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Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

EUROPE ON THE MOVE

An agenda for a socially fair transition towards clean, competitive and connected mobility for all

{COM(2017) 283 final}

Introduction

Traditional transport systems are being shaken up and remodelled by important changes in our societies. A more urban European population is growing and aging, changing the needs, expectations and demands for mobility. Rapidly developing mobile information and communication technologies and penetration of new players into the transport sector are giving rise to the emergence of new mobility services and systems. Transport technologies are evolving under the pressure for the sector to become safer, smarter and cleaner. New societal (collaborative economy), technological (self-driving cars) and economic changes have impacts on the transport system as a whole.

Effective facilitating measures are necessary at EU level to support policies for the adaptation of the transport system to the many challenges and trends described in the Communication on clean, connected and competitive mobility.[1] This document describes the many ongoing activities and the future actions to facilitate this transition, which provide an important contribution to the Commission's comprehensive agenda for mobility presented in the Communication.

1. Investment and finance to support clean and connected mobility

1.1 Investment challenges

Europe still largely relies on infrastructure rolled out over a period that spans two centuries and that is in permanent need of maintenance, repair, upgrading and expansion. New requirements on safety, connectivity and availability of charging infrastructure will further increase investment needs. Around **EUR 740 billion is needed to deliver the Core Network for Transport**, **supporting both digitalisation and decarbonisation.**[2] This is the essential European infrastructure network not only allowing people to travel and goods to be delivered but also using the most environmentally friendly modes of transport.

1.2 EU funding support

EU funds play an important role in supporting mobility (mostly in rail and road), in particular in those Member States and regions where the investments needs are high and the financial resources limited, as well as for cross-border projects where Member States traditionally see less appeal for funding.

For the 2014-2020 period, regional policy is the main source of EU co-financing for transport investments. Around EUR 70 billion have been programmed in the **Cohesion Fund and European Regional Development Fund** to support investments in the field of mobility and transport. Over 200 investment and cooperation programmes, covering all EU Member States, are supporting not only investment projects but also a close cooperation between the relevant actors, across borders and across the different levels of government. Throughout the Union,

[1] COM(2017) 283

[2] Work plans of the European Coordinators for the TEN-T core network: https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors_en

and particularly in the less-developed Member States and regions, Cohesion Fund and/or European Regional Development Fund co-financing is available to support national, regional and local actors in the implementation of projects that will deliver on EU objectives for clean, competitive and connected mobility on the ground, such as the installation of alternative fuel infrastructure or the deployment of digital transport solutions.

The **extension of the Sofia metro line 3**: the project includes a new section of metro line which has a length of 7.8 km, eight metro stations and one depot, as well as the supply of the necessary rolling stock (20 metro trains). This project will considerably increase the quality of public transport services in Sofia, offering an attractive and sustainable alternative to private car use.[3]

In **Krakow**, the Cohesion Fund finances the purchase of 35 modern and energy-efficient low-floor trams. The purchased trams will contain modern passenger information systems as well as ticket vending machines. The investment will improve the quality of public transport services in Krakow and make them more accessible for people with reduced mobility.[4] In **Bratislava,** it supported the purchase of 120 electric trolleybuses, with energy recuperation. The project contributes to the achievement of a modal shift from private cars to public transport, thus improving the urban environment and the quality of life.[5]

Environmentally friendly mobility in Latvia: supported by the ERDF, this project supports the establishment of charging infrastructure for electric vehicles to create a country-wide Latvian network of 150 electric vehicles charging outlets in line with the EU's alternative fuel infrastructure requirements. It will also improve the quality of life in cities and towns where air pollution resulting from traffic congestion is a growing health concern.[6]

The **CROCODILE 2** is an EU project/programme involving public authorities, road administrations and traffic information service providers, whose objective is to ensure coordinated traffic management and control resulting in higher quality traveller information services. Partners from Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Germany, Greece, Hungary, Italy, Poland, Romania, Slovakia and Slovenia are working together to improve cross-border traffic and transport through implementing harmonised and synchronised applications for Intelligent Transport Systems (ITS). The Action will directly contribute to the provision of road safety-related minimum universal traffic information free of charge to users, as well as the provision of information services for safe and secure parking places for trucks and commercial vehicles. In addition, CROCODILE 2 will contribute to the provision of EU-wide real-time traffic information services.[7]

The EU-ITS Platform is an EU-funded project which has been used by EU Member States with great success for decades as a necessary means to alleviate problems caused by the increasing demand for road transport while using existing infrastructures. Ensuring continuity of high quality ITS services across Europe requires harmonisation of existing and future ITS services. By monitoring, evaluating and disseminating results from the ITS Road Corridor projects, the EU ITS Platform can be considered as the technical European ITS "Knowledge Management Centre".[8]

The **Connecting Europe Facility** ("CEF") for transport, with funds of about EUR 24 billion over the period 2014-2020, is financing large and complex projects. So far, under the calls for

[3] Total value of EUR 521 million and co-financing from the ERDF of almost EUR 370 million.

[4] This project has a total volume of EUR 73 million, with EUR 29 million co-financed from the Cohesion Fund.

[5] The total value of the project is EUR 60,928,060 and the CF co-financing EUR 49,199,408.

[6] The total investment is EUR 7,835,300 with an ERDF contribution of EUR 6,660,000.

[7] Start date: January 2015 - End date: December 2018. Budget: Estimated total cost of the action: €41,285,000 - Maximum EU contribution: € 8, 257,000 - Percentage of EU support: 20%.

[8] Implementation schedule: Start date July 2015 - End date: December 2020.

proposals launched in 2014 and 2015, the CEF has co-funded 452 projects for a total amount of EUR 19.4 billion in grants. This represents a total investment of EUR 37.7 billion. These calls for proposals showed the very strong demand for CEF funding, with 1,087 eligible projects requesting EUR 45.1 billion, i.e. 2.5 times the indicative budget.

The **2016 CEF call** for proposals, with a budget of EUR 1.94 billion, was closed in February 2017. The selected proposals are expected to be announced in early July 2017. There has been significant interest, with 349 proposals received representing oversubscription of 3.9 times the budget available.

The **CEF Blending Call** launched in February 2017 seeks to combine EUR 1 billion of CEF grants or CEF financial instruments with financing from public financial institutions, the private sector and/or, for the first time, support under the European Fund for Strategic Investments. This first ever combination of funds will help to achieve the twin objectives of boosting investment to fund innovative, sustainable transport infrastructure upgrades while supporting the jobs needed to put that infrastructure into place. The outcome of this call is still pending; however a significant number of project promoters are signalling their interest and some are already engaging with the European Investment Advisory Hub for support.[9]

Progress is needed in providing widespread deployment of alternative fuel infrastructure throughout the EU. Ensuring sufficient coverage of public charging infrastructure alongside the TEN-T core network is estimated to cost EUR 1.5 billion in the future.[10] By 2020, over one thousand of such fuelling points will have received grant support and by 2025 most of the core network is expected to be equipped. The scarce grant support under the Connecting Europe Facility has been given entirely to environmentally friendly transport modes, mostly rail, and the greening of transport. These are productive investments that should be made as a matter of priority.

To promote larger uptake of cars running on alternative fuels, high quality, easily accessible infrastructure has to be rolled-out quickly. The national policy frameworks submitted by Member States so far (20 Member States) estimated the cost at EUR 850 million to EUR 900 million for funding the publicly accessible recharging points for electric mobility.

The **FastEvNet is an EU** project that combines a study with an integrated pilot implemented in Slovakia and Poland along the North Sea-Baltic, Baltic-Adriatic, Orient/East-Med and Rhine–Danube TEN-T Core Network Corridors. FastEvNet will deploy 10 multi-standard fast charging stations for electric vehicles in Slovakia and 75 in Poland. Three of them include battery storage to cover peak demand. The project benefits from a CEF grant amounting to nearly EUR 3.3 million. Expected in March 2019, the outcomes of the pilot and business models will be studied so as to facilitate future larger deployments of fast-charging infrastructure. FastEvNet is part of a global project which builds on several ongoing European transport network actions in Eastern Europe to contribute to roll-out of alternative fuels.

