policies and investment support programs that typically foster urban public transport.

3. Passenger and Freight Railways

Photo credit: Anthony Ivanoff

Overview

Background

Rail transport demand is steadily expanding in most regions of the world, in particular in metropolitan areas with soaring populations (See *Section III.B.2 Urban Public Transport*). It is estimated that this transport subsector will experience and average growth of 2.7% worldwide for the 2021 to 2023 period.[495] Africa/Middle East and Latin America are the regions with the highest expected growth rates, at 5.2% and 4.8% respectively.[496] **Passenger rail transport** demand is also being driven by a surge in demand for intercity and interurban mobility. Furthermore, the demand for long distance rail journeys is growing in many countries, a trend that is expected to increase with further development of **high-speed rail (HSR)** networks in Europe and particularly Asia. For distances up to 1,200 km, HSR is increasingly competing with air transport, especially in **China** where in 2015, 910 million Chinese traveled by all forms of rail, more than double the 415.4 million who flew.[497]

In addition to passenger rail transport, **rail freight** is a key element in an interconnected transport system. Rail freight generates a low level of externalities and produces much lower CO_2 emissions and energy consumption per tonne-km than road freight.

Policy Landscape

Measures Implemented

Shifting transport activity towards low carbon rail transport is essential to achieve climate targets, and releases increasing pressure on congested road networks. In addition to this modal shift, rail's energy usage could be further improved; since 1990 it has improved by 37% per transport unit, and rail's carbon emissions have improved by 30% per transport unit.[498]

'Shift' Measures: The list below showcases examples of shift measures for passenger and freight trips to more energy efficient or environmentally friendly modes, including rail.

- **Standardization of Cross-Border Rail:** Countries worldwide over time have adopted different track gauge standards, electrification, and traffic management systems, differences that form a barrier for both passenger and freight rail transport to be internationally competitive with other modes. Therefore, different networks aim to overcome these problems and standardize international network standards.
    - **The Trans-European Transport Network (TEN-T)** is a European Commission policy that aims to implement a Europe-wide network of roads, railway lines, inland waterways, maritime shipping routes, ports, airports and rail-road terminals. Many TEN-T rail projects focus on creating international long-distance corridors, the implementation of common technical standards, and the European Rail Traffic Management System.[499] The Gotthard base tunnel (**Switzerland**) opened at the start of 2017 for freight rail transport, and is an important piece of the TEN-T Core Network enhancing European integration.[500] **Bulgaria's** Transport Minister announced in March 2017 that until 2020, Bulgaria will invest EUR 2.25 billion in transport infrastructure (under the Operational Programme Transport), and another EUR 207.8 million under Connecting Europe Facility, to develop by priority the Core Corridors of the TEN-T network.[501] **Spain** is set to invest EUR 500 million in updating its high-speed rail network, and to extend it by adding an important new southern route. It also plans to invest EUR 2 billion in the Mediterranean Railway Corridor to connect **Murcia**, **Valencia** and **Catalonia** with the French rail network, improving regional connectivity for both passenger and freight rail.[502]

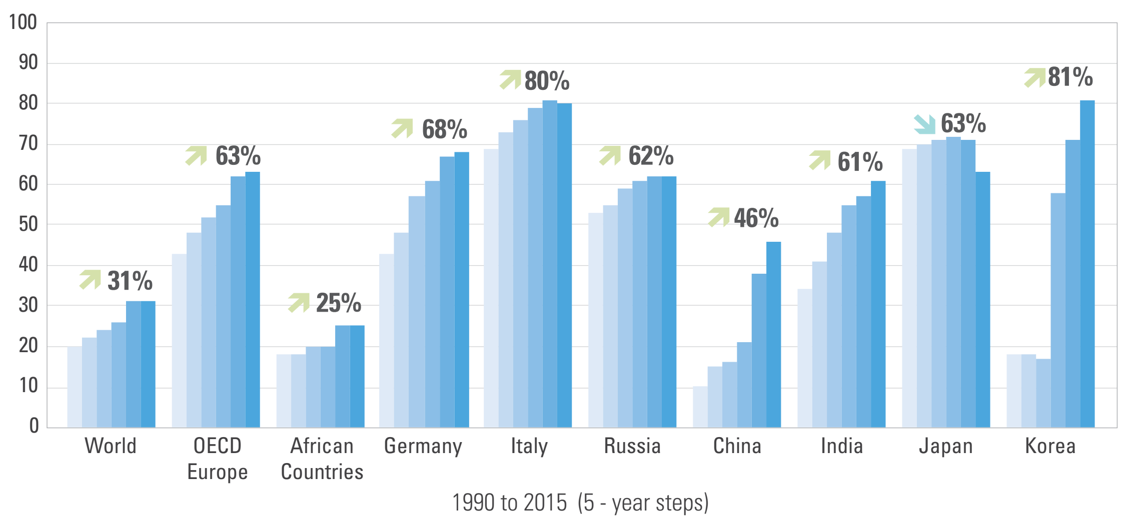
- **Expansion of Inter-Regional Passenger and Freight Rail Networks**
    - The Trans-Asian Railway network now comprises 117,500 km of railway lines, serving 28-member countries, and aiming to serve cultural exchanges and trade within Asia, and between Asia and Europe.[503] The first freight train carrying 88 containers traveled along the ancient Silk Road, and arrived after 12,000 km and 20 days of travel from **London, UK in Yiwu, China.**[504]
    - **Argentina** strongly committed in 2017 to developing its rail freight network, when the Ministry of Transport and China Railway Construction Corporation agreed on the conditions to fully modernize rail freight transport between the **Mendoza province** and **Buenos Aires** to increase the capacity from 2.3 million tonnes to 13 million tonnes by 2024, and by renewing the signaling systems, and many civil structures.[505]

- The **Australian** Federal Government in 2017 has committed to the full delivery of Inland Rail with an additional USD 6.5 billion. The 1700 km long freight rail line will complete the national freight network between **Melbourne** and **Brisbane**.[506]
- **Kenya** inaugurated a 480 km long new rail track (Standard Gauge Railway) connecting port city **Mombasa** and capital **Nairobi** in four-and-half hours, the largest infrastructure project since its independence in 1963.[507] The aim is to shift 30% of freight on the corridor to rail.

- **Improve Intermodality:** The first and last mile of journeys, as well as the interfaces between modes, present significant barriers to passengers using intercity and interurban rail. The city center location of the intercity rail station, however, allows intermodality with urban public transport services and cycling and walking. This interaction, and how several cities have enhanced their overall transport systems by creating multimodal hubs is discussed in more detail in *Section III.B.2 Urban Public Transport.*
- Intermodal **freight transport** is the ideal solution for effective transport services based on cooperation between different modes, carrying the major part of the journey by a sustainable and efficient mode such as rail, and involving other actors such as trucks to complete the door-to-door carriage. New sustainable urban commodity delivery modes such as bike or electric vehicles require logistic hubs located near the city, like the railway stations, to ensure sustainable door-to-door freight services.
    - **Arken Combi Terminal** at the **Port of Gothenburg, Sweden** was opened in December 2017. On completion in 2020, the terminal will be served by 12 trains and 200 trucks daily.[508] The terminal area has seven rail tracks and is located beside the roll-on/roll-off terminals. It is estimated that 100,000 trailers per year will switch from one transport mode to another at the terminal.[509]
    - In the **Port of Hamburg's** modal split, rail further increased its share of containers transported from 41.6% to 42.3% in 2016. More than 200 freight trains reach or leave Hamburg's rail port daily.[510]
    - In December 2017, **Jundiaí Intermodal Terminal**, operated by **Contrail Logistica**, opened for operation in **Brazil**. The terminal is strategically located close to South America's largest port **(Port of Santos)**, and has reduced cargo transport times from 24 hours to 16 hours. Currently, the cargo volume moved by railroad is just 2%, but Contrail aims to increase this in the coming years.[511] The environmental benefits are substantial: one train of 21 wagons carries the equivalent of 42 trucks.[512]
    - **Inland waterways** provide a complementary option to railways for passenger and freight transport, as they are significantly more efficient in terms of GHG emissions than roads, and in many cases at least equivalent to railways. Inland waterway transport can be used for distribution of construction materials in urban regions to relieve congestion and reduce GHG emissions.[513]

'Improve' Measures: increase the energy efficiency of passenger and freight rail modes, operations and technologies.

Figure 34: Electrification of Railways for Global and Selected Countries from 1990 to 2015[517]



- **Increasing Rail Efficiency and Energy Diversification:** Multiple countries in 2017 have taken steps to decarbonize their railway systems:
  - The amount of **electrified railway** tracks is increasingly growing, and this positively influences the carbon intensity of the rail sector, enabling opportunities for rail transport decarbonization.[514] Rail electrification has reached 81% in **Korea**, 63% in **Japan**, 61% in **India** and 46% in **China** (Figure 34). The increase in Korea and China comes from the opening of their high-speed rail networks. In addition, as part of its 'Mission Electrification' plan, **Indian Railways** signed its first large engineering and construction contract for route electrification in August 2017.[515] In September 2017, the first electric freight trains ran between **Minsk**, **Belarus** and **Vilnius, Lithuania** after completion of electrification on the line.[516]
  - The railways of **Austria**, **Denmark**, **Finland**, the **Netherlands**, **Norway**, **Sweden** and **Switzerland** are running on 100% renewable electricity, either purchased from renewable energy providers or produced in renewable energy plants owned and operated by the rail companies.[518] All electric trains in the **Netherlands** are running on wind energy since January 2017.[519] **India** launched its first solar-powered local train. One solar-powered diesel electric multiple unit train could save 21,000 liters of diesel per year.[520]
  - In September 2018, the world's first hydrogen train entered service in **Germany**. The **Coradia iLint** uses fuel cells, and the hydrogen to power the train is produced carbon-free. **Alstom** will deliver 14 additional trains by 2021, replacing all diesel trains on the route.[521]

Policy Targets Set

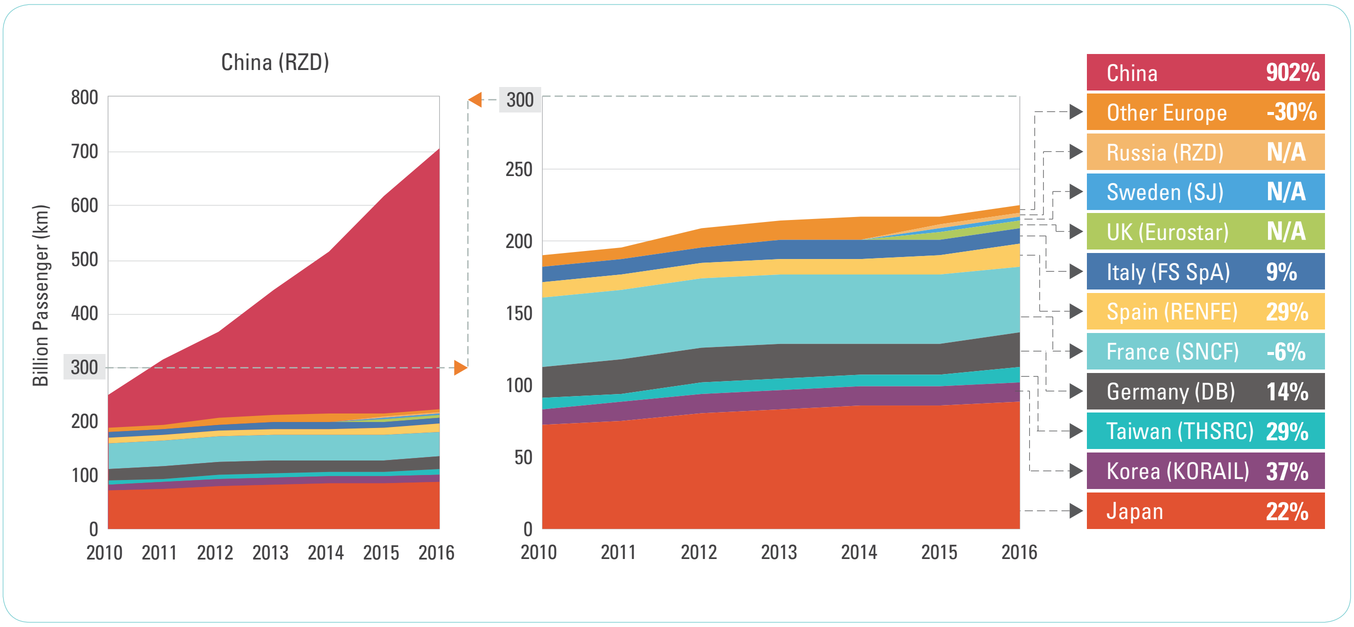
- The **Dutch** railway company **Nederlandse Spoorwegen** had a target to power all electric trains with 100% renewable electricity by 2018, but achieved it in 2017, ahead of schedule.
- **India's** railways minister in November 2017 announced a target for the complete electrification of the country's mainline network within five years.[522] In 2017, 4,000km of railway was electrified, or 6% of India's national network.[523]
- The main **German** rail operator **Deutsche Bahn** announced in late 2017 an even more ambitious climate target. By 2020, Deutsche Bahn aims to reduce its specific CO_2 emissions from rail, road, air and ocean transportation by 30% compared to 2006 levels; and by 50% by 2030.[524]
- In 2018, **Eurostar** committed to having no traction energy sourced from fossil fuel sources by 2030.[525]
- Railway accounted for 27% of the cargo volume moved at **Port of Santos, Brazil** in 2017, which the port aims to increase to 40% in the next 10 years.[526]
- **Port of Antwerp, Belgium** invested 1.4 million euros over three years to shift port- generated freight traffic to sustainable modes and aims at a modal split of 10% for rail transport by 2020.[527]

Market Trends

Passenger Rail Transport

- In 2015, rail accounted for 6.7% of global passenger transport activity (in passenger-km).[528] High-capacity services account for most of the global urban rail activity (estimated in passenger-km).
- The share of high-speed rail in global intercity rail passenger activity grew considerably between 2010 and 2015, doubling from 10% to 20%. While the global high-speed rail network accounts for only 2% of the global rail network, it transports now a fifth of rail passengers. This growth was largely driven by a surge of high-speed rail activity in **China** in the same period, and a number of countries recently inaugurating new HSR connections (Figure 35).
  - In 2017, China further developed its already extensive 25,000 km long HSR network, by opening several new lines (e.g. the 1300 km long Chongqing – Taiyuan line, and the 300 km long Shijiazhuang – Jinan line).[529] **China** clearly dominates the growth in recent years, with a 10-fold increase between 2010 and 2016.
  - **Deutsche Bahn** achieved a 2.6% increase in passenger-km in 2017—the third year in a row with growth in passenger numbers—mainly caused by the opening of the new HSR Munich – Berlin connection.[530]
  - **France** inaugurated two new HSR lines between Tours to Bordeaux and Rennes, both constructed under public-private-partnerships, reducing travel times by 35-40%.[531] The Tours – Bordeaux link is also part of the **TEN-T** Atlantic Network.
  - **Republic of Korea** opened a new 120 km-long HSR line from Wonju to Gangneung, connecting the eastern coast to Korea's HSR network, and increasing accessibility from the **Seoul** capital region.[532]

Figure 35: Development of HSR Worldwide[533]



Freight Rail Transport

In North America, but also in Asia, freight rail operations generally meet better structural conditions than in Europe. Distances are generally longer, stops less frequent, and the infrastructure allows for substantially longer and heavier trains, thus making freight operations less costly than in Europe. In some places such as in **North America** and **Australia**, railway infrastructure and operations are often single integrated companies, often with far less passenger traffic. In the European Union, the so-called rail freight corridors have been implemented to focus efforts on improving the framework conditions on designated lines with high economic importance.

In 2015, rail accounted for 6.9% of global freight transport activity (in tonne-km). Rail freight reached 9.5 trillion tonne-km by 2015, which equals a 37% increase since 2000. Non-OECD countries account for two-thirds of the rail freight activities. Africa, Latin America and Asia make up only 1%, 4% and 3% share of global rail freight (excluding OECD-countries, China and India), respectively.[534]

Rail freight volumes have increased by 6.9% in 2017 in **Brazil**, and the handled tonne-km increased by 10%, representing the strongest increase in the last 12 years.[535] Rail freight operators in **Switzerland** saw a 0.9% increase in market share compared to 2016, with rail accounting for 39% of freight carried, while road's share of freight transport decreased by 1.5%.[536] During the first half of 2017, rail freight between **Russia** and **China** increased 19% compared to the same period last year.[537]

Key Indicators

Rail transport can significantly contribute towards the decarbonization of the transport sector, by reducing road freight transport and shifting passengers from air transport to (high-speed) rail transport. This decarbonization process firstly significantly depends on the amount of railway tracks with electrification, and secondly on the energy sources used to generate that electricity. In cities, the specific energy consumption of high-capacity urban rail is the lowest of all urban passenger transport modes, and therefore also has untapped decarbonization potential.[538] The competitiveness and market position of rail transport is measured by the indicators of mode share and rail activity.

Emission Reductions Impacts and Modal Shift

Among the different modes of transport, railways have the highest **share of electrification**. Electricity represents around one-third of the energy used globally by the railway sector, with 40% of rolling stock powered by electric traction, and electrified lines representing 25% of the total. The use of electricity in railways worldwide went from 17% to 39% (measured as share of final energy consumption) between 1990 and 2015.[539] Just over one-third of the electricity is estimated to be renewable, contributing 9% of rail energy.[540] (See *Section III.B.8 Renewable Energy*)

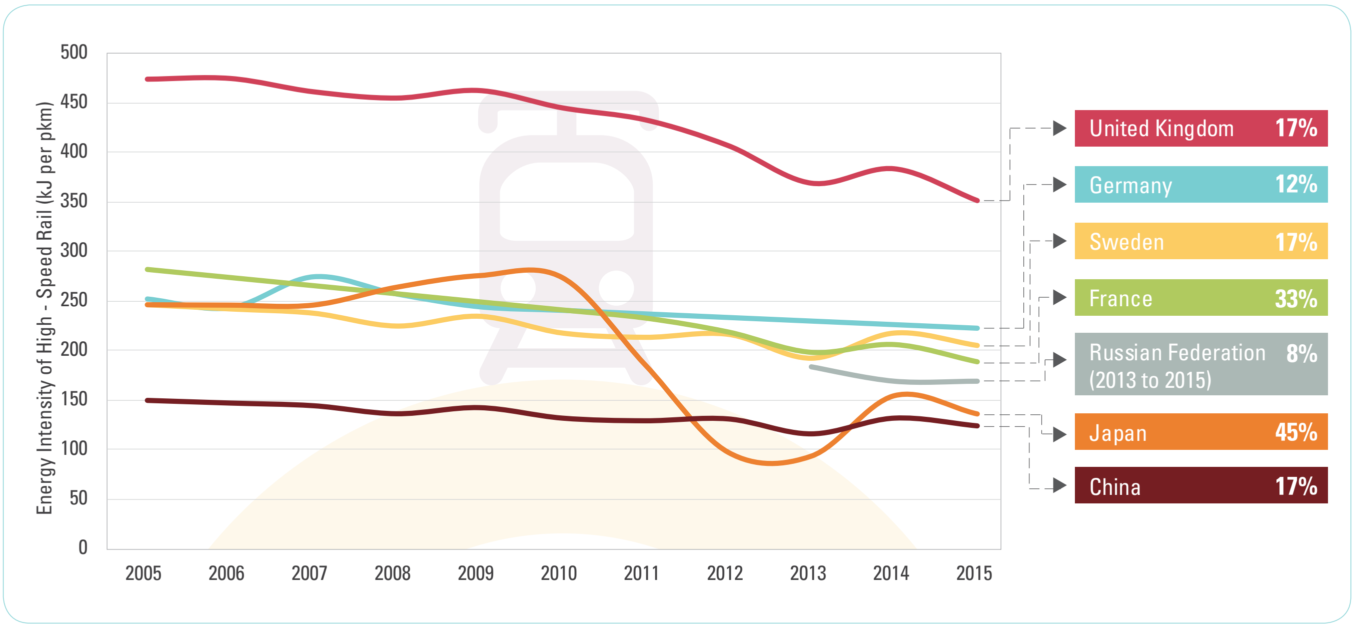
Available data also suggest that high-speed trains in East Asia have a larger capacity and operate with loads well above the European average.[541] In the case of **China** and

Table 6: Overview of Key Indicators for Passenger and Freight Railways

KEY INDICATORS FOR RAILWAYS

	2016	2015	% CHANGE	Source/s
Policy Landscape Indicators				
Countries with railway mode shift targets *(# of countries)*	N/A	N/A	N/A	N/A
Market Development Indicators				
Rail passenger activity *(trillion passenger-km)*	2.833	2.954	-4%	UIC, (2016). Railway Statistics 2015 Synopsis. International Union of Railways. Available at: https://uic.org/IMG/pdf/synopsis_2015_print_5_.pdf; UIC, (2017). Railway Statistics 2016 Synopsis. International Union of Railways. Available at: https://uic.org/IMG/pdf/synopsis_2016.pdf
High-speed rail *(billion passenger-km)*	704	616	14%	
Rail freight activity *(billion tonne-km)*	8.614872	8.567466	0.5%	
Rail network length *(km)*	(2015): 1,701,721	(2014): 1,697,505	0.2%	UIC and IEA, (2017). Railway Handbook 2017. Energy Consumptions and CO_2 Emissions International Union of Railways and International Energy Agency. Available at: https://uic.org/IMG/pdf/handbook_iea-uic_2017_web3.pdf
High-speed rail *(length in km)*	32,587	30,125	8%	
Railway electrification share *(% of rail network)*	(2015): 31.4	(2014): 30.1	1%	
Passenger Rail CO_2 Intensity *(g CO_2 /passenger-km)*	(2015): 17.61	(2014): 17.17	1.9%	
Freight Rail CO_2 Intensity *(g CO_2 /tonne-km)*	(2015): 14.22	(2014): 14.91	-3.9%	

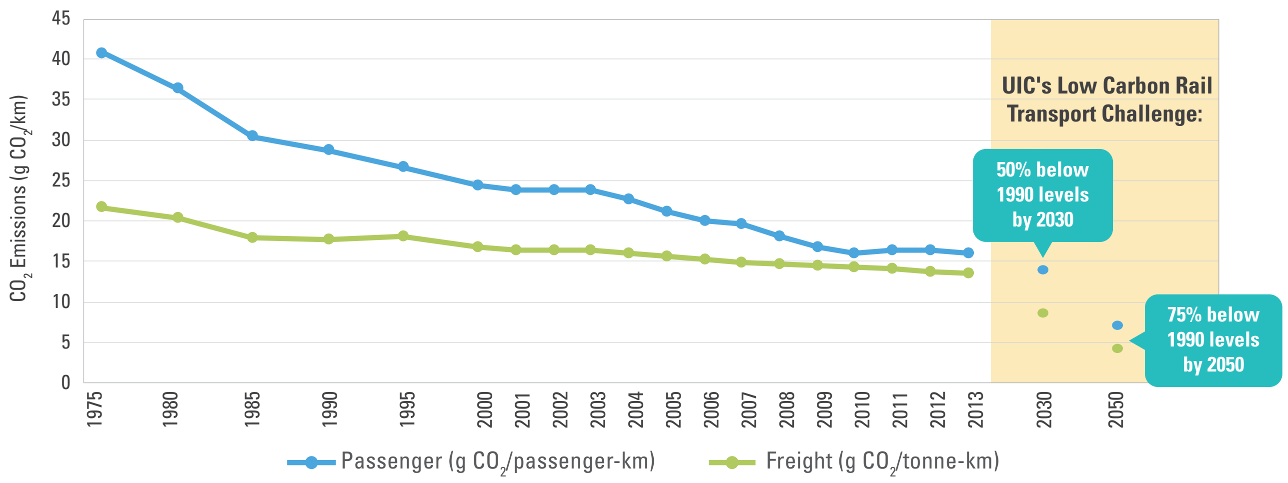
Figure 36: Energy Intensity of High-Speed Rail by Geographic Area (kJ/passenger-km)[542]



Japan, loads are estimated to be, on average, three times larger than in Europe, where high-speed trains transport on average 300 passengers. As a result, passenger movements in **China** and **Japan** take place at a lower energy intensity per passenger-km compared with European averages, despite higher energy intensities per train-km (Figure 36).

HSR can deliver much-needed environmental benefits (CO_2 emission savings) by shifting passengers away from air transport, which has a much higher carbon intensity. Firstly, the energy use per passenger-km of HSR is about 10 to 20% of aviation in global average. Secondly, this energy, when obtained from decarbonized electricity, has the potential to emit very low or even zero CO_2 emissions.[543] Shown below (Figure 37) is the low carbon intensity of rail transport, which over the years has dropped to levels around 15 g CO_2/passenger-km.

Figure 37: Railway CO_2 Emissions for Passenger and Freight Transport[544]



Global Initiatives Supporting Railways

- **International Union of Railways** (UIC) Low Carbon Sustainable Rail Transport Challenge sets out ambitious but achievable targets to improve rail sector energy efficiency, reduce GHG emissions, and achieve a more sustainable balance between transport modes. The UIC challenge is supported by UIC's 240-member railway companies based in 95 countries worldwide. The Climate Responsibility Pledge was signed by more than 70 members of UIC.
- **Shift2Rail** contributes to smart and sustainable growth by fostering research and innovation in the railway sector. The purpose is to: achieve Single European Railway Area; enhance the attractiveness and competitiveness of the European railway system to ensure a modal shift from roads towards rail; and sustain the leadership of the European rail industry on the global market.

Photo credit: Nikola Medimorec

4. Walking and Cycling

Overview

Background

Globally, more than one-third of all trips are made on foot or by bicycle[545] and in a few countries the modal share of walking and cycling is between 50% and 70%. It is important to note that much of the global level research has not historically split the data between walking and cycling. Further research indicates that most of this mode share is by foot, as is the case in Nairobi, where the mode split is 47% walking and 2% cycling.[546] Cycling and walking are still the principal mode of transport in most developing cities, particularly in Africa and Asia.[547]

The climate-friendliness of these modes, and the contributions they make to meeting the **Sustainable Development Goals (SDGs)** and the **New Urban Agenda (NUA)** are clear.[548] Article 114 of the NUA prioritizes sustainable infrastructure for public transport, and walking and cycling over private motorized transport. By seamlessly integrating the transport networks of motorized and active modes (walking and cycling), the mobility needs of citizens can be met.[549] Walking and cycling are space- and cost-efficient modes that require minimal infrastructure and capital investment. However, walking and cycling are still often underrepresented in sustainable mobility planning policies and often not perceived as full-fledged alternatives to motorized transport modes.[550] Bikesharing is primarily discussed in *Section III.B.5 New Mobility Services*, and electric (assist) bicycles are discussed in *Section III.B.7 Electric Mobility.*

Walking and cycling also offer a variety of co-benefits that include health, inclusion and economic gains (e.g. improving property values, increasing revenues for businesses).[551] Prioritization of walking and cycling can strengthen social cohesion, and improve the overall quality of life in cities: "Walking and cycling […] enhance urban quality and facilitate social cohesion; they are cheap, flexible, personal modes without which the majority of people in low- and middle-income countries are unable to participate in the economy and community, or access education, health-care and other urban services."[552] The safe systems approach of building safer infrastructure for walking and cycling increases road safety for cars as well. (Complete Streets and multimodal integration are also discussed in *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management*).

Policy Landscape

Policy Measures Implemented

- **Walking and Cycling Plans:** 69% of African countries, 75% of Latin American countries and 83% of Asian countries have at least one national transport commitment that recognizes the value of walking and cycling in their countries, cities and rural regions.[553] In **Brazil**, the first National Network for Low Carbon Mobility was launched in 2017 and 10 cities started to work on a Complete Streets project to have better walking and cycling.[554] Some examples of different policy targets, measures and investments are shown below. Here, cities are often the leading examples of government entities with walking plans:
  - **Paris**, **France**, under the leadership of Mayor Anne Hidalgo, has begun to reorganize urban space and 'pedestrianize' the city.[555] As part of the walking plan Paris Piéton several intersections have been redesigned, and car traffic has been restricted.[556] **Terrassa**, **Spain** launched its Step by Step campaign to improve the walkability of the city. The campaign consists of several measures to encourage the shift towards walking and cycling as part of the city's Urban Mobility Plan 2016-2020, which was approved in June 2017.[557] **Boston's** Green Links is a city plan to connect people in every area to Boston's greenway network by installing new paths and bike facilities.[558]
- **Public investments in walking and cycling**
  - The **United Kingdom** government in April 2017 published a EUR 1.4 billion plan to increase cycling and walking, aiming to double cycling by 2025.[559] **Barcelona**, **Spain** announced a EUR 32 million plan in August 2016 to improve its cycling infrastructure network.[560] By mid-2017, the city's cycling infrastructure network had grown 20% over the previous year-and-a-half, and the number of trips taken on bikes grew 14% in 2016.[561] **Bordeaux**, **France** adopted a new EUR 70 million Cycling Plan 2017-2020, aiming to increase the modal share to 15% by 2020. The focus within the plan is cycling infrastructure, in addition to extending the public bikeshare system, bicycle parking, 2 new bike rent and information centers, subsidies for bike purchases, and campaigns to promote cycling.[562] **Toronto**, **Canada** approved its 10 Year

Cycling Network Plan in mid-2016, which identifies around 252 centreline km of new infrastructure.[563] The government of Ontario, Canada doubled its investment (to USD 74 million) in local cycling in 2017, and allocated almost one-third to the **City of Toronto** to support its 10 Year Cycling Network Plan.[564] **Seattle, United States** updated its Pedestrian Master Plan in March 2017, with USD 22 million invested in sidewalk improvements to provide safe access to schools and public transit.[565]

- In May 2017, **Seoul, Korea** opened Seoullo 2017, a former overpass transformed into a pedestrian bridge. The USD 40 million project, which attracted 1 million visitors in the first 14 days,[566] is a step to making the city more pedestrian friendly.[567]
- The **Dutch** government continues to stimulate cycling, and allocated EUR 100 million in 2018 to accelerate the construction of cycling routes, and to improve parking facilities at train stations. The State Secretary of Infrastructure and Water Management highlights the important contribution of the bicycle to accessibility, livability and health. The aim is to pull another 200,000 commuters out of their private vehicles and onto bicycles by making 3 billion more cycling kilometers.[568]
- **Germany** runs a subsidy scheme "Climate Protection through Cycling," and co-funds the construction of fast cycle routes as a climate action measure. In addition, around EUR 3.2 million of funding is made available every year for the implementation of the National Cycling Plan.[569] **Colombia** included the possibility of 70% financial support to cities towards walking and cycling improvements in its national development plan for 2015-2018.[570] Even though governments have increased interest in cycling and walking, in reality most transport investments are still focused on non-sustainable transport modes. For example, in Latin America, 60% of mobility investments are concentrated in projects for private vehicles.[571]

- **Bicycle-Friendly Cities:** The bi-annual index of the most bicycle-friendly cities captures efforts by local governments to implement urban cycling policy measures. The **Copenhagenize Design Company** has published this index since 2011, currently ranking 136 cities through 14 indicators (Table 7).

