

EU Transition Towards Green and Smart Mobility

Action Toolbox to Unleash
Innovation Potentials

Paul Hofhuis
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Clingendael Report



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1 Background, aims, assumptions and ambitions

The aim of this report is to provide input for discussion at the informal EU inter-ministerial meeting of Ministers of transport and environment in Amsterdam on April 14, 2016. This meeting is part of the programme the Netherlands' government is organizing in its presidency role of the EU Council during the first half of 2016. The leading theme for the informal Amsterdam meetings of transport and environment Ministers is innovation.

In the informal inter-ministerial session the Ministers will exchange views in an innovative format, according to a so-called Scenario Based Policy Discussion concept. During this session, Ministers will focus on the way in which they can contribute to a *transition* towards smart and sustainable mobility in the EU and its member states, and on which short-term action is needed in order to realize a competitive, *zero-emission* transport sector in the long term.

This report is based on a number of assumptions. Given long-term developments and trends, the transport sector faces challenges to maintain its competitiveness in the long term, on both national, continental and intercontinental scales. The sector's emissions are an important contributor to climate change, global warming and the deterioration of local air quality. In order to reduce emissions and to achieve the global and European climate change ambitions, a greater sense of *urgency* is needed. More drastic measures are required, particularly in the transportation sector. 'Business-as-usual' on the basis of standing policies will not be enough.

Therefore, this report proposes an innovative longer-term integrated approach by both the EU, member states, local authorities and other stakeholders, applying the full potential of *innovations* in the technological domain as well as regarding governance instruments.

This innovation potential refers in particular to three *arenas*, which are expanded upon in this report:

- a. The use of Cooperative Intelligent Transport Systems (C-ITS).
- b. Innovation regarding the reduction of transport emissions.
- c. New instruments for financing investments in sustainable transport.

By exploring and fully exploiting the potential for innovation in these three arenas, the EU and its member states can provoke a 'green revolution' in the transport sector and in this manner contribute to smarter and more sustainable mobility, while remaining competitive at the same time.

The report identifies options for public policy action to unleash the innovation potential in the three arenas in a 'Toolbox for Action'; an array of policy instruments from which Ministers can *'pick and choose'* and which they can use as an input for their discussions in Amsterdam on April 14.

The focus of this report is on the medium and longer term, making a distinction between the period until 2030-2035 and the period thereafter. During the first period, further intensification of existing policies is needed. However, even during this period, steps should already be taken in order to create a zero-emission transport sector beyond 2030-2035.

The main focus of this report is on transport by road and rail, both private and public.

This report is the result of a research project carried out by the Clingendael Institute in The Hague, at the request of the Netherlands Ministry of Infrastructure and Environment. The authors are responsible for the content of this report.

2 Trends and EU standing policies

Trends

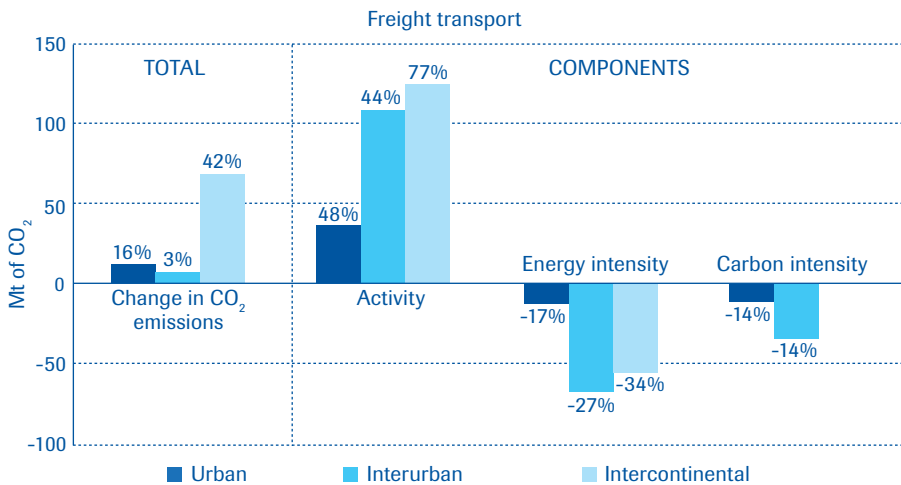
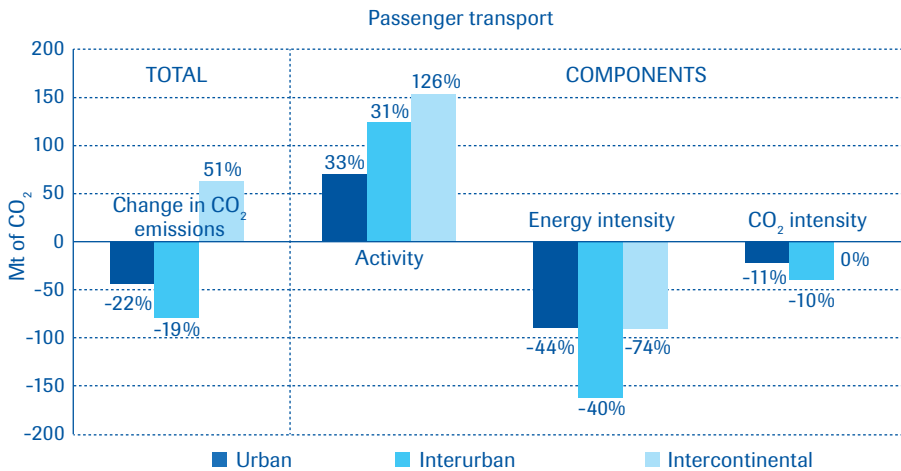
A view on developments in the European transportation sector towards 2030-2050 would not be complete without knowledge of long-term trends, along with the corresponding impact they are predicted to have on market opportunities for the sector. In this chapter we identify five significant trends, and briefly highlight their potential implications for the ambitions concerning the transition to smart and sustainable mobility.

- I. Continued economic growth (expected: average on a global scale, modest in the EU), implying:
 - Strong increase of passenger and freight (road) transport activity.
In relative terms, the biggest increase will occur across the new EU member states, particularly in combination with their further integration into the internal market.
 - High congestion, increasing emissions and higher oil prices, due to increased mobility and mobility demand.
 - Pressures on both transport demand and supply due to the aging population and continued urbanisation.
 - Connectivity and digitalization processes disrupting existing business models in numerous industries.
The economy of the future will be increasingly data-driven via consumers; citizens are able to reshape economic developments as part of the rise of the so-called 'sharing economy'.
 - Increasing importance of the service sector and the relevance of smart logistics.¹

- II. Priority for climate change, air quality and noise effects, implying:
 - Unsustainable, high contribution of the transport sector to climate change and to other environmental effects, despite a declining trend in the emissions of air pollutants by 2030 and current policy (proposals).
 - The transport sector will not meet its 67% greenhouse gas emission reduction target as required subsequent to the Paris Climate Agreements.
The sector's relative share is growing from a quarter of the total EU's greenhouse gas emissions (71.3% by road transport) at present, to 38% by 2030 and almost 50% by 2050.
Ambitious implementation of foreseeable technologies and of supporting policies promises a 42-50% reduction by 2050 compared to 1990. Not pulling through would mean only a 1% reduction by 2030 compared to 2005 levels.

- Air quality standards are (most likely) to be exceeded significantly, causing damage to public health.
- Many citizens will live in areas without acoustical comfort and will increasingly be exposed to road traffic noise.²

Decomposition of CO₂ emissions of transport in the Reference scenario 2005-2050
(source: PRIMES REMOVE transport model)



III. Turbulent energy market developments, implying:

- Transport itself will be disproportionately dependent on fossil energy, particularly on gas and oil.

Gasoline and diesel consumption currently accounts for 95% of energy use in road transport. This is in stark contrast to other sectors, and to the EU's aim of greater energy independency and its ambitions concerning the production and use of green energy in order to achieve sustainable economic growth.

- High costs of energy within the context of intensified global competition for (fossil fuel) energy and the associated risks of market volatility, geo-political tensions and instability.

Currently, Europe e.g. imports 84% of its crude oil from abroad.

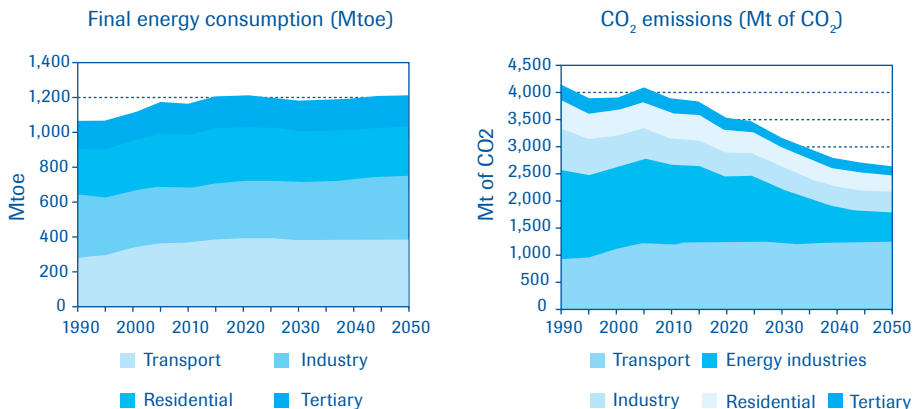
- Renewable energy (even with a high oil price environment) is expected to cover only around 10% of the energy needs of EU transport by 2020 and 13% by 2050. *Oil would cover at least 50% of the energy need of the transport sector (the European Commission stating 89% in its Transport Whitepaper reference scenario).*

- Vast opportunities for alternative energy sources.

