AN ACTIONABLE VISION OF TRANSPORT DECARBONIZATION
IMPLEMENTING THE PARIS AGREEMENT IN A GLOBAL ROADMAP
AIMING AT NET-ZERO EMISSIONS TRANSPORT
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AIMING AT NET-ZERO EMISSIONS TRANSPORT

Prepared by the Paris Process on Mobility and Climate (PPMC)
on behalf of the Global Climate Action Agenda Transport Team
Discussion Paper
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<tr>
<td>2DS</td>
<td>Two-Degree Celsius Scenario</td>
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<td>BAU</td>
<td>Business-As-Usual</td>
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<td>BRT</td>
<td>Bus Rapid Transit</td>
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<td>CO2</td>
<td>Carbon Dioxide</td>
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<td>COP22</td>
<td>The 22nd Session of the Conference of the Parties</td>
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<td>ECF</td>
<td>European Cyclists’ Federation</td>
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<td>EVs</td>
<td>Electric Vehicles</td>
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<td>FC</td>
<td>Fuel Cell</td>
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<td>FfD</td>
<td>Addis Ababa Action Agenda “Financing for Development”</td>
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<td>GCAA</td>
<td>Global Climate Action Agenda</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>HDV</td>
<td>Heavy-Duty Vehicle</td>
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<td>HLC</td>
<td>High Level Champions</td>
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<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<td>ICE</td>
<td>Internal Combustion Engines</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>ITS</td>
<td>Intelligent Transport Systems</td>
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<td>ITEM</td>
<td>International Transportation Energy Modelling</td>
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<td>ITF</td>
<td>International Transport Forum</td>
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<td>LDCs</td>
<td>Least Developed Countries</td>
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<td>LDV</td>
<td>Light-Duty Vehicle</td>
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<td>LEZ</td>
<td>Low Emission Zones</td>
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<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<td>LPAA</td>
<td>Lima Paris Action Agenda</td>
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<td>LT</td>
<td>Light Trucks</td>
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<td>MYC</td>
<td>Mobilise Your City</td>
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<td>NDCs</td>
<td>Nationally Determined Contributions</td>
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<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>PC</td>
<td>Private Cars</td>
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<td>PPMC</td>
<td>Paris Process for Mobility and Climate</td>
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<td>SDGs</td>
<td>Sustainable Development Goals</td>
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<td>SIE</td>
<td>Energy Investment Company</td>
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<td>SLoCaT</td>
<td>Partnership on Sustainable, Low Carbon Transport</td>
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<td>SUMPs</td>
<td>Sustainable Urban Mobility Plans</td>
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<td>TEM</td>
<td>Transport Expert Meeting</td>
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<td>UEMI</td>
<td>Urban Electric Mobility Vehicles Initiative</td>
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<td>UITP</td>
<td>International Association of Public Transport</td>
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<td>ULEZs</td>
<td>Ultra Low Emission Zones</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>w2w</td>
<td>Well-to-Wheel Emissions</td>
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<td>WCA</td>
<td>World Cycling Alliance</td>
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<td>WTO</td>
<td>World Trade Organization</td>
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<td>ZEV</td>
<td>Zero Emission Vehicles</td>
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<td>ZEZ/ZEC</td>
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I. The need for a bold action plan to implement the Paris Agreement on Climate Change for Transport

A. New challenging frontier for the Transport sector

Three recent major international agreements outline a “new frontier” for sustainable development and climate change, thereby putting a stronger pressure on all human activity sectors, including Transport:

- The 2030 Agenda for Sustainable Development, adopted in New York September 2015;
- The Paris Agreement at COP21, adopted in Paris December 2015;
- The New Urban Agenda set up in Quito, October 2016, with a 20 year time span.

The Sustainable Development Agenda and New Urban Agenda call for improvements in access to economic opportunities and services that can only be achieved through a large increase in transport infrastructure and services; this is set against a backdrop of the increasing importance of social and environmental sustainability.

The Paris Agreement in particular sets an overall long-term direction for climate change policy, and sends a clear message to all sectors that there is need for disruptive change, as incremental approaches will be insufficient to realize needed reductions in greenhouse gas (GHG) emissions in line with the ambitious target of limiting temperature increases ‘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 whilst taking into account:

- a decarbonization timeline of 2050-2060 for the most advanced, and 2060-2080 for the less advanced economies, without forgetting a focus on adaptation;
- the specific constraints of industrial investment cycles and innovation, that run from 5 to 40 years, imposed on the transformation of key sectors such as Transport;
- required synergies in public policy to promote a seamless transition towards a net-zero emissions economy;
- the key role to be played by the financial community in funding the decarbonization process.

This international backdrop amounts to a call for action in all walks of life, and in particular transport. The entire sector (mobility of people and transportation of goods) accounts for approximately 25% of CO2 emissions from the burning of fossil fuels, and 15% of global GHG emissions. On top of this, the sector enjoys spectacular growth, with experts forecasting a potential doubling of transportation activity by 2050, resulting in a business-as-usual (BAU) emissions scenario of about 12-13Gt/year. This trend is driven by demographic growth, particularly in cities (accounting for 75% of carbon emissions), and against a background of urban growth, with 3 billion new town dwellers by 2050.

The challenge therefore is daunting: catering to an increasing need for mobility and transport, whilst drastically cutting GHG emissions.