Policy Targets Set

- The city of **Nairobi** set a target to increase mode share of walking from 47% to 50% for trips up to 5 km by 2025, and to increase mode share of cycling from 2% to 10% for trips up to 15 km by 2015.[573] In **Bogota, Colombia** Mayor Peñalosa's administration aims to double the number of cycling trips in Bogotá by 2020, from 5% to 10% of all trips.[574]
- **Helsinki, Finland** aims to increase the modal share for cycling to 15% by 2020, with 11% of trips made by bicycle in 2013.[575] The national goal is to increase the numbers of trips made by bicycle or foot to 30% by 2030.[576] **Ljubljana, Slovenia** reached their modal share target of 15% of cycling by 2020 (10% by 2010) already in 2017, and set a new target of 30% by 2030, and **Düsseldorf, Germany** increased the modal share from 5% (2004) to 12.4% (2013).
- **Vienna, Austria** developed a Strategy Paper for Pedestrian Traffic in 2014 and followed up with a comprehensive and exemplary monitoring program.[577] On the federal level, **Austria** devised a 2015 Master Plan for Walking, containing a strategy to promote walking and raise its status in all fields of policy making.[578]

Market Trends

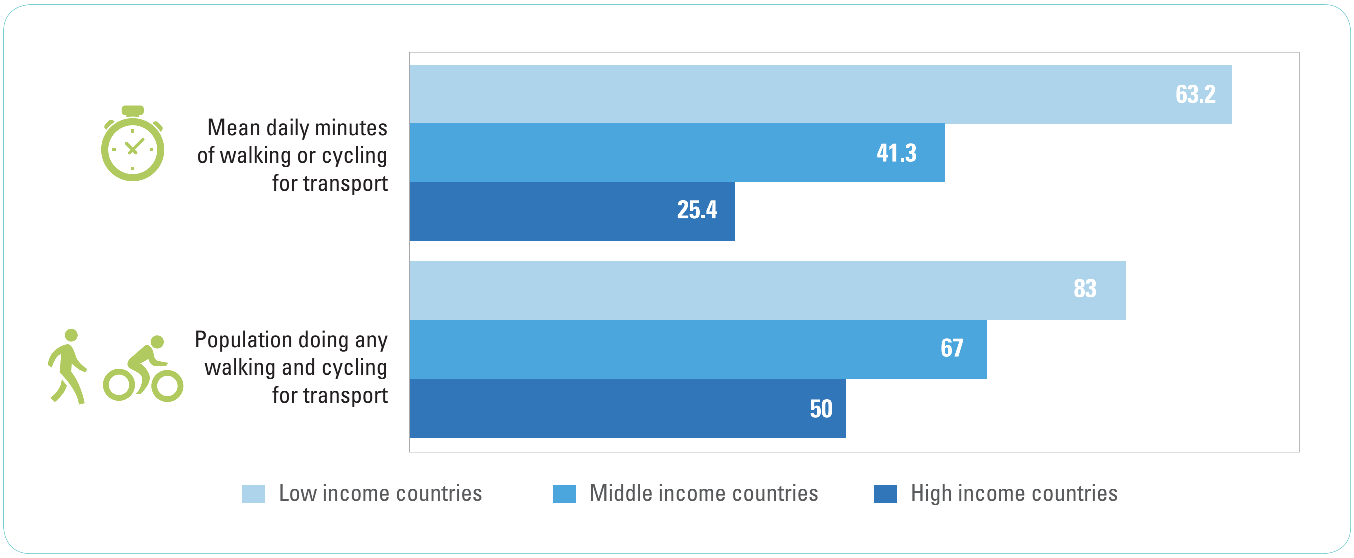
Walking and Cycling for Transport Activity

- Population-based surveys conducted between 2002 and 2016 show that people in low-income countries walk or cycle on average 63 minutes per day for transport, while people in middle-income countries walk or cycle 41 minutes, and high-income country citizens walk or cycle only 25 minutes per day to get to and from places. The 63 minutes in low-income countries can be regarded as mostly walking but the survey did not differentiate between walking and cycling in the data collection. Similarly, 83% of people in low-income countries walk or cycle for transport at least once a week. This share is around 50% in high-income countries. Figure 38 summarizes the results of the **World Health Organization (WHO)** analysis of population-based survey data collected with the Global Physical Activity Questionnaire in 101 countries from nearly half a million adults over the age of 18, covering all regions and income groups.[579]

Table 7: Top 10 Bicycle-Friendly Cities in 2017[572]

Rank	1	2	3	4	5	6	7	8	9	10
City	Copenhagen	Utrecht	Amsterdam	Strasbourg	Malmo	Bordeaux	Antwerp	Ljubljana	Tokyo	Berlin

Figure 38: Walking and Cycling for Transport by Income Group[580]



Walking Mode Share Trends

- Modal share of walking differs substantially between continents, countries and cities. As shown (Figure 39), it is particularly high in low-income countries, and in cities with a high share of public transport. However, the real share of walking could easily be 10% higher or lower depending on the data collection methodology used. It is very difficult to compare the data since its reliability differs considerably. Since mode share often plays a crucial role in policy decisions, and in policies to reduce carbon emissions, developing a reliable global measurement of mode share should be a high-priority task. The WHO methodology, and the International Walking Data Standard could serve as starting references for such important efforts.

Cycling Mode Share Trends

- Cycling is a well-established transport mode in the **Netherlands**, **Denmark** and **Japan**. As Figure 40 shows, the modal share in larger **Danish cities** reaches up to 45%, with an estimated national share of 27%. In **China**, e-bikes contribute a significant share to cycling, and in cities the share of cycling in total trips is close to 25%.

Figure 40 also shows that bicycle ownership rates are higher in countries with a higher share of cycling. **The Netherlands** (1.3) and **Denmark** (0.8) have higher rates of bicycles per citizen than many other countries. A study from 2015 regarding the availability of bicycles worldwide

Figure 39: Modal Share of Walking in Different Cities Globally[582]

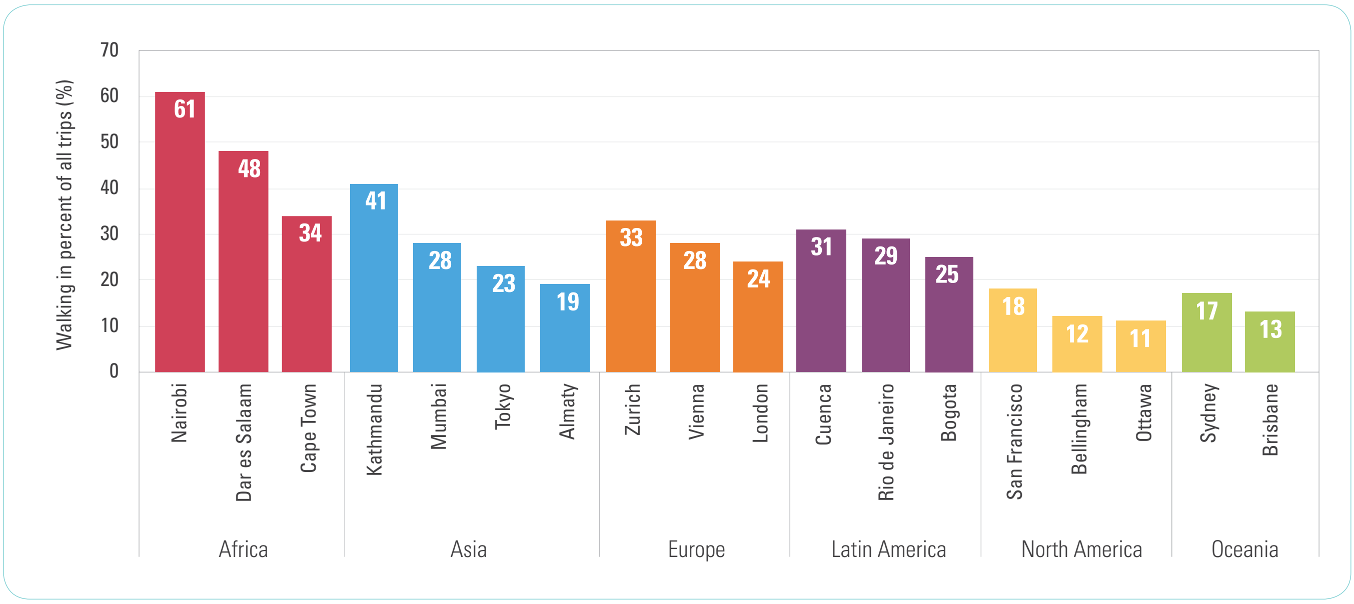
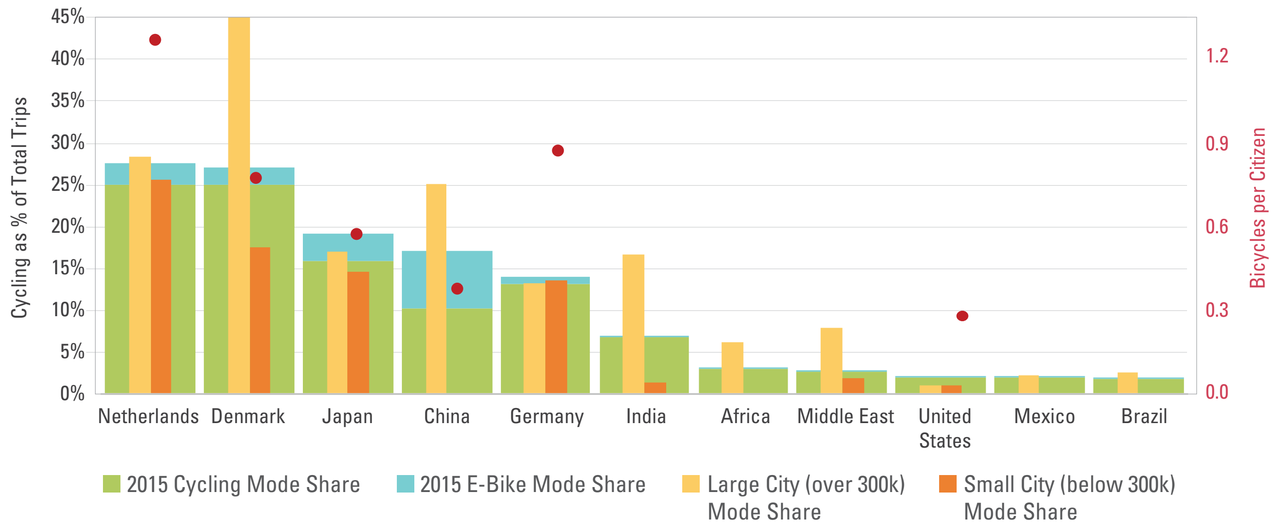


Figure 40: Modal Share of Cycling for Transport[583]



showed through a global survey that availability of bicycles is the lowest in Africa, and highest in Europe.[584]

An analysis of cycling in Latin American cities supports the argument that cycling infrastructure among other factors enables higher shares of the population using cycling for transport: In **Bogota**, a city with a 392 km cycling network, recorded that 5% of all trips are done through cycling. **Rio de Janeiro** developed 307 km of cycling lanes and has a share of 3.2%.[585]

Bikeshare Growth

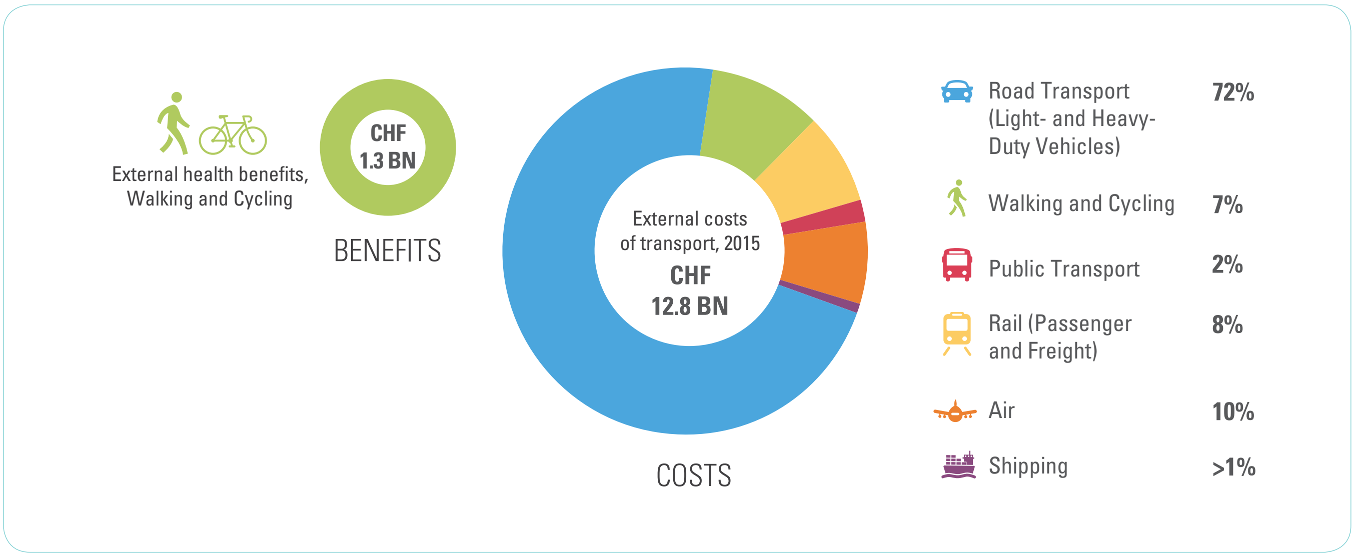
Growth in bikesharing, including the new dockless bikeshare systems, accelerated in **China** and the **United States** in 2017. For more discussion on global bikeshare trends, see *Section III.B.5 New Mobility Services.*

Co-Benefits of Walking and Cycling

Walking and cycling offer a variety of co-benefits, a few of which are mentioned below. Given that the negative externalities of individual motorized transport are becoming more apparent, government interest in cycling and walking transport infrastructure has increased globally in recent years.[586]

- Walking and cycling are the only transport modes that render more **external benefits** than costs. In the case of walking, a study in **Switzerland** shows that CHF 10 cents are saved for every kilometer walked. The external costs of walking and cycling are CHF 1 billion (USD 1.3 billion), while the external benefits are CHF 1.3 billion (USD 1.6 billion) (Figure 41).[587]
- The economic benefits of cycling are significant; estimated at around EUR 500 billion per year in the **European Union.**[589]
- Similarly, the market for neighborhood walkability is increasingly recognized by the real estate industry in some parts of the world to create economic value and enable more rail opportunity. The common objective of a more walkable and bikeable environment is completely aligned with the goal of emission reductions.
- The pedestrianization of **Mexico City's** Madero Street resulted in 117 million new walking trips, a 30% increase in economic activity and 96% reduction in crime along the project street.[590]
- Another co-benefit of cycling is the connection it builds with road safety. A larger share of people cycling leads to a safer environment for cyclists, and fewer road traffic fatalities among people riding bicycles.[591]
- Walking and cycling deliver better public health and reduces air pollution: Residents of neighborhoods with sidewalks, transit stops and shops are more likely to walk, and therefore tend to have lower levels of cardiovascular disease, obesity and other health issues related to sedentary lifestyles.[592 593] More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO limits. While all regions of the world are affected, populations in low-income cities are the most impacted.[594] Thus a shift from motorized transport to walking and cycling contributes to the reduction of local pollutants and related negative impacts.

Figure 41: External Costs and Benefits of Transport in 2015[588]



- Walking and cycling support equity and inclusion particularly for the poor. More effective public transport and safer walking/cycling routes can yield significant savings in travel time and expense, as well as benefits in disease prevention and health promotion.[595] More walkable cities enable greater equity in physical activity levels, across all ages, genders and health profiles.[596]

Cargo Bikes for Freight Transport

The use of standard bicycles, cargo bikes, and cargo tricycles is important for the transport of goods, primarily in urban areas, for last-miles deliveries. **Germany's** Cycling Freight Last Mile Funding Program is funding 30% (up to max. 2500%) of new cargo bikes.[597] In the busiest areas of **Rio de Janeiro**, restaurants, pharmacies, supermarkets, hardware & building supplies stores, and other small businesses employ workers to make most deliveries (about 75%) in an area of under 3 km, and the rest (25%) in areas of up to about 8 km.[598] (For more discussion of electric bikes, and their application in freight transport, see *Section III.B.7 Electric Mobility*.)

Emission Reductions from Walking and Cycling

Shifting Towards Low-Emission Modes

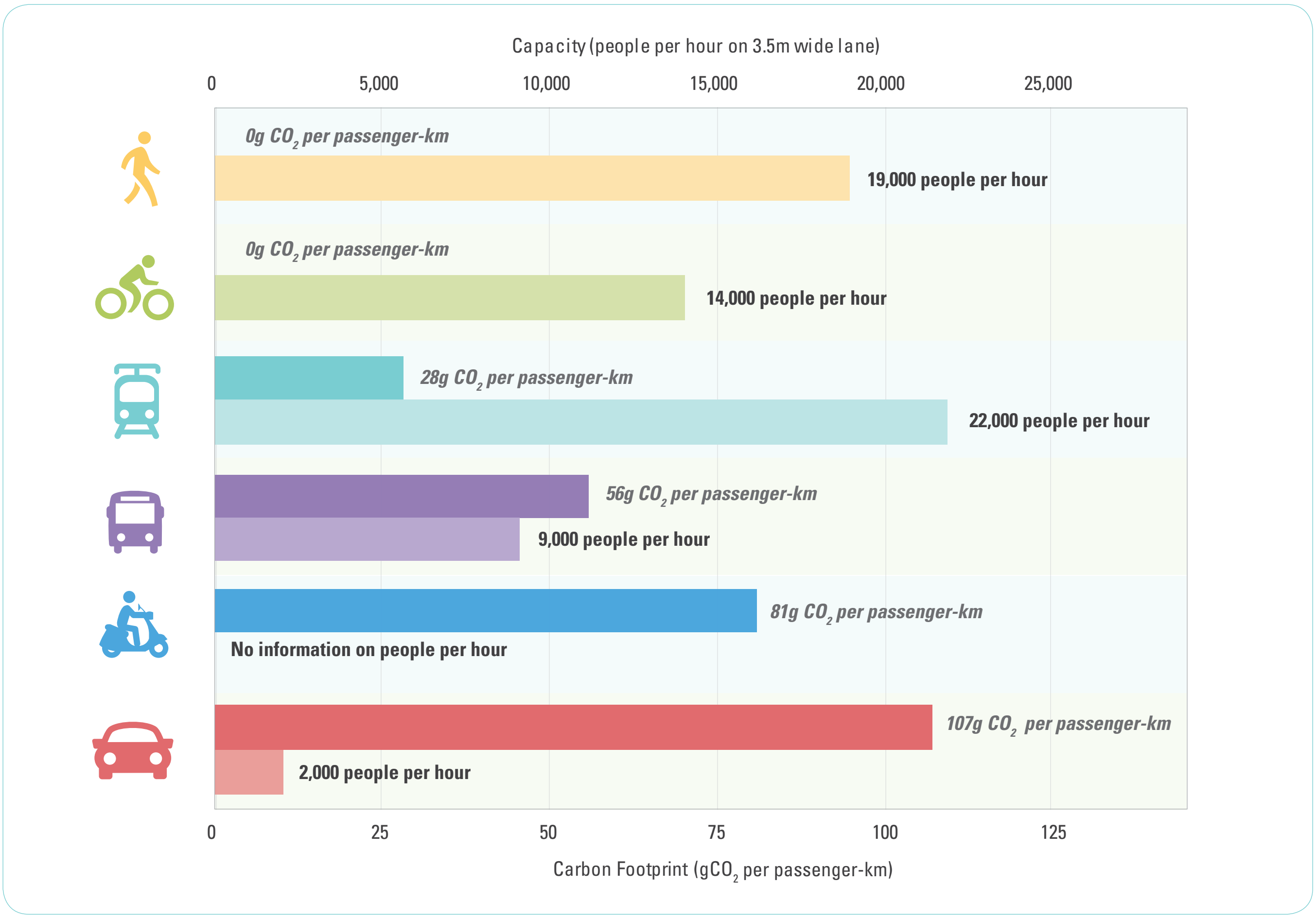
- Walking and cycling are the most environmentally friendly transport modes. Figure 42 compares walking and cycling to other major transport modes in Europe, and clearly shows their advantage for low carbon transport. A 3.5-meter corridor used by pedestrians or cyclists can respectively host 19,000 or 14,000 people per hour while having no carbon footprint.
- A **Swiss** study estimated that, depending on the scenario, 4% to 15% of the gap towards the emission reduction targets can be met by shifting car trips to walking and cycling.[600]
- Cycling and walking by residents of **Copenhagen** saves the city every year around 90,000 tonnes CO_2.[601]
- The carbon reduction potential of walking is not extensively researched, but one study estimates that increases in the mode share of walking in **Bogota**, **Colombia** from 20% to 25% of travel could reduce transport emissions by 6.9%, which equals an investment of USD 17 to reduce a tonne of CO_2.[602] In addition, a package of walkways, cycleways and BRT could reduce emissions by 25%, at an investment cost of USD 30 per tonne CO_2.[603] Most research on the carbon reduction potential is often calculated based on shifting short car trips to walking or cycling. It is assumed, for example, that 20% of CO_2 emissions in the **United Kingdom** comes from car trips of 8 km or less.[604] In the United States, 60% of car trips in 2017 were less than 10 km and many short trips can be substituted by walking or cycling. [605]
- The mode shift potential of walking and cycling is significant. Based on best practices in cities, walking and cycling together with public transport can easily reach 80%. **Hong Kong** (mostly walking and transit) already reached 90% in 2011,[606] **Zurich** and **Vienna** were near 75% in 2016.[607]

Table 8: Overview of Key Indicators for Walking and Cycling

KEY INDICATORS FOR WALKING AND CYCLING

	2017	2016	% CHANGE	Source/s
Policy Landscape Indicators				
Countries with national cycling plans *(# of countries)*	N/A	N/A	N/A	N/A
Countries with national walking plans *(# of countries)*	N/A	N/A	N/A	N/A
Market Development Indicators				
Modal share of walking	N/A	N/A	N/A	N/A
Modal share of cycling	N/A	N/A	N/A	
Mean minutes walked by day	N/A	N/A	N/A	
Mean minutes cycled by day	N/A	N/A	N/A	
Bicycle ownership *(bicycles per 1,000 people)*	N/A	N/A	N/A	
Cycling infrastructure *(dedicated protected cycling lanes per capita)*	N/A	N/A	N/A	

Figure 42: Comparison of Cycling and Walking to Other Modes[599]



Potential for Emission Reduction Based on Denser Cities and Mixed-Use Neighborhoods

- Research continuously confirms the importance of high-density, mixed-use neighborhoods and cities.[608] **International Association of Public Transport (UITP)** shows in the synthesis report about its "Mobility in Cities Database" that the shorter trip distances in high density areas naturally lend themselves to more walking and cycling and allow for more efficient and viable public transport. This is also shown in Figure 43 with different data. (Information on how to increase urban density are given in *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management.*)
- A comparison of the densely populated city of **Nairobi** with the less densely populated city of **Dar es Salaam** shows that mode share of walking and cycling in Nairobi was 61%, and in Dar es Salaam it was 48% (data from 2010). Both cities have a similar GDP.[609] Even in relatively densely populated countries like **Switzerland** the effects, particularly on walking, are substantial: In places with 17 to 24 residents and workplaces per hectare, 34% of all trips are made on foot. In places with a density of more than 162 residents and workplaces per hectare, the mode share of walking rises to 57%.[610]
- Density, connectivity and destinations within walking and cycling distance are the cornerstones of the built environment for walkable and cyclable communities. Emissions reduction potential based on an integrated approach with denser cities and good public transport services is much bigger, and still needs to be explored by research on both a global and regional basis.

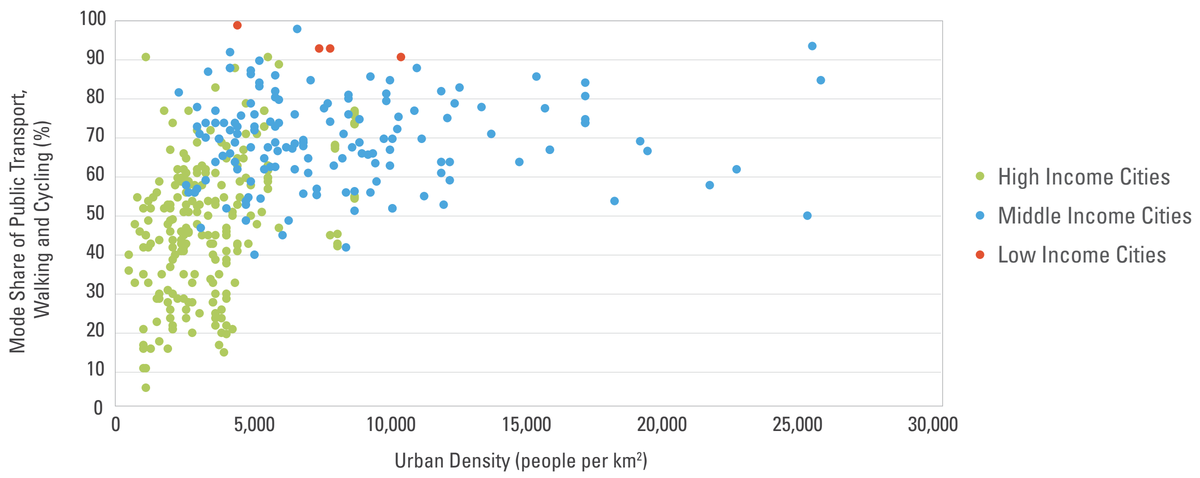
Freight Transport

- Research suggests that more than 25% of all goods, and 50% of light goods could be dispatched by cycle in European cities,[612] and a European Union-co-funded project report concludes that 50% of motorized trips in European urban areas that involve goods transport have the potential to be shifted to the bicycle.[613]

Overview of Key Indicators

Key indicators of walking and cycling are listed below, but as noted, there is currently a lack of global and regional data to complete the values. The main indicators that would provide a clear picture of the status of walking and cycling are modal share; mean minutes walked and cycled; length of bicycle networks; and bicycle ownership rates. The policy landscape can be indicated by the specific plans of countries and cities in relation to walking and cycling. It is important to acknowledge that while walking and cycling have many features in common, they also differ substantially from each other, and require different approaches in terms of policy and planning and infrastructure because of the different movement patterns, trip purposes, and physical abilities involved.

Figure 43: Urban Density & Modal Split Share[611]



Global Initiatives Supporting Walking and Cycling

- **European Cyclists' Federation (ECF)**, promotes cycling as a sustainable and healthy means of transportation and recreation through projects in Europe and the world. The premier international planning conference on cycling (Velo-City) brings together knowledge and information on cycling and encourages cycling as part of daily transportation and recreation.
- **Cycling Delivers on the Global Goals**, led by the World Cycling Alliance (WCA) and the ECF, aims to increase the modal share of cycling worldwide, to double cycling in Europe by 2020, and to mobilize support in local, national and international governments and institutions to scale up action on cycling.
- **Walk21** is an initiative and international charity dedicated to ensuring the right to walk and the opportunity to enjoy it for everyone throughout the world. It convenes its largest international conference once a year. Walk21 developed the International Charter for Walking, signed by more than 5,000 people including 500 mayors. Further, they adopted a standard for walking data and provide ongoing work with cities around the world (e.g. Hong Kong and Lagos).
- **Global Sidewalk Challenge,** spearheaded by Walk21, sets the target to construct, or rehabilitate, 100,000 km of additional dedicated, safe, barrier-free sidewalks in the proximity of public transport hubs. Many projects will be realized in low- and middle-income countries by 2030.
- ITDP's **Pedestrians First,** a tool that facilitates the understanding and measurement of the features that promote walkability in urban environments around the world. It increases the understanding of walkability and supports decision-makers to create walkable urban areas. The UN declared June 3 *World Bicycle Day* and encourages Member States to devote attention to the bicycle in cross-cutting development strategies, and to include the bicycle in international, regional, national and subnational development policies and programs.

Photo credit: Davidson Luna

Overview

Background

New mobility services offer users access to shared transport modes on an 'as-needed' basis.[614] Examples of new mobility services for hire covered in this section focus on those innovative mobility technologies that include ridesharing or app-based bikesharing schemes. The term 'new mobility' covers a variety of services, ranging from one-way free-floating services (a transport mode used to reach a destination and left anywhere within a certain geographic area), one-way station-based services (a transport mode returned to a designated station near the destination), round-trip services (a transport mode returned to origin) and ridesharing services (arrangements made on an app for a shared ride).[615, 616] Other new mobility services and definitions, such as transportation network companies (TNCs), microtransit, micromobility services and shared autonomous vehicles (SAVs), will be touched on in this section (Definitions in *Box 4*).

These mobility options promise a more efficient usage of vehicles and infrastructure through a better matching of supply and demand. Except for carpooling, these new service options are collecting data that can inform infrastructure planning, and generally help understand mobility patterns and gaps in a network. It is important to note that the advent of these new technology options to use of shared private vehicles could lead to more lower occupancy vehicle trips and a shift away from public transport, if it is not planned for effectively and sustainably. Such an impact can be solved through TDM measures (See *Section III.B.1 Sustainable Mobility Planning and Transport Demand Management*). Electrification of transport (See *Section III.B.7 Electric Mobility*) and AVs have the highest potential to reduce emissions and improve efficiency if combined with shared mobility.[617] Understanding the status and advantages of new mobility services can support policy-makers in leveraging its positive mobility impacts and environmental outcomes while mitigating its unintended or negative impacts.

