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OUTPUT DOCUMENT

MOVING TO A BETTER EUROPE

How to achieve digital and sustainable mobility

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Introduction

During the next decades the mobility sector will go through some dramatic changes because of the changes in people's behavior, as well as other external factors. From a social point of view, several trends will actually require an adaptation in the mobility sector. These trends involve the growing number of people moving to (and within) urban areas, the shift towards an even more individual and personalized mobility - due to the growing number of single-person households and longer life expectancy - and the increase in tourism flows. In the last 50 years, the percentage of the population moving to urban areas has significantly increased in every part of the world. These changes require an evolution in the sector both from a regulatory point of view and an opening up to sustainable mobility and new digital technologies.
Moreover, technological progress and, in particular, 5G deployment, are revolutionizing the transport sector enabling new services, improving the existing ones and highlighting new critical issues.

1. The European Union towards safe, clean and connected mobility

1.1. The Cooperative Intelligent Transport Systems: a European strategy for the future

The development of digital technologies is revolutionizing the transport sector improving road safety, traffic efficiency and comfort of driving, by helping the driver to take the right decisions and to adapt to traffic conditions. Communication among vehicles, infrastructures and other road users is also important for increasing the safety of automated vehicles and their full integration into the overall transport system.
On 30 November 2016, the Commission launched a **European Strategy on Cooperative Intelligent Transport Systems (C-ITS), a milestone initiative towards cooperative, connected and automated mobility**. It aims at facilitating the convergence of investments and regulatory frameworks across the EU, in order to see the deployment of mature C-ITS services in 2019 and beyond. The document identifies the priorities for deployment of C-ITS Services underlining the importance to ensure continuity of service. This involves the availability of C-ITS

services across the EU for end-users, to develop a common EU security and certificate policy for C-ITS, to ensure privacy, data protection and interoperability at all levels, to encourage international cooperation promoting international standardization, to protect the privacy of individuals and their personal data and cyber security, to address the legal aspects and to coordinate research.

On 13 March 2019, the Commission published a **delegated regulation - C(2019) 1789 final - supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the deployment and operational use of cooperative intelligent transport systems.** It sets new rules to accelerate the new Intelligent Cooperative Transport Systems, a technology that allows vehicles to communicate with each other and with the road infrastructure regarding any situation, dangerous or not (e.g. accidents and traffic jams), laying the bases for a cleaner, more efficient and above all safer future on the road. It is an important initiative that has triggered widespread debate and the firm opposition of the operators regarding the technological protocol choices to be adopted. Indeed, the Commission proposed to base the C-Its systems on Wi-Fi, specifically the 802.11p short-range connectivity protocol, instead of 5G-Cellular-V2x solutions. This proposal is founded on the idea that Wi-Fi is a consolidated and economic solution. On the contrary, many operators and also telecommunications experts, claim that cellular networks - 4G and 5G - guarantee the extension of car services connected to the whole national territory, with enormous cost savings, greater service performance and superior communication security performance.

Considering the importance of protecting the principle of technological neutrality and not hindering the development of the 5G, after the Parliament's approval, the European Council rejected the Commission's proposal.

1.2. EU mobility package

The European Union was the first major economy to present its climate plan on 6 March 2015, reflecting the 2030 climate and energy policy framework established by the October 2014 European Council and the European Commission's blueprint for tackling global climate change beyond 2020. The EU has set an ambitious economy-wide domestic target of at least 40% greenhouse gas emission reduction for 2030.

In December 2015, the Paris Agreement was drawn up. It is the first multilateral agreement on climate change covering almost all of the world's emissions and a confirmation of the EU's path to a low carbon economy. In the **Communication on the Implementation of the Paris Agreement Commitments** in March 2016, the European Commission explained that this Agreement sets out an ambitious long term goal to limit temperature increases to 1.5°C; provides for a meeting every five years (from 2023) to consider progress in emission reductions, adaptation and support provided and received in view of the long-term goals of the Agreement;

fixes the obligation to pursue domestic mitigation measures, with the aim of achieving the objectives of their contributions; prescribes a biennial submission by all parties of greenhouse gas inventories; and establishes for the first time a global goal with the aim to enhance capacity, climate resilience and reduce climate vulnerability encouraging greater cooperation among parties to share scientific knowledge on adaptation as well as information on practices and policies.

European institutions are aware of the importance of implementing policies able to facilitate the transition to a cleaner economy. Thus, on 20 July 2016, the Commission presented a **European Strategy for Low-Emission Mobility** highlighting the importance of ensuring fair and efficient pricing in transport and promoting multi-modality such as inland waterways, short-sea shipping and rail. In order to increase the use of low-emission alternative energy for transport, the Commission emphasizes the importance of advanced biofuels for aviation, as well as for lorries and coaches, and natural gas as an alternative for marine fuels in shipping and for diesel in lorries and coaches. Specific infrastructures should be created and interoperability and standardization for electro-mobility should be developed in order to encourage the use of alternative fuels.

Considering that road transport employs 5 million Europeans and contributes to almost a fifth of the EU's greenhouse gas emissions, the European Commission crafted a series of **Mobility Packages** to improve the functioning of the road haulage market and help improve workers' social and employment conditions. It is a collection of three initiatives released in May 2017, November 2017 and May 2018, respectively, concerning the governance of commercial road transport in the European Union.

Specifically, on 31 May 2017, the European Commission presented the Communication, **Europe on the Move. An agenda for a socially fair transition towards clean, competitive and connected mobility for all.** It aims to ensure that Europe plays a leading role in clean, competitive and connected mobility, supporting the adoption of the best low-emission mobility solutions, equipment and vehicles and the development of modern infrastructures to support them. This Communication focuses on the key contribution that must be made by road transport and it is accompanied by several proposals to support the rollout of infrastructure for road charging, alternative fuels and connectivity, better information for consumers, a stronger internal market and improved working conditions for the road haulage sector, as well as steps to lay the ground for cooperative, connected and automated mobility.

Considering that road transport is a major contributor to air pollution and greenhouse gas emissions (posing a serious threat to public health) and transport activity across Europe is expected to keep growing, the paper emphasizes the importance of ensuring that the EU transport sector should rapidly embark on innovation and the deployment of new technologies , supporting the rollout of cooperative, connected and highly automated mobility solutions and the emergence of new mobility concepts such as car-sharing and new solutions for optimizing logistics. The Commission also underlines the impact of clean, connected and automated

vehicles on labor intensity in manufacturing, focusing on the deployment of new skills and the necessity to ensure a stronger social dialogue as well as support mechanisms to help people make the best of the new opportunities.