For the Transport sector, the goal is to move from 7.7Gt emissions/year down to 3 or 2Gt by 2050, and aim to “net-zero emissions” between 2060 (most advanced areas) and 2080 (other parts of the world). All modes of transport (road, railway, aircraft, maritime, rivers, transport for people and goods) will need to be part of a global systemic transformation involving consumption pattern and behavioral changes, major technological innovations, the emergence of new mobility ecosystems, and the creation of new business models. Such a change, both in scope and need for urgent action, calls for unprecedented immediate and coordinated mobilization of all Transport sector players, public and private alike, including policy makers, economic and corporate players, and the full participation of civil society. The Transport sector will not be able to realize such ambitious action by itself and will need to gain the full cooperation of other sectors that interact with the Transport sector, especially the Energy sector and urban development.
B. Time to Take Action Now

Transport has been named one of the thematic areas under the Global Climate Action Agenda (GCAA), formerly the Lima Paris Action Agenda (LPAA). The discussion on transport within the GCAA has been shaped since COP21 by the Paris Process for Mobility and Climate (PPMC), in close interaction with the French Government (COP21 Presidency) and the Moroccan Government (COP22 Presidency), as well the Energy Investment Company (SIE). Together as the GCAA Transport team, they have made strides in building a genuine “Low-carbon Transport community,” and making a start in the setting of an agenda for structural, long-term change in the Transport sector.

The Marrakech COP22 comes in the aftermath of a series of 2015-2016 international workgroups which, beyond New York, Paris, and Quito, sent multiple converging signals showing public and private actors’ intent to use powerful levers (policy – technological – financial) to drive massive and coordinated action in order to achieve sustainable development and address global warming. This is reflected also in discussions in recent G20 and G7 meetings in China and Japan, which are increasingly embracing the concept of sustainable infrastructure. The ramping up of discussions on financial architecture for climate action (Green Climate Fund), the strong global partnership of the Addis Ababa Action Agenda “Financing for Development” (FFD) to underpin implementation of the 2030 sustainable development goals (SDGs), and the Innovation Mission launched at COP21 to significantly enhance global investment capacity in R&D towards a shift to renewable energy, are further indications of the willingness to consider transformational change.

The GCAA Transport team, on behalf of the numerous transport stakeholders that it represents, acknowledges this progress at international level and proposes a process to develop a framework for action in the coming decades. As a count-down from the 2050+ decarbonization horizon set by the Paris Agreement, this action plan hinges on three main actions:

1. Plan 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, a reference or compass to set the course towards the long-term direction set in Paris, enabling each actor to develop their own positioning and work out their contribution in line with the overall directions set by the Global Macro-Roadmap.

2. Taking the short term decisions which the success of the Paris Agreement ultimately depends on (2016-2020):
   - recommend urgent measures (Quick Wins) to public authorities and private sector stakeholders to kick-start the transformation of the Transport sector;
   - contribute towards strengthening of existing NDCs and support them to push up the required ambition level in 2020, inspired by the directions set in the Global Macro-Roadmap.

3. Leveraging existing GCAA Transport Initiatives and encouraging new ones:
   - strengthen GCAA Transport Initiatives, improve their governance, and help them to scale 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.

In sum, the recent adoption of the 2030 Sustainable Development Goals (SDGs) and the signing of the Paris Agreement on climate change have set, for us all, clearer long-term goals to improve human well-being, and have added a new level of urgency to implementing long-sought but little-realized steps toward these ends. Crucially, country-level Nationally Determined Contributions (NDCs) provide an instrument that can be used to structure national
climate action. The first generation of NDCs presented last year, prior to COP21, are generally acknowledged to lack in ambition, and do not have time frames which enable the planning of a comprehensive transformation of the Transport sector towards net-zero emissions which will be required by 2050 and beyond. This is why the GCAA Transport team proposes the development of a decarbonization roadmap as described below.

II. A Global Macro-Roadmap to decarbonize transport by 2050+

We propose the development of a roadmap through a phased action process, covering a 2020-2050+ timeline and thereby encompassing the mid- to long-term legs of the Action plan.

This 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, maritime; urban and rural), and offering new sustainable and inclusive growth opportunities, generated by the planned transformation of the Transport sector and the development of new technologies and business models as levers of growth. Such change will not come at the same pace in all sub-sectors and regions of the world, and therefore the emphasis is on a phased and regionally specific approach.

The roadmap will take a balanced look across the Transport sector as a whole – and focus on a broader 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). It will focus on identifying a balanced package of measures necessary, that will take into account the main sustainable transport paradigm, which combines Avoid (reduce unnecessary travel through e.g. land use planning and halting counterproductive regulation), Shift (shift movement of goods and people to the most efficient modes by scaling up good practices) and Improve (improve environmental performance of fuels, engines, and transport management. Successful implementation of Avoid-Shift-Improve measures at scale will be enabled through the potential of new, (shared) mobility solutions and supportive enabling institutional, regulatory, and financial mechanisms. The aim is to ensure that ALL the necessary policies AND technologies are included in a single, comprehensive, sustainable development sensitive, Transport sector roadmap integrating regional specifics. This will include a certain amount of prioritization of actions based on an assessment of mitigation potential, whilst also taking into account cost effectiveness, broader sustainable development impacts, and political acceptability.

The roadmap process enables all Transport players to position themselves and to contribute, at their own level and at their own pace, to implementing the Paris Agreement along the 8 priority areas set forth below. This tentative Global Macro-Roadmap is transformative in ambition by applying major priorities and transformation phases for key parts of the Transport sector. It must be regarded as work in progress; the basic elements have been presented and positively received in various state and non-state arenas. It needs to be further confronted to the views of state and non-state actors, experts, and other stakeholders from various sub-sectors and regions.