Box 4: Definitions of New Mobility Services

- **Shared mobility** is transport services and resources that are shared among users, either concurrently or one after another. Transport modes for hire could include traditional services such as public transport, private shuttles, buses, taxis, auto-rickshaws or new mobility service options such as car and bike-sharing.[618]
- **Bikesharing** is a service where bicycles are shared among members of a system. Typically, the bikesharing organization owns and operates a fleet of bicycles. Each bicycle is shared by different people at different times, whereby each time a participant utilizes the bicycle for private use. Users access bicycles on an as-needed basis for one-way (point-to-point) or round-trip travel.
- **Carsharing** is a service where individuals typically access vehicles by joining an organization that maintains a fleet of cars and light trucks deployed in lots and other parking spaces located within neighborhoods and at public transit stations, employment centers, colleges and universities. Typically, the carsharing operator provides gasoline, parking, and maintenance. Generally, participants pay a fee each time they use a vehicle.[619] Such systems are classified as one-way carsharing (user can leave vehicle at another place) and two-way carsharing (user needs to return vehicle to original location). Carsharing can be made through a peer-to-peer system where car owners make their private vehicle accessible for others to use.
- **Ridesharing** facilitates incidental shared rides between drivers and passengers with similar origin-destination pairings (also known as carpooling).[620]
- **Ridesourcing / transportation network companies (TNCs)** provide prearranged and on-demand transportation services for compensation, which connect drivers of personal vehicles with passengers. Smartphone applications are used for booking, ratings (of both drivers and passengers), and electronic payment.[621]
- **Microtransit** is a technology-enabled private transit service that often uses shuttles or vans and is characterized by fixed schedules, dispatch operations, fixed routes, flexible routing, or a combination of these.
- **Shared Automated Vehicle (SAV)** is an automated vehicle shared by more than one user. This can include both "pooled" and "non-pooled" options; "pooled" refers to a vehicle being shared by multiple unrelated users on a single trip to the same destination, and "non-pooled" refers to a vehicle shared by multiple individual users making separate, sequential trips.[622]

Policy Landscape

Policy Measures Implemented

- **National new mobility regulations: China** tightened the regulatory framework for its carsharing market in 2017 to ensure that the quickly growing market is developing in an organized way. In addition, local governments have been encouraged to cut parking fees and even provide free spaces for shared cars to promote the growing business.[623] Both **BMW** and **Daimler** expanded their carsharing programs in China in 2017.[624] There is a clear increased presence of car companies in the field of mobility as a service (MaaS) and shared mobility.
- **Priorities for new mobility** can accelerate shared mobility growth by allocating parking for carsharing, curb space for bikesharing stations, and loading zones for ridesourcing/ TNCs, microtransit, and shuttles. In 2017, **Madrid's** city council actively encouraged the uptake of electric carsharing, which are allowed to travel in restricted zones and park almost anywhere for free.[625] In September 2017, a Carsharing Act entered into force in **Germany**. The Act enables authorities to prioritize shared vehicles with regard to parking fees and parking spaces to improve user benefit.[626] In **Seattle** some parking spaces throughout the city are designated for carsharing vehicles[627] and **Seoul** designated 1,600 parking spots in 2016 to carsharing services, raising the designation to 2,400 by 2018.[628] **Bremen**, Germany, a forerunner in carsharing with 10,000 users, has 14 sharing stations that combine cars, public transport and bicycles.[629] **New York City** announced in May 2018 that it will take away 300 public parking spaces and reserve them exclusively for cars from sharing companies like **Zipcar**.[630]
- **Easing zoning regulations and parking minimums** can promote the inclusion of shared mobility in new developments. Commonly referred to as incentive zoning for shared mobility, these policies can be categorized as: (1) policies that enable reduced parking (including reducing the number of required parking spaces in new developments and substituting general use parking for shared modes); and (2) policies that allow increased density.
- **Joint marketing campaigns & business customers:** Municipalities can engage in joint marketing campaigns with shared mobility operators and ensure that programs have visibility on public agency websites and in newsletters, outreach materials, and press releases. The United States General Services Administration, for example, which manages one of the largest federal government vehicle fleets, announced in the fall of 2014 that it was beginning a one-year pilot program to replace its fleet of vehicles with **Enterprise CarShare** in **Boston**, **Chicago**, **New York**, and **Washington, DC**.[631]
- **Grants and low/no-interest loans** from local municipalities and agencies to operators can provide seed money that may not be available through the private sector for capital expenditures. For low-income countries, funding can be provided through international funding or climate finance instruments (See *Part IV.A Financing for Transport and Climate Change*). This funding can also be used to finance feasibility studies and pilot programs. USD 18 million in federal Congestion Mitigation and Air Quality Improvement Program funds, and USD 3 million in municipal funds were leveraged to launch the first phase of **Chicago's** bikesharing program, **Divvy.**[632]
- **Risk-sharing partnerships:** Using the "subtraction model," a shared mobility operator values the monthly operational cost of providing a service at a particular location, and then subtracts the monthly revenue. If there is a shortfall, they can bill the partner. Under this model, the risk-sharing partner only pays the cost needed to maintain service availability. This can also be a strategy to encourage service in new locations (e.g. low-income or lower-density areas) that may not otherwise be economically feasible for a shared mobility operator. For example, Montgomery County in **Maryland** launched a one-year carsharing pilot program with **WeCar** (now **Enterprise CarShare**) using a risk-sharing model. Under the pilot program, the county provided USD 1,100 per month in guaranteed revenue for 20 to 30 vehicles placed on county property.[633]
- **Requests for proposals (RFPs)** issued by local governments and public agencies can encourage new mobility startup operations in their communities. In many cases, an RFP process allows public entities to be active advocates and partners of new mobility services, providing the agencies with the ability to negotiate and regulate areas such as parking and instituting requirements for operations (e.g. requirements that new mobility operators provide travel behavior data to local governments). In April 2016, for example, the City of **New Orleans** issued an RFP for the private operation and financing of a comprehensive bikesharing system.[634]
- **Public Permitting:** For cities where new mobility services operate on a for-profit basis without city subsidy, local governments and public agencies may use permitting structures to guide those services to align with the public interest. **Seattle** implemented a permit system for companies operating dockless bikeshare systems to ensure effective and proper use of public space, monitor policy compliance, and to require that the data produced by these companies is available for permit enforcement and for government planning efforts. In June 2017, a regulatory framework for dockless bikesharing was published by the Department of Transportation.[635] **Sao Paulo, Brazil** has also introduced

a permit structure for TNCs, requiring data, setting vehicle standards, imposing fees on the kilometers of travel, and incentivizing women and minority drivers.[636] In 2017, **Estonia** passed as one of the first countries in Europe a law allowing ridehailing services to operate.[637] **Jordan** released a new bylaw to legalize ridehailing services that use mobile apps beginning in 2018. The government demands high vehicle standards and regulates the fee structure the ridehailing operators must pay to the government.[638] **Uber** received in June 2018 a permit to operate in **London** after being banned in United Kingdom's capital since multiple months.[639]

- **Integrated Urban Planning:** Incorporating shared mobility into plans and planning processes at all levels of government can aid in understanding the current and future impacts of new mobility on communities and allow local communities to leverage the positive impacts of new mobility. Data collected by ridehailing services can benefit local authorities for infrastructure planning and network improvements. New mobility services can benefit from better walking environments to increase accessibility. Integrating shared mobility allows communities to establish a longer-term vision for new mobility services' role in urban design, planning, and policy-making efforts. For example, **San Diego's** general plan identifies numerous transport policies that support shared mobility, alternative modes and TDM.[640]
- **Public Transit Partnerships:** In **Dallas,** Dallas Area Rapid Transit partnered with paratransit service provider, **MV Transportation,** and TNC service provider, **Lyft**, to offer on-demand paratransit service.[641] **Finland** adopted The Act on Transport Services, reforming the current transport legislation[642] to further stimulate the MaaS concept. The new law intends to link different transport services (ridehailing, taxis and train journeys) into travel chains. The Act on Transport Services sets obligations for service providers to share their relevant data via platforms.[643] The operator of **Vienna's** public transport system Wiener Linien launched **WienMobil**, a Maas platform, in 2017 allowing users to book and pay for multi-modal trips from door to door.[644] More transport measures that affect new mobility services as well are discussed in *Part III.B.1 Sustainable Mobility Planning and Transport Demand Management.*

Policy Targets Set

- **Shanghai** set a target in early 2016 for carsharing to achieve 8,000 service spots, a fleet of 20,000 EVs, and 30,000 charging poles by 2020.[645]
- The **Netherlands** aims to have 100,000 shared cars on the road in 2018. Carsharing is part of the Green Deals, a program in which the Dutch government promotes innovative initiatives for sustainable economic growth. Since the start of the deal in 2015, the number of shared cars has grown by 55%.[646]

Market Trends

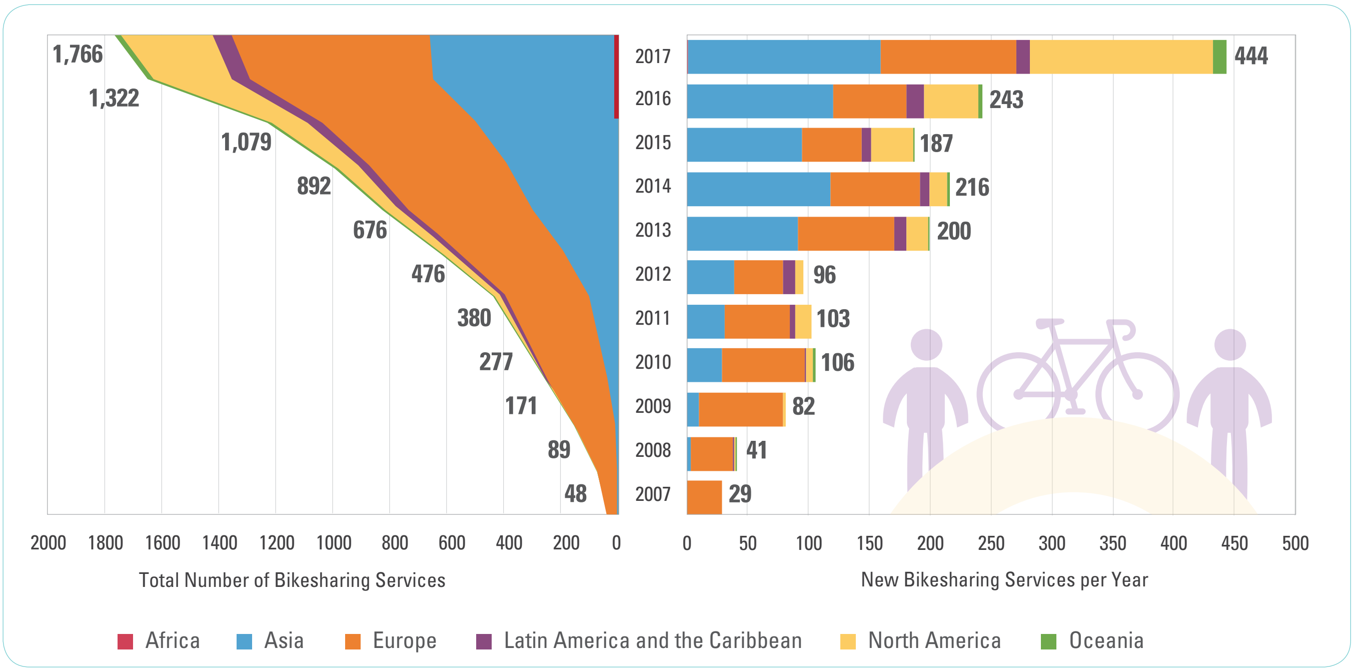
Ridesourcing / Transport Network Companies

- As of early 2017, **Didi** in **China** has over 400 million users in 400 cities, accumulating 25 million rides per day, which is more than twice the amount of all other global ridesourcing companies combined.[647] In Southeast Asia, the ridesourcing service **Grab** expanded operations to 168 cities by the end of 2017 and their service covers bicycles, scooters, cars and buses.[648]
- In 2017, **Lyft** was used for over 375 million rides in North America and Uber served 4 billion rides globally.[649] By 2018, **Uber's** ridehailing app service was operating in 80 countries.[650] Many other ridehailing services expanded their operations in different regions and countries, offering app-based services in recent years.
- **Indonesia's GO-JEK** provides 18 app-based on-demand services including transportation (motorcycle taxis and ridehailing) and freight/delivery/logistics. As of May 2018, GO-JEK had a fleet of 1 million motorcycle taxis, and will deliver food, groceries, shopping, tickets and even medicine. In early 2018, the company was valued at USD 5 billion and announced plans to invest USD 500 million towards expansion across Southeast Asia, including **Vietnam, Thailand, Singapore and the Philippines.**[651]
- Among developing countries, the **Philippines** had one of the earliest regulations on Transport Network Companies (TNCs) passed in 2015.[652]
- New apps that aggregate options and optimize routes, enable users to ride microtransit (e.g. **Chariot, Via**); or have groceries delivered using courier network services (e.g. **Postmates, Caviar**).
- A new trend in 2018 is the acquisition of bikesharing companies by ride sourcing firms for the development of broader mobility platforms. In April 2018, **Uber** acquired dockless bikeshare company, **JUMP**, for a reported USD 100 million,[653] and in July 2018, Lyft acquired **Motivate**, the company operating the largest station-based bikeshare systems in the United States, including **New York's Citibike, Washington, D.C.'s Capital Bikeshare,** and **Portland's Biketown**, for an estimated USD 250 million.[654]

Bikesharing[655]

- There were 250 bikesharing systems in 2010, and over 1,000 by 2015 (Figure 44). A total of 443 new bikesharing programs were launched in 2017, bringing the number of bikesharing services to 1,765. Within a year, the number of global bikesharing systems grew by 33%.
- While bikesharing expansion between 2000 and 2010 took place mainly in Europe, it shifted to Asia from 2011 and has also taken off in North America since 2015.

Figure 44: Growth of Bikesharing (2007 to 2017)[662]

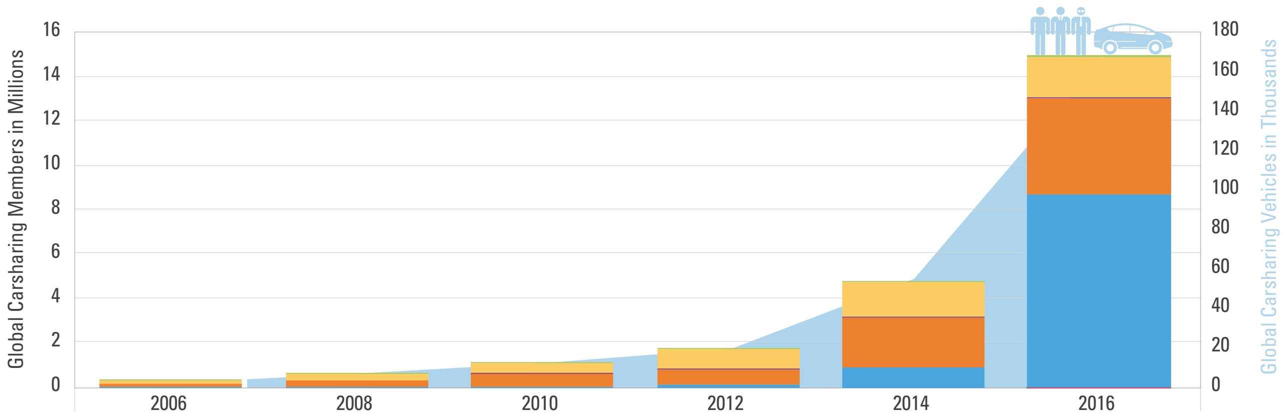


- The growth was spearheaded by the **United States**, where around 146 new bicycle programs were brought to the streets in 2017, followed by **China**, with at least 123 identified bikeshare system launches in the same year.
- Bikesharing systems expanded in cities around the world, with steep increases since successful launches in **Paris** (2007), **London** (2010) and **New York** (2013). There has been a recent emergence of transformative business models by the private sector in bikesharing. **Mobike**, a dockless bikesharing company, whose bikes have integrated global positioning system (GPS), no chains and tubeless tires, is an example of this trend. By the end of 2017, it had placed 8 million bikes in more than 200 cities globally and raised USD 600 million[656]. In 2018 Mobike was acquired by Meituan Dianping, the largest on-demand online service provider in China for USD 2.7 billion.[657] Through an increase of such systems, **Shanghai** emerged in 2017 as the "largest bikesharing city in the world,"[658] with 1.7 million bicycles available to the public.
- **China** was the leading country in new bikeshare launches from 2010 to 2016. Between 2016 and 2017 dockless bikesharing systems grew tremendously in China and began to expand globally in 2017. While in 2016 the ratio of traditional bikesharing systems to dockless bikesharing openings was 4:1, it changed to 1:4 in 2017. In 2016 and 2017 nearly 100 dockless bikesharing systems were introduced in Chinese cities.
- In Africa, the only city-wide bikesharing system was offered in **Marrakech**, **Morocco**, until in 2017 **Cairo** launched a bikesharing service with the support of the United Nations Human Settlements Programme (UN-HABITAT).[659] More systems are being piloted in neighborhoods and certain areas (e.g. neighborhoods, campuses) of a city, and dockless bikesharing systems are entering the African market as well.
- Bikesharing also grew substantially in the **United States**, with 25% more bikeshare trips taken in 2017 compared to 2016 due to increased ridership and new system launches. In June 2017 **Seattle** DOT published a regulatory framework for dockless bikesharing and launched a pilot project that had more than 15,000 rides in the first week.[660] By the end of 2017, five dockless bikeshare systems were operating in 25 United States cities. The number of bikeshare bikes doubled from 42,500 in 2016 to nearly 100,000 in 2017. To make bikeshare more accessible and affordable to more of the population, 32% of cities with station-based bikeshare systems offer fee discounts to lower-income users.[661]

Carsharing

- As of October 2016, carsharing was operating in an estimated 2,095 cities in 46 countries on six continents. Approximately 15 million carsharing members shared over 157,000 vehicles.[663] (Figure 45)
- **Asia** accounts for 58% of worldwide carsharing membership, and 43% of global fleets deployed. Since 2015 carsharing took off in **China**; with fleet sizes reaching up to 30,000 vehicles as of early 2017. The average yearly growth rate has been over 200%, driven by strong (both national and local) government support, as well as receptiveness among Chinese customers for new mobility solutions.[664] **Europe** is the second largest carsharing market, accounting for 29% of worldwide members and 37% of vehicle fleets.[665]

Figure 45: Global Carsharing Members and Vehicles Trends[666]



Ridesharing

Egypt's Raye7 mobile carpooling app was founded in 2014 to help commuters share rides to work. The app has hosted more than 50,000 rides, and several corporations offer it as a benefit to their employees.[667]

Other Forms of Micromobility Services

- After the first scooter sharing service launched in **San Francisco** in 2012, there are now 29 cities world-wide with around 8,000 free-floating, mostly electric scooters (92% of all vehicles) and an estimated 350,000 users. In Electric kick scooter sharing was introduced in late 2017/early 2018 in **North America. Bird**, **Lime** and other private companies have electric kick scooters in 33 countries (of which 30 are in the **United States**), as of mid-2018.[669] Reports show that more women than men have a positive perception of electric kick scooters and women seem to adopt them more quickly than they have adopted to shared bicycles. Overall, electric kick scooters have the potential to attract more diverse group of users.[670] 2017 twice as many systems launched as in 2016 with a strong geographic focus on **Europe**.[668]

Autonomous Vehicles

- The development of autonomous vehicles (AVs) has surged, with 104 cities in 26 countries piloting or preparing to pilot AV systems by the end of 2017.[671] Further, trials by companies are being showcased at large conferences, but few autonomous technologies are broadly accessible to the public.
- In January 2017, **Paris** introduced an electric AV shuttle, that is driverless and able to transport up to 10 people over the Charles de Gaulle Bridge.[672] After a successful trial where it served 30,000 passengers, it was expanded to two more areas at the end of 2017.[673, 674]
- As of 2018, there are no known shared autonomous vehicle (SAV) fleets in service, though some private companies are beginning to explore fully-automated SAV fleets, while public agencies have begun to explore potential strategies of regulating such services.[675]

Emission Reductions and Mode Shift to New Mobility Services

Ridehailing / Ridesourcing / TNC impacts

- There are still uncertainties about the impacts of ridehailing services. A 2017 study of 4,000 ridehailing members in seven major United States cities concluded that the services are increasing VKT. The study found that between 49% and 61% of ridehailing trips either would not have been made at all, or would have been accomplished via transit, bike, or foot.[676] This finding supports the argument that new mobility services need to be included in a coordinated transport system to improve efficiency and complement existing shared mobility services.

Bikesharing impacts

- **Paris' Vélib'** bikeshare has the intention to reduce GHG emissions by 25% until 2020 as part of the city's Climate Energy Plan.[677] **Mobike** claims that in **China** the usage of their bicycles has saved 540,000t CO_2 and doubled the modal share of cycling from 5.5% to 11.6% from 2016 to 2017, but such self-reported data has to be taken with caution .[678]

Table 9: Overview of Key Indicators for New Mobility Services

KEY INDICATORS FOR NEW MOBILITY SERVICES	2017	2016	% CHANGE	Source/s
Policy Landscape Indicators				
Countries with new mobility regulations *(# of countries)*	N/A	N/A	N/A	N/A
Market Development Indicators				
Ridesharing systems *(# of cities with ridesharing/ridehailing services)*	N/A	N/A	N/A	N/A
Bikesharing systems *(# of systems in total)*	1,766	1,322	33%	SLoCaT calculations based on Meddin, R., (2018). Bikesharing Map. Available at: http://www.bikesharingmap.com
Carsharing vehicles *(# of vehicles)*	2016: 157,357	2014: 104,060	51%	Shaheen, S., Cohen, A. and Jaffee, M., (2018). Innovative Mobility: Carsharing Outlook. UC Berkeley: Transportation Sustainability Research Center. Available at: https://escholarship.org/uc/item/49j961wb
AV systems in trial *(# of countries)*	26	N/A	N/A	Bloomberg, (2018). Initiative on cities and autonomous vehicles. Bloomberg Aspen Initiative on Cities and Autonomous Vehicles. Available at: https://avsincities.bloomberg.org/

Carsharing impacts

- A survey of **car2go** users in five **North American cities** found that each carsharing vehicle removed between 7 to 11 vehicles from the road (either sold or forgone). Two to 5% of carsharing members sold a vehicle, and 7% to 10% postponed a vehicle purchase.[679] A study of station-based one-way carsharing participants in **France** found a 23% reduction in private-vehicle ownership after joining **Autolib**. Carsharing in **Munich** showed a clear reduction in privately-owned cars and in this case each carsharing vehicle can replace up to eight private vehicles.[680]
- Cohen and Shaheen (2018) see that VKT are reduced between 7.6% to 80% among carshare members in **North America**, which reflects uncertainty about exact impacts.[681] Reductions in vehicle miles traveled ranged from 6% to 16% on average across the one-way carsharing company car2go population.
- Correspondingly, reductions in GHG emissions ranged from 4% (**Calgary**) to 18% (**Washington, DC**) on average.[682] Carsharing use in the **United States** is estimated to reduce household emissions by 35% to 41%, and to reduce vehicle miles traveled by 28% to 43% annually.

Overview of Key Indicators

- Indicators of new mobility services take stock of impacts to date by tracking the current extent of sharing systems around the world. The expansion of bikesharing and carsharing systems is analyzed, as well as countries with AV systems in trial, to show the market development of new mobility services. For the policy landscape, the focus will be on the number of countries with new mobility regulations in place. New mobility regulations can stand for plans to introduce or to regulate the use of any type of new mobility system. Cities such as **Seattle, San Francisco, Washington, DC, Providence (Rhode Island)**[683], and other United States cities have the introduced regulations on new mobility services.

Global Initiatives Supporting New Mobility Services

- **Shared-Use Mobility Center** is a public-interest partnership working to foster collaboration around shared mobility, and helping to connect the growing industry with public transport agencies, cities, and communities across the country.
- **Innovative Mobility Research Group** and the **Transportation Sustainability Research Center at the University of California, Berkeley** explore innovative mobility technologies and services that could improve transportation options, while reducing their negative societal and environmental impacts. They publish relevant research on shared mobility, including a semi-annual global carsharing outlook data and syntheses.
- **Shared Mobility Principles for Livable Cities** was launched in 2017 and endorsed by countries, international organizations and mobility service providers. The 10 established principles aim to support the development of sustainable, inclusive, prosperous, and resilient cities.
- **Bloomberg Aspen Initiative on Cities and Autonomous Vehicles** monitors and supports the advancement of the development of AVs in cities around the world since October 2016. It provides information on new technologies and methods on how to transition to AVs.

6. Fuel Economy

Photo credit: Manfred Breithaupt

Overview

Background

The **International Energy Agency (IEA)** has estimated that the number of passenger cars on the road could triple globally from 2010 to 2050 and freight activity by trucks would double, with the majority of this growth occurring in non-OECD countries.[684] Implementation of stricter fuel economy standards are essential to address some of the negative implications of this growth, and an important tool to decarbonize our transport systems worldwide. Improved fuel economy (liters per vehicle-km) can help reduce negative impacts by reducing oil use and CO_2 emissions, and saving money. New technologies to improve vehicle efficiency must be part of a wider approach that also includes 'Avoid' and 'Shift' interventions (i.e. behavior or lifestyle changes of consumers towards more efficient vehicles, driving less and more efficiently). The "Dieselgate" scandal in 2015, in which the **International Council on Clean Transportation (ICCT)** found that some diesel-engine Volkswagen Group vehicles in the United States were emitting substantially more NO_x pollution than in laboratory tests, reinforced the need for more robust test procedures that better reflect real-world driving conditions.[685] It is well documented that the gap between CO_2 (or fuel consumption) in the laboratory and in the real world has been widening over time.[686]

The **Global Fuel Economy Initiative (GFEI)** has shown that with existing cost-effective technologies, it is possible to double average light vehicle fuel economy globally by 2030 for new light duty vehicles, and by 2050 for all light duty vehicles ('50by50').[687] This includes the use of improved materials and aerodynamics, and new technologies such as start-stop engines, regenerative braking and hybrid or fully electric drivetrains. The mix of available vehicles - hybrid, electric, as well as internal combustion engine (ICE) drivetrains - in the global fleet will vary by market and the relative affordability of the technologies available, particularly in low-income or developing countries.

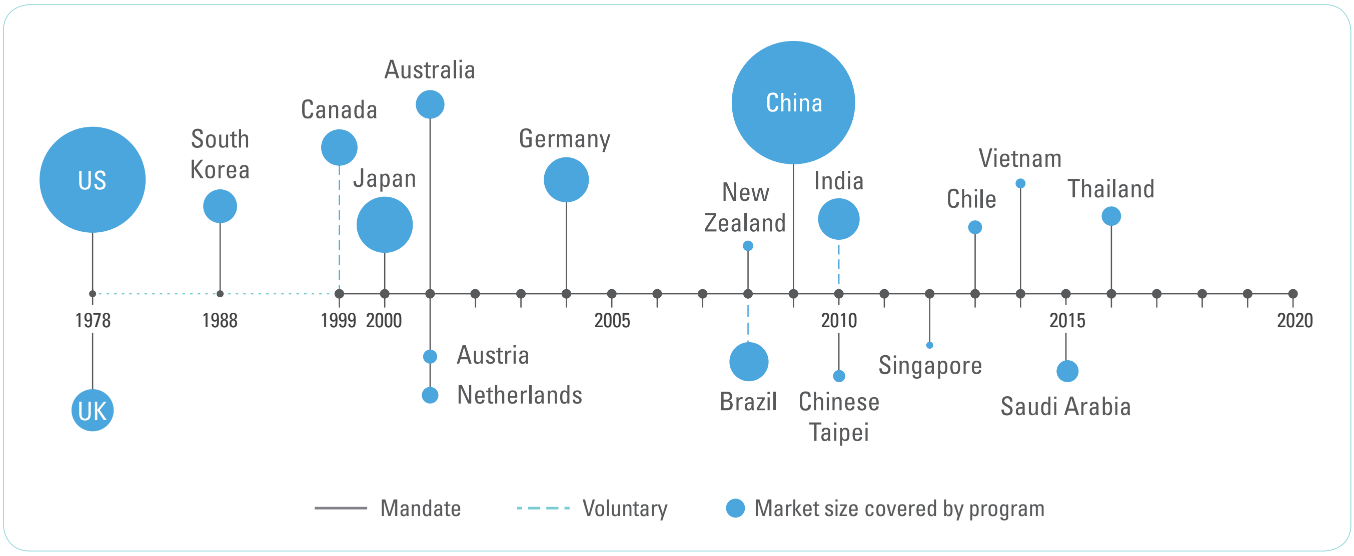
Fuel economy is important for all types of passenger and freight vehicles, as well as for aircraft and ships. Most data and analysis have been carried out for light-duty vehicles (LDV), which is why the focus of this section is primarily on this category, but increasingly attention is being paid to other areas, including heavy-duty vehicles (HDVs). GFEI has established a new '35by35' target for HDVs.[688]

Policy Landscape

Policy Measures Implemented

- **Labeling Schemes:** Labeling schemes make it easier for consumers to understand the fuel economy or CO_2 emissions of the vehicle that they are considering for purchase, and to identify vehicles that are more efficient and cheaper to run. Labeling should complement fuel economy standards to better influence consumer choices.[689] Many countries have introduced fuel economy labeling schemes in recent years, including a number of developing or emerging economies, such as **South Africa**, **Chile** (the first and only Latin American country with a mandatory scheme), **Thailand**, and **Vietnam** (Figure 46). In March 2018, **Montenegro** introduced a mandatory fuel economy labeling scheme for all new vehicles.[690]
- **Fiscal incentives:** Many **European Union** countries have various tax schemes (e.g. registration tax, circulation tax) in place to encourage the purchase of low CO_2 emitting vehicles. **South Africa** has an emission tax rate based on the amount of CO_2 exiting the exhaust.[692] Since 2016, **Thailand's** excise tax on new vehicle purchases has been based on CO_2 instead of engine size. The average fuel economy of new passenger cars has improved by 4.6% in 2016-2017 due to the increasing sales of vehicles with lower engine displacement and vehicle weight.[693] **Turkey**, despite no official CO_2 regulation for new vehicles, has an average CO_2 emission level lower than the European Union, because of very high fuel taxes.[694] Other countries, including **Austria**, **Chile**, **Denmark**, **France**, **Mauritius**, and **Singapore** have developed a fee rebate system that provides subsidies for the most efficient vehicles, and additional taxes on the least efficient ones.[695] Feebate systems are a good instrument for developing economies, as they can be a budget-neutral government policy, by balancing the fees the government receives and the rebates it pays.[696] In January 2018, **Singapore** revised its feebate system to cover not just CO_2 but also four other pollutants as an important approach to reduce air pollution and climate change impacts; the surcharge for a vehicle is determined by its worst-performing pollutant.[697] **Sweden** adopted a new bonus-malus system for green vehicles with low emissions in 2017 which came into force in 2018 to help increase the share of green vehicles on the road. Cars, vans and light buses will all be affected

Figure 46: Year of Implementation of Vehicle Fuel Economy Labeling Programs for a Selection of Countries[691]



by the new system, where high emission vehicles will be taxed at a higher rate for the first three years. The new measure supports the government's aim to reduce transport emissions by 70% by 2030, compared with 2010 levels.[698]

Policy Targets Set

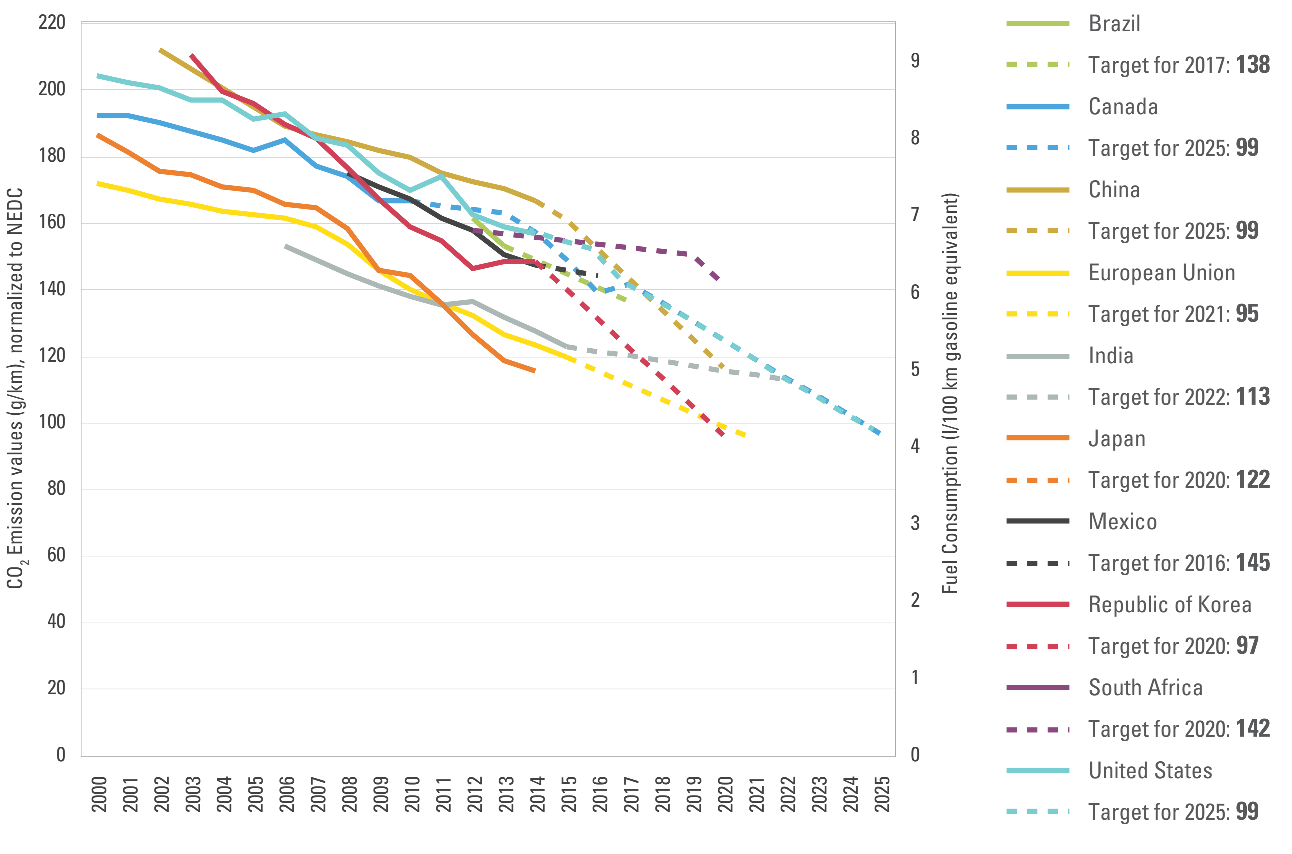
Fuel Economy Standards:

Light-Duty Vehicles: LDV fuel economy has been targeted since the 1970s, initially in response to increasing oil prices, but more recently due to a recognition of the reduction of vehicle CO_2 emissions, decreased oil consumption and increased investment in vehicle technologies.[699] More countries have introduced fuel economy policies for passenger cars since 2005. Since carbon emissions are proportional to fuel consumption, regulation can be made based on CO_2 or fuel economy.