[9] The European Investment Advisory Hub offers 360 degree advisory and technical assistance. Project promoters, public authorities and private companies can receive technical support to help get their projects off the ground, make them investment-ready or get advice on suitable funding sources. The Hub has already dealt with more than 430 requests.

[10] Clean Power for Transport Infrastructure Deployment – Final report, Steer Davies Gleeve, 2015.

Over 95% of the Connecting Europe Facility transport budget will be allocated in summer 2017 when the 2016 call and the blending call will be evaluated. As regards the cohesion envelope of CEF, the vast majority of the 15 cohesion countries will have allocated the entirety of their national envelopes with the 2016 call, which focusses on sustainable transport development along the TEN-T core network. Still, further thoughts should be given to optimise the full use of the CEF, by increasing the **possibilities for synergies** between the CEF sectors. A first **synergy call** was organised at the end of 2016 between the transport and energy components of the CEF. Limited strictly to projects that are defined as of common interest in the TEN-E and are situated on the TEN-T, it produced a good but limited turnout and only slightly more than half of the EUR 40 million budget could be absorbed in this first synergy call. It is important to further exploit synergies between transport, energy and telecoms within the CEF instrument as the infrastructure for future electromobility or connected mobility calls for infrastructure that combines energy, transport and ICT applications.

The **Cleaner Transport Facility** launched by the European Investment Bank and the Commission on 1st December 2016 supports the deployment of new cleaner technologies in transport. After being in place for only a few months, four clean urban mobility projects have already been approved:

- Hydrogen fuel cell trolley buses and associated infrastructure in Riga (Latvia),
- Six bus lines equipped with hybrid hydrogen buses in Artois-Gohelle (France),
- Compressed natural gas (CNG) buses in Las Palmas (Spain),
- Bus rapid transit system in Palma de Mallorca (Spain).

EFSI - The EUR 195 million **Riga Transport Company project** consists of the purchase of 20 new low-floor tram units to operate in the city of Riga, and the modernisation of tramway infrastructure and depot. It also involves the purchase of 10 hydrogen fuel cell buses and 10 hydrogen trolleys, as well as the construction of a hydrogen fuel production and storage facility.[11]

As part of the European Investment Advisory Hub (EIAH) services, the **European Local Energy Assistance (ELENA) for transport** facility for 2016/2017 can support project promoters with grant funding for technical assistance for the preparation of sustainable investments in innovative transport and mobility solutions. ELENA support has been well received by European cities and a project pipeline is building up.

ELENA's first approved transport project is to be signed in May 2017. The project will fund EUR 3.5 million worth of technical assistance in Amsterdam to plan a total investment of about EUR 168 million in 70 zero-emission buses, new real-time travel information services and an innovative regenerative braking system, which will allow up to 70% of the metro's braking energy to be recuperated.

As of April 2017, the European Investment Bank Board has approved **European Fund for Strategic Investment (EFSI) support** to 36 operations, contributing to transport objectives triggering a total EUR 15.2 billion in related investment. This represents around 14 % of the EFSI overall investment.

[11] The project was approved on 14 October 2016 for EUR 75 million in EFSI financing.

EFSI - KSPG AUTOMOTIVE RDI: the project concerns selected research and development (R&D) investments to innovate combustion engines contributing to reduced emissions of automotive vehicles. It will be of critical importance for European automotive manufacturers in order to address emission regulation objectives.[12]

EFSI - AUTOMOTIVE STEEL RDI: the project comprises investments in research, development and innovation (RDI) for automotive devices. It will mainly be carried out in Germany, Spain, Sweden, UK and France. The project will be implemented in the period 2016-2019. Due to the promoter's close collaboration with customers and suppliers, the project is also expected to contribute to the diffusion of new knowledge.[13]

The **LIFE programme** supports pilot, demonstration, governance and awareness projects and in this way complements the other EU funding programmes. It has over the years included projects related to sustainable transport, such as low emission vehicles, e-mobility, alternative fuel, urban logistics, smart technologies and retrofitting, resulting in best practices for inclusion in Sustainable Urban Mobility Plans and in Air Quality Plans to reduce pollution. Examples include CLEAN AIR and PEHRT projects.

CLEAN AIR is an umbrella project in which nine European environmental NGOs joined forces in 2012 to support the implementation of the Air Quality directive in the cities of the EU Member States and to help improve air quality. The nine project partners put into practice sub-projects in the fields of eco-driving, clean air in ports, low emission zones, cycling including cargo e-bikes for last mile delivery and retrofitting buses in public transport. All these sub-projects combined to help raise the awareness of decision-makers on the problematic nature of poor air quality and suggested practical solutions that will also often benefit the local economy and employment through green jobs.

The **PEHRT** project in Italy tests how ITS can help improve urban logistics, particularly in towns and cities with a historic centre, where the impacts of individual and commercial traffic on air quality and buildings can be severe. The project is testing a system for delivering multi-modal travel information to commuters, visitors and businesses before and during trips.

The 2017 LIFE call for proposals includes a priority on projects enhancing consumers' empowerment to benefit from real-world fuel consumption savings in cars and vans. This initiative, together with the experience gained with the introduction of the new test cycle will provide useful insight to the Commission's ongoing reflection on how to improve consumer information to allow them to make informed purchase decisions for cars with low pollutant emissions.[14]

[In the current EU Emissions Trading System trading period (which runs until 2020), 300 million allowances were endowed to the New Entrants Reserve (NER) 300 programme[15] to fund innovative renewable energy and carbon, capture and storage demonstration projects. While 14 projects have already successfully reached the final investment decision, four projects from the first call are not going ahead. These **non-disbursed NER 300 revenues** will be channelled via relevant financial instruments managed by the European Investment Bank, in particular InnovFin Energy Demo Projects under Horizon 2020 and the Clean Transport Facility's Debt Instrument. Member States in the Climate Change Committee have provided a positive opinion on this proposal, which is planned for adoption in autumn 2017, following a

[12] Total cost (approximate amount) EUR 528 million, proposed EIB finance: EUR 250 million.
[13] Total cost (approximate amount) EUR 330 million, proposed EIB finance: EUR 160 million.
[14] http://ec.europa.eu/environment/life/funding/life2017/index.htm
[15] https://ec.europa.eu/clima/policies/lowcarbon/ner300_en

scrutiny period by the European Parliament and the Council. It can be expected that the funding will be effectively available for projects towards the end of 2017.

Nevertheless, the EU funding is only a fraction of the overall financing provided to European infrastructure[16]. Realising these transport investments would require increased private sector investments.

Financing and funding alone are not the only answers to attract investment and prepare projects: the real technical and financial engineering capacity must be catered for, at the level of European instruments, but also at the level of national administrations: in the Ministries, in regional and local authorities who hold the keys for preparing, launching and following the projects. Regional policy supports this endeavour by providing Technical Assistance and guidance material, on issues like cost-benefit analysis for major transport projects. Furthermore, platforms and networks, like the JASPERS Network, are in place at EU level that will facilitate cooperation, coordination, and exchange of experience across the Union.

2. Preparing people for changes with the necessary skills

The changes in the automotive industry linked to digitalisation, automation or cleaner cars require new expertise and modes of working. By 2025, the expected number of new high-skilled job openings is expected to stand at 213,000 in the EU.[17] Already today, the industry faces tremendous challenges to recruit staff with appropriate skills: clean vehicles require existing workers to acquire new skills in the assembly of electric powertrains (including batteries and fuel cells), computing or sensing equipment and, while the growth in engineering jobs is expected to continue, software skills are a new requirement that companies have to look for.

Automated driving may also require reskilling in the medium to long-term. This will mostly affect lower skilled professions such as truck drivers. In the future truck drivers may for instance have to carry-out additional clerical tasks while navigating platoons consisting of several trucks. Funds under the COSME programme for supporting small and medium enterprises[18] can help prepare the truck drivers' profession for the future of connected and automated driving.