Component 1: Synergistic urban transformation – Leverage aspiration for healthier, inclusive lifestyles and less wasted time to drive de-carbonization

The fight against climate change will be won or lost in cities, according to many. The goal for the Transport community is modern cities with no pollution, with inclusive mobility of people and de- last-mile freight delivery that fits into the city and does not cause pollution. In densely populated areas, the mitigation of climate change will be closely linked to fulfilling the growing aspiration of people to breathe clean air. The way forward points at maintaining walking, increasing cycling, and providing local emission-free electrically-driven means of transportation.

Initial steps in this direction have been made through LEZ-style Initiatives (Low Emission Zones), targeting both air quality improvements and congestion reduction in selected areas. This has been done often through a combination of local road charging, regulation (access restriction for most polluting vehicles, based on emission standards), improvement in mass transit systems, promotion of pedestrian areas, and cycling lanes.

The first publicized LEZ was in Tokyo (2003), with very visible results today. Several European cities and others followed suit. But fossil fuels and internal combustion engines continue to rule buses, trucks, and passenger cars in such cities. Moving ultimately towards Zero Emission Zones and Cities (ZEzs/ZECs, for both air pollutants and GHGs) can be accelerated through an intermediate step: Ultra Low Emission Zones (ULEZ, soon thereafter to be extended to ULECities, thus including suburbs) in which emission control measures, provision of clean public
transport and continued prioritization of walking and cycling is combined with seamlessly connected (intelligent transport systems (ITS)/ICT) other modes, to ensure optimal intermodality between public and private modes of transport. This is to be accompanied by a phasing out of internal combustion engines (ICE) vehicles. It will also require modifications in land use to minimize unwanted travel. London announced in 2014, after reviewing the benefits of the LEZ it introduced in 2008, the decision to move to a ULEZ in 2020.

A first key step and Quick Win will be to massively ramp up the creation of LEZs in the next couple of years, for cities above 100 000 citizens. Following this, cities across the world need to join London in its effort to create ULEZ. This would not only spark a sizeable and positive transformation of life in cities but would also create the scaling-up conditions needed to develop huge business opportunities and trim down the cost of change. Ideally, deciding to make the change within 10, maximum 15 years, would pave the way to easier standardization, synergism in best practice exchanges, and favorable joint procurement conditions. Moving to ULEZs also means revitalizing city centers through “life-in-the-city” policies (e.g. tourism, shops, social events). Managing such a transformation across countries would not only require municipal government decisions, but also national coordination and intergovernmental harmonization.

To pursue the goal of 100% transport-related-emission-free cities by 2060, front-running cities would have to turn to Zero Emission Zones (which implies electric or plug-in hybrid systems only, smart door-to door solutions, asset sharing) by 2030.

**Component 2: Low-carbon energy supply strategy**

A three pronged low-carbon energy strategy -- a) decarbonize power generation through renewables; b) develop a clean hydrogen industry; and c) ensure a sustainable bio-fuel supply -- is a key part of the transformation of the Transport sector. It is especially in this area where the Transport sector will need to improve coordination with the other sectors: i.e. the Energy Sector.

Low carbon electricity is a necessity to making e-drive vehicles environmentally friendly. E-mobility will not develop at scale without low-carbon electricity and low carbon hydrogen as an energy carrier. This needs to be supported by storage and local generation systems (batteries, supercaps, fuel cells) supported by smart grids to optimize energy needs and flows. The last requirement for scaled e-mobility is the ability of the energy infrastructure to recharge/refill quickly.

There is a potential especially for introducing renewable energy and if done successfully, such decentralized renewable energy power production linked up with charging infrastructure could open up medium-distance and long-distance travel, which would expand e-mobility beyond the current urban focus.

The International Energy Agency (IEA) says that decarbonized power production (~20 gCO2/kWh) is possible by 2050 for the Organization for Economic Co-operation and Development (OECD) countries. Developing countries are likely to take longer (~2070), but some are changing rapidly already. To initiate momentum to low-carbon power generation, countries that are above 400-600g CO2/kWh need to embrace a shift in their primary energy mix immediately.

There is agreement that clean hydrogen production will need to be part of future media to longer term energy supply. The latest studies show that to be economically and ecologically pertinent, hydrogen must be produced from renewable sources and made available locally. A fully established industry of sustainable bio-fuels is also most likely to be needed by 2030-2035, for the aviation sector in particular but also elsewhere (e.g. trucks, trains, boats).

**Component 3: Improve modal and system efficiencies**

3-a/ Drive down energy consumption and emissions of new light duty vehicles (LDVs). Hybridize and electrify a growing part of the fleet

Estimates are that there could be around 2 billion light vehicles on the road by mid-century. Drastic energy consumption reductions are therefore necessary, and we know they are feasible.
Today, in real world driving conditions, the fleet-average “well-to-wheel” (w2w) emissions of private cars (PC) and Light Trucks (LT) worldwide is around 200 gCO2/km (closer to 170 gCO2/km in Europe). The technical feasibility of reducing this to 50 gCO2/km is well established, and it is understood that further reductions to 25 gCO2/km are feasible as well. “2 liter” (~50 gCO2/km, tailpipe) and even “1 liter” (~25 gCO2/km, tailpipe) prototypes are already publicized by car manufacturers. Reaching 50 gCO2/km w2w on average for new vehicles in 2040, in real world conditions, is technically achievable i.e. almost achievable with conventional technologies - provided that vehicles become lighter, with crash avoidance systems – and it is clearly achievable with hybrid/electric solutions and sustainable biofuels.