- Currently 38 governments have established fuel economy (or CO_2 emission standards) for LDVs: **Brazil** (CO_2-tax based system), Canada, China, India, Japan, **Mexico**, **Saudi Arabia**, **South Korea** and the **United States**, as well the 28 countries of the **European Union**.[700] A number of other countries also follow these regulations, such as **Iceland**, **Norway** (which has additionally set a more ambitious non-binding target of 85g) and Switzerland. In the United States, **California** has established its own fuel economy standards, which meet or exceed federal standards. California's more stringent standard has been adopted by 15 other states as well.[701] In total, these countries account for around 80% of all LDV sales globally and they have the following targets:[702]
    - The **European Union** has the most ambitious (lowest) target, at 95 gCO_2/km by 2021 for passenger vehicles. The **United States** and **Canada** have a target of 99 gCO_2/km for 2025. **South Korea** has a target of 97 gCO_2/km for 2020, while **China's** 2020 target is 117 gCO_2/km (Figure 47).
    - For passenger light-truck vehicles, **Japan** has the lowest current target, at 135 gCO_2/km by 2022, followed by **Canada**, the **United States** and the **European Union.**[703]
- In 2017, the **European Union** started to replace the New European Driving Cycle (NEDC) with the Worldwide Harmonised Light Vehicle Test Procedure to guarantee more realistic testing conditions and more reliable results, followed by **Japan** in 2018.[704] In 2018, the **European Union** agreed to reduce vehicles' CO_2 emissions by 35% by 2030, compared with 2021 levels.[705] It is part of a bigger 'Clean Mobility Package' that supports procurement of clean vehicles, deployment of alternative fuels, freight intermodality, long-distance bus travel, and research and development investments in battery technology.[706]
- In October 2017, **China**'s Ministry of Industry and Information Technology implemented the first zero emission vehicle (ZEV) national policy on top of the existing fuel economy standards with a target of 5 L/100 km in 2020.[707]

Heavy-Duty Vehicles: In the past 5 years, countries have also started putting in place standards for HDV fuel economy, which is important since trucks are the fastest growing source of global oil demand.[709] **Canada**, **China**, **Japan**, the **United States**, and most recently **India** have approved HDV

Figure 47: CO_2 Emissions Performance and Standards for Light Duty Vehicles (2000-2015)[708]



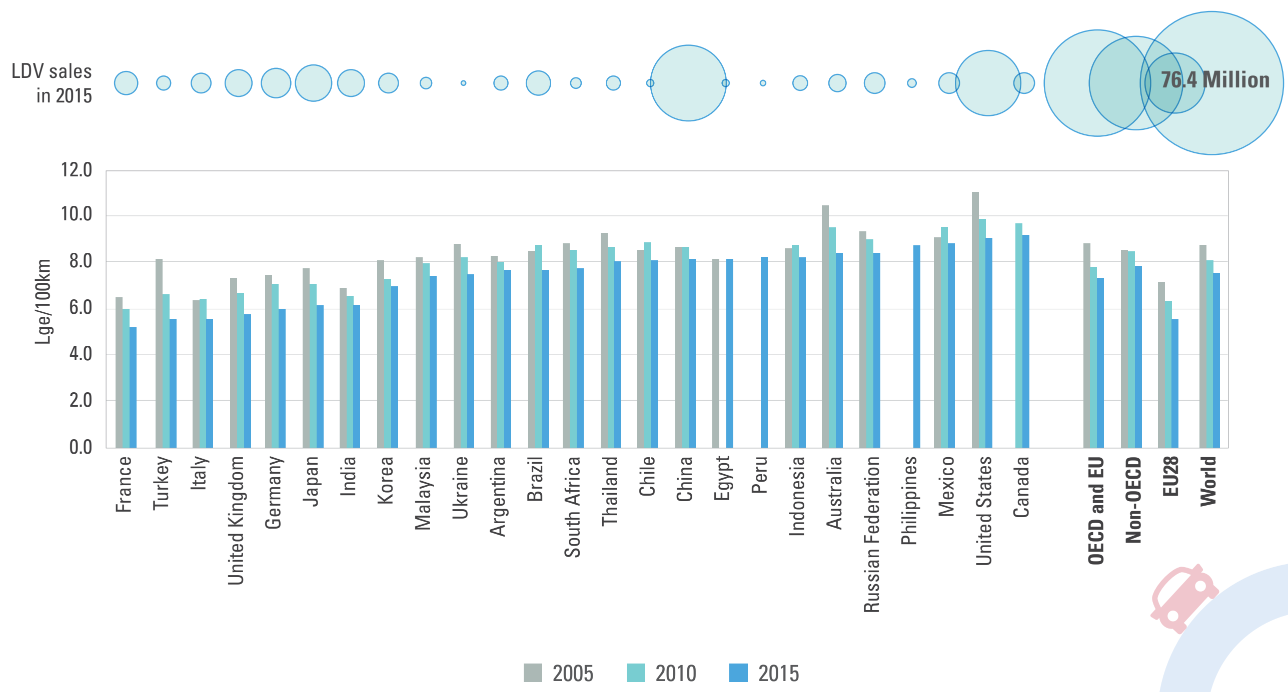
fuel economy programs, while the **European Union**, **Mexico**, and **South Korea** are actively developing programs. India passed in August 2017 a two-phased plan to raise the fuel-efficiency of HDVs, with the first phase starting in April 2018, while the second phase targeted for implementation in April 2021. It applies to diesel-powered trucks and buses with a gross vehicle weight of 12 tonnes or more; currently, such vehicles account for 60% of the fuel use and CO_2 emissions of the HDV fleet in **India**.[710]

Market Trends

Fuel Economy

- Average fuel economy globally improved by 1.5% between 2005 and 2015.[711] This is roughly half of the rate needed to achieve GFEI's target to double average vehicle efficiency of new vehicles by 2030, which initially required a 2.8% annual rate of improvement, although this has now increased to 3.7% a year between 2015-2030 because of a lack of progress.[712]
- Improvements in fuel economy slowed from 1.8% in 2005-2008, to 1.2% in 2012-2015, and to only 1.1% in 2014-2015.[713] In the period between 2005 and 2015, the global motorization rate had an annual growth rate of 2.5%,[714] which implies that improvements in fuel economy can't compensate for the growth in vehicles on the road.
- 25 countries monitored by GFEI showed an improvement in average fuel economy in 2015 compared with 2005. The greatest progress was observed in **Turkey**, which improved its fuel economy by more than 30% between 2005 and 2015 (Figure 48).[715]
- Despite having the most ambitious targets, the European Union recorded a decrease in fuel economy of new vehicles in 2017. New cars sold in the **European Union** emitted 0.4 g/km more than in 2016, reaching 118.5 g CO_2/km (by NEDC test procedure).[716] It is the first-ever recorded increase in fuel economy for the European Union.[717]
- An increasing proportion of vehicles are now sold in non-OECD markets; these accounted for 49% of all sales by 2015, up from 31% in 2005. 40% of the global vehicle stock (vehicles in operation) is now in non-OECD markets.[718]

Figure 48: Light-Duty Vehicle Fuel Economy and Vehicle Sales by Country (2005 to 2015)[719]



Trends in Vehicle Size

The size of vehicles has a significant impact on CO_2 emissions.

- From 2010 to 2015, globally, the average vehicle registered increased in weight by over 5%, and in size (footprint) by more than 3%. This included average footprint increases of 6% for newly registered cars in **China**, where the greatest number of cars were sold, with local manufacturers matching the larger size and weight of foreign designs.[720]
- A significant trend in recent years has been a global shift towards demand for **sports utility vehicle** (SUV) body styles, which tend to have similar footprints to sedans but are taller and heavier. The market share of SUVs has tripled in the past decade.[721]
- In addition, **battery electric vehicles** tend to be heavier because of the weight of the battery pack. Currently most technological improvements in power density and specific power of battery packs are being used to increase vehicle range, rather than reduce vehicle weight.[722]

Emission Reductions Impacts and Modal Shift

Available data indicates that the introduction of vehicle fuel economy standards has saved an estimated 2.3 million barrels per day (mb/d) of oil consumption worldwide in 2015; reduced global oil demand by 2.5%; and reduced the energy consumption in the global road transport sector by 6%. Countries with fuel economy standards saved 9.7% of fuel consumption in road transport.[723] There is a gap in information about the global emissions reduction impacts from the implementation of stricter fuel economy policies; however, the data available indicates there is a reduction of consumption. Additionally, this data shows there is a shift to more fuel-efficient vehicle types.

Overview of Key Indicators

The indicators summarized below provide a snapshot of the global fuel economy trends in development of policy landscape and market development.

Table 10: Overview of Key Indicators for Fuel Economy

KEY INDICATORS FOR FUEL ECONOMY

	2017	2016	% CHANGE	Source/s
Policy Landscape Indicators				
Countries completed GFEI fuel economy benchmarking *(# of countries)*	38	27	41%	GFEI, (2016). Global Fuel Economy An Update For COP 22. Global Fuel Economy Initiative. Available at: https://www.globalfueleconomy.org/media/412594/gfei-cop22-update-lr-spreads.pdf GFEI, (2017). GFEI action for more fuel-efficient vehicles: COP 23 update. Global Fuel Economy Initiative. Available at: https://www.globalfueleconomy.org/media/460944/cop23-update-report.pdf
Countries with LDV fuel economy labeling schemes *(# of countries)*	50	44	14%	ICCT & APEC, (2015). A Review and Evaluation of Vehicle Fuel Efficiency Labeling and Consumer Information Programs. Asia-Pacific Economic Cooperation. APEC#215-RE-01.27 Available at: https://www.apec.org/Publications/2015/12/A-Review-and-Evaluation-of-Vehicle-Fuel-Efficiency-Labeling-and-Consumer-Information-Programs & Shahbandari, S. (2016). Cars in UAE to have fuel efficiency rating next year. Gulf News. Available at: https://gulfnews.com/news/uae/transport/cars-in-uae-to-have-fuel-efficiency-rating-next-year-1.1678219 & GFEI, (2018). GFEI enables new fuel economy label for Montenegro. Global Fuel Economy Initiative. Available at: https://www.globalfueleconomy.org/blog/2018/march/gfei-enables-new-fuel-economy-label-for-montenegro
Countries with LDV fiscal incentives for efficient vehicles *(# of countries)*	18	18	0%	APEC, (2015). A Review and Evaluation of Vehicle Fuel Efficiency Labeling and Consumer Information Programs. Asia-Pacific Economic Cooperation. APEC#215-RE-01.27 Available at: https://www.apec.org/Publications/2015/12/A-Review-and-Evaluation-of-Vehicle-Fuel-Efficiency-Labeling-and-Consumer-Information-Programs & Yang, Z., Bandivadekar, A., (2017). 2017 Global Update Light-duty vehicle and greenhouse gas and fuel economy standards. The International Council on Clean Transportation. Available at: https://www.theicct.org/sites/default/files/publications/2017-Global-LDV-Standards-Update_ICCT-Report_23062017_vF.pdf
Countries with LDV fuel economy standards *(# of countries)*	37	36	3%	Yang, Z., Bandivadekar, A. (2017). 2017 Global Update Light-duty vehicle and greenhouse gas and fuel economy standards. The International Council on Clean Transportation. Available at: https://www.theicct.org/sites/default/files/publications/2017-Global-LDV-Standards-Update_ICCT-Report_23062017_vF.pdf
Countries with HDV fuel economy standards *(# of countries)*	5	4	25%	GFEI, (2017). Targeting Heavy Duty Vehicle Fuel Economy. Global Fuel Economy Initiative. Available at: https://www.globalfueleconomy.org/media/460941/hdv-fuel-economy.pdf
Countries with green freight schemes *(# of countries)*	20	N/A		Smart Freight Centre, (2017). Smart Freight Leadership: Green Freight Programs Worldwide 2017. Available at: http://www.nucms.nl/tpl/smart-freight-centre/upload/Green%20Freight%20Programs%20Worldwide%20-%20SFC%20May2017_FINAL.pdf
Market Development Indicators				
Average light duty vehicle fuel economy *(Liters of gasoline equivalent (Lge)/100 km))*	7.6	8.1	6.2%	IEA and GFEI, (2017). International comparison of light-duty vehicle fuel economy 2005-2015. Ten Years of Fuel Economy Benchmarking. International Energy Agency and Global Fuel Economy Initiative. Available at: http://www.iea.org/publications/freepublications/publication/wp15ldvcomparison.pdf

Global Initiatives Supporting Fuel Economy

- The **Global Fuel Economy Initiative (GFEI)** assists governments and transport stakeholders in improving vehicle fuel economy and reducing carbon dioxide emissions. It aims to double the average fuel economy of new light-duty vehicles globally by 2030, and all vehicles by 2050. The initiative works to secure real improvements in fuel economy, and the maximum deployment of vehicle efficiency technologies across the world, across the full range of vehicle sizes and technologies, including hybrid and fully electric vehicles.
- The **Partnership for Clean Fuels and Vehicles (PCFV)** is a global public-private partnership working with developing and transitional countries to reduce air pollution from vehicles through the promotion of cleaner fuels and vehicles.
- **below50** is a global collaboration that brings together the entire value-chain for sustainable fuels, i.e. fuels that produce at least 50% less CO_2 emissions than conventional fossil fuels. The initiative aims to create a critical mass of players (developers, users and investors) to grow the global market for the world's most sustainable fuels.
- The objective of the **Global Strategy for Cleaner Fuels** and Vehicles is to virtually eliminate fine particle and black carbon emissions from new and existing heavy-duty diesel vehicles and engines through the introduction of low sulfur fuels, and vehicle emission standards by 2030.
- Other relevant global initiatives, for example the ***Global Green Freight Action Plan***, are mentioned in *Section IV.B Stakeholders Mobilizing for Action on Transport and Climate Change.*

7. Electric Mobility

Photo credit: Avda

Overview

Background

The first automobiles in the 19th century were powered through electricity.[724] These were quickly overtaken by gasoline- or diesel-fueled cars, which are primary contributors to climate change. Since 2010, electricity has regained attention as a power source for two- and three-wheelers, public transport vehicles, LDVs and HDVs. Electrification is already well established in rail transport, which is further discussed in *Section III.B.2 Railways and Section III.B.8 Renewable Energy in Transport.* Electric vehicles (the employment of EV, referring to electric battery passenger cars if not mentioned otherwise), have grown from almost zero electrically-powered passenger vehicles before 2010, to one million cars in 2015, to two million vehicles a year later in 2016, and three million by 2017 (Figure 49).[725]

Fuel cell EVs are not covered due to lower levels of global implementation. If powered by hydrogen form renewables, this type of vehicle would be a low carbon mobility solution with potential for heavy-duty vehicles, rail transport, maritime shipping and aviation.[727]

There are several critical barriers to overcome to ensure that electric vehicles are helping achieve the full potential in decarbonization and meeting SDG targets. Today, one major issue is that the electricity for powering EVs is based on mostly non-renewable energy sources. An electric motor is more efficient than an ICE vehicle, but CO_2 savings can only be achieved if the electricity grid is decarbonized. However, as the European case shows, renewable energy production is growing rapidly, and in terms of lifecycle emissions EVs emit less CO_2 than fossil fuel cars even with the most CO_2-intensive power sources.

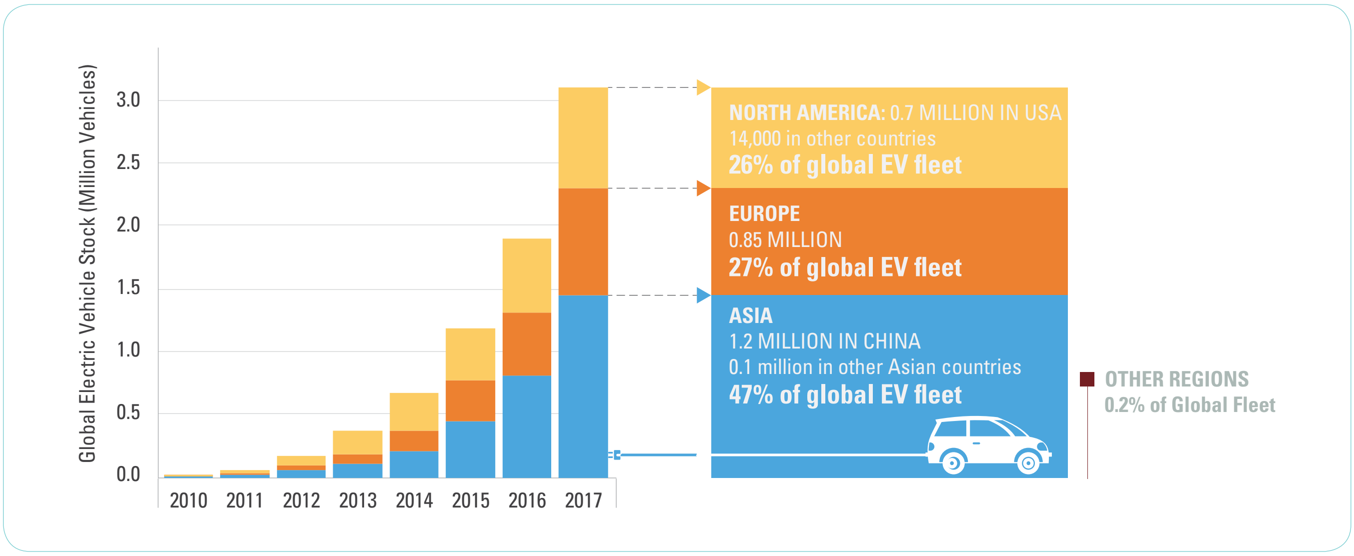
Further, battery production contributes significantly to the lifecycle emissions of EVs, and sourcing raw materials for the lithium ion batteries produced mostly of nickel and graphite can have other negative environmental and social impacts. The **Philippines**, for example, closed or suspended operations at 17 nickel mines in 2017 due to environmental concerns.[728] Policies and standards can help govern the sustainable production and disposal (or recycling) of EV batteries. The increasing uptake and popularity of EVs is met by a supply bottleneck which leads to a limit accessibility of EVs and a slow transition to EVs.[729]

Policy Landscape

Policy Measures Implemented

The recent growth of electric mobility is stimulated by concerns about climate change, air pollution and traffic noise caused by ICE. Other contributing factors include oil independence goals, energy efficiency targets and

Figure 49: Electric Vehicle Stock (battery and plug-in electric hybrids)[726]



industrial policy, as well as innovations reducing the costs of batteries that make EVs more affordable. As the example of **California** shows, some of the main policy drivers of EVs have been standards for automakers, fuel economy and zero emission mandates. Several countries have adopted tax incentives and exemptions for EVs, and to introduce the use of EV in public transport fleets and carsharing services, which unlock a huge potential to reduce car ownership levels and transport costs. **Volvo** announced in 2017—the first major automobile company to do so—that it would stop the production of cars with ICEs from 2019 on and switch all models to electric or plug-in hybrids.[730] **Sweden** launched several innovative projects and published a National Plan for Electric Roads in November 2017. The plan envisages electrifying around 1,400 km of road between the three main cities—**Stockholm**, **Malmö** and **Gothenburg**—which together represent 70% of Sweden's heavy goods traffic.[731]

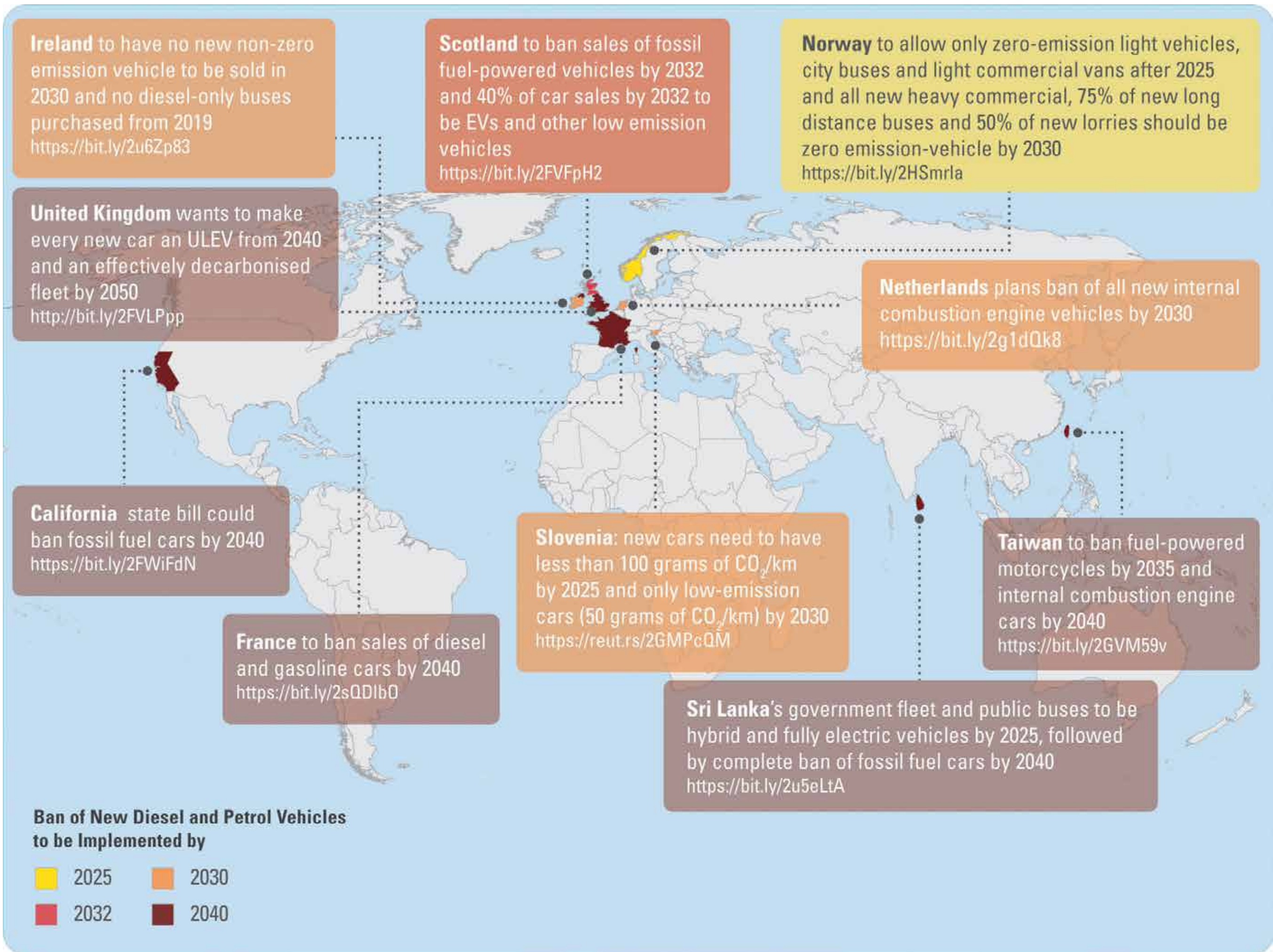
- **Electric Buses:** While electric buses with overhead wires (often called trolley buses) have been in use for several decades, recent developments focus on battery-powered electric buses. In **Edinburgh**, **UK** the first all-electric public buses started operation in October 2017. Much of central Edinburgh is served by these vehicles, and the fleet will be extended in 2018 to create a first fully-electric route in the city.[732] **Cape Town**, **South Africa**, received its first ten electric buses in the second half of 2017, and from there electric buses will expand to **Windhoek in Namibia** and **Mauritius** in the coming years.[733] **Santiago**, **Chile** incorporated the first two electric buses into its public transport fleet in November 2017, with 90 of these buses expected to be in circulation by the end of 2018.[734] **Shenzhen**, **China** replaced all of its buses (16,539) with EVs by the end of 2017, becoming the first city worldwide with a fully electric bus fleet.[735] Both the national **German** and **United Kingdom** governments launched programs to promote electric buses, offering substantial financial support to public transport operators for the acquisition of plug-in hybrid or full-electric buses and charging infrastructure.[736] The German electric bus promotion program launched in 2018, covering up to 80% of incremental e-bus costs and up to 40% of charging infrastructure costs.[737] These are just a few of various examples of electric bus deployment in 2017.
- **Electric Cars: Norway** accounted for the largest market share (39%) of new car sales in 2017 and has the highest share of EVs per capita.[738] EV owners in **China** receive purchase tax exemptions between USD 5,000 and USD 8,500 from the national government.[739] Local governments can add further subsidies, and EV owners do not pay license plate restrictions/acquiring fees.[740] In January 2017, new import tax laws came into force in **Georgia** reducing import duties for plug-in hybrid cars by 60% and removing them completely for battery EVs which led to a 42% of car imports to be hybrid or fully electric by September 2017.[741] **Ukraine** has adopted a provisional exemption on value-added tax and excise tax on a temporary pilot basis for 2018 for all EVs.[742] **Argentina** slashed import duties on electric, hybrid and hydrogen cars in May 2017. The lower duties (reduced from 35% to 5% and lower) will be in place for three years.[743] As of early 2017, **Austria** offered a purchase premium for electric cars charged with 100% renewable electricity. For a full electric or fuel cell powered vehicle people can receive up to EUR 4,000, and up to EUR 1,500 for a plug-in hybrid.[744] **Singapore** replaced the Carbon Emission-based Vehicle Scheme with the new Vehicular Emissions Scheme, which enables rebates of up to SGD 20,000 (around USD 15,000) at the end of 2017.[745] In 2018, **Uzbekistan** and **Kyrgyzstan** both introduced zero import duties on electric vehicles.[746] The **United States** provides a federal tax credit of between USD 2,500 and USD 7,500 for EVs acquired after December 2009; however, the credit will begin to phase out for each manufacturer after 200,000 EVs have been sold by the manufacturer in the **United States**.[747]
- **Electric Car Sharing:** In March 2017, in **Madrid** a new electric carsharing service was launched **(Emov)** for which more than 100,000 customers signed up in just 5 months.[748] **Singapore**'s first electric carsharing service was officially launched in December 2017, with 80 cars and 32 charging stations.[749] **car2go** has approximately 1,400 purely electric car2go vehicles circulating on the roads of **Amsterdam**, **Madrid** and **Stuttgart**.[750] (Car- and bikesharing is discussed further in *Section III.B.5 New Mobility Services.*)
- **Electric Two- and Three-Wheelers: Sweden** gives a boost to e-bikes with a 25% subsidy for the purchase of an e-bike (budgeting USD 42 million per year for the period 2018-2020). The program is extremely popular: approximately 2,000 applications per week were sent to Sweden's Environmental Protection Agency during the first three months.[751] **France** announced in February 2017 that individuals can receive EUR 200 financial assist (one per person) for purchasing a pedal-assist electric bike through January 2018.[752] **China** accounts for 42% of the global stock of electric two wheelers.[753] In **India**, **Ola** plans to add 10,000 three-wheelers between 2018 and 2019, as part of a major expansion of 1 million EVs by 2021.[754]

Policy Targets Set

The clear majority of EVs are sold in markets that have adopted public policies to help overcome the prevailing barriers to EV adoption: model availability, upfront cost, charging infrastructure, and awareness. New announcements on EV policy targets are emerging from companies, cities and countries on a regular basis (Figure 50).