The proposal presented by the Commission in May 2017 covers the following areas:

1) **access to the road haulage market and to the profession of passenger and freight transport operators**. The Commission presented a proposal for a regulation amending Regulation n. 1071/2009 (which lays down the provisions that undertakings must comply with in order to become a road transport operator and also certain provisions to regulate and enable enforcement by Member States) and Regulation n. 1072/2009 (which lays down the provisions that undertakings intending to operate in the international road haulage market and national markets other than their own (cabotage) must include provisions related to the documents to be issued to such undertakings by the Member State of registration as well as to drivers from third countries) with a view to adapting them to sector developments; 2) **hired freight transport vehicles**. The Commission presented a proposal for a Directive amending Directive 2006/1/EC on the use of vehicles hired without drivers for the carriage of goods by road; 3) **road charging and electronic tolling**. The Commission launched a proposal for a Directive on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union. It lays down the conditions necessary to ensure the interoperability of electronic road toll systems and to facilitate the cross-border exchange of information on the failure to pay road fees in the European Union; 4) **driving and rest time rules.** The Commission presented a proposal for a Regulation amending Regulation n. 561/2006 as regards to minimum requirements on maximum daily and weekly driving times, minimum breaks and daily and weekly rest periods and Regulation (EU) 165/2014 as regards positioning by means of tachographs; 5) **posting of workers.** The Commission presented a proposal for a Directive amending Directive 2006/22/EC as regards enforcement requirements and laying down specific rules with respect to Directive 96/71/EC and Directive 2014/67/EU for posting drivers in the road transport sector. In particular, the proposal establishes specific rules regarding certain aspects of Directive 96/71/EC for the posting of drivers in the road transport sector and of Directive 2014/67/EU of the European Parliament and Council for the administrative requirements and control measures for the posting of those drivers; 6) **enforcement**. The Commission launched a proposal for a Directive amending Directive 2006/22/EC regarding enforcement requirements and laying down specific rules with respect to Directive 96/71/EC and Directive 2014/67/EU for posting drivers in the road transport sector; 7) **vehicle taxation.** The Commission presented a proposal for a Council Directive amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures, as regards certain provisions on vehicle taxation; 8) **CO2 monitoring and reporting of Heavy Duty Vehicles**. On 28 June 2018, Regulation 2018/956 on the monitoring and reporting of CO2 emissions from and fuel consumption of new heavy-duty vehicles was approved. It lays down the requirements for the monitoring and reporting of CO2 emissions from

and fuel consumption of new heavy-duty vehicles registered in the Union. It prescribes monitoring and reporting by Member States and manufacturers and the conservation by the Commission of a public Central Register for the data on heavy-duty vehicles reported by Member States and manufacturers.

On 8 November 2017, the Commission launched the **Second Mobility Package**, focusing on clean mobility. It consists of:

1) the Communication, **Delivering on Low-emission Mobility - A European Union that protects the planet, empowers its consumers and defends its industry and workers**, outlining the steps to make clean mobility a reality. The Commission explained that this Second Package addresses three key political priorities: a) Europe that protects the planet; b) Europe that empowers its citizens; c) Europe that defends its industry and workers;

2) the Communication, **Towards the Broadest Use of Alternative Fuels - an Action Plan on Alternative Fuel Infrastructures, under Article 10(6) of Directive 2014/94/EU, including the assessment of national policy frameworks under Article 10(2) of Directive 2014/94/EU**.

The Directive 2014/94/EU of 22 October 2014, on the deployment of alternative fuel infrastructures, established a common framework of measures for the deployment of alternative fuel infrastructures in the Union in order to minimize dependence on oil and to mitigate the environmental impact of transport.

Analyzing the Action Plan, describing the current situation and needs' estimates, the Commission underlines the necessity to accelerate deployment in the TEN-T core and comprehensive network (the Communication 'Europe on Move' of May 2017 has set a target for a backbone infrastructure to be in place for the core network by 2025 at the latest) and in urban and sub-urban areas, where vehicles are being used for most of the time; 3) a set of **4 legislative initiatives**, targeting road and combined transport, which aim at strengthening CO2 emission standards for new cars and vans from 2020, promoting clean mobility through public procurement, stimulating combined use of trucks and trains, barges and ships for the transport of goods and, finally, promoting the development of bus connections over long distances.

Finally, on 17 May 2018, the Commission presented the **Third Mobility Package**, supporting a safe, clean and connected mobility completing the process launched with the 2016 Low Emission Mobility Strategy. This package consists of:

1) the Communication, **Europe on the move. Sustainable Mobility for Europe: safe, connected, and clean,** presenting a strategic Action Plan on road safety for 2020-2030, including two legislative initiatives on vehicle and pedestrian safety and on infrastructure safety management. In this Communication, the Commission underlined that even if road safety in the EU has greatly improved in recent decades, thanks to actions at EU, national, regional and local levels, opportunities to further improve safety performance must be seized. The Commission describes the EU's long-term goal that is moving as close as possible to zero fatalities in road transport by 2050 ("Vision Zero") while reducing the number of road deaths and serious injuries by 50 % between 2020 and 2030. To achieve these ambitious goals, the Commission launched

two proposals, the first aimed at transforming EU **vehicle safety standards**, the second to improve **safety management of road infrastructure**.
This Communication is also accompanied by a **Strategic Action Plan for Batteries** (Annex 2), setting out concrete measures that will contribute to creating an innovative, sustainable and competitive battery "ecosystem" in Europe.
2) the Communication, **A Europe that Protects: Clean Air for All,** sets out wide-ranging EU policy efforts to support and facilitate the necessary measures for Member States to meet their targets and the enforcements to be taken to help ensure that the common objective of clean air for all Europeans is achieved and maintained across the EU. EU policy efforts rest on three main pillars. The first, involves the ambient air quality standards set out in the Ambient Air Quality Directives for ground level ozone, particulate matter, nitrogen oxides, dangerous heavy metals and a number of other pollutants. The second involves national emission reduction targets established in the National Emissions Ceiling Directive for the most important trans-boundary air pollutants (sulphur oxides, nitrogen oxides, ammonia, volatile organic compounds and particulate matter). The third involves emission standards for key sources of pollution, from vehicle and ship emissions to energy and industry. To achieve the goal to ensure clean air, the Commission emphasizes the importance of strengthening Member State cooperation via Clean Air Dialogues, bringing together Member States, regions and cities, making EU funding available to support measures to improve air quality, and state aid to facilitate domestic investments in low and zero emission mobility;
3) the Communication, **On the Road to Automated Mobility: An EU Strategy for Mobility of the Future,** proposes a comprehensive EU approach towards connected and automated mobility setting out a clear, forward-looking and ambitious European agenda. This agenda provides a common vision and identifies supporting actions for developing and deploying key technologies, services and infrastructures. It will ensure that EU legal and policy frameworks are ready to support the deployment of safe connected and automated mobility, while simultaneously addressing societal and environmental concerns which will be decisive for public acceptance. This proposal is accompanied by two legislative initiatives. The first is a **proposal for a regulation establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU.** It establishes a framework for a harmonized and interoperable European Maritime Single Window environment ('EMSWe'), based on National Single Windows, in order to facilitate electronic transmission of information concerning reporting obligations for ships arriving, staying in and departing from a Union port. The second proposal, instead, introduces a **framework of an electronic communication system for freight transport**.;
4) reaffirming the EU's objective of reducing transport greenhouse gas emissions and meeting the Paris Agreement commitments, the Commission presented a proposal for a regulation **setting CO2 emission performance standards for new heavy-duty vehicles**. It prescribes that the specific CO2 emissions of the Union's fleet of new heavy-duty vehicles must be reduced