For the entire fleet to be at 50 gCO2/km w2w will require that retrofit regulations be enacted and/or fast rotation scenarios (e.g. sharing) become routine. Moving further down to an average of 25 gCO2/km w2w will require a massive development of electric drive systems, including plug-in hybrids, battery vehicles with or without range extenders (ICEs or fuel cells (FC)), very light ICE vehicles with energy recovery and biofuels, FC vehicles. This is achievable around 2050 (in most advanced areas) with the proper infrastructure investments and the right experience curve. Common standards will be needed to enable a quick and decisive move towards electrification of transport.

Moving down to 15 gCO2/km w2w will require an almost complete shift to e-mobility with electricity and/or hydrogen produced through almost zero carbon techniques. Scaling up should be heavily incentivized to get a sizeable market by 2030 and ensure close-to-zero emission fleets by 2050.

3-b/ Curb GHG emissions of heavy duty vehicles (HDVs)

Heavy trucks are key in regional and long distance freight transport and, despite necessary action to shifts towards more waterborne and rail transport of goods, roads might continue to play an important role in freight transport, even increasing in net numbers.

As trade grows in the coming decades and the world population benefits from more consumer goods, cities, states, and nations must make a drastic effort geared at reducing the pollution and energy consumption of trucks. Scaling up will take time and thus transformation of this sector should begin in the next decade. The pace of change will depend largely to the extent that the freight and logistics sector can be brought aboard as a partner rather than being seen as an adversary.

Assuming that thanks to all possible technical improvements (drag reduction, weight decrease, engine efficiency, hybridization, lower carbon fuels (e.g. CH4, biofuels)) the emissions per tkm (ton kilometer) would decrease by a rate of progress close to the one observed for cars, whilst realistically integrating the necessity of a longer timeframe, one could assume that by 2050, on average a heavy truck currently emitting around 850 gCO2/km could on average emit around or less than 300 gCO2/km.

Tighter fuel economy standards for trucks are a must, and a system of standards of increasing stringency needs to be put in place as soon as possible. Moving down below 100 gCO2/km on average could be a post-2060 goal, and could require clean hydrogen, second/third generation biofuels, and e-motorways. Urban “e”-trucks are now available and initial testing of e-motorways is underway.

ITS and connected infrastructure will also be key in “greening” road freight transport.

3-c/ Continue electrifying rail and foster modal shift

Railways (trains, subways, trams) are in many cases, together with modern Bus Rapid Transport (BRT) systems in urban areas, the mode of choice for moving large numbers of people; this promotes inclusive access across ages and levels of ability and disability. Electric power systems will need to be mandatory both within designated ULEZs/ULECs and ZEZs/ZECs as well as outside, the latter especially in the case of inter-urban passenger transport.

The modal shift (at least partially) from road to train for long distance passenger and freight transport could be an effective strategy to limit GHG emissions. Improving railway effectiveness, densifying networks, reducing down time for freight, facilitating border crossing, successfully competing with airlines on mid-distance regional travel, using clean electricity, and so on, all are key to making such shifts possible. Particular attention and support is needed for transit corridors.
3-d/ Manage the two key technical transitions for aviation: bio-kerosene and hybrids

The International Civil Aviation Organization (ICAO) agreement to reach carbon neutral growth by 2020 is a remarkable short term objective, and is line with the general understanding that transport emissions should peak at latest by 2020. Then, aiming at reducing net CO2 emissions to 50% of what they were in 2005 by 2050 (through technology, improved operations, better infrastructure management and global market-based measures -- primarily offsetting) can be hailed as an encouraging move. However, this may not prove to be enough to meet the Paris objective of a “net-zero emissions” economy, especially if the enhanced harmfulness of high altitude GHG emissions is confirmed.

Sustainable bio-kerosene, complemented by fuel cells for on-board operations, are two solutions currently being favored and actively developed in parallel to the advancement of all the energy efficiency tools in aircraft operations and traffic. By 2035, this transition should be completed worldwide. Technology should then be advanced enough to embark on the second transition: hybrids (taking off on liquid fuels, cruising on electric power). A clear phasing of progress in the aviation sector must be crafted, with associated emission regulations.

As airports develop as mobility hubs, efforts need to be made to make them “clean mobility hubs”.

3-e / Convert river and coastal shipping to electric engines and battery/fuel cell systems. Wind and biofuels play a role in long-haul shipping, after liquefied natural gas (LNG)

Because shipping operates at low speed it does not require huge power in comparison to other transport means. For relatively short distances, fuel cells and locally produced hydrogen appear to be promising solutions, all the more as space availability, weight, and fears of hydrogen leaks are lesser issues for such open air applications. Various electric powered ships (river and coastal) are currently being tested. The use of wind, through ingenious sail designs, is also a part of the solution for long-distance, heavy-weight shipping. Second/third generation biofuels must complement the current solution package (LNG primarily). As in the case of aviation there will be a need for a transparent and predictable long-term emission pathway for the international shipping sector, based on which a system of standards will need to be put in place sooner rather than later.

3-f/ Improve system efficiency (intermodality, door-to-door solutions, sharing applications)

Beyond the modal optimization described in the previous sections, rapid improvements in smart co-modality will bring the highest benefits in terms of lowering GHG emissions in the Transport sector. ITS and ICT development must be accelerated to ensure efficient, seamless travel both for people and transport of goods. Seamless intermodality (between existing modes, with shared services and (fully or partially) autonomous vehicles) is the key to door-to-door solutions, reduced congestion, and decreased individual car ownership in cities.

New business models based on ICT and ITS (e.g. Uber, Blablacar) must be encouraged (with the proper set of regulations to ensure social fairness). This is a key step towards the development of ULEZs, and breaking the dominance of an urban mobility model based on individual car ownership.
As a first step towards greater intermodality, local and national authorities should enact policies favoring (in some cases forcing) the coordination of various modal development agencies to avoid the continuation of dogmatic, mono-modal development strategies.

