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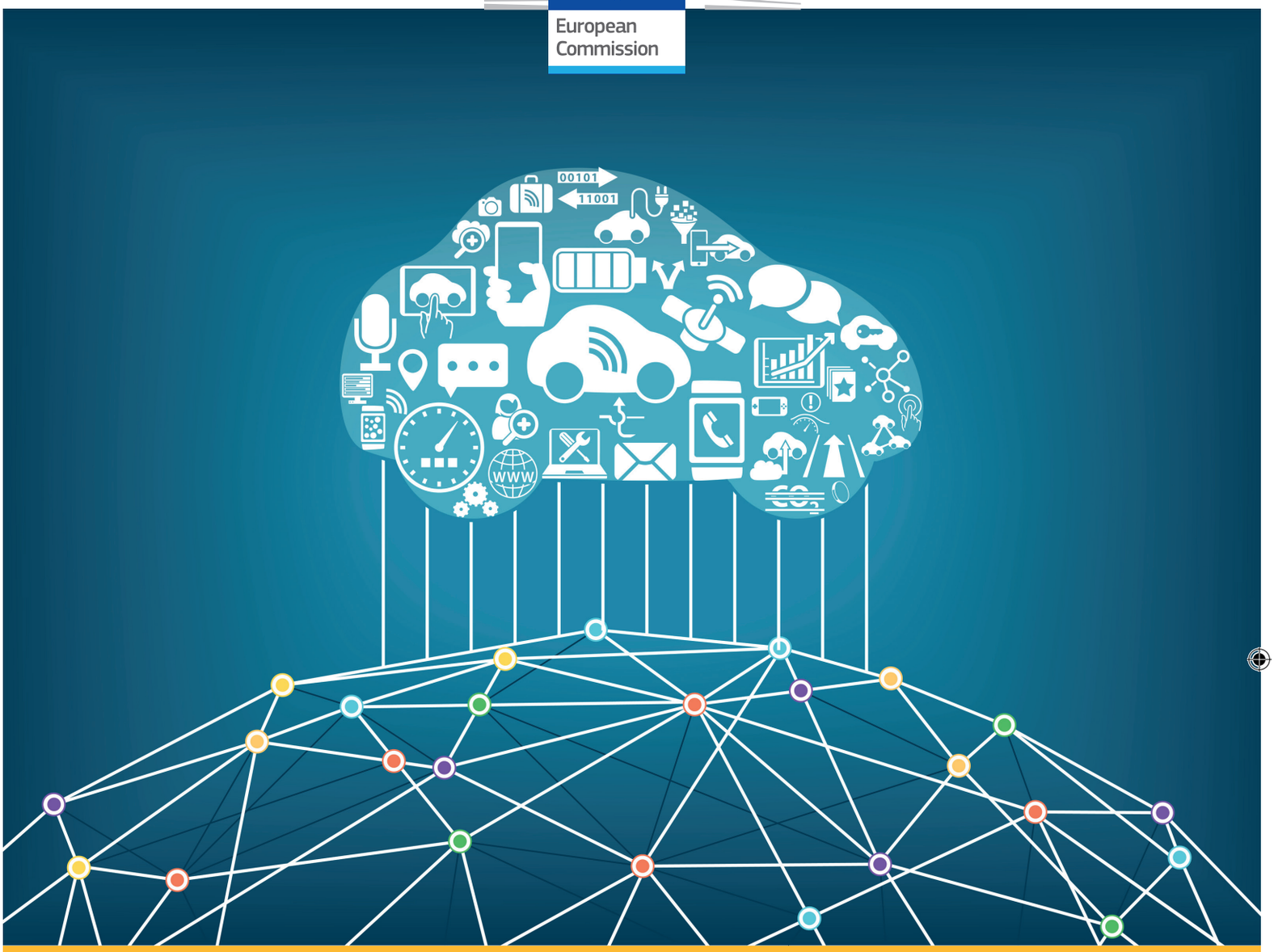

GEAR 2030

High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union

FINAL REPORT - 2017

DG GROW – Internal Market, Industry, Entrepreneurship and SMEs

ENSURING THAT EUROPE HAS THE MOST COMPETITIVE, INNOVATIVE AND SUSTAINABLE AUTOMOTIVE INDUSTRY OF THE 2030s AND BEYOND

The Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (GEAR 2030)

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Executive Summary

The EU's automotive sector enjoys a central place in Europe's industrial landscape. It is the employer of millions of Europeans, often in highly skilled jobs and a major investor in research and development. The sector is one of the most competitive in the world and generates a substantial trade surplus for the EU. It is at a junction of many important EU policies including; competitiveness, research, energy, environment, transport, single market, etc. Today's automotive industry is at a turning point: it must embrace the upcoming digital revolution, automated and connected driving, environmental challenges (such as climate goals), societal changes and growing globalisation.

In order to develop a co-ordinated and effective EU approach for the automotive industry in this changing landscape, the European Commission established the *High Level Group (HLG) GEAR 2030* in October 2015. The group brought together Member States' authorities and key stakeholders representing the industry, services, consumers and environmental protection and road safety. This Report sets out the HLG's analysis of the situation and recommendations to address the main challenges and opportunities for the sector in the run-up to 2030 and beyond. It examines the developments in global competitiveness and changes in the value chain. In this context, given the profound impacts of the transformation on the entire value chain, the HLG decided to focus on connected and automated driving (CAD) and on zero emissions and zero emissions-capable vehicles (ZEVs and ZECs). However, the HLG also recognises that cleaner internal combustion engine (ICE) vehicles will have an important role in the on-going transformation of the sector. They will be especially important in the case of heavy duty vehicles to help their transition to low and zero emission technologies.

Regarding **global competitiveness and access to markets** the HLG recognises that the European automotive sector is globally competitive and it is in a strong position to take advantage of opportunities created by new technologies, changing consumer demand and the growth in overseas markets, especially in China and India. At the same time, growing competition from non-EU manufacturers on the EU market is becoming a major challenge. An ambitious but realistic, cost effective and properly enforced EU regulatory and policy environment can support technological development, competitiveness and play a leading role in worldwide efforts to enhance environmental protection and improve safety of road users. Furthermore, the HLG stresses the importance of global technical harmonisation under the United Nations Economic Commission for Europe (UNECE) framework as a key factor in strengthening global competitiveness, reducing redundant development and testing costs and avoiding duplication of administrative procedures. The HLG also recommends that the Commission pursues bilateral regulatory dialogues to ensure common approaches with important third country markets and, if necessary, make use of trade policy instruments against unfair trade practices and protectionism measures to ensure there is a level playing field with the EU.

The European automotive sector is expected to **undergo structural changes** in its value chain due to the development of digital technologies and the shift towards low and zero emission mobility. The industry, in particular SMEs, will need to assess and, if necessary, redefine their position in the value chain as well as increase their capacity to integrate digital technologies, alternative powertrains and circular economy concepts in their products portfolio and production processes. The Commission and Member States stand ready to support and stimulate this transition.

The HLG highlights that the transformation of the automotive industry will have a significant impact on the industry's **workforce** and also, more widely, in the transport sector. The HLG proposes measures that should be developed at the level of the industry, Member States and EU to support the acquisition of new skills, retain and reskill the workforce in the sector. Such measures could include supporting mobility and transferability of skills, developing a well-functioning apprenticeship market and encouraging non-formal learning certification. Finally, automotive regions affected by the low-carbon transition of the industry should be supported by the deployment of Smart Specialisation Strategies and comprehensive regional development plans.

The HLG recognises the **ever-increasing importance of ZEVs and ZECs** for the sector. The industry and Member States will need to step up measures to tackle urban air pollution and meet long-term objectives in reducing greenhouse emissions by 2030 and beyond and respond to the challenge posed by new market entrants. This must be supported by an appropriate technology neutral regulatory framework, variety of incentives at national and local level, faster development of refuelling and recharging infrastructure and further progress in batteries technology. EU CO_2 fleet emission regulations are recognised as one of the most effective EU-level tools for driving fuel efficiency, creating a level playing field, ensuring market predictability and stimulating innovation. The existing emission targets are being revised for the post-2020 period. It is now crucial to set a framework that uses all options to reduce emissions and supports the market penetration for ZEVs and ZECs vehicles. A key element to the potential success of ZEVs and ZECs is the need for improved performance of batteries. The HLG therefore recommends the setting-up of an industry-led initiative to support measures for research, development and, in particular, manufacturing of the next generation of battery cells and packs in the EU, jointly with the Member States and the Commission.

The HLG stresses that Europe needs a **shared strategy on automated and connected vehicles** as underlined in the Amsterdam Declaration of 14 April 2016. These technologies are already coming to the EU market in line with a global trend and represent challenges and opportunities for the EU competitiveness and for EU policies. EU governance is needed in particular to take the full benefit of large scale testing and research and financing programmes both at the EU and at Member State level. Strategic planning and public private partnerships could help. As these vehicles will take over some tasks of the driver there is a need to develop rules on data recording (black boxes) and associated data access rules. The expected tasks of the driver and performance of the vehicles also need to be regulated in traffic rules and vehicle rules in a coherent manner within the respective responsibilities at EU and national levels. This also calls for a new approach on vehicle approval. The EU framework should encourage the necessary investment in connectivity in vehicles and in the infrastructure. Finally, the long term impact of increasingly automated and connected vehicles, in particular on jobs and ethical issues should be assessed, discussed and included in broader EU policies (e.g. transport, regional development, jobs and skills) to ensure social acceptance.

The Report concludes with a number of recommendations to ensure that there is a co-ordinated and collective implementation effort to help the strategically vital automotive sector meet the challenges, and take advantage of new opportunities, in the coming years. The implementation of these recommendations will require a follow-up by the Commission together with relevant Member States' experts, the industry and other stakeholders.

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1. Introduction

1.1 The importance of the automotive industry for Europe's society and economy

Europe's automotive sector enjoys a central place in Europe's industrial landscape.

The sector has long been key to the creation of jobs across Europe. Around 12 million Europeans work in the automotive sector or in mobility jobs in the EU[1].

The automotive sector is providing jobs and livelihoods across Europe including in otherwise declining industrial regions with small and medium-sized (SME) suppliers often being an essential element of value chain. Its impact is changing as it becomes ever more complex and outsourced. Its success brings valuable investment and revenues to communities. In 2016 alone, fiscal income from motor vehicles in fourteen EU members accounted for €395.7 billion[2].

It positively contributes to the EU's overall balance of payments especially with imports to key markets in Asia increasing. As an essential component of the EU's trade agenda it accounts for extra-EU exports of €135.4 billion in 2016 - a positive trade balance of €89.7 billion[3].

Furthermore it is central to the mobility of citizens and the provision of services. The industry plays a vital role not only in personal mobility but in the services sector such as public transport, emergency services and distribution of goods in the private sector. And this is growing: from 2010 to 2050, it is estimated that passenger transport will grow by about 42% and freight transport by 60%[4].

Today the sector is experiencing a rapid phase of transition which is affecting not only manufacturers but the whole automotive value chain. The main trends that are driving this transition are the development of new technologies in areas such as automated driving, greater digitalisation of manufacturing, the drive by Member States to meet targets to reduce impact of vehicle pollution on the environment and health, and societal challenges such as changes in consumers' preference or aging populations.

The Report places an emphasis on zero emissions vehicles (ZEVs) reflecting the clear policy objective of many Member States and their regions. The shift to zero emission vehicles also represents the crucial competitive issue with expected growing global demand of electric vehicles and profound impacts on the entire value chain. The Report examines how to transform this trend - pushed by policy objectives, climate change and evolving consumers demand - into an opportunity for the whole EU automotive industry.

The Report clearly recognizes the importance of technologies other than electric that are emerging as an alternative to internal combustion engine (ICE). By the same token, the Report underscores the place of better performing ICEs in the on-going transformation of the sector. Low emission ICE technologies will continue to have an important role on the EU market in the run up to 2030 and, in particular, in the case of heavy duty vehicles, are expected to help the transition to zero emission technologies.

The automotive sector and mobility more widely, are essential parts of the European Commission's agenda in a number of areas including the EU's Energy Union[5], the move to a Circular and Low

[1] According to the ACEA Pocket Guide 2017-2018 based on Eurostat figures, around 3,3 million people work in the manufacturing of motor vehicles and components, more than 4,3 million people are employed in the wider 'Automobile Use' (dealers, repairers and aftermarket service providers), and more than 5 million are mobility jobs related through transport and road construction activities. Furthermore, according to European Motorcycles Manufacturers Association (ACEM) Industry Report (2015) the L-category industry is estimated to support about 22600 jobs in manufacturing in the EU. The upstream and downstream L-category sectors account for about 133700 jobs.

[2] ACEA (2017) The Automobile Industry Pocket Guide

[3] ibid

[4] European Commission Communication: Europe on the Move – COM (2017) 283

[5] https://ec.europa.eu/commission/priorities/energy-union-and-climate_en

Carbon Economy[6], the Investment Plan for Europe[7] and the Digital Single Market[8]. Furthermore the sector was specifically addressed in the 2016 Communication ''European Strategy for Low emission mobility'' [9] as well as the 2017 "Europe on the Move" Communication[10]. This Communication established an agenda for a socially fair transition towards clean, competitive and connected mobility for all[11]. It recognised that transport is a major contributor to Europe's greenhouse gas emissions, second only to energy with road transport alone responsible for almost a fifth of EU emissions. The transport sector is therefore an essential focus of the EU's 2030 climate and energy framework targets. Indeed the Commission's 2011 Transport White Paper[12] identified the need to cut overall transport emissions by at least 60% over 1990 levels by 2050.

In September 2017 the European Commission launched a new comprehensive Industrial Policy Strategy[13] designed to help the EU's industries stay, or become, the world leader in innovation, digitalisation and decarbonisation. It confirmed the intention to publish proposals for clean, competitive and connected mobility as part of the second Mobility Package due to be adopted in November 2017, including new CO2 emissions performance standards for cars and vans post 2020, a proposal for the revision of the Clean Vehicles Directive and an Alternative Fuels Infrastructure Action Plan[14] with a view to support the deployment of charging infrastructure, and actions to foster autonomous driving.

1.2 Challenges and opportunities up to 2030 and beyond

The EU industry as a whole is facing a number of challenges and the automotive sector is not immune to this. Europe is experiencing the emergence of a new industrial age where areas such as robotics, artificial intelligence, energy storage, electrification and the bio-economy are key drivers of change. Traditional manufacturing processes are being transformed by automation and industries are increasingly integrated in global value chains. Most importantly of all, the pace of change is accelerating. These challenges also create opportunities for those sectors that adapt in time.

There are five key challenges the automotive sector is facing now and in the mid-term:

i. **New technologies and business models** will require high investment, in particular, to manage the shift to alternative power trains, electrification, connected and automated driving. In addition, significant investment is required to take advantage of the developments in advanced manufacturing (including the greater digitalisation and robotisation of the manufacturing process), handling of, and access to, vehicle data , 3D printing, new communications technologies and the use of new materials;

ii. **Climate goals, environmental and health challenges** including the need to profoundly reduce greenhouse gas emissions from vehicles necessitating a move to alternative power trains, with zero-emission and plug-in hybrid vehicles taking an ever greater share of the market, supported by greater range autonomy, more efficient batteries and improved charging infrastructure;

iii. **Societal changes and changes in the way that consumers access, purchase and use cars** and other modes of transport, spurred by increasing connectivity and the greater use of e-commerce;

[6] https://ec.europa.eu/growth/industry/sustainability/low-carbon-economy_es
[7] https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan_en
[8] https://ec.europa.eu/commission/priorities/digital-single-market_en
[9] COM (2016) 501
[10] COM (2017) 283
[11] COM (2017) 283
[12] COM (2011) 144
[13] https://ec.europa.eu/commission/news/new-industrial-policy-strategy-2017-sep-18_en
[14] http://europa.eu/rapid/press-release_IP-17-3185_en.htm

iv. **Globalisation and the rise of new players**, including technology providers, the need to ensure a level playing field and fair access to markets as well as the necessity of a European industry being competitive and producing the goods corresponding to the demand on the international markets; and

v. **Structural change** due to the move to low and zero emission vehicles and increasingly automated driving with potential significant implications for the labour market in terms of potential restructuring, acquisition of new skills, retraining etc., and the whole value chain.

Those immediate challenges are also long-term opportunities. If Europe is to seize them, and create new and sustainable jobs for its citizens, the livelihoods for its regions and communities and restore consumer confidence in EU's car manufacturers, the EU automotive industry must recognise the importance of making a resolute transition towards more sustainable technologies and new business models, accompanied by an ambitious regulatory and policy framework.

The central issue for the policy makers will be to establish a framework that will foster innovation, enable production of competitive products and secure jobs in the long-term.

1.3 The need for change: the GEAR 2030 process

With this in mind, and with a view to ensuring a co-ordinated approach at the EU level, in 2015, the Commission set up a new High-Level Group (HLG) for the automotive industry. The High Level Group GEAR 2030 was formally established on the basis of the Commission Decision 2015/C 6943/2 of 19 October 2015.

The Commission requested GEAR 2030 to "*help to develop medium and long-term recommendations to address main challenges and opportunities for the European automotive industry in the run-up to 2030 and beyond*."

"*GEAR 2030 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*.''

"*By providing a stakeholder forum for discussion and strategic advice GEAR 2030 should, help building consensus amongst the automotive community and assist the different departments of the Commission in developing policies for the EU automotive sector and its whole value chain. By its level of representation it should also help to build political support for the implementation of such policies.''*

"GEAR 2030 is expected to deliver a final report that will build on the conclusions from the Working Groups defined for three priority areas below. The final report should contain recommendations for the Commission, Member States and industry. The HLG will give a particular attention to the identified priorities, such as adaptation of EU automotive value chain, highly automated and connected vehicles or global competitiveness and under which it may also develop roadmaps for particular issues, for example, regarding alternative fuel vehicles, new business models in automotive sector or highly automated and connected vehicles. These roadmaps may further serve for preparation of the above mentioned recommendations.''

While the scope of the Report covers the main medium and long-term challenges facing the automotive sector, it does focus on passenger cars. To tackle all the topics, including L-category (two and three wheeled vehicles) and heavy duty vehicles, would have been impossible for the GEAR 2030 HLG to address in the timescale. Nevertheless these and other parts of the sector are also very important and the work in these areas will continue in other dedicated fora. The European Commission is, for example, working on proposals to curb carbon dioxide emissions from lorries, buses and coaches[15]. It is also exploring a way forward to support hybridisation of heavy duty vehicles such as 'clean buses' and has initiated a discussion with Member States and industry on the batteries' cells development.

[15] Strategy for low-emission mobility of July 2016 [COM (2016) 501]

The details of the composition and operational structure of GEAR 2030 are set out in Annex 1, but in short, GEAR 2030 had a four-tier structure:

i. The **High Level Group**, composed of Ministers of Economy, Industry or Transport of a large number of Member States, key industry associations, representatives of consumers, trade unions, and environmental protection and road safety organisations, the European Investment Bank, Committee of the Regions, and European Economic and Social Committee acting as observers[16];

ii. a **Sherpa Group** responsible for preparing the input to the High Level Group and for steering the Working Groups;

iii. **three Working Groups** focusing on: the adaptation of the EU automotive value chain; highly automated and connected vehicles; and global competitiveness;

iv. **thematic sub-group Project Teams** to examine specific questions related to the mission of the Working Groups.

A series of Project Teams and Working Group meetings have taken place over the last 20 months with a view to address specific challenges and discuss the priorities for the sector for years to come. In particular Project Teams have been a primary notional generator, as they have brought together various experts from the automotive sector (OEMs, suppliers, dealers and a wide range of automotive aftermarket operators), chemical, financial and insurance industry, social partners, associations, NGOs, Member States, Commission services and other institutions thus successfully marrying the top-down regulatory intervention with a bottom-up experience-based policy making.

1.4 A Step Change

This Report provides a large number of recommendations, to address challenges and seize the opportunities with the objective of ensuring that Europe has the most competitive, innovative and sustainable automotive industry of the 2030s and beyond.

As a result a step change will be required in a number of areas that are intrinsically related to the automotive sector. This will require a collective effort by public authorities, the industry, and social and environmental stakeholders with respect to:

- **regulation, standards and their enforcement as well as incentives** for consumers, the industry and public and private investors;
- **focused investment**: for instance on alternative powertrains and connected and automated vehicles, and investment in battery cell manufacturing and charging/refuelling infrastructure for ZEVs;
- **technology and business models development** for instance around circular economy concepts, business and science cooperation for technology transfer or the use of Mobility as a Service (MaaS);
- in **international co-operation and trade,** focusing on securing access on key global markets, including through promotion of the work of the 1958 UNECE framework, dedicated regulatory dialogues with most relevant trading partners, and a special focus on China;
- **mind-set and culture** development across the automotive sector towards a sustainable industry in which the needs of citizens, society and the environment are prioritised away from some of the bad practices revealed by the emissions scandal[17].

[16] A full list of participants is included in Annex 2.

[17] In September 2015 the "Dieselgate" scandal broke in the US, followed by Europe. Some manufacturers were shown to have artificially reduced emission limits during testing by applying defeat devices. It led to a wide investigation of

The industry, governments and stakeholders recognise that, when this shift is made, Europe will be in the best position to retain its global competitiveness into the 2030s. The shift will enable the automotive industry to play its full role in the economy, including on productivity and competitiveness. This does not imply choosing one form of industry or model over another, but clearly prioritises the approaches that are economically and socially more viable on a long run.

The Report is structured as follows:

Section 2 sets out the most likely scenario for the **development of the automotive sector** in the years to 2030 and beyond.