Unconventional gas (Liquefied Natural Gas and shale gas) can stimulate electrification in transport. In combination with biofuels (competitive by 2020) it can serve as a transition fuel towards sustainable and clean energy. In the long term the key to a complete transition of road transport to a zero-emission sector lies in renewable electricity and hydrogen.³

Final energy consumption and CO₂ emissions projections

(source: PRIMES and projections based on TRANSTOOLS for maritime)



IV. Technological developments and innovations

Fuel & vehicle related cleaner technology, implying:

- Electrification, particularly with hybrids, short distance (passenger) and urban transport.

In addition, great potential for hydrogen as vehicle fuel under the condition of fuel purification and new infrastructure throughout the whole supply chain. Hydrogen is particularly suitable in the long run for the heavy/long-distance car segments.

- Battery-electric vehicles will be cost competitive with conventional internal combustion engines by 2020-2030 (given the right incentives).

Fully autonomous battery-electric long haul Heavy Duty Vehicles will be an option towards 2050.

(Economic) implementation will be slow approaching 2050.

- Alternative fuels, such as biofuels, synthetic and paraffinic fuels, methane, Liquefied Natural Gas and Liquefied Petroleum Gas can be used as transition fuels for various types of transport, requiring only minor adjustments to existing engines and infrastructure.⁴

Digitally related technology, implying:

- Improved safety, comfort and efficiency, also resulting in reduced congestion and pollution.

- Intelligent Transport Systems that include automated vehicle technology, intermodal traffic planning, app devices and the concept of mobility as a service (e.g. car-sharing).

Availability of data will 'fuel' business cases for the consumer oriented market.

- Potential for gradual improvement of automation in conventional vehicles.

This could be realized by traditional car manufacturers, for instance via automated driving, Advanced Driver Assistance Systems on freeways and/or for low-speed operation (for affluent consumers and fleet operators), including (truck) platooning and via shared vehicles during non-peak periods.

- Potential for radical technological shifts, such as the deployment of driverless vehicles in limited (infrastructure) contexts.

To be realized by public transport initiatives or specific new market initiatives, low-speed operations in urban areas and automated 'on-demand' systems (for diverse groups).

- Resolving issues in coordination between various stakeholders, such as application developers, transport industry and public authorities, resulting in actual economic sustainable mobility for all citizens.

Safety, liability, roadworthiness testing, privacy and data coordination need to be addressed specifically, in combination with anticipatory regulatory action for the purpose of large-scale deployment across jurisdictions.⁵

V. Further urbanisation, implying:

- Urban areas currently account for about 80% of energy use, generating up to 85% of Europe's GDP, and urban road transport being largely responsible for about 25% of total CO₂ emissions.
- An increasing proportion of the EU population residing in urban areas, from 74% in 2009 to about 80% in 2030 and 85% in 2050.
This leads to increasing congestion and pollution, impacting more people and businesses.
- Citizens and businesses are prisoners of current mobility options, as 50% of journeys in urban areas are shorter than five kilometres.
Alternatives exist in bicycle transport and (public transport) initiatives in ITS, including (automated) on demand systems, intermodal passenger and freight transport with urban transition (inter-modal) points for last-mile delivery.⁶

Standing policies

The 2011 Whitepaper 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport' is the cornerstone of the EU's present transport policy. Key goals by 2050 include e.g. moving towards elimination of conventionally-fuelled cars in cities and a decrease in carbon emissions of the transport sector by 60%. Action steps entail, *inter alia*, improving inter-modality, the complete and mandatory internalisation of external costs for rail and road transport, launching frameworks for intelligent and automated transport systems, and mobility from door to door.⁷ The Trans-European Transport Networks (TEN-T) policy constitutes the EU's major transport policy as of January 2014. Under the guidance of European Coordinators, it aims to create a smooth Europe-wide transport network, while keeping up with the latest technological trends.⁸ Among the ten priorities of the Juncker Commission,⁹ the connected Digital Single Market, an Energy Union with a forward-looking climate change policy, and a deeper and fairer internal market with a strengthened industrial base, are of additional relevance, as well as European support for the UNFCCC Paris Agreement on Climate Change.¹⁰

These ambitions conform to the aforementioned trends, and they are supported by various additional policies. These policies concern *inter alia* the following policy areas:

I. Air quality, via:

- Thematic Strategy on Air Pollution 2005¹¹ and Clean Air Policy Package 2013 with National Emission Ceilings Directive for the six main pollutants which Member States have to comply with by 2025.¹²

II. Clean energy in transport, via:

- Several vehicle emission standards up until Euro VI and current revisions in real world driving testing.¹³
- ‘Clean Power for Transport package’,¹⁴ adopted on 24 January 2014 with Directive 2014/94/EU on the deployment of alternative fuels infrastructures with National Policy Frameworks by the Member States by 2016.¹⁵
- Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (2009/33/EC), introducing fuel standards and fuel type approval regulations for vehicles, including gas and hydrogen.¹⁶

III. ITS and data coordination, via:

- Action Plan for the Deployment of Intelligent Transport Systems in Europe,¹⁷ the Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems,¹⁸ C-ITS Deployment Platform (cooperative framework, including national authorities, C-ITS stakeholders and the European Commission),¹⁹ Connecting Europe Facility and a Master Plan for the Deployment of C-ITS ready by mid-2016.²⁰
- the Copernicus Big Data system,²¹ EU data protection reform and harmonisation in 2015 with the General Data Protection Regulation,²² e-Privacy Directive (Directive on Privacy and Electronic communications 2009),²³ Data protection Directive 95/46/EC²⁴ and Directive 97/66/EC for protection of privacy in telecommunications.²⁵
- 2016 plans for European Cloud (Big Data, ownership, free flow between providers, cloud computing),²⁶ e-Government Action Plan, including an initiative on mandatory interconnection of business registers.²⁷

IV. Sustainable urban mobility, via:

The EU Urban Agenda,²⁸ Urban Mobility Package,²⁹ Action Plan on Urban Mobility of 2009,³⁰ urban mobility observatory Eltis,³¹ the CIVITAS initiative,³² European Innovation Partnerships (EIP),³³ Smart Cities and Communities and CLARS platform (Charging Low emissions zones, other Access Regulation Schemes),³⁴ Intelligent Energy Europe Program (STEER),³⁵ the European Platform on Sustainable Urban Mobility Plans and Initiative ‘CITIES: Cities of Tomorrow: Investing in Europe’.³⁶

V. Finance, including research and development, via:

European Investment Bank (lending more than 10 billion Euro per year for infrastructure), ESIF, EFSI, Structural and Cohesion Funds, Regional Development Fund, European Social Fund,³⁷ Horizon 2020 (up to 938 million Euro in 2016-2017).³⁸

3 EU ambitions and standing policies confronted: a need for urgent action

The EU, being an important contributor to climate change and environmental and health problems as a result of emissions, has high ambitions regarding a reduction of emissions and its contribution to greater sustainability. These ambitions were underlined during the 2015 Paris meeting on climate change. The EU wants to be in the lead, both in its goals concerning combating climate change and with regard to exploiting technological innovations that contribute to emission reductions, as well as the use of renewable energy sources (wind, solar, etc.). The exploitation of innovations must also support the EU's ambition to maintain and strengthen the competitiveness of its economies. These ambitions fit into the EU's strategic agenda as defined by the Juncker Commission mentioned above, which aims, *inter alia*, for a stronger and more innovative European economy, and more secure and sustainable long-term prospects for energy and climate.

As was shown above regarding trends affecting the transport sector, this sector is responsible for substantial share of the total amount of CO₂ emissions. In addition, transport by road is the main cause of air pollution, environmental damage and other effects that harm public health. Taking adequate measures to reduce emissions by the transport sector is therefore a precondition for the EU to realise its ambitions regarding a reduction of CO₂ emissions and improving air quality.

In order to achieve these goals, a broad range of policies, regulations, programmes and initiatives have been adopted at the level of the EU and its member states (see the previous chapter on standing policies). Their aim is to contribute to both a competitive and sustainable European transport sector.