**Component 4: De-fragment and shorten supply chains (freight)**

International trade continues to increase, and the linked growth in long-distance freight transport is large. Therefore, above and beyond promoting lower-carbon transport means, more fundamental steps are to be taken towards rationalizing supply chains, and reducing overall transport distances. For business this can mean:

- (re)-localizing and/or optimizing purchasing choices, redefining supplying schemes;
- de-fragmenting certain operations (e.g. semi-finished products manufactured in different places and then assembled elsewhere);
- simplifying and streamlining distribution circuits.

The current economy and world trade have been built on “given” externality costs of nearly zero and relatively inexpensive transport. Many national regulations, based on protectionist or other grounds, hinder the optimized use of transport assets - more than a third of trucks in the world move empty! Future policies on trade should be increasingly based on environmentally-led paradigms. The “fourth industrial revolution” and “factory 4.0” developments must address the critical topic of modal shift and overall reduction of mileage.

This is an area which is today overlooked by both Parties and business. It must become a more urgent priority for companies, the World Trade Organization (WTO) and countries. It is through the re-design of supply chains in the coming two decades that some modal shift could be accomplished, together with a certain decrease of miles travelled by freight.

**Component 5: Transform work practices and accelerate unwanted individual commuting reduction**

There is considerable potential to reduce daily commuting and at the same time, reduce associated congestion, lost time and cost linked to current commuting patterns. Work-at-home, telework, telecommuting, remote office centers exist and have proved their relevance, at least for a certain percentage of time, but are still representing a tiny proportion of human work worldwide.

As commuting represents a sizeable share of an individual’s use of mobility, often at the expense of family life and at the same time costing organizations a sizeable amount of labor time and a significant budget, now is the time to move decisively into innovative ways of working, deriving dividends in environmental benefits, better health, time saved for family and/or individual activities, better availability for work, cash savings for more gratifying expenditures. Another large benefit would be in terms of land use and jobs-housing balance. Combined with carpooling, developments with regard to shared, automated, and connected vehicles, electric vehicles (EVs), and more, these practices and new technologies could reduce the amount of travel significantly.

Addressing work practices and commuting in an effective manner calls for more direct and structured coordination between transport planners and Human Resource development managers.

If it turns out to be feasible to reduce work related travel considerably, this opens the door for other types of travel demand reductions measures in other travel modes.

**Component 6: Tailor solutions for the rural (non-urban) populations**

Even though the key transformations in the Transport sector will be driven by cities, or by changing travel between cities,
A successful transition will necessarily need to involve rural areas as well.

There is currently a large unmet demand for mobility of people and goods which is holding back the economic and social development of many rural areas, especially in the developing world. The 2030 Sustainable Development Agenda therefore rightfully calls for improvements in rural access through an expansion of transport infrastructure and services.

Decentralized generation of electricity through sun or wind could make e-mobility a solution of choice for rural populations, provided that the costs of vehicles can be managed. Reaching a high level of access to e-mobility, leveraged by vehicle-sharing and vehicle-pooling, might be feasible in a limited amount of time. In the same vein, local generation and use of sustainable bio-fuels (in the medium- to long-term, including hydrogen) can be fostered where relevant. Accustoming the rural world to modern decarbonization tools is very important to gain wider public acceptance of energy transformation.

In rural areas too ITS and ICT will increasingly be key enablers for optimizing travel planning and the use of transport infrastructure and services.

**Component 7: Invest in adaptation**

Adaptation in the Transport sector is necessary for both developed and developing countries, as transport systems worldwide are vulnerable to the increasing impacts of extreme weather, and rapid urbanization increases the potential for catastrophic impacts. Transport systems and services are already being severely disrupted by climate related events, with a growing number of examples from both developed and developing world. In all cases, temperature is going to rise and extreme weather events will increase in frequency. The adaptation effort today is far from sufficient and a wise strategy calls for:

1. Raising the profile of adaptation 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. Adopting industry relevant technical standards to ensure transport infrastructures are climate resilient, with appropriate adaptive capacities to minimize future risk;
4. Leveraging additional climate finance to shift public and private investments towards resilient transport systems;
5. Integrating adaptation into project design, including through enhanced emergency preparedness;
6. Strengthening coordination across agencies (including funding, implementing, and operating agencies);
7. Building capacity at local, national and international levels on transport adaptation;
8. Co-operating with the broader adaptation community to integrate transport into adaptation programs and activities.

Component 8: Speed up the advent of economic instruments giving a value to carbon, de-risking long-term investment in low-carbon solutions, and helping society at large embrace new behaviors/technologies

One of the key outcomes of COP21 has been the strengthened resolve to adopt carbon pricing to promote action on climate change. In Paris it was argued that pricing CO2 at around 50 €/ton could give a strong push to alternative energies and that pricing it at around 100 €/ton would make certain technologies like carbon capture and sequestration became economically viable. Discussions continue both on price levels/trajectories and ways to foster a level playing field. Putting a value on carbon -- be it in the form of a carbon tax or of quotas (emission rights) to be traded e.g. on a transport carbon market -- is a major lever to inform player decisions towards low carbon solutions. This new economic instrument, if implemented at scale, will generate income to be pumped back into the economy, particularly through infrastructural investment, including networks and new technologies.
Till now carbon pricing in the Transport sector has been poorly developed in comparison to other sectors, and additional efforts will have to be made by the Transport sector to catch up. It is encouraging that a number of transport related companies have started to introduce an internal or shadow carbon price.

Carbon pricing, like other economic instruments, is important but will need to be combined with, rather than replace, regulatory approaches (for example fuel economy standards described above for different transport modes).