Section 3 provides recommendations on **how to improve global competitiveness of the automotive sector** including through international co-operation, trade and enforcement. It provides specific recommendations for the key relationship with China.

Section 4 examines **structural change in the value chain**. It contains a number of cross-cutting recommendations, including on facilitating investment and innovation, setting a framework for new mobility concepts and new business models, and addressing the employment impacts of the changes.

Section 5 is dedicated to **zero emission vehicles and zero emission capable vehicles**, including plug-in hybrid vehicles. It looks at scenarios for their likely development and deployment and offers a number of recommendations, including on CO2 emissions regulations, infrastructure, public procurement and other enablers. There is a specific focus on battery production.

Section 6 covers **connected and automated driving (CAD)**, looking both at the policy and regulatory issues involved and at funding and financing support.

Section 7 provides the conclusions and lists all the recommendations.

2. The automobile sector now and by 2030 and beyond

2.1 Economic data and the likely scenario for 2030

According to "GEAR 2030 Strategy 2015-2017 – Comparative analysis of the competitive position of the EU automotive industry and the impact of the introduction of autonomous vehicles", due to be published shortly, total production of passenger cars in the six major geographical markets (EU, US, China, India, South Korea and Japan) grew from 32 million cars in 2000 to 57 million cars in 2015 as illustrated in Figure 2.1. The historical trend in the production of passenger cars shows that the EU was the top producer until 2010 when it was overtaken by China. By 2015, China was producing 21 million cars per year[18], while the EU produced 16 million cars. Apart from the substantial growth in China and a rapid increase in production in India starting from a very low base, the volume of production is quite stable year on year in the developed markets up to 2015.

Production of powered two-wheelers (covering both light and heavier powered two-wheelers) in the referenced countries (Korea excluded) was 28 million in 2005 and increased to 39 million in 2015, as Figure 2.2 illustrates. India became the largest producer of powered two-wheelers in 2015 with 19 million units produced.

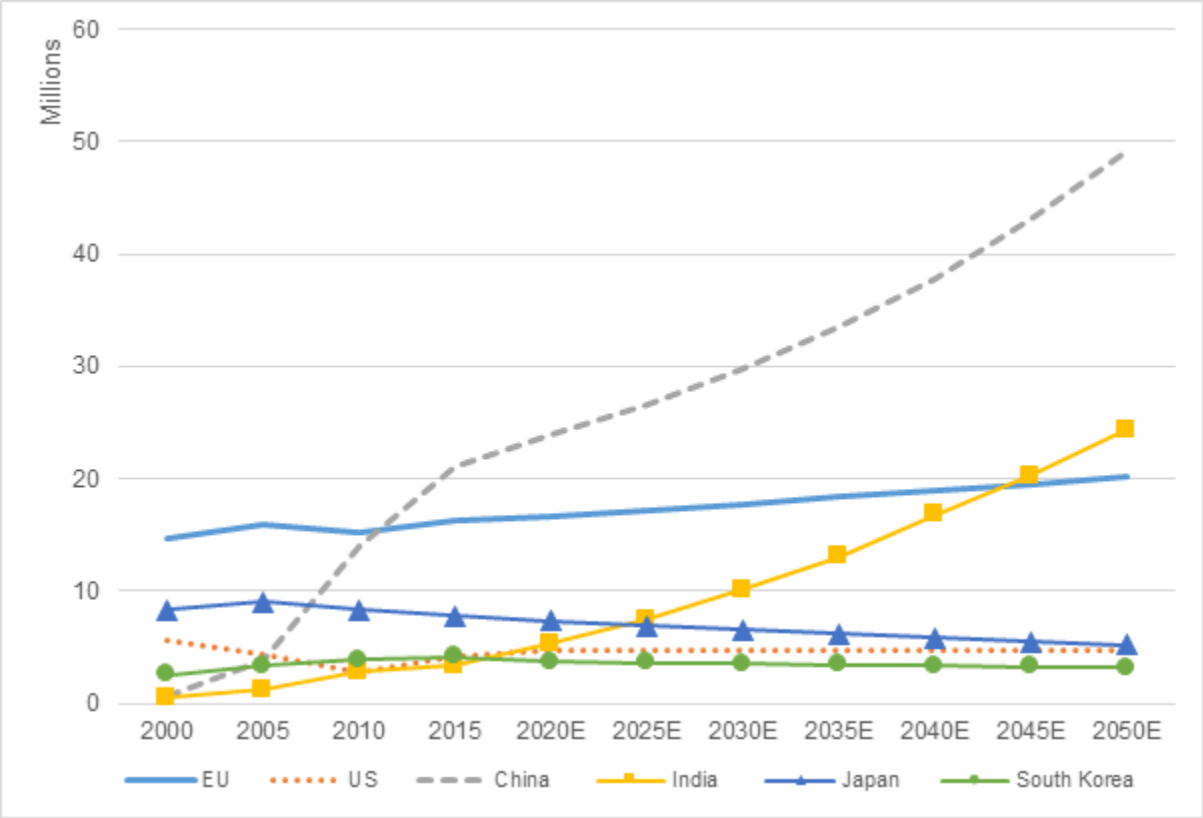
According to the same study, after 2015, total production of passenger cars in the selected six markets is expected to grow significantly, reaching 107 million cars by 2050. This increase is led by large increases in production in China and India, which is likely to be motivated by increases in population and rising purchasing power leading to higher demand for passenger cars. China is expected to be the largest producer (forecast of 49 million cars produced in 2050), followed by India (24 million cars produced in 2050), whose growth will enable the country to catch up with the EU by 2045. The EU is expected to only observe a marginal growth in production, whilst Japan, the

emissions from diesel vehicles on both sides of the Atlantic. The issues raised by this episode are now being addressed by the industry, Member States and the European Commission.

[18] 24% of the vehicles produced were localised brands.

US and Korea observe flat, or declining production figures until 2050. This is likely to be reflecting the saturation of the market.

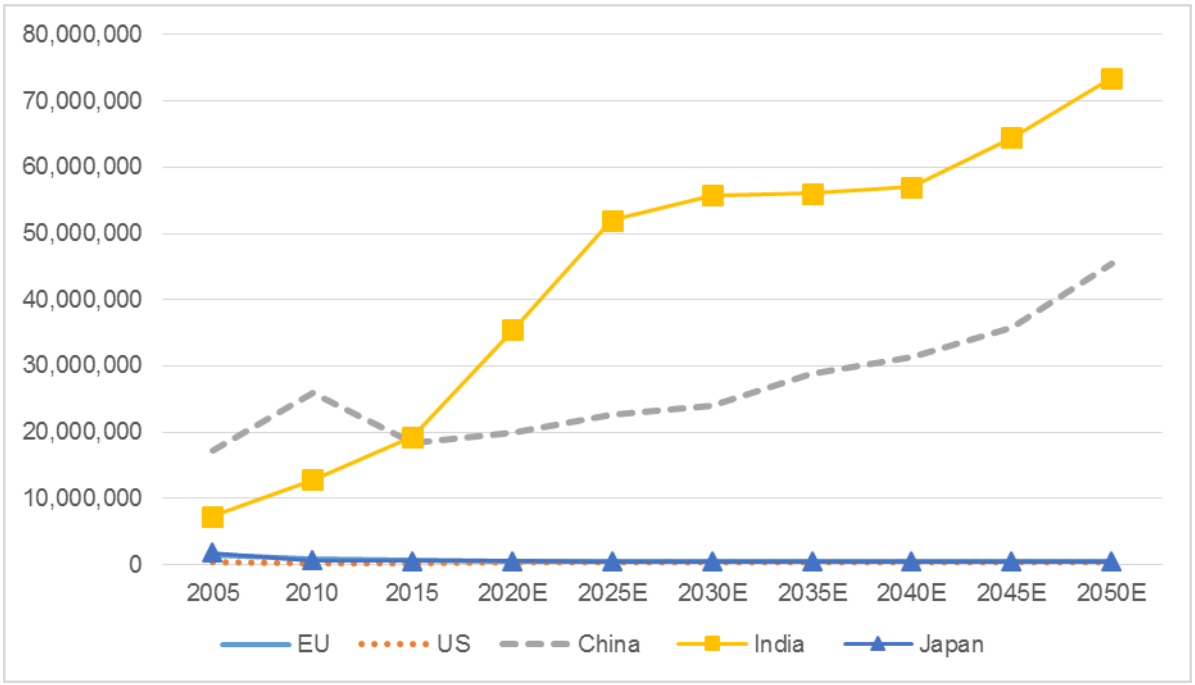
Figure 2.1: Production of Passenger Cars in Key Markets, 2000-2050[19]



Source: GEAR 2030 Strategy 2015-2017 – Comparative analysis of the competitive position of the EU automotive industry and the impact of the introduction of autonomous vehicles

19 Source: GEAR 2030 Strategy 2015-2017 – Comparative analysis of the competitive position of the EU automotive industry and the impact of the introduction of autonomous vehicles

Figure 2.2: Production of Powered Two-Wheelers in Key Markets, 2005-2050



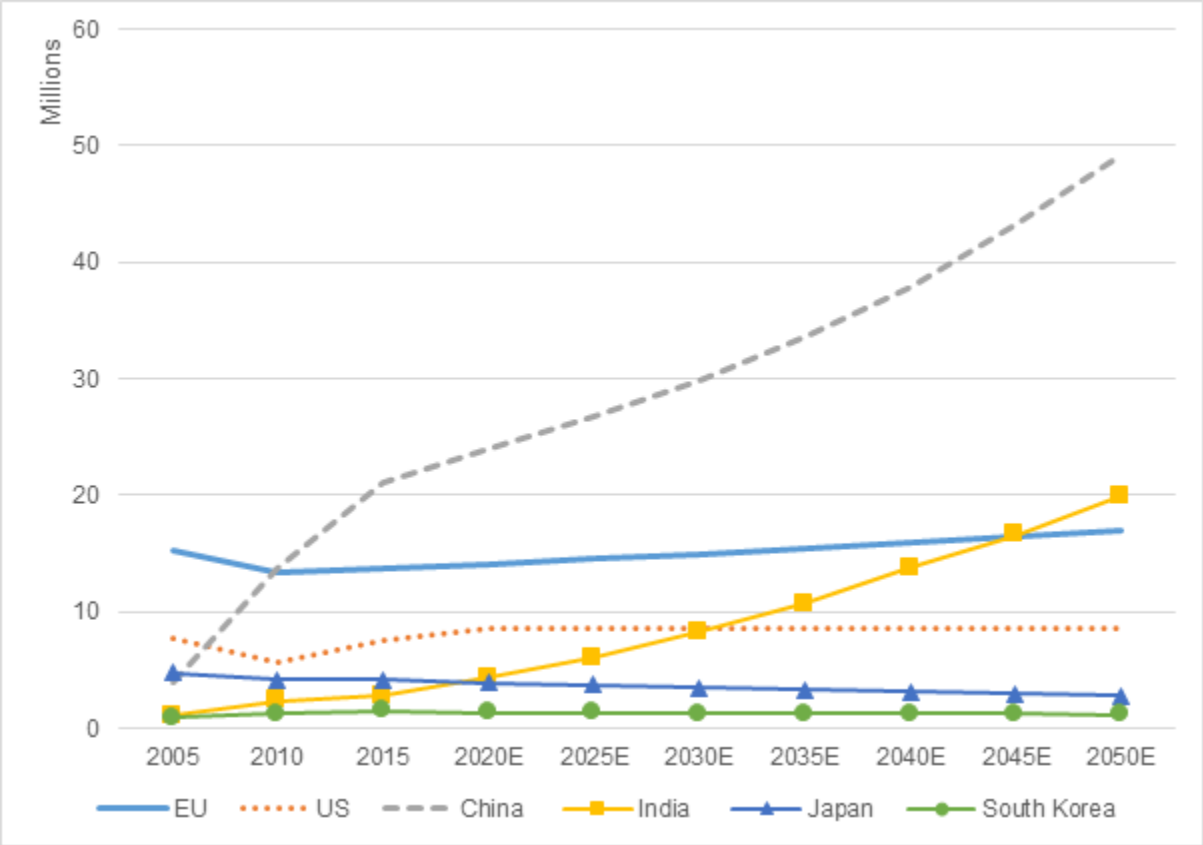
E - Estimate
Source: IMMA data (2005-2015)[20] and internal analysis

Similar to production, sales of passenger cars in the selected six markets increased significantly between 2005 and 2015, growing from 34 to 51 million[21]. It is worth noting that sales of passenger cars are slightly lower than production figures since sales also occur in markets besides the countries included in the analysis, e.g. via export to South America or Africa. Figure 2.3 shows that the EU was the biggest market for passenger cars until 2010 when China overtook it. By 2015, China was leading with 21 million sales, followed by the EU with 14 million sales and the US with 7.6 million sales.

Emerging markets (China and India) are expected to lead growth in sales and should reach a total of 99 million cars globally in 2050. Although growth is expected to slow in China, the country is still expected to be the biggest market in 2050 with 49 million sales. The next largest market is expected to be India with less than half of China's yearly sales in 2050 (24 million cars). Sales are only expected to increase slightly in the EU and are anticipated to decrease marginally in the US, Japan and Korea. The rationale behind these changes is broadly the same as that outlined above for production figures.

[20] China and India's data have been augmented with data on the share of e-bikes that correspond to electric scooters
21 Source: GEAR 2030 Strategy 2015-2017 – Comparative analysis of the competitive position of the EU automotive industry and the impact of the introduction of autonomous vehicles

Figure 2.3: Sales of Passenger Cars in Key Markets, 2000-2050

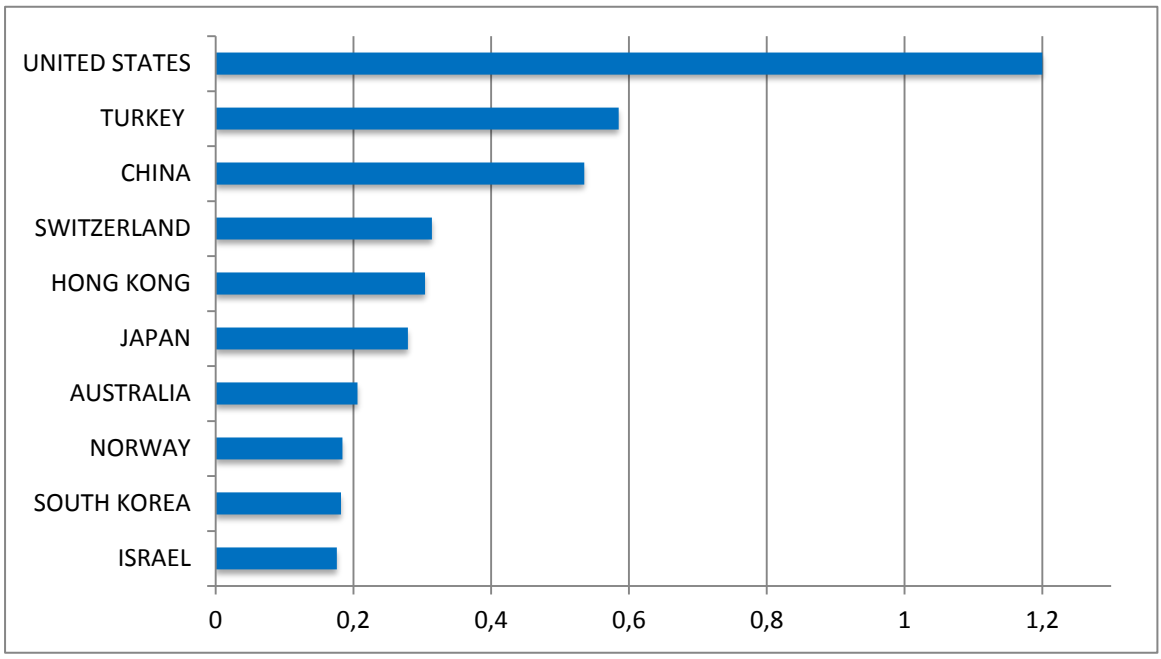


Source: GEAR 2030 Strategy 2015-2017 – Comparative analysis of the competitive position of the EU automotive industry and the impact of the introduction of autonomous vehicles

Currently, most of the cars that are sold in Europe are also produced in Europe and the larger original equipment manufacturers of non-European origin have production plants in Europe. According to the European Automobile Manufacturers' Organisation (ACEA), local production accounts for 80% of sales in the EU, while imports account for only 20% of sales (2016 figures). In many large overseas markets, local production accounts for most of the total sales. In Brazil it accounts for almost 100% of European Original Equipment Manufacturer (OEM) sales. In Japan and Korea, imports play an important role in meeting local demand for European vehicles.

In terms of exports (see Figure 2.4), the US represents the most important destination with 1.2 million units sold in 2016 followed by Turkey. Exports to China, due to a higher rate of localisation and high tariffs, are lower (around 0.5 million units sold).

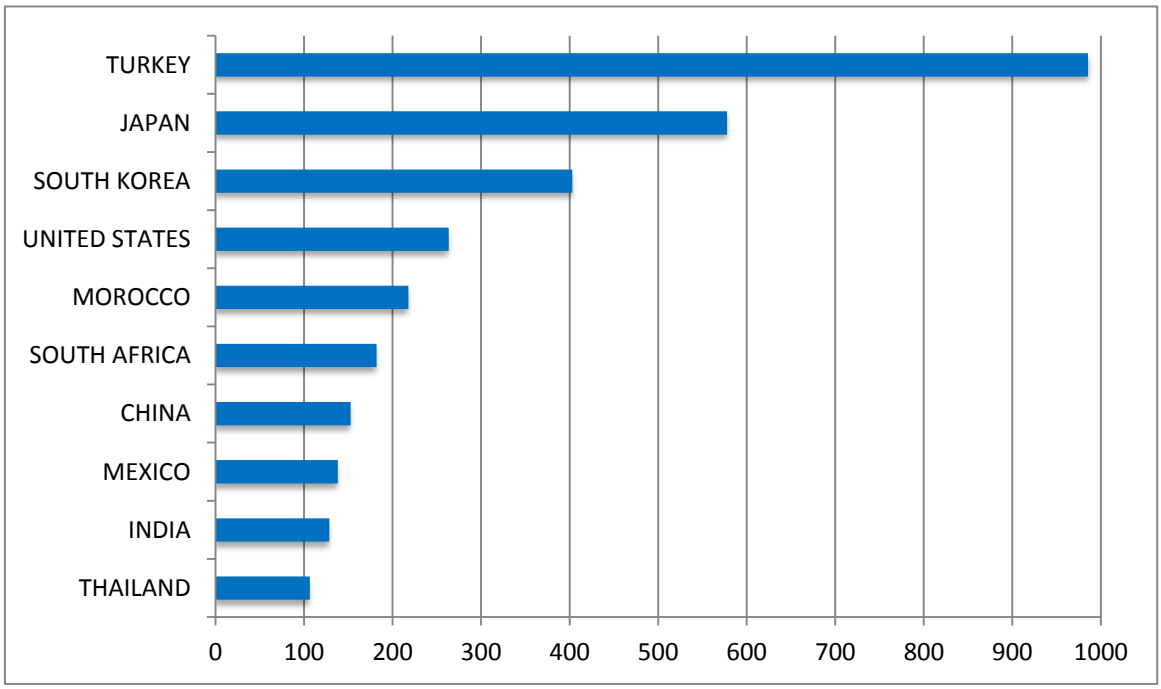
Figure 2.4: Main destinations for EU motor vehicles exports, in million units/2016



Source: Eurostat

Japan and Korea, excluding Turkey, which benefits from the customs union arrangement, represent the main importing markets for the EU (see Figure 2.5), with a combined volume of nearly 1 million units sold.

Figure 2.5: Main countries of origin of EU motor vehicles imports, in thousand units/2016



Source: Eurostat

The European Union enjoys the status of net exporter of cars and light commercial vehicles, and the trade surplus in 2016 was nearly €90 billion.

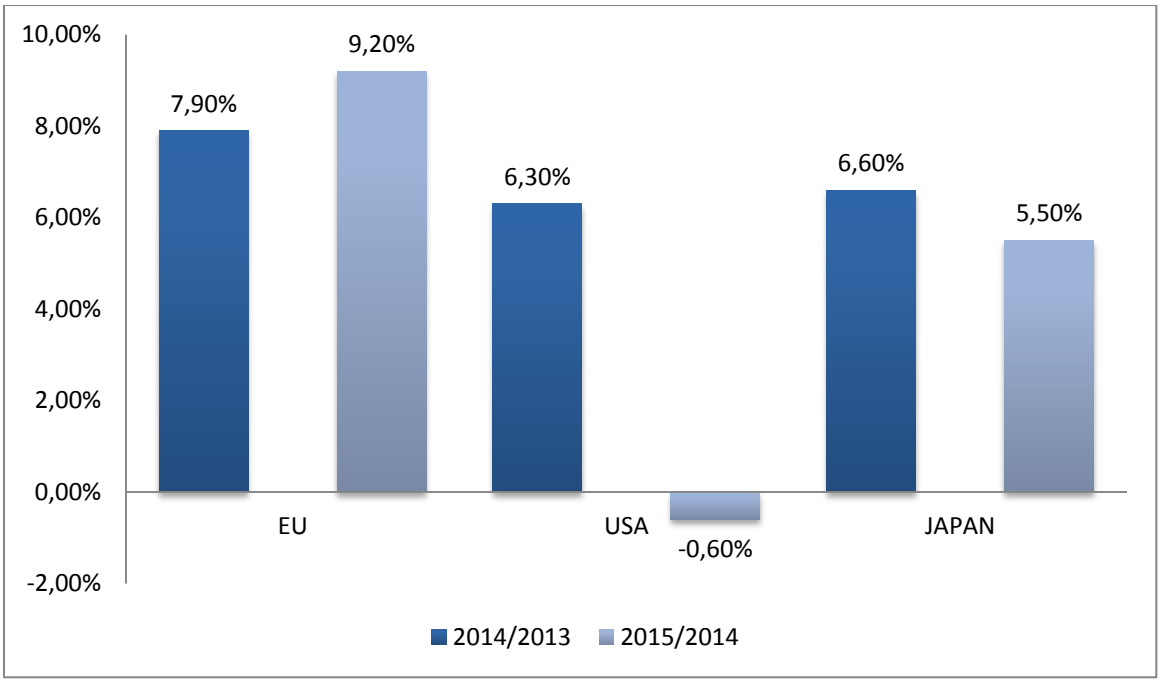
Moreover, the role of R&D investment and innovation remains decisive for EU automotive competitiveness and the EU continues to have a global lead particularly in respect to conventional

technologies. Japanese companies have a lead in hybrid technology whilst China has developed significant capacity in battery electric vehicles,

Four out of the top 5 companies investing most in R&D are the automotive companies, i.e. Volkswagen (No. 1 worldwide), Daimler, Bosch and BMW. In total, with some €50 billion invested in R&D in 2015, which is equal to a combined investment of pharmaceuticals & biotechnology and technology hardware & equipment the automotive sector remains the most innovative contributor to the growth of EU economy.