As impressive as these standing policies would seem to be at first glance, when viewed from a longer term perspective, as is strived for in this report, it becomes clear that they will not enable the EU to fulfil its ambitions in delivering the required results regarding climate change and air quality. As this chapter shows (see chapter on trends), on the basis of present policies the transport sector will not meet the reduction targets needed in order to comply with what was agreed upon in the UNFCCC Paris Agreement. On the contrary, transport is the only sector in which emissions continue to increase. Its relative share is growing from a quarter of the total EU's greenhouse gas emissions (71.3% by road transport) at present to 38% by 2030 and almost 50% by 2050. In addition, the results with regard to air quality are also below what is required. A conclusion that is

in particular disturbing in view of the described trends, i.e. a continuing increase of the volume of transport due to economic growth, a continuing use of fossil fuels by the transport sector, and further urbanisation. These trends underline the need for a greater sense of urgency.

The implication of this is that a 'business as usual' scenario using the current policy mechanisms will not suffice.

Making the move towards a competitive, zero-emission transport sector after 2030-2035 therefore requires more drastic actions, both on the level of the EU and of the member states themselves, in particular regarding the development and introduction of cutting-edge technologies in the fields of non-fossil fuels (electricity and hydrogen) and ITS. Realising the full potential of these technologies, which will significantly contribute to a competitive, zero-emission transport sector, requires innovative action *today*.

The main elements of such a 'revolution' are:

- *Implementation of existing policies and initiatives.* Although the EU focuses on a competitive sustainable transport sector via various policies and frameworks with several elements in place, safe on paper, the actual implementation of these policies and initiatives is rather weak and not consistent. Therefore, more coordinated and concerted action is needed in the short and medium term regarding the application of existing instruments and of those initiatives still in the pipeline.
- *Focus on innovative cutting-edge technologies.* The efforts on the level of the European Union, both in terms of governance and attitudes of the transport sector and the car industry, are often too conservative in their focus on proven existing technologies, i.e. improving fossil fuel technologies, instead of technologies that have the potential to deliver a real contribution to a fossil free transport sector. Thinking ahead beyond the 2030-2035 horizon, with an emphasis on not yet fully proven technologies, is therefore a precondition for effective action.
- *Integration of mobility and sustainability.* Too often these two dimensions are dealt with separately, while an effective policy leading to a sustainable transport sector requires a full integration of these two aspects, meaning that both mobility and sustainability are equally important as part of a fully integrated and coherent policy framework.
- *An integrated governance approach on various levels.* Too often effective action and policy making is being hindered by a lack of coordination due to bureaucratic stove piping and infighting. An integrated approach, being a prerequisite for effective policies, is needed on the EU level (within the European Commission as a leading actor), between the EU level and the member states, and within the member states themselves. Leading principles for realising the required integration and coordination are multilevel governance, flexibility and subsidiarity.
- *Inclusiveness on the part of all relevant actors.* A successful policy regarding a sustainable transport sector requires the participation of all relevant stakeholders, i.e. next to public authorities, in particular the private sector, i.e. the transport

sector, car industry, energy companies, etc. Without their involvement, support and efforts, any initiative is due to fail. This requires innovative (governance) solutions to guarantee inclusiveness. It also requires a clear understanding of what role on what level which actor is to play.

- *Tailor-made solutions.* Seen from the perspective of transport and sustainability, the EU is characterised by a great variety and diversity in terms of level of urbanisation, congestions, distances, etc. This implies that on the one hand harmonisation across the Union is sometimes needed, but that on the other hand, taking into account this variety and diversity, solutions have to be adjusted to specific circumstances. This requires a tailor-made flexible approach.
- *Courage to take risks.* The future is uncertain. But tackling climate change and investing in the economy of the future require the willingness to take risks. Room for pilots, experiments, and flexibility is therefore essential in order to realise the full potential of technological, financial and governance innovations.

Finally, a policy based upon these elements, i.e. a policy which facilitates a long-term transition to a clean transport sector which both guarantees the advantages of freely available (public) transport and strengthens the position of the transport sector as a competitive industry, requires above all a long-term vision. Without such a vision, the coherence, continuity and stability that are a prerequisite for such a policy to be effective, will be lacking.

Developing such a coherent and integrated policy will not be easy in view of a number of uncertainties which may have a serious impact on the ability to devise the approach needed. These uncertainties concern, *inter alia*, the future of the European integration process itself, the global system in view of rising geopolitical tensions, the international energy markets and the price of fossil fuels, leaving aside the uncertainty in the global economy in general. These uncertainties, serious as they are, should not prevent us from taking steps that are required to build a real sustainable European transport sector.

4 Transition framework: identification of key innovation potentials

According to the analysis above, the challenge is to embark on a comprehensive transition process towards green and smart transportation. Starting this transition is urgent for two reasons:

1. Technological development is accelerating at 'a dizzying pace'. Many new technological innovations are already available, and even more are in the pipeline. In other words, availability of innovative technology is not the issue. The problem is the slow speed by which they are implemented in the market place. Hence an urgent need occurs to speed up marketization of innovations, *inter alia*, by means of effective supporting policy incentives.
2. For many years now, the transport sector operates in a European and global market, in which companies compete fiercely. Now more than ever, competition is not only about quality of service and price, but also about effective contributions to protect human health and welfare, and to avoid further climate change. Growing societal pressure, *inter alia* by NGO's, urges governments to bring these issues into the arena of market competition. In many parts of the world, governments are taking up the challenge of enabling 'their' transport sector to become market leader in smart and sustainable transport. The urgent challenge for the EU is to join this arena of global competition, *inter alia*, by mobilizing and innovating its resources and policy instruments in support of market forces.

This research paper focuses on two related areas:

- Identifying potentials of technological innovations which might play a key role in the transition process.
- Identifying potentials of government policy innovations which might play a key role in enabling further R&D in this sector and in the implementation of these technological innovations, thereby unleashing their potential to realize the required transition to smart and green mobility.

Which cutting-edge innovations and policy accelerations may deliver potential contributions to the transition to 'real' smart and sustainable transport towards 2035-2050? We have identified innovation potentials in four arenas:

1. The future of Cooperative Intelligent Transport Systems (C-ITS), including automated driving

By definition, the transport sector is an economic system which tries to match the supply of transportation services – both for passengers and for freight – to the demand for those services. Preferences for vehicle and engine technology as well as for specific energy sources are important elements determining the (efficiency of) supply and demand matching process. Other factors determining preferences are transfer time, costs, environmental impact (CO₂/air emissions and noise), safety, comfort, reliability, etc.

In an ideal situation, the marketplace should be transparent, offering information on all internal and external costs determining supply and demand in order to enable a perfect, i.e. market optimal, match between demand and supply for each individual market customer. It is no secret, however, that transport markets – both for passengers and freight – struggle with market imperfections, which, in the first place, lead to economic losses, e.g. losses due to suboptimal logistics (empty return trips), suboptimal use of infrastructure capacities, and to congestion (delays due to traffic jams, accidents, ...). Further imperfections concern environmental damage (including climate change), and negative human health effects (air pollution, noise) in local areas. A major cause for these market imperfections lies in the insufficient availability of transparent supply information that is necessary for a perfect match between demand and supply of individual preferences.

Market clients in general do not have access to necessary data for making a comprehensive, smart and environmentally friendly 'market perfect' choice. This is due to government interventions in price setting based on economic, fiscal and/or social arguments, to service suppliers not providing appropriate data or providing data for their market niche only, and last but not least, due to the lack of clear and comprehensive knowledge of the relationship between economic and environmental data.

Our analysis in this arena leads to the identification of powerful innovative potential in the area of digitalization and 'connectivity'. This potential includes further exploration of options for automated driving. It is additional to what is already being proposed and discussed in the context of the EU ITS Directive. Rapid technological development in data digitalization and data processing, and similarly rapid development in connecting databases to real-time online communication systems, offer a strong potential to make the transport market (more) 'perfect'. Market operation may gain economic and environmental effectiveness and transparency by feeding its supply and demand matching systems with a higher quality of comprehensive, digitalized information. If properly organized, comprehensive digitalization of data may substantially contribute to diminishing or even avoiding existing market imperfections, as well as having a positive impact on sustainable transport.

At present, only preliminary applications of such innovations are to be found in the market place. A number of European public transport service providers offer on-line services to individual clients, including information on travel time, necessary transfers and costs. Also, on-line, real time information on the intensity of road traffic is amply available across Europe. Most of these services are offered by individual suppliers and/or fit only one specific transportation mode. In most cases clients looking for input to make *intermodal* transportation choices, have to resort to comparing different options themselves. In addition, comparative information on energy-use and air/noise emissions of specific mobility services is still very hard to find.

Intelligent Transport Systems (ETSI)



Assessments of future developments illustrate realistic possibilities to build online, market-based data systems with real time information on three specific, transport related data streams:

- a. **Service supply:** On-line, real time information provided by transport suppliers on the main aspects of their services (capacity, route, transfer time, price, etc.).
- b. **Infrastructure capacity:** On-line information on real time traffic streams (intensity) and available capacities of infrastructure, generated by dedicated ITS networks, built into vehicles and into rail/road infrastructure.
- c. **Impact on climate/environment:** On-line information on energy use and air quality/ noise aspects of specific transport choices, generated by combining info on chosen vehicle type, transportation mode, real time traffic situation, etc.