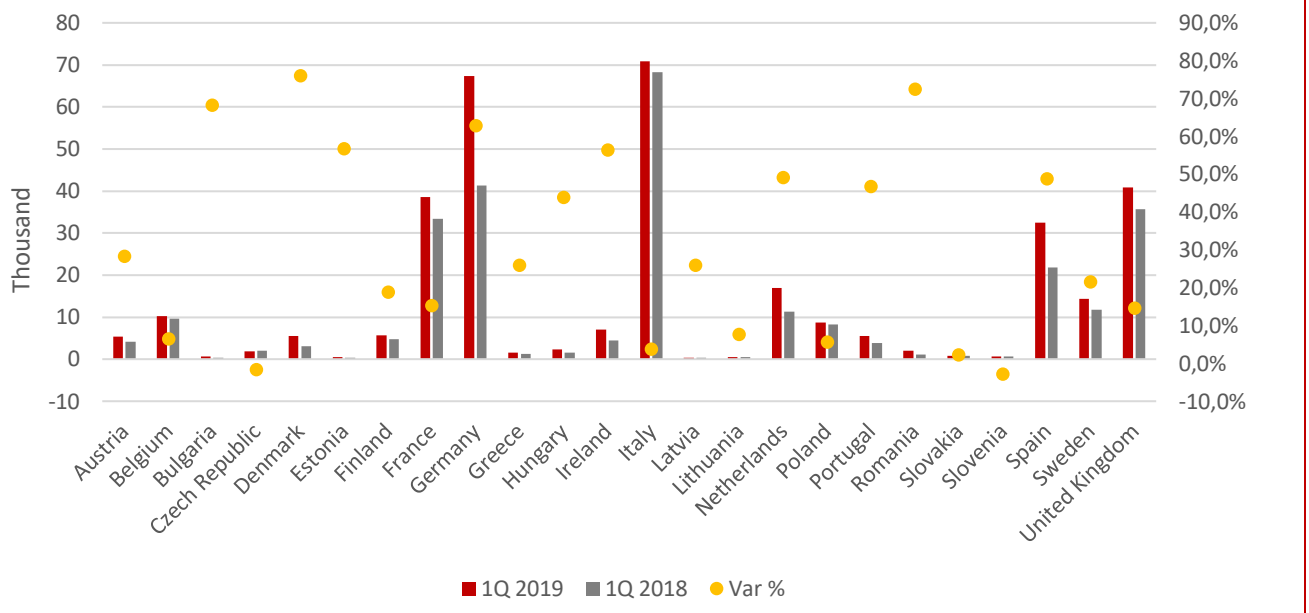
(compared to the reference CO2 emissions) by 15% from 1 January 2025 to 31 December 2029 and by at least 30% from 1 January 2030 onwards. To determine a manufacturer's compliance with its specific emission targets in the period 2025 to 2029, the proposal introduces a system based on emission credits or emission debts setting that emission credits/debts acquired in 2025 and any of the subsequent calendar years until 2028 shall be carried-over from one calendar year to another until 2029 when any remaining emission debts shall be cleared.
The Commission also proposed a regulation on the **labelling of tyres** regarding fuel efficiency and other essential parameters. It also repeals Regulation (EC) No 1222/2009 and includes a proposal for amending Council Directive 96/53/EC on **the time limit for the implementation of the special rules regarding maximum length in case of cabs delivering improved aerodynamic performance, energy efficiency and safety performance**;
5) a legislative initiative to streamline **procedures for advancing the trans-European transport network**. Considering that many investments aimed at completing the TEN-T[1] are confronted with complex permit granting procedures, cross-border procurement and other procedures, the proposal prescribes duration and implementation of the permit granting procedure and a coordination of cross-border permit granting procedures for projects that involve two or more Member States.

2. E-mobility and alternative fuels

Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of urban noise and air pollution, often in breach of air pollution limits. Therefore, moving towards a low-emission mobility is essential to the broader shift towards an EU low-carbon economy. Research and innovation activities are fundamental in supporting the long-term transition towards zero-emission and reduced noise pollution mobility across all transport modes. Decarbonization will be one of the main goals of the European Union in the coming years. The use of alternative fuels such as electricity, hydrogen or natural gas, will increase mobility sector energy efficiency and reduce carbon emissions. For this reason, most Member States have introduced incentives for those who buy alternative fuel vehicles and are also investing in infrastructure development. According to ANFIA data, 340,868 alternative fuel vehicles were registered in the EU in the first quarter of 2019 (Fig.1).

[1] The trans-European transport networks (TEN-T) have a dual layer structure: the comprehensive network ensures connectivity of all regions of the Union, whereas the core network involves those elements of the network which are of the highest strategic importance for the Union.

Fig.1: Alternative fuel vehicles registered in the EU in the first quarter of 2019



Source: ACEA

The best performers are Italy and Germany, where 70,880 and 67,405 vehicles, respectively, were registered. Comparing the 2019 data with those of the previous year, the number of registered vehicles in Europe has risen by 25.9%. **Electric mobility** could make a major contribution to reducing pollution in urban areas. However, “green vehicles” still represent a small part of the car fleet with air pollution still being a general concern. Drivers have a choice between several different types of electric vehicles. Following, are listed the EEA’s description of each of the main electric vehicle and hybrid technology types, how each works and their associated advantages and disadvantages.

Battery Electric Vehicles (BEVs) are powered only by an electric motor, using electricity stored in an onboard battery. The battery must be regularly charged, typically by plugging in the vehicle to a charging point connected to the local electricity grid. BEVs have the highest energy efficiency of all vehicle propulsion systems, typically able to convert around 80% or more of the energy stored in the battery into motion. BEVs, however, still have somewhat limited driving ranges compared to conventional vehicles and typically need a long time to recharge the onboard batteries. BEVs tend to have large batteries to maximize the energy storage capacity and hence allow for longer driving ranges.

