PARIS PROCESS
ON MOBILITY AND CLIMATE

A GLOBAL MACRO ROADMAP OUTLINING AN ACTIONABLE VISION TOWARDS DECARBONIZED, RESILIENT TRANSPORT

IMPLEMENTING THE PARIS AGREEMENT ON CLIMATE CHANGE IN THE TRANSPORT SECTOR IN SUPPORT OF A NET-ZERO EMISSION, CLIMATE-RESILIENT ECONOMY BY 2050 OR SHORTLY THEREAFTER

PPMC

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MOVIN'ON by Michelin

Partnership on Sustainable Low Carbon Transport

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The recommendations on possible pathways to the decarbonization of transport provided in the Global MacroRoadmap are the result of a process of collective discussions and reflections facilitated through the Paris Process on Mobility and Climate. The recommendations are not binding and have not been endorsed individually by supporters of, or partners in the PPMC, such as the Partnership on Sustainable, Low Carbon Transport or the Michelin Challenge Bibendum/Movin'On.

List of Abbreviations

2DS	2-degree Celsius scenario
BAU	Business-as-usual
BRT	Bus rapid transit
CO2	Carbon dioxide
COP22	The 22nd Session of the Conference of the Parties
ECF	European Cyclists' Federation
EVs	Electric vehicles
FC	Fuel cell
FfD	Addis Ababa Action Agenda "Financing for Development"
GCAA	Global Climate Action Agenda
GHG	Greenhouse gas
HDV	Heavy-duty vehicle
HLC	High Level Champion on Climate Change
ICAO	International Civil Aviation Organization
ICE	Internal combustion engine
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITS	Intelligent transport systems
iTEM	International Transportation Energy Modelling
ITF	International Transport Forum
LDC	Least developed country
LDV	Light-duty vehicle
LEZ	Low-emission zone
LNG	Liquefied natural gas
LPAA	Lima-Paris Action Agenda
LT	Light truck
MCB	Michelin Challenge Bibendum –becoming Movin'On in 2017
MPGCA	Marrakech Partnership for Global Climate Action
MYC	Mobilise Your City
NDCs	Nationally determined contributions
OECD	Organisation for Economic Co-operation and Development
PC	Private car
PPMC	Paris Process on Mobility and Climate
SDGs	Sustainable Development Goals
SIE	Sociétéd'investissementénergétiques - Morocco
SLoCaT	Partnership on Sustainable, Low Carbon Transport
SUMPs	Sustainable urban mobility plans
TEM	Transport Expert Meeting
UEMI	Urban Electric Mobility Initiative
UITP	International Association of Public Transport
ULEZ	Ultra-low-emission zone
UNEP	United Nations Environment Program
WTW	Well-to-wheel (emissions)
WBCSD	World Business Council for Sustainable Development
WCA	World Cycling Alliance
WEF	World Economic Forum
WTO	World Trade Organization
ZEV	Zero-emission vehicle
ZEZ/ZEC	Zero-emission zone/city

Executive Summary

The Paris Agreement adopted at COP 21 requires us collectively to successfully transform world transport systemically over the next 40 years, in order to achieve a "net-zero-emission economy".

It is with this objective in mind that PPMC, the global transport coalition since COP 21, is putting forward a macro roadmap. This tool, designed to be relevant for all continents, comprises eight components that are phased and articulated in synergy with each other.

It is now up to the countries that are Parties to the Agreement to adapt these actions to their specific contexts, thereby maximizing their chances of successfully implementing deep change which, above and beyond the unavoidable disruptions it will bring, is promising. If well-orchestrated, it will offer great potential for new growth. We see this decarbonized economy as more innovative, more inclusive, positive for the environment, conducive to boosting employment and better suited to our societies' aspirations for better quality of life. The project is ambitious yet feasible.

Several countries have expressed an interest in this approach that was put forward in 2016 in Marrakesh, insofar as it identifies strategic coordination needs between public and private actors. Where massive investments are required to enable the emergence of new technologies and services, the authorities must introduce targeted measures allowing companies to innovate and investors to facilitate the emergence of new markets.

The Paris Agreement will enter into force in 2020. In the meantime, we invite countries – both governments and non-state actors – to prepare the implementation of the proposed long-term strategy; use it for establishing their NDCs; and immediately take short-term steps that can help them position themselves on the desired trajectory.

If backed by a genuine energy transition, transport can become one of the most brilliant examples of successful transformation!

I. The need for a bold action plan to implement the Paris Agreement on Climate Change for transport

A. A challenging new frontier for the transport sector

1. Three recent major international agreements outline a new vision for sustainable development and climate change, putting stronger pressure on all human activity sectors, including transport, to transform in line with the targets set out therein:

- The 2030 Agenda for Sustainable Development, adopted in New York in September 2015;

- The Paris Agreement on Climate Change, adopted at COP21 in Paris in December 2015;

- The New Urban Agenda, the outcome document of the Habitat III Conference, adopted in Quito in October 2016, to guide sustainable urban transport over the next 20 years.

2. The agreed UN 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals (SDGs) and Habitat III´s New Urban Agenda (NUA) both call for improvements in access to opportunities and services that will require a large increase in what will need to be climate-resilient transport infrastructures and services. Both agreements on sustainable development emphasize the growing importance of social and environmental sustainability in all efforts to promote economic development and eradicate poverty.

3. The Paris Agreement on Climate Change sets an overall long-term direction for climate change policy. It sends a clear message to all economic sectors that there is a need for disruptive change, as incremental approaches will not suffice to achieve the necessary reductions in greenhouse gas (GHG) emissions, in line with the ambitious target of limiting temperature increase ('well below 2°C above pre-industrial levels, and to aim for a temperature increase of not more than 1.5°C'). Therefore, each sector of human activity, including the transport sector, must define its course of action while taking into account:

- A decarbonization horizon of 2050 or shortly thereafter for most countries, with the option for less developed economiesof moving at a slower pace in decarbonizing their economy;

- The development and implementation of a transformation pathway that acknowledges the specific characteristics imposed by transport-specific industrial investment innovation cycles, which run from 5 to 40 years;

- The need to strengthen resilience and adapt transport systems and services to the demands of a changing climate;

- The synergies in public policy required to promote the changes in behavior and the clear market signals necessary for a disruptive transition towards a net-zero-emission economy;

- The key role that the financial community will have to play in funding the decarbonization and adaptation process.

4. Change of this magnitude and transformative nature in the transport sector can only be achieved through combined action from all stakeholders (public and private) covering all segments of the transport sector: land transport as well as international aviation and shipping.

5. At present, the sector as a whole (mobility of people and transportation of goods) accounts for some 7.7 Gt of CO2 emissions, with 23% of CO2 emissions from the burning of fossil fuels and 14% from anthropogenic GHG emissions, making it one of the largest sources of CO2 emissions (see Figure 1). Road and rail transport represents the bulk of transport emissions.

6. The transport sector at the global level continues to grow, with several experts still forecasting a potential doubling of transportation activity by 2050, which gives a business-as-usual (BAU) emissions scenario of some 12-13 Gt per year by 2050. This trend is driven by economic development and population growth, particularly in cities (which already account for 75% of overall CO2 emissions), with an additional 2-3 billion urban dwellers expected by 2050. The challenge therefore is daunting: catering to fast-growing demand for mobility and transport while slashing GHG emissions, increasing climate resilience and promoting social and economic development. For transport to do its part in achieving the 2030 SDGs, the sector will also need to reduce negative externalities such as road traffic accidents, congestion and air pollution.

Transport as part of a net-zero-emission economy

7. For the transport sector, an ambitious but realistic goal in terms of decarbonization is to move from 7.7 Gt emissions/year down to 3 and 2 Gt by mid-century (see Figure 2). Rapid peaking of GHG emissions (by 2020 or shortly thereafter) is key, and further decreases must

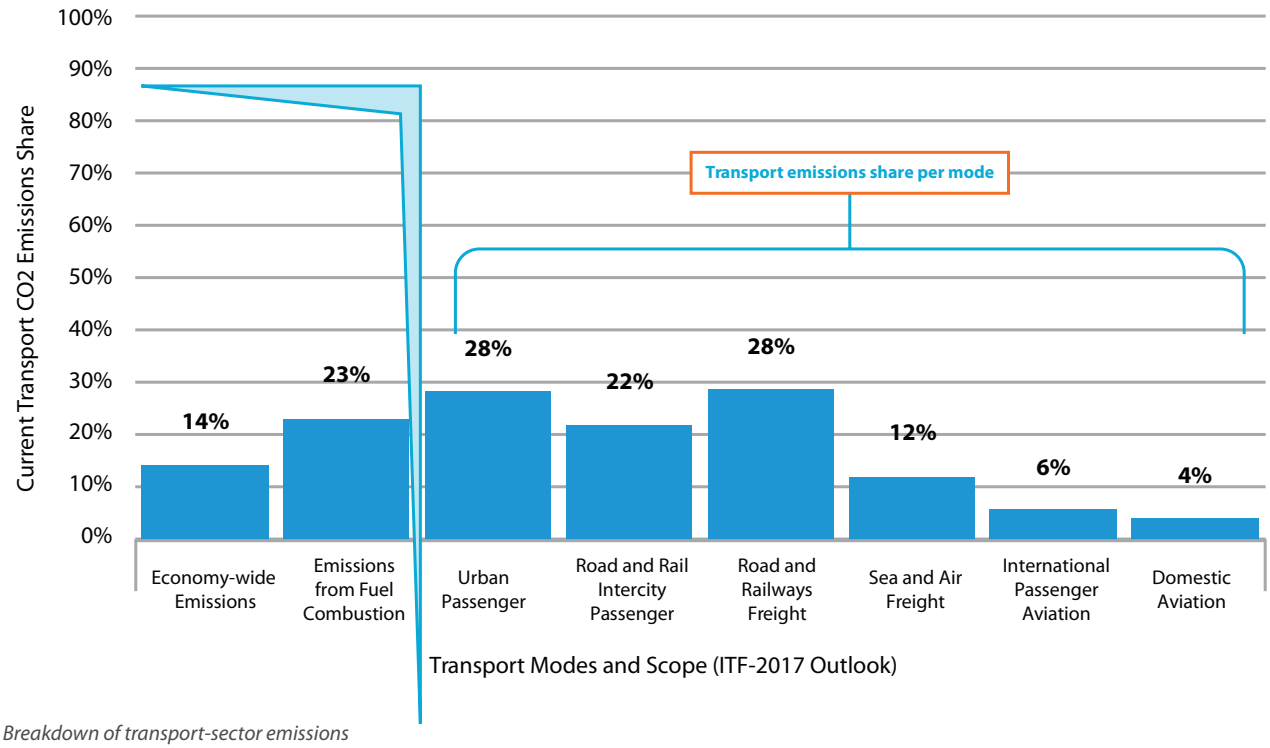


Figure 1: Breakdown of transport-sector emissions

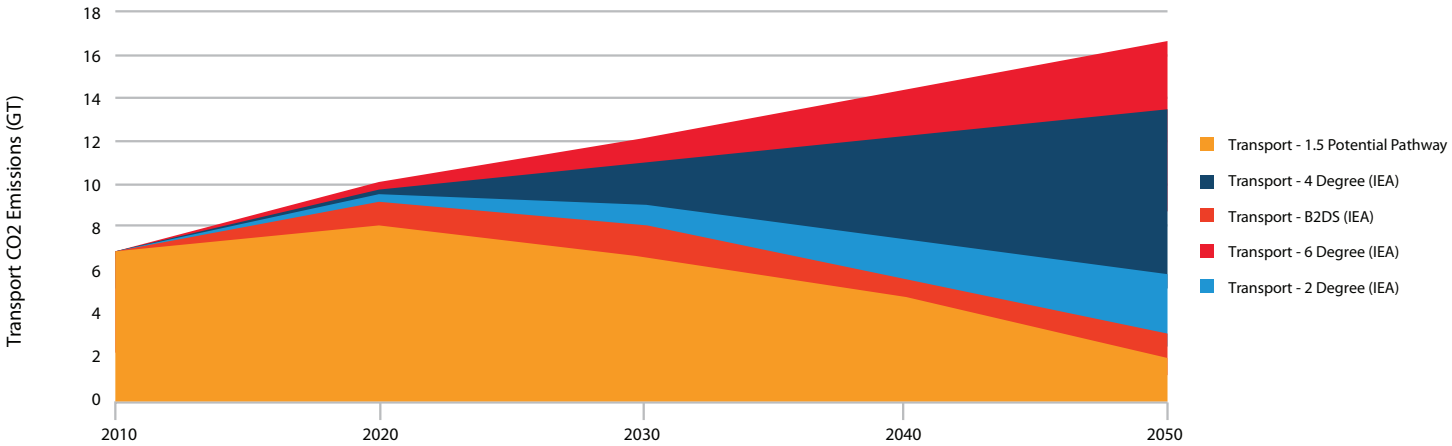


Figure 2: 2010-2050 CO_2 pathways for the transport sector

SLoCaT Transport Knowledge Base (TraKB) and IEA – ETP 2017

be orchestrated in a phased manner. By 2050 or shortly thereafter, transport will be part of a "net-zero-emission" economy, where remaining emissions from specific sectors will need to be sequestered or offset by other means. Investing in GHG sequestration/removal solutions though R&D and implementation of proven solutions must continue, be further prioritized and scaled up. While CO2 capture and storage or removal is often still thought of as a (primarily) long-term, post-2050 mitigation approach, research into such technologies must be intensified now, to allow much faster deployment at scale than 2050.

8. The broad majority of countries will have to largely complete the transformation of the transport sector by 2050 or shortly thereafter. All modes of transport (road, railway, aircraft, maritime, river, transport of people and goods) will need to be part of the global systemic transformation involving new consumption patterns and behavioral changes, scaled-up implementation of proven technologies and major technological innovations, the emergence of new mobility ecosystems, and the creation of new business models. Given its scope and urgency, such a change calls for an unprecedented immediate and coordinated mobilization of all transport sector stakeholders, public and private, including policy-makers and representatives of the business sector, and requires the full participation of civil society. The transport sector alone cannot realize such ambitious actions and will need to gain the full cooperation of other economic sectors that interact with it, especially energy, industry and urban development.