- **EV Fleet Targets:** In 2017, 13 new countries announced targets on EV uptake, bringing the number of countries with targets to 60.[755] These targets aim to increase EV fleets, incorporate EVs into public transport services,

Figure 50: Countries and Regions with Fossil Fuel Vehicle Phase-out Plans[762]



introduce EV tax exemptions and financial incentives to help consumers overcome the barrier of higher upfront costs,[756] and enforce regulations to ensure that car manufacturers produce a certain amount of EVs as part of their annual sales (in the case of **China**). For example, **Costa Rica** in December 2017 approved its Electric Transportation Bill, which sets a goal of 37,000 EVs within 5 years. The usage of EVs is promoted by making them more affordable with several tax exemptions, and developing a national network of fast-charging infrastructure.[757] **Malta** extended the grant scheme on environmentally friendly vehicles with another EUR 150,000 in July 2017, setting an indicative target of 5,000 EVs by 2020.[758] **Malaysia** announced an Electric Mobility Blueprint with the goal of having 100,000 EVs, 125,000 charging stations, 2,000 electric buses and 100,000 electrified motorcycles by 2030.[759] **New Zealand** announced its Electric Vehicles Programme in 2016, aiming to reach approximately 64,000 EVs on the road by the end of 2021.[760] **Sri Lanka** announced plans to replace all state-owned vehicles (including buses) with electric or hybrid models by 2025, and private vehicles by 2040.[761]

- **Phase-out of Fossil Fuel Vehicles:** Vehicle and fuel regulations help overcome the barrier of EV model availability.[763] In 2016, **Norway** became the first country to announce a ban of vehicles with ICEs, going into effect as early as 2025. In 2017, six more countries and a few regions followed with plans for a complete shift to electric mobility. **Netherlands**, **Slovenia** and **Ireland** plan to phase-out ICE vehicles by 2030, **Scotland** in 2032, and **California**, **France**, **Sri Lanka**, **Taiwan** and the **UK** in 2040 (Figure 50).
- **Electric Buses:** twelve major cities, including **Seattle**, **London**, **Barcelona** and **Cape Town** promised in October 2017 to buy only zero-emissions buses from 2025 on, under the **C40** joint "Fossil Fuel Free Streets Declaration," with 59,000 buses (of all types) currently operating.[764] In **Los Angeles**, the County Metropolitan Transportation Authority voted in July 2017 to transition its fleet of more than 2,200 buses to zero emission electric buses by the year 2030. It immediately took a first step of acquiring 95 electric buses as well as charging infrastructure for USD 138 million.[765] In **Poland**, 41 cities and municipalities signed an agreement beginning 2017 to buy fleets of

electric buses by 2020.[766] **Mexico City** is planning an electric bus project serving approximately 160,000 daily trips along a 22 km-long corridor, which is the largest-scale electric bus project in Latin America to date.[767] In December 2016, 43 articulated zero-emission buses started operating in the Dutch cities **Eindhoven** and **Helmond**.[768] Beginning in 2018, an additional 100 electric buses were introduced at **Amsterdam** Schiphol Airport and the surrounding area. The projects contribute to the goal set by the government to have only zero emission buses starting from 2025 in the **Netherlands**.[769] **Barcelona**, **Spain** introduced two electric articulated buses in September 2016, which can charge batteries while en route.[770]

- **Electric Cars: South Africa** announced in April 2017 the commitment to have more than 2.9-million electric cars on the road by 2050 to meet Paris Agreement goals.[771] **Thailand** also aims to have 1.2 million electric vehicles on its roads by 2036.[772] In September 2017, China imposed a tough sales target on car makers in which NEVs need to account for 10% of annual sales by 2019.[773] The target will be raised to 12% for 2020. **Poland** wants to make electric mobility a key part of its agenda and plans to put 1 million EVs on the road by 2025.[774]
- **Electric Freight:** China's Ministry of Transport identified green freight as a top priority in its 13th Five-Year Strategy, and aims to reduce CO_2 emissions by 7% to 8% by 2020.[775] By the end of 2017, the government released an action plan (Action Plan for Promoting the Healthy and Stable Development of Road Freight Transport Industry 2017-2020) to help companies gain easy access to NEVs, and to promote the electrification of urban freight vehicles.[776] In March 2017, 27 **BYD Company** electric trucks went into service at the **Los Angeles**, freight facilities area.[777] One key component of California's Sustainable Freight Action Plan, released in 2016, is the deployment of more than 100,000 ZEVs/equipment by 2020.[778] The **California** Air Resources Control Board proposed in 2017 that 2.5% of truck sales be zero emissions starting in 2023, increasing to 15% by 2030.[779] **Sweden** has invested in an electric road system to meet its 2030 target (a transport sector independent of fossil-fuel vehicles). The first 2-km stretch, which is a catenary system that supplies the trucks with electric power like trolley buses, opened in April 2018.[780]

EV Charging Infrastructure

Charging stations are an important element of electric mobility. Charging infrastructure helps overcome refueling and convenience barriers. Countries or industries set certain standards to allow charging of different models. Charging stations can be configured for slow or quick-charging of EVs. Charging infrastructure is generally categorized into private and public charging stations. The low availability of public charging stations is often described as a bottleneck for electric mobility,[781] because public charging infrastructure reduces range anxiety and could be at least partially addressed with more public investment or private-sector business models such as **Tesla**. As the electric mobility industry evolves, standards for charging stations need to evolve as well, to keep pace with the rate of innovation in vehicle models and technology.

- In 2017, China built world's largest EV charging network with 167,000 stations, and the aim that the distance between two charging stations would be less than one kilometer in urban areas.[782] **Germany** announced in 2017 a commitment to build 1,000 new EV charging stations along the German Autobahn by 2020.[783]
- **Egypt** announced in February 2018 that it would work with a EV company (**Revolta**), to build 65 charging stations across the country, with the goal of having 300 stations by 2020.[784] **Chilectrica**, an electric company in **Chile**, is leading the installment of charging stations in that country, and plans to build the necessary charging infrastructure to service 600 electric buses by 2020, which is equivalent to 10% of the present public transport fleet. **Slovenia**'s strategy on alternative fuels in the transportation sector includes plans to expand the current network of charging stations to 1,200 by 2020, 7,000 by 2025 and 22,300 by 2030.[785]

Market Trends

Market Development

EV Fleets

- **Private EV fleets:** Total electric passenger car stock (including battery and hybrids) stood at 0.3% of total cars in 2017.[786] In 2017, **China** had the largest fleet of individual four-wheelers, with nearly 1.2 million electric cars, followed by the **United States** with 762,000 cars, **Japan** (205,000 cars), **Norway** (176,000 cars), and the **Netherlands** (119,000 cars). In addition, **China** had 250 million electric two-wheelers, and 50 million three-wheelers on its roads in 2017.[787]
- **Public EV fleets:** The global electric bus stock was around 375,000 to 385,000 buses in 2017, which means that 13% of the total global bus fleet (mostly related to public buses, but any kind of bus (standard or articulated) is implied) is electrified.[788] There are over 300 cities in the world with battery-powered electric or hybrid buses, and the majority of them are in Eastern Asia, Europe and North America.[789] **China** alone has 370,000 electric buses in operation.[790] The electrification of bus fleets is happening at a rapid pace. **Energy Efficiency Limited Services**, an **Indian** public sector company tendered 10,000 EVs and is distributing these especially to public institutions, firms, and ministries. This has eased the beginning of the EV market in **India** significantly.[791]

Electric Freight

- Companies such as **Deutsche Post DHL Group** announced long-term 2050 decarbonization plans, and introduced technology solutions including electric-drive trucks, e-scooters, and City Hub cargo bicycles.[792] By November 2017, Deutsche Post DHL Group had introduced 5,000 StreetScooters in service, with an annual reduction of more than 16,000 tonnes of CO_2 after 13.5 million kilometers driven.[793] **FedEx** added 292 electric vehicles to their fleet (in total 2,100) in 2017. **UPS** currently has 300 fully electric vehicles in operation with the goal of having a quarter of their fleet purchased by 2020 use alternative fuels.
- **Daimler** delivered in 2017 the first all-electric light-trucks with a range of 100 km and 83-kilowatt hour (kWh) batteries to **UPS** in the United States,[794] and later to **DHL** for use in Europe[795]. Electric heavy truck projects have been announced by several companies: **Tesla** showcased their first all-electric truck model to go into production by 2019;[796] **Nikola Motors** developed a fuel cell long-distance truck in 2017;[797] and **Daimler** announced two all-electric heavy and medium duty vehicles.[798]
- **Amazon's Prime Air** service introduced a drone freight delivery pilot in the **United Kingdom** in 2016, with development centers in **Austria**, **France**, **Israel**, **United Kingdom** and the **United States**,[799] and with other autonomous freight delivery options under development in **Europe**.[800]

EV Battery Storage and Cost

The lithium-ion technology that EV batteries use is constantly improving. As a result, the batteries have an improved lifespan and power capacity, while charging speeds, costs, battery size and weight are decreasing. This is a critical tipping point for the gradual uptake of EVs in the global market.

The costs of batteries will decline further. In 2017, the average battery price is USD 209/kWh, and it is predicted to fall below USD 100/kWh by 2025 and USD 70/kWh by 2030.[801] With reductions in battery costs, the economic competitiveness of EVs with ICE vehicles is also increasing, because batteries are the main cost increment of an EV. This is an important tipping point necessary for wider adoption of electric vehicles.

Charging Infrastructure

Worldwide, there are more than 3.5 million charging outlets, over 85% of which are private, and follow different, in some cases conflicting standards.[802] Similar to global electric car stock, global electric vehicle supply equipment outlets are increasing rapidly, surpassing 2 million in 2016, and 3 million in 2017.[803] Electric cars still outnumber public charging stations by more than six to one, indicating that most drivers rely primarily on private charging stations.

- **Tesla** set the ambitious 2017 target of doubling its **Supercharger** network, which is already the largest fast-charging network in the world, from roughly 5,000 charging stalls to 10,000. While the company fell short of its goal, it did make notable progress, increasing the number of private charging stations from 5,000 in 770 locations to 8,250 chargers in 1,120 locations worldwide.[804] Tesla's new goal is to have 18,000 Superchargers installed by the end of 2018.[805]

Overview of Key Indicators

The global uptake of EVs depends on several factors, including advances in **vehicle and battery technologies**, reduced costs from economies of scale and technological innovation, enabling policy environments, and government incentives. The reduction in cost of batteries is a critical tipping point that will predicate the widespread global uptake of EVs. The availability of **charging infrastructure** is also a helpful for a broad global rollout of EVs, because it will increase the attractiveness of EVs across market segments and will allow EV integration into larger urban transport systems.

Emission Reduction Impacts

The obstacle to higher emissions savings is a very carbon-intensive power generation.[806] Vehicles with battery EVs emit 39% less CO_2 emissions per kilometer than vehicles with ICE on average, depending on vehicle type and country's power source.[807]

According to the IEA, EVs avoided emissions of 29.4 Mt CO_2 in 2017, 81% of which can be attributed to **China**'s 2-wheelers, 7% North America, 5% Europe, and 3% China's LDV and 3% China's bus and 1% by other Asian countries. The electric buses in **Shenzhen**, for example, emit 48% less CO_2 than comparable diesel buses.[808] As the integration of electric buses increases globally, research on the service level impacts of these vehicle types is still in its infancy.

Table 11: Overview of Key Indicators for Electric Mobility

KEY INDICATORS FOR ELECTRIC MOBILITY				
	2017	**2016**	**% CHANGE**	**Source/s**
Policy Landscape Indicators				
Electric vehicle targets *(# of countries)*	61	48	27%	SLoCaT, (2018). E-mobility Overview on Trends and Targets. Available at: http://slocat.net/sites/default/files/e-mobility_overview.pdf
ICE phase-out targets *(# of countries)*	7	1	700%	
EV incentives (subsidy, enabling legislation) for consumers *(# of countries)*	67	N/A	N/A	
Market Development Indicators				
Electric vehicle market share *(% of total fleet)*	0.3%	0.2%	50%	IEA, (2018). Global EV Outlook 2018. International Energy Agency. Available at: https://webstore.iea.org/global-ev-outlook-2018
Electric vehicle stock *(plug-in hybrids and battery)*	3,109,050	1,982,040	57%	
Public charging points *(slow and fast)*	430,151	313,567	37%	
Public charging points *(slow and fast)*	318,128	237,258	34%	
Public charging points *(slow and fast)*	112,023	76,309	47%	

Global Initiatives Supporting Electric Mobility

- The **EV30@30 c**ampaign, launched at the Eighth Clean Energy Ministerial in 2017, set the collective aspirational goal of a 30% market share for electric vehicles in the total of all passenger cars, light commercial vehicles, buses and trucks by 2030.
- **EV100** is part of the Marrakech Partnership for Global Climate Action (MPGCA), a transport initiative that aims to accelerate the transition to electro-mobility by leveraging the role corporate demand can play in driving EV uptake, and the roll-out of charging infrastructure. The initiative was launched in 2017, with ten-member companies from various sectors in Europe and China.
- The **International Zero-Emission Vehicle Alliance (ZEV Alliance)** is a collaboration of governments acting together to accelerate the adoption of zero-emission vehicles (electric, plug-in hybrid, and fuel cell vehicles). The governments have committed to making all passenger vehicle sales in their jurisdictions ZEVs by no later than 2050, and to collaborating on policies and actions to achieve their ZEV targets.
- The **Taxi4SmartCities** coalition connects worldwide taxi companies that are committed to accelerating the energy transition of their vehicle fleet by 2020 and 2030. More generally, the Taxi4SmartCities coalition intends to defend a progressive and modern version of the taxi as a key actor of the Smart City.
- The **Urban Electric Mobility Initiative (UEMI)** aims to boost the share of EVs in individual mobility (two- and three-wheelers and light duty vehicles), and integrate electric mobility into a wider concept of sustainable urban transport that achieves a 30% reduction of greenhouse gas emissions in urban areas by 2030.

8. Renewable Energy in Transport

Overview

Background

In the power sector, the renewable energy transformation is well underway, but other sectors like the transport sector are still lagging. To achieve the Paris Agreement's objectives, the transport sector needs to follow a similar path to the energy sector's.[809] The entry points for renewable energy in the transport sub-sectors can include: the use of 100% liquid **biofuels** (i.e. ethanol, biodiesel and advanced biofuels)[810] or of biofuels blended with conventional fuels; **natural gas** vehicles and infrastructure converted to run on upgraded **biomethane and biogas**; and the **electrification** of transport (provided the electricity is renewable). There is also an ongoing discussion about how to generate liquid or gaseous electricity-based synthetic fuels, in particular **hydrogen** pathways, especially for passenger transport. Hydrogen from renewable electricity can supply power to support decarbonization of transport and other sectors.[811] However, fuels and vehicle technologies vary greatly in terms of their technical maturity, costs, level of sustainability, climate mitigation potential, distribution and acceptance rates among users.[812] Policy strategies are thus being implemented at different levels (from international to sub-national), and while some are relevant to the transport sector overall, others are sub-sector specific to accommodate industry and users' needs and preferences.

In 2015, the renewable energy share in transport was estimated at 3.1%, while renewable electricity represented approximately 0.3% of energy use in the sector (Figure 51).[813] In **road** transport, renewable energy use was estimated at 4.2%, with more than 96% attributable to biofuels.[814] **Rail** can integrate biofuels in fleets fueled by oil products, and renewable electricity in fleets powered by electricity; 9% of rail energy in 2015 came from renewable sources (See also rail electrification in *Part III.B.3 Railways*). **Aviation** and **shipping** remain the most difficult sub-sectors to decarbonize, but several options are being explored. Planes can use biofuels blended into traditional jet fuel at various levels (e.g. bio-jet fuels), and ships can use biofuels or other renewable-based fuels (e.g. electricity-based hydrogen or ammonia) for propulsion, or they can directly incorporate wind and solar energy. As the transport sector adopts biofuels and promotes their production, from a sustainable development point of view it is critical that the industry mandates the sustainable production of its biofuels.

Overview of Key Indicators

The deployment of renewables is encouraged explicitly, for instance, by policies that promote the use of renewable electricity in transport,[816] but it is also likely to be driven implicitly by policies that support the uptake of renewable electricity in parallel or independently of policies that support electric mobility.[817] The removal of fossil fuel subsidies, the application of a carbon tax, low carbon standards or vehicles

Figure 51: Share of Renewable Energy in Transport in 2015[815]

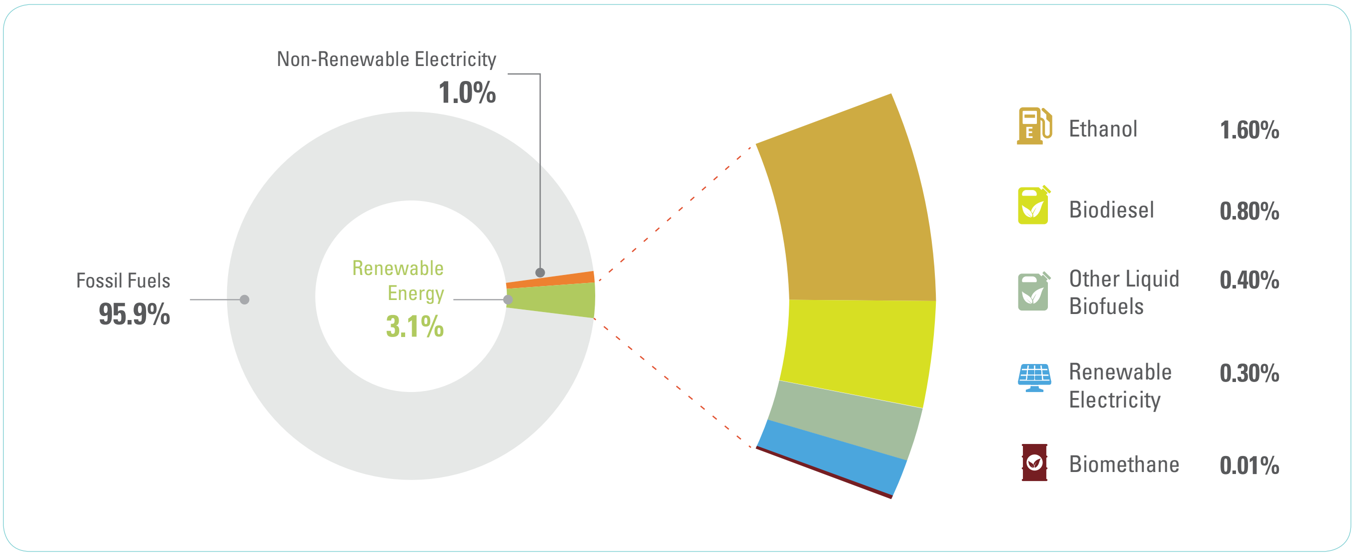
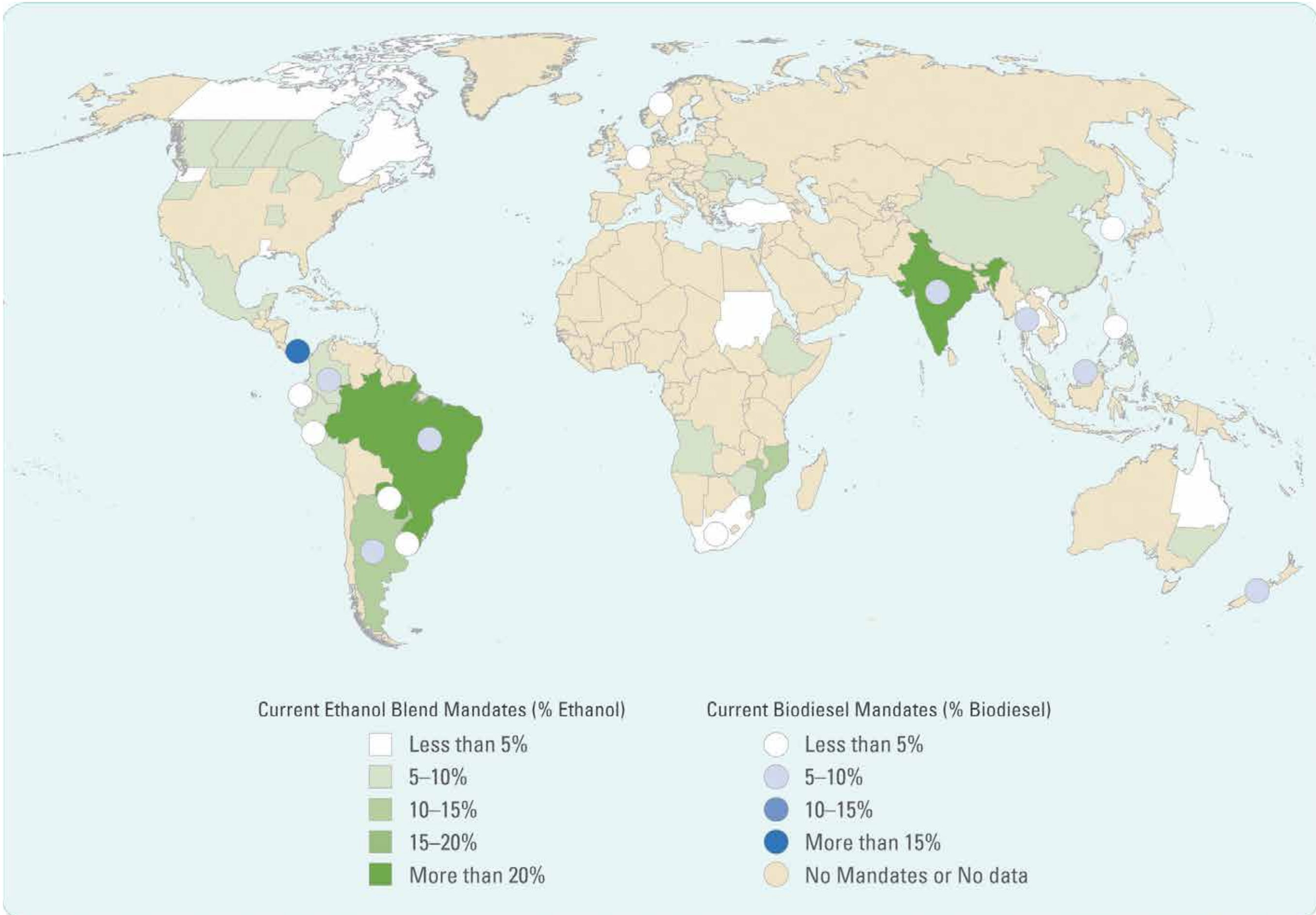


Table 12: Overview of Key Indicators for Renewable Energy in Transport

KEY INDICATORS FOR RENEWABLE ENERGY

	2017	2016	% CHANGE	Source/s
Policy Landscape Indicators				
Biofuel mandates *(# of countries)*	70	68	+3%	REN21, (2018), Policy Database. Available at: http://www.ren21.net/status-of-renewables/ren21-interactive-map/
Advanced biofuel mandates *(# of countries)*	2	2	0%	
Renewable transport targets *(# of countries)*	42	42	0%	
100% renewable energy in transport target *(# of countries)*	1	1	0%	
Policies for EVs combined with renewable electricity *(# of countries)*	2	2	0%	
Renewable electricity target and electric vehicles targets *(# of countries with both)*	43	N/A	N/A	REN21, (2018), Policy Database. Available at: http://www.ren21.net/status-of-renewables/ren21-interactive-map/; SLoCaT, (2018). E-mobility Overview on Trends and Targets. Available at: http://slocat.net/sites/default/files/e-mobility_overview.pdf
Market Development Indicators				
Share of renewable energy in transport *(%)* • **Biofuels share in transport** *(%)* • **Renewable electricity share in transport** *(%)*	N/A	3.1% 2.8% 0.3%	N/A	IEA, (2017). World Energy Outlook 2017. International Energy Agency. Available at: https://webstore.iea.org/world-energy-outlook-2017
Share of renewable energy in road *(%)*	N/A	4.2%	N/A	IEA, (2017). Renewables 2017. International Energy Agency. Available at: https://www.iea.org/publications/renewables2017/
Share of renewable energy in rail *(%)*	N/A	2015: 9%	N/A	UIC and IEA, (2017). Railway Handbook 2017. Energy Consumption and CO_2 Emissions. International Union of Railways. Available at: https://uic.org/IMG/pdf/handbook_iea-uic_2017_web3.pdf
Share of renewable energy in aviation *(%)*	N/A	N/A	N/A	
Share of renewable energy in shipping *(%)*	N/A	N/A	N/A	
Biofuels global production *(billion liters)*	142.7	139.2	+2.5%	REN21, (2018). Global Status Report 2018. Paris, REN21 Secretariat. Available at: http://www.ren21.net/gsr-2018/
Ethanol global production *(billion liters)*	105.5	102.6	+2.8%	
Biodiesel (FAME) global production *(billion liters)*	30.7	30.6	+0.3%	
Biodiesel (HVO) global production *(billion liters)*	6.5	5.9	+10.2%	
Biofuel use *(% of fuel consumption)*	N/A	3%	N/A	IEA, (2017). World Energy Outlook 2017. International Energy Agency. Available at: https://webstore.iea.org/world-energy-outlook-2017
Biofuel use in road transport *(million barrels of oil equivalent per day, mboe/d)*	N/A	1.7	N/A	
Biofuel use in aviation and maritime[818] *(million barrels of oil equivalent per day, mboe/d)*	N/A	<0.1	N/A	

Figure 52: Biofuel Blend Mandates[820]



emission standards also represent measures that support the decarbonization of the transport sector, and renewable energy implicitly.

Policy Landscape

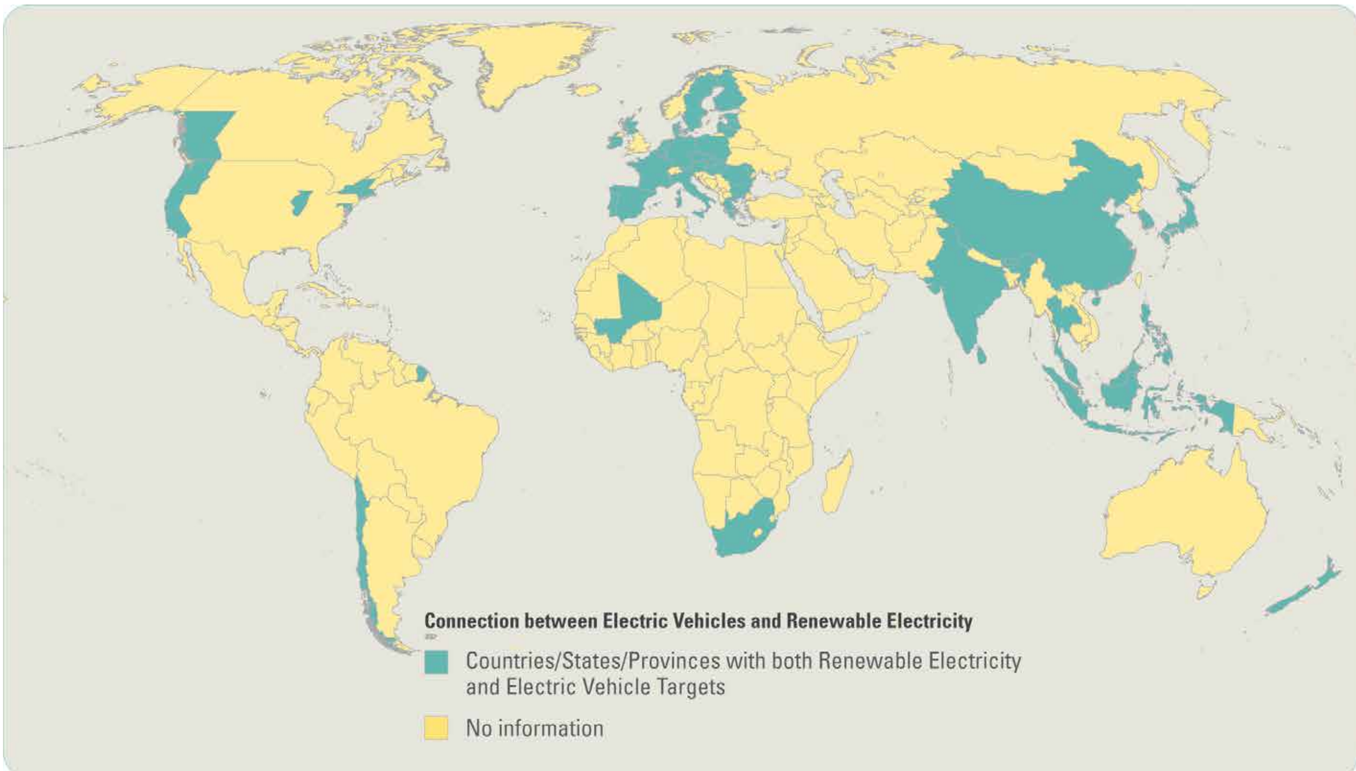
Policy Measures Implemented

- At least 70 countries have now enacted **biofuel blending mandates** (at the national or subnational level), seven of which have adopted blending requirements for biofuel shares higher than 10%.[819]
- The debate over the use of crop-based biofuel feedstocks continued in 2017, particularly in Europe. Concerns cited by those who challenge the use of traditional biofuels for fueling transport include: food availability, cost to consumers, potential land-use concerns, the sustainability of fuel sources used for biofuel production, and life-cycle emissions impacts. As a consequence, biofuel promotion policies have begun to include specific requirements for the use of next-generation cellulosic biofuels.[821] In the European Union the use of palm oil, for example, will be phased out by 2030 due to the environmental concerns about this biofuel.[822] Further, to ensure the climate-friendliness and low carbon value of biofuels, induced land-use change emissions from crops need to be estimated.[823]
- To date, only **Denmark**, **Italy** and the **United States** have introduced **mandates for advanced biofuels**. The **United States** through the Renewable Fuel Standard, and **California** through the Low Carbon Fuel Standard, support advanced biofuels by giving them a higher value than conventional biofuels in trading mechanisms designed to enable market actors to comply with the **United States** standard.
- Some countries have implemented **fiscal and financial incentives** to promote biofuel production, distribution and consumption, as well as conducting research and development into new technologies. The **United States** and other countries, including **Australia**, and **United Kingdom** continue to support the development of advanced biofuels with grants for research and development.[824] In 2016, **Argentina** put in place tax exemptions for biodiesel production; **Sweden** reintroduced tax cuts on ethanol and biodiesel; and **Thailand** supported E20 and E85 blends as well as a trial program for the use of B20 in trucks and B10 for military/government use.[825] Some countries, such as

Brazil and **Thailand**, have successfully introduced policies expanding their fleet of flexible-fuel vehicles,[826] facilitating the widespread deployment of higher-level biofuels, and the use of unblended biofuels in flexible-fuel vehicles.