Plug-in hybrid electric vehicles (PHEVs) are powered by an electric motor and an internal combustion engine designed to work either together or separately. The onboard battery can be charged from the grid, and the combustion engine supports the electric motor when higher operating power is required or when the battery's charge is low. The electric driving range is less than for BEVs, as the batteries tend to have smaller capacities. The batteries have less energy storage capacity as they rely less on electrical power alone to power the vehicle. The battery capacity in PHEVs is designed more for short trips in the city or commuting, for example, rather than for long-distance journeys. However, as for REEVs, the combustion engine allows for a much longer overall driving range. The environmental impact of PHEVs depends on their operation mode. Moreover, as for BEVs, the overall environmental performance of PHEVs depends greatly on the share of renewables in the electricity generation mix.

Range-extended electric vehicles (REEVs) have a serial hybrid configuration in which their internal combustion engine has no direct link to the wheels. Instead the combustion engine acts as an electricity generator and is used to power the electric motor or recharge the battery when it is low. The onboard battery can also be charged from the grid. Therefore, the electric motor is solely responsible for directly powering the vehicle. One advantage of REEVs is that the conventional engine can be small, as it is needed only when the vehicle exceeds its electric driving range. This helps reduce the vehicle's weight. As for a PHEV, a REEV overcomes the problem of a restricted driving range associated with BEVs because it can be fuelled at conventional filling stations.

Fuel cell electric vehicles (FCEVs) are also entirely propelled by electricity. In this case, the electrical energy is not stored in a large battery system but is, instead, provided by a fuel cell 'stack' that uses hydrogen from an onboard tank combined with oxygen from the air. The main advantages of FCEVs over BEVs are their longer driving ranges and faster refuelling, similar to those of a conventional vehicle. Because of the current size and weight of fuel cell stacks, FCEVs are better suited for medium-sized to large vehicles and longer distances. Fuel cell stack technology is at an earlier development stage compared to the technologies described above and few models of FCEVs are currently commercially available. Further technological development is needed for FCEVs to improve their durability, lower the costs and establish a hydrogen fuelling infrastructure, including standalone stations or pumps for hydrogen.

Hybrid electric vehicles (HEVs) combine an internal combustion engine and an electric motor that assists the conventional engine during, for example, vehicle acceleration. A HEV battery cannot be charged from the grid but is typically charged during regenerative braking or while the vehicle is coasting. As an HEV is predominantly powered by its conventional engine, hybridization can be regarded as a technology added to conventional vehicles with the aim of increasing fuel efficiency, reducing pollutant and CO2 emissions, rather than being an entirely

separate type of vehicle. HEVs typically have lower fuel consumption and exhaust emissions than conventional technologies. The more sophisticated the hybrid system, the greater the potential to lower emissions. Many different types and models of HEVs exist, ranging from 'micro-HEVs', whose only fuel-saving feature is regenerative braking and where the electric engine on its own is not capable of powering the vehicle, through to 'full HEVs', which are able to drive small distances in electric-only mode.

In the first quarter of 2019, the European market of electric cars – including BEVs, PHEVs, REEVs, FCEVs – amounted to 99,174 registrations, increasing by 40% relative to the first half year of 2018. The leading market was Germany with 23,326 electric cars registered in the first half year of 2018, followed by the United Kingdom (14,579), France (14,503) and the Netherlands (11,704). Sweden and Finland recorded the highest rate in electric vehicle registrations compared to the total number of cars registered in the country (19.5%) among the EU Member States in the first quarter of this year.

The other alternative fuels on which the European Union is focusing in order to achieve its objectives of environmental sustainability are natural gas and biofuels.

Natural gas is seen as an important part of the EU's energy mix and will play a significant role in the mobility of the future. In a vehicle powered by natural gas, energy is released from the combustion of a mixture of methane and other gases that have a lower environmental impact compared to traditional fuels. This type of gas occupies more volume than traditional liquid fuels, thus, it must be compressed (Compressed Natural Gas) or liquefied (Liquefied Natural Gas) to make it practical for transport application. CNG is mainly used for small vehicles (cars and light-duty trucks), while LNG is used for heavy-duty vehicles (trucks, locomotives and vessels). The market for natural gas vehicles is expected to grow enormously by 2030. According to a study by NGVA Europe, the number of CNG cars in Europe will increase 10 times, reaching a market share of 12%. CNG and LNG are a real alternative to conventional diesel, even for long distance transport. Gas fuelled urban buses and coaches will see a 33% market share, whereas the freight transport sector is projected to reach 25%. The average price for CNG in Europe is €0.99/kg, which is 48% lower than petrol and 31% lower than diesel, making it an economical fuel for transport. Even though natural gas vehicles are, on average, more expensive to buy than conventionally fuelled vehicles, the initial cost is offset by the lower CNG fuel price. HDV vehicles will see the largest fleet development with numbers expected to increase112 times by 2030, resulting from the spread of LNG refuelling stations (currently, there are only 164 filling stations in the EU10). LNG is a natural gas that has been converted to liquid form for ease of transportation. By cooling the gas down to -162 °C, the volume reduces to 1/600 compared to its gaseous state. In this process, heavy hydrocarbons (condensate, LPG), carbon dioxide, water and sulphur are removed. It is nontoxic, colourless, non-flammable and non-corrosive.

The energy density is 2.4 times higher than CNG. LNG is also used for waterborne transport both at sea and on inland waterways. The LNG infrastructure for fuelling vessels is, however, at a very early stage, with only Sweden having a small-scale LNG bunkering facility for sea going vessels, though several Member States have drawn up development plans. According to the European Commission, a network of refuelling points for LNG maritime should be available at least by the end of 2030. Despite important growth forecasts in Europe, natural gas-powered vehicles are still not widespread. Among the top 20 countries in the world for the number of LNG and CNG vehicles, there are only 2 European countries (Italy and Germany).