Sustained EU R&D investment is required and, according to the latest data[22], it is growing at the annual rate of 8-9% (see Figure 2.6), which is mostly due to heavy investment efforts of some large companies, apart from the above mentioned, e.g. Peugeot Continental and Mahle.

Figure 2.6: R&D investment, % change



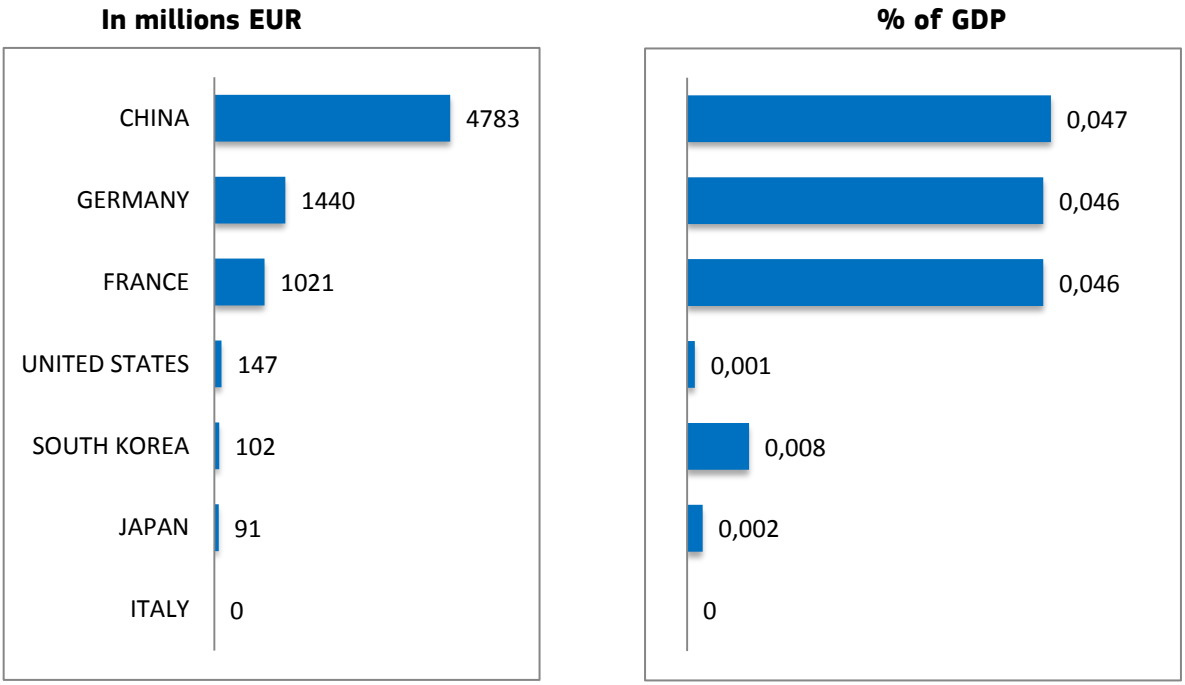
Source: ACEA Pocket Guide 2017

However, companies outside the EU, US, and Japan are lately exhibiting even more impressive R&D annual growth rates of nearly 40%, led by e.g. Tata Motors of India (108.9%), Hyundai of South Korea (26.9%), and Saic Motor of China (16.0%).

What is more, China's R&D investment in electromobility (€4.8 billion), as shown in Figure 2.7 exceeds the sum of investments of Germany (€1.4 billion), France (€1 billion), USA (€0.15 billion), Japan (0.1 billion) and Korea (€0.1 billion) together[23].

[22] Häckel, M.; Steiger, E. (2016): Funding the Future: Do we need a Coherent Funding Strategy for Connected & Automated Driving? FormForum 2016, Data from EU Industrial R&D Investment Scoreboard
[23] Roland Berger e-mobility index, Q2 2017

Figure 2.7: State of R&D funding for e-mobility



Source: Roland Berger e-mobility index, Q2 2017

This is why maintaining, or even increasing, the level of EU investment including by Member States and the industry, in innovation, and particular on electromobility, will be essential to ensure the sector's future global competitiveness.

2.2 Challenges

By 2030, the overall automotive industry landscape will have undergone significant changes which will affect the entire value chain.

The GEAR 2030 High Level Group examined these and looked at different possible scenarios for the future development of the automotive sector with a view to highlighting the main challenges and opportunities due to emerging trends.

The scenario described below represents therefore a likely snapshot of the sector in 2030 on the basis of available studies and the best knowledge of the stakeholders, and builds on five key trends and challenges.

2.2.1 New technologies and new business models requiring high investment

There are two key strands that will transform the whole value chain of the automotive sector:

i. The move to Connected and Automated Driving (CAD), dealt with in detail in Section 6; and

ii. Deployment of alternative power trains, in particular electromobility, and related infrastructure dealt with in detail in Section 5.

These developments will lead to changes in the production and capability of the vehicles. They will require more substantial funding and/or financial support and the public authorities will have a key role to play in facilitating the roll-out of automated driving and electomobility by putting in place relevant legal and financing frameworks and physical infrastructure.

By 2030 there will need to be greater EU funding and financing of the development of **automated driving technologies**. This should be supplemented by incentives such as exemption from registration tax and VAT or reduction of insurance premiums.

Deployment of the necessary **infrastructures** will initially focus on motorways with a clear involvement from public authorities to finance this. Effective CAD deployment will also need more

infrastructure investment in urban areas especially as there is likely to be greater demand for mobility services.

Progressively, in the medium term, it can be expected that 5G infrastructure will be deployed along major terrestrial transport paths. As part of the development of the 5G national roadmaps, the Commission will work with the industry, Member States and stakeholders to set roll-out and quality objectives for the monitoring of the progress of key fibre and cell deployment scenarios. This is to meet the target of, at least all urban areas and all major terrestrial transport paths, having uninterrupted 5G coverage by 2025[24].

Furthermore, there will be additional costs and changes to business models imposed by the technologies required for greater **interoperability** between vehicles and any entity that may affect them (e.g. related infrastructure). There will also be an impact from evolving **legal requirements, consumer demands and acceptance of the new technologies**.

In the area of alternative powertrains and electromobility the main challenge is not only the development of new technologies but the investment in new production processes and the heavy investment required in establishing widespread recharging and refuelling infrastructure.

A key issue for ZEVs more generally is the need for weight reduction to enhance range. The use of **new materials** will enable further weight reduction. There should also be further gains from robotisation of manufacturing processes which will transform the way products are designed and produced.

Greater digitalization of manufacturing, encouraged by the increasing use of new technologies such as Internet of Things, cloud computing, Big Data or **3D printing** may also lead to a 20% reduction in the total costs of production[25] as well as a reduction in defects but will also have an impact on jobs and skills requirements.

2.2.2 Environmental and health challenges

The 2030 climate targets will require a significantly larger proportion of new cars to be low- and zero-emission vehicles as road transport is a key contributor to CO2 emissions. In addition, improving air quality, particularly in cities, is a major goal of both EU and national policies. Recent events in relation to diesel emissions have underlined the need for action to tackle environmental and health challenges for the automotive industry.

Particulate matter, nitrogen dioxide and ground-level ozone, are now generally recognised as the three pollutants that most significantly affect human health. Long-term and peak exposures to these pollutants range in severity of impact, from impairing the respiratory system to premature death. Around 90% of city dwellers in Europe are exposed to pollutants at concentrations higher than those deemed not harmful to health. Particulate matter is singlehandedly responsible for around 400.000 premature deaths in the EU in 2012[26].

In the light of this, and spurred on by both consumer demand and public action, the automotive industry is stepping-up efforts to find viable alternatives that are capable of reducing the negative effect of car pollution in run up to 2030 and beyond.

As a consequence of these factors, and their importance in retaining global competitiveness, this Report focuses on zero-emission vehicles (ZEV) and "zero-emission capable" (ZECs) (often referred to as plug-in hybrid vehicles (PHEVs)) as these are as central to efforts to reduce the adverse environmental effects of cars.

[24] 5Gfor Europe: An Action Plan (SWD (2016) 306)
[25] PWC: 2016 Global Industry 4.0 Survey – Building the digital enterprise
[26] European Environment Agency – Air Quality in Europe Report, 2015

2.2.3 Societal changes, consumer preferences and changing demand

The way that consumers access, purchase and use cars and other modes of transport is changing due to increasing connectivity and the greater use of e-commerce. New technologies and the massive use of the internet will have a huge impact on the use and concept of mobility. There is also likely to be a public expectation that greater automation will lead to even higher standards of road safety.

The increasing connectivity of vehicles is a **game changer for the entire automotive value chain**. Higher connectivity will trigger the emergence of a new demand for connected services such as those related to consumer convenience, insurance, aftersales, fleet management or health.

Higher connectivity of vehicles will also generate large amounts of **new data**. This will need to be taken into account as appropriate policy and legal solutions are found for the problems of vehicle integrity, security, road safety and liability. These will support the emergence of new business models and it is likely that this will include provision for direct, safe and secure access to a wide set of vehicle data for the provision of connected services. At the same time, more and more customers are buying automotive-related products on the Internet.

Technological advances and greater connectivity are also enabling and encouraging new mobility solutions, combining various modes of transport and allowing users to find the most efficient way to reach their final destination. There is already a trend away from 'ownership' to 'use' of vehicles, mainly in urban areas. In the coming years, it is highly probable that all modes of transport will be integrated into a single “Mobility as a Service” (MaaS) offer.

Consumers will tend to increasingly use shared mobility services to travel, especially in urban areas. Furthermore, PwC estimates that, in the medium-term, the transition to “mobility as a service” is set to reach just over 20% of the profit potential in the mobility market by 2030 and that barely 50% of sectoral value-added will be contributed from car production or car sales compared to 85% today[27].

Increased demand for mobility services is likely to have a negative impact on the purchase of new vehicles but only in the long-term. In the short-term, sales are expected to grow as private and shared ownership models compete.

In addition to the constraints imposed by the likely shrinking global demand for ICE motor vehicles and the move to alternative powertrains, connectivity and automation, the industry will also have the competitive challenge of dealing with the emergence of new players in the automotive sector such as Google and the Chinese manufacturer BYD Auto.

Traditional automakers are already shifting their business models and in all likelihood will start providing mobility solutions such as shared mobility services while retaining their core business of manufacturing vehicles.

2.2.4 Globalisation

As highlighted earlier in this chapter, the EU automotive sector is facing growing competition on non-EU markets and from non-EU competitors. While the markets in India and China are expected to grow strongly in the coming years, together with local production, the EU market is anticipated to remain relatively flat. Maintaining global competitiveness of the EU industry will depend on ensuring high levels of investment in the new and emerging technologies, especially in the area of electromobility, supported by global technical harmonisation and regulatory dialogue with the EU's main trading partners and, in particular, China.

[27] PWC: Digital Auto Report – Fast and Furious; 2017

2.2.5 Structural Change

The automotive sector is a major employer in Europe and the impact on the workforce of the structural change implied by the transition to new technologies will be significant. The HLG identified a number of trends including digitalisation, electrification, CAD, the automation of production processes and smart mobility as key drivers of structural change. The demand for new skills and experience will see in parallel a fall in demand for other more traditional skills. For example, the move towards electrification will increase demand for software and digital engineers but is likely to be matched by a reduction in demand for those skilled in the production of traditional powertrains. Meeting this challenge, coupled with a need for a restructuring of the sector balancing out the existing production and distribution inefficiencies will require significant investment, both in the new technologies and production processes themselves. There will also need to be significant investment in the workforce to reskill and retain employees.

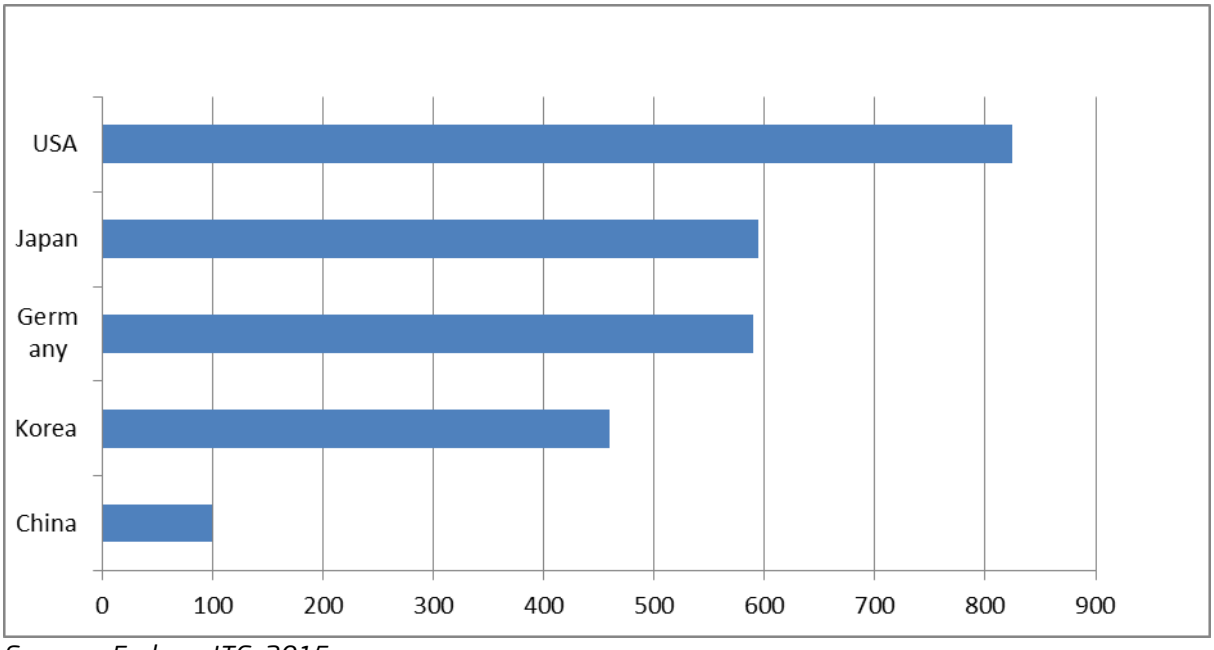
3. The Big Shift: Global Competitiveness and Access to Markets

3.1 The issue

Global automotive markets are expanding faster than ever before and for the EU automotive industry to remain competitive the EU OEMs and their suppliers must continue tapping into the potential of emerging markets which represent the main source of future revenue and profits.

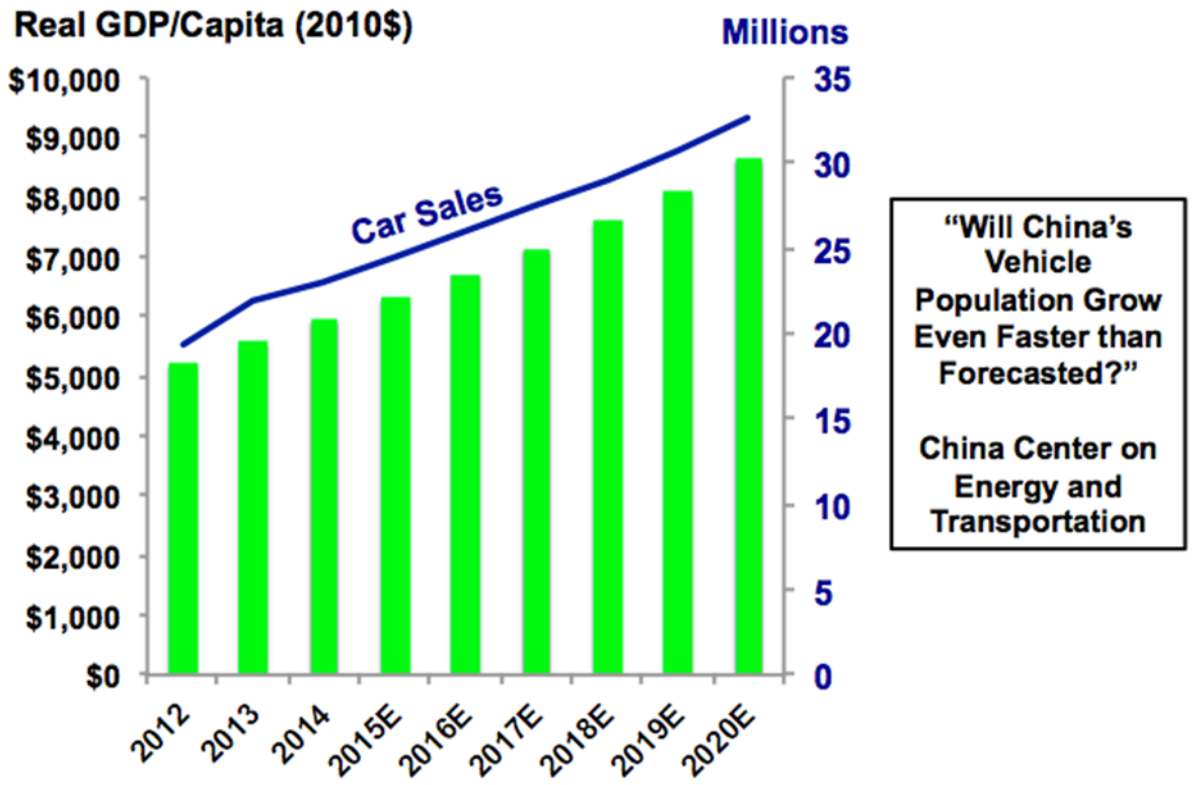
With vehicle penetration in China and India much lower than in the EU, the US and Japan for example, there is a potential for significant growth over the next five to ten years. Even if China reaches only a half of today's vehicle penetration (see Figure 3.1) in Japan and Germany (600 vehicles per 1,000 people) by 2030 it would still represent between three to four-fold increase of market potential. Given its strength in producing premium vehicles, the EU automotive industry could be particularly strong in China as over half of China's urban households will be "upper middle class" by 2020, compared with 14% in 2012, with an income of €15,000 to €32,000 a year (see Figure 3.2). Thanks to higher profit margins and important sales volumes, profits derived from operations in China already today represent an important source of revenue for European OEMs

Figure 3.1: The Potential of China's Vehicle market – International Vehicle Penetration Comparison, number of vehicles per 1000 people



Sources: Forbes, JTC, 2015

Figure 3.2: China's Rising Personal Incomes Mean Rising Vehicle Sales



Sources: Forbes, USDA, JTC, 2015

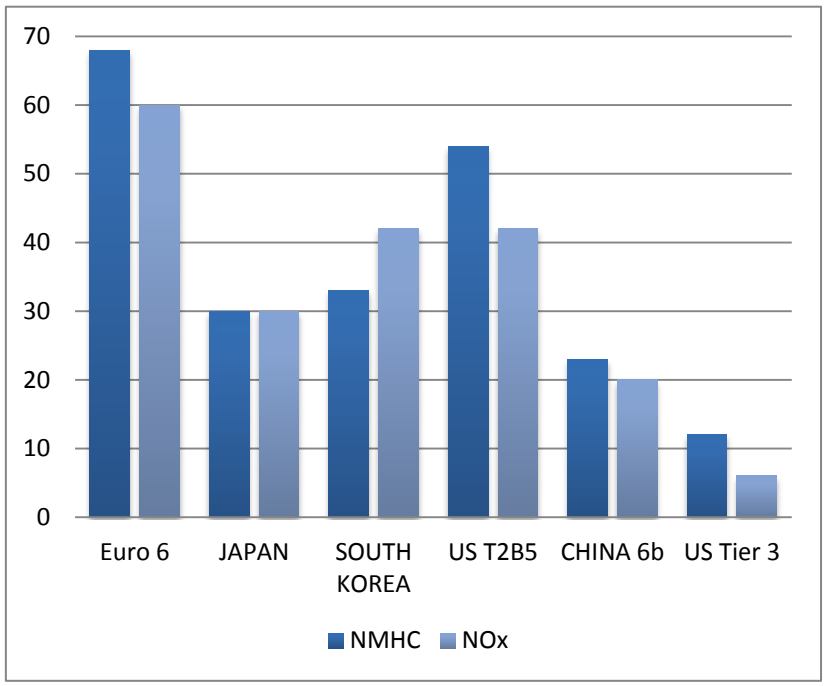
However, the trend over the last few decades of the EU automotive industry successfully gaining market share in both mature and emerging markets outside the EU is under threat despite significant investments and growing efforts to localise EU industry abroad.