B. Time to take action

9. Transport has been established as one of the thematic areas under the Marrakech Partnership on Global Climate Action (MPGCA), formerly the Global Climate Action Agenda (GCAA), and before that the Lima Paris Action Agenda (LPAA). The discussions on transport within the MPGCA have been facilitated since COP21 by the Paris Process on Mobility and Climate (PPMC),[1] in close interaction with the French Government (COP21 Presidency) and subsequent COP Presidencies and High Level Champions. Through joint action and broad consultation, great strides have been made towards building a genuine "Community of stakeholders committed to a low-carbon and resilient transport sector" and setting an agenda for structural, long-term change in the sector.

10. The Paris Agreement on Climate Change, the NUA and the 2030 SDGs provide multiple converging signals demonstrating the intent of public and private actors to use powerful levers (policy, technology, finance) to drive large-scale, coordinated action to address global warming while achieving sustainable development. This was also reflected by discussions in the 2016-2017 G20 and G7 meetings, all of which saw continued strong global support for the concept of sustainable infrastructure (notwithstanding the recent shift in the USA Administration's position on the Paris Agreement). The prioritization of funding for climate action (e.g. through the Green Climate Fund), the global partnership of the Addis Ababa Action Agenda "Financing for Development" (FfD) that underpins implementation of the 2030 SDGs, and the Innovation Mission launched at COP21 to significantly enhance global investment capacity in R&D towards a shift to renewable energy all provide further indications of the willingness to trigger transformational change in support of action on climate change and sustainable development.

11. The PPMC, on behalf of the numerous transport stakeholders it represents, acknowledges this progress at the international level and proposes an overarching framework for action on transport and climate change for the coming decades. As a countdown from the 2050+ decarbonization horizon set by the Paris Agreement, this framework for a systemic transformation hinges on three main actions:

1. Planning for mid/long-term disruptions towards a systemic transformation of the transport sector (2020-2050+):

- Bring together all relevant stakeholders (public and private sector, think tanks) around a sound "Global Macro Roadmap" (GMR). We understand the GMR to be both a process and a document that can serve as a reference or compass to set the course towards realizing the long-term climate goals agreed in Paris;

- Enable each geographic region and group of transport stakeholders to develop its own strategy for the transformation of the transport sector. The GMR sets out the approach and overall direction for the transport sector through its conceptual framework without being overly prescriptive on the details of actions required to achieve transformative change.

2. Taking short-term decisions that will improve chances for the ultimate successful implementation of the Paris Agreement on Climate Change(2016-2020):

1 The Paris Process on Mobility and Climate (PPMC) is a joint initiative of Michelin Challenge Bibendum (MCB) (which in 2017 continued as Movin'On and the Open Lab by Michelin) and the Partnership on Sustainable, Low Carbon Transport (SLoCaT). It brings together well over 150 organizations, networks and initiatives that support ambitious, transformative action on transport and climate change. Read more about the PPMC at www.ppmc-transport.org.

- Recommend urgent measures (Quick Wins) to public authorities and private sector stakeholders to kick start the transformation of the transport sector;

- Contribute to the strengthening of existing nationally determined contributions (NDCs) as well as the development of the second generation of NDCs and, in close coordination with the MPGCA, support the NDC process to facilitate an early peaking of transport emissions, inspired by the directions set in the GMR.

3. Leveraging existing MPGCA Transport Initiatives and encouraging new ones:

- Strengthen MPGCA stakeholder Transport Initiatives[2] and encourage their scaling up by linking more directly to action by Parties;

- Promote the emergence of new Initiatives to address those areas of action that have yet to be worked out by the transport sector.

12. In sum, the 2030 Sustainable Development Goals, the New Urban Agenda and the Paris Agreement on Climate Change have set clearer long-term goals for us all to improve human well-being, and have added a new level of urgency to the development and implementation of a comprehensive transformation strategy in the transport sector. In terms of climate policy, there is an urgent need to step up action on NDCs, which together with long-term emission reduction strategies provide an instrument that can be used to drive national climate action. The first generation of NDCs presented in 2015 prior to COP21 lack ambition, in terms of both mitigation and adaptation. They do not yet provide a credible pathway for the comprehensive transformation of the transport sector towards a net-zero-emission, resilient economy, which will be required by 2050 and beyond. Nor is the need to accelerate negative emissions properly addressed. This is why the PPMC has proposed the development of the GMR.

II. A Global Macro Roadmap to decarbonize transport and ensure its resilience by 2050+

13. We propose the development of such a Roadmap through a phased action process, covering a 2020-2050+ timeline by recommending both short- as well as mid- to long-term actions. The proposed actions are grouped into eight components (see Figure 3).

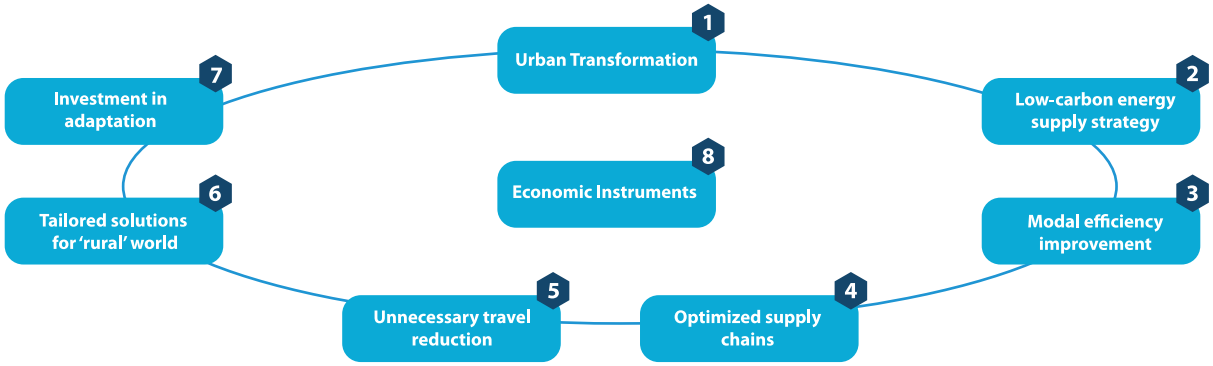


Figure 3: 8 Components of the Global Macro Roadmap

14. The Roadmap aims to give a realistic (technically feasible) vision, with an operational focus for each segment of the transport sector (people and freight; road, railway, aviation, waterborne; urban and rural). It is driven by the new sustainable and inclusive growth opportunities foreseen by the SDGs. Moreover, it assumes the development of new technologies and business models as levers for the growth and transformation of the transport sector. While globally phased, such change will not occur at the same pace in all regions of the world, and must factor in regional differentiation in climate action as regards transport. The idea is that the development of the GMR will be followed by the development of regionally specific roadmaps.[3] In its recommendations for actions, the GMR differentiates between "Front-runners" and "Fast-followers". The regional versions of the Roadmap will specify whether the region under planning should be viewed as a "Front-runner" or a "Fast-follower"[4].

2 This concerns a series of initiatives taken by non-state actors to promote action on transport and climate change in different transport sub-sectors. For details see: http://www.ppmc-transport.org/transportinitiatives/

3 See Chapter 3 section B for an initial assessment of how the different components of this Global Macro Roadmap and the associated milestones are relevant to different geographical regions.

4 The terms "Front-runner" and "Fast-follower" are preferred, as these do not follow standard terms such as developed – developing or OECD –Non OECD countries. Experience has shown that "Front-runner" status does not follow these types of categorization. China, for example, is globally accepted as a leader for electric mobility, high-speed rail and fourth-generation (dock-free) bike-sharing systems.

15. As part of a broader sustainable development agenda, the Roadmap, in addition to being climate-relevant, also emphasizes the equity dimension of sustainable transport. It takes an overarching look across the transport sector and focuses on the broad deployment of appropriate low-carbon transport solutions for passengers and freight "in the context of sustainable development and efforts to eradicate poverty" (Paris Agreement, Article 2). Figure 4 shows the linkages between the 8 GMR components and the 17 SDGs that form part of the 2030 Sustainable Development Agenda, demonstrating that successful implementation of the GMR would make a significant contribution to sustainable development as well.

16. The Roadmap focuses on identifying a balanced package of actions, taking into account the increasingly widely supported sustainable transport paradigm that combines **Avoid** (reduce unnecessary travel through e.g. land-use planning or logistics redesign and halt counterproductive regulation that incentivizes travel by single-occupancy vehicles), **Shift** (shift movement of goods and people to the most efficient modes by scaling up good practices) and **Improve** (improve environmental performance of fuels and powertrains, intermodality and transport management). Successful large-scale implementation

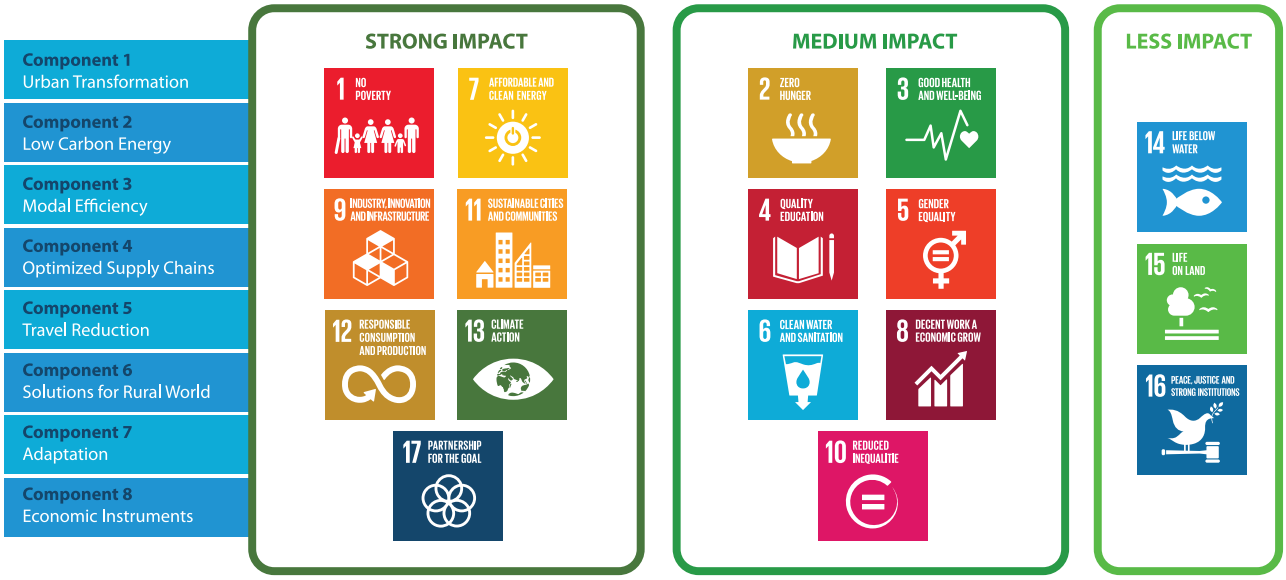


Figure 4: Linkage between the GMR Components and the 2030 SDGs

of Avoid-Shift-Improve measures on a large scale will be enabled by new (shared) mobility solutions and supportive enabling institutional, regulatory and financial mechanisms. Figure 5 explains the relationship between the individual GMR Components and the Avoid – Shift – Improve dimensions of sustainable transport. Additional details are given in the description of the respective GMR Components.

17. The aim of the GMR process is to ensure that all required policies and technologies can be included in a single, comprehensive, sustainable development-sensitive Roadmap for the transport sector. Implementing the GMR will change the structure of the transport sector as we know it, partly because of, for example: (a) the scaled-down importance of cars as the main mode of transport and greater dependence on walking and cycling in cities; (b) vehicles that are increasingly powered by alternative, renewable, zero-carbon power sources. To help make this happen, the GMR for the transport sector is closely aligned with the Roadmap for the energy sector, which is guiding the energy transition, or the Roadmap for cities and climate change.

18. Development of the GMR (Components and related actions) is based on an assessment of the expected effectiveness of proposed measures in terms of avoiding or mitigating emissions and contribution to climate resiliency, while also taking into account cost, broader sustainable development impacts and political acceptability. The PPMC continues to consult extensively with a broad range of stakeholders on the actions proposed in the GMR and the recommended level of ambition for these actions.

19. The Roadmap brings current efforts at the technological, modal, national and regional levels together into a single vision for the global transport sector along the eight proposed priority areas. The GMR must be seen as an overarching common framework for transformative ambition in the transport sector. It is intended to inspire transport stakeholders to develop their own customized roadmaps, policies and action plans for the subsector of transport in which they work or the region in which they live. The need for downscaling and translation into more specific policies and actions is emphasized through the labels "Global" and "Macro" in the naming of the Roadmap.