Biofuels can be derived from plants, or from agricultural, commercial, domestic and industrial waste and, today, represent the most concrete response to reduce CO2 emissions from the transport sector. These fuels have a low environmental impact and unlike other alternative fuels do not need new infrastructures to be built. The promotion of biofuels is a political priority of the EU energy-climate policy. Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and, subsequently, repealing Directives 2001/77/EC and 2003/30/EC introduces a binding target for 10% share of renewable energy in transport by 2020, with biofuels also making a substantial contribution to this aim. Biofuels are compatible with vehicles already on the market and have a very similar cost and range compared to traditional fuels, making them a sustainable solution, also for aviation, heavy-duty and marine transport. According to a test carried out by the United States Environmental Protection Agency, the use of biodiesel in diesel engines results in substantial reductions in unburned hydrocarbons, carbon monoxide and particulate matter. Emissions of nitrogen oxides remain the same or only slightly increase. The exhaust emissions of sulphur oxides and sulphates (major components of acid rain) from pure biodiesel are essentially eliminated. The ozone forming potential of the speciated hydrocarbon emissions is 50 % less than that measured for diesel fuel.

3. Autonomous and connected cars: current situation and market trends

The distinction between the 1st and 2nd digital revolution is crucial in order to clarify the difference between Connected Vehicles (CV) and Autonomous Vehicles (AV). It is worth noting that they both differ from Electric Vehicles (EV), which do not indicate the electronic technology used to connect vehicles and make them drive autonomously, but the power used by the motors for propulsion. Hence, Connected Vehicles, as well as Autonomous Vehicles, can be powered by fuel, electricity or other kinds of energy.

Connected vehicles are provided with technologies that allow them to communicate with the environment, as well as between each other. The Connected Vehicle concept is related to supplying useful information to a driver (or a vehicle) to help them to make more informed decisions. Hence, this implies that the vehicle only supplies information to the driver, e.g. related

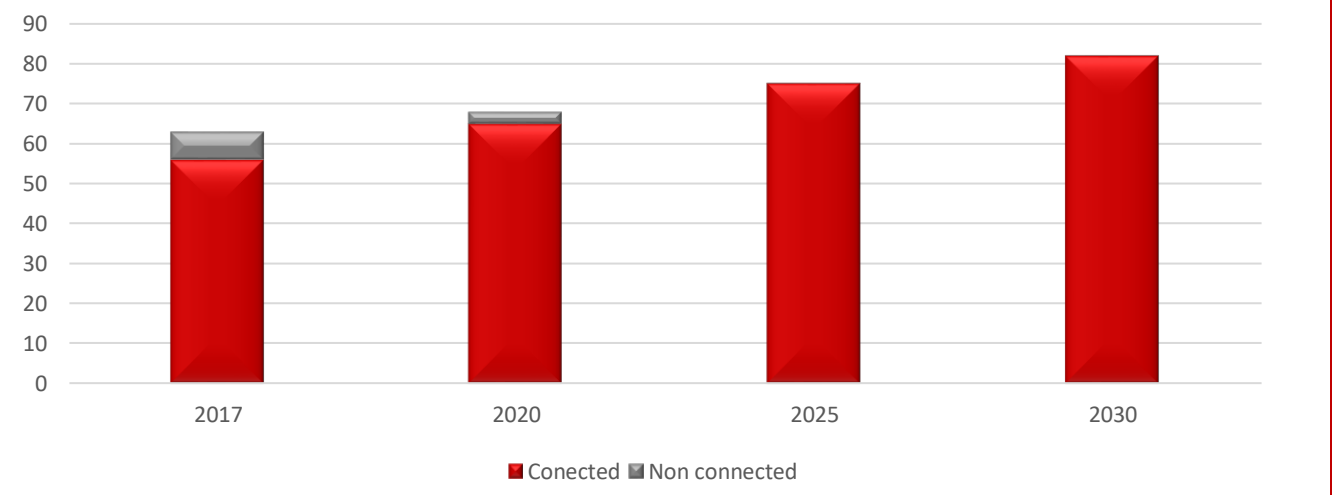
to traffic conditions or to potentially dangerous situations to avoid, without making any choices in their place. In most cases, CVs send the information to the driver as well as transportation collecting data agencies, in order to generate historic data to improve real-time conditions and better allocate resources and improve future infrastructure planning, also related to the further deployment of a nationwide (and international) connected vehicle system. The navigation systems currently used in vehicles already include CV functionalities such as dynamic route guidance, whereas the GPS system receives information on traffic congestion and elaborates and suggests the best route.

Autonomous Vehicles (AV) imply that machines, provided with proper equipment and real time information flows, can take decisions and carry out their own actions, such as self-parking, avoiding collisions autonomously and driving. The Society of Automotive Engineers (SAE) found 6 different levels of automation, from level 0 to level 5. **Level 0** identifies vehicles without any information support, while **level 1** identifies autonomous guidance systems capable of performing dynamic sub-tasks related to longitudinal or lateral movements (but not both simultaneously) in specific contexts, leaving the other tasks to the pilot. Some examples are automatic braking systems or driving assistance systems (e.g. speed control). **Level 2** identifies those autonomous driving systems capable of performing long (and simultaneously) sub-tasks related to both longitudinal and lateral movements in specific environmental contexts, leaving the pilot to identify obstacles or unexpected events (Object and Event Detection and Response or OEDR) and the execution of the appropriate response, as well as the supervision of autonomous driving activity. In this case the car is ready to accelerate, brake and steer independently. This type of car can identify other vehicles and keep the right safety distance on the move, preventing potential collisions and making changes in direction and lanes on motorways as well as parking. **Level 3** is also defined as partial driving automation, or partial autonomous driving, and identifies autonomous driving systems (ADS) capable of performing all dynamic tasks (DDT) for a long time, waiting for the driver to be ready to intervene in the event of a request by the system (fallback), as well as in case of malfunctions inside other devices. The possible causes of intervention requests include in particular the environmental and meteorological conditions, as well as other technical eventualities (e.g. difficulties in recognizing an obstacle or danger). **Level 4** is called High Driving Automation and implies that cars are able to drive completely independently, especially in environments called “driving modes”. These can be situations such as driving on a highway or parking in a garage. Even if, theoretically, they should be able to cope with all situations, models belonging to this level may not be capable of self-managing under specific circumstances, due to equipment limitations (e.g. some vehicles may not be suitable for highways as their sensors are not designed to perform at the range needed to travel at high speeds). **Level 5** is identified as Full Automation, a system that should be able to handle, unconditionally, all driving tasks just as a human driver. This means the Automated Driving System is ODD (Operational Design Domain) independent and can work in

all driving modes and under all environmental conditions (rain, fog, snow) without any expectation that the human driver will answer to any request to intervene.

According to PwC estimates, there will not be more non-connected cars sold by 2025. Indeed, out of about 63 million cars sold in the US, the EU and China in 2017, the number of connected cars exceeded 55 million, while the non-connected cars sold were only 7 million. In 2020, the connected cars sold should reach the 65 million threshold, up to 82 million by 2030 (Fig.2).