With **all major markets with the exception of China and India projected to stall in the future**, and with Russia still struggling to return to its pre-crisis levels, the scope for future growth is shrinking rapidly.

In addition, t**he EU's commercial partners, authorities and competitors are also responding to the challenges and opportunities** set out in Section 2 above. This poses a commercial and regulatory threat to the competitiveness of European automotive industry.

As a result, according to the statistics provided by ACEA, the sales of EU manufactured passenger cars relative to global sales have decreased from 33% since the beginning of the economic crisis (2007) and stand at 24% today. This indicates a need for the EU industry to consider not only increasing exporting volumes but adapting to the changing demands which will require greater focus on innovation to retain competitiveness and to become (again) the leading region for global automotive standards and contribute to establishing global competitiveness. The EU can no longer boast that it is an absolute leader, with the US, Japan, Korea, and China improving quickly (see Figures 3.3. and 3.4). Whilst the CO2 standards set in Europe for 2021 are ambitious compared to real world performance the use of the obsolete NEDC test means real world emissions are significantly higher. Such large gaps do not exist between test and real world performance in other regulations (e.g. in Europe the gap with NEDC is over 40%, whereas in the US it is much smaller). The introduction of the WLTP tests should improve this situation.

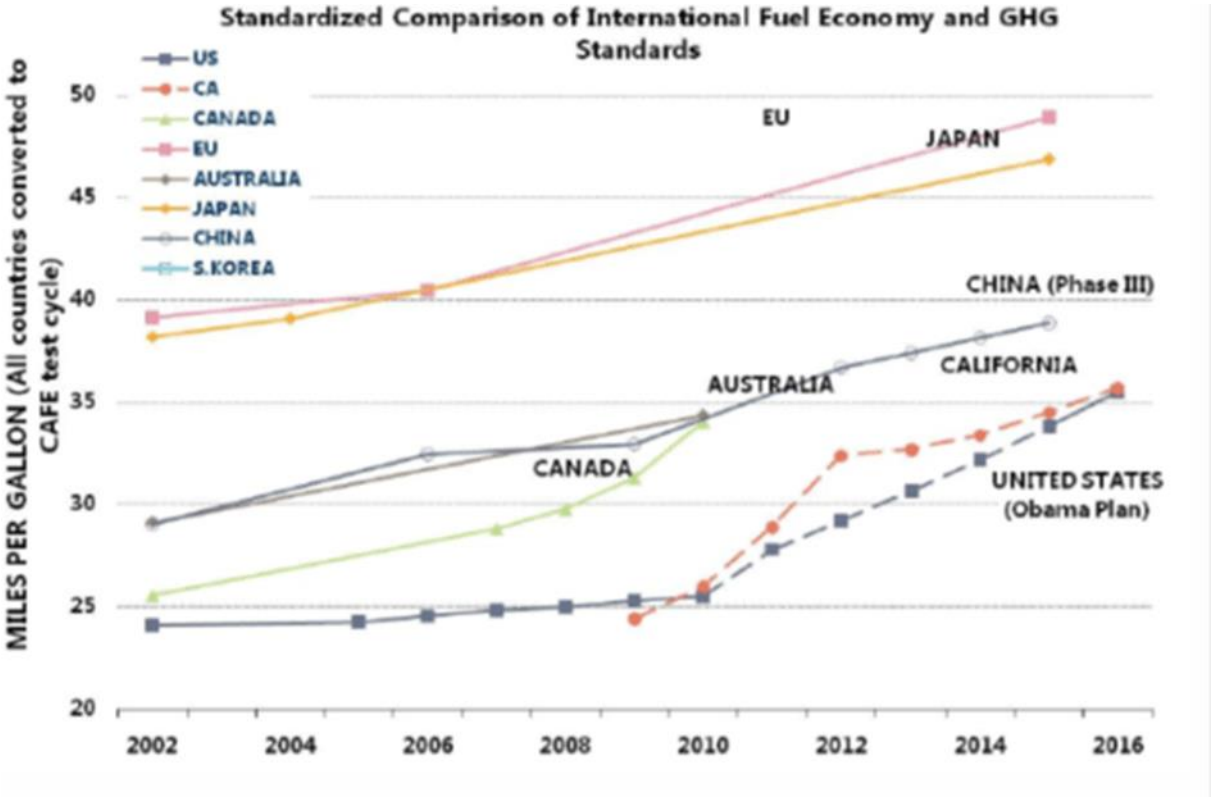
Figure 3.3: Gasoline Pollutant Emission Limits, mg/km (and durability requirements)



Durability Requirements:
– China 5: 160,000 km
– Euro 6: 160,000 km
– Japan: 80,000 km
– Korea: 192,000 km
– China 6b: 200,000 km
– US: 192,000 km
– LEVIII, T3:240,000 km

Source: Cornering 2017

Figure 3.4: International Fuel Economy and GHG Standards Comparison



Source: CRS Report 2014

China and other emerging markets do not only represent a growing direct source of competition to incumbent industries and technologies but are challenging the very concept of the existing

businesses by taking full advantage of the changing automotive landscape. For example, according to a recent report from the International Energy Agency (IEA)[28], China (0.65 million electric vehicles on roads) leapfrogged the US (0.56 million electric vehicles on roads) in 2016 to become the country with the most electric passenger vehicles[29] and these are expected to grow rapidly as a proportion of sales. If European carmakers are to capture market share they will need to rapidly expand the range of models available as at present Chinese manufacturers dominate their home market for electric cars.

In terms of safety, though several regions impose a variety of safety measures that vary in terms of effectiveness and appropriateness, the advantage historically enjoyed by the EU is starting to narrow in some cases. Compared to the EU, new safety features have been mandated more recently in the US regarding the fitting of rear view cameras. Korea is also expected to mandate the installation of safety belt reminders for all seats from September 2019. Other areas of safety where the requirements of other markets result in market access difficulties for the EU industry include rear impact, armrests, auxiliary braking for heavy vehicles and electric vehicles test, whilst in the case of tyres and vehicle fitting, EU through the adoption of UNECE regulations still has the lead and has the strictest regulatory requirements.

3.2 How can Europe respond?

In going forward, the European automotive industry and European policy makers will need to consider the different nature of third country markets, including numerous trade barriers and incentives' frameworks in place discriminating between vehicles produced locally and vehicles imported, and develop strategies and business models that are compatible with them and aim to tackle these barriers. For example, in many large overseas markets, local production accounts for most of the total sales. In Brazil it accounts for almost 100% of European OEM sales. China is also a market with a large share of localised production. In Japan and Korea, imports play an important role in meeting local demand for European vehicles.

In the view of the GEAR 2030 HLG, Europe will need to respond in four broad ways:

i. By using the results of Research, Development and Innovation (RDI) effectively, ensuring that the **regulatory and policy framework** is future oriented and both guidance and rule based, fit for purpose, predictable, and delivers standards that are recognised as the de facto global standards;

ii. By **co-operating internationally**, most notably within the United Nations Economic Commission for Europe (UNECE) ;

iii. By engaging in an ambitious **trade policy and industrial dialogues** that enhance the industry's place in global value chains and making the most from existing trade agreements; and

iv. By paying special attention to the regulatory and trade issues in particular posed by global players, in particular China, in order to ensure a level playing field by addressing i.e. import restriction requirements, local content related obligations, taxation regimes and subsidy schemes.

3.2.1 Ensuring Global Competitiveness

Sound competitive position of the EU companies is a pre-requisite for a strong automotive sector performance, be it in the EU or globally.

The first way that the automotive sector can improve its global competitiveness is the rather obvious one, underpinning this entire Report: **by accelerating transition towards new and more sustainable technologies and new business models.**

[28] See: https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf
[29] For example, the total stock of EVs in Germany, France, the Netherlands, Sweden and the UK is 0.39 million

The focus on high quality performance and clean power trains are key to achieving this. This, supported by an adequate deployment of infrastructure, will give the EU automotive industry a competitive advantage which will allow maintaining, or increasing, the share of highly profitable and technologically advanced vehicles on fast-growing third markets. Repatriating these proceeds, facilitated by the economies of scale, will allow better allocation of production factors, improve the productivity, job creation and consequently GDP growth in the EU.

Importantly, the competitiveness of the car manufacturers may have a significant direct effect on the other parts of the value chain, suppliers in particular, and could affect value in those segments too.

A key issue for the industry, especially SMEs, is to adapt to rapid production cycles and mitigate the need for high capital expenditure. However, developing a significant home market for new technologies in the EU is essential to ensure the value and expertise is retained here.

The specifics of that transition are covered elsewhere in this Report (e.g. in Sections 5 and 6 on decarbonisation and zero-emission vehicles and on connected and automated vehicles respectively).

The competitiveness of the EU automotive industry also depends on the framework conditions and supportive regulatory environment in which the business operates. Such conditions and rules influence the production base in the EU and globally, and the investment flow into new technologies and subsequently jobs.

In order to remain in the vanguard, Europe needs a common approach to emission compliance, surveillance and measurement methods, and more transparency on consumer information standards. This calls for an ambitious but realistic EU regulatory framework, which can help secure an early-mover advantage for domestic firms and facilitates technological development and is cost-effective in the long run, can credibly inspire regulatory developments outside the EU. With a strong focus on innovation and quality rather than price, the EU car manufacturers will not only secure market access abroad but will also reduce external competitive pressure on the EU market This in turn will allow the EU to keep its Single Market as a cornerstone of the competitiveness of the European industry.

Implementation of stricter regulatory requirements will require major periodic investment and may represent an important financial burden on the industry. However, if spread over the long term, stricter regulatory requirements can create an environment that will provide incentives for fresh capital, helping the automotive sector to sustain its level of innovation, gain a leaner structure, and adapt to the challenges of the future, including those ensuing from the EU's 2030 Climate and Energy framework policy targets.

It is important in this process to ensure that regulatory requirements are cost-effective, predictable and consistent with adequate lead times to ensure there are necessary investments into new technologies and mobility solutions.

But it will not be enough to put in place a world class set of regulations in these areas. The EU will have **to implement the existing EU regulatory framework** and ensure the effective implementation of future regulations. This will allow compliance issues, such as those related to emission standards, are quickly identified and tackled appropriately. If the EU aspires to having its regulations as a model for global standards it will need to rebuild its reputation, particularly in terms of robust enforcement and avoidance of regulatory uncertainty through designing robust regulations.

This may also remove the pressure within various urban areas to introduce measures limiting the use of certain powertrain technologies in an effort to reduce the high levels of air pollution.

3.2.2 International harmonization

Global technical harmonisation is a key factor in strengthening the competitiveness of a traditionally highly export-intensive EU automotive industry. Common technical requirements, like those under the UNECE framework, and in particular the introduction of mutual recognition of

international whole vehicle type approval (IWVTA), reduce development costs and avoid duplication of administrative procedures.

Recently revised rules of the UNECE 1958 Agreement[30], together with the improved voting procedures, ensure that new contracting parties are more fairly represented and are expected to further promote the efficiency of international regulatory harmonisation. They will render the adoption and implementation of international regulations more attractive for third countries, whilst at the same time guaranteeing continued reliability and robustness.

The Commission will also continue to work to extend the recognition by trade partners of the 1958 UNECE Agreement as the forum for international standardisation and rule-setting in the area of motor vehicles. Recently concluded FTAs with Vietnam (1 February 2016) and Japan (6 July 2017) are an example on how the policy, based on UNECE 1958 Agreement serving as the forum for international harmonisation of motor vehicle regulation, should be further implemented.

Within the framework of the 1998 UNECE Agreement[31] the most promising areas of work are breakthrough technologies, in particular on electric vehicles and fuel cell vehicles and also automated driving being identified as one of the top priority.

A major challenge is to increase the transposition of Global Technical Regulations (GTRs) by the contracting parties to the 1998 UNECE Agreement. However, there needs to be a deeper reflection on how GTRs are developed in terms of good regulatory practices, transparency and stakeholder involvement.

3.2.3 Trade policy

EU trade policy is an essential and highly effective instrument to facilitate free and fair trade, including exports to third countries.

As per the Commission's 2015 "Trade for All" Communication[32] the Commission will continue placing increased emphasis on **implementation and enforcement of FTAs[33]** already in place (such as that with Korea[34]). To that effect, the Commission has proposed an enhanced partnership with Member States, the European Parliament and stakeholders. All share the responsibility to facilitate the implementation of the FTAs. In addition, it is important to encourage the application of WTO principles in particular through the channels of industrial dialogues and to carefully monitor developments and to have regulatory dialogues in third countries.

Given the importance of the automotive sector, the Commission will also continue promoting the inclusion of **sector-specific annexes** in FTAs under negotiation, wherever useful. These annexes attempt to resolve existing barriers, establish disciplines to avoid new barriers arising and promote harmonisation regulations covering technical requirements, conformity assessment and marking schemes.

In "Trade for All" the Commission pledged to continue its efforts to eliminate non-tariff barriers through **regulatory co-operation**. This is particularly pertinent in cases where FTAs are not an option. The policy continues to rely on bilateral regulatory dialogues with a view to securing

[30] https://www.unece.org/trans/main/wp29/wp29regs.html
[31] https://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29glob.html
[32] http://trade.ec.europa.eu/doclib/docs/2015/october/tradoc_153846.pdf
[33] While FTAs provide improved market access for industry, the extent of the benefits can vary depending inter alia on the compatibility of the existing regulatory frameworks and the state of the domestic industry of the trading partner concerned. In certain cases, regulatory alignment can be relatively limited or tariff reduction staging can be lengthy, which reduces or slows the anticipated benefits. In terms of incompatibility of regulatory regimes, the US is the biggest challenge. Reducing or overcoming over time this divide could potentially provide a significant economic benefit for both partners.
[34] The EU-Korea FTA has so far been beneficial for the car industry in terms of increased exports. Though progress can be noted in terms of reducing the existing import barriers over the last five years, various technical and regulatory barriers continue to hamper effective market access.

common approaches or the equivalence of the existing and future automotive regulations and standards between the EU and the most important third country markets.

3.2.4 China

On the one hand, given its sheer scale and the evolving technological and regulatory dynamics, the EU and its automotive industry should monitor closely the Chinese automotive market developments. These should be fully accounted for in particular when devising and implementing EU's future internal market policy and standards. For example, communication technologies in the Chinese automotive sector relevant to CAD should be monitored considering their potential implications for the internal and external EU market.

China is adopting ambitious environmental regulations for example the "Tentative Administrative Rules on Enterprises Average Fuel Consumption and New Energy Vehicle Credits" which will introduce quotas for electric vehicles from 2019[35]. This presents a challenge and opportunity for EU companies but will require investment in the necessary innovation to compete with Chinese companies.

On the other hand, with a view to creating a fairer level playing field in trade and investment, the EU should invest substantially more effort in promoting collaborative regulatory approach with China that will steer China towards: abiding by WTO principles; harmonizing Chinese technical regulations with international ones; and, opening up and eliminating discriminatory treatment of foreign manufacturers. If strengthening the negotiating position be necessary, the EU should not hesitate exploring all mechanisms to defend EU trade.

4. The Big Shift: Structural Change in the Value Chain

4.1 The issue: the value chain of the automotive sector

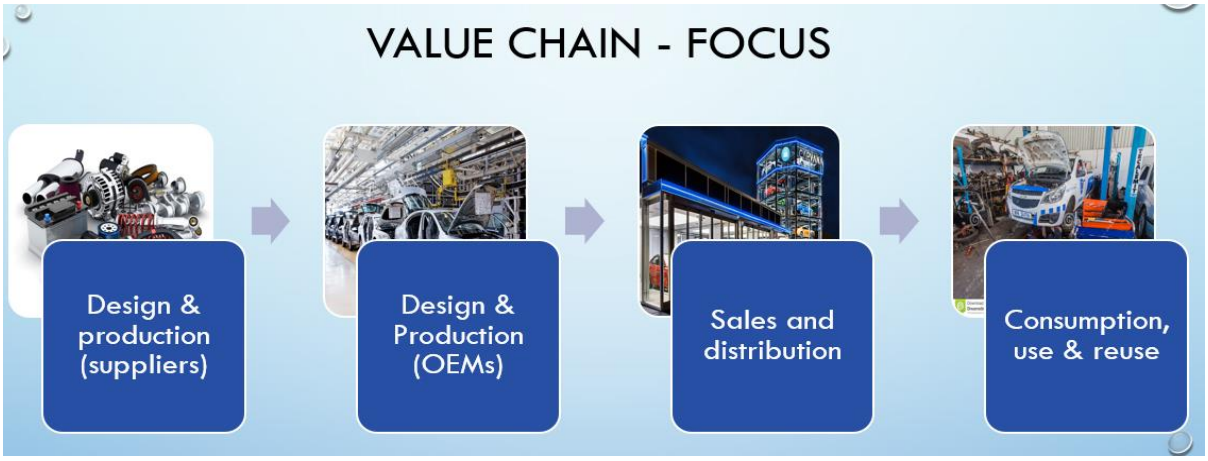
The automotive value chain is one of the most advanced and specialised in Europe. It stretches from suppliers of raw materials, basic components and materials, to manufacturers of parts, service providers, vehicle manufacturers, dealers and the aftermarket sector.

However, the future of this value chain remains uncertain. It is likely to face profound structural change as with the rest of the European automotive sector as it faces up to increased competitive pressure and the adaption to new technologies, production processes, evolving regulatory requirements and consumer demands. It is, therefore, vital to critically assess the impact of the on-going changes and prepare the entire European automotive value chain for the transformation.

In order to best understand the value chain, it is necessary to look at each of its components in turn.

[35] Car companies, with annual sales of more than 30,000 vehicles, will have to meet a quota of 10% of sales being New Energy Vehicles (NEV - all-electric battery vehicles or plug-in hybrids). This level will rise to 12% in 2020. The objective is for NEVs to make up at least a fifth of Chinese auto sales by 2025.

Figure 4.1: Overview of the Value Chain



4.1.1 Raw materials

Similar to most industries, the value chain of the automotive industry starts with the extraction / recycling of raw materials. In addition to being a major consumer of basic and commonly accessible commodities, including a wide variety of metal alloys, the automotive industry now also plays a prominent role in the market for critical raw materials for highly specialised applications. Moving towards cleaner and more efficient solutions including hybrid or electric powertrains, efficient lighting, magnets or lightweight materials requires increasing quantities of such materials including rare earth elements. That is why ensuring unrestricted access to raw materials which are indispensable to the functioning of the sector and the development of advanced technologies is important. The demand trends for commodities and materials that are currently not widely used in automotive manufacturing should also be assessed to anticipate future changes. Some of these issues are being monitored and addressed in the framework of the EU policy and strategy for raw materials[36].

4.1.2 Suppliers

Automotive component manufacturers are responsible for approximately 75-80 % of the total added value of the vehicle and this is likely to increase. The component supply business is highly complex, specialized and diversified, building synergies between industries across Europe. Altogether this involves more than 3,000 companies across all Member States, and is made up of both SMEs and several big multinational tier 1 suppliers.

One of the hallmarks of this part of the value chain is the investment in R&D activities (€25bn out of the €30bn spent annually on R&D by the automotive industry is attributable to suppliers[37]) often reaching more than 5% of turnover.

The supply chain of the suppliers has significantly benefited from the unprecedented growth in third countries. Automotive suppliers have been well placed to develop a manufacturing capacity outside Europe with the objective of supplying the rapidly expanding global markets which is expected to continue to be an important source of growth.

The demand for new technologies and mobility solutions is expected to result in the reshuffling of the supply base and far reaching changes in the market and with a number of new entrants from third countries.

The ongoing demand shift to third markets entails a number of challenges and potential threats. Appropriate protection from intellectual property theft and industrial espionage are often important

[36] See: https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy_en
[37] European Association of Automotive Suppliers (CLEPA)

concerns. Furthermore, there is the issue of access to finance for the development of the production capacities. For European suppliers those two aspects will be of critical importance when taking investment decisions in third country markets.

Europe hosts a whole digital value chain that supports the automotive sector from components to software applications. Electronic components alone, without including the ICT investments of industry in the production and design phases, represent close to a third of the cost of a car. Europe's strong position in this sector is also based on leadership in ICT. The European digital value chain for the automotive sector is still strong and is a pillar to build on but is at risk if the automotive industry in Europe loses its competitive edge and lags behind in shifting to more autonomous and connected vehicles.

The need to reduce harmful pollutant emissions and to improve the energy efficiency of motor vehicles preoccupies automotive companies worldwide and will determine the future of the sector. The EU focus in recent years on emissions and efficiency standards has helped European suppliers to establish:

- leading position in clean and efficient powertrains responding to demanding environmental requirements that are being introduced around the world; and
- considerable competitive advantage over third countries suppliers.

The competition, however, is getting stiffer and the technological advantage once enjoyed by European manufactures appears to be reducing. In addition, European suppliers need to stay ahead of the curve and be open to new technological approaches (e.g. zero emission vehicles and batteries, automated driving, active safety and the development of connected vehicles).

4.1.3 Vehicle manufacturers

The EU is among the leading vehicle producers in the world but OEMs need to properly anticipate demand trends and fine-tune or completely revamp their operations in order to maintain a leading position throughout the anticipated changes. The need to decarbonise and tackle air pollution will require regulations that drive a change from combustion engine technology, in which European vehicle manufacturers have long-standing expertise, to other propulsion technologies. This is likely to become a turning point for the automotive sector. The industry has already started to shift an important part of the value added from pure mechanical engineering towards domains such as electrochemistry and electronics. This development has to be maintained and reinforced in the future.