- **Australia** has awarded funding for the construction of a bio-crude and advanced biofuel laboratory, potentially resulting in the capability of producing renewable diesel and jet fuel from plant material. Under the Sustainable Biofuels Innovation Challenge, the **United States** provided funding for the development of a demonstration-scale facility capable of producing renewable diesel and renewable jet fuel out of gases from industrial waste.[827] In the **Netherlands**, a public-private partnership aims at getting a bio-jet fuel supply chain up and running to supply significant quantities of sustainable jet fuel to Schiphol Airport. Bioport Holland involves aviation and bio-jet fuel stakeholders at the main Dutch ports and airports.[828]
- The European Union's sustainability criteria for conventional biofuels envision a 50% higher minimum reduction in GHG compared with fossil fuels and prohibits growing biofuels in areas converted from land with previously high carbon stock (e.g. wetland or forest) or producing them from raw materials obtained from land with high levels of biodiversity (e.g. primary forest or grassland).[829] **Canada** has also released a set of guiding principles for sustainable biofuels;[830] and the state of **California** has defined policy frameworks requiring a reduction in life-cycle carbon intensity for transport fuels.[831]
- **Integrated planning** allows for the leveraging of synergies between EVs and variable renewable energy, for example, by strengthening demand-side management opportunities related to vehicle charging practices (e.g. smart charging, vehicle-to-grid (V2G) strategies), planning charging infrastructure along with the renewable electricity production, and developing V2G services.[832] Figure 53 highlights countries, states and provinces with EV and renewable energy targets that are the foundation for integrated policy planning. Sector coupling refers to the integration of energy supply and demand across electricity, thermal and transport applications, which may occur via co-production, combined use, conversion or substitution. The coupling of the electricity sector with efficient transport can assist in integrating rising shares of variable renewable energy, stabilizing the grid and reduce its curtailment; it can also open pathways for renewable electricity into new end-use markets, provided that the additional demand is aligned with system requirements and does not instead increase system stress.[833] The development of V2G services is still in the early stages, implemented only in pilot and demonstration programs. For example, in **Holland**, 325 Dutch municipalities, several companies, universities and grid operators have joined the Living Lab Smart Charging platform. Supported by the national government, the platform's ultimate objective is to ensure that solar and wind energy power all electric vehicles in the country.[834]

Figure 53: Countries, States and Provinces with Electric Vehicle and Renewable Energy Targets[835]



- While there are limited examples of countries with explicit policy linkages between EVs and renewable electricity, such as **Austria**, **Luxembourg** and **Germany**: Until 2015, **Luxembourg** provided a grant of EUR 5,000 for the purchase of flexible, plugin hybrid and extended range electric vehicles. Only purchasers who had also signed a renewable electricity contract with their energy provider received the premium. In their current electric mobility policy, applicable from 2017 to 2018, **Austria** provides a grant for a range of electric vehicle and two wheelers if they use renewable electricity or hydrogen for fuel. In 2017, **Germany** established a tendering program of EUR 300 million to stimulate the deployment of charging infrastructure for electric vehicles. Only charging stations that supply renewable electricity for charging (renewable electricity procurement or self-generation) qualify for the grant.[836] Forty-three countries have targets (at the national or sub-national level) for both EVs and for shares of renewable electricity, which can result in increased use of renewable energy in transport as the number of EVs increase on the roads while more renewable energy becomes available for charging (Figure 53).[837]
- The railways of **Austria**, **Denmark**, **Finland**, the **Netherlands**, **Norway**, **Sweden** and **Switzerland** are running on 100% renewable electricity, either purchased from renewable energy providers or produced in renewable energy plants owned and operated by the rail companies.[838] (See *Part III.B.3 Railways for more discussion about railway electrification*).

Policy Targets Set

- In Europe, 10% of **transport fuels** consumed in each European Union member state must come from renewable sources by 2020.[839] In 2018, the European renewable energy goal was adopted, which increased the target to 14% by 2030.[840] Several countries, mainly in Europe, have set up their own targets for renewable energy in transport, focusing primarily on road transport.

- The rail sector has a long history of using renewable energy, spurred by national and subnational obligations and mandates. For example, the **Bay Area Rapid Transit system**, which provides public rail service to California's **San Francisco** Bay Area, set a requirement that 50% of the rail system's power come from renewable energy by 2025 (compared to a state-wide target of 50% renewable electricity by 2030) and 100% by 2045.[841] However, rail companies have been the primary drivers of renewable energy as part of their effort to decarbonize their businesses, increase energy security and reduce energy costs. In 2015, prior to the Paris Agreement, the rail operators around the world had already committed to the following targets, which formed the UIC Low Carbon Rail Transport Challenge:[842]
    - A 50% reduction in CO_2 emissions from train operations by 2030, and a 75% reduction by 2050;
    - A 50% reduction in energy consumption from train operations by 2030, and a 60% reduction by 2050.

- The global aviation industry, representing 192 countries, also recognizes the need to address climate change and has adopted a number of aspirational goals, including a 50% reduction in net aviation CO_2 emissions by 2050 (relative to 2005 levels).[843] In 2016, the International Civil Aviation Organization (ICAO) adopted the Carbon Offset and Reduction Scheme for International Aviation (CORSIA) which, among other things, supports the production and use of sustainable aviation fuels, particularly drop-in fuels produced from biomass and different types of waste.[844] To date, over 100,000 commercial flights have used sustainable aviation fuels,[845] including **United Airlines**, which, among other airlines, has begun to use commercial-scale volumes of alternative fuels for regularly scheduled flights.[846] **Avinor**, the public operator of Norwegian airports, announced in January 2018 that all flights under 1.5 hours are targeted to be entirely electric by 2040.[847] Aviation fuels are generally not included in national transport mandates for biofuels with **Indonesia** being the only exception, where a 2% renewable jet fuel mandate was introduced in 2017, which has the intention to be raised to 5% by 2025.[848]To also reduce their emissions, Delta Airlines reported that it had converted 15% (or 15,00 pieces) of its ground support equipment (GSE) fleet to electric (eGSE) as of early 2016; eGSE is used to service airplanes between flights including refueling, towing, luggage/freight carts, etc.[849]

- The International Maritime Organization (IMO) agreed to a 0.5% sulphur cap by 2020, which will have implications for the burning of heavy fuel oil and offers opportunities for the development of renewable-based fuels. IMO's initial strategy on GHG reductions mentions that IMO will consider and analyze measures to encourage ports and ships to use power supplied by renewable sources.[850]

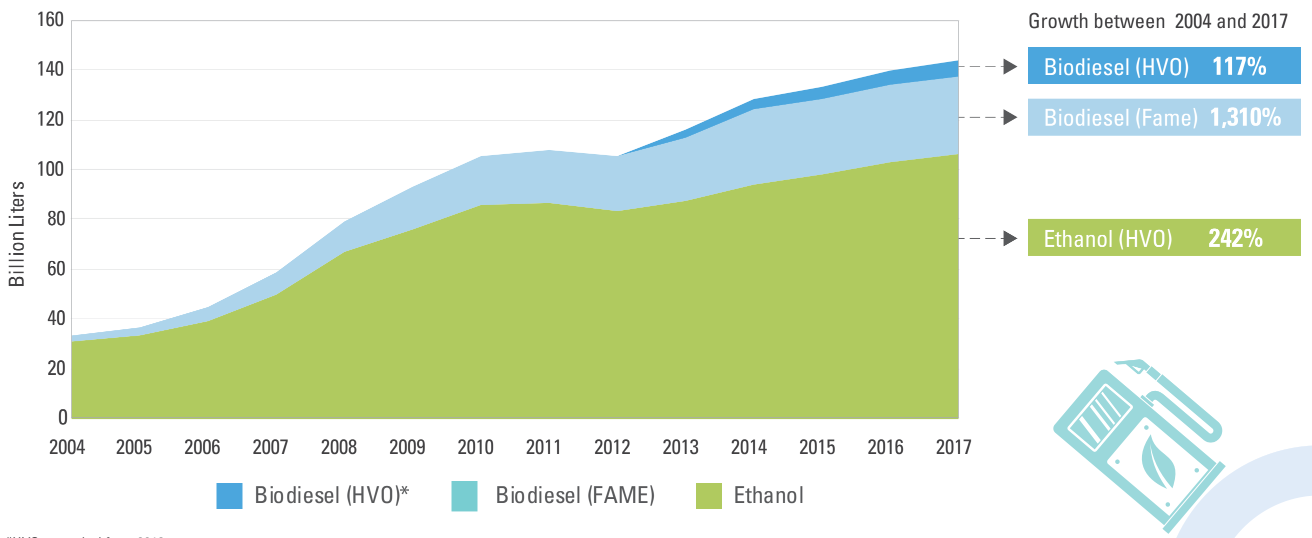
Market Trends

Market Development

- In 2017, global ethanol production increased 2.5% in relation to 2016; the slight decline in **Brazil** was offset by increases in the **United States**, **Europe**, and **China**. Biodiesel production remained relatively stable in 2017, following a 9% increase in 2016 compared to 2015 (Figure 54).

- The technology for producing, purifying and upgrading **biogas** for use in transport is relatively mature, and

Figure 54: Biofuel Production from 2004 to 2017[851]



*HVO recorded from 2013
Note: Two categories of biodiesel exist: HVO biodiesel (Hydrotreated Vegetable Oil) and FAME biodiesel (Fatty Acid Methyl Ester).

natural gas vehicles (NGVs) and the associated infrastructure are increasing slowly but steadily around the globe. NGVs provide a good entry point for biogas in the transport sector, so it is encouraging to see that many countries, although mostly developed countries, have relatively well-developed NGV infrastructure.[852] A few examples of NGV infrastructure in developing countries can be found in **Colombia** and **Pakistan**.[853]

- **Power-to-X** (P2X) refers to any technology that converts electricity to a gaseous or liquid energy carrier and offers another option for deploying renewable energies in transport. Although still in the early stages of development, P2X is expected to be particularly useful and economically viable on the development of ammonia for the shipping sector as well as long haul road transport and aviation, where few or no competing low carbon technologies exist yet. Nevertheless, such technology is less energy efficient as a direct supply of electricity to drivetrains, as P2X currently delivers 13% efficiency against electricity's 73% efficiency.[854]

- **Uniper Energy Storage** constructed the world's first demonstration plant for storing wind energy in the natural gas grid, **WindGas Falkenhagen (Germany)**.[855] Around 360 Nm3/h of hydrogen is generated by means of electrolysis and fed via a 1.6 km hydrogen pipeline into the gas grid operated by **ONTRAS Gastransport GmbH**. This energy is then available to the electricity, heating, mobility and industrial market.[856]

- **Electrification** of the transport sector was historically limited to trains, light rail and some buses. In 2017, there were signs of the entire sector opening to electrification.[857] Fully electric passenger cars, scooters, and bicycles are rapidly becoming commonplace, and prototypes for heavy duty trucks, planes, and ships were released in 2017[858] (See *Part III.B.7 Electric Mobility* for further discussion of electric modes). Further electrification of the transport sector has the potential to create a new market for renewable energy and facilitate the integration of variable renewable energy, if market and policy settings ensure that the charging patterns are effectively harmonized with the electricity system requirements.

- **Biofuels:** The production of biofuels in **Asia** increased by 2.4% in 2017 in relation to 2016, compared to an increase of more than 12% in 2016.[859] The biggest producer was **China,** followed by **Thailand** and **Indonesia**. Ethanol production increased by 8.6% in 2017 over 2016, mainly driven by a rise of 15% in **China**, which produced more than half of Asian ethanol.[860] Biodiesel production was relatively stable relative to 2016, with **Indonesia** responsible for 36% of production in Asia.[861] The fact that **China** and **India** together house approximately 32% of the world's NGVs and have well-developed NGV infrastructure shows the potential for integrating biogas. In 2017, **India** announced that its first biogas-fueled bus started operation.[862]

In **Europe**, policy and public support for first-generation biofuels continued to be uncertain, partly due to sustainability concerns, but also due to an increasing interest in electric mobility. Conversely to ethanol and biodiesel's slow growth, biogas' share in the transport fuels mix continued to increase (+12% between 2015 and 2016). Europe is home to three of the world's four largest producers of biogas for vehicle fuel: **Germany**, **Sweden** and **Switzerland**.[863]

The **United States** continued to be the largest producer of biofuels, supported by both agricultural policy and the federal renewable fuel standard. Production of ethanol increased by close to 2.8% in 2017 relative to 2016, and a record average blend rate of 10.08% was achieved,[864] and further increase can be expected due to new regulations allowing all-year use of E15.[865] In 2018, Minnesota implemented a mandate that diesel has to contain 20% biofuel.[866] The **United States** is the largest market globally for biogas as a transport fuel, and production, which grew nearly six-fold between 2014 and 2016, increased again in 2017 by 15% relative to 2016.

Biofuel production in Latin America grew 2% in 2017. Biodiesel production went up by 9% following an 11% increase in 2016, while ethanol production was stable.[867] Biodiesel production in **Brazil** increased by 12.9% relative to 2016, reversing the 4.4% decline in 2016.[868] **Uruguay** launched the first electric route in Latin America, with six charging stations at 60 km intervals.[869] Since Uruguay gets 98% of its electricity from renewable energy, its electric mobility strategy is part of a larger national goal to increase the share of renewables in the country's energy mix.[870] In June 2017, the first all-electric **TransMilenio bus**, running on 100% renewable energy, started operation in **Bogotá, Colombia**. The long-term goal is to expand the zero fuel buses fleet over the next years to help reduce carbon emissions. One single electric bus will curb 135 tonnes of CO_2 emissions every year.[871]

In Africa, production of biofuels increased 28% in 2017, up from 17% in 2016.[872] In **Nigeria**, the state oil corporation signed an agreement with the government of the **state of Kebbi** to build an ethanol plant, and in **Zambia**, **Sunbird Bioenergy Africa** launched a program to secure the feedstock for an ethanol project to provide 15% of **Zambia**'s petroleum requirements.[873]

- **Aviation** accounts for around 11% of the total energy used in transport.[874] In 2017, several airlines and airports made progress using biofuels for long haul flights, securing appropriate fuels and making biofuels available at key airports. **Virgin Australia** procured aviation fuels from **Gevo**, and Chicago's O'Hare airport also used fuel from Gevo to supply eight airlines using the airport for a trial period.[875] **Qantas** signed a long-term supply contract with **Agrisoma** to supply fuels based on carinata oil seed, and carried out a trans-pacific flight from Los Angeles to Melbourne using 24 tonnes of a 10% blend of carinata-based biofuels.[876] China's **Hainan Airlines** also made a trans-Pacific flight from Beijing to Chicago using biofuel derived from waste cooking oil.[877]

- **Shipping** consumes around 12% of the global energy used in transport,[878] and is responsible for approximately 2% of total economy-wide CO_2 emissions. **China** saw the launch of the world's first all-electric cargo ship in 2017, while in **Sweden**, two large ferries were converted from diesel to electricity.[879] The Finnish company Viking Line installed the world's first rotor sails on a passenger vessel in 2018, which saves them 900 tons of fuel annually.[880] For example, in the **Netherlands**, **GoodFuels** collaborated with the Dutch coastguard to supply biofuels for use in its ships, and with **Heineken** and **Nedcargo** to demonstrate the use of biofuels on inland waterways, transporting beer from a brewery in Zouterwoude to Rotterdam before being exported internationally.[881] The Great Green Fleet – an energy efficiency initiative by the United States Navy – is supporting the Australian Navy to reduce their resilience on fossil fuels by trialing biofuels in its fleet.[882]

- **Rail** accounts for around 1.9% of the total energy used in transport, and it is the most highly electrified transport sub-sector. The share of electricity was estimated at 39% in 2015, up from 29% in 2005.[883] Just over a third of the electricity is estimated to be renewable, contributing 9% of rail energy.[884] The **New South Wales** government in Australia announced a renewable tender for the **Sydney** light rail system.[885] In 2016, **Chile** announced that as of 2018, Santiago's subway system – the second largest in Latin America after **Mexico City** – would be powered by solar photovoltaic (42%) and wind energy (18%).[886]

Global Initiatives Supporting Renewable Energy in Transport

- The **Future of Fuels** is a collaborative initiative led by the nongovernmental organization Business for Social Responsibility (BSR) to drive a sustainable transition to low carbon commercial road freight with new tools, convenings and partnerships. They have developed the Sustainable Fuel Buyers' Principles, and a Fuel Sustainability Tool.

- The **BioFuture Platform** is an international, country-led initiative, a multi-stakeholder mechanism for policy dialogue and collaboration among leading countries, organizations, academia and the private sector. In 2017, the BioFuture Platform saw 19 countries agree to scale up their bioenergy commitments and develop sustainable biofuels targets, and the Mission Innovation Sustainable Biofuels Challenge was launched and aims to stimulate and coordinate efforts to bring new sustainable biofuels to the market.

- The **World Business Council for Sustainable Development (WBCSD)** created the Low Carbon Technology Partnership initiative on Low Carbon Freight, which is building a coalition of companies, governments and customers to share and scale replicable models to achieve emissions reduction actions in road freight globally.

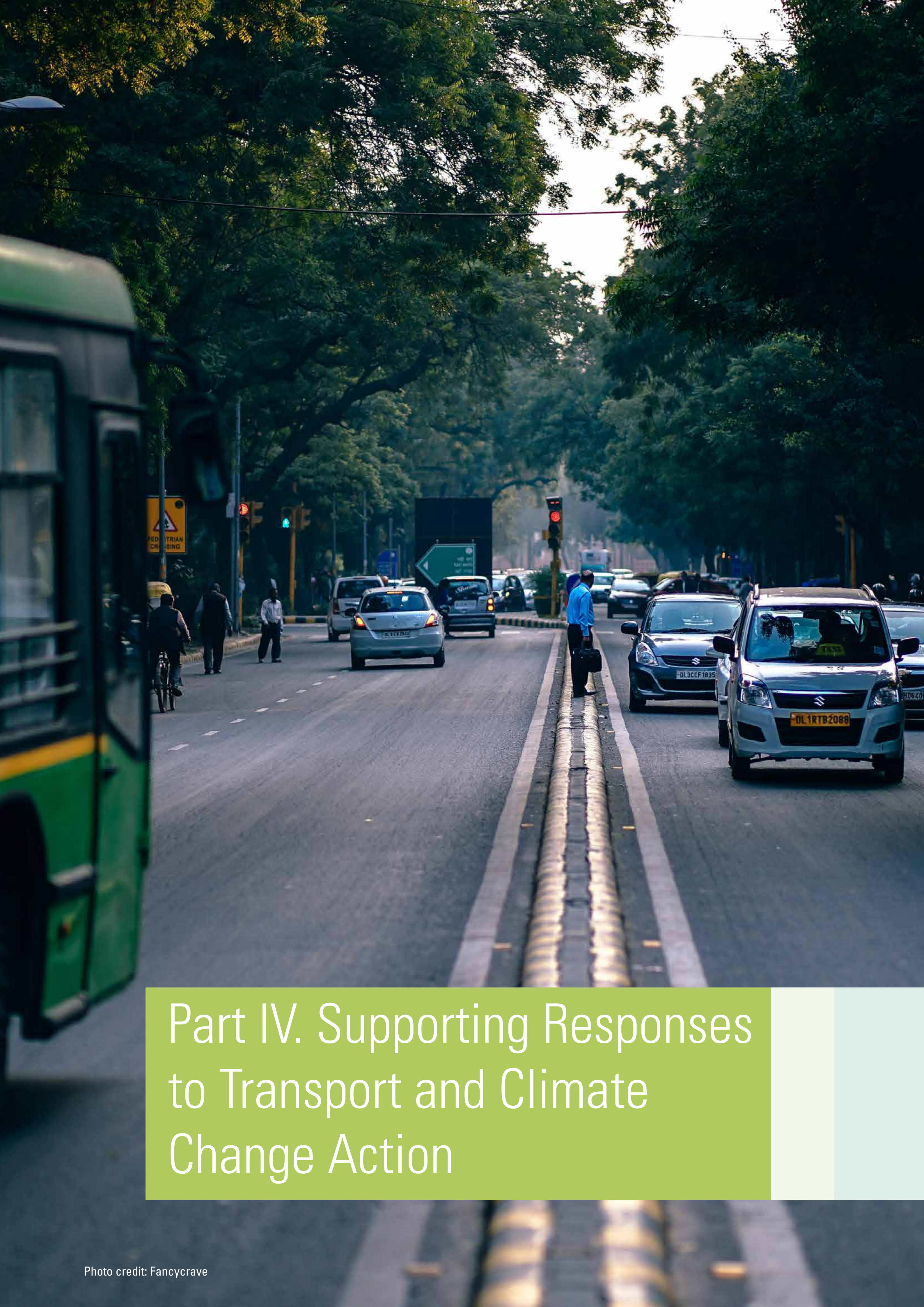
- **RE100** is a global initiative led by The Climate Group in partnership with the CDP (former Carbon Disclosure Project). It involves over 130 influential businesses committed to 100% renewable electricity, including companies in the transport sector. For example, the FIA Formula E, the first electric single-seater championship where all cars run on 100% renewable power, and La Poste, the leading mail service in France committed to powering its EV fleet with 100% renewable electricity by 2020.

- At the climate conference COP 23 in November 2017, a multi-stakeholder alliance launched the **Transport Decarbonisation Alliance (TDA)**.[887] **France**, the **Netherlands**, **Portugal**, **Costa Rica** and the **Paris Process on Mobility and Climate (PPMC)** are members of the Alliance, which includes countries, cities, regions, and private-sector companies committed to ambitious action on transport and climate change.

Dashboard III: Market Developments and Policy Landscape

	Years	Global Value	Regional Breakdown						Data Sources
			Africa	Asia	Europe	Latin America	North America	Oceania	
1. Sustainable Mobility Planning and Transport Demand Management									
Low emissions zones (# of cities)	2015	189	0	2	187	0	0	0	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb, Sadler Consultants Europe GmbH, (2018). Urban Access Regulations in Europe. Available at: http://urbanaccessregulations.eu/, Wang, Y. et al., (2017). Study on International Practices for Low Emission Zone and Congestion Charging. World Resources Institute. Available at: https://www.wri.org/sites/default/files/Study_on_International_Practices_for_Low_Emission_Zone_and_Congestion_Charging.pdf
	2017	241	0	3	238	0	0	0	
	% Δ	28%	0%	50%	27%	0%	0%	0%	
Sustainable Urban Mobility Plans (# of plans)	2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Based on SLoCaT calculations of GIZ, (2018). Urban Mobility Plans. Available at: https://www.google.com/maps/d/u/0/viewer?mid=1PnE9ux2r3BhcFGv2M_AZ1pD7SwU&ll=19.816856479523285%2C-1.4289565999999922&z=3
	2017	806	42	123	500	68	51	22	
	% Δ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
2. Urban Public Transport									
Bus Rapid Transit (BRT) (# of systems)	2016	167	5	42	44	54	18	4	BRT+ Centre of Excellence and EMBARQ, (2018). Global BRTData. Version 3.37. Available at: http://www.brtdata.org
	2017	169	5	43	44	55	18	4	
	% Δ	1%	0%	2%	0%	2%	0%	0%	
Urban Rail (Metro and Modern Light Rail) (# of systems)	2015	220	6	82	88	20	24	0	SLoCaT, (2018). TraKB. Available at: http://www.slocat.net/trakb
	2017	223	6	85	88	20	24	0	
	% Δ	1%	0%	4%	0%	0%	0%	0%	
3. Railways									
Rail freight activity (billion ton-km)	2015	8567.47	136.492	3022.488	2824.252	0.000	2524.585	59.649	UIC, (2016). Railway Statistics 2015 Synopsis. International Union of Railways. Available at: https://uic.org/IMG/pdf/synopsis_2015_print_5_.pdf; UIC, (2017). Railway Statistics 2016 Synopsis. International Union of Railways. Available at: https://uic.org/IMG/pdf/synopsis_2016.pdf
	2016	8614.87	133.453	2985.763	2899.528	0.000	2547.253	59.649	
	% Δ	1%	-2%	-1%	3%	0%	1%	0%	
High-speed rail (km)	2015	33,174	0	23481.3	9692.4	0	0	0	UIC and IEA, (2017). Railway Handbook 2017. Energy Consumptions and CO2 Emissions International Union of Railways and International Energy Agency. Available at: https://uic.org/IMG/pdf/handbook_iea-uic_2017_web3.pdf
	2016	34,678	0	24216.2	10462.118	0	0	0	
	% Δ	5%	0%	3%	8%	0%	0%	0	
4. Walking and Cycling									
Mode share of walking (% of travel time or distance)	2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	% Δ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mode share of cycling (% of travel time or distance)	2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	% Δ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

	Years	Global Value	Regional Breakdown						Data Sources
			Africa	Asia	Europe	Latin America	North America	Oceania	
5. New Mobility Services									
Bike-sharing systems (# of systems)	2010	277	0	44	219	2	9	3	SLoCaT calculations based on Meddin, R., (2018). Bikesharing Map. Available at: http://www.bikesharingmap.com
	2017	1766	2	698	685	67	291	22	
	% Δ	538%	N/A	1486%	213%	3250%	3133%	633%	
Car-sharing systems (# of vehicles)	2014	104,060	N/A	20,344	57,947	35	24,210	1,524	Shaheen, S., Cohen, A. and Jaffee, M., (2018). Innovative Mobility: Carsharing Outlook. UC Berkeley: Transportation Sustainability Research Center. Available at: https://escholarship.org/uc/item/49j961wb
	2016	157,357	379	67,329	57,857	61	26,691	5,040	
	% Δ	51%	N/A	231%	0%	74%	10%	231%	
6. Fuel Economy									
Countries with LDV fuel economy standards (# of countries)	2016	37	0	4	30	1	2	0	Yang, Z., Bandivadekar, A. (2017). 2017 Global Update Light-duty vehicle and greenhouse gas and fuel economy standards. The International Council on Clean Transportation. Available at: https://www.theicct.org/sites/default/files/publications/2017-Global-LDV-Standards-Update_ICCT-Report_23062017_vF.pdf
	2017	38	0	5	30	1	2	0	
	% Δ	3%	0%	0%	0%	0%	0%	0%	
Countries with HDV fuel economy standards (# of countries)	2016	4	0	2	0	0	1	0	GFEI, (2017). Targeting Heavy Duty Vehicle Fuel Economy. Global Fuel Economy Initiative. Available at: https://www.globalfueleconomy.org/media/460941/hdv-fuel-economy.pdf
	2017	5	0	3	0	0	1	0	
	% Δ	25%	0%	50%	0%	0%	0%	0%	
7. E-Mobility									
Electric vehicle stock (Battery and Plugin-Hybrid Electric Vehicle)	2016	198204	670	816410	563460	1080	592980	7609	IEA, (2018). Global EV Outlook 2018. International Energy Agency. Available at: https://webstore.iea.org/global-ev-outlook-2018
	2017	3109050	860	1466240	798870	1850	808010	13541	
	% Δ	57%	28%	80%	42%	71%	36%	78%	
Countries with electric vehicle targets (# of countries)	2016	48	4	14	24	3	1	2	SLoCaT, (2018). E-mobility Overview on Trends and Targets. Available at: http://slocat.net/sites/default/files/e-mobility_overview.pdf
	2017	61	4	19	31	4	1	2	
	% Δ	27%	0%	36%	29%	33%	0%	0%	
8. Renewable Energy in Transport									
Biofuels global production (billion litres)	2016	139.9	0*	11.3*	19.5*	35.6*	67.2*	0	REN21, (2017). Global Status Report 2017. REN21 Secretariat. Available at: http://www.ren21.net/gsr-2017/, REN21, (2018). Global Status Report 2018. Paris, REN21 Secretariat. Available at: http://www.ren21.net/gsr-2018/
	2017	143.5	0*	12.2*	19.4*	38.1*	69.9*	0	
	% Δ	3%	0%	8%	-1%	7%	4%	0%	
Countries with biofuel mandates (# of countries)	2016	61	7	9	30	12	2	1	*Data for regions based only on a subset of countries
	2017	62	7	9	30	12	2	2	
	% Δ	2%	0%	0%	0%	0%	0%	100%	



Part IV. Supporting Responses to Transport and Climate Change Action

Photo credit: Fancycrave

A. Financing for Transport and Climate Change

This section summarizes global investment in the transport sector and examines the current level of investment from four sources: the public sector, the private sector, official development assistance (ODA), and climate finance. The funding gap between the current level of investment and projected future needs in the transport sector is highlighted as well (Box 5).

1. Current Transport Investments and Projected Future Investment Needs

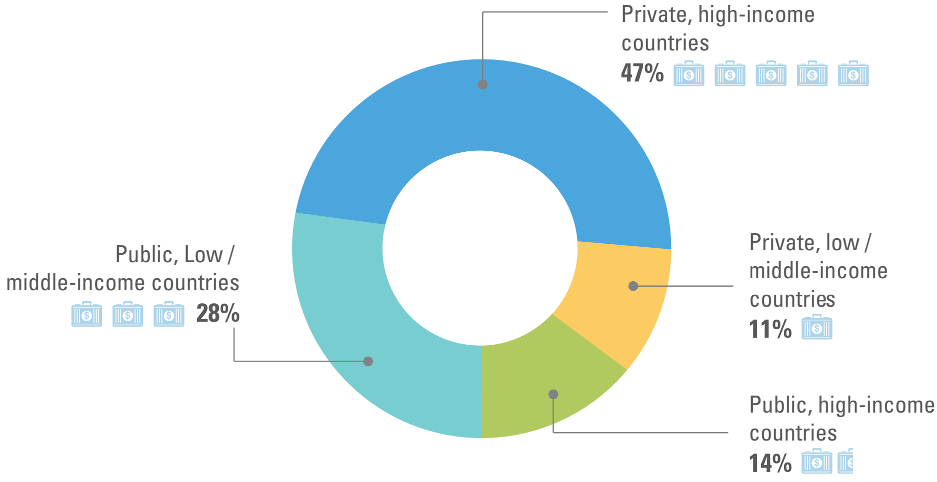
- Global annual investment in transport in 2010 was estimated in the range of USD 1.4 and USD 2.1 trillion, with a mean value of USD 1.75 trillion.
- Projected transport infrastructure financing needs are between USD 2 to USD 5.8 trillion per year for 2DS, and USD 5.8 trillion per year for B2DS.
- Transport investment needs (infrastructure, fuels and vehicles) can reach USD 860 trillion between 2017 and 2060 in a BAU scenario, and USD 751 trillion for B2DS.