Fig.2: Estimate of connected cars until 2030 (U.S/E.U./China; in millions)



Source: PwC (September 2017)

Autonomous car sale projections are related to the different levels explained above. Level 0 cars are those identified in the above Figure, also labelled as “non-connected”. Out of the connected cars (almost 56 million in total), more than 50 million belonged to Level 1, while the autonomous cars sold in 2017 were less than 1 million (Level 2). According to PwC projections, Level 2 cars should reach 5 million units sold by 2020, climbing up to 33 million by 2025. Level 3 cars, not yet available on the market, should reach 4 million units by 2020, arriving at the 13 million threshold by 2025. By 2030, Level 2 and Level 3 car sales should begin to decline, due to the increase in Level 4 and Level 5 vehicles. For the latter, Level 4 cars should reach 5 million units sold by 2025 and up to 28 million by 2030, while the fully autonomous cars (Level 5) will be available only after 2025, reaching 12 million units sold per year by 2030. Projections on the spreading of electric, semiautonomous and (fully) Autonomous Vehicles have also been carried out by other consultancy companies, such as McKinsey and IHS Automotive. According to the International Council on Clean Transportation, which collected and compared this data with its own projections for electric vehicles, projections on future autonomous vehicle sales significantly

exceed demand estimates for electric vehicles. Indeed, the latter will account for about 15% of the car total by 2030, while Level 3+ Autonomous cars should account for more than 50% of the total cars sold. This means that, according to the projections, one car in every three connected (or autonomous) car sold could be electric, while the other two could be powered by another type of energy. McKinsey estimates indicate that vehicles with Level 3 or higher automation could exceed 50% of worldwide cars sold by 2030, rising to 90% by 2035 (McKinsey & Company, 2016). According to ICCT projections, electric vehicles should reach 30% of total cars sold, maintaining the 1:3 ratio. IHS Automotive projections, related to fully autonomous vehicles sold globally, will be below 5% of total sales by 2030, reaching 15% by 2035 and exceeding 50% by 2040 (IHS Automotive, 2016).

4. Technological issues. 5G standard and its impact on the transport industry

5G networks represent an extraordinary opportunity for global development and growth. This technological evolution allows for an up to 100 times faster data transfer rate, reducing latency by bringing it closer to zero, allowing for managing one million devices in 1 km², ensuring greater longevity of the device battery and allowing the use of different frequencies from 400 MHz at 100 GHz enabling the development of new services and generating enormous socio-economic benefits. We are facing a high-performance and innovative technology that will deeply reshape the fixed (wireless last mile, high capacity) and mobile (high data volumes) connectivity services, resulting in the spread of devices able to interact with each other and with man by sharing the acquired knowledge. The technological evolution of 5G will allow for the development of highly innovative applications and services in many sectors, including automotive, transport, energy, health and manufacturing. Currently, the automotive and, more generally, the transport sectors are the most quoted cases, probably due to the revolution involving the wide-scale spread of vehicles with (completely) autonomous driving, both in terms of comfort and efficiency and productivity. These innovations, in addition to eliminating a daily activity that can be tiring, would lead to intelligent traffic management and a drastic reduction in road accidents. Transport has a well-developed innovation roadmap spanning both infrastructure and ICT where numerous new connected devices and services could be supported and enhanced by 5G capabilities. In the most optimistic scenario, transport data flows freely between once closed sub-transport sectors enabling new collaboration and application possibilities. Transport could be heralded as one of the first industries to deliver a true “IoT” experience enabled by a Pan European Integrated Transport system connecting everything (roads, cars, trains, planes, bikes etc.). Data and advanced data products (provided by analytics) are acknowledged by all stakeholders and protected as the fuel in the new value chain. For this vertical, more so than in the preceding two examples, transport data sharing and access is fundamental to achieving benefits. By automatizing roadways, railways and airways, smart systems will transform passenger experiences and reshape the way cargo and merchandise are tracked and delivered, creating

substantial business opportunities for new players. Automated transport management will offer several benefits, such as increasing safety and efficiency, reducing congestion and transport costs and economizing on fuels. Moreover, the incorporation of intelligent systems (ITS), such as communication systems, sensors and smart devices to connect the transportation system in a real-time environment, and IoT solutions in the transportation sector will enable vehicles to transfer messages and signals to other vehicles for tracking and monitoring on a real-time basis. The integration of ITS with IoT applications will help to monitor the data from surroundings and increase safety in passenger and commercial vehicles. According to the study (Tab.1) conducted for the EC by Trinity College, Tech4i2, Real Wireless and InterDigital, the economic benefits of 5G would amount to € 62 billion from the main verticals (automotive, transport, health, energy networks). There would be an additional € 50 billion from smart city solutions, extra-urban areas and intelligent digitalization of homes and workplaces, reaching a total of € 113 billion a year as early as 2025. Automotive and transport will bring about € 50.3 billion in total of benefits.

Tab.1.: Annual vertical and environmental benefits in 2025

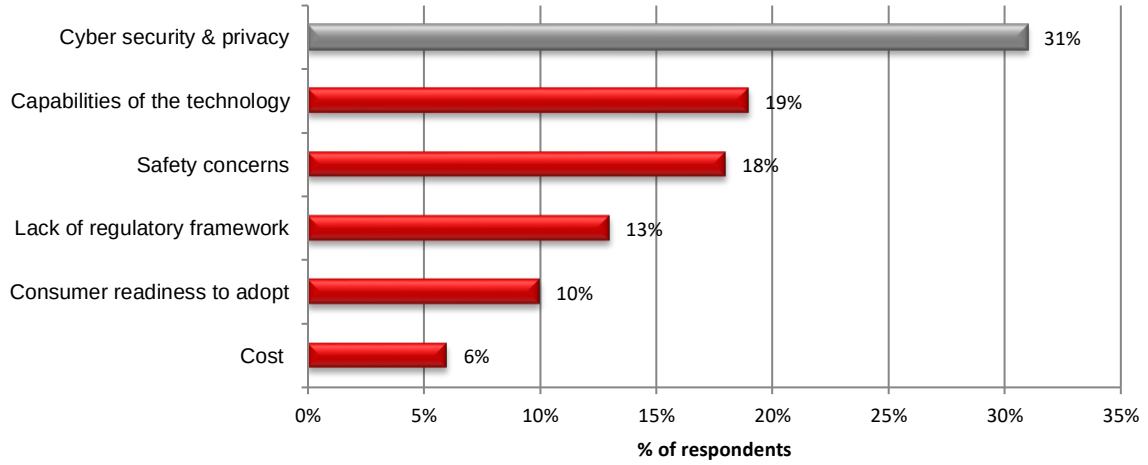
Benefits from verticals per year to 2025	**mld €**
Automotive	42.2
Healthcare	5.5
Transport	8.3
Utilities	6.5
Total benefits from verticals	62.5
Benefits deriving from "environmental" developments by year to 2025	**mld €**
Smart cities	8.1
Non-urban areas	10.5
Smart homes	1.3
Smart workplaces	30.6
Total environmental benefits	50.6
Total annual benefits	**113.1**