Moreover, the advent of automated and connected vehicles can be expected to significantly change the face of the automotive sector. Increasing automation and the exchange of data between vehicles (V2V), between vehicles and the traffic infrastructure (V2I) and the connection of vehicles to the internet are developments with far reaching consequences. Industry analysts expect that most new cars will have at least some basic automated driving features and wireless data exchange capabilities by 2020. As a result, consumer electronics and ICT companies will increasingly enter the automotive value chain. The resulting convergence of industries with very different philosophies will be challenging. Product life cycles have historically been long in the automotive sector and consumer electronics interfaces change much faster. In particular, new entrants from the consumer electronics and ICT sectors will have to adjust to the testing and approval regime for safety critical applications and the high demands on reliability and system lifetime in the automotive domain. The automotive industry may need to rapidly accelerate product cycles to compete with ICT companies.

It should also be noted that the speed of transformation is different for vehicle segments, which would represent additional costs for manufacturers. The speed of decarbonisation and connectivity will be different (and so will the technologies used) for passenger cars, light commercial vehicles and heavy-duty vehicles for freight transport.

In addition, internet and consumer electronics companies are preparing to enter the automotive market with a clear intention to introduce vehicles which will redefine individual mobility. This trend is reinforced by the increasing accessibility of tools and technologies for rapid prototyping and advanced manufacturing (e.g. 3D printing).

With pressure on margins and growing customer expectations, OEMs will have to consider new business models including those which are based on harnessing big data coming from the connected vehicles.

4.1.4 Dealers and aftermarket operators

Dealers

Dealers represent an important part of the automotive value chain and profit pool. Europe has a well-developed network of dealerships and service points with a major share of OEM-authorised points, but also with a significant number of independent dealers and workshops. They are also a substantial employer[38].

The drop in vehicle sales in Europe following the start of the economic crisis in 2007 has put the dealers under strong pressure. The number of main dealers in Western Europe has fallen from nearly 54,000 in 2007 to 48,000 in 2013[39]. This was particularly challenging for independent operators who could not count on support from vehicle manufacturers.

Dealers will need to adapt to the rapid evolution of the market, in particular, the emergence of new types of vehicles (e.g. electric, alternative powertrains and new services such as connected and automated driving). They will also need to adapt to a growing tendency of consumers to switch away from dealerships to online platforms to buy their cars.

Aftermarket Operators

Moreover, the automotive aftermarket value chain represents a wide variety of operators such as independent manufacturers and distributors of vehicle retrofitting and replacement parts, manufacturers of garage and test equipment, road patrols, independent publishers of repair information databases, inspection and periodic testing centres, manufacturers of fluids and lubricants as well as independent and authorised workshops. It is estimated that this part of the value chain employs more than 4 million employees in over 500.000 companies[40].

The existence of a competitive and functioning automotive aftermarket value chain is key to the proper maintenance of the EU's 284 million vehicles throughout their lives. This has an impact on emissions, public health, road safety and the environment. Competition for all vehicle-related products and services is highly relevant for consumers. Their services are performed predominantly by independent SMEs and ensure independent entrepreneurship as a backbone of the automotive aftermarket value chain.

Independent workshops specialized in the repair and maintenance of vehicles have been less affected by the fall in the sales of new vehicles during the economic crisis. Nevertheless, their position could be challenged by a growing complexity of the application of electronic systems and communication technologies in vehicles and is related to access to data for repair and maintenance purposes which remain within the sphere of manufacturers. This constitutes a challenge to independent operators which will need to be addressed.

[38] The European Council for Motor Trades and Repairs (CERCA) represents 120,000 authorised dealers, 260,000 independent repairers employing between them 2.8 million people.
[39] Bernstein Research: 'Euro Autos: the lost continent - how have dealer network been hurt by Europe's car slump sales – December 2014
[40] ACEA Statistical Yearbook 2016/2017 and Wolk Aftersales Experts. The Car Aftermarket Report 2015. Statistical investigation carried out in 35 European countries and research of Eurostat figures

4.1.5 Challenges to human capital

The European automotive industry directly and indirectly employs some 3.3 million people in manufacturing jobs and about 4.3 million people in non-manufacturing jobs including sales, maintenance, retail and renting[41]. Today, the industry is experiencing increasing quantitative and qualitative shortages in suitable workers, especially in the areas of engineering, scientific, and soft skills (communication, team leading, consumer-facing skills). This is due mainly to the ageing workforce (23% are approaching retirement age[42]), the poor image of the manufacturing sector in the eyes of young talent, and women of all ages, the wide diversity of national education systems and cultures, and the ever-accelerating pace of technological change.

Engineering industries struggle to attract young people, particularly female workers. A poorly functioning **apprenticeship** single market and a lack of clarity / awareness of the required job profiles does not help this process. Additionally, the cut back in recruitments as a consequence of the 2008 economic crisis has slowed down the process of substitution of workers approaching the retirement age, particularly in traditional and craft skills. This has created a skills transfer void, as experienced workers are unable to pass on their knowledge to suitably experienced younger colleagues, before retiring.

In addition, mobility of talent within the entire automotive value chain is impeded by a lack of vocational qualification recognition and standard approaches to validation of non-formal learning among Member States and their limited transferability across the EU and the automotive value chain.

SMEs are an important part of the European automotive supply chain. Unfortunately, because of their low visibility and outreach capacity, they face greater difficulties in recruiting the right person for the right job, and to provide the required learning and development for their employees.

The on-going trends, identified in this report, including digitalisation, electrification, CAD, the automation of production processes (smart manufacturing & Industry 4.0) and smart mobility, will bring significant **structural changes** to automotive enterprises and their workforce in the future. For example, the move towards electrification will lead to a greater demand for engineers with software and digital skills and most likely a decrease in jobs linked to production of conventional powertrains (unless the transition to full electric cars is preceded by a prolonged period of hybrid cars which require two powertrains and, thus, more components).

Equally, a number of traditional job profiles will disappear. To limit the employment impact, all the participants of the automotive value chain will need to use substantial resources to regularly **upskill and retrain staff** to ensure their effectiveness. There will be an increased demand for digital and advanced engineering skills as well as a need to refocus some talent towards basic skills. This demand must be reflected in both formal and informal education pathways. Moreover higher technical education would need to be developed to solve the competence demands in industry that come with digitalisation and electrification. Engineering courses do not put enough emphasis on fundamental engineering knowledge, such as ICT, programming and system design.

It is in the nature of these trends, that there are likely to be mismatches (in timing and in skills profiles) between job roles which become obsolete and those that will be created. Social and employment-related impacts of the paradigm shift in the automotive industry have to be investigated in the near future i.e. beyond the GEAR 2030 process.

In the long run the social impacts of the shift to autonomous and connected vehicles could also affect to a great extent the people employed in transport sector, namely workers driving vehicles, which account for about 4, 4 million people[43]. The impact will not however be immediate but progressive and reskilling of employees in the transport sector will also need to be adequately

[41] ACEA (2017) The Automobile Industry Pocket Guide
[42] SWD(2016) A New Skills Agenda for Europe
[43] ACEA (2017) The Automobile Industry Pocket Guide

addressed in the future. Societal issues of automation are further explained in Section 6 on automated vehicles and connected vehicles.

4.2 How can Europe respond?

The coming decade will be marked by a major shift of technologies and approaches to mobility. In order to ensure that innovation is generated and deployed in the EU. The EU must create a strong market for innovative technologies and develop framework conditions to facilitate their development and commercialisation. Automotive players will need to invest in different technological solutions, to safeguard their leading role in the global market as developing innovation and cutting-edge technologies is the only way to maintain and strengthen European competitiveness.

Jobs in manufacturing activities related to conventional powertrains are likely to decline. On the other hand, the digitalisation of both the cars themselves and of the workplace, the new mobility services and infrastructure developments will create new jobs. For example, unlocking vast amounts of transport and in-vehicle generated technical data will support the development of new mobility concepts where users are incentivised to use a package of mobility options rather than privately-owned vehicles and will allow new digital services and repair methods to be available for vehicle owners and operators. Data generated by vehicle use will be of strategic value for automotive players since knowledge of the vehicle condition/status and end-user behaviour could generate significant additional income.

4.2.1 Facilitating investment and innovation

There is a need to increase the level of private and public investment to develop and deploy **new technologies, especially those which are near-to-market**. This needs to be done via dedicated programmes and by Member States and regions creating knowledge centres on alternative powertrains, technologies for connected and automated vehicles, advanced manufacturing processes and novel materials.

The EU also needs to support investments related to the development of, and transformation towards, **digitalization of the value chain** (at the level of processes, products and services). This digitalization has even a more significant impact in the automotive sector since the vehicles themselves, but also the manufacturing processes and the sales, distribution, aftermarket and use are becoming more and more digital. The process of migrating from traditional services to digital ones requires significant investments, particularly for SMEs.

Given the need to use resources efficiently and reduce energy consumption and mitigate climate change, **the circular economy** will play an increasingly important role (by reducing use and promoting reuse and recycling) in limiting raw materials costs. Reusing and recycling of batteries, to name one, could become the basis of new business models in the European automotive industry. This can create new competitive advantage by establishing a new circular value chain. The EU needs to invest in these new technologies and the European Commission should continue funding fundamental research and industrialisation on reuse, recycling and substitution of spare parts, raw materials (steel, aluminium, glass, plastics, etc.), critical raw materials and hazardous substances coming from vehicles and vehicle components.

This needs to be a collective effort. The European Commission, Member States, regional authorities and the European Investment Bank (EIB) should examine whether existing R&D programmes could focus (even more) on the development of low and zero emission vehicles / technologies, connected and automated vehicles, advanced manufacturing processes as well as for the cost-effective introduction of advanced materials into vehicle components.

The EIB plays a particularly important role in support of the automotive sector providing a key source of continued financing in the area of RDI and **specifically aiming at automotive manufacturing projects that support the transformation of the transport sector into a more sustainable sector**. Lending for projects supporting the urban public transport, in particular

those forming part of the TEN-T and/or situated in less developed regions, represent another area which could benefit from EIB's continued involvement.

The EIB should continue providing specific support to SMEs such as Innovative SME guarantee schemes, mitigating the uptake risk, so they are able to invest in digital technologies and services. Finally, it should continue supporting skills, climate action and strategic infrastructure across the EU that support the transport sector.

This approach should be reinforced by developing collaboration and strategic alliances to help companies to share the costs of R&D investments, to enter new value chains and to develop new business models. This could also help to avoid bankruptcies and destruction of capital. In turn, the industry, within the automotive value chain, will need to identify their own digitalisation priorities, define their implementation plans and invest in the implementation of digital processes and services.

4.2.2 Framework for new mobility concepts

Moving to the new forms of mobility offers huge opportunities for Europe's citizens and automotive industry. The HLG has identified four key areas where the EU will need to act.

First, the EU will need to ensure safe and secure **access to transport and vehicle data,** taking into account the principles set out in the Communication on Building a European Data Economy[44] on data location as well as the guiding principles laid down in the C-ITS platform report[45] namely; data provision based on consent, fair and undistorted competition, data privacy and data protection, tamper-proof access and liability, data economy. Transport and vehicle data will change the way vehicles are operated and serviced today. Access to data from the vehicles (but also public transport data, car sharing data, etc.) will change the way services are proposed to customers within the privacy boundaries of the General Data Protection Regulation and will enable all actors of the value chain to develop new services and business models and to create additional value for users and society. Nevertheless potential threats from cyber security as well as vehicle integrity and safety need to be analysed and taken into account.

Second, the EU will need to evaluate whether or not a framework allowing access to transport and vehicle data needs to be established. In addition, the European Commission would need to consider how to ensure an effective stakeholder dialogue on issues related to data. It is essential that this process is underpinned by the industry and service providers guaranteeing fair access, storage and sharing of vehicle data. Consumers must have control of their personal data.

Third, the EU needs to **facilitate the deployment of mobility as a service (MaaS) in Europe**. MaaS safeguards mobility, whilst making the most efficient use of existing assets (private cars, fleet, public transport). It fosters co-modality and increase convenience for users. Furthermore, the development of adequate IT MaaS tools could be an interesting product to export for the European industry.

Finally, the EU needs to encourage a level-playing field for **new economy business models** whilst at the same time ensuring a level playing field for all mobility service providers. To this end, guidance should be provided to clarify that these new economic actors operate within the evolving legal framework **subject to the same rules as incumbent operators**. Also, in this context, the European Commission issued a Communication on Collaborative Economy[46] in June 2016 which highlighted the need of the Commission and Member States to review developments in the collaborative economy and to support the exchange of best practice between Member states and stakeholders.

[44] COM (2017) 9
[45] Final Report of January 2016: https://ec.europa.eu/transport/sites/transport/files/themes/its/doc/c-its-platform-final-report-january-2016.pdf
[46] COM (2016) 356

4.2.3 Regional Perspective

Industrial modernisation requires important investment efforts at the regional level. The Research and Innovation Smart Specialisation Strategies (RIS3)[47] that are developed in relation to requests for funding under the European Regional Development Fund helps to prioritise and align efforts between public and private stakeholders in EU regions and allocate EU and regional funds in a focused and efficient way.

At the same time, there are clear opportunities to engage in strategic interregional co-operation along shared RIS3 priorities in order to complement each other's competences, share infrastructure, and develop joint investment projects. Such interregional co-operation allows the scaling up towards larger impact and more effective collaboration along industrial value chains. The Smart Specialisation Platform for Industrial Modernisation (S3P-Industry) supports EU regions committed to generate a pipeline of industrial investment projects following a bottom-up approach - implemented through interregional co-operation, cluster participation and industry involvement. Regional authorities should create thematic partnerships for the automotive sector under the Smart Specialisation Platform for Industrial Modernisation and develop a cluster Policy so as Regional Strategic Plans contain a sectorial perspective and include specific actions targeting all actors within the value chain. They also have an important role in this area especially to support the development and implementation of new technologies and increased digitalisation by SMEs and the creation of regional training programmes for the automotive industry to help attract and retain talents. In addition, there should also promote circular economy projects at the regional level and to take the circular economy principles into account in the evaluation of projects.

4.2.4 Skills and the Human Dimension

To help the automotive sector to face the challenges of adapting to new technologies there is a need to:

i. support the mobility and transferability of skills;
ii. encourage non-formal learning certification; and
iii. develop a well-functioning apprenticeship market.

Additionally, EU also needs to take account of the specific needs of SMEs, the importance of identifying and developing digital skills, retraining of the workforce and a proactive response to any adverse impact on employment from structural changes to the sector.

A key tool to increasing opportunities and flexibility in the work force is the development of **Standard Job Frameworks**. Building on ESCO (European, Skills/Competences, Occupations and Qualifications) classifications, would provide improved knowledge of specific roles, standard job framework descriptions and guide candidates towards potential career tracks. This will enable coordination and promotion of professional development courses and training on the job. This work will need to be led by industry but supported by Member States, training providers and academia and take into account successful examples such as the UK's Automotive Industrial Partnership's (AIP) framework[48].

In addition the skills and knowledge acquired by the labour force should be recognised across the value chain and across the EU. One way to support **transferability of skills** across the value chain is to create individual competence portfolios by introducing a **sectoral Skills Pass** (or Skills Passport). In particular the Skills Pass would provide a recognised document to register all competences acquired outside the formal education system. This will depend on co-operation between industry, education and training providers, and local and national authorities, coordinated under an EU umbrella. It should be linked to the creation of **up-skilling paths** for certain profiles as well as **ad-hoc cross-national programmes to attract young talented people** to the

[47] See: http://s3platform.jrc.ec.europa.eu/industrial-modernisation
[48] UK Automotive Industrial Partnership: https://www.automotiveip.co.uk/

automotive sector and underpin the Skills Pass.

In particular industry and social partners should define the professions for which **validation of non-formal and informal learning** is important, by using or extending the ESCO classification. This will require action from training providers and academia, to define, develop and allow comparability of validation processes. This could be supported by the European Commission in developing **a common approach for the validation process** based on the principle that the system is based on the same standards as the ones used for formal qualifications. The implementation of this approach will need to identify how to develop and organise the validation process by ensuring the comparability and transparency of the outcomes in line with the Council Recommendation of 20 December 2012[49]. It could be underpinned by **a platform for Member States to co-ordinate their activities**.

Apprenticeships, as a form of work-based learning, can attract young people to the sector. To enable a free flow of talented and skilled young professionals across Europe, it is essential to **ensure that a single market for apprentices is developed across the EU** by linking regional, national and European apprenticeship initiatives. Establishing an EU industry-wide apprenticeship matching service would be relevant to help apprentices stay within the automotive sector by matching them, and their skillset, with the right company. The Commission should support the creation of a better functioning EU apprenticeship market. Better penetration of the existing practical models such as the EU Alliance for Apprenticeships (EAfA)[50] should be assured in the automotive sector. The work of the Alliance should be backed up by the exchange of best practice (e.g. the Bosch Southern Europe Apprenticeship Initiative and the UK industry-led apprenticeship matching service model).

In the light of addressing the human capital needs outlined above, the European Commission launched the Blueprint for Sectoral Co-operation on Skills (Blueprint) as the key vehicle for delivering the recommendations of this report. It provides financing through Erasmus+ and COSME funds. The Blueprint projects will develop concrete tools (vocational education and training solutions) to address new job profile requirements, skill shortages, gaps and mismatches identified in the European Automotive Skill Council (EASC) as well as the GEAR 2030 Human Capital Project Team work. While Erasmus+ aims to set up sectoral skills partnerships of key players at the European level, encourage private investment and promotes more strategic use of relevant EU and national funding programmes; COSME programme complements it with targeted policy-oriented actions, awareness raising, promotion of the attractiveness of the automotive sector as an employer and exchange of best practices within the industry. COSME will be particularly focused on SMEs which have the greatest difficulty in planning their workforce needs on their own.

Furthermore when considering the changes in the automotive sector, any employment impacts of structural change should be properly addressed and structural disruptions should be dealt with in a socially progressive and gradual way. This should be done through retraining or developing alternative employment opportunities within, or outside, the automotive value chain. In that respect, the European Commission should assess the impact of the potential cost related implications of electrification and digitalisation on the quantity and quality of jobs.

[49]Council Recommendations on the validation of non-formal and informal learning (2012): http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32012H1222(01)&from=EN

[50] EU Alliance for Apprenticeships: http://ec.europa.eu/social/main.jsp?catId=1147

5. The Big Shift: Decarbonisation and Zero Emission Vehicles

5.1 The issue

5.1.1 The importance of decarbonisation

The EU is committed to reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990 with an intermediate target for 2030 of 40% and a reduction in the non-ETS sectors (including transport) of 30% in line with the Paris Climate Accord.

To achieve these targets, a comprehensive approach to transport decarbonisation is needed including:

- improving the efficiency of new vehicles and optimising the use of road space;
- a switch to sustainably sourced low emission alternative fuels and techniques;
- encouraging a shift to low and ultimately zero emission transport modes;
- better management of mobility and freight, reducing the need for unnecessary travel.

In 2016, the European Commission issued a Communication setting out '**A European Strategy for Low-Emission Mobility**'[51] with a policy framework of regulatory and non-regulatory initiatives for low-emission mobility based on optimising the transport system and improving its efficiency; scaling up the use of low-emission alternative energy for transport and moving towards low-emission vehicles. It also set out a number of horizontal initiatives on linking the transport and energy systems; research, innovation and competitiveness; digital technologies; skills; investment; action by cities and global action on international transport. The Communication emphasised the importance of a combination of EU, national and local policies to accelerate the use of low and zero-emission vehicles throughout the Union, as far as possible in a technology neutral manner.

As noted in Section 2, reaching the 2030 climate targets will require a significantly larger proportion of new cars to be low- and zero-emission vehicles. Though this view is largely shared by the automotive industry, there is no unique scenario to achieve this. The internal combustion engine will still have an important market share of new vehicles in 2030. However, to remain in the vanguard of the shift to zero emission technology, EU automotive industry will need to invest heavily in this technology, in particular to compete with China. The sooner the markets receive a clear signal on where the EU regulatory ambition is heading in the longer term the smoother and economically more viable will be the transition, allowing the EU to get ahead of the game on the deployment of zero-emission vehicles.

Having in mind the global trends (especially in China) and the most disruptive implications for the industry and value chain, the **GEAR 2030 HLG decided to give specific attention to zero emission vehicles (ZEVs) in this Report,** while recognising the potential of all powertrain technologies contributing to the decarbonisation of transport**.**

[51] COM(2016) 501 final: http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52016DC0501

5.1.2 Deployment of Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEVs)

ZEVs and PHEVs are becoming increasingly available for the vehicle segments of passenger cars, mopeds/motorbikes and buses. Assessments of country targets, original equipment manufacturer (OEM) announcements and scenarios on electric car deployment seem to confirm these positive signals, indicating a good chance that the electric car stock will range between 9 and 20 million by 2020 and between 40 and 70 million by 2025[52]. This assumption is valid provided that several conditions are met (e.g. the availability of the relevant infrastructure, fiscal and non-fiscal supportive measures and consumer acceptance). It is also important to note that, given the average age of cars in circulation, it will take some time for ZEVs and PHEVs to represent a significant percentage of cars in circulation.