20. The GMR was first presented at events organized by the GCAA Transport team during COP 22 at the invitation of the two High Level Champions, including the Round Table for Transport Ministers and the Round Table for Transport CEOs. The wider sustainable transport community discussed the relevance of the Global Macro Roadmap at the annual Transport Day organized by the PPMC on 13 November 2016 as part of COP22. This version of the GMR was developed following an extensive stakeholder consultation in April–May, 2017. It must be regarded as a living document that will be updated on a regular basis to reflect relevant policy announcements and new technological developments.[5]

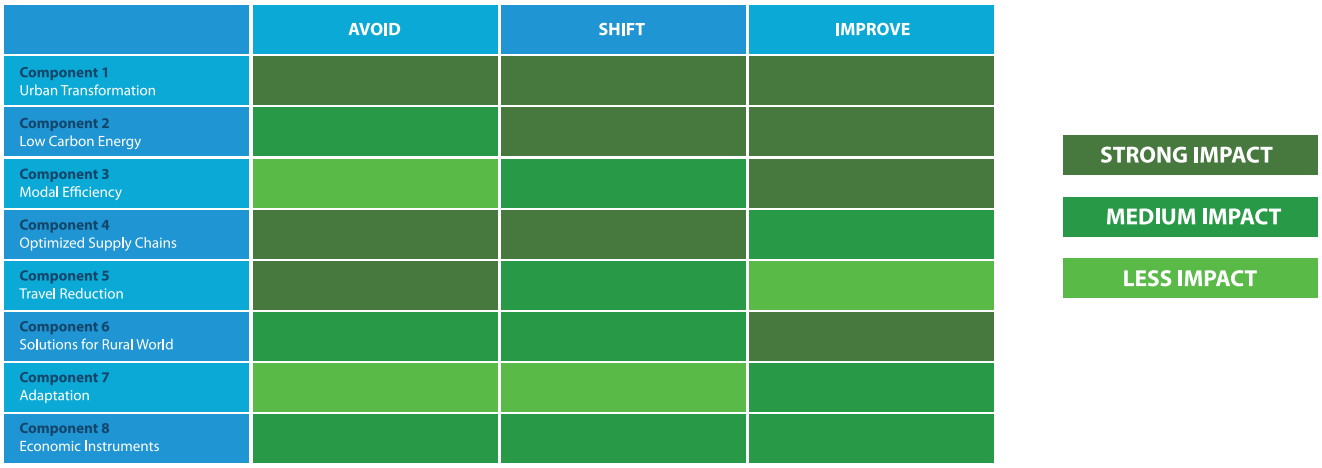


Figure 5: Interrelationship between GMR components and the Avoid - Shift - Improve dimensions of sustainable transport

Component 1: Effecting urban transformation – Leveraging aspirations for healthier, inclusive lifestyles and efficient prosperous cities to drive urban transport decarbonization

21. In the light of demographic trends, action on GHG emissions by cities will greatly influence the overall success of future climate action. Indeed, the fight against climate change will be lost if cities do not achieve ambitious decarbonization objectives. Clearly, the first goal for the transport community is to provide inclusive, safe, clean and efficient access for all to jobs, markets, services and social life. This will require an increase in transport services and supporting infrastructure. Secondly, climate action on urban transport is not yet listed as a top priority in citizen surveys and must therefore in many cases be conducted indirectly, by leveraging people's growing aspiration for better health (breathing clean air, exercising safely) and travel enjoyment. People must be offered pollution-free, enjoyable mobility patterns. There is also a need to design and introduce pollution-free, highly efficient freight delivery solutions. A common factor for all urban transport solutions is that they must be low-carbon. All of this is doable, provided that such objectives are set and communicated and that phased plans are established to reach them.

22. The expected increase in urban population by 2-3 billion people between now and 2050 offers urban planners a key opportunity to enable the transformation of cities by realizing better quality of life, higher-density, mixed land-use cities. This should help to ensure that a greater number of trips are made by walking or cycling and create successful enabling conditions for attractive, non-polluting mass transit solutions, by bus, rail or other efficient shared means. Efforts to promote walking, cycling and clean mass transit will need to be accompanied by travel demand management (TDM) measures to reduce the passenger kilometers traveled by light-duty vehicles. Possible TDM-related measures include parking, congestion and new vehicle registration policies. Greater deployment of "Mobility as a shared service" can also help to reduce single- (or even zero-) occupancy vehicle travel. Guided by the recent London's

5 The need to monitor policy announcements is well illustrated by recent (June-July 2017) announcements by France and the United Kingdom of their intention to ban the sales of new petrol and gasoline cars by 2040 and statements by China and Germany on the relevance of these announcements for their respective countries and vehicle industries. This certainly makes the proposed milestones in Components 1 and 3 on emission reduction from light-duty vehicles more attainable

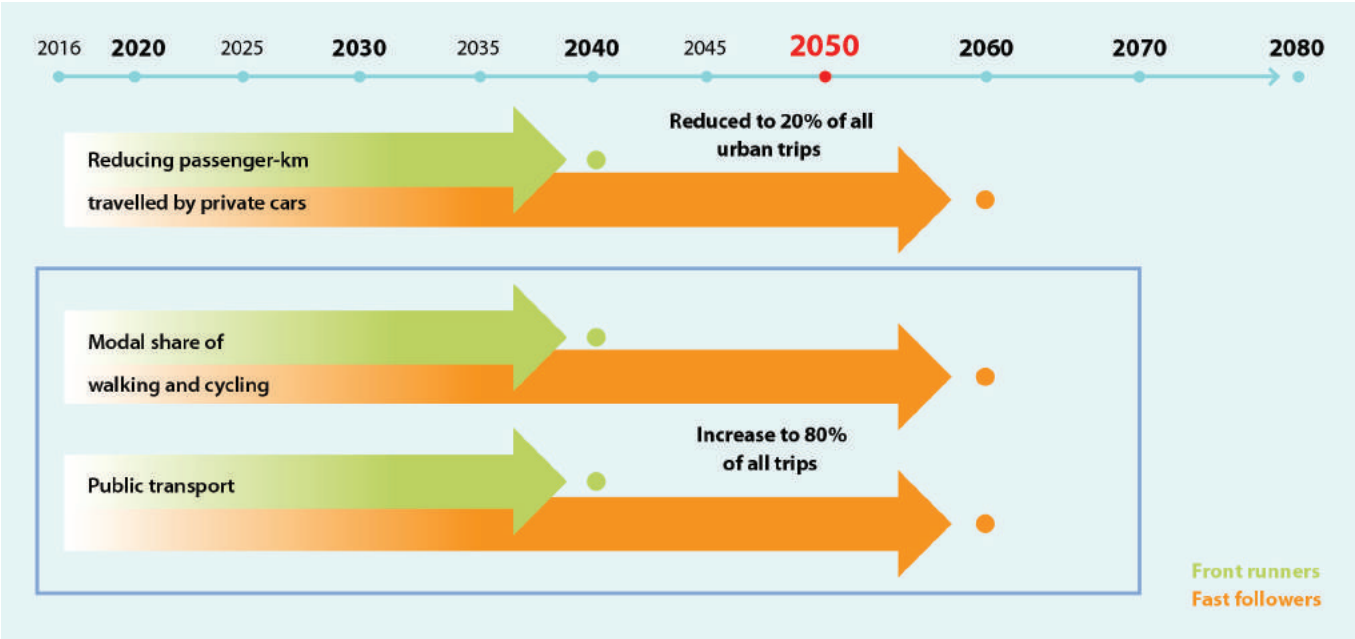
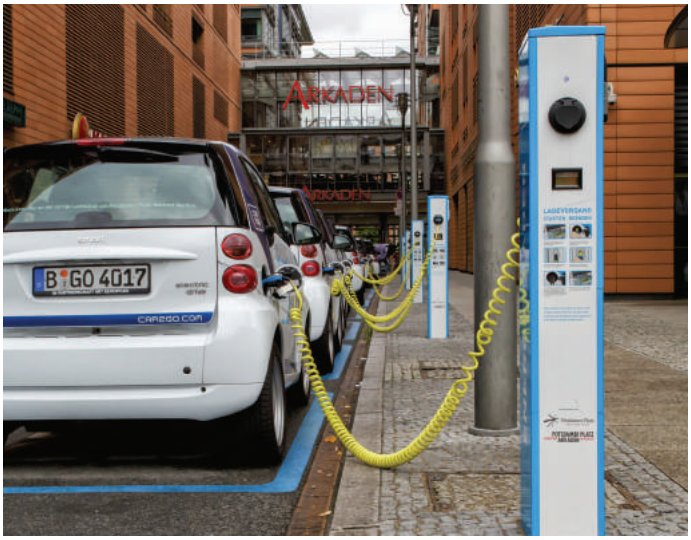


Figure 6: Component 1-a : Proposed urban modal shift

2017 draft Transport Strategy, the GMR suggested the following milestones for 2040/2060: urban passenger trips are reduced to 20% while the combined share of trips by walking, cycling, and shared transport trips rises to 80% of all trips (see Figure 6). These are global averages; in some selected cases, cities may already be meeting these milestones in part, and the challenge would be to maintain them. In the majority of cases of cities this will, however, require considerable political will and investment.

23. Urban pollution (and co-generated GHG emissions) depends greatly on the type of vehicles used for personal mobility and urban freight. Cities should therefore further intensify efforts to shift towards the use of electric mobility (with low-carbon energy sources), both for individual and mass transit and for freight. Following the lead of a growing number of cities, fossil fuel-powered transport systems can start being the exception, rather than the rule, from 2025 or 2030 onwards in cities in the developed world. Component 3 of the GMR provides details on the expected transformation of vehicle fleets, including urban fleets.

24. An effective driver for synergized success in transforming cities to enjoyable low-carbon cities is to set a phased course towards zero- (polluting) emission cities, strategically moving from low- (polluting) emission cities to ultra-low- (polluting) emission cities, with the ultimate goal of zero- (polluting) emission cities. Today, dispersed elements of such a vision already exist. Following the example of Tokyo (2003), more than 300 cities in the world have created low- (polluting) emission zones, with London aiming to create an ultra-low-emission zone by 2019. Copenhagen and Oslo have further committed to zero carbon by 2025. The GMR advocates that cities around the world join forces towards this goal with a view to creating the best political and market conditions to make the transition economically achievable, socially attractive and environmentally efficient.



25. The introduction of low- or zero-emission cities will typically follow initial deployment of low-emission zones, which target both air quality improvements and congestion reduction, mostly in dense, central urban areas. This has often been done through a combination of local road charging and regulation (access restrictions for more polluting vehicles, based on emission standards). To be successful, they require improvements in mass transit systems, promotion of pedestrian areas, and bus and cycling lanes. There is a clear correlation between the ability of cities to declare effective low-emission zones and their track record on walking, cycling and mass transit as well as their success in reducing passenger car use. Front-runner cities on climate action

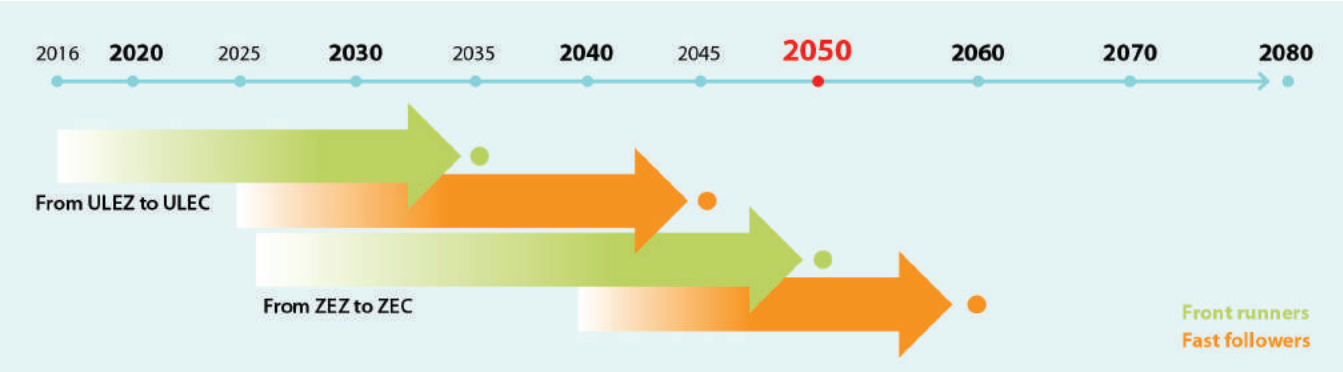


Figure 7: Component 1-b : Urban transformation

on transport, like Amsterdam, Copenhagen, London and Oslo, typically have already favorable mode shares for walking, cycling and mass transit and continue to make large investments.

26. It is clear, however, that while the planned modal shift and the concept of low-emission zones or cities are very helpful approaches to deliver the required climate impacts, they will need to be supported by ambitious targets for transport-related GHG emissions and air pollutants. Front-runners will aim for zero-emission transport by 2025 or 2030. The recent announcements by France and the United Kingdom of the intention to ban the sale of petrol and diesel cars by 2040 set important precedents for the transition to ZECs.

27. Having a clear timeframe for urban transformation, with a proposed timeframe of 10 or maximum 20 years (2020-2040), would pave the way for easier standardization, synergies in best practice exchanges, and favorable joint procurement conditions for e.g. electric busses. Managing such a transformation within and across countries would require not only municipal government decisions but also national coordination (e.g. through diesel and then petrol car bans or EV mandates) and intergovernmental regulation harmonization accompanied by transparency requirements (e.g. real emissions data) in order to let consumers make informed choices. To plan and implement the transformation of urban transport, the transport community will need to work much more closely and effectively with the urban development community. This should extend from urban planning and urban design to creating a better street environment for people to be encouraged to walk and cycle more, financing, environmental planning and safety considerations.

28. The proposed transformation of urban transport based on a combined approach of modal shift and environmental improvements will have large developmental benefits such as improved accessibility, reduced congestion and air pollution as well as a reduction in road traffic accidents. Generally, promoting walking, cycling and well-interconnected mass transit with the active use of TDM policy instruments will also be beneficial as regards greater equity in access to economic opportunities and essential services. This is all good news for transport's contribution to the SDGs. The economic savings associated with these developmental benefits would help reduce the cost of implementing the transformation in urban transport. At the same time, this would create the necessary conditions for cities to remain drivers for growth.

Component 2: Implementing a low-carbon energy supply strategy

29. A low- or zero-carbon power supply is a necessity to allow the rollout of "zero"-emission vehicles at scale while eliminating emissions of GHGs and air pollutants. A three-pronged low-carbon energy for transport strategy, including (a) decarbonizing power generation through renewables; (b) developing a clean hydrogen industry; and (c) ensuring a sustainable bio- or synthetic fuel supply, together with improved energy efficiency (described in more detail under Component 3), is a key part of transport sector transformation.