Source: Trinity College, Tech4i2, Real Wireless e InterDigital

An important challenge related to connected vehicles is that of cyberattacks. Each electronic control unit (ECU), as well as the increasing array of sensors they work with, must be secured in some shape or form, whether it is via cooperating or co-processors, code verification, protection of data at rest and in transit, or other capabilities that have become common in Internet security. There are several potential vulnerabilities. Experts showed how hackers could

remotely access and control vehicle components, as well as tap into private customer data collected by the onboard system. In particular, hackers could access the internal network of the car and control the safety critical ECUs such as braking and engine start/stop operations, making the hacked vehicles extremely dangerous. Cybersecurity threats to connected cars could undermine the industry's roadmap towards autonomous and connected vehicles. According to a survey conducted in 2017 on 83 automotive and technology executives between America and Asia, IT security and privacy – selected by 31% of respondents – were an important concern for connected cars and the main obstacle to their development (Fig.3).

Fig.3: Main obstacles to the growth of connected cars



Source: Foley, 2017 Connected Cars & Autonomous Vehicles Survey

In addition, cybersecurity attacks emerged as the top legal issue for 63% of respondents. Consumers were also worried about cybersecurity in connected and autonomous cars, being aware that connected vehicles have the potential to be targeted by a cyberattack. The Irdeto Global Consumer Connected Car Survey examined consumer awareness of cyberattacks targeting connected cars and autonomous vehicles in six countries – Canada, China, Germany, Japan, the UK and the US. According to this survey, 85% of global consumers indicated that they believe any connected car has the potential to be targeted by a cyberattack. In addition, the survey found that 59% of connected car owners were concerned that their vehicle could be targeted by a cyberattack. Moreover, the rising number of connected cars has increased the risk, resulting in two core future challenges – establishing and maintaining trust and consumer confidence, as well as vehicle safety. Concerning these important topics, companies must play an important role in promoting and guaranteeing cybersecurity in the automotive sector.

4.1 European Policies on 5G and the allocation of pioneer bands in EU

The European Commission, aware of the disruptive potential of 5G on a multiplicity of strategic sectors - including transport - and of the extraordinary opportunities for social and economic growth, laid the foundations for the implementation of a unified strategy for the coordinated adoption of the new mobile standard. The main cornerstone of this strategy is the Communication "**5G for Europe: an Action Plan**", published in September 2016 and accompanied by the working document "5G Global Developments", in which the eight actions for its development were identified. These can be divided into three directions - technical, organizational and financial. At a technical level, Member States are required to identify a "pioneer" frequency list for the initial launch of 5G services, to adopt an agreement regarding the complete set of frequencies and to monitor the progress of small cells, favoring their development. At an organizational level, States are encouraged to adopt national roadmaps, to promote preliminary trials (from 2017) and commercial trials (from 2018), to make available an initial global 5G standard (end of 2019) and to identify at least one city that will become "5G enabled" (by the end of 2020). Finally, at the economic level, it is proposed to identify the hypotheses and methods for a venture financing facility.

The following Communication, **Gigabit Society,** advanced 3 connectivity goals to 2025 - the provision of connectivity to all families, even in rural areas, with a download capacity of at least 100 Mbps; the need for schools, universities, hospitals and all the main socio-economic engines to have access to 1 Gbps connectivity; and 5G coverage of all urban areas and major roads and railways.

Some Member States have already carried out auctions for the allocation of pioneer bands for 5G. The EU country in which operators have supported the highest cost for the acquisition of frequencies rights is Italy (€ 6.550 bill.), followed by Germany (€ 6.549 bill.). The average duration of the assigned rights is 16.7 years. Italy and Germany are also the countries with the highest pioneer band assignment costs (the band destined for the first 5G experimentation projects) (Tab.2). Despite being the first two countries in the ranking, the cost of MHz per number of inhabitants in Italy is more than double that of Germany (€ 19.98 and € 8.39, respectively).

Tab.2.: 5G Auctions

Country	Spent	Duration	Population (2018)	Bandwidth (MHz)	Band	Cost x MHz (€/1000 inhabitants)
Italy	4,346,820.000 €	18	60,431,280	200	3.6-3.8 GHz	19.98 €
Germany	4,175,529,000 €	20	82,927,920	300	3.4-3.7 GHz	8.39 €
Spain*	1,410,700,000 €	20	46,723,750	200	3.6-3.8 GHz	7.55 €
United Kingdom	1,143,714,909 €	20	66,488,990	150	3.4-3.6 GHz	5.73 €
Austria	188,000,000 €	20	8,847,040	190	3.4-3.8 GHz	5.59 €
Ireland	78,000,000 €	15	4,853,510	360	3.6-3.8 GHz	2.98 €
Finland	77,000,000 €	14	5,518,050	390	3.4-3.8 GHz	2.56 €
Czech Republic**	39,673.,87 €	10	10,625,690	200	3.6-3.8 GHz	1.87 €
Latvia***	7,000,000 €	10	1,926,540	150	3.4-3.8 GHz	2.42 €
Hungary	2,760,000 €	20	9,768,780	90	3.4-3.8 GHz	0.16 €

Note: *Spain has already sold 160 MHz in the 3.4-3.6 GHz band in 2016; **Czech Republic next launch in November for the 700 MHz band and 3.4-3.6 GHz. Allocation price CZK 1.015 billion; ***Latvia sold 100 MHz with the first auction at a cost of € 500,000 and another 50 MHz at a cost of €6.5 mill..
Source: I-Com

5G networks will form the backbone for a wide range of services essential for the working of the internal market and the maintenance and operation of vital societal and economic functions, ensuring that 5G network cybersecurity is an issue of strategic importance for the Union, especially considering that cyberattacks are on the rise and more sophisticated than ever. Aware of the importance to ensure 5G network security, on 26 March 2019, the Commission published Recommendation n. 2019/534 "**Cybersecurity of 5G network**" which highlighted the risks of cybersecurity in 5G networks and presented guidelines on the appropriate risk analysis and management measures at national level. The document underlines the necessity to consider technical factors but also others such as regulation, the governance model existing in the country analyzed, the general risk of influence by a third country, etc. The same recommendation sets a roadmap that encourages Member States to carry out a 5G infrastructure risk assessment by 30 June 2019, also identifying the most sensitive elements where security breaches would have a significant negative impact, as well as reviewing the security requirements and risk

management methods applicable at national level, in order to take into account cyber- security threats.
The recommendation specifically identifies a series of temporally scanned steps: 1) the completion, by 10 October 2019, by the Member States, with the support of the Commission and ENISA, of a joint review of the risks related to the infrastructures and specifically the 5G networks; 2) on the basis of these national best practices, sharing, by 31 December 2019, a set of possible adequate, effective and proportionate risk management measures in order to mitigate the cybersecurity risks identified at national and Union level. These will guide the Commission in developing common minimum requirements to further guarantee a high level of cybersecurity for 5G networks across the Union. This set of tools should include an inventory of the types of security risks that can affect 5G network cybersecurity and possible mitigation measures.
Finally, the recommendation calls on the Member States to cooperate with the Commission to assess the effects of what is foreseen by 10 October 2020, in order to determine the actions to be taken.