Light commercial vehicles are often used for inner city transport (including "last-mile logistics", a large share of which only consists of small loads that can also be transported by light, small vehicles), and so are an important contributor to pollution. Therefore the introduction of zero emission light commercial vehicles would have an important effect on air quality. Given that the technology of those vehicles does not differ substantially from the one used in passenger vehicles, OEMs would be able to respond quickly to a higher demand. There is also a growing market for battery-electric urban buses.

The truck segment could also be partially electrified in the next years, possibly using hybrid technologies, hydrogen fuel cells and catenary systems or pure electric battery solutions once inductive charging technologies become more widespread[53]. This could reach scale before2030 provided the charging infrastructure outside the urban areas is sufficiently available.

ZEVs have the advantage of zero tailpipe CO2 emissions but also zero tailpipe air pollutants (NOx and particulates) emissions as well as reduced noise. They contribute, therefore, to **improve urban quality of life and to lower health effects from air pollution**. As the effects of air pollution are, to a large extent, affecting urban areas, fast uptake of low and ZEVs will contribute to improve the situation in the most affected air pollution areas.

When considering ZEVs from a life cycle perspective, **greenhouse gas emissions** from electricity generation and from the vehicle manufacturing process also have to be considered, while noting that such emissions are (partially) captured by the Emissions Trading Scheme. Over the next decade, at the EU level, both on a full-lifecycle and well-to-wheel basis, battery electric cars will be, lower carbon emitters than their conventional equivalents[54], particularly in the countries where electricity generated or supplied will be substantially decarbonised thus increasing the net carbon benefits delivered by electric vehicles. Similarly, hydrogen fuel cell vehicles will be substantially less carbon intensive than conventional equivalents if the hydrogen is produced from zero carbon energy.

The creation of a significant market for zero-emission vehicles and renewable electricity will also **reduce oil dependence**. Increased demand for batteries and catalysts could cause new dependencies for critical raw materials which could however be partially offset by recycling or by technologies (some of them already available) that reduce dependencies for critical raw materials.

PHEVs are an important transitional technology. These vehicles have the benefit of maintaining much of the existing powertrain whilst adding electrified components and therefore create an easier transition for the automotive supply chain (e.g. smoother adaptation of human resources to the structural change) and the consumer. However, if the price and performance of

[52] E*xpert judgement reflecting consultation in the context of GEAR 2030, consistent with other sources such as IEA/OECD Global EV Outlook and Bloomberg forecasts.*

[53] For passenger cars and trucks alternative fuels technologies especially natural gas and biofuels are also being increasingly exploited.

[54] Fraunhofer Institut für System- und Innovationsforschung. Under the assumption that conventional combustion engines are used with conventional fuels. On the well-to-wheel basis diesel engines with biodiesel can have the same CO2 emissions as PEV (European electricity level).

battery packs continue to improve as forecast, the inclusion of a second powertrain will add cost making it likely that PHEVs will face more competitive environment in the long term.

PHEVs are zero emission capable vehicles (ZECs) but will only achieve low emissions if they are both **regularly charged and have an adequate electric range**. While in most Member States a large share of the usual daily distances stay under the 40 km, the initial market deployment for PHEVs in the Netherlands suggests that they were only operated with zero tailpipe emissions around 30% of the total mileage driven (there were however improvements over time linked with the deployment of the recharging infrastructure). The Netherlands experience can be to a large extent explained by realistic electric ranges of around 30 km and daily distances of around 100km in average, i.e. by long distance commuters. With a view to deliver significant environmental benefits**, the share of the electric mileage driven must be significantly higher.** This will require a combination of longer range vehicles, an adequate fast charge network and, perhaps, fiscal incentives.

It is expected that prices of electrical vehicles will decrease over time while conventional vehicles could become more expensive through the need of new technologies to improve their efficiency and reduce pollution. However, combustion vehicles will remain an important part of the fleet to 2030 and beyond, most notably for the light commercial and the heavy duty segments.

From the perspective of the competitiveness of the European automotive value chain, the development of a strong market for ZEVs with European manufacturers offering a wide range of powertrain solutions for both the European and export market is essential but requires a number of steps/actions. Battery-charged vehicles are now the leading segment of zero tailpipe emission around the world. In order to retain global competitiveness in this area, Europe should create proper framework conditions for ZEVs and support innovations.

5.1.3 Highlight: Battery production

It is expected that the change in the market uptake for ZEVs and ZECs will also be driven by improved performance of battery cells and battery packs and increased manufacturing efficiencies for vehicles resulting in lower costs. The electrification of the automotive sector will also influence European battery production and its localization. Today's leaders in Li-ion traction battery production (at the cell level) which are mostly non-European (e.g. Japanese, South Korean and Chinese), have begun localising their production in Europe.

Moreover, it is expected that European companies will develop battery cells' mass manufacturing capacity (if demand picks up). This will require, however, large investments. European companies are also expected to continue playing an important role in automotive battery applications and in the area of battery assembly. In addition, new business opportunities related to traction batteries are likely to emerge notably the business around battery reuse and battery recycling, which is key to reducing EU dependency on imports of critical materials.

Batteries are therefore recognised as a key enabling technology for electric mobility given that they represent a considerable amount of the electrical vehicle cost and improvements in battery performance (range autonomy, durability and recharging speed) will be key for the consumer acceptance of electric vehicles. In the past, several research and development initiatives focused on improving batteries' performance (e.g. increased autonomy range) and reducing battery costs (e.g. improved battery materials, chemistries and designs, better manufacturing processes for battery cells and battery packs and improved battery management systems, recycling, etc.). RDI programmes financed also pre-market deployment and pilot production lines.

However, the fact remains that the EU does not have a complete battery value chain albeit being competitive in several of its segments. Battery cells are mostly imported from third countries. This weakness needs to be addressed to reinforce and build a complete value chain in Europe. In addition, the development of hybrid and electric powertrains is expected to require increasing quantities of rare earth elements. Therefore ensuring access to the required raw materials and developing technologies less dependent from those raw materials will be particularly important.

For this reason the Communication ''Europe on the Move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all'' announced a specific flagship initiative on batteries. *"The Commission will step up its work with stakeholders (including the work under the Strategic Energy Technology Plan) to support an industry-led initiative and develop support measures for research, development and manufacturing of the next generation of battery cells and battery packs in the EU. The Commission will promote an integrated European battery eco-system in support of electric mobility and energy storage addressing the issue of scarce resources and battery recycling, which will help facilitate the emergence of new circular economy business models for the automotive industry."*

5.2 How can Europe respond?

The shift towards zero-emission mobility is a challenge but also an opportunity along the value chain. Transition towards more significant ZEV and ZEC market shares in the EU cannot happen without a number of regulatory and non-regulatory incentives, and the EU needs to combine an approach that reduces greenhouse gas and pollutant emissions with one that ensures the growth and global competitiveness of Europe's automotive industry. This means that the EU should aim to retain its position as a key global early adopter of those technologies.

By resolutely promoting the production and sales of such vehicles, the EU can foster conditions based on economies of scale that will permit the industry to overcome market uptake uncertainties and will in turn promote the development of an industrial production base and value chain for these technologies in the EU.

The responsibility for:

- regulations on **CO2 emissions and pollutant emissions**;
- putting in place a sufficient and interoperable **refuelling and recharging infrastructure**;
- using **public procurement** effectively to stimulate demand for ZEVs and ZECs;
- offering **financial incentives** to encourage private purchase of ZEVs and ZECs;
- using **non-financial incentives and other public measures** to encourage the purchase and use of ZEVs and ZECs; and
- putting in place a **common EU vision and adapt the overall policy framework, which amongst others** *support the development of a full battery value chain and promotes mass production of batteries cells in Europe*;

is a common responsibility of policy makers at European national, regional and local levels of policy making. However, the industry in parallel should take all the necessary steps to improve the autonomy range of the vehicles, reduce their costs and increase the choice of models in the market.

The EU **CO2 emission regulations** setting emission targets for cars and vans are an effective and efficient EU-level tool driving the fuel efficiency of vehicles, creating a level-playing-field, ensuring a predictable market and stimulating innovation to help meet climate goals. These targets will be revised for the post 2020 period.

Moreover, a variety of additional measures such as for example specific targets or a crediting system coupled with incentives for zero-emission vehicles is being considered.

Public vehicle fleets will contribute to deployment of ZEVs and related infrastructure and could lead by example. The forthcoming Commission proposal for the revision of the Clean Vehicle Directive due in November 2017 is an opportunity to provide a stronger push for the roll-out of low and zero-emission and zero-emission capable vehicles within the public procurement framework wherever practicable. In that respect, new alternative supportive measures, for example technology neutral registration quotas for the public authorities for low and zero-emission and zero-emission capable vehicles can be considered. This action should be accompanied by an ambitious revision of the voluntary Green Public Procurement criteria.

Adequate deployment of the infrastructure covering strategic parts of the road network and where the business case is weaker is also essential. To this end the implementation of the Alternative Fuels Infrastructures Directive as per the planned legislative timing[55] is important, along with enhanced co-operation, facilitated by the Commission, among the Strategic National Policy Frameworks (NPFs) that had to be submitted by Member States by November 2016. Almost all Member States have submitted their plans, but some plans do not fully respond to the requirements of the Alternative Fuels Infrastructure Directive. There is broad agreement amongst stakeholders that this needs to be strengthened as the deployment of an interoperable recharging and refuelling infrastructure is a prerequisite for an accelerated market uptake of low and zero-emission and zero-emission capable vehicles. When deploying the infrastructure particular attention must be paid in the countries that are expected to be the recipients of second hand cars. In absence of the appropriate infrastructure catering for the needs of second hand cars the values of these would be likely depressed making the case for the new vehicles to become even more expensive.

Moreover, in 2030, depending on the outcomes of discussions on the Commission proposal for an amended Directive on Energy Performance of Buildings [expected by the end of 2017], there might well be an obligation for newly-built buildings to include charging points for EVs and PHEVs and an incentive system to favour the installation of more of them (i.e. preliminary measures such as conduits for cables). To meet this new demand in 2030, initiatives are likely to come from private actors or be implemented through public-private partnerships.

Range autonomy and charging infrastructure capacities will also be extended to support the deployment of a greater share of ZEVs on the market. Taking advantage of sustained advances in technology, the range autonomy of electric vehicles and charging infrastructure capacities will increase significantly. A charging infrastructure of 150 kW is being put in place now (e.g. CLEVER - an electric vehicle charging network) and the European Commission is supporting projects for the roll out of ultra-fast chargers with a capacity of 300 kW by 2018 (ULTRA-E – to support the installation and testing of 25 ultra-fast chargers on road infrastructure in the Netherlands, Belgium, Germany and Austria). As regards range autonomy, some brands are announcing a range up to 700 km (e.g. BMW) by 2020. However, depending on specific mobility demands, some automotive brands might offer Electric Vehicles with lower autonomies.

The **Guidelines on financial incentives[56]** to promote energy efficient vehicles remain relevant. In particular, the mandatory principles (e.g. non-discrimination with regard to the origin of the vehicle concerned, the respect of EU state-aid rules and procurement rules, etc.) remain valid. The guidance principles of technological neutrality (i.e. incentives should not be limited to specific technology), the principle of making reference to common performance-criteria and the proportionality principle (i.e. the incentive granted should be proportional to performance improvement) should continue to be respected (details in Annex 5). In order to assess the use of the Guidelines and to further improve them, it would be important to monitor their implementation by Member States.

Based on the experience of Norway and the Netherlands it seems that only a well-balanced combination of financial and non-financial **incentives,** such as a frequent use of financial purchase incentives and permission to use bus lanes or free parking for such vehicles, guarantees a sustainable market uptake of ZEVs and ZECs. In addition, enabling consumers to experience mobility in a seamless way, as they are used to with conventionally fuelled vehicles is essential. In the Netherlands, despite the increasing availability of charging infrastructure for ZEVs in urban and along the highways, the uptake of clean vehicles decreased as soon as the fiscal incentives ceased. Therefore, it has to be taken into account that the establishment of a market for ZEV and ZECs will require financial support for a time.

[55] Member States to deploy an appropriate number of publically accessible electric charging points by 2020 and an appropriate number of points for refuelling hydrogen by 2025.
[56] SWD(2013) 27 final

At the same time, the regulatory approach towards **vehicles equipped with advanced ICE** is likely to change significantly by 2030 since it is very likely that regulations on pollutants will be further adjusted.

6. The Big Shift: Automated Vehicles and Connected Vehicles

6.1 The Issue

Increased automation and connectivity are major trends that are shaping the future of road transport and mobility. They hold the promise of addressing many of the major challenges facing today's transport system, such as user safety, energy efficiency, air quality, traffic congestion, and to enhance the drivers' comfort and convenience. The combination of advanced connectivity systems and automated vehicles could disrupt the entire automotive ecosystem.

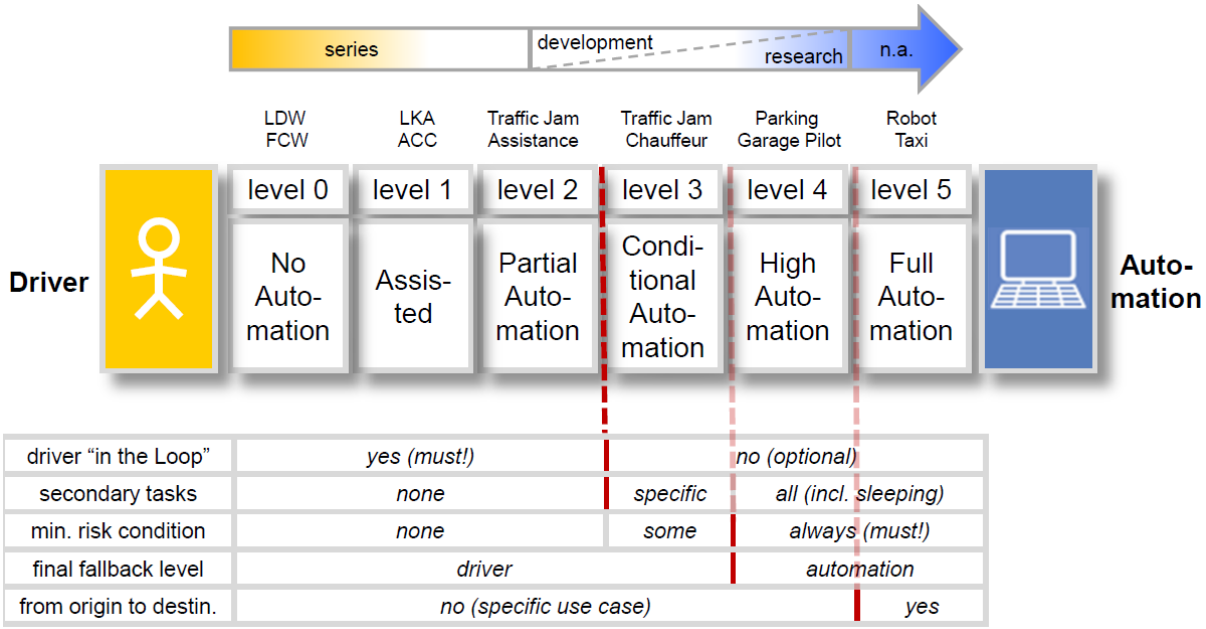
The impact of automated and connected vehicles could be huge. On the transport system, these vehicles could drastically reduce road fatalities as 90% of road accidents come from human error[57]. In addition automated and connected vehicles could provide new mobility on demand services e.g. for elderly or impaired people. They will provide new business models and the development on a large scale of new technologies (e.g. sensors, big data and communication technologies) for the automotive sector will also decrease the cost of these technologies and create spill over for other sectors. In the long run, automation could have a revolutionary impact on travel behaviour, social inclusion and urban development, environment, entertainment and commerce, growth and jobs. Various studies revealed the outstanding economic impact projected for automated driving for the years to come ranging up to €71bn in 2030[58]. The estimated global market for automated vehicles is of 20% of new car sales in 2025 (€30-60 billions[59,60]) and 44 million vehicles by 2030[61].

To leverage and realise the foreseen impacts for society through automated and connected vehicles, stakeholders need to work together and remove hurdles to implementation, address key challenges and build an innovation-friendly environment accelerating market-uptake. Automated and Connected vehicles in particular bring new challenges for regulators and policy makers concerning e.g. road safety, environmental, societal and ethical issues, cybersecurity protection of personal data, competitiveness and jobs, etc. which need to be addressed. The big question is how to develop a new coherent legal framework for some vehicles that have not yet been built. These challenges need to be tackled by both Member States and the Commission.

Automated vehicles are vehicles that can replace the driver for some or all of the driving tasks. Vehicles acting automatically on the brakes, the accelerator or/and the steering control under the constant supervision of the driver ('SAE level 2'- see figure below) are already available on the EU market. According to ERTRAC[62], automated vehicles allowing the driver to perform secondary tasks (SAE levels 3-4) should be available by 2020 on the EU market for a limited number of driving situations (e.g. automated cruising on the motorway or urban shuttles for dedicated trips). Vehicles able to drive autonomously door-to-door (SAE level 5) in any traffic conditions are not expected to be available before 2030 except for testing.

[57] Various accident causation sources (Member States, US NHTSA) for example: Hale, A. R. & Glendon, A. I., Individual behaviour in the control of danger. Elsevier, Amsterdam, 1987.
[58] KPMG, Connected and Autonomous Vehicles – The UK Economic Opportunity, Boston Consulting Group (2015). Revolution in the Driver's Seat: The Road to Autonomous Vehicles in ERTRAC (2015) Automated Driving Roadmap.
[59] Boston Consulting Group (2015) Revolution in the Driver's Seat: The Road to Autonomous Vehicles
[60] Cacilo, A. et al. (2015), Hochautomatisiertes Fahren auf Autobahnen - Industriepolitische Schlussfolgerungen, Fraunhofer-Institut für Arbeitswirtschaft und Organisation, Stuttgart
[61] Boston Consulting Group (2015) Revolution in the Driver's Seat: The Road to Autonomous Vehicles.
62 See ERTRAC Automated Driving Roadmap: http://www.ertrac.org/uploads/images/ERTRAC_Automated_Driving_2017.pdf

Figure 6.1: Different levels of automation (Society of automotive Engineers[63])



ACC: Automatic Cruise control
FCW: Forward collision warning
LDW: Lane departure warning
LKA: Line keeping assist

In parallel, vehicles (automated or not) are getting more and more connected in particular through the cellular network (SIM card) for communication and the GPS network for positioning (satellites). Given the current performance of the cellular network (speed, coverage, etc) and GPS network (accuracy), connectivity is mainly used for telephones, provide info traffic, route planning, fleet management and internet services ("infotainment") in vehicles. It is also used for a number of safety applications (e.g. Ecall).

In the future automation and connectivity could reinforce each other. On one hand, automated vehicles should increase the use of the cellular network through the large amount of data they will share (big data) and because they will allow the driver to perform secondary tasks (e.g. internet surfing) during driving time. On the other hand with increased performances, existing communication technologies (ETSI-ITS G5), forthcoming communication technologies (e.g. LTE-V2X, satellites) and future technologies (5G) could better support automated vehicles in particular for cooperation between vehicles and for better positioning (Galileo). Several manufacturers have already committed to fit short range communication devices (WiFi based: ETSI-ITS G5) on vehicles from 2019 [64] while some others[65] are also considering equipping their cars with LTE-V2X or using cloud based solutions.

It was not the intention of GEAR 2030 to discuss the future of cellular or satellite networks as they go beyond providing services just for the car sector. The discussion of the group was therefore focused on the connectivity aspects linked to the deployment of automated vehicles. The general discussion on the impact of digitization on the car sector is covered under section 4 of this Report.

63 For the full definition of SAE levels see: https://www.sae.org/misc/pdfs/automated_driving.pdf. Levels 4 includes vehicles able to drive autonomously in a limited number of driving situations either with a driver (e.g. motorway autopilot) or without a driver (e.g. shuttles on dedicated trips).

64 https://www.volkswagen-media-services.com/en/detailpage/-/detail/With-the-aim-of-increasing-safety-in-road-traffic-Volkswagen-will-enable-vehicles-to-communicate-with-each-other-as-from-2019/view/5234247/7a5bbec13158edd433c6630f5ac445da?p_p_auth=ugQ4cXwM

65 http://5gaa.org/.

6.2 How can Europe respond?

A lot of activities have already been taking place on automated vehicles in the Member States and in the European Commission. Several Member States have a national strategy for automated and connected driving (e.g. France, United Kingdom, The Netherlands, Germany and Sweden) and large scale tests are taking place, or will soon take place, in testbeds in several Member States. These trials are mainly taking place on and beyond the TEN-T network. On automation, the Commission is supporting large scale cross border trials of automated vehicles with dedicated research and innovation calls on Automated Road Transport and Internet of Things in Horizon 2020[66]. On connectivity, the Commission proposed a strategy on Cooperative Intelligent Transport Systems ("C-ITS")[67] and supports C-ITS deployment through the C-ROADS platform [68]. The Commission also proposed a strategy for the development of 5G cellular technologies[69] and fosters the collaboration between telecom and automotive industries by organising Roundtable sessions[70] which resulted in the establishment of the European Automotive Telecom Alliance (EATA)[71], the 5G Automotive Alliance (5GAA) as well as a letter of intent on testing the testing and large scale demonstrations of CAD signed by 27 Member States[72].

Regarding regulatory aspects, responsibilities are split amongst Member States and the EU. It is important to link policy initiatives and regulatory initiatives to ensure the best framework for the development of these fast evolving technologies while at the same time being able to cope with the associated challenges. Recognizing the need to work together, Transport Ministers[73] agreed on 14-15 April 2016, in the Declaration of Amsterdam, to strengthen cooperation in the field of automated and connected driving and called on the Commission to develop a shared European strategy on connected and automated driving, to review, and where necessary, adapt the EU regulatory framework, to develop a coordinated approach towards research and innovation and to consider the continuation of the C-ITS platform for the deployment of interoperable C-ITS in the EU.