Specific software to combine and integrate these three data systems can turn the systems into an on-line, real time data system, storing all information necessary for 'perfect', smart and sustainable matching of individual transportation supply and demand. In addition, if the integrated data system can be approached on-line by applications in the public domain, it may become an instrument to the benefit of individuals who are looking for tailor-made, smart and sustainable transportation services (public or private) to suit their own preferences.

For clients, the system could offer multiple choices for (combinations of) service providers and modes of transportation, travel time, price, environment and health (air quality/noise) impact, etc. For service suppliers, the system could provide an arena for enhancing open competition, by facilitating full access to real time market developments and to the relative position and reaction of their competitors. For governments, the system could offer powerful information to monitor clients' and service providers' behaviour, and would allow public authorities to use these data to optimize policies and policy development.

In the following passage, a brief overview is offered of how the application of such systems may look, in two subsectors (transportation of passengers and of freight), and at two scales (local and 'interlocal'):

- Passengers/local: The combination of public and private transport markets operates as 'Mobility as a Service' (MaaS), with individual, digital coordination of transport supply and demand; with possibilities for flexible choices of individual and/or collectively owned, autonomously driving vehicles (automation), different types of public transport, and for flexible choices regarding levels of comfort; possibilities for flexible interchanges between individual transport modes and local public transit modes; digital MaaS-coordination and programming guided by built-in ITS-infrastructure for public and private vehicles, and for road/rail infrastructure; a system providing individual, real time advice for route-path, mode choice, parking, etc., with feedback regarding environmental issues (carbon neutral energy-use, air quality, noise).
- Passengers/interlocal (*supplementary to passengers/local*): Flexible, multimodal supply and demand systems, digitally (ITS) coordinated, economically efficient and environmentally friendly supply and demand matching; possibility of flexible choices to interconnect mass public transport modes and individual, self-driving transportation (automation); key role for modal interchange stations ('transferia'), i.e. specifically designed infrastructure for comfortable and smooth mode changes and for interconnection of local/interlocal transport.
- Freight/local: Market development towards digitally coordinated logistics; supply and demand matching in an open, on-line system offering mode choice, price, transfer time, etc.; including choices for either shelf-to-door delivery, or shelf-to-decentralized-pick-up points; matching and mode choice programming guided by environmental data (energy use; air quality; noise); including automation options.

- Freight/interlocal (*supplementary to freight/local*): Digitally coordinated logistics; supply and demand matching and mode choice (including automation options, platooning trucks, trains, etc.); system programming guided by environmental data; key role for transferia infrastructure for smooth mode changes and smooth interconnection of local/interlocal transport.

In this arena, connected *government policy accelerations* may be built on the awareness that a comprehensive, perfect functioning transport market is an economic system which should operate on its own strength, without government interventions. The challenge for government policy activity is not 'downstream', in setting restrictions to the operation of the system once it is running, but 'upstream', in setting enabling conditions by which market stakeholders commit themselves to active and ambitious participation, and by creating incentives for market participants (service providers and users) to keep them on board.

Important enabling activities in this context are first and foremost: Taking initiative to organize critical 'mass' and support for the building of C-ITS systems for the future, mobilizing actors who support the available potential and who are connected to all relevant stakeholders.

Furthermore, policy acceleration should aim at EU-wide assessment of the potential of such systems, involving all relevant stakeholders. It should also prioritize the development of policies to speed up the building of the three highlighted data streams, to bring together their data into integrated databases, and to develop on-line supply and demand matching applications.

Another area of policy acceleration concerns the definition of the position and role of a novel institution, operating as the supply and demand matching 'market director' with specific mandate on oversight, monitoring and enforcement, and dispute settlement. A final issue regards privacy aspects. The system generates and uses information concerning the behaviour of transport clients, their individual choices for transport type (type of car, bicycle, etc.), for transport mode (public/private), and for environmental/health consequences. To really allow these data to be used for policy development to a fuller extent, privacy issues certainly have to be addressed.

These aspects are further addressed in the '*Action Toolbox*' in chapter 5.

2. The future of transport emissions

In this second arena, the (global) trends concerning local air quality, noise levels and climate change put immense societal pressure on research and innovation activities. The list of analyses that underline the urgency of action is long. Furthermore, the overall direction of the transition is already quite clear: towards a combination of zero emission vehicle technologies and the production and distribution of carbon neutral, clean power.

In line with main-stream analyses this report emphasizes the high innovation potential and the need for policy acceleration in three areas:

- a. Engine technology: In the long term – towards 2035-2050 – two realistic options for individual vehicle technology will remain: electric and hydrogen. Only the application of these technologies can provide an adequate response to the societal pressure for taking action towards fulfilling the ambitions of climate change policies, as well as local air quality/noise policies.

It is evident that the current transport industry is moving towards further development and marketization of 'zero emission' vehicles (ZEV's), in all transport modes (bicycles, cars, buses, trucks, lorries, trains, etc.) and for different vehicle types (i.e. with different specifications for short, medium and long distances). In this regard, the electric and hydrogen option both have their specific pros and cons, particularly regarding specific transport types (people/freight), mode, distance, safety procedures, etc.

Connected priorities for *policy acceleration* in this context are clear: focus on phasing out internal combustion engine technology, and full-scale policy support for further development and marketization of ZEV's as soon as possible. Regarding priority-setting for the electric or hydrogen option, in the short term it seems best to give ample space for further development with policies supporting R&D and market introduction, as well as allowing these technologies to prove their anticipated value through experiments and pilot programmes.

Car of the future (Mercedes Benz F015)



- b. Alternative fuels: In line with the analysis above, the transport sector is under pressure to make its contribution to the use of sustainable, carbon neutral and cleanly produced energy. The long-term transition goal is to reach a situation with 'zero emission fleets only', fuelled by energy that is produced cleanly and in

a carbon neutral fashion. The way towards this ultimate situation will lead through a temporary, intermediate phase of at least 20 years during which the realization of innovation potential of 'old fashioned' combustion technology still remains a crucial factor. In this intermediate phase, on-going innovation of high quality biofuels and of combustion technology to burn these fuels efficiently and cleanly, are key. On-going R&D activities in this area still have a large remaining potential, not only for the short-term intermediate phase in the transition of land-based transport, but also in the long run for transitions in the arena of air and water transportation.

Connected policy accelerations in this area may focus on maintaining pressure on the automobile sector to invest in a two-track innovation pathway: full exploitation of the potential of conventional combustion technologies as well as alternative fuels in the short/medium term, and full focus on R&D of ZEV technologies in the long run.

- c. Energy distribution: the infrastructure of power distribution, electricity, and hydrogen constitutes another innovation potential in this arena. Transport is a major energy consumer (23% overall). The transport sector is thus well positioned to fully participate in the transition in which the energy sector itself is involved. As a major player, the transport sector has a right to 'make its case' with regard to the on-going energy transition. This is equally the case, if not even more so, regarding the development and exploitation of innovative power distribution infrastructure. Whichever choice is made regarding the electric and/or hydrogen option, there is a clear need for building new distribution networks, which take advantage of innovative new technologies specifically fit for a smart and sustainable transport sector, and which are offering efficient, safe, and easily accessible power services to all users. Special potentials lie in the further development of inductive, wireless charging, and of connecting fuel-cell equipped vehicles to the grid. Connected *policy accelerations* in this area should aim at enabling the development and building of efficient, safe and easily accessible energy distribution networks, providing an infrastructure specifically fit for the transportation sector which is safe and easy accessible everywhere. The network should provide well-to-wheel, carbon neutral, clean energy.

3. Future financing of investments

A third arena with innovative potential which may contribute to the required transition concerns the providing of appropriate levels and quality of funding and financing by the capital markets. It should be clear that exploiting the innovation potentials of arena's 1 and 2 above requires massive investments on the part of government institutions and private sector actors, both for on-going R&D activities and for creating operational facilities. In overview, required investments include three main categories:

- a. Vehicles: on a local scale, short distance: small, digitally C-ITS equipped, zero emission, self-driving people 'pods'; idem self-driving package deliverers;

on interlocal, longer distance scale: comfortable, digitally C-ITS equipped, zero emission, self-driving 'cars'; idem interlocal zero emission, digitally equipped truck fleets, trains.

- b. Physical infrastructure: clean, carbon neutral power distribution and charging networks; urban nodes (transferia), facilitating interchanges of local/interlocal and mode transportation; built-in C-ITS-technology in roads and rail.
- c. Digital infrastructure: databases supply and demand supporting and coordinating matching systems, including integrated sustainable guidance applications. Investment decisions have to be made on a broad scale, regarding further R&D, market introduction and operational equipment in the transport-, energy- and IT-sector, and in transition-enhancing infrastructure. Investors are companies in the transport-, energy- and IT-sector, institutions on all levels of government, as well as individuals. Some government funding will be available, but in most cases investors will have to find funding on the capital market. In most cases the required investments concern the implementation of new technologies, with higher than average financial risk and lacking an easy to prove business case. Given the size of the capital market, funding for high-risk transition investments has to compete with the provision of funds for other, less risky investments.

The analysis of innovation potential in the financial sector points towards options for realizing a mind-set change, which is already visible in market niches, regarding risk assessment and lending procedures which determine capital investment decisions.