5. Power Breakfast Main Highlights

Environmental sustainability and digital innovation are increasingly becoming major issues in different sectors. For instance, in transport, we are witnessing a continuous transition and upheaval in the traditional approach to mobility, both at European and global level.
The EC's objective to achieve a climate-neutral Europe by 2050 will require a joint action and political leadership. Therefore, intervening in the field of mobility will be fundamental. The European transport system needs to be safe, sustainable, affordable and accessible and - as a cross cutting sector - will require initiatives both digital and environmental.

Connected, safe and sustainable mobility

A prerequisite for the development and deployment of a connected, safe and sustainable mobility is the assessment of a number of variables and challenges.
Transport digitalization is a preliminary condition to make mobility more sustainable. The evolution of digital technologies is having a major impact on the transport sector, producing effects on several dimensions that should be addressed by policy-making. Urban areas are the places to better observe this disruptive process: European cities are increasingly facing problems caused by transport and traffic. While cities attempt to adapt to these changes, they have to take into account an incomplete legal framework and human shortcomings in skills, added to poorly developed digital infrastructures. The Urban Mobility Package, which was launched in 2013 to address these challenges, i.e. by improving the standards of mobility and sustainability in urban environments, will be further followed-up by the new European

Commission. Therefore, both a strong coordination between authorities responsible for different sectors and a cross-cutting approach by the Commission are needed. For this, interconnection, inter-service and interaction will be key words to guide the Commission through the upcoming institutional cycle.

Another key challenge lies in the strong connection between mobility and security on the one hand, and cybersecurity on the other. Thus, the increasing importance and potential application of data (which are key to developing new technologies and economic models) and artificial intelligence entails a high degree of cooperation among European institutions, Member States and the private sector. Standard procedures proposed by regulators need to cope on a daily basis with rapid transformations and emerging technologies, while intelligent transport systems and automated vehicles are still evolving faster than the regulations.

The introduction of 5G technology and the related debate concerning security is another major challenge to tackle. It is important to make the general public - not only the decision-makers – aware of the saliency of this specific issue, as technological innovation involves several potential vulnerabilities, mainly concerning the exposure to cyberattacks. To address the problem, the Commission published the Recommendation “Cybersecurity of 5G networks”, outlining guidelines for appropriate risk analysis. Those guidelines will be integrated with the provisions of the new Delegated Act concerning 5G, increasing efforts to ensure more effective regulation, while leaving room for the introduction of new technologies.

Moreover, sustainable mobility should be considered both socially and environmentally. The ambitious objective of achieving a climate-neutral Europe by 2050 calls both for a strengthening of the implementation of the existing legal framework and for the introduction of new legislative tools. The three mobility packages cover many aspects of the transport sector, introducing innovative tools to manage the transition to a cleaner and more sustainable mobility.

Alternative fuels and of CO2 emission reduction are key issues to be taken into account. Given that the transport sector is traditionally one of the major sources of pollution, the transition to low and zero emission mobility and the implementation of a carbon neutral continent should imply a 90% reduction in transport greenhouse-gas emissions by 2050 compared to 2005. Moreover, an increase in alternative fuels in the short-medium term would have a significant impact in reducing overall emissions in Europe. In particular, a shift to alternative forms of vehicles on the market is one of the most urgent measures to take in those sectors that have the greatest impact on the total emissions, i.e. air transport (in the aviation sector, only 2% of the flights in the EU are provided with alternative fuels). Finally, in terms of alternative forms of mobility, electric vehicles are widely considered the best option to direct the sector towards a more sustainable path.

However, an insufficient legislative framework and levels of investments slow down a smooth transition to alternative forms of mobility, both on a large scale and at local level. Therefore, the Commission's strategy for low emission mobility aims at combining a number of different issues to finally adopt a comprehensive approach to the transport sector. To consider mobility as a

right, to ensure fair and efficient pricing in transport and promote multi-modality are the best ways to improve sustainability, in particular in public transport.

Steps forward

The second half of 2020 will be crucial for the new Commission to implement a comprehensive strategy to achieve sustainable and smart mobility. Some of the policy guidelines should already be laid down in the Green Deal for Europe Communication, to be published within the first 100 days of the new Commission. The Mission letter from President Von der Leyen to the newly-appointed Commissioner for Transport, Rovana Plumb, considers a comprehensive sustainable transport strategy as a major first step to further develop, strengthen and implement. By this strategy the Commission will address all the relevant areas, while underling the need to speed up, with sound financial tools. A large amount of the budget will continue to be dedicated to rail and the Commission will continue to strongly support the deployment of ERTMS systems and corridors throughout Europe.

Moreover, a significant step forward requires strong cooperation among institutions, Member States and local authorities. This implies a significant improvement and modernization of EU funding, for instance, through blending - combining EU grants with loans or equity from public and private investors - is becoming the most fitting financial tool to ensure a dynamic and stable approach. EU grants can be strategically used to attract additional financing while reducing risk exposure. Cooperation among different DGs, e.g. DG MOVE, DG REGIO, DG GROW and DG CNECT, is becoming increasingly necessary due to the cross-cutting nature of the mobility issue. An example of this enhanced coordination and synergy within the Commission is represented by the funding tool Connecting Europe Facility (CEF), which provides support to high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. In terms of funding programs, Horizon 2020 is still a major R&I instrument for the future, providing financial support for development and testing of new clean energy and transport technologies.

In terms of institutional coordination required to harmonize the European mobility landscape, there is a growing need to increase capacity-building, particularly in areas with weaker budgets and to train national and local authorities in preparing and presenting projects. The issue of the geographical divide can only be tackled by increasing investments, especially from private actors, also through a multi-level coordination.