30. The International Energy Agency predicts that decarbonized power production (~20gCO2/kWh) will be possible by 2050 in the OECD countries. Developing

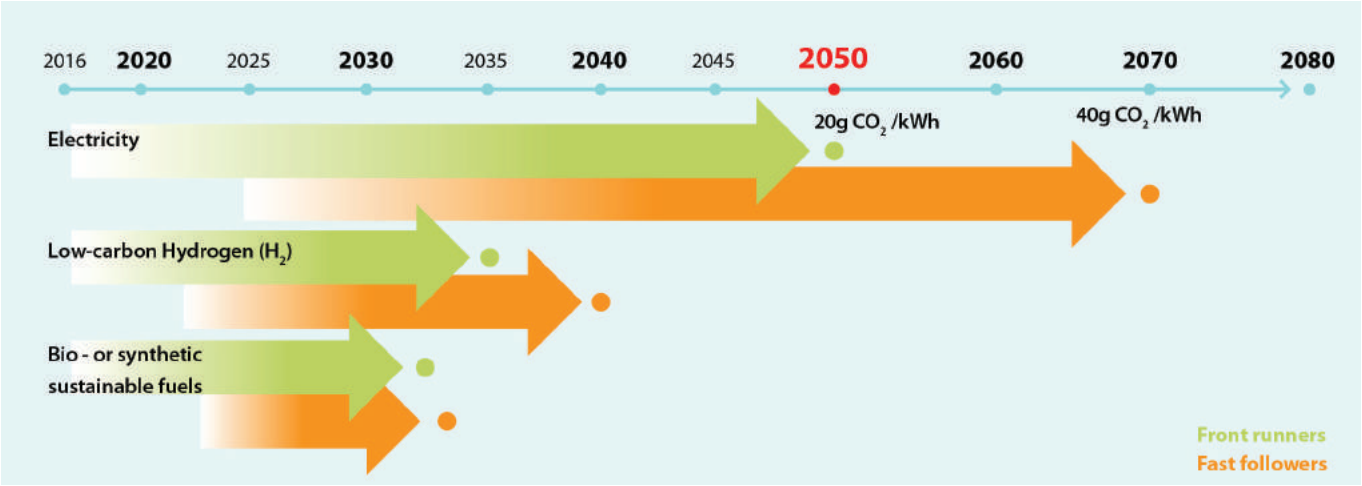


Figure 8: Component 2 : Implementing a low-carbon energy supply strategy

countries are likely to take longer (~2070), but some are already changing fast, following the rapid fall in the price of renewable energy. To initiate momentum towards low-carbon power generation, countries that are currently above 400-600g CO2/kWh will need to embrace a shift in their primary energy mix without delay and prioritize renewable sources of energy (e.g. solar and wind) in new power programs.

31. After an initial but premature focus on hydrogen several years back, there are converging indications that significant clean hydrogen production is possible. Based on this assumption, hydrogen could become a greater part of future medium- to longer-term energy sources for the transport sector. This would happen through the introduction of fuel cell-powered vehicles (especially for longer-distance travel) in meaningful quantities, by 2030 and beyond. To be ecologically relevant and financially sustainable, hydrogen must be produced from renewable sources and should preferably be made available locally. A dual supply of clean electricity and clean H2 would enable the large-scale deployment of zero-emission vehicles for both short distances (urban) and long distances, including freight travel.

32. Immediate steps are required as well on the production of second-generation, more sustainable biofuels and synthetic (non-fossil-fuel-derived) liquid fuels. The use of such fuels is a necessity if the aviation and international shipping sectors are to contribute to the decarbonization of transport. Initially, biofuels will be utilized through blending with other fuels. Their substantial deployment will take time and is not expected to take place at scale before 2030-2035. Depending on the production volumes that can be achieved, other transport modes, e.g. trucks and trains, could also be powered by such sustainable fuels. The use of agro-fuels for passenger cars is expected to remain limited to niche markets with proven sustainability on a life-cycle basis (e.g. Brazil, with fuels produced from sugarcane waste).

33. The transition to a renewables-based secured energy supply, which will be in part through local generation systems, needs to be supported by better storage (batteries, supercaps and hydrogen) and by smart grids to optimize energy needs and flows. A specific requirement for scaled e-mobility is the development of charging infrastructure with the ability to recharge batteries at various speeds, and deliver hydrogen. Such infrastructure needs to be scaled up in cities but also increasingly in areas outside cities. These are prerequisites for scaled-up medium- and long-distance travel by electric vehicles, which would also expand e-mobility beyond the current urban focus. Open standards would increase the interoperability of charging infrastructure.

34. The transport sector is increasingly acknowledging the importance of a low-carbon energy supply. To date,

however, it has not really acted in concert with the energy sector to map out the necessary steps to ensure the timely available supply of low-carbon energy for the sector. The successful transformation of the energy

supply for transport will require a much closer alignment of energy and transport strategies. Although transport is one of the largest end users of energy, the energy sector has only recently started to get in touch with the transport sector to draft joint approaches. Typically, the transport sector has in the past viewed energy supply largely as being outside the scope of its policies. The ongoing transition to electric mobility makes it important for utilities to engage more actively with the transport sector as a new, and much more important, end user of electricity. This should result in the development of joint pathways for the production of renewable sources of energy and their deployment in transport.

Component 3: Improving modal and system efficiencies

35. The environmental performance of different types of vehicles: motorized 2- and 3-wheelers, LDVs (cars), HDVs (trucks and busses), trains, ships and airplanes has a large impact on the contribution of transport to climate change and must be addressed. The Roadmap is primarily driven by climate impacts, but we acknowledge that wherever possible, improvements in GHG emission reductions should also target other environmental performance aspects, in particular, those related to health. In the case of diesel vehicles, measures to reduce CO2, as well as unhealthy particulate emissions (PM) and NOx must also target black carbon emissions, one of the major non-CO2, short-lived climate pollutants.

36. The approach taken in the Roadmap is that proposed milestones should be viewed as fleet averages for the concerned vehicle sector. This means that more ambitious, average CO2 emissions for LDVs can be realized through a combination of stricter fuel economy for petrol or diesel vehicles and greater deployment of electric vehicles. To ensure that positive climate impacts are achieved, effective monitoring of on-road emissions is required and climate impacts of electricity generation will need to be considered. Where the Roadmap suggests the scaling-up of electric vehicles, this will necessitate close alignment with Component 2 on low-carbon energy supply.

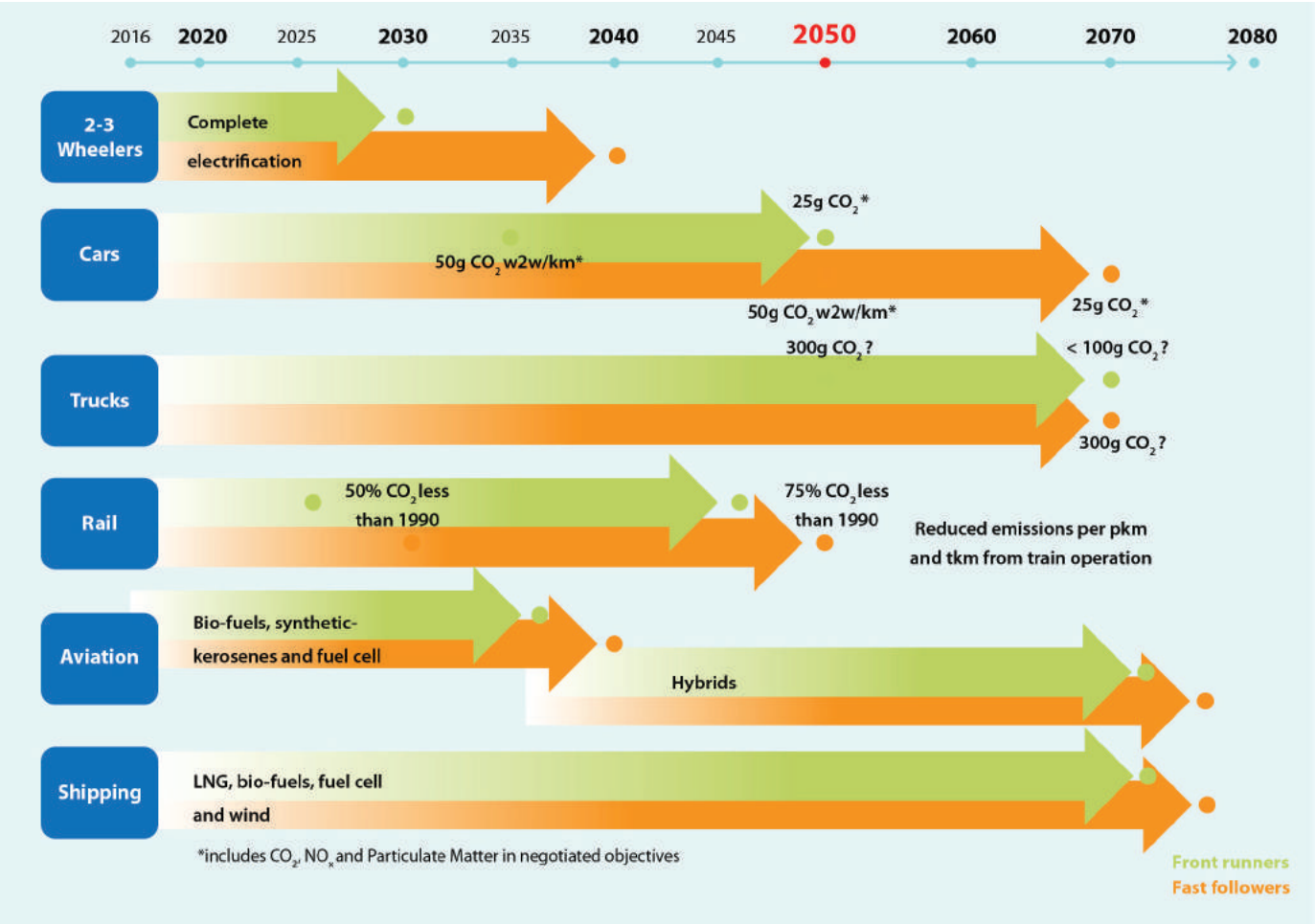


Figure 9: Component 3 : Improving modal and system efficiencies

3-a/ Transforming motorized 2- and 3-wheeled fleets

37. Motorized 2- and 3-wheelers have been a key part of urban transport in many parts of Asia for years, where in many cities they are one of the dominant forms of private (motorcycles – scooters) or public (e.g. rickshaws and tuk-tuks) transport. In other parts of the developing world in particular (e.g. Africa and Latin America), they are rapidly gaining in numbers, in the urban areas, and in the case of Africa in rural areas as well. Two major and fairly recent transformations have taken place that reflect the feasibility and direction of change that can be considered for motorized 2- and 3-wheelers. First, the comprehensive shift from gasoline-fueled rickshaws to compressed natural gas in New Delhi and other main cities in India as well as Dhaka, Bangladesh shows the potential for legislative action in these countries to realize relatively quick impacts on a fleet-wide scale. Second, the ban on traditional motor bikes in over 100 Chinese cities and the emergence of a well-established market for electric motorbikes and scooters, of which over 200 million have been deployed, demonstrate the technical and financial feasibility of large-scale electrification of this type of vehicle. This being so, there is growing consensus that electrification of 2- and 3-wheelers is the preferred route, rather than an approach with phased tightening of fuel economy standards and/or CO2 emission standards. Moreover, the benefits are huge!

3-b/ Driving down energy consumption and emissions of new LDVs. Hybridizing and electrifying a growing share of passenger and freight transport fleets

38. Estimates are that under a Business-as-usual scenario, without any measures to reduce the demand for individualized motorized mobility, there could be some two billion light vehicles on the road by 2050. In combination with measures to reduce such demand, described in other GMR Components, drastic energy consumption reductions are therefore necessary. Technologically, such ambitious improvements in energy efficiency are feasible.

39. Today, in real-world driving conditions, the fleet-average of "well-to-wheel" (WTW) emissions for passenger cars (LDVs) and light commercial vehicles (LCVs) worldwide is around 200 g CO2/km (closer to 170 g CO2/km in Europe). The technical feasibility of reducing this to 50 g CO2/km is now well established, and it is understood that further reductions to 25 g CO2/km are feasible as well. Car manufacturers are already publicizing "2-liter" (~50 g CO2/km, tailpipe) and even "1-liter" (~25 g CO2/km, tailpipe) prototypes. Reaching an 50 g CO2/km WTW on average for new vehicles by 2040, in real-world conditions, is technically achievable, i.e. almost achievable with conventional technologies - provided in particular that vehicles become lighter, with crash avoidance systems – and it is clearly achievable with hybrid/electric solutions or sustainable bio- or synthetic fuels. We should bear in mind that under almost all prospective scenarios, gasoline and diesel vehicles will remain the dominant vehicle type for many years to come. To accelerate the necessary transition, which market forces will not suffice to bring about, it is therefore important that fuel economy (and pollution) regulations be introduced in all countries and revised and tightened on a regular basis.

40. Achieving fleet-wide 50 g CO2/km WTW by 2050+ will require the large-scale rollout of plug-in hybrid and preferably full electric vehicles. To deal with existing vehicles, which will continue to account for the bulk of the fleet, fast-rotation scenarios would help to phase out those vehicles that do not meet standards.

41. Moving further down to an average of 25 g CO2/km WTW would require an almost full technological shift towards electric drive systems, including plug-in hybrids, battery vehicles with or without range extenders (ICEs or fuel cells (FC)), FC vehicles as well as very light ICE vehicles with energy recovery and sustainable liquid fuels. In view of recent announcements on major vehicle markets in Asia and Europe, such a technology shift appears increasingly achievable before or around 2040 in most selected vehicle markets and by 2050 or shortly thereafter, subject to introduction of the proper energy-related infrastructure. Common open standards, e.g. on charging, will be needed to enable a quick and decisive move towards the electrification of transport. The scaling-up of vehicles that meet these emission standards should be heavily incentivized in order to obtain a sizeable market by 2030+ and ensure significant "close-to-zero" emission fleets by 2060. Several countries or subnational entities are introducing increasingly ambitious mandates to promote the use of e-mobility and, in some cases, to ban the use of ICEs (either for both gasoline and diesel, or for only the latter).

42. Moving down to 15 g CO2/km WTW would require an almost complete shift to e-mobility with electricity and/or hydrogen produced through almost zero-carbon techniques.