Also, as investments in new infrastructure, new technologies, and mass transit systems will have to be substantially increased, 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 solutions have to be designed and deployed (e.g. shorter period amortization) without delay.

Parties are invited to start working together with business and consumer associations on such a toolbox of economic instruments, to favor 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 unlock policy and regulation obstacles towards embrace transformative change.

Climate finance constitutes a tiny share of the total financing need for transport, and climate finance 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. We advocate climate funds being used to help ensure that all transport funding (public and private) becomes more climate-oriented.

In order to reach net-zero emissions by 2060 or so, GHG trapping and environmental restoration of degraded areas is key for the Transport sector, which will not be able to fully eliminate all GHG emissions. Investing in trapping solutions (R&D and implementation of proven solutions) must start now. Peaking as soon as possible in GHG emissions is key and, while a lot of people still think of capture and sequestration/transformation 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.

III. Quick Wins on transport, sustainable development and climate change to initiate immediate disruptive action

In addition to medium to long-term action, there is a need for immediate bold and ambitious action that will kick-start the transformation of the Transport sector in the desired roadmap directions, and limit the lock-in effects of a high-carbon BAU scenario. This is key to promote pre-2020 mitigation action and, in the case of the Transport sector, help ensure that emissions peak in the very early 2020s.

Accordingly, a set of twenty pre-2020 actions\(^1\) are proposed for full-scale implementation in the next 4 years, in line with the Global Macro-Roadmap towards genuine systemic transformation of the Transport sector. These 20 “Quick Wins” were reviewed and shortlisted in consultation with a large panel of experts and sector actors. They touch upon all transportation modes under what is a resolutely multimodal approach targeting the worst externalities, in both the mobility of people and freight transport. They are attuned to regional concerns, they include all change drivers (new technologies, new behaviors) and they underpin new value creation and business models.

\(^1\) [http://www.ppmc-transport.org/quick-win-actions/](http://www.ppmc-transport.org/quick-win-actions/)
Operational and Capacity Solutions

- Expand city transport official training programs to build local capacity for sustainable transport in primary and secondary cities.
- Formulate Sustainable Urban Mobility Plans (SUMPs) in primary and secondary cities.
- Modernize ageing rail fleets and traction systems to increase efficiency.
- Ramp up charging infrastructure to encourage expansion of electric vehicle fleets in primary and secondary cities.

Freight Transport

- Expand sustainable freight recognition schemes to reward proactive carriers and shippers.
- Implement zero-emissions (last-mile) urban freight through e-mobility and cycling solutions.
- 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.
- Invest in rural road maintenance and modern supply chains to reduce global food loss and waste.

Passenger Transport

- Expand car and (e-)bike sharing systems in primary and secondary cities.
- Increase quality, availability, reliability, frequency, and efficiency of bus-based transit.
- Provide and improve walking and cycling infrastructure (e.g. connected walking paths, protected cycle lanes), reallocating road space where necessary.

Technical and Regulatory solutions

- Accelerate deployment of tighter fuel quality standards to reduce emissions of black carbon and other short-lived climate pollutants.
- Expand use of ICT/ITS applications for real-time travel information and route planning for walking, cycling, public transport and car sharing.
- Legislate and enforce stricter speeding regulations by operational and technical means to reduce emissions and road crashes.
- Tighten fuel economy standards for passenger and freight vehicles towards 2040-2050 objectives.

Policy/Pricing Solutions

- Accelerate global phase-out of fossil fuel subsidies
- Implement (ultra-) low emission zones.
- Introduce carbon pricing for the Transport sector where (sub-) national carbon markets currently exist or are under development.
- Introduce car-free days and ciclovías (temporary street closures to encourage cycling and walking) in primary and secondary cities to build support for longer-term policies.
- Introduce and scale up pricing for motorized travel options (e.g. congestion/road charging, parking pricing) in primary and secondary cities.

These pre-2020 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 which have already proven their efficiency at a smaller scale or with a less ambitious scope.
- Halting existing practices and/or regulations that run in directions opposite 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.

It is essential to stress that Quick Wins are not stand-alone solutions; they are essentially pre-2020 steps towards the implementation of the de-carbonization 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.
These Quick Wins have been selected through input from a broad set of transport experts and other stakeholders, and have been evaluated through multifaceted impact analysis. These actions have the potential to contribute toward reducing GHG emissions, thereby moderating climate impacts, while at the same time providing key development co-benefits such as improved access, increased efficiency, and enhanced safety. While the Quick Wins enumerated here are mitigation-focused, it is acknowledged that continued consultations will be needed to identify Quick Wins on adaptation in discussions leading up to COP23.

While both public and private sector have key roles to play in the implementation of these Quick Wins, the respective responsibility will vary per Quick Win and might also differ by region. An important next step is the development of enabling public policies in support of these Quick Wins, and raising awareness in the private sector as to how they can take part in, and benefit from, the implementation of the Quick Wins.

IV. Way Forward

A. Role of Transport Initiatives under the GCAA in supporting the Global Macro-Roadmap and Quick Wins

COP21 decided to appoint two High Level Champions (HLC) 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”.

The Partnership on Sustainable, Low Carbon Transport (SLoCaT) and the PPMC have helped, since early in 2015, to facilitate the development of 15 transport Initiatives by non-state actors in the transport sector. Their engagement was inspired by the call to action by Secretary General Ban Ki-moon in September 2014, and followed up by the Action Agenda under the aegis of two High Level Champions (HLC).