Scenarios defined by ERTRAC (see section 6.1) have been taken as a baseline for the recommendations proposed below, within 2020 and 2030 horizon. The group did not consider the expected possible market penetration of the different automated and connected vehicles as it will mainly depend on how the market will respond. Legal and policy issues will have to be solved regardless of the penetration rate.

6.2.1 The legal and policy framework for automated and connected driving

Testing on open roads

GEAR 2030 HLG considers that large-scale tests are a major tool to make progress on the technology for vehicles expected beyond 2020, develop relevant rules, increase public acceptance and develop co-operation between the different actors. The Member States confirmed that such trials are possible under the existing 1949 Geneva and 1968 Vienna conventions on road traffic. The European Commission supports cross boarder trials through Horizon 2020 and the Connecting Europe Facility (CEF). GEAR 2030 HLG considers that proper governance through one EU wide focal

[66] http://ec.europa.eu/research/index.cfm?pg=newsalert&year=2017&na=na-030417.
[67] http://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v5.pdf
[68] https://www.c-roads.eu/platform.html. The C-ROADS platform brings together all ongoing C-ITS deployment activities across the EU in particular to ensure the interoperability of C-ITS services. It also looks at the convergence of cooperative and automated vehicles. On 20 June 2017, the C-Roads platform and the CAR 2 CAR Communication Consortium (industry) signed a Memorandum of Understanding.
[69] Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "5G for Europe: An Action Plan" - COM(2016)588 and Staff Working Document - SWD(2016)306
[70] https://ec.europa.eu/digital-single-market/en/cooperative-connected-and-automated-mobility-europe.
[71] http://www.acea.be/press-releases/article/37-leading-companies-join-forces-in-european-automotive-telecom-alliance)
[72] https://ec.europa.eu/digital-single-market/en/news/eu-and-eea-member-states-sign-cross-border-experiments-cooperative-connected-and-automated. It was also signed by Norway and Switzerland
[73] https://www.regjeringen.no/contentassets/ba7ab6e2a0e14e39baa77f5b76f59d14/2016-04-08-declaration-of-amsterdam---final1400661.pdf

point should be put in place to better coordinate open road testing and exchange on lessons learnt during testing on subjects of public interest.

The HLG did not feel the need for legally harmonised national testing requirements at this stage as testing the vehicle in different environments is important to make progress on the technology. The group however identified common building blocks for the voluntary mutual recognition of approval of vehicles used for testing (see Annex 4). These could be further developed in the future.

Road safety (rules for drivers, vehicles and infrastructures

Traditionally road safety is addressed through measures on vehicles, drivers and infrastructure. Automated cars will, in many cases, have a quicker reaction time than drivers but, as many of them will still require actions from the drivers, they can also raise new road safety concerns such as risks of driver confusion/distraction, misuse of the systems and liability issues.

Automated vehicles will blur the traditional distinction between rules applying to drivers (mainly national traffic rules) and rules applying to vehicles (mainly harmonized EU vehicle approval legislation). It is therefore essential that adaptation on vehicles and on traffic rules follow a coherent path. Member States should report when they intend to develop national rules on automated vehicles (e.g. safety distance) to support converging approaches across the EU and avoid conflicts with EU rules on vehicles. The European Commission will support the development of harmonized EU rules when needed.

On traffic rules, no major changes are expected for mass market systems expected by 2020 as most of them will still require a driver. However, some issues have to be addressed for some cases (e.g. authorisation for urban shuttles, safety distance for truck platooning). Vehicles with no driver may require fundamental changes as the current rules are designed on the assumption that a vehicle is always driven by a driver. This case should however concern, at least in a first stage, a limited number of driving situations (e.g. shuttles motorway application) which gives time to adapt the relevant pieces of legislation. The international level can support converging approaches on traffic rules, in particular Member States should confirm as rapidly as possible in the UNECE that the 1949 Geneva Convention and the 1968 Vienna Convention on Road Traffic [74] are compatible with the safe use of automated vehicles with a driver expected by 2020 (level 3 and 4), and should speed-up the discussion on driverless vehicles (level 4/5) as some use cases could soon be available (e.g. shuttles).

The tasks of the vehicle and the driver should be clarified/regulated (urgently for 2020 systems) in the relevant instruments (mainly vehicle legislation and traffic rules but also driver training/information tools) to ensure that the vehicle will respect traffic rules and that the driver is not confused or does not misuse the system (e.g. allowed secondary tasks). Human Machine Interface (HMI) is particularly important for automated vehicles with a driver (levels 2 to 4) and rules should ensure a high level of commonality. Communication (e.g. through external HMI) with other road users (e.g. vulnerable road users) and Authorities (e.g. police) will be important in particular for driverless vehicles and should also be considered. Principles for HMI have been developed by the group (see Annex 3). Some of these issues need further research and testing.

Regarding vehicle rules for mass market products, Directive 2007/46/EC on vehicle approval makes a large use of UNECE Regulations for vehicle safety rules. Work is on-going in UNECE to adapt the relevant UNECE Regulations (mainly Regulation 79 on steering at this stage) for systems expected by 2020. Pending the finalization of the UNECE Regulations, manufacturers can already have their vehicles approved using a national ad-hoc safety assessment for new technologies which is

[74]The 1968 Convention is applied by most of EU Member States. https://www.unece.org/fileadmin/DAM/trans/conventn/crt1968e.pdf as amended by http://www.unece.org/fileadmin/DAM/trans/doc/2014/wp1/ECE-TRANS-WP1-147e.pdf . The 1949 Geneva (predecessor of the Vienna convention) is applied by some EU Member States: https://www.unece.org/fileadmin/DAM/trans/conventn/Convention_on_Road_Traffic_of_1949.pdf

mutually recognized under the procedure foreseen in Article 20 of Directive 2007/46/EC[75]. The European Commission will develop, in 2018, EU implementing rules for systems currently covered by Article 20 procedure in the framework of Directive 2007/46/EC in particular if it is expected that the UNECE will not deliver the relevant rules by the end of 2017.

No major change is expected to the physical infrastructure (roads and signs) for automated vehicles. The HLG considered that further harmonization or improvement of the physical elements on the road (e.g. lane markings and signs) was not required compared to manual driving. Automated vehicles should, in principle, be designed with no need for special features on the road. However further harmonisation, as well as self-explaining[76] and well maintained roads and signs, could help both manual and automated driving.

Digital maps and updated road traffic information will play a significant role for automated vehicles. Data sharing and cooperation between involved actors (e.g. industry, traffic authorities, road operators, municipalities and traffic data providers) will become increasingly important to ensure at all times, the reliability, interoperability of the data conveyed to road users. The legal and technical framework on data for road safety, road traffic and multimodal travel information developed under the ITS Directive 2010/40/EU provides the European framework for the exchange of data used in digital maps. It should be implemented by Member States and service providers. It should be strengthened for automated vehicle needs.

Reflection should also start for 2030 systems in the relevant fora for other EU legal instruments such as the driving licence directive, professional driving directive, the directive on roadworthiness testing, etc.

On liability:

In general and in case of normal operation of a vehicle with no defects, the behavior of the vehicle can be determined or influenced by driver or automated vehicle/system. The actual cause of events (who has influenced the behavior) that lead to damage or incident is decisive for the attribution of liability.

As automated vehicles will be taking over driver's tasks, one could argue that it could become more complicated to assign liability in case of an accident and that victims of an accident with an automated vehicles would have problems to be compensated.

The group considered that data recording (i.e. black boxes) should be required in the type-approval legislation to clarify who was driving (the car or the driver) in case of accident to help assign liability. The legislation should cover the minimum set of data needed to clarify liability and mechanisms to regulate the data access from a technical point of view.

Regarding compensation of victims, GEAR 2030 HLG is of the opinion that motor insurance and product liability directives are sufficient at this stage, at least for systems expected by 2020. The Motor Insurance Directive (MID)[77] ensures a fast, simple and efficient means of compensation by insurers for victims of road traffic accidents, even where an automated vehicle is involved. The insurer (having settled the traffic victim's claim) can then take legal action vis-à-vis a vehicle manufacturer in case of a malfunction/defective product of the automated driving system in the context of the Product Liability Directive (PLD)[78].

[75] Directive 2007/46/EC: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0046

[76] https://www.swov.nl/sites/default/files/publicaties/rapport/dmdv/advancing_sustainable_safety.pdf . See also: https://ec.europa.eu/transport/road_safety/specialist/knowledge/road/designing_for_road_function/self_explaining_roads_en

[77] Directive 2009/103/EC relating to insurance against civil liability in respect of the use of motor vehicles: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0103

[78] Council Directive 85/374/EEC concerning liability for defective products http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31985L0374

Besides the already harmonised EU product liability regime and MID, there are some differences between the liability regimes in the Member States (e.g. road and traffic law, civil law, strict liability regime, and implementation of product liability). There are diverging views as to whether it is necessary, or even desirable, to harmonise more the different national liability regimes. Some stakeholders consider that the conclusion on the PLD and the MID may need to be revised at some point with development of future technologies. Therefore the European Commission will monitor the need to revise the MID and PLD (e.g. definition of product/service, definition of defect) as well as the need for additional EU legal instruments with the future development of technologies. In all cases, the liability system has been and will be formed by jurisprudence and situations will and must be considered on a case by case basis.

On connectivity for automation:

Vehicle-to-everything (V2X) connectivity, in its various forms (GSM short range and satellites), should act as an additional enabler for the highly and fully automated vehicles that will hit EU roads by 2030. It is expected that basic safety and automation functions will be performed by vehicles solely through the use of on-board sensors, cameras, radars and other technologies, V2X will help in some cases, and will be essential in other cases (e.g. platooning), to enable individual, collective and collaborative driving, where perception and prediction with non-line of sight sensing and coordinated resolution of complex decisions will be beneficial. Connectivity can add collective intelligence and action to automation, thus improving the overall efficiency of transport flows, including in an intermodal perspective, e.g. buses and trams.

The different types of connectivity technologies have their advantages and disadvantages (e.g. coverage, speed, security, etc.) for the different uses of automated vehicles and may have to be combined. While most of the investment should come from the private sector, the EU can help in providing regulatory approaches that foster the investments needed to deploy V2X connectivity in vehicles and communication infrastructure (road and telecoms) in a sustainable manner across the EU, in line with public policy priorities[79]. In particular, the outcome of the discussion on the European Electronic Communications Code needs to provide investment-friendly incentives to promote extensive and coherent coverage of networks. Regarding spectrum, for the 5.9 GHz ITS band reserved for safety-related applications, it will be essential to ensure the technological neutrality coupled with interoperability in the ITS band to allow the best solutions be developed by the market in line with public policy priorities in particular road safety. The European Commission is doing its best to facilitate the dialogue between stakeholders[80].

The European Commission will also work with Member States and industry stakeholders towards the voluntary establishment of a common timetable for the launch of early 5G networks by the end of 2018, followed by the launch of fully commercial 5G services in Europe by the end of 2020.

On data issues:

GEAR 2030 HLG considers the opinions set out in section 4.2.2. are applicable to automated and connected vehicles in particular; on data protection, cybersecurity, data access and, therefore, did not consider necessary to develop specific recommendations in this area.

On vehicle certification for mass market products:

GEAR 2030 HLG expressed the wish to keep the EU type-approval concept (used by many countries around the world) which is preferred to the self-certification used in the USA. However the group agreed that the type-approval system as it currently stands will have to be supplemented for automated and connected vehicles.

[79] The implementation of the Cost Reduction Directive 2014/61/EU enabling access to passive infrastructure cross sector and coordination of civil works can further facilitate increased coverage through cheaper deployment of high-speed electronic communications networks along roads

[80] https://ec.europa.eu/digital-single-market/en/news/workshop-short-range-vehicular-communications-59-ghz-band

The replacement of some driver's task as well as connectivity will require new areas to be regulated (e.g. acceleration or distance keeping, interoperability for multi brand platooning are not regulated for vehicles today). In addition the certification of functions of vehicles (braking, steering, field of vision) are currently regulated in separate regulations as the combination of these functions is done by the driver. With automated vehicles, this combination will be done by the system which may call for a specific regulation on the combination of these functions. New vehicle design should also be brought by automation, which may need new categories of vehicles and new specific requirements (e.g. shuttles of less than 8 seating passengers, front seat occupants to face the rear). Some topics are already being discussed (e.g. cybersecurity, software update, automated steering in UNECE, etc.). What is missing is a comprehensive approach and priorities. Issues that should be addressed by use cases should be identified (e.g. Human Machine Interface) as well as those that should be approached horizontally (e.g. cybersecurity).

The development of increasing electronics able to adapt the behaviour of the vehicle to a large variety of situations as well as the possibility of improving these systems in the course of the vehicle lifetime (i.e. software updates) challenge the traditional approach of vehicle approval based on pre-market harmonized tests. Alternative methods to assess vehicles such as risk analysis, hardware in the loop tests, in service conformity rules, etc. could be used. In this respect, technical services and authorities need to update their competence in electronic system certification. The extension of the EU type-approval concept to software updates of used vehicles/aftermarket currently regulated nationally should be considered to avoid market fragmentation and to keep track of vehicle changes over the lifecycle.

More information will have to be provided by manufacturers to complement the type-approval tests and assess the systems as there are limits to what can reasonably be tested safely by technical services. More information may also be needed for the registration process.

The European Commission should make the necessary proposals to supplement the EU type-approval framework for the certification of mass market automated and connected vehicles[81], look for alternative assessment methods and identify areas relevant for UNECE, EU and Member State levels. Member States may still have their own rules for vehicles produced in small series. In particular rules for vehicles designed for a specific local trip (e.g. shuttles) rules may not need to be harmonized at EU level (at least in the first stage) but vehicles could be approved locally to meet the infrastructure needs and provide flexibility.

On societal issues:

Highly automated and driverless vehicles will not only have effects on Europe's industry. The societal aspects (e.g. driver acceptance, ethical issues, social inclusion) and economic issues (impact on economic activities, environmental issues) of these vehicles should also be looked at.

Very little is known about the long term effects automated and connected driving will have on vehicle use, traffic flows, public transport or the use of space (e.g. for parking or for spatial separated lanes for automated transport) as a result of freeing up of time for work or entertainment in the vehicle. New mobility patterns might cause different urban planning and a better air quality. But they could also lead to more or longer journeys by freeing the driver from driving tasks increasing emissions. Automation will affect the attractiveness of areas as places to live in and social inclusion especially in rural areas with limited public transport networks or for people that are now depending on others (e.g. children, aging population, impaired people).This substantial change of mobility will have an impact on regions and cities and their development.

Market penetration of automated vehicles will have implications on the labour market. In the short run, the effects are anticipated to be positive. The development of new technologies and services will require new skills and highly paid jobs (engineer, researchers) together with new medium skills

[81] See in particular Commission study here: http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=9199

jobs to maintain these new technologies. A range of new businesses, services and jobs will emerge to develop new "mobility-on-demand" and digital services. It is often argued that in the long run (i.e. when driverless vehicle will be available), automation could threaten the business of professional drivers of trucks, buses or taxis and other related professions. This needs to be anticipated and may need to be accompanied through public support actions (action on skills, vocational training, etc.). However at the current stage, technology is far for being able to completely replace drivers in all driving situations and it is more likely that instead of replacing drivers, the vehicle will assist the driver who will be then able to perform other tasks during driving in certain conditions (e.g. on the motorway). These jobs will therefore evolve and qualifications, education and training will be needed in order to adapt the workforce to this new landscape. The driving and resting times of drivers should, even with the availability of driver-supporting and automated functionalities, continue to be regulated in a way that ensures both traffic safety and the protection of standards for drivers' working conditions

In order to be able to fully profit from the economic benefits and to be prepared to handle potential challenges, economic partners, regions, cities, and authorities should get involved at an early stage. The participation of authorities, regions and cities in testing and the operation of test beds in pilot projects, studies and research on automated vehicles would help to gain the citizens' acceptance of this new technology. Pilot projects between industry, public transport providers and regions and cities guaranteeing the transfer of experience to other regions and cities would be beneficial.

In conclusion, the introduction of automated and connected vehicles should be included in broader European visions and strategies, especially in the ones on regional development, transport policies (e.g. traffic management public transport policies), energy, climate change and environment policies (in particular to seize the opportunity of combining automation with clean powertrains), ethics, growth and jobs and skills (see also Section 4.2.4.). There needs to be a wider dialogue on societal challenges of automated and connected vehicles to ensure there is widespread driver and public acceptability of the technology when it is ready for deployment. This dialogue should involve the European Commission, all social partners, Member States, local and regional authorities. Pilot and research projects could help to make progress on these issues.

6.2.2 The funding and financing framework for connected and automated driving

It is vital to strengthen the position of Europe as a world leader in innovative mobility and to create new global market opportunities for our industry. Car manufacturers in particular are in a worldwide race to develop automated and connected vehicles, which includes new entrants from the global ICT industry.

Investment in key technologies for automated and connected vehicles will play an important role for the EU automotive industry to remain globally competitive. The automotive sector is the largest private investor in R&D but the EU has dropped from being the largest region for corporate R&D spending to being the third largest, with Asia now taking the lead[82].

Moreover, the development of automated and connected vehicles is supported by different government programmes around the world given the potential spill over effects for the transport system, for the environment, for other sectors and for the economy as a whole. In 2016, the US government announced investment of $4 billion into automated vehicles[83].

To accelerate the implementation, realise the foreseen benefits for society and secure global competitiveness of the sector, Europe needs a consistent and coherent funding and financing strategy. Policy and industry stakeholders must develop this strategy together to create an innovation-friendly environment for connected and automated driving and tackle the key challenges and remove barriers to implementation and accelerate deployment. For this purpose, the objectives

[82] https://www.strategyand.pwc.com/media/file/The-2015-Global-Innovation-1000-Media-report.pdf

[83] https://obamawhitehouse.archives.gov/the-press-office/2016/01/20/fact-sheet-how-bold-investments-administration-auto-industry-and-city

in GEAR 2030 were to analyse current funding and financing mechanisms at national and European level (see Annex 5) and, secondly, to give concrete recommendations to the EU, Member States and other relevant stakeholders for coherent financing and funding mechanisms.

At the European level, several funding and financing mechanisms exist. However, while there is a range of opportunities available in Member States and Europe, overall programme strategies appear to be lacking.

The analysis has shown that there is a strong need for a coordinated approach and priority setting for funding research, demonstration and deployment activities at European and national levels in order to maximise synergies and avoid fragmentation between different programmes (e.g. Horizon 2020, Connecting Europe facility).

In the first place, in order to promote such coordinated approach, further actions are required to foster strategic planning, linking research, and (pre-) deployment based on industrial roadmaps and societal needs.

Existing national and multinational tools and programmes have specific purposes and requirements, but do not yet follow one comprehensive approach towards CAD deployment. A better coordination of national and multinational funding programmes would support the fast roll-out of CAD. Such an approach can leverage additional potential to accelerate innovation and find further synergies between initiatives of existing communities. National and multinational funding programmes should identify the relevant actors and prioritize the most important issues related to CAD in order to achieve concrete and useful outcomes that would accelerate the deployment of CAD in Europe.

Secondly, CAD is a strategic topic for the EU competitiveness that needs a long-term perspective for research and innovation. At the same time, it is a quickly evolving and multi-disciplinary topic that needs the involvement of public and private stakeholders. In this context, a Public Private Partnership (PPP) could help build a long term vision for research and deployment. This instrument would give the framework for a coherent, comprehensive and fast approach for research and innovation activities with European added value. Moreover, it would represent a long-term commitment from the European Commission and industry to invest and innovate with a joint vision and deliver quantifiable objectives. Finally, a PPP would contribute to build a comprehensive approach integrating additional resources for automotive-related topics such as cyber security, artificial intelligence, or robotics.

Thirdly, with regard to the research and innovation phase to assess impacts and understand user and societal effects across many different Member States, Europe needs larger scale demonstrations, pre-deployment projects and pilot initiatives involving all relevant stakeholders. This will also help strengthen public awareness.

They have the potential to accelerate implementation and remove technological, political and other types of barriers related to CAD. Because of the complexity of the mobility system, only large-scale demonstrations and pilot initiatives can validate societal benefits. Furthermore, these activities would make it possible to identify necessary regulatory measures, validate (data) business models and study socio-economic impacts including societal acceptance.

However, these activities are highly cost-intensive and require significant resources due to the technical maturity and multi stakeholder involvement. Therefore, they should be supported by appropriate funding by the Member States and the Commission in the long run.

Finally, with regard to the industrialisation phase, the European Commission may consider an Important Project of Common European Interest (IPCEI) for connected and automated driving (CAD). This instrument could facilitate Member States, EU and industry to co-finance a large scale comprehensive project or project portfolio to develop, deploy and realize CAD in Europe. Member States and industry should define which topics and priorities should be addressed by this IPCEI, in order to produce concrete and useful deliverables that could accelerate the deployment of CAD in Europe.

Any reference to funding would, of course, imply complying with the relevant procedures and conditions for each type of funding and financing instrument, both at the national and European level.

7. Conclusions and Way Forward

The challenges facing the European automotive sector are immense but so are the potential opportunities. As this Report clearly identifies, the sector requires a collaborative effort from the European Commission, Member States, the industry and other stakeholders to ensure that the sector retains its global competitiveness and leads the transformation. The sector is facing a combination of major challenges that, together, are leading to a major structural change in the industry and the entire value chain.