Innovations may focus on:

- Changing risk assessment procedures, in favour of investments in 'progressive', i.e. breakthrough innovations, instead of in slowly developing, 'conservative' innovations.
- Giving more space/setting better financial conditions to start-ups and small-scale experiments.
- Participating in innovative public-private partnerships, with options to share risks between involved parties.
- Prioritizing investments which contribute to the tackling of climate change and local air quality problems (or: deprioritizing 'business-as-usual' investments).

Innovation could enhance the availability of capital funding for the three investment categories determining the transport sector transition (vehicle/engine technology, physical and digital infrastructure).

As in the two arena's above, innovations in this arena definitely are already present in the financial sector, but they are not well spread, and the speed of their implementation is not very high as of yet.

According to this analysis, government initiative is crucial in this arena as well.

A breakthrough has to originate from policy acceleration activities, aimed at convincing

decision-makers in the financial sector to reassess their investment criteria. Crucial options for policy acceleration are:

- specific focus on creating long-term stability in the transition process, in its policy ambitions and implementation strategies, combined with
- extra spending of public funding and policy support for front running, small-scale, experimental and promising innovative market initiatives.

Such approaches may definitely be effective for accelerating an innovative mind-set change among capital investors, as highlighted above. It could be argued that the mind-set of capital investors can be influenced by other societal developments as well, as is evidenced by the 2015 Paris Climate Agreements, more specifically in the discussion on stranded assets of 'fossil fuel' companies.

4. Innovative governance and innovative regulation

The three innovation arenas above deal with independent market sectors, in which companies and consumers may use innovations for improving their contribution to the required transition. This fourth – governmental – arena regards the sector which has an explicit ambition to trigger and direct, or at least to facilitate, a societal and market transition towards a more sustainable transport sector. In the case of the European transport sector, governments have ambitions, as well as a mandate to transform the sector into a competitive, carbon neutral, public-health supporting, 'circular' and smart sector with a world-wide exemplary role .

Given the dynamics and uncertainties of the European political context, this complex ambition needs innovative government action, both in governance styles and in regulatory instruments. Transition expert Rotmans states in this context:

'It is not possible to govern such uncertainties but it is possible to influence the development's direction and speed through a concept known as evolutionary governance or planning. This comes down to creating innovation spaces for radical innovation. We are very good at incremental innovation but we are not very good at doing things entirely differently. That requires bringing together frontrunners in innovation spaces in order to develop a vision and agenda for radical innovation. The transition governance cycle is not about blueprint thinking but about searching, learning and experimenting. The market arena and the political arena are necessary here but they do not deal sufficiently with radical innovation. It is therefore necessary to bring the transition arena into play – it is concerned with radical, revolutionary, and long-term goal searching. It challenges the market and mobilises society. It is also concerned with long-term thinking and short-term action. It is both evolutionary and revolutionary, and requires patience, time and trust.'

Which are the innovation potentials in the governance arena in the transport transition?
This analysis underlines a potential for governance innovation in two related areas:

a. The potential of innovation in the role of governments

Transitions are often complex processes. The road towards a smart and sustainable transportation sector surely is complicated and full of uncertainties. The transport market consists of a large number of countervailing powers, which are in strong competition with each other. Each actor is trying to affect policy development in its favour. During the last decades, governments' role in policy development has mainly been to facilitate the making of compromises, guaranteeing that all (or at least the most powerful) market competitors could take a fair share of the proverbial pie. As a consequence, we observe that available technological innovations are usually implemented at a relatively low pace.

The transition of the transport sector has to deal with core aspects of this disadvantageous context, more specifically with:

- extremely high and accelerating speed of technological innovation;
- strong competition in the global transport market, in which governments play a leading role;
- strong societal pressure on governments to take urgent and decisive action.

These transition aspects definitely require innovation with regard to the role of (European) governments. In line with Rotmans' plea, the style of governance should shift towards 'evolutionary governance', on the basis of 'management by strategic foresight' instead of 'management by crisis', with a more guiding government role, by:

- setting out a strategic, comprehensive long-term vision regarding the transport transition;
- connecting long-term thinking with short-term action;
- taking up an active role in the transition process, focusing on building networks of market actors, based upon cooperation and trust;
- reprioritizing existing regulations to synchronize them with the required speed and urgency of the transition process;
- taking initiative for new, innovative regulations to directly support front-runner initiatives, helping technological innovations towards implementation as quickly as possible.

Rotmans' plea to 'bring the transition arena into play' refers not only to a change in the role of government in general, but also includes an innovative look at how different levels of government should cooperate. 'Governing' a transition in general, and the transport sector transition in particular, needs network cooperation of European, national, regional and local governments. 'Revolutionary goal searching by learning and experimenting' may only bear fruit if it is founded on (political) commitment to the transition ambition of all involved government levels. '*l'Unité fait la force*' should be the transition *adagio*, focusing on a clear definition of the role and mandate on the basis of which each government level should act, as well as

emphasizing mechanisms with which to turn short-term discourses on subsidiarity and proportionality into constructive, long-term comprehensive cooperation.

b. The potential of innovative policy instruments, in the context of a more guiding government role

As stated, the complex transition process may improve by dedicated innovative guidance of network-based 'governance'. It may also take advantage of the application of innovative types of regulatory instruments, fit to support the changed role of governments.

Application of sector-based, top-down, command-and-control regulations does not fit a modern, complex network society very well. In the context of transition, the effectiveness of government regulation could be improved by 'smart' policy instruments which specifically aim to unleash the potential of cross-sectorial network cooperation from the bottom-up, by:

- providing space and/or opportunity to experiment with and secure regulatory lee way for promising, new, transition-enhancing initiatives such as voluntary cooperation and partnerships, including start-ups;
- giving high profile initiatives the benefit of the doubt as well as a chance to prove their value for the transition.

Smarter regulation may also lead to better implementation, to the extent that it helps to improve the quality and coherence of (EU) regulation.

Initiatives for improving and innovating European legislation are already underway in the environmental policy area, more specifically in the *Make it Work Project*.

This project seeks to identify opportunities to systematically improve the quality of European (environmental) law and thus helps to achieve the benefits associated with the law while delivering a more level playing field across the EU. In particular, it aims to establish a more coherent and consistent framework for the EU policy acquis through developing drafting principles on the use of cross-cutting instruments and procedures in EU directives and regulations.

The initiative for the project *Make it Work* has been taken by member states, specifically by the United Kingdom, Germany and The Netherlands.

5 Action toolbox

The presented analysis leads to the identification of 'options for government action', at different levels of government (EU, national, local, etc.), which fit the transition governance role as described above under arena 4, and from which policy makers may pick and choose according to their ambitions and preferences.

The overview below presents an '*Action Toolbox*' inventory with innovative potential-enabling policy instruments. This inventory is based on the analysis of innovation potential of the three 'market' arena's in chapter 4 (C-ITS, transport emissions, investment funding).

In this toolbox options for action are categorized within each of the three arena's, and for four types of policy instruments: 'soft' regulation, information/education, economic instruments, and 'hard' regulation. Each paragraph starts with some general remarks on specific conditions of each arena.

Arena 1. The future of Cooperative Intelligent Transport Systems (C-ITS), including automated driving

Long-term, additional innovation potential of C-ITS affects the main operational mechanism of transport markets (passengers and freight; public and private). C-ITS technologies have potentials to address existing transport market imperfections (see *chapter 4*). Exploiting these potentials requires commitment and cooperation on all government levels, from EU to local.

Enabling R&D activities and successful marketization and implementation of C-ITS calls for considerable achievements in transition governance, at the EU central level by taking up a transition guiding role, by offering a framework for dealing with privacy and security issues, by convincing stakeholders to start network cooperation, by assigning a strong transition role to regions and cities, by creating market space for 'learning by experimenting' on all levels of government. Most of all, transition actions should be taken from the bottom-up, initiated on a market size and scale on which such an initiative can be developed as a 'business case', and with the relevant government level taking on a transition-guiding, networking role in order to involve all relevant stakeholders. Traditional pull (demand-side oriented) and push (supply-side oriented) policy instruments may complement this guiding role.

The initiative of the Netherlands' EU Presidency to adopt *the Declaration of Amsterdam on connected and automated driving* during the 2016 Informal EU Transport Ministers Meeting on April 14 aims to generate EU wide support for these ambitions (see also the marked (*) actions in the Toolbox below, which have a connection with the Netherlands' initiative in particular).