43. The transformation of the vehicle manufacturing industry towards zero-emission electric vehicles has major implications for the current industrial structure and thus the labor market. To ensure the required political support for such a transformation, it is key to have a better understanding of those in the automotive sector

who would potentially benefit and those who would be adversely affected by such a transformation and to identify what policy measures could be taken to address the concerns of the latter.

3-c/ Curbing emissions of HDVs

44. Heavy trucks are key to regional and long distance freight transport. Despite necessary expanded action to shift towards more waterborne and rail transport of goods, roads will continue to play an important role in freight transport with, under a Business-as-usual scenario, an increase in the number of trucks.

45. As trade grows in coming decades and the world population benefits from increased trade, cities, states and nations must make a drastic effort to reduce the energy consumption and pollution of trucks. Scaling up energy efficiency improvements will take time, so the transformation of this sector should begin as soon as possible. The pace of change can be faster if the freight and logistics sectors can be brought aboard as partners and if they see the financial benefits of drastically reducing GHG and air pollution emissions through the reduced use of fuel and more efficient operations, including greater use of ITS and connected modes (see Component 4).

46. Emissions per t.km (ton x kilometer) can be cut by a rate of progress close to the one observed for cars through a range of technical improvements (drag reduction, weight decrease, engine efficiency, hybridization, lower carbon fuels (e.g. CH4, biofuels, speed management)). The rate of change would be slower, however, and on this basis one could assume that by 2050, on average a heavy truck currently emitting around 850 g CO2/km could emit on average around or less than 300 g CO2/km.

47. Tighter fuel economy standards for trucks are necessary part of the transformation strategy, and a system of standards of increasing stringency needs to be put in place as soon as possible. Moving down below 100 g CO2/km on average is likely to be a post-2060 goal and would most likely require clean hydrogen, second/third generation biofuels or synthetic fuels, or large-scale rollout of fully electric trucks. Until recently, full electric HDVs were not deemed a major option. However, based on recent developments, it may be too early to reject this option out of hand. One option in certain cases could be e-motorways, on which initial testing is underway.

48. The quickest progress in decarbonizing freight transport can be made in urban areas, where there is already a substantive body of experience with the use of e-trucks (both medium- and heavy-duty). Several cities have indicated that zero-emission urban freight systems can be in place by 2030. Much progress can also be achieved in lowering bus emissions. Recently, there has been a rapid acceleration in the rate of deployment of electric busses, with several cities now committing to full electrification of urban bus fleets by 2025–2030.

49. Making ultra-low sulfur diesel available, combined with Euro VI emission standards for trucks, would almost immediately help to reduce air pollution, especially in developing countries. Moreover, because of the greenhouse effect of black carbon, it could also have a positive climate impact.

3-d/ Continuing to electrify and improve the energy efficiency of rail

50. Rail-based means of transport are used for moving large numbers of people, by subway, light-rail or tram in the case of cities and trains, by heavy rail and sometimes high-speed travel, in the case of inter-city suburban travel. Freight transport by rail is almost always by heavy rail. In addition to calling for improvements in efficiency under this Component in several other places (e.g. Component 1 for urban transport and Components 4 and 5), the GMR makes a case for shifting the transportation of goods and people to rail-based modes.

51. Greater use of electricity (generated from renewable sources) and efficiency measures are required for all forms of rail transport to reduce emissions. Urban rail infrastructure and services are already largely electrified, and this could be made mandatory in the future. The degree of electrification of long-distance heavy rail currently varies between countries. Intermediate targets should be set for expanding the percentage of rail systems operated in part, or in full, on electricity. Linked to this, for long-distance rail, thought should also be given to the source of electricity and, where possible,

to following the example of the Netherlands, which since the beginning of 2017 has been operating a fully renewable energy-powered rail network.

52. Prior to COP 21, the rail sector had already committed to an industry-wide initiative with a series of milestones in terms of CO2 emission reductions:

- A 50% reduction in CO2 emissions from train operations by 2030, and a 75% reduction by 2050 (specific average CO2 relative to a 1990 baseline – i.e. reduction of emissions per passenger/km + ton/km);
- A 50% reduction in energy consumption from train operations by 2030, and a 60% reduction by 2050 (specific final energy relative to a 1990 baseline).

53. These milestones can serve as the basis for a modified rail-specific roadmap that takes into account the increased ambition of the Paris Agreement to limit temperature increase to 'well below 2°C'

3-e/ Managing the two key technical transitions for aviation: sustainable low-carbon kerosene and hybrid planes

54. The International Civil Aviation Organization (ICAO) agreement to achieve carbon-neutral growth by 2020 is in line with the general understanding that transport emissions should peak at the latest by the early 2020s. The subsequent objective, aiming at reducing by 2050 net CO2 emissions to 50% of what they were in 2005 (through technology, improved operations, better infrastructure management and global market-based measures -- primarily offsetting), is still being elaborated through detailed plans and adjusted business models to support the transformation of aviation. However, the 2050 ambition for the aviation sector, as agreed in 2016, may not prove sufficient for the overall transport sector to be in line with the Paris objective of a "net-zero-emission economy". There is a need to craft a clear phasing of mitigation measures in the aviation sector, with related emission regulations agreed at international or national level in accordance with established institutional mandates. Action on aviation will need to be a combination of measures agreed under ICAO in the case of international aviation and through UNFCCC in the case of domestic aviation (e.g. through NDCs and long-term emission reduction strategies).

55. Sustainable low-carbon kerosene (bio- or synthetic) for jet engines, complemented by fuel cells for on-board operations, are solutions currently being developed in parallel to the advancement of all the energy efficiency and fuel-saving tools in aircraft operations and traffic. By 2035, this transition should be completed worldwide. Technology should then be sufficiently advanced to embark on the second transition: hybrid planes (taking off with liquid fuels and cruising on electric power).

56. Pilot tests of fully electric short-range planes have been announced as well, but it is too early to make conclusive statements on the feasibility of fully electric planes and their large-scale introduction if they prove feasible. In the event that fully electric planes turn out to be feasible, the proposed targets and actions for the aviation sector would require adjustment.

57. Excellent progress is already being made in terms of the carbon accreditation of airports, with a growing number of carbon-neutral airports for day-to-day operations. As a next step, it is also important to consider the role of airports as mobility hubs. Guided by the actions indicated in other components of the Roadmap, efforts are needed to make them "clean mobility hubs".

3-f / Electrifying river and coastal shipping and scaling up the role of wind-energy and sustainable bio- or synthetic fuels in long-haul shipping, as a complement to greater use of LNG

58. Because shipping can operate at low speed, it does not require huge power in comparison to other transport means. At present, however, shipping is almost completely fossil fuel-powered. As in the case of aviation, if no effective action is taken, this will compromise the ability of the transport sector to contribute effectively to the Paris Agreement. "Slow steaming" and liquefied natural gas (LNG) have demonstrated their positive albeit non-revolutionary impacts and the sector has not yet come up with a more comprehensive strategy for the future. For relatively short distances, fuel cells and locally produced hydrogen appear to be promising solutions, all the more so as space availability, weight, and fears of hydrogen leaks are lesser issues for such open-air applications. Various technologies for electric-powered ships (river and coastal) are currently being tested, with positive results. Wind-powered or wind-assisted shipping is (re)gaining interest, through ingenious sail designs. There is a need to incentivize the scaling-up of all these options through supportive public policy, with the expectation that large-scale demonstration projects will drive market development and thus bring down the price of new technologies.

59. As in the case of aviation, there will be a need for a transparent and predictable long-term emissions pathway for the international and domestic shipping sector, based on which a target and implementation mechanism for emission reductions will need to be put in place sooner rather than later. In 2016, the International Maritime Organization (IMO) decided to adopt an initial IMO strategy on the reduction of GHG emissions from shipping, aiming to report on this achievement at COP24 in 2018. Adoption of the revised IMO strategy, including short-, medium- and long-term measures with implementation schedules is expected in the spring of 2023. While IMO will need to handle the international dimension of standard-setting, UNFCCC can address emissions from domestic shipping through NDCs and long-term emission reduction strategies.

Component 4: Optimizing supply chains to manage freight transport emissions

60. Trade continues to increase, thereby contributing to greater economic prosperity. The linked growth in freight movements, however, is potentially huge. Therefore, above and beyond the promotion of lower-carbon transport means, there is a need for more fundamental steps towards the rationalization of supply chains and the reduction of overall transport distances. For business and the logistics sector, this could mean:

- (Re)-localizing and/or optimizing purchasing choices and redefining supplying schemes;
- De-fragmenting certain operations (e.g. semi-finished products manufactured in different places and then assembled elsewhere);
- Ensuring greater collaboration, e.g. logistics centers, data, final delivery;
- Simplifying and streamlining distribution channels.

61. The "Fourth Industrial Revolution" and "Factory 4.0" developments must be implemented in a manner that encourages the overall reduction of mileage.

62. Optimizing supply chains also calls for reassessing the suitability of transport modes from a climate perspective. Over the past few years, road and airfreight transport have grown at the expense of rail and (inland) water transport. More recently, there has been renewed interest in railways, especially in emerging economies. Greater use of rail and inland water transport can help reduce the growth of freight-related GHG emissions, especially if this is done through renewable energy-operated railways and low-carbon shipping.

63. To transform transportation towards a net-zero-emission economy, trade policy will have to be increasingly based on environmentally led paradigms, and the success of such policies should specifically address GHG impacts. Today, this area is being overlooked by both governments and business. It must become a more urgent priority for companies, the World Trade Organization (WTO) and countries.

64. System efficiency also plays a key role in long-distance freight transport. Many national regulations, based on protectionist or other grounds, hinder the efficient use of resources, e.g. transport assets (more than one-third of all trucks worldwide move empty). Increasing load factors, improving railway effectiveness, densifying networks, reducing downtime for freight, facilitating border crossing, successfully competing with airlines on mid-distance regional travel, using clean electricity, and so on, are all key for increasing system efficiency for non-urban freight transport. Particular attention and support are needed for transit corridors.

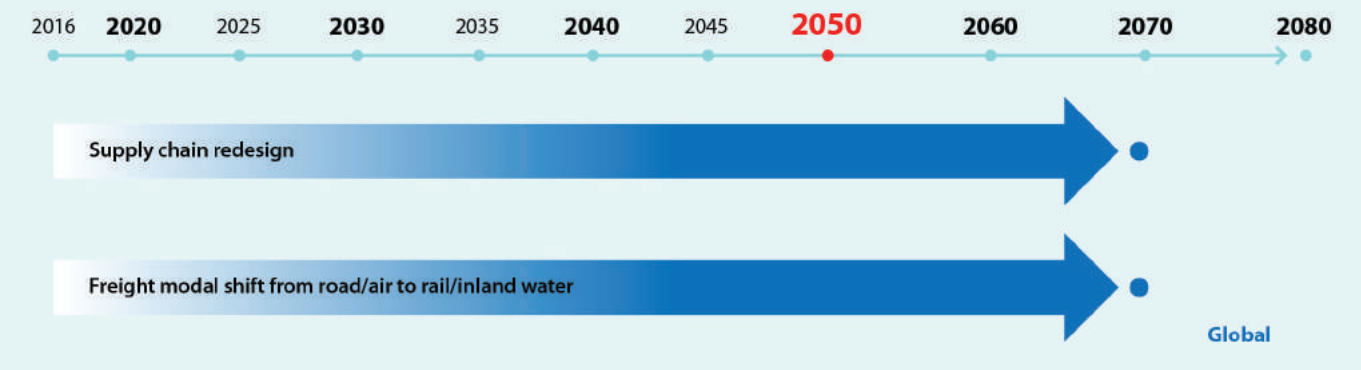


Figure 10: Component 4 : Optimized supply chain

Component 5: Avoiding vehicle kilometers through greater intermodality and shared transport for commuting, shopping and accessing services

65. The efficiency of transportation systems and hence energy use and related GHG emissions is partly determined by the efficiency and environmental performance of the respective transport modes used (see Component 3). Beyond modal optimization, rapid improvements in enhancing smart intermodality can bring considerable benefits in terms of lowering GHG emissions in the transport sector.

66. Further scaling up ITS and ICT development and deployment is key for ensuring efficient, seamless travel for both people and the transport of goods. Seamless intermodality between existing modes (public and private) can help to increase the modal share of public and shared transport by offering door-to-door solutions in the case of passenger mobility. Rapid progress has been made in recent years in rolling out large-scale

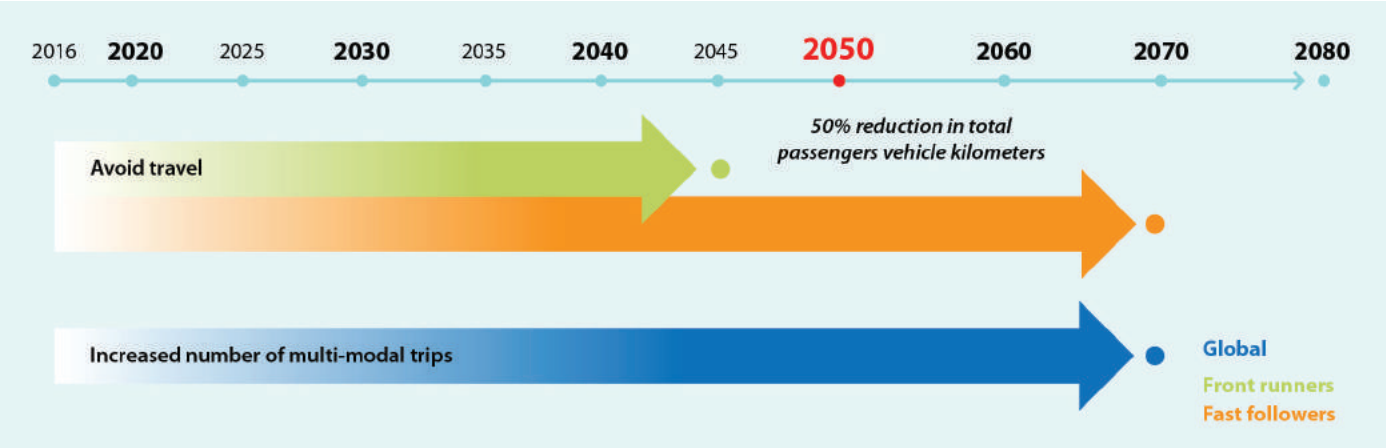


Figure 11: Component 5 : Unnecessary travel reduction

docking free bike-share programs, initially in China but now also in other parts of the world. In some cities, this has had a measurable impact on congestion. Urban freight delivery systems based on urban distribution, and logistics systems with last-mile delivery through electric or 2- or 3-wheel-based solutions, can reduce emissions from freight transport.