The total investment in transport infrastructure in 2011 for 25 Asia-Pacific economies, which represent around 60% of the global population, was around USD 300 billion.[890] In Africa, investments for transport totaled USD 24.5 billion in 2016, down from USD 34.4 billion in 2014.[891] The World Bank estimated that developing regions invested approximately 4% to 8% of their GDP in infrastructure, with the exception of Latin America, which invested less than 3%.[892]

Public-sector investment represented 42% of the global total for transport in 2010, and private-sector investment therefore represented 58% of the global total (mean value estimate of USD 1.015 trillion) (Figure 55). ODA for transport constituted only 2% of public-sector investments investment in 2010. While 12 transport projects funded by climate finance instruments (CFI) in 2017 totaled only USD 111 million, and 16 climate-related bonds (often referred to as green bonds) enabled an investment volume of USD 6.9 billion.[894]

Many investments are given to conventional projects instead of focusing on sustainable, low carbon transport. An analysis of the private participation in infrastructure (PPI) Database shows that for land transport, conventional road projects account for three out of four transport investments.[895] Official development finance (i.e. ODA and other official flows) for transport show that in 2013 only 30% of transport financing

Figure 55: Proportion of Public and Private Investment in Transport, 2010 estimate[893]



Current Investments in Transport

Global annual investment in transport in 2010 was estimated to be in the range of USD 1.4 and USD 2.1 trillion.[888,889] An estimated 76% of the total mean investment (USD 1.75 trillion) from public and private sources was in high-income countries (USD 1.3 trillion), and the remaining 24% (USD 420 billion) was in low and middle-income countries (Figure 55).

can be considered in support of low carbon transport.[896] In Africa, 44% of the transport support was used for road projects, only 19.2% for urban transport and 4.15% for rail.[897] The **European Union**, in November 2017 proposed to invest EUR 1 billion in 39 transport projects using the European Union Fund, Connecting Europe Facility. For the first time European Union grants are combined with financing from the European Investment Bank (EIB), National Promotional Banks and private banks.[898]

Projected Future Investment Needs

Focusing on transport infrastructure needs, a follow-up study by the **World Resources Institute (WRI)** estimates 2050 investment needs at USD 2.3 trillion per year in to reach 4DS benchmarks, and USD 2 trillion per year for 2DS, suggesting that a low carbon transport pathway is more cost-effective. Non-OECD countries are projected to require over twice the investment of the OECD countries to 2060, with 2DS requiring about 15% more investment in the non-OECD countries compared to the status-quo.[899]

Box 5: Calculating Projected Transport Investment Needs

The International Energy Agency (IEA) presented three pathways for energy sector development to 2060,[901] and estimated their relative costs:

Table 13: IEA pathways for energy sector development to 2060

IEA Scenario	RTS: reference for 'business as usual' scenario (i.e. the global four-degree Celsius warming scenario)[902]	2DS: two-degree Celsius warming	B2DS: beyond two-degree Celsius warming
Projected Cost vs. RTS (2017-2060)	--	USD 130 trillion cheaper	USD 110 trillion cheaper
Projected Savings	--	Projected fuel savings of USD 88 trillion	Projected fuel savings of USD 110 trillion

Recurrent fuel savings are mainly expected to accrue in the first instance to individuals and firms, not the public sector. Thus, it is useful to look at what component of total costs in the RTS and the B2DS required public investment (e.g. roads, railways, other transport infrastructure, associated rolling stock) as opposed to those associated with the spending of individuals and firms (e.g. vehicles, fuels). Using IEA data, components of public investment for the RTS and B2DS scenarios from 2017-2060 are estimated to be USD 193 trillion and USD 261 trillion, respectively; a difference of USD 66 trillion.

Using this approach, the financing gap may be as low as USD 40 trillion from 2017-2060, or USD 930 billion per annum (2015 prices), with 60% required to meet the needs in developing countries. This estimate assumes that the savings on roads are realizable, and that some of the higher investment required in the B2DS can be offset by new revenues from motoring taxes and charges.[903]

Calculations by the IEA for the whole transport sector (expenditure on vehicles, infrastructure and fuels) show that the projected financing need for 2017-2060 is USD 20 trillion per year (Reference Technology Scenario (RTS)) and 17.5 trillion per year to meet the B2DS low carbon pathway, which results in a gap of USD 109 trillion (See Box 5 for more details.) Under the same scenarios, transport infrastructure spending projections assume a need of USD 5.7 trillion per year for RTS, USD 5.8 trillion per year for 2DS, and USD 7.2 trillion per year for B2DS. The higher costs for the low carbon scenarios (i.e. 2DS and B2DS) are due to expansion of intercity rail, metro systems and HSR networks.[900]

The **Institute for Transportation and Development Policy (ITDP) and University of California, Davis** estimated the infrastructure costs for urban transport between 2010 and 2050 in a BAU scenario and a high-shift scenario, where investment prioritizes public transport, walking and cycling. In the BAU scenario, the total costs came to roughly USD 12.5 trillion per year (or USD 500 trillion in total), while the costs in the high-shift scenario are USD 10 trillion per year (USD 400 trillion in total). It concludes that investments in low carbon transport are over 20% cheaper and reduce CO_2 emissions of urban transport by 40% below the 2050 BAU scenario. In the study, OECD countries account for 40% of costs, while non-OECD countries account for the remaining 60%.[904]

For the period 2015-2035, the net transitional investment required to increase the ability of existing and new transport systems to mitigate climate change is estimated at just over USD 3 trillion (in addition to existing transport investments estimated at USD 1-2 trillion per year), of which over 80% relates to low-carbon modes (e.g. railways and mass transit).[905]

The transport infrastructure financing needs of the 45 developing countries in Asia-Pacific are estimated to be an average USD 557 billion per year (or USD 8.4 trillion in total) between 2016 and 2030. This includes an estimated USD 37 billion per annum for climate proofing treatment of transport.[906]

2. Current Sources of Transport Finance

- The private sector contributed 58% of the global total transport investment, with the bulk (81%) of this in high-income countries.
- Transport lags behind other sectors in climate finance, as less than 2% of climate finance projects are associated with low carbon transport.
- Green bonds for transport are on the rise, reaching between USD 17 to USD 24 billion in 2017.
- Transport remains largely marginalized in discussions of carbon pricing and emission trading schemes, with key exceptions.

To reach Paris Agreement targets, significant transformational investments are required to increase the sustainability of both existing and new transport systems. Transport finance can be channeled through a range of capital financing instruments, and through a mix of institutional channels in a variety of ways:

1. Investment by **government agencies**, which draw on revenue from user charges, beneficiary charges, taxes, borrowing, asset sales, operating efficiencies and, for lower levels of government, transfers from higher levels of government;
2. Investment by **public or semi-public business enterprises**, which contribute equity and draw on loans and other debt instruments such as bonds that are serviced by revenue from beneficiary charges and government contributions; and
3. Investment by the **private sector**, through public-private partnerships, with the private sector contributing equity and drawing on loans and other debt instruments such as bonds that are serviced by revenue from beneficiary charges and government contributions.

Public Sector Investment

Global domestic transport investment by governments was estimated to range between USD 558 billion and USD 886 billion in 2010, or 42% of the total global transport investment.[907] **China**, **Japan**, and the **United States** accounted for around half of all domestic government transport spending in 2010.[908] Nearly one-third of public investment in transport occurs in developing countries, primarily in large upper-middle income countries like **Brazil**, **India**, and **Russia**. Among all low and middle-income countries, public investment accounts for more than half (56%) of the total transport investment.[909] In the Asia-Pacific region, the public sector was the dominant mode of financing of transport infrastructure between 2011-2014. During this period, **Bhutan**, **China**, **India** and **Vietnam** each invested more than 5% of GDP in infrastructure.[910] The rapid growth of transport demand factors will lead to many future investments to be taking place in developing countries.

National Transport Investment Programs

High-quality public transport networks are generally reliant on dedicated national government financial support, and in many cases national funding is contingent on lower levels of government meeting certain criteria, such as the completion of sustainable urban mobility plans (SUMPs). National governments in **Brazil**, **Colombia**, **India** and **Mexico** have introduced programs to at least partially fund construction of new mass transit systems.[911] The MobiliseYourCity Partnership is assisting the development of mobility plans to support new national mass transit investment programs in countries such as **Indonesia** and **Peru**.[912]

Sustainable Transport Subsidies

Public subsidies can reduce the cost of sustainable transport measures, including, low-emission transport modes and freight transport. This can help incentivize shifting trips from more energy intensive, higher emitting modes to more sustainable modes.

Public subsidies may target transport users (e.g. through public transport fare subsidies for low-income populations), though evidence suggests that current subsidies do not always benefit those with the greatest need. Other subsidies target transport operators (e.g. to increase available supply of public transport services), though there is broad evidence that operating subsidies can lead to inefficiencies.[913] Subsidies may also incentivize less sustainable transport modes (e.g. by reducing the cost of fossil-fuel based modes; see *Box 6: Fossil Fuel Subsidies*).

Some recent subsidy announcements accrue directly to transport consumers. For example, EV owners in **China** receive purchase tax exemptions between USD 5,000 and USD 8,500 from the national government.[914] **Sweden** budgeted USD 42 million annually from 2018-2020 to provide consumers with a 25% discount on the purchase price of an e-bike.[915] Similarly, in February 2017, **France** announced that individuals can receive a EUR 200 rebate for purchasing a pedal-assist electric bike through January 2018.[916] (See *Section III.B.7 Electric Mobility* for further discussion of EV uptake targets and subsidies.)

Box 6: Fossil Fuel Subsidies

Many governments maintain fossil fuel subsidies or fail to adequately tax fossil fuels, suppressing retail prices of gasoline below the price of crude oil on the world market.[917] These public subsidies lock society into private road transport powered by gasoline or diesel fuels.[918] The International Monetary Fund (IMF) estimates that the monetized impacts of externalities are 10 times the direct financial cost of subsidies. While the distortionary effects of these direct and indirect subsidies are well recognized, many governments find these policies difficult to abandon due to vested interests.

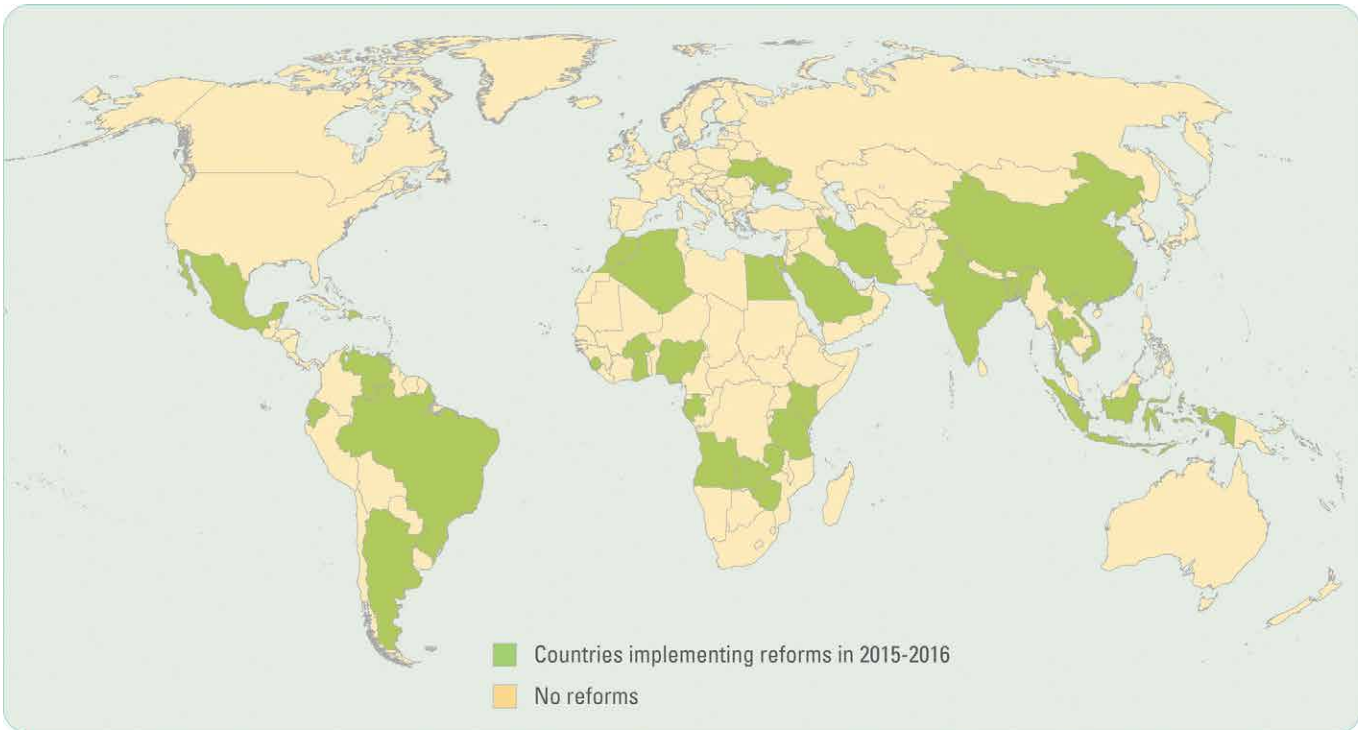
Annual global fossil fuel subsidies were estimated to be around USD 425 billion in 2015.[919] Of this, USD 325 billion are spent on consumer subsidies to keep the price of fossil fuels down, while the remaining USD 100 billion are government subsidies that artificially lower the costs of production.[920] On average in 2015 and 2016, G7 governments gave at least USD 81 billion annually in fiscal support and USD 20 billion in public finance, for both production and consumption of oil, gas and coal at home and overseas, and a significant part of the subsidies (USD 26 billion) goes towards fossil fuel use in the transport sector.[921] In 2016, the G7 decided to end most of fossil fuel subsidies by 2025.[922]

Between 2014-2016, 11 European countries and the European Union (responsible for 83% of Europe's energy-related GHG emissions) provided at least EUR 112 billion in annual subsidies to the production and consumption of fossil fuels, with 44% of these subsidies provided to the transport sector.[923]

Several countries have reformed their **fossil fuel subsidies** since 2015 (Figure 56): Fossil fuel reforms in **Indonesia** in 2015 realized 10% savings of the state budget (USD 15.6 billion), and increased the budget of the Ministry of Transportation by 45%.[924, 925] **India** removed price controls on diesel and gasoline, and launched a successful campaign to get richer consumers to voluntarily give up subsidized liquefied petroleum gas.[926] **The United Arab Emirates** in July 2015 announced additional reforms on fuel subsidies to encourage individuals to adopt more fuel-efficient vehicles and use more public transport. As a result of fuel price increases, the modal split of public transport increased from 6% in 2006 to 17% in 2017.[927]

In April 2017 prime ministers of the **Nordic countries** together launched the Nordic Solutions to Global Challenges initiative, which incorporated fossil fuel subsidy reform as a key priority.[928] The implementation of pricing reforms for transport fuels remains a complicated domestic issue in many countries, as shown by the social unrest that followed fuel reforms in **Mexico** in January 2017. The 20% rise of transport fuel prices, caused by bringing the fuel prices closer to the true market value, led to nationwide protests.[929]

Figure 56: Countries Implementing Fossil Fuel Subsidy Reform in 2015-2016[930]



Private Sector Investment

In 2010, private-sector investment represented 58% of the **global total transport investment** (mean value estimate of USD 1.015 trillion), or approximately USD 589 billion.[931] Private-sector investments in transport were distributed by sub-sector as follows: (i) roads, about 50%; (ii) rail/ metro, about 22%; (iii) airports 19%; and (iv) ports 9%.[932]

Private-sector investment commitments in **developing countries** totaled USD 71.5 billion across 242 projects in all sectors. Transport represented 36% of these investments (USD 44 billion).[933] Transport represented about 29% of the estimated mean private investment in 2010 in low-middle income countries, excluding **China**.[934] In Africa in 2016, the non-public-sector investment in transport accounted for 20% of total investment.[935] And for example in **India** and **China**, transport infrastructure (including roads, railways, airports, and seaports) accounts for more than 30% of total private infrastructure investment.[936]

So much of this is public investment which is privately financed as governments issue **bonds** and used for their own project development; considered here to be public investment. Many of the world's railways and metros were privately funded using bond issuance - whether project bonds, local authority bonds, or government bonds. At present, large institutional investors want to buy infrastructure bonds to match their long-term local currency liabilities, so there is great potential for developing bonds as the major arm of private investment in sustainable transport, if necessary with guarantees and credit enhancement measures to arrive at a suitable risk allocation. Approximately USD 263 billion of rail bonds were issued in **China** in 2010 (See discussion of climate-themed and "green" bonds in Part 5, below.).[937] About USD 181 billion of private-sector finance was estimated for low and middle-income countries in 2010, or 18% of total private investment.[938]

Another mechanism for private-sector investment in transport is a **public-private partnership (PPP)**. PPPs can entail the private-sector funding, constructing and even operating of public infrastructure and services. The private sector does this using equity provided by shareholders and drawing on loans and other debt instruments such as bonds. PPP agreements also provide the private-sector business with a stream of revenue that it can use to service its debts, and to provide a return on its equity. In 2017, PPI investment for transport nearly doubled from 2016, from USD 18.8 billion to USD 36.5 billion, equal to 39% of global PPI investment. This was largely due to a USD 6.8 billion HSR project in **China**; a USD 6.0 billion HSR project in **Indonesia**; and a USD 3.1 billion monorail project in **Thailand**.[939]

3. Official Development Assistance for Transport

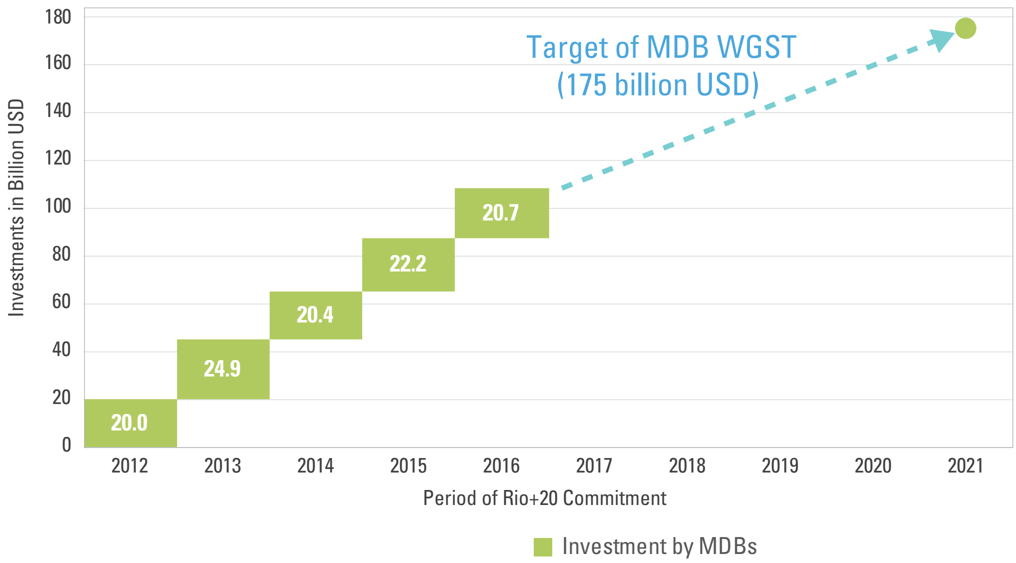
Multilateral and bilateral ODA channeled through governments was estimated to be about 2% of total transport sector investment in 2010.[940] For the Asia-Pacific region, it is estimated that 2.5% of total investment was via ODA in 2015.[941] Thus, current domestically public-financed investment in transport is by far greater than ODA. Nevertheless, ODA may have a more significant role in certain regions, locations and at periods of economic downturn. For example, in 2012, up to 10% of total spending in Sub-Saharan Africa on infrastructure of USD 81.6 billion was financed by international development assistance.[942]

Of similar significance to ODA are **export credits**, which represented about USD 16 billion of commitments for 'Transport and Storage' in 2012.[943] For example, **France** and **Germany** are financing new metro lines via export credits in **Hanoi** and **Ho Chi Minh City**, **Vietnam**, respectively.

4. Multilateral Development Bank Investments in Sustainable Transport

In 2012, eight multilateral development banks (MDBs)[944] committed to invest USD 175 billion in loans and grants for sustainable transport in developing countries from 2012-2022 as part of the Rio+20 Commitment (Figure 57).[945] Between 2012 and 2016, the MDBs had collectively committed USD 108 billion, which is on track to meet the target. Even though the average of USD 17.5 billion per annum is itself only a part of total ODA, this commitment supports a shift of investments towards sustainable transport. These MDBs also committed to a greater purpose of bringing the latest knowledge on sustainable transport activities to countries and demonstrating effective approaches that can then be scaled up.

Figure 57: Investments by MDB Working Group on Sustainable Transport Towards the Goal of Rio+20 Commitment[945]



From 2012 to 2016, Asia has received the greatest volume of MDB investment with USD 39.6 billion, followed by Europe (USD 25.8 billion), Africa (USD 21.3 billion) and the Latin American and Caribbean region (USD 19.7 billion) (Reference Table 6).

Funding for Mitigation and Adaptation

Not all transport investments are not considered climate finance. MDBs define climate finance as financial resources committed by MDBs for operations and components enabling activities related to climate change mitigation and adaptation in developing and emerging economies.[947] Examples of types of projects or project elements that count as mitigation investments counted as climate finance include railways, inland waterway transport, urban public transport and energy switching/reduction. In the case of adaptation, each project is examined on a case by case basis and only the incremental portion of investment needed for adaptation is counted as climate finance. If an investment includes mitigation and adaptation there is no double-counting, and its value is apportioned between the two as considered appropriate by the respective MDB. From 2011 to 2017, multilateral development banks committed USD 37.4 billion to MDB climate finance for transport mitigation, representing 19% of the total MDB climate finance of USD 193.8 billion during the period (Reference Table 7).

In 2016, the eight largest MDBs reportedly provided USD 4.7 billion to climate finance for mitigation in the transport sector, representing 22% of the total **mitigation** finance of USD 27.4 billion. Year to year total figures for mitigation have averaged USD 26 billion (in current prices). In total, finance for adaptation for all sectors in 2016 was 29% of that provided for mitigation.[948] Investment loans have provided 73% of mitigation finance, and 79% of **adaptation** finance.

Climate Change Funding Targets[949]

Establishing long-term targets to increase climate-focused investments is a growing trend among MDBs. At or around COP 21 Paris in 2015, seven of eight MDBs represented in the Working Group on Sustainable Transport set targets to increase climate spending for transport and other sectors, and two years later, these targets are being translated to the implementation of projects to support low-carbon, resilient transport systems.

Some MDBs have set specific targets to increase climate-specific investments for transport. For example, in 2015, the **Asian Development Bank (ADB)** set a 2020 goal of USD 1 billion for transport climate mitigation and adaptation, out of a planned USD 6 billion investment in climate action by 2020. In 2013, **European Bank for Reconstruction and Development's (EBRD)** Transport Strategy committed to doubling the contribution of transport (by annual business volume) to the goals of its Sustainable Energy Initiative over the five-year period (2013-2018), relative to the previous five-year period. **Islamic Development Bank (IsDB)** expects to set specific investment targets for transport and other sectors following the anticipated development of its action plan in 2018. **The World Bank (WB)** has the target of 28% climate finance by 2020, and 35% for transport by 2020.[950]

Other MDBs have opted to set **aggregated targets across sectors**, or to set only indicative targets for climate investments in sustainable transport. In this vein, **African Development Bank (AfDB)** has not set sector-specific targets in its USD 5 billion 2020 climate change lending goal (set in 2015); but it is anticipated that transport and energy will account for more than 50% of the total. In 2013, **EIB** targeted at least 25% of annual investment in climate change mitigation and adaptation; and in 2015 increased this target to 35% of investments in developing countries by

2020. **Development Bank of Latin America (CAF)** established a new climate target in 2017, with the goal that by 2020 30% of operations have at least one climate change component (building on 22% in 2016), though there is no specific target for the transport sector. **Inter-American Development Bank (IADB)** aims for 30% of approvals by 2020 to be climate change-related, including project (sub)components that contribute to adaptation or mitigation.

5. Climate Finance for Sustainable Transport[951]

Climate Finance Instruments

Climate finance covers projects by nine major climate finance instruments (CFIs): Clean Development Mechanism (CDM), the Clean Technology Fund (CTF), the Green Climate Fund (GCF), the Global Environment Facility (GEF), the International Climate Initiative (IKI), the Joint Crediting Mechanism (JCM), Joint Implementation (JI), Nationally Appropriate Mitigation Actions (NAMA), and the Nordic Development Fund (NDF).

Until now, transport lags behind other sectors in climate finance, mainly because of project selection criteria that favor other sectors, and overlook co-benefits of low-carbon transport projects. Less than 2% of climate finance projects have been for transport. From 1992 to 2017, nine CFIs have approved 282 projects for transport, cumulatively contributing approximately USD 3.8 billion of support. [952] However, analysis of recent projects in the CFI pipelines indicates a decrease in transport projects: 12 transport projects in 2017 supported by CFIs, down from a peak of 41 CFI-funded transport projects in 2012.

The overall trend of CFIs shows a decrease of transport projects and investment since 2012, apart from 2016, when over USD 1 billion investment volume was achieved through NAMA projects in **Mongolia**, **Serbia** and **Vietnam**. Between 2000 and 2009, the average investment volume was around USD 64 million per year, and it grew to USD 390 million in average for transport between 2010 and 2017. The average number of transport projects per year was 4.5 between 2000 and 2009, and 26.5 between 2010 and 2017 (Figure 58).[953] Overall, the investments of CFIs are marginal compared to the general public and the private-sector investment in transport.

Transport is only a small portion of other financial instruments. For example, the sector accounts for less than 2% for CDM, GEF and JI. Less than 10% of climate change mitigation related funds from the GEF, and 16% of the WB´s CTF have gone to low-carbon transport projects. For the CDM, this share was even lower, with only 0.3% of Certified Emission Reductions being generated from transport projects.

Twelve transport project investments by CFI in 2017 received a total of USD 111 million.[955] The lion's share of CFI-approved transport projects until 2017 were implemented in Asia and the Latin America and the Caribbean region, respectively 134 (48% of all CFI projects), and 69 projects (24%). Africa followed with 47 projects (17%), but the level of investment was higher than in Latin America. **China** received 24 projects, followed by **Vietnam** (20), **Colombia** (18), **India** (17) and **Mexico** (15) (Figure 59).

Figure 58: Climate Finance Projects and Investment Volume by Year[954]

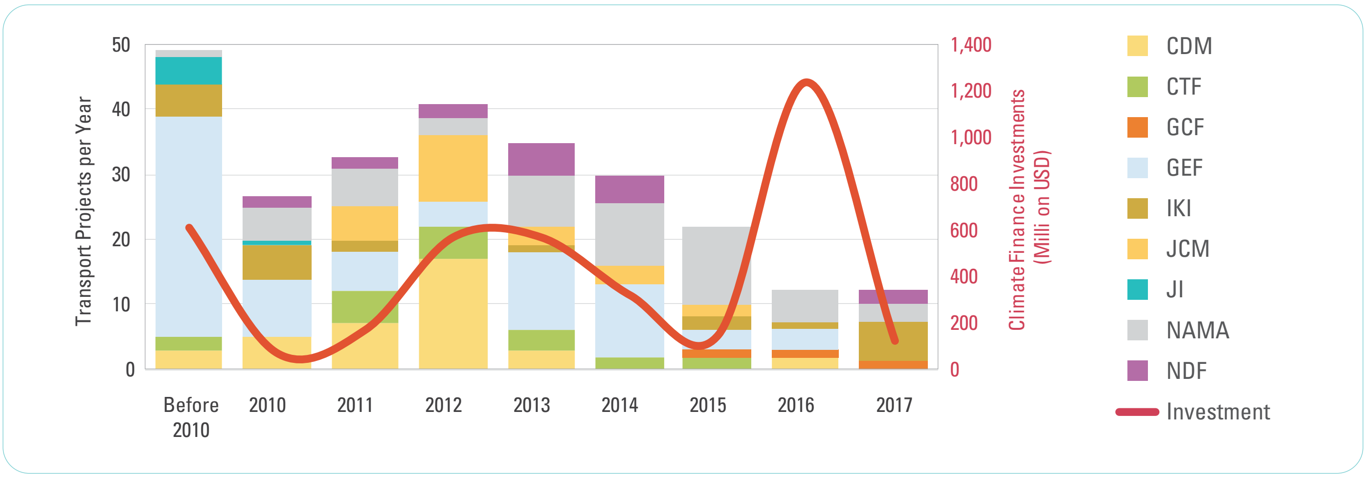
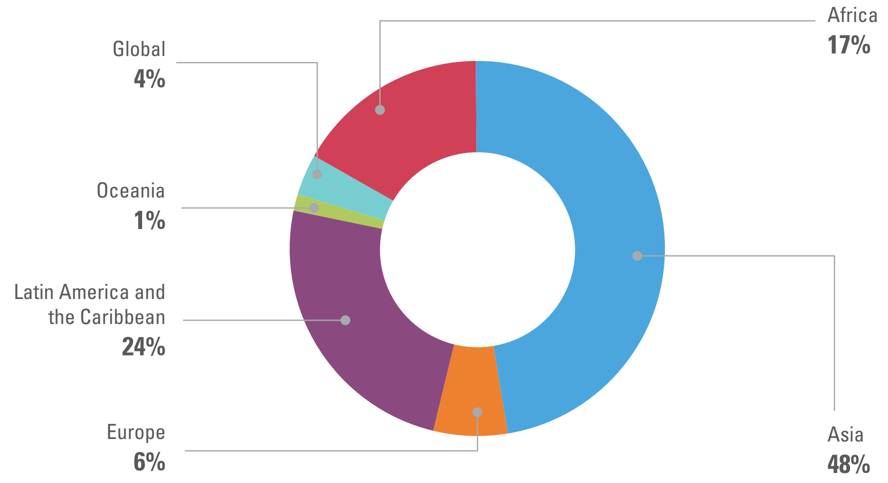


Figure 59: Climate Finance Instruments for Transport from 1992 to 2017 by Region[956]



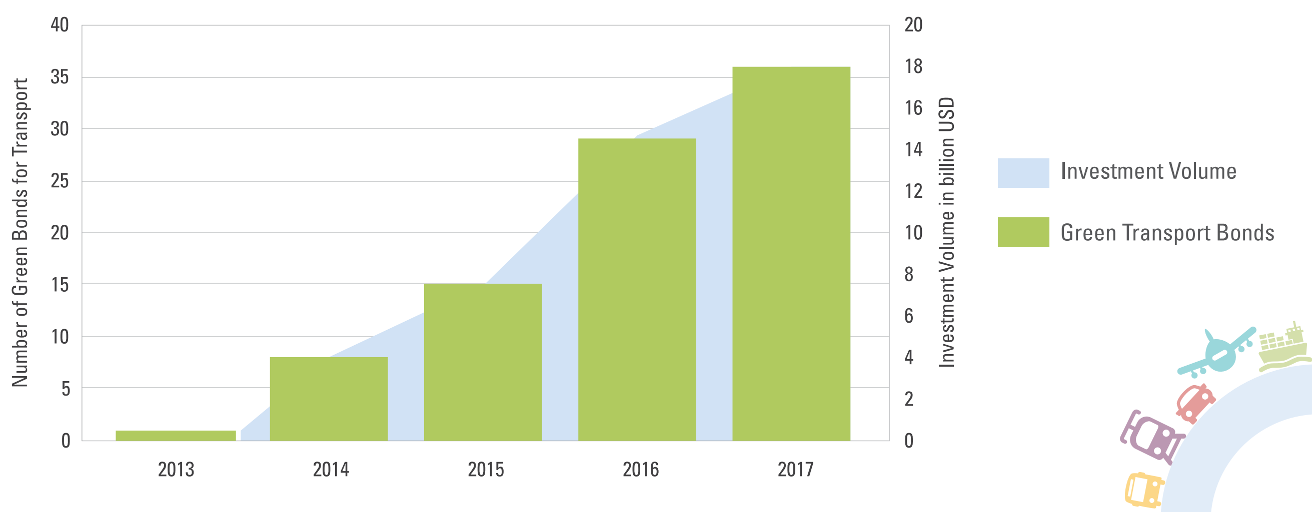
Three-quarters of CFI transport projects are related to **passenger transport**, and among transport sub-sectors, more than 70% relate to **urban transport**, followed by heavy rail (6%) and **walking and cycling projects** (5%).[957] A small amount of CFI projects are related to **water transport** and **shipping** (3%) and **aviation** (1%). No CFI project has been implemented for **high-speed rail** to date.