On the way to further unleash the potential of this arena, policy makers may pick from (combinations) of the following instruments:

1. 'Soft' regulation, guiding and enhancing the C-ITS transition process
 - Taking initiative to make C-ITS, including already on-going initiatives under the ITS-Directive, a key priority for the EU transition to green and smart mobility, and asking the European Commission to further develop a C-ITS Road Map/Strategic Action Plan (initiative role: Council of Ministers with strong connections to the EU Conference of Mayors and the EU Committee of the Regions). (*)
 - Transforming the existing C-ITS Stakeholder Platform (organizing national, regional, local authorities, and relevant market and societal stakeholders) into a guiding entity which implements and monitors C-ITS transition activities and takes action if needed (initiative role: European Commission). (*)
 - Giving regulatory leeway (i.e. removing technical and administrative barriers) to front-runner initiatives and small scale C-ITS experiments on a local and regional scale, including so called Innovation Deals, such as cross-border, regional autonomous-driving and truck platooning projects (initiative role: European Commission, member states, regional and local authorities). (*)
 - Establishing a novel institution, operating as C-ITS supply and demand matching 'market director', with specific mandate on oversight, monitoring and enforcement, and dispute settlement (initiative role: European Commission).
 - Developing cross-border EU technical C-ITS standards to guarantee open, easy C-ITS access, and seamless connection for all users (initiative role: European Commission). (*)

2. Information and education, sharing knowledge for better understanding
 - Assessing the potential of C-ITS, specifically focusing on its potential to address existing economic and environmental imperfections in the European transport market, and focusing on its 'business case potential' (initiative role: European Commission). (*)
 - Assessing the effectiveness of combinations of different C-ITS communication technologies (such as for specific geographic areas, specific target groups) (initiative role: European Commission).
 - Assessing existing and still developing communication standards and architecture to support interoperability and seamless connections (initiative role: European Commission).
 - Enhancing/subsidizing capacity building and knowledge sharing regarding C-ITS best practices among member states, regional and city authorities (initiative role: European Commission, member states, regional and local authorities). (*)
 - Starting C-ITS benchmarking programs, including progress awards (initiative role: European Commission, member states, regional and local authorities).

- Organizing communication campaigns on the C-ITS transition, specifically aimed towards generating public support (initiative role: European Commission, member states, regional and local authorities).
3. Economic instruments, affecting the market cost (supply side) or market price (demand side)
- Providing Horizon 2020 funding for further R&D for C-ITS-technology, such as for
 - ‘on board’ C-ITS for all types of vehicles (passengers and freight; private and public transport);
 - C-ITS to be built into rail and road infrastructure;
 - C-ITS applications to generate data on transport service supply (passenger and freight);
 - C-ITS applications to generate data on transport-related energy/environment impact (initiative role: European Commission).
 - Providing Horizon 2020 funding for (further) development of comprehensive, on-line accessible data systems for C-ITS-generated information (service supply, traffic streams, related energy/environment impact) (initiative role: European Commission, in cooperation with member states).
 - Providing Horizon 2020 funding for developing digital applications that enable opening up the ITS-data systems and turning them into user-centric mobility service centres for on-line, real time, multimodal supply and demand matching (initiative role: European Commission).
 - Providing Horizon 2020 funding for developing ‘urban node’ infrastructure concepts (‘transferia’) that enable multimodal connection of local and interlocal traffic (passengers and freight) (initiative role: European Commission).
 - (EU coordinated) Financial, demand/pull incentives for front running, small scale C-ITS/Smart Cities/MaaS experiments in cities and densely populated regions, for passengers and freight (initiative role: member states).
 - (EU coordinated) Financial, demand/pull incentives for comprehensive C-ITS start-ups (passengers and freight) on local, regional and national level (initiative role: member states).
 - (EU coordinated) Financial, demand/pull incentives for C-ITS participation of public transport service providers to safeguard their national, inter-regional and international market position and competitiveness (initiative role: member states).
 - (Hourly and daily flexible, demand/pull oriented) road pricing to influence C-ITS generated mobility demand and avoid congestion (passengers and freight) (initiative role: member states, in cooperation with Council of Ministers).
4. ‘Hard’ regulation, legally binding command and control EU rules
- Finding solutions for regulatory conflicts with existing EU/ECE law, regarding individual privacy (access to in-vehicle data), interaction between automated

and 'traditional' mobility, safety and liability issues (initiative role: member states). (*)

Arena 2. The future of transport emissions

The innovation potential in this arena affects three areas: vehicle technology, alternative fuels and energy production and distribution, including infrastructure. In all areas, policy development mandates are mainly located at central EU-level, based upon the EU economic, transport and environment/climate agenda's (aiming at fair competition on the internal market, at energy security and energy independence, at providing effective and efficient public and private transportation services, at achieving a carbon neutral and circular economy/society, and at improving EU competitiveness in world markets). Transition policy initiatives may therefore primarily be taken up at the central EU-level, by organizing member states commitment for the transition, both in the Council and European Council and by the European Parliament, with flexibility options for individual member states, and by involving all relevant stakeholders in network cooperation.

To (further) unleash the potential of this arena, policy makers may pick from (combinations) of the following instruments:

1. 'Soft' regulation, guiding and enhancing the transport emission transition process
 - Reconfirming the 2050 EU-ambitions for the transport sector and identifying the electric/hydrogen option as a key long-term priority for the EU transition to green and smart mobility, and asking the European Commission to further develop an electric-hydrogen Road Map/Strategic Action Plan (initiative role: Council of Ministers).
 - Strengthening existing stakeholder platforms regarding emission policy in order for them to play a cooperative, sector guiding role in the transition, to monitor transition developments and enforce continuity of action and take action if needed (initiative role: European Commission).
 - Including ECE-countries and cities in the transition, to create a 'European' market in one geographic arena for experimenting with and implementing new zero-emission transport technology (initiative role: European Commission).
 - Giving regulatory leeway to small-scale experiments with ZEV-vehicles, both for short/medium-term low-CO₂/biofuel options and for long-term zero emission, electric/hydrogen options, such as is the case in so-called Innovation Deals, and to experiments with inductive, wireless charging, and with connecting fuel cell vehicles to return power to the grid (initiative role: European Commission).
 - Allowing flexibility in implementing EU emission standards (more or less stringent) for national, regional and local situations when economic and/or environmental arguments justify such action (initiative role: European Commission).

2. Information and education, sharing knowledge for better understanding

- Organizing communication campaigns regarding the priority established for pursuing the electric/ hydrogen transition, especially aimed at informing and generating public support (initiative role: European Commission).

3. Economic instruments, to speed up innovation and to bring down market cost or market price of new technologies

- (EU coordinated) Financial incentives for the EU car industry in order to
 - speed up R&D on low (short/medium term) and zero (long term) emission vehicle technology (for passengers and freight);
 - enable quick marketization of these technologies, with specific ambition to incentivise the sector to successfully compete on the world market;
 - facilitate equal regimes for R&D and marketization on both electric and hydrogen options, for their further development and for allowing them to show their specific benefits for the transition;
 - speed up further R&D and marketization of different types of ZEV's (for passenger and freight), with specifications addressing both short-local and long-interlocal transport ranges. (initiative role: member states in Council of Ministers).
- (EU coordinated) Tax incentives for fleet owners (such as accelerated depreciation) and individuals, to buy ZEV's and to support quick market penetration of ZEV's, combined with a launching customer approach in procurement policies of governments (initiative role: member states in Council of Ministers).
- (EU coordinated) Privileges for cities to organize fine tuning in their mobility policies, aimed at specific advantages for low/zero emission vehicles regarding city access time, use of dedicated traffic lanes, parking, etc. (initiative role: member states in Council of Ministers).
- (EU coordinated) Financial incentives for suppliers of public transport services to switch to zero-emission technology (carbon neutral and clean) (initiative role: member states in Council of Ministers).
- (EU coordinated) Financial incentives for energy producers to prioritize investment in electricity/hydrogen distribution networks, fit for the transport sector on local and interlocal scale (initiative role: member states in Council of Ministers).
- Further strengthening information labelling schemes for car batteries, in accordance with the EU Circular Economy Action Plan (initiative role: Council of Ministers).
- Providing Horizon 2020 funding for further R&D on technologies for inductive, wireless charging and connecting fuel cell vehicles to return power to the grid (initiative role: European Commission).
- Providing Horizon 2020 funding for (further) technology development and marketization for generation of vehicle related (on-board) digital information on

energy/environment impact of car use, as key element for building C-ITS data infrastructure (*see: Arena 1*) (initiative role: European Commission).

4. 'Hard' regulation, legally binding command and control EU rules

- For the short term, from the present towards 2030: Further step-stone strengthening of emission standards for 'traditional' internal combustion technology, and the use of alternative fuels (biofuel/LNG/etc.) for maximum performance with respect to energy efficiency, air quality and noise, including real-time driving tests (initiative role: Council of Ministers).
- Gradually strengthening EU 'fleet emission' standard setting towards 'zero' (passenger and freight; all tailpipe emissions), with flexible implementation for individual member states (initiative role: Council of Ministers).
- Setting EU-wide mandatory standards for power charging infrastructure for vehicles, especially regarding distance between charging stations, standardization of charging connectors, individual payment protocols (initiative role: Council of Ministers).
- Setting EU-wide quality standards for the power generation sector to safeguard the long-term availability of clean, climate-neutral electricity for the transport sector (based upon the Paris 2015 Climate Agreement, and the sector's stake in the EU energy market) (initiative role: Council of Ministers).
- Setting post-2020 CO₂-standards for fuels in order to promote low-emission fuels, such as electric energy, H₂ and sustainable, advanced biofuels (initiative role: Council of Ministers).