67. There is much discussion on fully or partially autonomous vehicles, often in the context of shared mobility services and the impact on number of kilometers driven. This could be an important part of door-to-door solutions and decreased individual car ownership in cities, if such shared autonomous vehicles are properly integrated with mass transport systems. In order to realize the full environmental impact, it is also important to ensure that they feature zero-pollution emissions and are powered by renewable energy.

68. The move towards greater intermodality and shared use of vehicles, including autonomous vehicles, is an area where new business models are especially relevant. Such business models promoting efficient, real-time, personalized solutions (e.g. Uber, Blablacar and car clubs) must be encouraged, with the proper set of regulations to ensure social fairness. It is key for them to be linked to public transport systems rather than replacing them, as happens in some cases due to a lack of local and national policies favoring (in some cases forcing) the coordination of various modal development agencies and their programs to maximize equitable accessibility and system efficiency. If implemented properly, intermodality can be a key step towards solving the problems of an urban mobility model, which today relies too heavily on individual car ownership.

69. There is also considerable potential for reducing regular daily travel, through both alternatives to job-related commuting and remote access to educational and other community-based services. The overall impact of on-line shopping, which is also growing at a very rapid pace, is still less well understood.

70. Commuting represents a sizeable share of individual use of transport. It contributes to congestion and often takes place at the expense of family and private life while costing organizations a significant amount of labor time and budget. Alternatives (such as work-at-home, telework, telecommuting and remote office centers) do exist and have proved their relevance, at least for a certain percentage of time. Although they are growing, they still represent only a tiny proportion of human work worldwide. However, effectively addressing work practices and commuting calls for more direct and structured coordination between transport planners and Human Resource Development managers.

71. Together, these alternatives to travel can provide dividends in terms of environmental benefits, better health, time saved for family and/or private activities, better availability for work, cash savings for more gratifying expenditures as well as a reduction in transport-related GHG emissions. Greater use of electronic services, home services (e.g healthcare) and home delivery can help to ensure better local provision of basic services and needs and, in some cases, connect disadvantaged areas to jobs and economic opportunities (see also Component 6).

72. If it proves feasible to reduce considerably these types of travel, this would open the door for other types of travel demand reduction measures in other travel modes. Combined with measures for land-use planning, car-pooling, developments with regard to shared, automated and connected vehicles, electric vehicles (EVs) and more, these practices and new technologies could significantly reduce the amount of vehicle kilometers travelled. Would a 50% reduction in private passenger vehicle kilometers traveled be unrealistic by 2040 if taken as a shared objective?

Component 6: Providing low-carbon solutions for rural (non-urban) populations

73. Even though most key transformations in the transport sector over the next 50-60 years will be driven by cities or by changing travel between cities, a successful transition will necessarily need to involve rural areas as well.

74. There is still substantial unmet demand for mobility of people and goods that is holding back the economic and social development of many rural areas, especially in the developing world. At present, one billion people lack access to all-season roads. Accordingly, the 2030 Sustainable Development Agenda quite rightly calls for improvements in rural access through the expansion of transport infrastructure and services.

75. The design of medium- to long-term low-carbon transport solutions for the rural population is guided by a number of relevant megatrends:

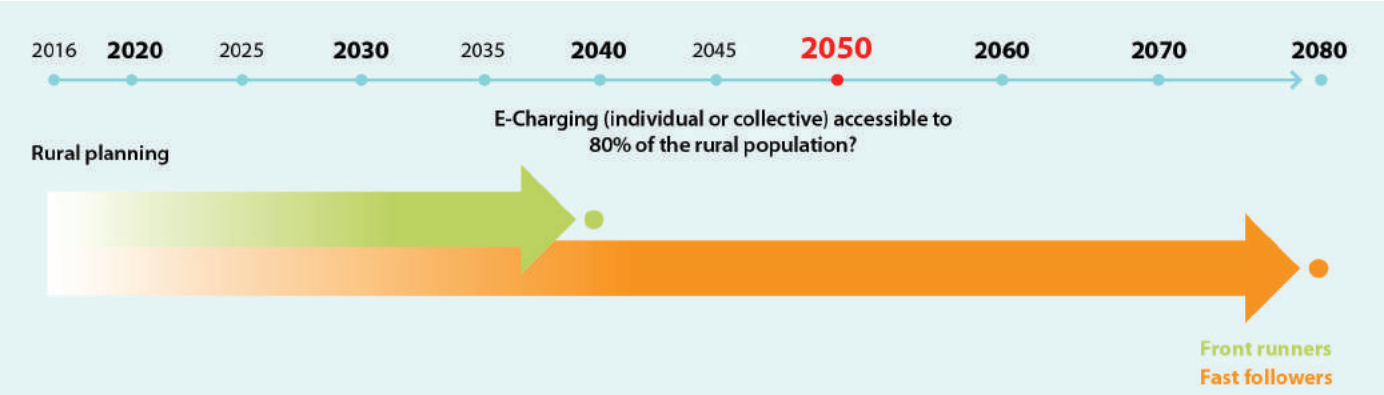


Figure 12: Component 6 : Tailored solutions for the 'rural' world

- Accelerated deployment of decentralized renewable energy production and improved energy storage facilities;
- Rollout of fast Internet across rural areas;
- Increased disposable incomes over time because of greater productivity.

76. Together, these trends can provide rural areas with a more diverse range of transport options, which will rely increasingly on renewable energy sources, via "green electricity" or locally generated renewable energy (e.g. wind, solar or biofuels). The relative short distances involved for most of the local trips, combined with decentralized renewable electricity supplies, make it likely that e-mobility will become a significant mode of transport for both freight and passengers by 2030, if proper territorial policies and incentivization of individual investment are developed. Given their strong tradition of sharing transport, rural areas are well positioned for tailored shared mobility applications.

77. Rural populations can benefit greatly from enhanced distant access to a wide range of services, e.g. market information, administrative and health services as well as online shopping. All of this would reduce the need for travel.

Component 7: Accelerating action on adaptation in the transport sector

78. Adaptation in the transport sector is necessary for both developed and developing countries. Crucially, sustainable 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, all of which are also vital for achieving full mitigation potential. Transport systems worldwide are vulnerable to the increasing impacts of a changing climate, a factor that increases 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.

79. In addition to providing access to jobs, goods and services, transport services are essential for agricultural, industrial and commercial activities. Disruptions to such services have a direct impact on the economy and the social well-being of communities. Left unmanaged, climate change will significantly affect the operational, financial, environmental and social performance of transport. In addition, climate change represents a significant risk for global transport infrastructure investments, which are estimated globally at $1.4 trillion to $2.1 trillion per year.

80. Climate change scenarios are uncertain, inter alia because of uncertainties in emissions scenarios, and the severity of climate impacts on transport infrastructure and systems also varies greatly depending on location, resilience and adaptive capacity. However, this uncertainty must not be used as an excuse for inaction. Decisions on adaptation have to be taken now, especially with respect to long-lived transport infrastructure assets that have the potential to lock in development patterns for many decades. Flexible responses allowing for adaptive management as the climate changes will therefore be essential. Pro-active adaptation can be a low/no-regret option in cases where project savings accrued over the infrastructure life cycle offset the higher construction and operational costs of inaction.

81. Transport is supported by infrastructure, which exists in all countries across the globe. Much of it has been in place for decades if not centuries. Investing in and planning for new infrastructure take time, yet transport infrastructure assets and components – bridges, earthworks, quays, ways (roads, rail tracks and drainage)

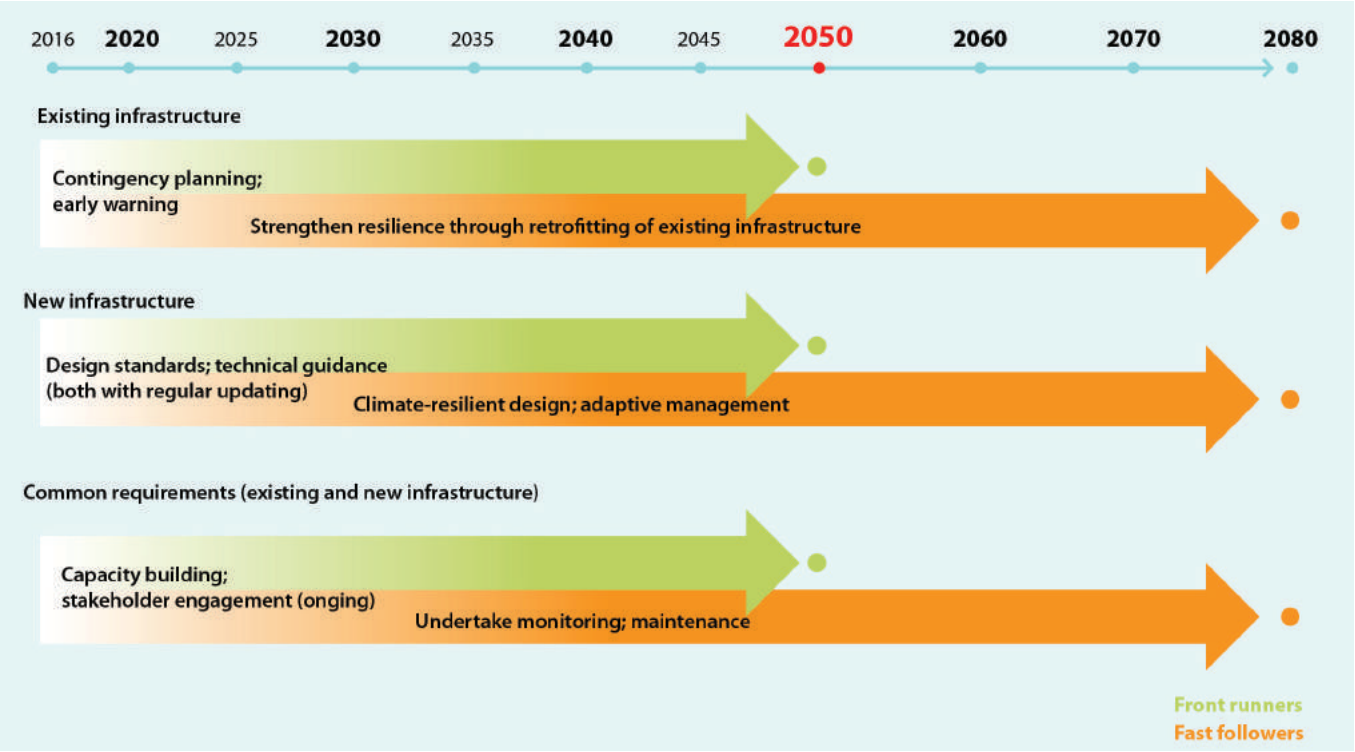


Figure 13: Component 7 : Investing in adaptation

can last well past the so-called 'design life' which in many cases can be over 100 years. As such, much transport infrastructure, whether existing or new, will be impacted by changes in climate.

82. There is a need for the global transport community to develop a framework for adaptation and resilience-building. This in turn would require expert, engaged leadership and support to work across transport modes and engage at national, regional and local scale. It would align with moves in the international standards community to bring consistency to adaptation through a framework approach. Such an approach is deemed vital in order to promote good practice at all levels.

83. In summary, the adaptation effort in transport today is far from sufficient and a wise strategy calls for:

1. Raising the profile of adaptation and resilience in discussions on climate change and transport;

2. Promoting climate risk screening and vulnerability assessment of existing transport systems, services, and all new projects;

3. Recognizing the key role of monitoring and maintenance in enhancing adaptive capacity;

4. Developing and adopting industry-relevant technical standards to ensure that transport infrastructures are climate resilient, with appropriate adaptive capacities to minimize future risk;

5. Leveraging additional climate finance to shift public and private investments towards resilient transport systems;

6. Integrating adaptation into project design, including through enhanced emergency preparedness;

7. Strengthening coordination across agencies (including funding, implementing and operating agencies);

8. Building transport adaptation capacity at local, national and international levels;

9. Cooperating with the broader adaptation community to integrate transport into adaptation programs and activities.

84. These actions apply to strengthening the resilience of existing infrastructure through retrofitting as well as climate-resilient design and adaptive management of new infrastructure.

Component 8: Deploying economic instruments on a large scale to catalyze the transformation of the transport sector, including putting a price on GHGs

85. Deep reforms of transport pricing are required to ensure that users pay a price that reflects the full marginal social costs of transport (e.g. noise, infrastructure, crashes, delays, as well as GHG emissions and air pollution). This will ensure fairer modal competition and stimulate innovation by allowing market forces to drive the transformation of transport. At the same time, it will also help shift investment patterns in the transport sector towards low-carbon and resilient transport, which will need to be a key component of successful transport sector transformation.

87. Such a combination of economic instruments and regulatory approaches (for example, the fuel economy standards described in Component 3), if implemented at scale, would provide much-needed market signals. It could also help generate income to be pumped back into the economy, preferably through sustainable transport-related infrastructural investment, including public transport networks, facilities for walking and cycling, and new supportive ITS and ICT technologies.

88. Until now, carbon pricing in the transport sector has been poorly developed in comparison to other sectors, and additional efforts are required to catch up. It is encouraging that a number of transport-related companies have started to introduce an internal or shadow carbon price.