Anticipation of demand for future skills within and across sectors, the coordination of the different public and private actors for effective training and education policies, as well as the standardisation of skills are essential to ensure that this transition towards low-carbon development models is not held back by lack of skills.[19]

In order to deliver sector-specific skills solutions, the **New Skills Agenda for Europe**[20] has launched the Blueprint for Sectoral Cooperation on Skills that is expected to stimulate investment, encourage the strategic use of EU and national funding opportunities and develop

[16] During the period 2014-2015, Member States provided for 84 % of funding for TEN-T, with EU complementing it with 16 %.

[17] EU Skills Panorama (2014) Automotive sector and clean vehicles Analytical Highlight, prepared by ICF GHK and Cedefop for the European Commission.

[18] https://ec.europa.eu/growth/smes/cosme_en

[19] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/strategic-energy-technology-set-plan-roadmap-education-and-training

[20] COM(2016) 381

concrete actions to satisfy short and medium term skills needs in support of the overall sectoral strategy.[21] Automotive is one of the six pilot "Blueprint" sectors for which funding has been made available through the Sector Skills Alliance action within the Erasmus+ programme.

Finally, the Commission launched in October 2016 a three-year research project, **SKILLFUL**, which is looking into the skills needed by 2020, 2030 and 2050 in the different transport modes to identify which jobs/professions will disappear and which will be created and how training curricula should evolve accordingly. Based on the outcome of the SKILLFUL project, it will be possible to assess the adequacy of the training and qualification requirements in place for road transport drivers, in particular in the light of new professions/skills.

The GEAR 2030 high-level group established by the Commission[22] is developing specific recommendations on the skills requirements in the industry.

3. Research and Innovation

Modernising the transport system and making mobility more efficient and more sustainable requires innovative technologies, services concepts and business models. They have to be developed, tested, and successfully introduced to the market. Research and innovation activities are primarily supported through the EU framework programme Horizon 2020 under the "Smart, Green and Integrated Transport" challenge to boost the competitiveness of the European transport industries and achieve a European transport system that is resource-efficient, climate-and-environmentally-friendly, safe and seamless for the benefit of all citizens, the economy and society. The Transport Challenge has been allocated a budget of €6 339 million for the period 2014-2020.

Within the framework of Smart Specialisation Strategies, ERDF co-financing provided for research and innovation in areas such as alternative fuels and powertrains for road transport or intelligent transport systems.

3.1 Short-term 2018-2020 perspectives

3.1.1 Clean transport - Horizon 2020 calls for proposals

Rising carbon dioxide emissions, air pollution and noise, especially in cities, mean that a major shift is necessary, from today's combustion engines (petrol/diesel) to alternative low and zero emission engines for most modes of road transport, if the EU is to achieve its greenhouse gas reduction and air quality targets.

High hopes are pinned on zero emission technologies, particularly in the road sector. However, the fleet renewal is still too slow to solve the pressing air quality issues. The

[21] http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7969

[22] Commission Decision C(2015) 6943 of 19 October 2015. The group will analyse and discuss the key trends which will be affecting the automotive industry in the future and come up with jointly agreed roadmaps that should set objectives, specify milestones and clearly define responsibilities of different stakeholders on value chains, connected and automated vehicles, trade and investments.

scandal surrounding car emissions ("Dieselgate") has caused a crisis in consumer confidence towards information marketed about cars by the industry itself. It is therefore important to address the impact of the existing internal combustion fleet and **provide local authorities and consumers with tools to detect high emitters;** be it due to poor maintenance, insufficient durability or tampering by the users, and to obtain accurate information and data on the basis of which informed choices can be made and infringements can be prosecuted. On-board measurement of pollutants can also provide an improved basis for new approaches to regulation and changing behaviour by, on the one hand, showing how much each driver pollutes while, on the other hand, allowing a real "polluter pays" approach to certification, taxation and traffic regulation.

More than 200 million vehicles with internal combustion engines circulate on European roads today, and will continue to emit high levels of pollutants for around another decade. The Commission has good experience with the organisation of inducement prizes that offer cash rewards to whoever can most effectively meet a defined challenge. The Commission has for instance launched an **inducement prize** focused on the development of retrofit technologies to clean the existing fleet, thus providing cities with a means to reduce emissions relatively fast.

EUNICE (Eco-design and Validation of In-Wheel Concept for Electric Vehicles) developed an innovative electric motor that fits in the wheel, with high performance and low weight. This allows huge flexibility in vehicle design and could be a stepping stone for highly attractive electric and hybrid vehicles in the future [23]

FABRIC (Feasibility analysis and development of on-road charging solutions for future electric vehicles) explores more futuristic options such as "electric roads" on which electric vehicles would run with unlimited range since they would pick up energy from the charging infrastructure under the road surface (a first demonstration took place in April 2017).[24]

Fuel cells and hydrogen as an efficient conversion technology, and hydrogen as a clean energy carrier generated from excess clean electricity, have a great potential to help fight carbon dioxide and local pollutant emissions, to reduce dependence on hydrocarbons and to contribute to economic growth, thereby constituting a triple "win" for Europe. The **Fuel Cells and Hydrogen Joint Undertaking**[25] offers an excellent opportunity for generating progress in fuel cells and hydrogen technologies by aligning private and public sectors' strategies, in a shared effort to cement Europe's competitive edge. Its future 2018-2020 work programme will address refuelling infrastructure, road vehicles, non-road mobile vehicles and machinery equipment as well as inland waterways, maritime, rail and aviation applications. The programme will include hydrogen local ecosystems, demonstration of zero-emission transport applications in clean urban and city areas, long distance applications (vessels, trains, trucks, and aviation); better understanding of market potential (and business cases/feasibility) and regulation issues, before launching well targeted demonstration activities.

[23] (EUNICE - Project duration: September 2012 to August 2015, EC funding: 2.9 M€, Coordinator: Fundacion Tecnalia Research & Innovation, Spain).

[24] (FABRIC - Project duration: 1 January 2014 — 31 December 2017, EC funding: 6.5 M€, Coordinator: Institute of Communication and Computer Systems, Greece).

[25] http://www.fch.europa.eu/

The other public-private partnership, the **European Green Vehicles Initiative**[26] is dedicated to delivering green vehicles and mobility solutions with a focus on improving the energy efficiency of vehicles based on alternative powertrains. The European Green Vehicles Initiative together with its predecessor in FP7, the European Green Cars Initiative, has supported research on electrified vehicles for a total budget of EUR 483 million (representing 128 research projects). Both initiatives have supported EU automotive manufacturers to successfully introduce a new generation of electrified vehicles with optimized power-trains and improved range. Its future calls will devote significantly increased attention to clean technology with the aim of increasing the accessibility and performance of these technologies and facilitating their deployment and public acceptance. The EU has also invested significant funds in research and development of advanced biofuels.[27]

3.1.2 Connected and automated transport - Horizon 2020 calls for proposals

Within Horizon 2020, the Commission is supporting not only technology research and development but also large-scale cross border trials of automated vehicles with dedicated calls on automated road transport and "Internet of Things" for both personal and freight logistics. The emphasis of these demonstration projects is to test the reliability and safety of automation technologies. **SCOUT** and **CARTRE** are both Horizon 2020 projects to support Automated Road Transport, and both started in 2016.

SCOUT (Safe and COnnected aUtomation in road Transport) works on developing use cases and sustainable business models and will develop cross-sectoral roadmaps for the development and accelerated implementation of safe, cooperative, connected and automated driving in Europe.[28]

CARTRE (Coordination of Automated Road Transport Deployment for Europe) will facilitate the exchange of data, experience and knowledge for comparing and deploying results from pilots and foster a common evaluation framework across the demonstrations. This project is establishing a joint stakeholder's forum and will support the international collaboration activities in the area of road automation, especially with the US and Japan.[29]

With the support of CARTRE, the Commission organised a workshop in December 2016 with several EU Member States that are undertaking, or planning, larger scale public road tests with automated vehicles. The presentations and exchanges of learning show that larger scale testing is in an initial phase, which will be accelerated in 2017 and 2018.