These commitments were developed to trigger more ambitious action in all major parts of the Transport sector, as part of the GCAA. The selection of the Initiatives followed a scientific and systematic approach, and combines a top down with a bottom up approach. The systematic top down approach was based on Intergovernmental Panel on Climate Change (IPCC) and united nations environment programme (UNEP) reports which defined the key sub sectors where action needs to be taken to remain on a two-degree celsius scenario (2DS) pathway. The bottom up process, through which organizations were invited to propose Initiatives, helped to understand what Initiatives stakeholders could contribute. The underlying idea of the GCAA was to make sure all key sectors were covered with impactful Initiatives, which could be joined by states as well as non- states actors, so that the global ambition of countries to act on climate change can be scaled up. The GCAA is planned to be a living process: some Initiatives might be added as they mature or as gaps are identified; some might exit.

There are now 15 Initiatives, which include both passenger and freight transport and touch on all Transport sectors and modes: from roads to rail, from air to waterborne transport, and from motorized vehicles to cycling. They address both mitigation of, and adaptation to, climate change. Collectively these Initiatives represent hundreds of partners and they bring together cities, regions, development organizations, the private sector, and civil society. The Initiatives contribute to all components of the Avoid-Shift-Improve approach and some of them actively support the principle of co-modality.

Collectively these Initiatives, if widely supported by state-and non-state actors and implemented at scale, can reduce the carbon footprint of an estimated half of all the passenger and freight trips made by 2025. Actions such as these can contribute to substantive savings associated with a shift to low carbon transport. The IEA estimated that these could be as high as
US$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.

The transport Initiatives are harnessing the energy and interest created by the Paris Agreement, alongside mobilizing global climate action and voluntary commitments from a wide range of non-state actors.

There is an increasing, but not universal, recognition from national governments as to the essential role of non-state actors in achieving and even guiding the mitigation efforts needed to deliver on the Paris Agreement.

These Initiatives can play an important role in the development and implementation of the Global Macro-Roadmap as are illustrated below:

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<th>Initiative</th>
<th>Urban</th>
<th>Energy Supply</th>
<th>Modal efficiency / intermodality</th>
<th>Supply chain efficiency</th>
<th>Avoid (commuting)</th>
<th>Rural Areas</th>
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There is an increasing, but not universal, recognition from national governments as to the essential role of non-state actors in achieving and even guiding the mitigation efforts needed to deliver on the Paris Agreement.

These Initiatives can play an important role in the development and implementation of the Global Macro-Roadmap as are illustrated below:

Weak linkage | Medium linkage | Strong linkage
It is apparent that the GCAA Transport Initiatives are especially relevant when it comes to the components focused on improving modal efficiency and urban transport. It is clear however that the geographic outreach of several Initiatives must be broadened. To take the Initiatives to scale Business’ and Parties’ will need to scale up their support for the Initiatives. There are two key areas of the Roadmap that are largely being ignored by the current transport Initiatives. Current Initiatives do have a focus on energy, however, this is mostly about efficiency or promoting alternative fuel sources, and there are no Initiatives that have a clear focus on the changing of energy supply which will be required by Transport in the context of transformative action. Therefore, either the Transport sector should encourage the development of such Initiatives, or work much closer with relevant energy sector Initiatives.

The other area where there is an urgent need for new, innovative Initiatives is the area of economic transition. Current Transport Initiatives acknowledge the importance of enabling economic instruments but do not undertake dedicated activities in this area. It is suggested that there is probably scope to strengthen such components within the existing Initiatives, but this is also an area where there is scope for new Initiatives or closer cooperation with other thematic areas.

COP22 in Marrakesh is an opportunity to launch a strong call to action to fill the gaps, and a clear action plan on the further development of the GCAA will be of help in this respect.

The Transport Initiatives 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 GCAA Transport Initiatives are good catalysts for the proposed Quick Wins. These Initiatives are intended to accelerate pre-2020 action by sub-national and non-state actors, and thus are a natural springboard for promoting the Quick Wins at local levels, 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.
- 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.

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

- C40 Clean Bus Declaration => ‘Increase quality, availability, reliability, frequency, and efficiency of bus-based transit’.
- UIC Low-Carbon Sustainable Rail Transport Challenge => ‘Modernize ageing 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’.

To strengthen the relevance of the Initiatives for the Global Macro-Roadmap and the Quick Wins process it is important to strengthen the outreach of the Initiatives to Parties. This will be key to helping ensure that Parties benefit optimally from the Initiatives in the development and implementation of the Global Roadmap and in the pre-2020 implementation of Quick Wins.
B. Next Steps in the Development of Global Macro-Roadmap and Implementation of the Quick Wins.

The GCAA Transport team proposes a work program in support of the Global Macro-Roadmap and Quick Wins till COP23 in 2017. We see the following key steps in the coming year:

1. Mapping of other existing contributions to potentially enrich the roadmap

The mapping of the existing modal, technology and regional roadmaps will focus on identifying the gaps and already proposed short term priorities – in order to have a clear picture of the missing elements of a balanced, comprehensive, and global roadmap for the decarbonization of transport. It will address:

- assessment of 12 global transportation/energy models identified and described in the International Transportation Energy Modelling (ITEM) initiative;
- assessment of emerging decarbonization efforts at regional (EU), national (e.g. Germany and Sweden as well as other countries that have expressed ambition to become carbon neutral or decarbonize their Transport sector) and local level (e.g. Helsinki and other cities that have expressed ambition to become carbon neutral).

2. Assessment of mitigation potential

The assessment of mitigation potential will have two focusses: by transport sub-sector (passenger – freight; land – aviation – shipping) and geography (developed – emerging – least developed economies):

- Sectorial – Assess the mitigation potential of different policies and measures in priority specific Transport sectors and sub-sectors.
- Geographic – Quantify degree of transformational-change at global level to achieve Transport sector decarbonization by second half of century.