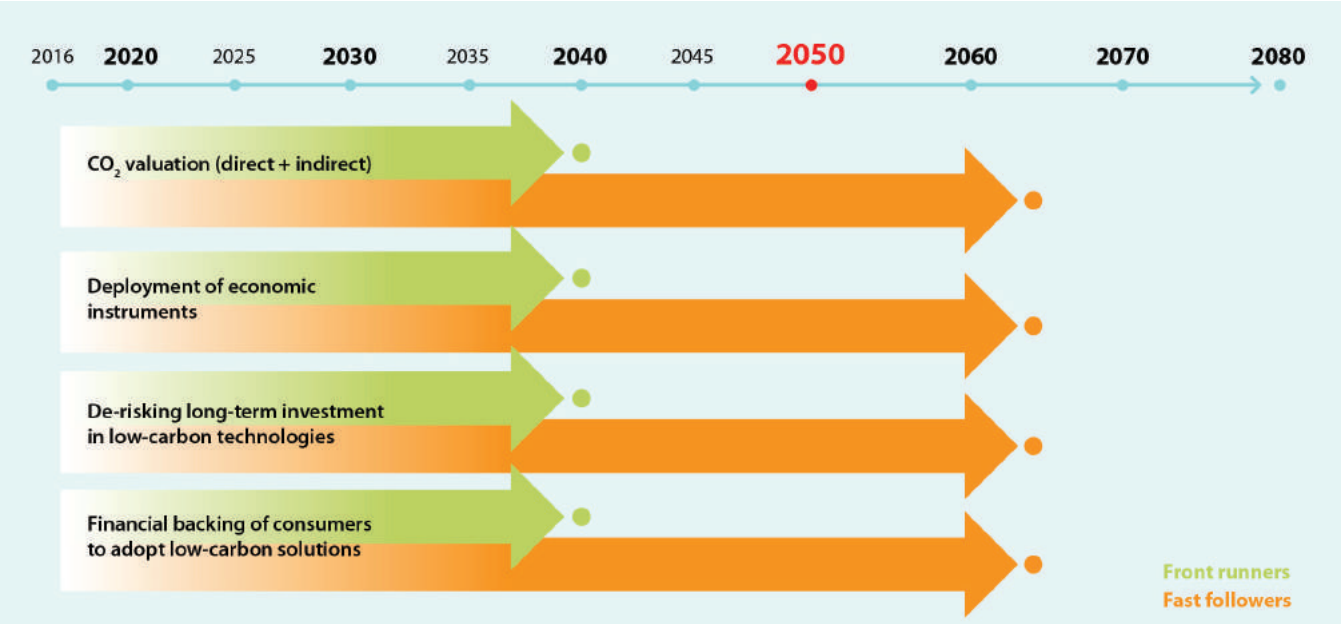


Figure 14: Component 8 : Economic instruments

86. One of the key outcomes of COP21 has been the strengthened resolve to adopt carbon pricing with a view to promoting action on climate change. In Paris, it was argued that pricing CO2 at around 50 $/ton would give a strong push to alternative energies and that pricing it at around 100 $/ton would ensure that technologies like carbon capture and sequestration become economically viable. Discussions are continuing on both price levels/ trajectories and ways to foster a level playing field. Putting a value on CO2 is a major lever for informing player decisions towards low-carbon solutions – be it in the form of:

- Direct instruments like CO2 pricing or emissions trading, e.g. by making transport part of carbon markets; or

- Indirect tools like CO2 emissions standards, bonus/ malus solutions, urban tolls, urban parking charging, low-occupancy lanes, fuel subsidy timeline (as mentioned in Quick Wins) or fiscal incentives for using low-carbon modes.

89. In addition to carbon pricing, other economic instruments such as electronic road pricing, parking policies, CO2-based vehicle taxation, number plate auctioning and fuel prices are important and have proven their effectiveness in reducing the amount of kilometers traveled or accelerating the adoption of low-carbon vehicles.

90. Parties are invited to start working together with business and consumer associations on such a toolbox of economic instruments, to promote the transformation of the transport sector. This will require business to be clearer about what it needs, and what it proposes in support of speeding up the transition. Political leadership will be necessary to remove policy and regulation obstacles to embracing transformative change.

91. Investments in new infrastructure, new technologies and mass transit systems will have to be substantially increased, and private money will need to be injected into areas traditionally managed by the public sector. Business models will have to evolve accordingly. To accomplish this, tools to de-risk long-term investments in low-carbon sustainable transport solutions will have to be designed and deployed (e.g. shorter amortization) to attract non-traditional investors to sustainable transport, such as insurance companies, pension funds and other institutional investors.

92. Climate finance, which constitutes a tiny share of total transport financing for both mitigation and adaptation purposes, should be used wisely – ideally to undertake the important upstream work to identify policies and investment opportunities, set standards and criteria, and only invest in or be used for key demonstration activities or path-changing activities, e.g. the first rail line in a city. Climate funds should be used to help ensure that all transport funding (public and private) becomes more climate-oriented.

III. The way forward

A. The Global Macro Roadmap in the UN process: Climate change in the broader context of sustainable development

93. There is widespread agreement that current ambition levels for both climate change mitigation and adaptation fall well short of the targets set by the Paris Agreement on Climate Change. Without a strong sectoral plan on transport, the objectives will not be achieved. The lack of ambition was evident at the time of the adoption of the Paris Agreement and needs to be addressed in 2018 with the first full Facilitative Dialogue to raise mitigation ambition in Nationally Determined Contributions (NDCs).

94. At COP22, the centrality of NDCs was more firmly established as the basis for national climate policies. NDCs are the main mechanism for disseminating and implementing the Paris Agreement. The main goals at present for the transport sector, as for other sectors, are how to operationalize strategies contained in current NDCs and how to take action by 2018 to scale up future iterations of NDCs. Countries need to set their own targets and their body of integrated policies by developing their national roadmaps in order to take action on decarbonization and resilience of transport. It is encouraging to see political and technical initiatives like the NDC Partnership, which can help scale up ambition levels in NDCs.

95. In 2018, it is also expected that countries will progress on the development of long-term emissions reduction strategies. These are voluntary in nature and are to be submitted to UNFCCC by 2020.

96. The manner in which the UNFCCC process is unfolding, with a strong focus on increased ambition levels and acknowledgement of the need for short-, medium - and long-term strategies, provides the transport sector with excellent opportunities to inform countries through the GMR on possible pathways for transforming the transport sector and scaling up ambitions.

97. Another key outcome of COP22, the Marrakech Action Proclamation, which gained unanimous support among Parties, reinforces the irreversible momentum toward collective climate action, stating "We, collectively, call on all non-state actors to join us for immediate and ambitious action and mobilization". This offers a clear mandate to the

transport community to move forward in the development of transformative pathways for the decarbonization of the transport sector.

98. The complementary Marrakesh Partnership for Global Climate Action (MPGCA launched by the High Level Champions on Climate Change) puts all climate action under one flag by noting that "coalitions of thousands of cities, regions, companies and investors from across the world announced voluntary commitments to support the implementation of the ambitious climate action." This bodes well for further efforts on the Transport Global Macro Roadmap, which actively links action by state and non-state actors. As part of MPGCA, a wide range of multi-stakeholder initiatives has been created to inspire ambitious action on transport and climate change. The potential contribution of these initiatives to the further development and implementation of the GMR is indicated below.

99. As part of MPGCA, UNFCCC, acting on behalf of the High Level Champions, has developed an impact and priority tracker, which is published on the UNFCCC website. This monitoring tool will be updated periodically to reflect the work plans and focus areas of the various institutions and organizations engaged in the different MPGCA thematic areas. The impacts in the transport section are closely aligned with the eight components of the Global Macro Roadmap.

100. As stated above, decarbonization of transport is not the ultimate objective of the Paris Process on Mobility and Climate, as it is felt that the Paris Agreement is much more than a binding treaty on climate change only: it holds great promise in terms of development and new opportunities for a more balanced and shared growth on a global scale. Climate change is one of the 17 SDGs: as such, it is important to recall the role that transport has to play in the realization of sustainable development, by providing equitable access to economic opportunities and essential services, enabling business to generate growth, and supplying livelihood to society at large, in support of poverty alleviation. In this regard, the successful development and implementation of the Global Macro Roadmap on transport decarbonization also represents, in addition to the realization of the SDGs and the Paris Agreement, a direct contribution to the New Urban Agenda and other relevant global and regional agreements on sustainable development.

B. Next steps in the development of the Global Macro Roadmap

1. Updating the GMR to reflect technological and policy progress

101. The GMR process is very much a living process, and it is essential to ensure that the actions and associated "targets" under the eight components are updated on a regular basis. This can either be on the basis of technological progress or because of greater policy commitments for ambitious actions. Modal efficiency and electric mobility are examples of this. In recent years, there have been a number of announcements on the possible deployment of electric mobility in freight transport and aviation as well. If these trends continue, several GMR components and "targets" will need to be modified. The recent announcements on banning internal combustion engines could, if followed up by concrete implementation plans, change the timing of some of the proposed milestones for LDV emissions.

2. Adapting the GMR to regional contexts

102. The GMR provides a global framework with eight components that need to be assessed in regional contexts with respect to their differentiated mitigation potential and adaptation needs, timing and expected impacts -but also taking into account cost-effectiveness, broader sustainable development impacts and political acceptability. In this connection, regional adaptations are important as they reflect regional characteristics, requirements and opportunities, based on local situations/analyses. Accordingly, PPMC has been involved since 2017 in a "GMR differentiation work stream" with the development of regionally adjusted versions based on analytical work and dedicated consultation workshops for Europe, Africa and Morocco (as a legacy from the Moroccan COP presidency). The first outcomes of which will be presented at COP 23 in Bonn. Other regional adaptations are planned in 2018 for Latin America and India.

3. Aligning the GMR with other key policy and analytical efforts on transport, climate change and sustainable development

103. The Global Macro Roadmap links up with wider efforts on sustainable transport and sustainable development, through its role in the newly established Sustainable Mobility for All initiative (SUM4ALL), which brings together relevant global processes on sustainable development and climate change in an integrated sustainable transport narrative. An important part of this initiative is the development of a Global Mobility Report, based on a global tracking framework that sets ambitious targets on sustainable transport. These targets include a "Green Objective" for transport, climate change and air pollution that is closely aligned with the targets set by the Paris Agreement and the SDGs. As a next step, SUM4ALL will develop an Action Stream to help accelerate the realization of the common targets proposed in the Global Mobility Report. The Global Macro Roadmap is designed to present a pathway for the realization of the "Green Objective" of SUM4ALL.

104. The Transport Decarbonization project (DP) of the International Transport Forum (ITF) consists of a comprehensive modelling approach designed to provide a "common assessment framework" for measuring the effectiveness of measures implemented or planned by an array of actors, primarily from government and industry. This will help increase the mutual confidence of all actors engaged in this process, thereby enhancing its effectiveness. The ITF model will enable the assessment of direct and indirect impacts of proposed transport measures and the testing of alternative scenarios on various levels of scale. ITF's DT project and the PPMC Global Macro Roadmap are complementary, and together provide a wide range of additional perspectives for stakeholders to explore for meeting carbon neutrality in transport by 2050 or shortly thereafter in the case of developing countries. Consequently, the GMR and ITF efforts can be mutually beneficial. In general terms, the PPMC efforts should increase the ambition of countries and other stakeholders to take action on transport and climate change. If successful, this would increase countries' interest in using the ITF analytical framework to assess the implications of specific policy measures. In addition, bottom-up mitigation potential analysis, enabled by ITF's DT project, in support of the development of recommended policy actions in individual components of the PPMC Global Macro Roadmap, can benefit the development of specific elements of the ITF analytical framework. Some of the milestone-related actions in the Global Macro Roadmap could also constitute cases to be tested within the ITF analytical framework with a view to providing useful calibration. Once implemented in their specific circumstances, the actions could provide additional data for feedback into the ITF's models, thus improving their capacity to support decisions for action by other actors.

C. Building support for the implementation of the Global Macro Road Map

1. Strengthening the scope of Transport Initiatives under the MPGCA in support of the Global Macro Roadmap

105. COP21 decided to appoint two High Level Champions (HLC) so as to "facilitate through strengthened high-level engagement in the period 2016–2020 the successful execution of existing efforts and the scaling-up and introduction of new or strengthened voluntary efforts, Initiatives, and coalitions". It is in this context that the Partnership on Sustainable Low Carbon Transport (SLoCaT) and the PPMC have been helping, since early 2015, to facilitate the development of a wide range of initiatives by non-State actors in the transport sector.[6] Their engagement was inspired by the call to action by UN Secretary General Ban Ki-moon in September 2014, and followed up by the 'Action Agenda' under the aegis of two HLCs, which since COP22 has been the Marrakech Partnership on Global Climate Action (MPGCA).

106. At the time of COP22, there were 15 initiatives, which cover both passenger and freight transport and touch on all transport sectors and modes: from road to rail, from air to waterborne transport, and from motorized vehicles to cycling. They address both mitigation of and adaptation to climate change, which means that they contribute to both the mitigation and the adaptation agenda. Collectively, these initiatives represent hundreds of partners and bring together cities, regions, development organizations, the private sector and civil society. Announcements on the launch of an additional five new GCA Transport Initiatives are to be made at COP23 (see figure below).

107. Taken together, 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 passenger and freight trips made by 2025. Such actions can contribute to substantive savings associated with a shift to low-carbon transport. The IEA has estimated that these could be as high as USD 70 trillion by 2050 (as less money would need to be invested in vehicles, fuel, and transport infrastructure), thus reflecting the strong economic case for climate action in the transport sector.