L3PILOT is an example of an important demonstration pilot project which will start in summer 2017. It will focus on large-scale piloting of a wide range of automated driving functions for passenger cars (including parking, overtaking and urban intersection driving) which will be tested in 11 European countries on around 100 vehicles involving some 1000 test drivers. A large number of car manufacturers and other stakeholders from the whole value chain will join forces in pilot testing and evaluation of automated driving systems in real traffic conditions with real users.

AUTOPILOT is an Internet of Things Large Scale Pilot that started in January 2017 and aims at the development and validation of sustainable solutions whereby automated driving cars become part of

[26] http://www.egvi.eu/
[27] https://ec.europa.eu/inea/en/horizon-2020/h2020-energy/projects-by-field/biofuels
[28] (SCOUT - Project duration: July 2016 – June 2018, EC funding: EUR 1 million, Coordinator: VDI/VDE Innovation + Technik GmbH, Germany).
[29] (CARTRE - Project duration: October 2016 – September 2018, EC funding: EUR 3 million, Coordinator: ERTICO, Belgium).

the Internet of Things. The eco-system will involve vehicles, road infrastructure and surrounding objects, with a particular attention to safety critical aspects of automated driving. These cars will be tested, in real conditions, at five permanent large scale pilot sites in Finland, France, the Netherlands, Italy and Spain.

Other important large-scale pilots are planned for 2018. They will focus on demonstrating:

- multi-brand truck platooning and fully automated urban transport systems,
- cross-border convergence of cooperative, connected and highly automated driving technologies, also addressing the testing of the performance and safety of these innovative technologies and systems and their integration in the existing mobility system.

These actions will include pilot testing of vehicle fleets, including shared and automated vehicles for seamless door-to-door mobility and freight delivery services. Testing of automation technologies for long distance freight logistics operations going from hub to hub on public roads in mixed traffic conditions will also be addressed.

Demonstration actions will consider the optimised use of digital technologies such as the Internet of Things, Artificial Intelligence and Big Data for automation. Common procedures for testing, validation and certification of highly automated driving functions in various traffic scenarios will also be developed.[30]

3.2 Looking into the future: long-term perspective for mobility

Major innovation can be observed in the European transport sector. It is the largest EU spender on research and innovation, supporting a range of world class businesses. In 2016, out of the top 20 research and development spenders worldwide, five are automotive companies.[31] Recent years have seen dramatic increases in the speed of evolution of societal requirements for *cleaner transport* with less dependence on oil as well as the start of the *cooperative, connected and automated mobility (r) evolution* allowing for new mobility services and logistics solutions. According to a number of forecasts and trends within the industry, in the next 5 to 10 years the sector will be responsible for more innovations than in the past fifty years. To keep up with these developments and provide European citizens with the best possible transport and mobility solutions and at the same time ensure that European enterprises can keep and expand their *competitive edge*, Europe needs a better framework for **joint action on transport research and innovation.** Ambitious goals for our future transport system can only be achieved if new ideas and concepts can be developed, tested and implemented in close interaction with policy and regulatory agendas.

Europe needs to improve the innovation ecosystem ranging from basic technology research to research on new services and business models leading to social innovation (once widely deployed on the market). Public support for the innovation ecosystem should focus on market failures for research and innovation as well as innovation-friendly policies, enabling European standardisation[32] and regulation and financial instruments to boost private sector investment in innovation.

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[30] Through the GEAR2030, in convergence with the development of C-Roads Platform along the TEN-T corridors and funded through Horizon2020.

[31] European Commission, Industrial R&D Investment scoreboard, 2016.

[32] COM(2016) 763 states that the Commission will make increasing use of the annual Union work programme for standardisation in the area of decarbonisation of transport.

Seven main areas for long-term action on research and innovation have been identified and are presented in another Staff Working Document:[33]

1) Connected and automated transport,
2) Electrification,
3) Alternative fuels,
4) Vehicle design and manufacturing,
5) Network and traffic management,
6) Smart mobility and services, and
7) Infrastructure

It is proposed to take an integrated approach which addresses at the same time the digitalisation and decarbonisation of transport via low carbon technologies, the improvement of air quality, the effective use of vehicles, innovative transport infrastructure; new and inclusive mobility services supported by innovative network management and modern infrastructure. The Commission services have cooperated with stakeholders to develop innovation roadmaps outlining research and innovation actions to accelerate the development and deployment of innovative, clean, cooperative, connected and competitive transport technologies and mobility solutions for 2020, 2030 and 2050 in the seven main areas identified. These contain options for future programmatic tools which will be adjusted to the technological progress as the operative dates approach and the overall picture becomes clearer.

The deployment of the strategy will need to span decades and requires a solid governance structure, involving EU institutions, Member States, local administrations and relevant stakeholders, which can oversee **the implementation of the strategy**, ensure its integrated approach, monitor progress, update the agenda when needed and also synchronise the research agendas of public authorities, the private sector and academia. Temporary sub-groups will examine and adapt specific innovation roadmaps which feed into the overall Strategic Transport Research and Innovation Agenda. Close links will be established with the Strategic Energy Technology (SET) Plan, especially on linking electro-mobility, smart grids and joint actions on battery development as well as the production, provision and use of alternative fuels such as hydrogen, biogas and synthetic fuels. A new tool for monitoring progress of transport research and innovation actions and providing better feedback to policy makers is being developed with the Transport Research and Innovation Monitoring and Information System (TRIMIS). Interfaces will be established with the energy sector's corresponding tool (SETIS).

4. Digitalisation

The ambitious Digital Single Market (DSM) strategy[34] presented by the Commission in May 2015 and its recent mid-term review[35] have led to a number of proposals which will facilitate and enable digitalisation across the Single Market, including in the transport sector. Measures taken in the context of the Digital Single Market are enablers for connectivity and new business models across the whole transport sector.

[33] SWD(2017) 223
[34] COM(2015) 192
[35] COM(2017) 228

Data is increasingly seen as 'the new fuel of transport' that drives the development of new innovative transport services. Within the EU, data needs to freely flow across borders. The European data economy initiative[36] aims to make non-personal data move freely within the EU, without undue restrictions, complementing EU data protection legislation that already ensures the free flow of personal data. [37] It also encourages making machine generated data held by private entities accessible to others for new innovative solutions. Combining data generated by the use of vehicles with anonymous information about the location of users, freely available weather data from EU satellites and data from public transport providers would **improve the reliability of intermodal transport solutions and timeliness of door-to-door mobility services**. Real-life experiments are on-going in cooperative, connected and automated mobility, to test whether current business practices on access to and re-use of non-personal data, and rules on liability for damages, are fit for innovative approaches in this sector. At the same time, in case personal data is being processed, the compliance of such processing with the EU legislation on the protection of personal data must be ensured.

The perspective of combining data across sectors, including from vehicles in connected mobility and sensors in logistics, manufacturing or health, through the **Internet of Things**, opens up further possibilities to provide new services that improve the quality of life of citizens and diminish the environmental burden of mobility.

The European **Cloud Initiative**[38] will put in place a high capacity data infrastructure, which will act as the **data highway** across Europe and act as a **basic infrastructure for the European data economy**. A **cloud interface** will be built on top of the data infrastructure, allowing researchers, but also public authorities and businesses, to make use of high capacity data transfers and analytics. The use of private cloud services will enable transport operators to run their infrastructure more efficiently. Standardisation and certification efforts are on-going for increased trust and security[39].

The rapid emergence of **new business models and mobility services** is already profoundly changing the transport sector. Many of those are based on **online platforms**[40] and collaborative economy business models, as digital technologies prove to be a strong driver for technological innovation in the transport sector. For example car-sharing contributes to reducing harmful emissions from fossil transport fuels and congestion. New digital mobility models, such as mobility as a service, will be needed in the future to achieve these goals, without decreasing mobility and quality of life for citizens. Setting the right environment enabling smooth emergence and scaling up of such new business models will be crucial in determining Europe's future as a leading global centre for innovative transport services.