We will quantify emission gaps in different regions and the potential for the Global Roadmap to bridge this gap. The focus of analysis will be on regional levels, since the necessary data is not yet currently available for individual countries.

This work will take advantage of the transportation mitigation potential database developed by the SLoCaT Partnership, now consisting now of over 400 mitigation potential studies (i.e. academic studies of mitigation potential at national level).

3. Prioritizing Roadmap elements

Based on the drivers of change/policy gaps, the national and regional analysis and the assessment of mitigation potential (but also taking into account cost effectiveness, broader sustainable development impacts and political acceptability) we will

i. finalize the short and long-term roadmaps globally
ii. determine regional/national priorities for action.

As part of the second point, we expect to make a substantive start with the development of regionally specific versions of the Global macro-roadmap for Asia, Africa, Europe and Latin America in 2017.

4. Roadmap Validation

Using a diverse panel of 12 external general transport and development policy/academic experts, we will improve and validate the methodology and roadmap before finalization. This is in effect a quality control/assurance step. The panel of independent experts will be engaged to provide comments and ideas during the preparation of the Roadmap – this is to
guarantee validity and quality of the work done before the Roadmap in published.

Extensive consultations will also be conducted with sub-sector and technology experts in support of each of the eight components of the roadmap.

5. Building Support for Global Roadmap

This will require building consensus and support amongst key stakeholder groups, with emphasis on government and private sector.

For government support priority will be given to:

- Developed economies in Europe and USA. Consensus building can be aligned with ongoing consultation efforts in the International Transport Forum (ITF), the Transport Research Board in the USA and relevant national processes. More specifically it is proposed to present and discuss the roadmap at:
  - Transport Expert Meeting (TEM) during the May meeting of UNFCCC in Bonn;
  - ITF Leipzig, May 2017 (the global roadmap will serve as a major input in the ITF “decarbonizing transport” simulation project);
  - Relevant G20 and EU meetings.

- Transitional and Developing economies in Africa, Asia and Latin America. In part use can be made of relevant ongoing transport policy processes, but additional dedicated efforts will also be made through the organization in 2017 of dedicated consultation workshops in Africa, Asia, and Latin America. The participants of these consultation workshops are national and local government officials, thought leaders on sustainable transport, business, consumers, and other stakeholders. It is proposed to organize these events, where possible, back to back with other large scale climate change and/or sustainable transport events. Discussions are ongoing with the UNFCCC Secretariat on how these workshops can fit in with regular consultations on the implementation of the different elements of the Paris Agreement on Climate Change, especially the implementation of current NDCs, the preparation of the next generation of NDCs, and the development of Low Greenhouse Gas Emissions Strategies.

This task will be implemented in a dual manner. A general review of NDCs as well as a focus on certain “priority” NDC’s representing each of various country group typologies (e.g. least developed countries (LDCs)).

The regional workshops are also intended as a means to enable the Transport Initiatives under the GCAA to increase their outreach to the developing world and enable the initiatives also to align their activities increasingly with the Global Roadmap.

Private sector engagement is also crucial for the necessary transformation of the Transport sector through providing investment, delivering services, and developing new solutions. Consultation with the private sector will make use of the momentum established through the Transport CEO Roundtable in COP22 in Marrakech.

It is expected that a group of countries and business associations will help spearhead the Global Macro-Roadmap process.
V. Conclusion

PPMC has been presenting its ideas for short term (Quick Wins) and long-term action (Global Macro-Roadmap) on decarbonizing the Transport sector to government decision-makers and the economic/financial community throughout 2016. The Global Roadmap concept was presented to the EU Council of Ministers (Environment) in Amsterdam in April 2016, and received good support in particular from Germany, France, Netherlands, Austria, and the Czech Republic. China, Japan, Russia and the OECD expressed their interest when it was presented at the ITF in Leipzig (May 2016). Its compatibility with the IEA energy scenarios was also established in June 2016. In October 2016, the Executive Council of the World Business Council for Sustainable Development also expressed its support for the concept and its will to foster business leadership in the transport transformation.

The Quick Wins and the initial version of the Global Macro-Roadmap form, in our view, a robust starting point, and can serve as a platform to bring together the public and private sectors. Such a platform can help the GCAA Transport process in putting forward realistic suggestions for political and policy guidelines and efficient economic instruments.

To help ensure that COP22 in Marrakech would indeed be action and forward oriented, the GCAA Transport team asked to convene a Roundtable of Ministers in charge of Transport chaired by Morocco, and a Meeting of Industry Executives, to involve these key actors.

The Global Macro-Roadmap and Quick Wins, and their connection to the GCAA Transport Initiatives, will also be a central element in the Transport Showcase and Transport Dialogue, which the GCAA Transport Team will organize at the invitation of the two HLCs on Climate Change. Lastly, the wider sustainable transport community will discuss the relevance of Global Macro-Roadmap and Quick Wins in the annual Transport Day organized by the PPMC on November 13th.

With the GCAA endorsement, immediately after COP22, efforts will continue to speed up consensus and implementation.

In sum, we believe that the Paris Agreement on Climate Change, together with other international agreements on sustainable development, present the Transport sector with compelling reasons to accelerate action on sustainable transport. Such action needs to cater to an increasing need for mobility and transport, whilst drastically cutting GHG emissions, and improving the wider social and economic sustainability of human activities. The pathway laid out in this plan of action does not guarantee that these ambitious objectives will be met, but they do present the Transport sector with 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, to guide the development of a sustainable “zero net emissions” Transport sector.