108. These Initiatives can play an important role in the development and implementation of the GMR's components, as illustrated below:

	Urban Transformation	Low-carbon energy supply	Modal efficiency/ Intermodality	Optimized supply chain efficiency	Travel reduction	Solutions for rural areas	Adaptation	Economic instruments
Airport Carbon Accreditation	√		√	√				
Aviation's Climate Action Takes Off			√	√				
Below 50*		√						
C40 Cities Clean Bus Declaration of Intent	√		√		√			
EcoMobility Alliance*	√		√	√	√			
EV 100*			√					

Weak linkage	Medium linkage	Strong linkage

6 http://www.ppmc-transport.org/transportinitiatives/

	Urban Transformation	Low-carbon energy supply	Modal efficiency/ Intermodality	Optimized supply chain efficiency	Travel reduction	Solutions for rural areas	Adaptation	Economic instruments
Global Fuel Economy Initiative	√		√			√		
Global Green Freight Action Plan	√		√	√		√		
Global Strategy to Introduce Low-Sulfur Fuels and Cleaner Diesel Vehicles*	√	√				√		
ITS for the Climate	√		√	√	√	√	√	
Low Carbon Road and Road Transport Initiative (LC2RTI)			√			√	√	
Mobilise Your City (MYC)	√		√	√	√		√	
Navigating A Changing Climate			√	√			√	
Sidewalk Challenge*	√		√					
Transport Urban Mobility Initiative*	√		√	√	√		√	√
UIC Low-Carbon Sustainable Rail Transport Challenge			√	√		√	√	
UITP Declaration on Climate Leadership	√		√			√	√	
Urban Electric Mobility Vehicles Initiative (UEMI)	√		√	√				
World Cycling Alliance (WCA) and European Cyclists' Federation (ECF) Commitment	√		√	√			√	
Worldwide Taxis4 Smart Cities Initiative	√		√					
ZEV Alliance	√		√	√		√		

** New initiatives launched at COP23.*

109. Clearly, the GCAA Transport Initiatives are especially relevant when it comes to the components focused on improving modal efficiency and urban transport. However, it is clear that the geographic outreach of several Initiatives must be broadened. To take the Initiatives to scale, business and Parties will need to reinforce their support for them. There are two key areas of the Roadmap that are largely being ignored by the current Transport Initiatives:

a) Current Initiatives do indeed have a focus on **energy**; however, this is mainly about efficiency or promoting alternative fuel sources, and only one Initiative has a clear focus on the changing energy supply. Yet, any transformative action implies a strong link between transport and energy transition. This being so, the transport sector should either encourage the development of bold energy sector Initiatives or work much more closely with existing relevant ones.

b) The other area where there is an urgent need for new, innovative Initiatives is that of **economic transition**. Current transport Initiatives acknowledge the importance of enabling economic instruments but do not undertake dedicated steps in this area, for which national governments are eventually liable. Hence, it is suggested that existing Initiatives should specify more precisely the economic tools/incentives that are needed to scale up their scope, and convey them to Parties.

COP 23 in Bonn (2017) and the upcoming COP 24 in Poland (2018) provide opportunities to launch a strong call to action to further fill the gaps, and a clear action plan on the further development of the MPGCA will be of help in this respect.

2. Linking Quick Wins to initiate immediate disruptive actions in support of advancing the GMR

110. Ambitious medium- to long-term action on the transformation of the transport sector needs to be supported by immediate bold action that would **kick start the transformation** in the desired Roadmap directions and **limit the lock-in effects** of a high-carbon BAU scenario. This is key for promoting pre-2020 mitigation actions and, in the case of the transport sector, **helping to ensure that emissions peak** in the very early 2020s.

111. Accordingly, the PPMC proposed a set of **20 pre-2020 actions**[7] for full-scale implementation in coming years. These actions are fully in line with the Global Macro Roadmap and can facilitate the systemic transformation of the transport sector. They support all components of the Roadmap with the exception of component 2 on sustainable low-carbon production. They touch upon all transportation modes under what is a resolutely multimodal approach targeting the worst externalities, in both people's mobility and freight transport. They are attuned to regional concerns, include all change drivers (new technologies, new behaviors), and underpin new value creation and business models.

112. To complement the Quick Win Actions focused on mitigation and mindful that the gestation period for tangible benefits from some adaptation actions can be far from 'quick', we also advocate **a series of 'early actions' for adaptation and resilience.** It is important to ensure that, where possible, adaptation and resilience activity also reduces or eliminates GHG emissions. As transport systems are interconnected and may rely heavily on each other (and on external infrastructure services such as energy and information communications technology (ICT)), it is considered essential that transport organizations work together to agree common themes and a framework for adaptation and resilience-building. Interconnectedness examples include marine ports' reliance on road and rail infrastructure as well as inland waterways, in order to forward and receive freight and passengers; railways' reliance on road networks, again for freight and passenger use, and all modes' reliance on ICT.

ORIENTATION	**Quick Wins on mitigation / Early actions on adaptation and resilience** • Were selected through inputs from a broad set of transport experts and other stakeholders, and have been evaluated through multifaceted impact analysis; • Have the potential to help reduce GHG emissions and moderate climate impacts; • Provide key development co-benefits, such as improved access, increased efficiency and enhanced safety.	**Related GMR Components**
MITIGATION	**Operational and capacity solutions**	
	• Expand city transport official training programs to build local capacity for sustainable transport in primary and secondary cities;	**Component 1**
	• Formulate sustainable urban mobility plans (SUMPs) in primary and secondary cities;	**Component 1**
	• Modernize aging rail fleets and traction systems to increase efficiency;	**Component 3**
	• Ramp up charging infrastructure to encourage expansion of electric vehicle fleets in primary and secondary	**Component 3**
	Freight transport	
	• Expand sustainable freight recognition schemes to reward proactive carriers and shippers;	**Component 4**
	• Implement zero-emission (last-mile) urban freight through e-mobility and cycling solutions;	**Component 3**
	• Improve freight efficiency (e.g. reduce empty load running by freight trucks) through route optimization, asset sharing between companies and increased use of ICT/ITS solutions;	**Component 4**
	• Invest in rural road maintenance and modern supply chains to reduce global food loss and waste.	**Component 6**

7 http://www.ppmc-transport.org/quick-win-actions/

MITIGATION	**Passenger transport**	
	• Expand car and (e-)bike sharing systems in primary and secondary cities;	**Components 1 and 3**
	• Increase the quality, availability, reliability, frequency and efficiency of train/bus-based transit;	**Component 1**
	• Provide and improve walking and cycling infrastructure (e.g. connected walking paths, protected cycle lanes), reallocating road space where necessary.	**Component 1**
	Technical and regulatory solutions	
	• Accelerate deployment of tighter fuel quality standards to reduce emissions of black carbon and other short-lived climate pollutants;	**Components 2 and 3**
	• Expand use of ICT/ITS applications for real-time travel information and route planning for walking, cycling, public transport and car sharing;	**Components 4 and 5**
	• Legislate and enforce stricter speeding regulations by operational and technical means to reduce emissions and road traffic accidents;	**Components 1 and 5**
	• Tighten fuel economy standards for passenger and freight vehicles towards 2040-2050 objectives.	**Component 3**
	Policy/pricing solutions	
	• Accelerate the global phase-out of fossil fuel subsidies;	**Component 8**
	• Implement (ultra-) low-emission zones;	**Component 8**
	• Introduce carbon pricing for the transport sector where (sub-)national carbon markets currently exist or are under development;	**Component 8**
	• Introduce car-free days and ciclovías (temporary street closures to encourage cycling and walking) in primary and secondary cities to build up support for longer-term policies;	**Component 1**
	• Introduce and scale up pricing for motorized travel options (e.g. congestion/road charging, parking pricing) in primary and secondary cities.	**Component 8**
ADAPTATION	**Existing transport infrastructure resilience**	
	• Build and embed institutional capacity to identify and manage climate risks;	**Component 7**
	• Develop real-time monitoring and early warning systems; prepare and publicize contingency plans;	**Component 7**
	• Monitor asset condition and prioritize maintenance activity to maximize adaptive capacity;	**Component 7**
	• Develop and deliver programs for climate-resilient refurbishment, retrofitting or renewal, using nature-based solutions where relevant.	**Component 7**

ADAPTATION	**Climate-resilient new transport infrastructure**	
	• Promote adaptive management and flexibility in infrastructure design through revised or new design standards, also planning processes and evaluation techniques that recognize and accommodate climate change-related risks;	**Component 7**
	• Engage all stakeholders including those along the supply chain to identify and exploit opportunities for integration, interconnectivity and efficiency;	**Component 7**
	• Review and refocus business case development and investment financing criteria to facilitate delivery of climate-resilient infrastructure;	**Component 7**
	• Facilitate information exchange and share evolving good practice and feedback into industry guidelines and standards.	**Component 7**

113. These pre-2020/early actions span policy, regulatory and operational solutions for both human mobility and freight movement, thus providing a balanced toolbox to ramp up needed actions across transport themes and modes and structuring efforts in three directions:

- Prompting decisions to expand the implementation of solutions that have already proven their efficiency on a smaller scale or with a less ambitious scope;
- Halting existing practices and/or regulations that run counter to what is required to set the global transport sector on a lower-carbon trajectory;
- Initiating without delay, and at relatively low cost, actions or decisions preparatory to full implementation of a global decarbonization roadmap.

114. It is essential to stress that Quick Wins/Early Actions are not stand-alone solutions; they are primarily pre-2020 steps towards the implementation of the decarbonization roadmap. Therefore, implementing a full-blown transformation will require scaling up proven no-regret actions without delay, with some of the ensuing benefits arriving pre-2020 and others post-2020.

115. The Transport Initiatives described above also have direct relevance for the Quick Wins. For rapid implementation and broad scalability, a Quick Win must have the support of one or more champion organizations or Initiatives. In this respect, the **MP-GCA Transport Initiatives are good catalysts for the proposed Quick Wins.** These Initiatives can accelerate pre-2020 action by sub-national and non-state actors, and are thus a natural springboard for promoting the Quick Wins at local level, where the bulk of implementation takes place. For example, some Initiatives are helpful in supporting a range of Quick Wins:

- Global Green Freight Action Plan => All freight transport Quick Win actions;
- MobiliseYourCity=> All urban-focused passenger and freight transport Quick Win actions; 'Formulate Sustainable Urban Mobility Plans in primary and secondary cities';
- UITP Declaration on Climate Change Leadership=> All public transport-focused passenger transport Quick Win actions;
- Transformative Urban Mobility Initiative=> All urban transport-related Quick Win Actions;
- ITS for the Climate=> All Quick Win technical solutions;
- World Cycling Alliance (WCA) and European Cyclists' Federation (ECF) Commitment=> All cycling-focused Quick Win actions;
- Navigating a Changing Climate=> All adaptation-focused Quick Win actions.

Other Initiatives are more relevant to Quick Wins on a one-to-one relationship:

- Global Fuel Economy Initiative=> 'Tighten fuel economy standards for passenger vehicles';
- C40 Clean Bus Declaration=> 'Increase quality, availability, reliability, frequency, and efficiency of bus-based transit';
- UIC Low-Carbon Sustainable Rail Transport Challenge=> 'Modernize aging rail fleets and traction systems to increase efficiency';
- Urban Electric Mobility Vehicles Initiative (UEMI) and ZEV Alliance=> 'Ramp up charging infrastructure to encourage expansion of electric vehicle fleets in primary and secondary cities'.

3. Building an "Avant-Garde" nexus

116. Successful actions on transport and climate change will require building strong partnerships among the transport sector and other key sectors, including both state and non-state actors. The international community has a role to play in fostering coordination and implementation process, be it:

- The multilateral development banks, whose significant potential in providing financial assistance and back-up to developing countries has been highlighted by the Addis Ababa Action Agenda;

- The research community, as a knowledge partner giving credentials to the implementation process;

- The civil society as a whole also has a critical role to play, in applying pressure to accelerate ambition and action from Parties: it is important to enhance the outreach of the Initiatives and Quick Wins to them so that they can benefit optimally from these drivers on the ground;

- The business community, as an innovation driver and investment partner into renewable and sustainable technologies;

- The community of developed countries, as providers for support (technical assistance, knowledge transfer and finance) to developing countries to promote their ambitions towards decarbonization and resilience of transport.

117. COP 23 takes place against a particular backdrop: two years after the Paris Agreement, it is time for delivery in a context where UNFCCC encourages all stakeholders to scale up their ambitions looking ahead to the upcoming Facilitative Dialogue on NDCs:

- National governments have started defining their mid- to long-term decarbonization plans (LTERS, or long-term emission reduction strategies);

- In addition to Parties who are in charge of implementing the Paris Agreement at national level, local governments are mobilizing on transport and air quality, be it states, provinces, regions or cities, with the latter acting as front-runners in setting ambitious targets for both GHG emission reductions and clean air strategies. Some examples of this trend are the sustainable urban mobility plans, or SUMPs, which address the entire urban area, including its commuter hinterland, to solve urban transport problems while reaching local and higher-level environmental, social, and economic objectives;

- Companies are actively shaping action on transport and climate change; developing plans; and making what are break-through announcements for some of them. Engaging the private sector is also crucial for the necessary transformation of the transport sector via strategic investment, service delivery and the development of new solutions.

118. In a nutshell, achieving decarbonization/resilience of the transport sector does encompass the implementation of consistent, cost-effective, long-term public policies and incentives (role of national and sub-national governments) to assist in bringing advanced technologies into the market (role of the business sector) and to promote R&D investment by the private sector. In this particular dynamic, **political leadership is now required to secure the transition to an overall net-zero-emission economy. The idea is emerging of an "Avant-Garde" nexus connecting some committed countries, cities and companies into an alliance willing to work on decarbonizing/adapting transport alongside implementation of the Paris Agreement.** This group would develop into a forum for exchanging experience and good practices as well as common challenges, between national and local governments as well as with business, and for determining how best to coordinate efforts.

Conclusion

1. The Paris Agreement on Climate Change, together with other international agreements on Sustainable Development, provides the transport sector with compelling reasons for accelerating transformative action. Such action needs to cater to growing needs for mobility and transport while slashing GHG emissions and improving the wider social and economic sustainability of human activities.

2. Decision-makers in the public and private sectors need guidance to prepare the ambitious policies required to implement the long-term climate targets set by the Paris Agreement. The pathway laid out in this plan of action does not guarantee that these ambitious objectives will be met, but it does give the transport sector a well-structured way forward. This can help present public and private stakeholders with relevant guidance to make timely and well-founded policy and investment decisions for the development of a sustainable "net-zero-emission" transport sector.

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