An attack on a connected car would threaten the safety and privacy of passengers and other citizens. One of the challenges **in vehicle cybersecurity** is that the **various electrical components in a car are connected via an internal network**. Therefore, if hackers manage to gain access to a vulnerable component — for instance, a car's Bluetooth — from there they may be able to take control of safety critical components like its brakes or engine. In 2016, the

[36] COM(2017) 9
[37] Directive 95/46/EC and upcoming General Data Protection Regulation (EU) 679/2016 ensure the free flow of personal data within the scope of their application.
[38] COM(2016) 178
[39] COM(2016) 176
[40] COM(2016) 288

EU Member States agreed to work towards a coherent European framework for the deployment of interoperable connected and automated driving, including on developing common trust models and certification policies to prevent risks and support cybersecurity, whilst ensuring safe and interoperable deployment. To reach this goal a number of actions regarding cyber security have been laid down in the Commission's strategy on the deployment of cooperative, connected and automated mobility.[41] The 2016 Directive on Security of Network and Information Systems[42] has put in place the necessary structures for strategic and operational cooperation between Member States to make critical sectors (such as transport) cyber resilient, and requires **operators of essential transport services** to take necessary **preventive measures** and to **report significant cyber incidents** to their national authorities. A EUR 1.8 billion cybersecurity contractual Public-Private Partnership was launched in 2016[43] and it will also work on sectoral demands, such as transport.

The proposed e-Privacy Regulation[44] will provide strong protection for the confidentiality of **communications between connected vehicles and other devices**, if that connection is made **via public networks**. This means it will be forbidden to intercept the communication between a smartphone and the connected vehicle of a user, and thereby to interfere with the functioning of the connected vehicle, or to access private data of the user, without his/her control or consent.

It will be essential to put in place the underlying digital and physical infrastructures with the capacity to deliver large volumes of digital information reliably and in real time across all areas of the EU, if the full capabilities of connected vehicles, automated driving and the Internet of Things are to be realised. A coordinated approach to **spectrum management and the roll-out of 5G technologies** will be crucial elements of this process. The proposed reform of the electronic communications framework[45] and the 5G Action Plan[46] will allow for radical improvements in connectivity, with upgraded cellular-based communications offering wide geographical coverage, reaching large user groups at high speed.

Intensive efforts are ongoing to accelerate the **digitisation of European industry**[47], along the lines set out be the Commission in April 2016. Particularly important for the transport sector are the ICT standardisation priorities, which aim at concentrating standard setting in a set of core technologies - 5G, Internet of Things, Cloud, Cybersecurity and Data Technologies – all of which are essential enablers for connected and automated cars, and other digital applications in the transport domain.

The **Internet of things** will have a great impact on vehicle operations through self-driving vehicle car sharing or smart parking solutions. In cities, it will help design and operate tolling systems. In logistics, it plays a role in asset controlling (location and condition) as well as traffic management. **Big data** can allow the manufacturers of vehicles to enhance the value of vehicles over their life-time through regular updates.

41 COM(2016) 766
42 Directive (EU) 2016/1148
43 COM(2016) 410 and C(2016) 4400
44 COM(2017) 10
45 COM(2016) 590 and 591
46 COM(2016) 587 and 588
47 COM(2016) 180

High Performance Computing is critical for the connected mobility sector to reap the benefits of the data economy, which enables higher value products and services. Substantial investments are needed to develop, acquire and operate high-end machines. Therefore the European Commission and the Member States are working to coordinate their efforts. On 23 March 2017 at the Digital Day in Rome, seven Member States[48] signed a declaration in support of the next generation of computing and data infrastructure.

Digitalisation has the potential to change the way cargo and traffic flows will be organised and managed for **freight transport logistics.** To support the process the Commission has set up the **Digital Transport and Logistics Forum**. This Forum focuses on two aspects, the digitalisation and acceptance of transport documents and the establishment of management systems. Corridor information and management systems aim at facilitating data sharing between all stakeholders along transport and logistics chains in given corridors through data exchange platforms. The work involves all logistics chain actors and there is a need to agree not only on technical solutions and rules for data accessibility, exchange, ownership, quality and protection, but also on financing and governance.

5. Governance, cities and partnerships for effective action

5.1 The trans-European network for better delivery

The **Trans-European Network for transport** (TEN-T) defines the framework for completing the transport infrastructure backbone in Europe. In order to arrive at a coordinated rollout of the network and to avoid a patchwork of national or regional sections, a coordination tool, in place since 2005, has been reinforced and granted the necessary resources. Core-network corridors have been defined (9 in total) integrating the main missing links in the network, as well as the bottlenecks that have a network-wide effect. **European Coordinators** have been appointed to closely monitor the progress made by European, national and other stakeholders investing in the deployment of this network. The European Coordinators have been fully exploiting the new instruments by setting up Corridor Forum meetings, bringing together all stakeholders along their Corridors and ensuring proper coordination and deployment of funding and financing. Work plans have been agreed by the Member States, after extensive consultation with all stakeholders.

Such innovative governance has facilitated consensus-building and securing commitments with the aim of delivering the core TEN-T network by 2030 and the full network by 2050. It ensured the development of a list of mature projects, with a strong emphasis on the long-term EU added-value projects, having a network effect beyond borders. Beyond these cross-border sections, the European Coordinators promote a wide range of infrastructure projects that aim to achieve a fully functional and multi-modal TEN-T network by focusing on environmentally friendly transport modes such as inland waterways and rail and on improved connectivity with maritime and air transport.

The timely delivery of TEN-T is largely dependent on regulatory framework and administrative **procedures necessary for authorising infrastructure projects**, as these are key elements enabling swift project implementation, in particular in a cross-border context. Experience on the Core Network Corridors shows that complex regulatory and administrative arrangements can lead to increased costs, delays and thus create uncertainty. Attention should

[48] France, Germany, Italy, Luxembourg, the Netherlands, Portugal and Spain.

therefore be paid to streamlining regulatory and authorisation procedures, notably by facilitating public procurement for cross-border projects, encouraging joint environmental impact assessments and building on existing best practices (i.e. one-stop-shop approach applicable to the projects of common interest in the energy sector). Such measures can help make public investment more efficient, while at the same time increase the legal certainty thus attracting private investors.

Furthermore, as required by the ex-ante conditions for receiving financial support from the Cohesion Fund and European Regional Development Fund for sustainable transport investments, comprehensive national and regional transport plans were developed in 20 Member States. These plans set out in detail how the development of the TEN-T will be taken forward in those Member States and regions concerned. They also provide a basis for a balanced and complementary development of non-TEN-T infrastructure at national, regional, and local levels. These plans reinforce planning security for both public and private investors.

5.2 Cities and the Urban Agenda for the EU

Given that **cities and urban communities** are the place where a major part of the transformation will actually take place, the EU has been paying particular attention to them.
The **Urban Agenda for the EU**[49]**,** launched in 2016, addresses problems facing cities by setting up partnerships between the EU, national governments, local authorities and stakeholders such as non-governmental organisations. Together they develop action plans to adopt better laws, to improve funding programmes and to share knowledge (data, studies, good practices). In the framework of the Urban Agenda for the EU an **Urban mobility partnership was launched in January 2017**. The objective of this partnership is to contribute to develop a sustainable and efficient urban mobility. The focus will be on public transport, soft mobility and accessibility (for disabled, elderly, young children, etc.), and efficient transport with good local and regional connectivity. The objective is to have a Draft Action Plan by the end of the year, consultations in 2018, and to implement the Action Plan in 2018 and 2019.