In all instruments, adaptation projects remain far behind compared to funding for transport mitigation projects. [958] Only 9% of the transport projects approved by CFI since 1992 focus on adaptation. The establishment of the GCF in 2015 has not yet led to an increase in transport adaptation and mitigation projects, as only three of 76 projects to date focus on transport. Resilience for transport infrastructure and services is an ongoing need.

Green Bonds

Many of the world's railways and metros were privately funded using bond issuance - whether project, local authority or government bonds. While CFI transport projects have been decreasing, the position of transport is gaining prominence in green and other climate-themed bonds. There is great potential for developing bonds as the major arm of private investment in sustainable transport because large institutional investors want to buy infrastructure bonds to match long term local currency liabilities. **Green bonds**, bonds with proceeds earmarked for projects with environmental benefits, help to attract investor demand for climate-aligned investments, reduces market friction and therefore facilitates financial flows.[959]

Figure 60: Growth of Transport Green Bonds[965]



In 2017, a total of USD 155.5 billion were labeled **green bonds**.[960] With a multitude of rail and urban metro deals, green bond allocations to low carbon transport almost doubled in volume (from USD 13 billion to USD 24 billion) in 2017, accounting for 15% of total green bond issuances.[961] Beyond this labeled green bond market, the Climate Bonds Initiative (CBI) has defined **unlabeled bonds** as those that fund climate solutions but are not specifically labeled as green.[962] Transport (with 61%) is the largest theme of these unlabeled bonds funding climate solutions, with USD 544 billion outstanding already identified.[963] The majority of these bonds are financing the railway sector (railway infrastructure, rolling stock, subway construction).

SLoCaT identified 36 green bonds issuing USD 17.5 billion in 2017; an increase of 21% in comparison to 2016 (Figure 60). The Climate Bonds Initiative identified that between 2010 and 2017 the number of green bonds prioritizing transport doubled to a total of 97 bonds. Major transport bonds that were issued in 2017 have been funded by the **Bank of China, New York MTA, San Francisco Bay Area Rapid Transit (BART), SCNF, Wuhan Metro** and other organizations. The **Alpha Trains Group**, based in Luxembourg, raised USD 250 million in 2017, and became the first green private bond invested in rail rolling stock to be used for the acquisition of 63 modern electric train sets.[964]

Carbon Pricing

Transport is still largely marginalized in discussions of **carbon pricing** and **emission trading schemes (ETS)** with some exceptions. California updated its **cap-and-trade** scheme in July 2017, which through the inclusion of fuel providers indirectly affects the transport sector.[966] In **China** the world's largest carbon market, which includes transport, was launched in December 2017 after approval of the national ETS by China's State Council.[967]

As of 2017, several countries and subnational entities have included transport in an emission trading or cap and trade schemes, including **Tokyo Metropolitan Area** (2010), **Kazakhstan** (2013), **Quebec** (2015), **California** (updated in 2017), and the seven pilot ETS launched in 2013 in **China**, which ultimately led to the national ETS in 2017.[968]

B. Stakeholders Mobilizing for Action on Transport and Climate Change

Stakeholders from the public and private sector, UN organizations, MDBs, non-government organizations (NGOs) and other transport-related entities are forming collaborative mechanisms to mobilize actions on transport and climate change. These initiatives demonstrate the potential of non-state actors working towards sustainable transport, measuring the progress of transport in addressing climate change, and raising awareness of policy-makers on global processes.

Inspired by the call to action by Secretary General Ban Ki-moon in September 2014 and followed up by the Lima Paris Action Agenda, 15 transport initiatives were developed by non-state actors in the transport sector that were showcased during COP 21. In 2017, six new transport initiatives were formed, and in 2018 one more transport initiative joined. There are now 22 Marrakech Partnership for Global Climate Action (MPGCA) Transport Initiatives, which include both passenger and freight transport and touch on all transport sectors and modes (Box 7). These initiatives complement and build on existing transport-focused initiatives in the UN system, which include the UN Centre for Regional Development (UNCRD) Environmentally Sustainable Transport Forum[969] and the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) Regional Action Programme for Transport Development.[970]


Photo credit: Sarah Petersen/ Portland Bureau of Transportation

Box 7: Marrakech Partnership for Global Climate Action (MPGCA) Transport Initiatives

Airport Carbon Accreditation
Reducing carbon emissions & increasing airport sustainability

Airport Carbon Accreditation aims to reduce carbon emissions and achieve best practices in carbon management from operations fully within the control of airports, with the ultimate target of airports becoming carbon neutral.

Aviation's Climate Action Takes Off
Collaborative climate action across the air transport sector

The Aviation's Climate Action Takes Off initiative aims to control international aviation CO_2 emissions through a basket of aviation CO_2-reduction measures, including a goal of carbon-neutral growth through a global market-based mechanism.

below50
Growing the global market for the world's most sustainable fuels

The initiative commits to reduce CO_2 emissions by replacing 10% of global transportation fossil fuel use with low-carbon transport fuels by 2030, and 27% by 2050; equivalent to 2.1 Gt CO_2 avoided per year.

C40 Clean Bus Declaration
Raising ambition and catalyzing markets

The cities that are part of the initiative will incorporate over 160,000 buses in their fleet by 2020, 42,000 buses of which they have committed to switching to low emission.

Cycling delivers on the global goals
Increase the modal share of cycling worldwide, and double cycling in Europe by 2020

The initiative aims to mobilize support of members from the World Cycling Alliance and the European Cyclists' Federation (ECF) to enable local, national and international governments and institutions to scale up action on cycling.

EcoMobility Alliance
Ambitious cities committed to sustainable transport

The EcoMobility Alliance reinforces local governments' commitments to transforming their transportation systems and mobility patterns, aiming to reduce automobile dependency and become more sustainable, low-carbon and people-centered.

Electric Vehicles Initiative
Accelerate the introduction and adoption of electric vehicles worldwide

The Electric Vehicles Initiative (EVI) is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide. The new campaign, EV 30@30, was launched in 2017 to speed up the deployment of electric vehicles and target at least 30% new electric vehicle sales by 2030.

EV100
Accelerate the transition to electro-mobility

EV100 aims to accelerate the transition to electro-mobility by leveraging the role corporate demand can play in driving EV uptake and the roll-out of charging infrastructure. Companies joining EV100 commit to transitioning their fleets to electric vehicles and/or installing charging infrastructure at their relevant premises by 2030.

Global Fuel Economy Initiative
100 countries for 50 by 50

GFEI aims to double the average fuel economy of new light-duty vehicles globally by 2030, and all vehicles by 2050. It assists governments and transport stakeholders in improving vehicle fuel economy and reducing emissions of carbon dioxide.

Global Green Freight Action Plan (GGFAP)
Reducing the climate and health impacts of goods transport

The GGFAP aims to enhance the environmental and energy efficiency of goods movement in ways that significantly reduce the climate, health, energy, and cost impacts of freight transport around the world.

Global Sidewalk Challenge
Valuing and delivering more walkable communities

The Challenge aims to commit cities and organizations to construct, or rehabilitate, 100,000 km of additional dedicated, safe, barrier-free sidewalks in the proximity of public transport hubs by 2030, the majority of which will be in low- and middle-income countries.

Global Strategy for Cleaner Fuels and Vehicles
Introducing low sulfur fuels, and vehicle emission standards by 2030

The Initiative's objective is to virtually eliminate fine particle and black carbon emissions from new and existing heavy-duty diesel vehicles and engines through the introduction of low sulfur fuels, and vehicle emission standards by 2030.

ITS for Climate
Using intelligent transportation systems (ITS) to deliver big results at a small cost

ITS for Climate Initiative aims to take a stand in favor of using ITS solutions to work towards a low-carbon, resilient world and to limit global warming below the 2-degree target and contribute to adaptation to climate change in large cities and isolated territories.

Low Carbon Road and Road Transport Initiative (LC2RTI)
Green roads-clean growth

LC2RTI is led by the World Road Association (PIARC), and its objective is building strong and sustainable adaptation policies for the road network, including sensitive engineering structures and infrastructure (bridges, rural roads, etc.).

MobiliseYourCity Partnership
100 cities engaged in sustainable urban mobility planning to reduce greenhouse gas emissions

The Partnership aims to engage national governments in Africa, Asia, Latin America and the European Union to introduce sustainable urban mobility policies and/or incentive programs, and to having local governments engaged in reducing their emissions by 50% through the development of integrated sustainable urban mobility plans. By 2018, 10 national governments and 39 cities have joined the network, which is supported by contributing donors, development finance institutions, technical assistance agencies and expert organizations predominantly from the European Union and its member states.

Navigating a Changing Climate:
'Think Climate' to reduce emissions, strengthen resilience, and adapt waterborne transport infrastructure

The coalition is committed to promoting a shift to low carbon inland and maritime navigation infrastructure and to raising awareness of the need to adapt and improve the resilience of waterborne transport infrastructure, with an emphasis on working with nature.

Taxis4SmartCities
Accelerating the introduction of low emission vehicles in taxi fleets by 2020

Taxis companies around the world are committed to accelerating the energy transition of their vehicle fleets by 2020 and 2030. The Taxi4SmartCities coalition intends to defend a progressive and modern version of the taxi as a key actor of the Smart City.

Transformative Urban Mobility Initiative (TUMI)
Accelerate the implementation of sustainable urban transport development and mitigation of climate change

The objective of the TUMI is to accelerate the implementation of sustainable urban transport development and mitigation of climate change by mobilizing finance, building capacities and promoting innovative approaches.

Urban Electric Mobility Initiative (UEMI)
Harnessing technological innovations and better urban planning to promote low carbon transport

UEMI is committed to boosting the share of electric vehicles in individual mobility (two- and three-wheelers and light duty vehicles) and integrating electric mobility into a wider concept of sustainable urban transport that achieves a 30% reduction of greenhouse gas emissions in urban areas by 2030.

The UIC Low Carbon Sustainable Rail Transport Challenge
On the low carbon track

The initiative sets a challenge in the framework of the green growth agenda and climate change perspective for 2030 and 2050. It sets ambitious but achievable targets for improvement of rail-sector energy efficiency, reductions in GHG emissions, and a more sustainable balance between transport modes.

UITP Declaration on Climate Change Leadership
Supporting our goal to double the market share of public transport by 2025

The initiative aims to double the market share of public transport by 2025 and implement 350 commitments to climate action made by UITP members.

ZEV Alliance
Accelerating global zero-emission vehicle adoption

The ZEV Alliance works to accelerate the adoption of ZEVs, including electric vehicles, plug-in hybrids, and fuel-cell vehicles. The governments pledged to the initiative commit that they will strive to make all passenger vehicle sales in their jurisdiction's ZEVs by no later than 2050.

The MPGCA Transport Initiatives represent a broad range of multi-stakeholder coalitions covering all modes of transport through decentralized action to reduce transport greenhouse gas emissions and strengthen the resilience of transport infrastructure. Collectively these initiatives, if widely supported by state-and non-state actors, and implemented at scale, can reduce the carbon footprint of an estimated half of all the passenger and freight trips made by 2025.[971]

Other broad-based initiatives on transport and climate change include the International Transport Forum (ITF) Decarbonising Transport Project, the Sustainable Mobility for All Initiative (SuM4All), and the Transport Decarbonisation Alliance (TDA) (Box 8).

Box 8: Other Initiatives on Transport and Climate Change

International Transport Forum (ITF) Decarbonising Transport Project

The International Transport Forum (ITF)'s Decarbonising Transport (DT) initiative will track global progress towards decarbonization of transport and help governments close the gap between their commitments and mitigation actions, by establishing commonly acceptable pathways to achieve zero transport emissions by around 2050.

The project consists of two components, one quantitative and one focusing on the creation of an inclusive policy dialogue. The quantitative outputs generated from a suite of transport models developed by ITF will produce policy insights that can be integrated into national climate mitigation strategies and used to support updated NDCs.

Sustainable Mobility for All (SuM4All) Initiative

The Sustainable Mobility for All (SuM4All) Initiative was established in 2017 as a multi-stakeholder platform to advance policies on sustainable mobility at global, national, and local levels. SuM4All aims to facilitate the delivery of four primary objectives of sustainable transport, which include Universal Access, Efficiency, Safety, and Green Mobility.

A Global Mobility Report (GMR) was released in 2017 to examine the performance of the transport sector based on three components: (i) four global objectives that define "sustainable mobility;" (ii) quantitative and qualitative targets for those objectives, drawn from international agreements; and (iii) indicators to track country-level progress towards those objectives. It covers all modes of transport, including road, air, waterborne and rail.

Transport Decarbonisation Alliance (TDA)

The Transport Decarbonisation Alliance (TDA), consisting of countries, cities & regions, as well as companies, is a "coalition of the willing" eager to pave the way for an accelerated worldwide transformation of the transport sector towards a net-zero emission mobility system.

TDA's members are resolutely committed to transport decarbonization and zero emission mobility dynamics, to reach the global goal of carbon neutrality by 2050 more quickly. As an avant-garde, TDA will act as a strong voice for ambitious action on transport and climate change in the Talanoa Dialogue, launched at COP 23.

The TDA was officially launched in May 2018 with six countries (Costa Rica, Finland, France, Luxembourg, Netherlands and Portugal), five cities (Gaia, Lisbon, Matosinhos, Porto, Rotterdam) and six companies (Alstom, CEiiA, EDP, ITAIPU Binancional, Michelin, and PTV). As of September 2018, the TDA had 20 members, consisting of six countries, six cities/regions and eight companies.

These initiatives and collaborations, while established by actors from different sub-sectors and organizations for various objectives, share certain common goals and perspectives. Some of these initiatives focus on coalition building and broadening support from state and non-state actors to implement sustainable transport actions (e.g. MPGCA Transport Initiatives, TDA), while others focus on measuring the progress of transport towards addressing climate change and sustainable issues (e.g. SuM4All, ITF Decarbonising Transport Project).

The TDA and SuM4All also share a strong emphasis on advocacy and raising policymakers' awareness of global agendas (e.g. UNFCCC Process). These initiatives are important players, demonstrating the potential and influence of non-state actors in enhancing knowledge of, and financing for, sustainable transport. Nonetheless, gaps remain in transport stakeholder collaborations, including the following:

- **A-S-I measures:** Promoting a **'Shift'** to more sustainable modes of transport and transport infrastructure is central for more than half of the MPGCA Transport Initiatives. Most of the MPGCA Transport Initiatives also have a strong **'Improve'** focus in their actions. Only a few of the initiatives have a strong focus on activities that **'Avoid'** the need for unnecessary motorized trips.

- **Passenger and Freight Transport:** There are far more initiatives and commitments made in relation to passenger transport than in relation to freight transport. For example, there are seven MPGCA transport initiatives on urban transport, and three initiatives on electric mobility, but only one initiative on green freight, and one on shipping and logistics. Also, among the four objectives of the SuM4ALL initiative - Universal Access, Efficiency, Green Mobility, and Safety – there is a heavy focus on passenger transport, with freight transport only represented within the Efficiency objective and the Green Mobility objective. Complementary initiatives such as the UN Conference on Trade and Development (UNCTAD) sustainable freight framework[972] and business-to-business leadership initiative Clean Cargo[973] can help to address this gap.

- **Mitigation and Adaptation:** There is also an imbalance between transport mitigation and adaptation. An analysis of 22 MPGCA transport initiatives[974] shows that they focus on mitigation (e.g. GFEI, GGFAP, ZEV Alliance), whereas Navigating a Changing Climate is one of the few with a very strong emphasis on adaptation. A number of initiatives incorporate adaptation-related outputs (e.g. policy guidelines, seminars), including ITS for Climate, Navigating a Changing Climate, and UIC Rail Challenge, but no initiative has set goals or targets related to transport adaptation. For others, adaptation is incorporated under the Green Mobility Objective of SuM4ALL, which proposes a qualitative Transport Vulnerability Index. TDA and ITS Decarbonising Transport project also primarily focus on mitigation actions.

- Technology: Technology is not treated equally among these initiatives. Technology is an important topic for the ITS Decarbonizing Transport Project, as it focuses on developing a suite of modeling tools that produce simulations of technological evolution. Technology for cleaner fuels and transport efficiency is highlighted under the Efficiency objective under SuM4All, but only one MPGCA transport initiative focuses on transport technology (ITS for Climate). These efforts are complemented by initiatives like the Climate and Clean Air Coalition's Heavy-Duty Diesel Vehicles and Engines Initiative, which works to reduce BC emissions through appropriate technologies.

Examples of Global Partnerships and Platforms

In addition to those mentioned above, several initiatives and partnerships have been established to support countries with technical knowledge resources needed to implement measures to meet climate change-related targets. Many of these initiatives are newly developed, and have yet to demonstrate consolidated support to countries

NDC Partnership[975]

Launched in 2016 to provide countries with access to the technical knowledge and financial support to achieve large-scale climate and sustainable development targets, including but not specific to the transport sector.

2050 Pathways Platform[976]

Launched in 2016 to build a broader constellation of cities, states, and companies engaged in long-term low-emissions planning, and in support of national strategies, including but not specific to the transport sector.

Low Emissions Development Strategies Global Partnership (LEDS GP)[977]

LEDS GP engages leaders from over 300 institutions across government agencies, technical institutes, international agencies, and NGOs. It operates through regional platforms in Africa, Asia, Europe and Eurasia, and Latin America and the Caribbean, and has six technical global working groups, including a Transport Working Group, and a global secretariat. Developing country leaders in each region set priorities for learning, collaboration, and advisory support delivered collectively through the Partnership.

Examples of City-Led Initiatives

Under2 MoU[978]

205 jurisdictions representing 43 countries and six continents have signed or endorsed the climate agreement known as the Under2 MOU (Memorandum of Understanding). Actions and commitments on sustainable transport are highlighted in the majority of Under2 MoU Appendixes submitted by signatory cities to date (e.g. Gifu (Japan), Nampula (Mozambique), Northern Holland, Mexico City, Québec).

Examples of Business Sector Initiatives

Science-Based Targets Initiative[979]

WWF and partners formed a joint initiative on Science-Based Targets to increase corporate ambition on climate action. The initiative will demonstrate achievable goals to reduce corporate (transport) emissions, with the aim of 250 companies adopting and disclosing emission reduction targets by 2020.[980]

We Mean Business[981]

By 2017, 660 companies had pledged 1,117 commitments related to climate change. Transport-related commitments under We Mean Business include below50 (sustainable fuels) and EV100 (commitment on electric mobility). 38 companies have committed to these transport goals to date.

Example of Other Sector-Led Initiatives

Shared Mobility Principles for Livable Cities[982]

The Shared Mobility Principles for Livable Cities were launched at the 2017 Ecomobility World Festival in Kaohsiung, Taiwan. These principles, produced by a working group of international NGOs, are designed to guide urban decision-makers and stakeholders towards developing sustainable, inclusive, prosperous, and resilient cities with transportation that facilitates the safe, efficient, and pollution-free flow of people and goods, while also providing affordable, healthy, and integrated mobility for all people.

Photo credit: Philipp Boehme

Reference Tables

Reference Table 1: Transport Targets Expressed in Nationally Determined Contributions[983]

Country	Transport Targets	Total Economy-Wide Targets
Bangladesh	24% below 2030 BAU	Reduce GHG emissions in the power, transport, and industry sectors by 12 MtCO2e by 2030 or 5% below BAU emissions for those sectors
Brunei Darussalam	Land Transport sector: to reduce CO_2 from morning peak hour vehicle use by 40% by 2035	Energy consumption 63% below 2035 BAU, Renewable share to be 10%, Increase forest to 55% of land area
Burkina Faso	Unconditional Target: 0.42% below BAU by 2030 Conditional Target: 42% below BAU by 2030	6.6% below 2030 BAU
Côte D'Ivoire	5.73% below 2030 BAU	28% below 2030 BAU
Dominica	16.9% below 2014 levels by 2030	44.7% below 2014 by 2030
Ethiopia	10 Mt by 2030	N/A
Gabon	20% below 2025 BAU	At least 50% below 2025 BAU
Grenada	20% below 2025 BAU	30% below 2010 levels by 2025
Japan	27% below 2013 or 163 Mt by 2030	26% below 2013 levels by 2030
Marshall Islands	16% below 2025 BAU and 27% below 2030 BAU	32% below 2010 levels by 2025
Palestine	20% trucks and buses using CNG by 2040 and 25% shift from private cars to public buses by 2030	No Information
Republic of Moldova	15% below BAU by 2020	64-67% of 1990 levels by 2030
Seychelles	Oil imports for transport 15% to 30% below 2030 BAU	29% below 2030 BAU
Trinidad and Tobago	30% below 2030 BAU for public transport	15% below 2030 BAU

Reference Table 2: Investment Requirements for NDC Measures[984]

Country	Priority Transport Projects	Investment Requirements (USD)
Bangladesh	Dhaka MRT and elevated highway	5.3 billion (2011-2030)
Benin	Development of intra- and inter-urban transit	2.78 billion (2011-2030)
Burkina Faso	Improvement of public transport, use of biofuel	98 million
Eritrea	Improve rail and bus transport	1 billion
Lao PDR	Implementation of nationally-appropriate mitigation actions (NAMA) in transport sector	105 million (2015-2020)
Lesotho	Improvement of vehicle efficiency, modal shift to public transport	Additional investment of 1.5 million (2020), 2.0 million (2030)
South Africa	1. Electric vehicles 2. Hybrid electric vehicles (20% by 2030)	1. 513 billion (2010-2050) 2. 488 billion
Togo	Promotion of low carbon transport modes	40 million

Reference Table 3: Transport References in Long-Term Strategies[985]

Country	Publication Year	Transport references in LTS
Benin	2016	Construction of better drainage structure to increase resilience of road infrastructure; inclusion of climate change strategies (i.e., adaptation and mitigation) in public procurement.
Canada	2016	Transport sector is a key sector for Canada's decarbonization pathway: electrification of transport modes, use of biofuels, LNG and renewable energy in the transport sector.
Czech Republic	2018	Transport Policy of the Czech Republic (2014–2020) and the Action Plan for Clean Mobility envisage a gradual increase in the share of alternative propulsion and fuels in road transport and further electrification of railways, a gradual shift of freight transportation from road to rail or water transport.
France	2016	Set target to improve vehicle energy efficiency (an average of 2l/100km for new light duty vehicles sold in 2030); transition to low-carbon energies and installation of charging points for electric cars and gas delivery units; management of travel demand (through remote working, spatial planning and other measures); improvement in vehicle occupancy rates (carpooling); modal shift of people and goods to non-road and non-air transports.
Germany	2016	Developed strategies to reduce GHG emissions in road transport, increase funding for electric mobility, provide financial incentives for use of low carbon mobility options, increase modal shift to public transport, rail freight, and inland shipping, promote walking and cycling, and expand the use of electricity-based fuels in national and international air and maritime transport.
Mexico	2016	Maximize transport system efficiency, development of multimodal transport networks, reduce transport needs (collective transport services for companies), incentives and programs for non-motorized transport, green freight, and reduction of fossil fuel subsidies to strengthen development of public transport.
Ukraine	2018	Modernization of transport through promotion of vehicles using alternative fuels or are electrified, increase high-speed train service, plan more efficient public transport systems, raise freight activities by rail and inland water through intermodality and port modernization. Ukraine aims to reduce GHG emissions from mobile sources by 60% compared to 1990 by 2030 and the LTS expresses the economy-wide target of 31-34% reduction by 2050, compared to 1990.
United Kingdom	2018	Passed the Renewable Transport Fuel Obligation to increase use of biofuels in transport, mass adoption of zero emission vehicles, invested in public and rail transport development; Every car and van will need to be zero emission by 2050 (UK has announced an end to the sale of all new conventional petrol and diesel cars and vans by 2040) By 2040, cycling and walking would to be the natural choices for shorter journeys, or as part of a longer journey Emissions from transport falling by almost 30 per cent compared to 2018 baseline (to around 83 Mt by 2032)
United States of America	2016	Continue to tighten fuel economy and GHG emissions standards for both light- and heavy-duty vehicles, increase fuel efficiency and electrification of transport modes, increase investment in low-carbon fuels and vehicles, reduce vehicle miles traveled by promoting public transport, ridesharing, walking and cycling.

Reference Table 4: Transport Adaptation Measures in Submitted NAPs[986]

Country	Publication Year	Transport Adaptation Measures
Brazil	2016	Harmonize national adaptation plans and policies with local planning, involving private-sector actors, civil society and academia; Elaborate adaptation and resilience programs at the local level, and integrate with other relevant sectors; Incorporate vulnerability studies and resilience planning in urban mobility plans Consider principles of Ecosystem-based Adaptation (AbE); Strengthen and qualify public and non-motorized public transport infrastructure Ensure intermodal integration and system flexibility; Incorporate adaptation studies in technical standards for design and maintenance of the urban mobility infrastructure Support innovation in projects that reduce carbon emissions and increase the adaptive capacity for climate change
Burkina Faso	2015	Pass and enforce laws and regulations on construction of hydraulic, road and settlement infrastructures Promote public transport in order to control energy consumption
Cameroon	2015	Integrate adaptation plans into local development plans (LDPs) Discourage construction of roads unsuitable for climate change Develop, maintain and rehabilitate urban infrastructures (construction of 150 km of roads and 17000 social housing) Develop and extend tarred road network (more than 3500 km by 2020) and rehabilitate the road network (2000 km of tarred roads to be rehabilitated by 2020) Provide at least 1000 km of railway tracks, and exploit the deep-water port of Kribi Construct the deep water port and the Limbe Yard.
Chile	2017	Enhance provisions of transport and transit, and introduce adaptation plans for cities
Kenya	2017	Short Term Actions: Conduct risk and vulnerability assessments of existing infrastructure Conduct risk and vulnerability assessments of upcoming infrastructure (roads, railways, marine, aviation, buildings, ICT)

Kenya	2017	Conduct an assessment of whether existing and planned infrastructure assets are compatible with a low carbon climate resilient economy; Conduct capacity building on infrastructure climate proofing. Medium Term Actions: Climate proof buildings, roads, railway, marine, aviation and ICT infrastructure through use of appropriate designs and building materials. Long Term Actions: Re-assess infrastructure vulnerability and upgrade infrastructure to withstand climate impacts with the latest technology.
Sri Lanka	2016	Improve climate resilience and disaster risk preparedness of transport; Assess the impacts of projected changes and extreme weather scenarios on transport systems Assess vulnerable and hazard prone areas/roads and prepare maps identify climate resilient improvements in transport planning, Develop guidelines to improve the resilience of transport system for extreme weather situations Create awareness on climate risks in transport to commuters, drivers and transport operators Establish an early warning and hazard communication system for commuters and drivers (Focus: mobile phones, navigation systems, radio channels)

Reference Table 5: NAPA Transport Measures[987]

Country	Publication Year	NAPA Transport Adaptation Measures
Afghanistan	2009	National Solidarity Program (NSP) for local community development supports small-scale reconstruction and development activities by establishing more than 16,343 locally elected Community Development Councils (CDCs) across the country and has financed over 22,458 community projects. 88% of the community projects involve infrastructure projects for rural roads, irrigation, electrification, and drinking water supply
Bhutan	2012	Implemented a project on landslide management and flood prevention to ensure safe and convenient mode of communication/ transportation facilities
Cambodia	2006	Rehabilitation of Upper Mekong and Provincial Waterways to improve water transportation
Comoros	2006	Reinforcement of energy infrastructures for production and transport
Maldives	2006	Develop coastal protection for airports and further develop main islands Strengthen capacity for planning and design of infrastructure to ensure development of resilient infrastructure.
Myanmar	2012	Development of road and transport infrastructure as adaptation options that should be considered for effective adaptation in the Energy and Industry sectors
Samoa	2005	Implementation of Road Asset Management Systems (RAMS) and Coastal Infrastructure Management Plans Compliance with Code of Environmental Practices on impact studies and design Construction of sea walls with standards and specification where appropriate
Timor-Leste	2010	Deliver a comprehensive roads maintenance program for all existing roads Construct new bridges to provide all-weather access on major routes within five years, and the remainder of national and district roads by 2030 Establish national ring road standards, and establish a ring road to these standards by 2030
Tuvalu	2007	Implementation of multi-million dollar tar-sealed roads infrastructure project for Funafuti to increase connectivity of rural communities with the main settlement and urban center

Reference Table 6: MDB Sustainable Transport Investment by Region (2011 - 2016)[988]

Region	MDB Investment for Sustainable Transport (2012-2016) (USD million)					
	2012	2013	2014	2015	2016	Total
Africa	3,970.4	3,809.4	3,615.1	5,343.8	4,574.1	**21,312.8**
Asia	6,331.7	7,791.1	8,062.9	8,906.7	8,556.8	**39,649.1**
Europe	5,765.7	7,068.6	4,964.2	4,575.1	3,464.8	**25,838.4**
Latin America and the Caribbean	3,899.3	5,845.2	3,074.5	3,244.1	3,671.9	**19,735.0**
Oceania	42.5	418.7	703.3	105.4	415.8	**1,685.8**

Reference Table 7: MDB Total Climate Finance and Transport Mitigation Finance Commitments (2011-2017)[989]

Year	MDB climate finance (USD billion)	Transport mitigation finance (USD billion)[990]	% of transport mitigation finance to total MDB climate finance
2011	27.014	4.011	15%
2012	26.846	4.743	18%
2013	23.803	4.23	18%
2014	28.345	6.316	22%
2015	25.096	5.283	21%
2016	27.441	4.667	17%
2017	35.219	8.114	23%
Total	**193.764**	**37.364**	**19%**

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990 Climate finance for sustainable transport used in graph is only provided under the MDBs' mitigation finance portfolio. Specific amount for financing transport activities under the adaptation portfolio is not provided in the reports.

Partnership on Sustainable Low Carbon Transport

For more information, please visit:
www.slocat.net/tcc-gsr