Arena 3. Future financing of investments

The transition to smart and green mobility requires high levels of (extra) investments. Investments often concern the further development and market introduction of new technologies with specific, high risk profiles for investors, such as:

- R&D and marketization of ZEV technologies;
- transport related power (electricity/hydrogen) distribution networks;
- power charging infrastructure for vehicles (charging stations, charging connectors, payment systems);
- R&D and marketization of C-ITS data technologies and related infrastructure;
- smart and green mobility C-ITS start-ups, on local/regional/member state level;
- comprehensive C-ITS initiatives by actors from the transportation market sector (passengers and freight).

Allocating adequate funding and financing for these investments from the capital market is difficult, largely due to the fact that their risk profile is different and more complicated compared to investments which are usually considered by financial institutions.

To foster the transition, funding and financing mechanisms could be improved in two areas:

1. Revisiting risk assessment rules for funding and financing by the financial sector, in favour of innovative, high risk transition investments;
2. (Re)prioritizing spending regulations for public funding of R&D and physical/digital infrastructure.

To increase available funding and financing, policy makers may pick from (combinations) of the following instruments:

1. 'Soft' regulation, guiding and enhancing the transition
 - Identifying the availability of adequate funding and financing as a key priority for the EU transition to green and smart mobility, and asking the European Commission to develop a Strategic Action Plan (initiative role: Council of Ministers).
 - Developing new lending products and financial instruments to support small-scale projects and start-ups with risk profiles different from those which banks usually consider (initiative role: European Commission, in cooperation with European Investment Bank/EIB and financial institutions).
 - Organizing stakeholder platforms to monitor the availability of funding and financing for high-risk investments benefitting the transport transition (initiative role: European Commission, in cooperation with the financial sector).
2. Information and education, sharing knowledge for better understanding
 - Assessing the overall size and risk profile of funding and financing needed for the transition (investments in vehicle technology, physical and digital infrastructure); and subsequently applying the assessment results to real, existing credit opportunities on the capital market (initiative role: member states, in cooperation with EIB and European Central Bank/ECB).
 - Organizing communication campaigns on the crucial role of the financial sector regarding the availability of adequate funding for the transport transition (initiative role: European Commission).
3. Economic instruments, affecting the market cost or market price
 - (EU coordinated) Tax incentives for innovative public-private-partnerships and small-scale experimental projects which invest in specific, progressive breakthrough innovations (initiative role: member states in Council of Ministers).
 - Providing additional funding from Horizon 2020, Structural Funds/ESIF, EFSI, Regional Development Fund, European Social Fund, etc., for further R&D and marketization of C-ITS and ZEV technologies (initiative role: Council of Ministers, in cooperation with EIB).

- Providing additional funds for public investment in C-ITS physical and digital infrastructure (initiative role: national governments, European Commission).
4. 'Hard' regulation, legally binding command and control EU rules
- New fund-raising schemes, with revenues earmarked for financing transition investments, such as pricing the use of physical or digital infrastructure ('physical road pricing' and 'digital road pricing') (initiative role: member states in Council of Ministers).

6 Concluding remarks

This paper aims to deliver input for a brainstorm session among high-level European politicians on ways and means to make the long term transition towards green and smart mobility; i.e. a transport sector which is both environmentally sustainable and economically competitive.

The analysis leads to the following optimistic and positive conclusions:

- It highlights impressive innovation potentials in three crucial areas for the further development of the European transportation sector: vehicle and engine technology, digital communication infrastructure, funding and financing.
- It highlights a growing awareness among politicians and policymakers of the urgent need to embark on a long-term transition process towards both maintaining the transport sector's competitiveness as well as shifting to smart and sustainable transportation which challenges market forces and mobilizes society.
- It highlights the need to redefine the role of public governance in the context of this transition process, with a primary focus on enabling and facilitating the innovation potential in society and the market to the furthest extent possible, by connecting long-term, visionary thinking with short-term, comprehensive action.
- It identifies in the 'Action Toolbox' a broad range and variety of options for government policy action to guide the transition process with an emphasis on the short/medium term and in particular the long term, to be initiated on all available levels of government (EU, member states, regional, local), and with all available instruments (soft regulation, education/information, economic, hard regulation).

It is first and foremost up to European politicians to take the next steps on the path towards smart and sustainable transportation in Europe. If and when they share the urgent need to take on a leading role in the transition process ahead, the Action Toolbox in this paper offers plenty of options to act in the pursuit of this important endeavour.

References

Trend I

1

- KPMG International, *KPMG's Global Automotive Executive Survey 2016. From a product centric world to a service-driven digital universe*, January 2016, pp18, 22 and 24;
- Delli, K., *Report on sustainable urban mobility (2014/2242(INI))*, European Parliament Committee on Transport and Tourism, Strasbourg, 2015, <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0319+0+DOC+PDF+V0//EN> (accessed November 2015), p 10: behavioural changes of vehicle ownership with car-sharing, car-pooling;
- ESPAS, *Global Trends to 2030: Can the EU meet the challenges ahead?*, Luxembourg: European Union, 2015, p 13;
- European Commission, *Impact Assessment. Accompanying document to the White Paper Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*, March 2011, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:0358:FIN:EN:PDF> (accessed September 2015) pp 19, 133, 136-139 and 152;
- European Environment Agency, 'Transport Briefing', in *The European environment – state and outlook 2015*, June 2015 (last modified January 2016), <http://www.eea.europa.eu/soer-2015/europe/transport> (accessed January 2016);
- European Commission, Directorate –General for Energy, for Climate Action and for Mobility and Transport, *EU Energy, Transport and GHG Emissions. Trends to 2050. Reference scenario 2013*, December 2013, p 38. Particularly freight transport;
- European Commission, *EU transport in figures. Statistical pocketbook 2015*, 2015, <http://ec.europa.eu/transport/facts-fundings/statistics/doc/2015/pocketbook2015.pdf>, (accessed January 2016) pp 19 and 21.

Trend II

2

- European Commission, *Impact Assessment*, pp 18, 37-38, 59, 60, 143, 145-147, 149-151;
- *Transport*, European Environment Agency, Copenhagen, 2015, <http://www.eea.europa.eu/soer-2015/europe/transport> (accessed November 2015);
- *All facts and figures*, European Commission Mobility and Transport, Brussels, 2011, http://ec.europa.eu/transport/strategies/facts-and-figures/all-themes/index_en.htm (accessed November 2015);
- European Commission, *EU Energy, Transport and GHG Emissions*, p53. In the long term it will become the largest source of CO2 emissions in the EU;
- Delli, K., *Report on sustainable urban mobility*, p 17, 20:
The EU estimates a 42% greenhouse reduction with ambitious policy implementation while the IEA (2010) estimates for OECD Europe a 50% reduction. Around 40% of total NO_x emissions (fine particulates) in the EU come from road transport, particularly due to growing diesel vehicles (currently more than 55% of all vehicles), real-world driving conditions and violations of emission standards. Half of the citizens in the EU-15 are estimated to live in areas which do not ensure acoustical comfort for residents, 40% will be exposed to road traffic noise that is increasingly dangerous to public health and 30% to sound levels that disturb sleep.

Trend III

3

- European Commission, *Impact Assessment*, pp12, 18-19, 134, 145;
- European Commission, *EU Energy, Transport and GHG Emissions*, 42-45;
- ESPAS, *Global Trends to 2030*, p37;
- *Topping wealthier nations, key emerging markets attract record \$126bn in clean energy investment*, Bloomberg New Energy Finance, New York, 2015, <http://about.bnef.com/press-releases/topping-wealthier-nations-key-emerging-markets-attract-record-126bn-clean-energy-investment/> (accessed January 2016);
- *Transport*, European Environment Agency
- *Future Transport Fuels. Report of the European Expert Group on Future Transport Fuels January 2011*, <http://ec.europa.eu/transport/themes/urban/cts/doc/2011-01-25-future-transport-fuels-report.pdf> (accessed September 2015), pp9, 11 and 41;
- European Commission, DG MOVE, Expert group on future transport fuels, *State of the Art on Alternative Fuels Transport Systems*, July 2015, <http://ec.europa.eu/transport/themes/urban/studies/doc/2015-07-alter-fuels-transport-syst-in-eu.pdf> (September 2015) p81. Albeit currently maritime transport and dependent on the expansion of refuelling infrastructure;
- World Economic Forum, *Energy Vision Update 2011: A new age for gas*, February 2011, http://www3.weforum.org/docs/WEF_EN_EnergyVision_NewGasEra_2011.pdf (accessed September 2015), p24, 26, 43, 46. LNG's share of the European supply mix is projected by the world economic forum to grow from 13% in 2009 to nearly 20% in 2020;
- International Renewable Energy Agency, *Irena Report. Road Transport: the cost of renewable solutions*, 2013, http://www.irena.org/DocumentDownloads/Publications/Road_Transport.pdf (accessed September 2015), p23;
- Last year key emerging markets attracted the most clean energy investment. By 2030, 93% of the rise in energy consumption will be in non-OECD countries. Transport sector is far behind in the developments while RES in electricity generation in the EU is attaining 43% in 2030 and 50% in 2050. The contribution of variable RES (Solar, wind, tidal/wave) will be 19% in 2020, 28% in 2030 and 35% in 2050. Even if an high oil price environment triggers the uptake of electric propulsion vehicles on a large scale, conventional ICE cars would still represent about 26% of the total passenger transport activity in 2050 according to the EU's impact assessment. According to the European Expert Group on Future of Transport Fuels in a baseline scenario, oil derived products will still provide 75% of the energy demand in 2050. For different alternative scenarios (representing different shares of dominant transport technologies including fossil fuels, biofuels, EVs and FCVs) the expected total contribution of oil products in 2050 stays over 50%.