The Commission has also recently launched a **One-stop shop for cities**.[50] This web portal is a single entry point for cities and stakeholders with complete reliable and customised information on urban matters in the EU such as: legislation (existing and upcoming), funding instruments, networks, projects, studies and data. Lending by EIB, municipal banks and commercial banks to cities is happening. However, individual municipal projects tend to be too small and are often too risky for the market. Municipal companies, private providers of municipal services or social enterprises often do not have access to adequate financing, cities face difficulties in attracting private investors, financial support for a multi-sector integrated urban development programmes is difficult to access. Commission is currently working with the European Investment Bank on a **One-stop-shop for city investments** that will be an integral part of the One-stop shop for cities. The aim of the One-stop-shop for city investments will be to raise awareness of the existing instruments, programmes and services as well as to **provide tailor-made technical and financial advice** and to explore innovative financing for city investments. A demand driven approach will be followed in its initial phase. Among the first to test the new approach are Rotterdam and The Hague.

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[49] https://ec.europa.eu/futurium/en/node/1829
[50] https://ec.europa.eu/info/eu-regional-and-urban-development/cities

An increasing number of cities and regions are considering to no longer buy conventionally-fuelled diesel buses in the near term (London, Paris/Ile de France, Copenhagen, Hamburg, all Dutch provinces among them).[51] The cost of e-buses has fallen quite strongly, some 25-30% since 2010 – from over EUR 1 million to around EUR 750,000 today. As part of the ZEeUS project, the International Association of Public Transport (UITP)[52] ran a survey with 9 major original equipment manufacturers (OEMs) on future market development, forecasting for battery-electric registrations a growth in 2025 of 30 % and up to 50 % by 2030.

The essential issue is the way in which public transport is organised and financed in many Member States. The problem is that many operators distinguish their operational expenditure budgets (OPEX) from the capital expenditure budgets (CAPEX), leading to fear about limited ability to purchase the same amount of vehicles when going electric and having hence to reduce services.

Through contacts with cities within the Sustainable Transport Forum, the Commission facilitates a Clean Bus Deployment initiative aiming at increasing the share of alternatively fuelled buses to 30 % of new registrations in 2025 (and up to 2.000 newly registered vehicles per year in 2019).

The **European Institute of Innovation and Technology** (EIT)[53] sets up the Knowledge and Innovation Communities[54] as partnerships between business, research institutes and academia to develop innovative products and services, to allow new companies to be started and new generation of entrepreneurs to be trained. In a recent event on urban mobility (29 March 2017) that mainly focused on the bottom-up and long-term approach to stimulate innovation in urban mobility, the idea of a new Knowledge and Innovation Community (KIC) in urban mobility was explored and the new KIC can be created in 2018 through a decision of the EIT.

6. External dimension

External and development policies are essential tools to support clean mobility and resource efficient infrastructures globally.

The Commission has identified support for design, construction and operation of urban infrastructures as one of the main areas for cooperation for the **new European consensus on Development.**[55] The EU and its Member States will support the development of sustainable, interconnected and secure transport networks and other resilient infrastructure to promote growth, trade and investments.

The EU and its Member States will seek to boost the potential of cities as hubs for sustainable, inclusive growth and innovation, taking account of their wider rural communities. In line with the **UN's New Urban Agenda**, they will promote the delivery of basic services, sustainable land planning, equitable management of land markets and sustainable urban mobility. They will promote inclusive and balanced territorial and urban policies.

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51 Feedback gathered by the Commission services on public procurement of clean vehicles.
52 http://www.uitp.org
53 https://eit.europa.eu
54 https://eit.europa.eu/eit-community
55 COM(2016) 740

The Commission has proposed **a European External Investment Plan**[56] to provide an integrated financial package to finance investments outside the EU. The Plan would include a European Fund for Sustainable Development, technical assistance to develop sustainable projects and attract investors, and a set of development technical assistance programmes to improve the investment and policy environments in the countries concerned, in particular scale up private and public investments in low-carbon mobility.

Because EU manufacturers compete on a global scale, the European Union is a Contracting Party to the 1958[57] and 1998[58] Agreements on vehicle regulations developed under the umbrella of the United Nations. These agreements establish harmonised requirements at global level to ensure high levels of safety, environmental protection and energy efficiency. They also facilitate international trade by eliminating the existing technical barriers and preventing the creation of new ones.

7. Batteries

Electric vehicles depend on the availability of high performance battery cells that store a large quantity of energy and can be charged many times, at high speed if necessary. Competitive battery packs (consisting of battery cells and electronics) are currently the most valuable part of new electric powertrains.

7.1 Europe faces challenges in batteries cells developments

The EU has been active at various stages of the battery cell value chain. Made available research funds for the development of more performant battery cells and batteries from battery materials (improved lithium chemistries and new battery chemistries, development of new lightweight and non-critical materials), to cell manufacturing technologies and machinery, cell battery assembly, battery systems integration and end of use and recycling. The EU has also developed legislation and framework conditions that are key for the deployment of batteries in different applications (e-mobility and energy storage).

However, **a large-scale market deployment of battery cell technology in Europe seems to be limited at present.** Despite a strong base for basic research (especially of technologies planned for commercialisation in the long term), the existence of EU suppliers of battery materials and other components, a good expertise in the production of equipment used for manufacturing battery cells, in battery packs assembly and in battery management systems e.g. (power electronics, software), Europe has not been able to establish on its territory a complete Li-ion battery value chain except for a few niche markets. Battery cell production (Li-ion technology) is dominated by Asian companies and there is a clear **lack of large-scale manufacturing of battery cells in Europe.** Many of EU-funded research projects resulted in the demonstration of new technologies at the laboratory scale. However, significant further research and development might be required to address the many issues and challenges that emerged and progress these technologies, in particular the post-Li-ion ones, towards scaled up demonstration under representative conditions. In addition, significant market penetration of electric vehicles and significant uptake of battery cells in other non-mobile applications is needed to overcome the resistance of market actors to commit to the large amount of

[56] COM(2016) 581
[57] OJ L 346, 17.12.1997, p. 78.
[58] OJ L 35, 10.2.2000, p.12.

resources needed to invest in mass production of battery cells in Europe i.e. invest in a sector currently monopolised by Asian manufacturers.

The inexistence of a complete mass production battery value chain in Europe has not been considered to be a major problem until now due to low demand for batteries in non-mobile applications resulting for instance from a lack of personal electronic industry and low up-take of e-mobility. However, it is becoming apparent now that with the progressing decarbonisation of the transport sector and the growing share of renewables in the energy supply, the demand for batteries will rise faster than anticipated.

Recent announcements by a number of industrial players show that **Europe is an attractive market with a healthy automotive industry and growing potential for the use of batteries for energy storage**. Furthermore, non-European companies are increasingly investing in the EU and launch battery cell production in the expectation of a growing market.

LG Chem opened in 2017 a cell and battery pack production facility in Poland (around 1000 people will be employed) with an intention to produce 100.000 batteries per year and Samsung which will launch in 2018 a new 50.000 batteries per year facility in Hungary.

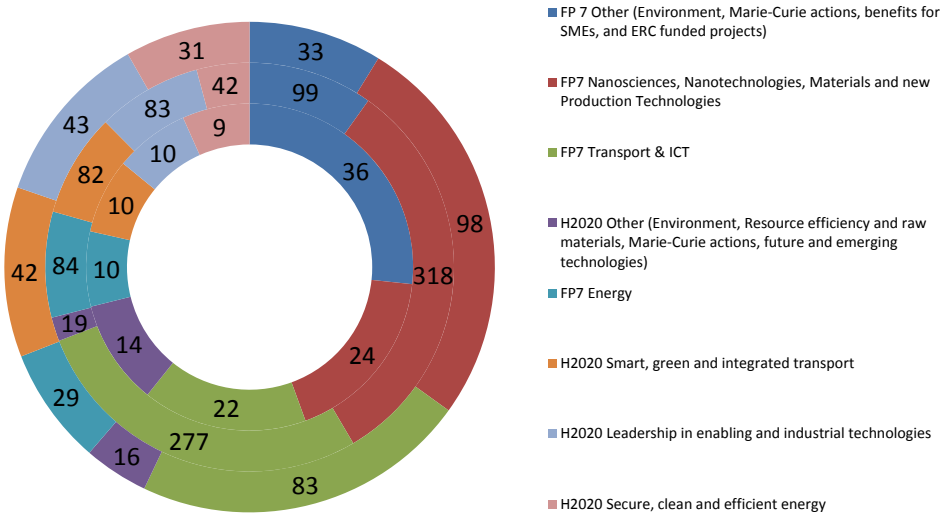
More recently a number of EU players announced their plans to establish gigafactories in Europe. Although the EU manufacturers' plans are not yet fully established, due to the strategic interest of batteries for the EU as a whole (batteries are considered a key enabling technology for e-mobility and energy union objectives), the European Commission and member States are following up very closely and should support any industry efforts to establish a battery value chain in the EU (i.e. EU production of battery cells).

7.2 Better coordination of existing instruments

There are many EU instruments supporting battery development to date. Over the years, Europe has become one of the major regions in terms of **battery cell research and development,** funding a total of about 140 projects via FP7 and Horizon 2020 on different levels of the battery value chain involving around 1000 participants from 36 countries. Under FP7, 25 projects on batteries for electric vehicles were funded representing EUR 95.7 million of EU funding. Under Horizon 2020, 8 projects on batteries for electric vehicles and battery chemistry were financed representing EUR 55.4 million, and more are in the pipeline. In addition, considerable funding is directed under Horizon 2020 to innovation projects related to integration of battery-based storage in electricity system[59]. In the programming period 2018-2020, Horizon 2020 is expected to continue funding research on cells, for instance on further development of current already used Li-ion technology and on improvements of 'post Li-ion' technology or 'beyond Li-ion' technologies and related chemistries. Europe scores very well in basic research on batteries, however, it has been lagging behind so far on the scaling up of manufacturing facilities and valorising (patenting) research results.

[59] EUR 121 million for currently running Horizon 2020 projects and more in the programming period 2018-2020; (even though calls for proposals were not specifically focused on battery-based stationary storage, received proposals mostly related to battery based storage).

Figure 1: Project calls funded under FP7 and H2020 programmes



The Declaration of Intent under the integrated Strategic Energy Technology Plan Key Action 7 "*Become competitive in the global battery sector to drive e-mobility forward*" sets important performance, manufacturing and recycling targets. It provides for a common vision on targets for battery performance, battery costs and battery manufacturing capability shared by the Member States, industrial and research stakeholders as well as the Commission within the SET Plan working group with time horizons of 2020 and 2030 to be reached through EU-level coordinated research and innovation efforts by Member states and EU industry.

The next step will be the development of **implementation plans** for achieving the defined targets. Those plans will suggest joint and/or coordinated actions, identify the ways in which the EU and national research and innovation programmes could most usefully contribute, identify the contributions of the private sector, research organisations, and universities, identify all issues of a technological, socio-economic, environmental, regulatory or other nature that may be of relevance in achieving the targets. Most of the actions will be implemented at national level.

Beyond coordinating R&I, SET-Plan Key Action 7 has the potential **to become the main coordination tool for batteries** in the years to come through serving as a basis for the High-Level Stakeholders' Forum on Batteries to be established. Going ahead with concrete recommendations would require increasing the outreach of the SET-Plan forum to engage with all relevant actors along the batteries value chain, covering research, innovation as well as market deployment of technologies and of manufacturing capacities in the EU.

There is urgency and a strategic interest **to move from research supporting activities to a market deployment dimension of battery cells manufacturing in the EU.** The "Important Projects of Common European Interest" instrument[60] should provide the necessary platform for a joint market deployment financing battery cell and batteries production in the EU.

[60] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0620(01)&from=EN

7.3 Tapping the potential of circular economy

A wide range of elements and raw materials are used in Li-ion battery cells including lithium (Li), nickel (Ni), cobalt (Co), manganese (Mn), aluminium (Al), copper (Cu), silicon (Si), tin (Sn), titanium (Ti) and carbon (C) in a variety of forms, e.g. natural graphite. Among the materials used in Li-ion cells, three are presently listed as critical raw materials – those representing high economic importance while at the same time having a high supply-risk - cobalt, natural graphite and silicon (metal). With a growing demand for the Li-ion batteries, it is expected that the pressure on these raw materials will increase. As Europe largely depends on supply of these raw materials from third countries[61], large scale production might result in an increased vulnerability in terms of security of supply.

The cost of raw materials still constitutes 30 % of the cost of a cell. The private sector will develop their purchasing strategies and alliances. Cutting the raw materials flow by either optimising the raw materials flows through vertical integration or by increasing the level of use of recycled material can become an important competitive advantage.

In the EU, the batteries market is shaped by the **Batteries Directive**[62] that covers all types of batteries and accumulators, establishes objectives for key stages in their life cycle, such as their placing on the market and recycling aspects and defines obligations for operators involved (authorities, manufacturers, sellers, importers). Along with those in the End of Life Vehicles Directive[63] (ELV), their provisions determine an important part of the 'regulatory environment' of batteries in the EU and actually constitute essential drivers for the markets concerned.

This Directive is now being evaluated by the Commission to assess the consistency with and contribution to different EU policies within which this initiative is developed. The scope of this evaluation stretches beyond circular economy aspects; it will also assess the contribution of the Directive to increasing the EU stock of raw materials, namely through the strengthening of collection, re-use and recycling of batteries.

At present, automotive batteries used for starting, lighting and ignition functions in vehicles are based on lead-acid chemistries. The Commission's draft proposal for the 8th amendment of Annex II to the ELV Directive foresees a review in 2021 for the exemption for use of lead in batteries for automotive batteries. It is acknowledged that the replacement of lead batteries is possible based on technological and scientific progress.[64] Changes in the status of lead-acid batteries will trigger important developments in this field.

The increased demand for batteries, the reliance on recycled material for materials sourcing and an open space for innovation are to be taken into consideration in all these reviews, and make any necessary adjustments to legal instruments an essential element to close the loop in the batteries life-cycle.

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61 EU imports of Li-ion battery related raw materials: cobalt – Russia; natural graphite – China, Brazil; silicon metal – Norway, Brazil; lithium – Australia, Chile. Exploration/extraction projects in East Germany, North of Sweden/Norway/Finland, Serbia are envisaged.

62 Directive 2006/66/EC

63 Directive 2000/53/EC

64 http://ec.europa.eu/environment/waste/elv/events_en.htm

In order to showcase an innovation favourable approach in the frame of the Circular Economy, the Commission selected an Innovation Deal on e-mobility. The Deal will help the Commission and the participating innovators to identify and analyse non-technical, legislative barriers which could hinder the re-use of electric vehicles batteries. In addition, re-use of electric vehicles' batteries is already being tested within Horizon2020 projects.[65]

8. Alternative fuels infrastructure

The Commission's proposal on alternative fuels infrastructure set targets for each Member State for electric, natural gas and hydrogen infrastructure to ensure a minimum EU-wide coverage for vehicles.[66] The Council rejected the fixed targets and reduced the scope to public recharging and refuelling stations. Instead, the now-adopted Directive requests Member States to submit their national policy frameworks to outline national targets and objectives, and supporting actions for the development of the market as regards alternative fuels, including the deployment of the necessary infrastructure to be put into place. The Directive requires the Commission to assess the national policy frameworks and to take additional action in case of shortcomings in the submitted national policy frameworks.

The Commission has received 20 national policy frameworks to date (Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Finland, Spain, France, Hungary, Italy, Lithuania, Luxembourg, Netherlands, Poland, Sweden, Slovakia). From the preliminary assessment, it is clear that there are significant gaps in the coverage.

In 2011, **Estonia** launched a national electric car mobility system. This programme promotes electric cars for emission-free personal transport. By November 2013, a total of 165 fast chargers had been installed in Estonia, covering the entire country. New electric vehicle owners could apply for a EUR 1 000 grant to cover the costs of installing a home charging station.