Trend IV

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- DG MOVE, *State of the Art on Alternative Fuels Transport Systems*, pp57-58, 66, 72, 76, 78-79, 81, 83 and 85;
- *Report of the European Expert Group on Future Transport Fuels January 2011*, pp 26 and 48;
- European Commission, *Impact Assessment*, pp53, 145;
- *Irena Report. Road Transport: the cost of renewable solutions*, p23;
- European Commission, *EU Energy, Transport and GHG Emissions*, p42;
- *Report of the European Expert Group on Future Transport Fuels January 2011*, p49. E.g. bio-ethanol, biodiesel, biogas. By 2050 the share of electric vehicles in the total stock of cars reaches approximately 8%.

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- International Transport Forum, *Automated and Autonomous Driving. Regulation under uncertainty*, March 2015, http://internationaltransportforum.org/Pub/pdf/15CPB_AutonomousDriving.pdf (accessed November 2015), pp5, 6, 7, 12, 15, 17, 18, 23, 28, 30, 32;
- KPMG International, *KPMG's Global Automotive Executive Survey 2016*, p2, 11,15, 37.
- DG MOVE, *State of the Art on Alternative Fuels Transport Systems*, 57-58. E.g. According to DG MOVE and other sources autonomous vehicle technology for highways is mature within the next decade. Long haul stretches during the night at low speeds and charging at interval for emission free freight transport will be possible towards 2050. Examples of high automation are CityMobil2 supported by the EU, the Navia shuttle by Induct and buggies announced by Google. Fully automated vehicles in specific contexts are also deployed in freight.

Trend V

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- European Commission, *Impact Assessment*, p141;
- Delli, K., *Report on sustainable urban mobility*, pp5, 17, 28.

Standing policies

- 7 European Commission, *Whitepaper. Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport*, March 2011, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN> (accessed August 2015).
- 8 *Infrastructure - TEN-T - Connecting Europe*, European Commission, Mobility and Transport, November 2015, http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/index_en.htm (accessed November 2015).
- 9 *Priorities*, European Commission, http://ec.europa.eu/priorities/index_en
- 10 *Paris Agreement*, European Commission, Climate Action, March 2016, http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm (accessed March 2016).
- 11 European Commission, DG Environment *Thematic Strategy on air pollution*, September 2005, http://ec.europa.eu/environment/archives/cape/pdf/strat_com_en.pdf (accessed September 2015).
- 12 European Commission, DG Environment, The Clean Air Policy Package 2013, December 2013, http://ec.europa.eu/environment/air/clean_air_policy.htm (accessed September 2015).
- 13 E.g. Directive 2007/46/EC establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles with important amendments; Regulation (EC) No 715/2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information; Directive 2009/33/EC on Clean Vehicles, Regulation (EU) No 443/2009 setting emission performance standards for new passenger cars [celex-32009r0443-en-txt.pdf](http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/index_en.htm); Regulation (EU) No 406/2010 implementing Regulation (EC) No 79/2009 on type-approval of hydrogen-powered motor vehicles Directive 98/70/EC relating to the quality of petrol and diesel fuels (Fuel Quality Directive); Regulation (EU) 582/2011 as regards emissions from heavy duty vehicles (Euro VI); Regulation (EU) No 630/2012 amending Regulation (EC) No 692/2008, as regards type-approval requirements for motor vehicles fuelled by hydrogen and mixtures of hydrogen and natural gas with respect to emissions; Regulation (EU) No 195/2013 as concerns innovative technologies for reducing CO2 emissions from light, passenger and commercial vehicles; Regulation (EU) No 510/2011 setting emission performance standards for new light commercial vehicles, Amended by Regulation (EU) No 253/2014; Regulation (EU) 136/2014

as regards emissions from light passenger and commercial vehicles (Euro 5 and Euro 6); Regulation (EU) 133/2014 amending Directive 2007/46/EC for the purposes of adapting to technical progress as regards emission limits.

- 14 European Commission, Mobility and Transport, *Clean Power for Transport: A European alternative fuels strategy*, January 2013, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0017&from=EN>, (accessed November 2015).
- 15 European Commission, Mobility and Transport, *Directive 2014/94/EU on the deployment of alternative fuels infrastructures*, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0018&from=EN> (accessed November 2015).
- 16 The European Parliament and the Council of the European Union, *Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (2009/33/EC)* <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0033&from=EN> (accessed November 2015).
- 17 *Action Plan for the Deployment of Intelligent Transport Systems*, European Commission, Mobility and Transport, Brussels, December 2008, http://ec.europa.eu/transport/themes/its/road/action_plan/ (accessed December 2015).
- 18 The European Parliament and the Council of the European Union, *Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems*, July 2010, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0040&from=EN> (accessed November 2015).
- 19 European Commission, Mobility and Transport, *C-ITS Deployment Platform*, July 2014, http://ec.europa.eu/transport/themes/its/news/c-its-deployment-platform_en.htm (accessed November 2015).
- 20 *Connected and automated driving (C-ITS)*, European Commission, Mobility and Transport, Brussels, January 2016 http://ec.europa.eu/transport/themes/its/c-its_en.htm (accessed January 2016).
- 21 *Copernicus*, European Environment Agency, Copenhagen, July 2015, <http://www.eea.europa.eu/about-us/what/seis-initiatives/copernicus> (accessed December 2015).
- 22 Council of the European Union, *General Data Protection Regulation 2015*, June 2015, <http://data.consilium.europa.eu/doc/document/ST-9565-2015-INIT/en/pdf> (accessed December 2015).
- 23 The European Parliament and the Council of the European Union, *Directive 2009/136/EC* (on Privacy and Electronic communications, amending the e-Privacy Directive), November 2009, https://secure.edps.europa.eu/EDPSWEB/webdav/site/mySite/shared/Documents/EDPS/DataProt/Legislation/Dir_2009_136_EN.pdf (accessed December 2015).
- 24 The European Parliament and the Council of the European Union, *Data protection Directive 95/46/EC*, October 1995, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31995L0046> (accessed December 2015).
- 25 The European Parliament and the Council of the European Union, *Directive 97/66/EC for protection of privacy in telecommunications*, <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31997L0066>, December 1997 (accessed December 2015).
- 26 European Commission, *A Digital Single Market for Europe: Commission sets out 16 initiatives to make it happen*, May 2015, http://europa.eu/rapid/press-release_IP-15-4919_en.htm (accessed December 2015).
- 27 *European eGovernment Action Plan 2011-2015*, European Commission, October 2015 (last updated) <https://ec.europa.eu/digital-single-market/european-egovernment-action-plan-2011-2015> (accessed December 2015).
- 28 *EU Urban Agenda*, European Union, <http://urbanagenda.nl/> (accessed February 2016).
- 29 *Urban Mobility Package*, European Commission, Transport and Mobility, http://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.htm (accessed December 2015).
- 30 European Parliament, *European Parliament resolution of 23 April 2009 on an action plan on urban mobility*, April 2009, <http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2009-0307&language=EN> (accessed December 2015).

- 31 *Eltis the urban mobility observatory*, Eltis <http://www.eltis.org/> (accessed December 2015).
- 32 *The CIVITAS initiative*, CIVITAS Initiative, <http://civitas-initiative.org/> (accessed December 2015).
- 33 *European Innovation Partnerships*, European Commission, http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip (accessed December 2015).
- 34 *CLARS platform*, European Commission, Mobility and Transport, http://ec.europa.eu/transport/themes/urban/programmes_projects_en.htm (accessed December 2015).
- 35 *Intelligent Energy Europe*, European Commission, Energy, <http://ec.europa.eu/energy/intelligent/> (accessed December 2015).
- 36 European Commission, European Platform on Sustainable Urban Mobility Plans and Initiative, December 2013, [http://ec.europa.eu/transport/themes/urban/doc/ump/com\(2013\)913-annex_en.pdf](http://ec.europa.eu/transport/themes/urban/doc/ump/com(2013)913-annex_en.pdf) (accessed December 2015).
- 37 E.g. noted in DG MOVE, *State of the Art on Alternative Fuels Transport Systems*, p105.
- 38 *Horizon 2020*, European Commission, Mobility and Transport, http://ec.europa.eu/transport/media/news/2015-10-13-h2020-new-work-pgm_en.htm (accessed December 2015).