Technical specifications (i.e. power level and number of charging points) of the recharging stations must be considered by the market actors to reflect the pattern of electric vehicle usage. This choice will impact the charging stations business case. Deploying charging points should be based on an economic business case (the short term business case is surely negative until a sufficient mass of electric vehicles is deployed, but this is in turn dependant on a minimal deployed infrastructure that allow long range travel). The deployment of electric recharging infrastructure, as part of Member States' national policy frameworks under Directive 2014/94/EU, will be supported by an innovation-friendly policy framework addressing easy access at reasonable cost to all electricity networks while roaming and harmonised payment issues should be ensured by technical interoperability.

The Alternative Fuels Infrastructure Directive covers only the public domain, which represents 10% of the required charging points at EU level. However, evidence shows that in 90% of the cases, recharging of electric vehicles take place in private parking spaces, which are not publicly accessible. Buildings regulation therefore can effectively promote e-mobility. The Commission's proposal for amending **the Energy Performance of Buildings Directive**[67] tackles this issue by requiring, under certain conditions, the rollout of electric vehicle

[65] See e.g. http://elsa-h2020.eu/
[66] Directive 2014/94/EU
[67] COM(2016) 765

recharging points and of pre-cabling in private buildings. The proposal is currently subject to discussions in the Council and the European Parliament.

The electrification of transport is also a potentially big leap in consumer empowerment as they become actors on energy markets. Using electric vehicles in a smart way to allow for electricity system services can be a source of income for owners of electric vehicles. The Clean energy for all European Package from November 2016[68] includes the necessary elements for **market design reforms**[69] to bring about such changes.

Investments into alternative fuels infrastructure will be further triggered by the Commission's proposal for **the recast of the Renewable Energy Directive**. The latter introduces an obligation on European transport fuel suppliers to provide an increasing share of non-crop-based renewable and low-carbon fuels, including advanced biofuels, renewable transport fuels of non-biological origin (e.g. hydrogen), waste-based fuels and renewable electricity. The level of this obligation is progressively increasing from 1.5% in 2021 to 6.8 % in 2030, including at least 3.6% of advanced biofuels.

9. Cooperative, connected and automated driving

Today, a new generation of vehicles is emerging. New vehicles are connected, increasingly autonomous and cooperate with their immediate environment. Expectations are high on these connected, cooperative and automated vehicles to offer new mobility services for passengers and freight, to improve traffic management, to save fuel and emissions, to improve road safety by compensating for human error, to help integrate all transport modes, and to create new jobs and business opportunities, to mention just a few of the potential benefits. Driverless vehicles could be available as mass-market products by 2030.

Although automated driving will initially rely on car sensor information, without cooperation amongst road users, **vehicle-to-everything (V2X) connectivity** can enhance autonomous driving by providing more sources, thus enabling collective perception and coordinated resolution of complex decisions.[70] It also enables better situation assessment by using information on road and traffic conditions. Time and investments will be needed for high penetration of V2X technology in both vehicles and infrastructure.

9.1 Europe already supports connected, cooperative and automated mobility

The Commission is supporting **technology research and development** and also large-scale cross-border trials of automated vehicles with dedicated calls on automated road transport and Internet of Things in Horizon 2020. The testing of vehicles is already possible in Member States (e.g. based on special permits). Cooperation across Member States for cross-border testing has been established by a Letter of Intent signed on 23 March 2017 in Rome. All Member States (with the exception of the UK) as well as Norway and Switzerland joined the

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68 COM(2016) 860

69 The market design initiative consists of a recast of the Electricity Directive (COM(2016) 864), a recast of the Electricity Regulation (COM(2016) 861), a recast of the ACER Regulation (COM(2016) 863), and a new Regulation on risk-preparedness in the electricity sector (COM(2016) 862).

70 The European Commission considers in its Communication on C-ITS, that communication between vehicles, infrastructure and with other road users is crucial also to increase the safety of automated vehicles and ensure their full integration into the overall transport system.

letter and the focus is now on putting in place the necessary arrangements for cross-border testing by 2017.

This letter joins up with the High Level Roundtable involving telecom and automotive industry, launched in September 2015 to develop joint roadmaps and establish cross-border deployment actions. The Roundtable has already achieved a commitment from both industries to form new alliances and to start real life experimentation with 5G technologies for connected and automated driving. [71]

The Connecting Europe Facility and Horizon 2020 have and continue to provide funding for testing of different features of connectivity and automation with current communication technologies (C-ITS) or 5G (automated driving). The number of involved Member States is on the rise for projects coordinated by the EU. The **C-ROADS initiative**[72] launched in 2016 gathers real-life deployment projects in 11 Member States and is instrumental in realising cross-border and cross-brand interoperability. These projects already produced a list of more than 20 mature services, enhancing road safety and traffic efficiency. 16 Member States are expected to participate by mid-2017 for total investments exceeding EUR 250 million.

Regarding the **deployment of interoperable infrastructure and services** for Cooperative Intelligent Transport Systems (C-ITS), the Commission launched the C-ITS platform in November 2014, to allow road users and traffic managers to share information and use it to coordinate their actions. The first phase resulted in an expert report endorsed and published in January 2016, which laid the groundwork for the EU Strategy on C-ITS[73], which in turn enables pan-European deployment of C-ITS services from 2019 onwards.

On **vehicle legislation and traffic rules for automated vehicles**, the Commission together with Member States and international partners (e.g. Japan) are working in the framework of the UNECE to adapt traffic law for upcoming partially automated systems. The GEAR2030 High Level Group gathering the relevant Commissioners, Member States and stakeholders representing various industries (i.e. automotive, telecoms, IT and insurance) has already delivered the first set of recommendations for vehicles up to 2020. All of them should still require a driver. In these recommendations, the group established that there is no major legal obstacle for marketing and using such vehicles. Manufacturers can already use the current EU framework which provides for the mutual recognition of a national ad-hoc safety assessment for new technologies (Article 20 of Directive 2007/46/EC). However GEAR 2030 considered that the fitting of event data recorders could help to assign liability and vehicle legislation shall ensure that the vehicle will respect traffic rules and will prevent that the driver is confused or misuse the system. These rules will be developed in priority with the framework of the UN, but alternative solutions may have to be considered at the EU level if it is expected that the UN will not deliver on time.

GEAR 2030 also identified no need for legal harmonisation for testing at this stage. However to take the full benefit of testing over Europe, the group recommended encouraging the exchange on main common lessons learnt through a dedicated group. The group already

[71] The European Automotive Telecom Alliance (EATA) (announced e.g. on: http://www.acea.be/press-releases/article/37-leading-companies-join-forces-in-european-automotive-telecom-alliance) and the 5G Automotive Alliance (5GAA) (http://5gaa.org/

[72] https://www.c-roads.eu/platform.html

[73] COM(2016)766

identified common building blocks which could help for the mutual recognition of the approvals/authorisations granted for testing and could help for cross border testing. Some Member states (e.g. The Netherlands, Spain) already apply this mutual recognition principle unilaterally.

9.2 Future efforts: liability issues and convergence between automated and cooperative systems

GEAR 2030 is now considering vehicles expected by 2030 which should include mass market driverless vehicles (driver as a passenger). Technical challenges are still high for driverless vehicles able to drive door to door. Large scale testing on open roads is a key tool to make progress on the technology, foster cooperation amongst the different actors and facilitate public acceptance. GEAR 2030 is looking at possible additional tools that could be used to support future large scale testing.

Public confidence in automated and connected vehicles will, besides providing clear added-value for users, depend upon how **the liability and privacy issues** are clarified. The Commission is looking at the appropriate framework to ensure public confidence in particular the certification approach, cyber security, **the liability and privacy issues.** The appropriateness of the current legal framework for what concerns liability and the differences in liability regimes in the Member States (e.g. road and traffic law, civil law, strict liability regimes, and national implementation of the product liability directive 85/374/EEC) which could impair the deployment of highly automated and connected vehicles are being examined.

Finally, as driverless vehicles may ultimately impact the transport systems, the group is looking at societal issues like impact of automation on public transport, jobs or skills.