Firstly there is a challenge from the growing competition from non-EU manufacturers in new technologies. A successful response requires ensuring that the EU regulatory framework is ambitious but realistic, cost-effective and properly enforced. This will lay the groundwork for technological development in key areas as well as contributing to the EU environmental and safety objectives. This should be supplemented by global technical harmonisation such as that under the UNECE framework which helps to create an international level playing field and reduce development costs and bureaucracy.

Secondly, the development of digital technologies and the drive to meet climate goals, reduce energy consumption and tackle pollutant emissions will have a significant impact on the industry and the entire value chain. The response will need to include continues investment in RDI and new production techniques.

Thirdly the increasing importance of ZEVs and ZECs are key drivers for change. This reflects the need to meet challenging climate change targets and to respond to the challenged posed by new entrants. To achieve substantial progress in this area will require an appropriate regulatory structure including incentives and a sufficient refuelling and recharging infrastructure. EU CO_2 emission regulations provide an effective EU tool; driving fuel efficiency, ensuring market predictability, stimulating innovation and creating a level playing field. This must be supported by measures to improve the performance of battery packs and cells and to develop the next generation of batteries and technologies. However, it is clear that cleaner internal combustion engine vehicles will have an important role in the on-going transformation of the sector. They will be especially important in the case of heavy duty vehicles to help their transition to low and zero emission technologies.

Fourthly there needs to be a shared strategy on automated and connected vehicles as underlined by the Amsterdam Declaration of April 2016 and in the European Strategy on Co-operative Intelligent Transport Systems (C-ITS). The successful development of these types of vehicles poses a number of challenges and so requires close co-operation at the EU and Member State level to ensure maximum benefit can be taken from large scale testing and research. It will also create a need to develop new rules on data storage.

Finally, and equally importantly, it must be recognised that there will be a significant impact on the sector's workforce. There will need to be EU, national and industry-led measures to help the workforce adjust to these changes especially to encourage mobility of staff, transferability of skills, developing a well-functioning apprenticeship market and certification of non-formal learning.

Overall the members of the GEAR 2030 HLG have, through this report, underlined their commitment to ensure Europe's automotive sector not only faces these challenges but does so with its competitiveness enhanced and making a substantial contribution to Europe's environmental goals.

Based on the GEAR 2030 discussions and the analysis made in this Report, a number of recommendations to meet the challenges outlined above and to guide the direction of future work, have been identified. The HLG GEAR 2030 makes the following recommendations (including a number of more technical recommendations on automated and connected vehicles):

I. Regulation, standards, enforcement and incentives

1. *An **EU industrial policy agenda,** aligned strongly with the 2030 Climate and Energy targets to provide robust investment signals, based on targeted EU and Member States' financing, strong R&D support with focus on the most innovative and state-of-the-art technologies and implementation, appropriate infrastructure development, smart regulation which is effectively monitored and enforced. This will reinforce **the Single Market.***

2. *Providing **acceptable lead times, clarity and rigor, including the simplification of the existing and future regulatory framework and its implementation** with a view to improve the predictability that is necessary for investment into new technologies and mobility solutions without compromising safety, sustainability and mobility**.***

More specifically on zero emission vehicles:

3. ***The rapid implementation of the Alternative Fuels Infrastructures Directive** along with enhanced co-operation, facilitated by the Commission, based on the National Policy Frameworks (NPFs) under Directive 2014/94/EU, with a view to cover strategic parts of the infrastructure network and also cover more remote parts where business cases are weak.*

4. *Revision of the CO2 targets for the post-2020 period is considered appropriate and necessary. Additional measures taken at the European level to stimulate faster and EU-wide uptake of zero-emission vehicles should be considered. The Impact Assessment for the revision of the EU CO2 Emission Regulation is still on-going. A variety of additional measures such as for example a specific target or crediting system coupled with incentives for zero-emission vehicles is being considered.*

5. *Development of **a coherent policy framework to support the mass production of batteries and battery cells** in Europe taking into account that batteries are used in a variety of sectors and applications.*

6. *Development and implementation of measures that increase the demand for clean vehicles i.e. low and zero emission vehicles for example ambitious fleet targets for heavy duty vehicles and technology neutral registration quotas for the public authorities for zero-emission and zero-emission capable vehicles in the context of **the Clean Vehicle Directive** revision. This should also provide a stronger push for the roll-out of low and zero-emission and zero-emission capable vehicles within the public procurement framework*

7. *Monitoring of the implementation of the **Guidelines on Financial Incentives** by the Commission and Member States to promote energy efficient vehicles remains relevant.*

More specifically on automated and connected vehicles

8. *Development of **large scale open road testing and trials** by the European Commission and Member States involving all stakeholders to strengthen awareness, assess the impacts and understand user and societal effects across different Member States.*

9. *Coordination by means of **only one EU-wide focal point for** open road testing and trials to **exchange lessons learnt** on public interest subjects.*

10. *Inclusion of **data storage requirements in the type-approval legislation to clarify liability** as to who was the driver (system or driver) in case of an accident. The Commission should monitor and evaluate the need to revise the Motor Insurance and Product Liability Directives as well as the need for additional EU legal instruments to take account of future development of technologies.*

11. *Revision by the Member States of their national **traffic rules system** and reporting **to support converging approaches across the EU**. Member States should also confirm, as rapidly as possible, in the UNECE that the 1949 Geneva Convention and the 1968 Vienna Convention on Road Traffic are compatible with the safe use of automated vehicles with a*

driver expected by 2020 (level 3 and 4), and should speed up the discussion on driverless vehicles (level 4/5) as some test cases could soon be available (e.g. shuttles).

12. *Preparation by the European Commission of **the EU type-approval framework for the certification of automated vehicles, including alternative assessment methods and identification of work priorities at the UNECE, EU and Member State levels.** Development by the European Commission of appropriate EU implementing rules in 2018 for new technologies fitted in vehicles currently covered by an EU exemption procedure.*

13. *Initiation of work on possible modification of the **EU legal instruments such as the driving licence directive, professional driving directive, the directive on roadworthiness testing**, etc.*

14. *Regarding connectivity, the Commission and Member states should **agree on Regulatory approaches that foster the investments** on connectivity in vehicles and infrastructure (e.g. road and telecoms) in a sustainable manner across the EU in line with public policy priorities. This should be implemented in the context of current work on the 5G Action Plan and discussions on the European Electronic Communications Code.*

15. *Effective implementation by the Member States of the legal and technical framework under the **ITS Directive and its delegated Regulations.** Moreover, the Commission shall further strengthen this framework with respect to 2030 systems (i.e. in relation to digital maps).*

16. ***Inclusion of societal challenges and social acceptance considerations in broader European visions and strategies on automated and connected vehicles**, especially on regional development, transport policies (e.g. traffic management), ethics, growth and jobs and skills. These issues should be discussed in the relevant fora with social partners and Member States. Pilot and research projects could help to make progress on these issues.*

17. ***Better co-ordination of national and multinational funding programmes** to foster strategic planning, linking research and pre-deployment activities at the European level. To overcome weaknesses in planning for funding and financing of connected and automated vehicles Member States and the relevant stakeholders should:*

    - *provide the Commission with the regular update about planned activities that would require EU financing;*
    - *better coordinate cross-border or EU wide activities requiring funding through exchange of information;*

    In order to achieve the above mentioned objectives, a platform managed by the European Commission to gather and subsequently disseminate such information should be established.

<u>More specifically on the value chain</u>:

18. *Implementation by Regional authorities of **measures** for supporting the competitiveness of the automotive value chain at the **regional level** including:*

    - *Designing programmes at the regional level to support the development and implementation of new technologies and increased digitalisation by SMEs;*
    - *Creating (regional) tailored-made training programmes for the automotive industry and a framework to attract and retain talents; and*
    - *Promoting circular economy projects at the regional level and use of circular economy considerations in the evaluation of projects.*

II. Investment

19. *The European Commission, Member States, regional authorities and the European Investment Bank (EIB) should, in a coherent way, **make available specific R&D programmes for further development and commercialisation** of low and **zero emission vehicles** / technologies, connected and automated vehicles and advanced manufacturing processes as well as for the cost-effective introduction of advanced materials into vehicle components. They should **promote collaboration and strategic alliances** as a way of enabling companies to share the costs of RDI investments in the light of the investment needs resulting from ongoing changes in the automotive sector to enter new value chains and to develop new business models, as well as to avoid bankruptcies and destruction of capital.*

20. *Development by the EIB and the European Commission of innovative financing models that aim at generating **more leverage, reducing risk and unlocking private sector's investments in new capital-intensive recharging and refuelling infrastructure** and hydrogen distribution infrastructure.*

21. *Exploring the possibility of **a multi stakeholder collaborative project between Member States and the industry, to start production of battery cells/packs in Europe** based on the existing and next generation (Li-ion) technologies (e.g. solid state).*

22. *Consideration by the European Commission, Member States and industry **of a Public Private Partnership (PPP) for connected and automated driving**. Such a partnership could help building a long term shared vision for research and deployment respecting the principle of subsidiarity. .*

III. Technology, business models and structural change

23. *Identification by the industry, **within the automotive value chain, of their digitalisation priorities. This should include the definition of implementation road maps/action plans**, and investment in the implementation of digital processes and services and coordination of activities with other stakeholders.*

24. *Identification and definition of future human capital needs according to identified trends and potential scenarios. The industry, with the support of EU, Member States, Education and Training providers, Academia should **identify tools and implement measures to address human capital / skills gap** including:*

    - *Creating a framework of standard job roles with associated skills requirement to increase the understanding on available opportunities in the sector;*
    - *Improving transferability of workforce across the value chain;*
    - *Creating a better functioning EU apprenticeship market; and*
    - *Improving the recognition of non-formal/informal learning recognition*

25. *Properly addressing any social and employment impacts of structural change by using the scope of already existing funds such as European structural and investment funds in order to increase the employability of the workforce, to re-train those whose jobs are at risk, to support the re-development of automotive regions.*

26. *The European Commission should assess the need to update to technological progress existing legislation and analyse to which extent it allows the entire automotive value chain and end users to benefit from the opportunities of digitalisation. The European Commission should assess whether additional sector specific legislation, relating to data, is needed.*

27. *The need for the Commission to continue to engage in a wide-ranging stakeholder dialogue on the issues relating to data and in particular support multi-stakeholders initiatives that*

***promote access, storage and sharing of vehicle data**. The industry and service providers should guarantee a fair access, storage and sharing of vehicle data.*

28. *Support by the Commission, Member States and OEMs of **the automotive SMEs in redefining their value chain positioning**, redirecting their core competencies to other fields of business within or outside the automotive industry and in increasing their capacity to integrate digital technologies in their products and production processes, support circular economy, reuse of spare parts, raw materials, setting up a thematic partnership for the automotive sector under the Smart Specialisation Platform for Industrial Modernisation.*

IV. International co-operation and trade

29. *Setting up/reinforcement by the EU and the industry of **dedicated regulatory dialogues with all relevant trading partners** including at least the US, Japan, China, Korea, Russia and India, and representing EU interests with a single voice.*

30. *Enhancing of the **existing institutional and industrial dialogue with China** at all levels in order to:*

    (1) identify and address trade issues that could impact EU competitiveness;

    (2) build up a collaborative "standards and regulatory" setting process, and seek to harmonise Chinese technical regulations with international ones (alignment of GB standards with UNECE), work with EU and other international partners in new regulatory areas, improve the functioning of the certification processes (CCC) and streamline market surveillance procedures (e.g. call back system NDRC/AQSIQ);

    (3) facilitate the process that will lead to a full opening of the market in China including the revision of the Joint Venture Regulation to promote EU investments; and

    (4) create a permanent regulatory platform where all stakeholders can discuss at regular intervals and strive towards a better understanding of China related issues and to define proactive actions and coordinate approaches. The new platform can also help to technically prepare the messages that can be passed to China at the government to government level.

    (5) reinforce the dialogue on the IPR whole spectrum (including copyrights, trademarks and patents), for example by exchanging best practice on local and global IPR protection with the objective of having common IPR laws compatible with international IPR treaties.

V. Mind-set and culture

The above set of recommendations represent a comprehensive framework for supporting the transformation of Europe's automotive industry to meet the challenges posed, in particular, by changing consumer demands, regulatory changes on third markets, while adapting to new technologies and developing business models. However, while necessary, this in itself is not sufficient to make the change required to ensure the long-term competitiveness of the sector. It is essential that the EU re-establishes itself as a global leader in automotive regulation as well as manufacturing.

Therefore:

31. *The EU should aim to become a global standards setter and regain the trust in EU rules that was lost during the diesel scandal. This can only be done effectively through close co-operation by the Commission, Member States and the industry. This is essential to ensure greater global certainty, prevent long-run declines in investment, restore consumer confidence and enhance the competitiveness of the European industry.*

32. *This approach must be underpinned by industry support of the ambitious and realistic EU regulatory framework that facilitates technological development, is cost-effective in the long run and can credibly inspire regulatory developments outside the EU. Promoting quality rather than price competition for example will not only secure market access abroad but will also reduce external competitive pressure on the EU market.*

Next Steps

The recommendations suggested above will require a joint follow-up by the Commission, Member States, industry and other stakeholders. Some will require an immediate action, while others may require a more long-term consideration.

To take forward this work, the Commission will set up informal working groups that will bring together the relevant experts within the Member States, industry and other stakeholders.

For this purpose, the Commission will consider the existing mechanisms (e.g. Motor Vehicle Working Group or Motor Vehicle Working Emissions Group, existing task forces) or propose any other adequate forum, in cooperation with the Member States and stakeholders.

The said implementation will be guided by the consensus reached on a number of key principles during the preparation of this report.

Annexes:

1. Terms of Reference of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (GEAR 2030)
2. List of High Level Representatives
3. Guidelines on Human Machine Interface for CAD.
4. Building Blocks for Road Testing
5. Guidelines on financial incentives
6. Definitions

Annex 1
High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (GEAR 2030)
- Terms of Reference –

CONTEXT

The automotive industry is undergoing an important transformation. It will need to adapt to changing conditions and take advantage of the opportunities they offer. This is especially important in the context of on-going structural societal changes (e.g. aging of the population, progressing urbanisation, ever increasing digitalisation or changes in mobility behaviour) as well as general trends including air pollution and global warming, high congestion in urban areas, improvements in public transport and longer vehicle life-times, which are gradually re-shaping mobility and private needs in Europe thus impacting patterns of demand for traditional vehicles. The developments attract both established automotive actors and newcomers to the sector. The European automotive industry needs to create competitive advantages and commercial business cases to meet "disruptors" entering the transport sector. Moreover, in a globalised environment, the competitiveness of this sector in the EU is closely interlinked with the external dimension: exports to third counties and localised production in dynamic - developing - markets. A major forward looking challenge is to maintain or increase the share of EU-produced high-quality and high-technology automotive products on third country markets with a high growth potential.

With a view to ensuring a co-ordinated approach at Union level and in order to address the challenges and the opportunities that the European automotive industry faces, the Commission has decided to set up a new High-Level Group for the automotive industry.

The High Level Group GEAR 2030 (HLG) was formally established on the basis of the Commission Decision 2015/C 6943/2 of 19 October 2015.

MISSION STATEMENT

GEAR 2030 should help to develop medium and long-term recommendations to address main challenges and opportunities for the European automotive industry in the run-up to 2030 and beyond.

GEAR 2030 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.

By providing a stakeholder forum for discussion and strategic advice GEAR 2030 should, help building consensus amongst the automotive community and assist the different departments of the Commission in developing policies for the EU automotive sector and its whole value chain. By its level of representation it should also help to build political support for the implementation of such policies.

DELIVERABLES

GEAR 2030 is expected to deliver a **final report** that will build on the conclusions from the Working Groups defined for three priority areas below. The final report should contain **recommendations** for the Commission, Member States and industry. The HLG will give a particular attention to the identified priorities, such as adaptation of EU automotive value chain, highly automated and connected vehicles or global competitiveness and under which it may also develop **roadmaps** for particular issues, for example, regarding alternative fuel vehicles, new business models in

automotive sector or highly automated and connected vehicles. These roadmaps may further serve for preparation of the above mentioned recommendations.

COMPOSITION OF GEAR 2030

GEAR 2030 has 25 members and 25 Sherpas, which have been selected through a public Call for application[1] based on a number of selection criteria (point 4.2.).

The following stakeholders participate:

- Member States
- Trade Unions
- Non-Governmental Organisations in the field of environment, road safety and telematics
- Distribution and aftermarket sector
- Consumers/Users/Car buyers
- Manufacturers of different types of vehicles (cars, trucks, buses, two-wheelers)
- Suppliers of vehicle components
- Insurance providers

The Commission may, taking into account suggestions from the HLG and Sherpa members, invite experts from outside the HLG with specific competence on a given subject to participate in the work of the HLG. It can also grant observer status to other individuals or organisations.

OPERATIONAL STRUCTURE

The work of GEAR 2030 will be supervised by the relevant Ministers, CEOs and Presidents of associations who are members of the HLG lending political visibility and authority to the process.

GEAR 2030 will operate at **three-level structure:**

- the "Sherpa" Group

- **the Working Groups**

- **the Project Teams**

Sherpa Group

The Sherpa Group will be responsible for preparing the input (discussions, roadmaps, position papers and advice for actions and policy measures) to the High Level Group and for steering the Working Groups. It will consolidate the work streams and prepare the input for the High Level Group meeting.

Working Groups

The Working Groups are thematic groups, responsible for steering the work in three areas being subjects of GEAR 2030. They will report to the Sherpa Group. The rapporteur can be Commission representative or selected member from the Working Group. The exact mandate and composition of Working Groups will need to be adopted by the Sherpa Group. The participants in the Working Group meetings are either representatives from organisations present in the High Level Group or additional participants, invited by the Commission or the Sherpa Group, having expertise in the specific issues discussed by the Working Group.

The three Working Groups will be set-up in total, each to address one of the following themes:

1) Adaptation of EU automotive value chain
2) Highly automated and connected vehicles
3) Global competitiveness

[1] http://ec.europa.eu/DocsRoom/documents/14330

1. Working Group "Adaptation of EU automotive value chain".

The Working Group on the "Adaptation of EU automotive value chain" will analyse the impact of the existing and future global trends of decarbonisation, disruptive technologies and services on the competitiveness of the European value chain and in particular SMEs. It will consider possible supportive measures which could strengthen the innovative potential of the automotive industry, including, for example rewarding top-runner manufacturers, tapping into the potential of circular economy models, and facilitate its adaptation for the up-coming changes.

In particular, a roadmap on alternative and clean powertrains including electrification/innovative business models will be elaborated and discussed. The Working Group should recommend possible initiatives at Commission, Member States and industry level.

The Working Group will also identify, analyse and discuss the existing and potential future knowledge gaps and develop policy approaches which will ensure that the EU will have access to adequate skills and technologies indispensable for the developments in the new mobility areas. The Working Group should come up with recommendations for possible initiatives at the Commission and the Member States levels.

2. Working Group "Highly automated and connected vehicles".

The "Highly automated and connected vehicles" Working Group will assist the Commission in identifying key areas which need to be addressed at the European level and in providing a set of concrete recommendations (roadmap) on:

- policy and regulatory needs (interaction vehicle-other road users, vehicle approval, liability issues, data issues, infrastructure needs, etc.);
- required research and investments mobilising existing EU, national and regional instruments as well as private investments;
- international co-operation and competitiveness aspects;

3. Working Group "Global competitiveness".

It is essential to better understand how the broader policy agenda and developments in the third country markets, including the setting of standards, shape the competitiveness of the EU automotive sector. The "Global competitiveness" Working Group will identify and analyse key opportunities and challenges facing the EU automotive industry in the run-up to 2030 and beyond by comparing the framework conditions including the regulatory framework of the EU's main partners (US, South Korea, Japan and China.

More specifically, this Working Group will explore the potential development of a regulatory framework as a means of enhancing certainty, investment and sustained/sustainable growth.

The "Global competitiveness" Working Group may also examine to what extent it would be relevant to develop trade specific roadmaps, for emerging economies with important development potential in the automotive sector (e.g. China), which would be compatible with and complementary to the Trade Strategy outlined in the Communication "Trade for all"[2].

Project Teams

A Working Group may, in agreement with the services of the Commission, set up thematic sub-groups Project Teams to examine specific questions related to the mission of the Working Groups. The Project Teams shall only last as long as necessary to fulfil their mandate. The Project Teams may be composed of representatives from organisations present in the Sherpa Group, in Working Groups or additional participants nominated by the Chairman of the relevant Working Group.

[2] http://trade.ec.europa.eu/doclib/docs/2015/october/tradoc_153846.pdf

WORKING METHOD

- GEAR 2030 shall regularly bring together the most relevant interest groups and experts necessary for carrying out its mission. It should hold a regular dialogue on all matters relating to the competitiveness, innovation and growth of the automotive industry. It is expected to issue recommendations on the priority areas and other relevant issues.
- The HLG will normally meet once a year. The meetings will be chaired by the Commissioner in charge of the Internal Market, Industry, Entrepreneurship and SMEs and attended by Commissioners responsible for relevant policy areas.
- Representatives at the Sherpa level will hold maximum four meetings per year. Each Working Group should meet on a regular basis at least every three months.
- GEAR 2030 will allow participation of a broader group of stakeholders at the level of Working Groups and Project Teams.
- The set-up of Project Teams as well as their mandate will be agreed by the Working Groups and validated at Sherpa Group level. Working Groups designate Project team Chairmen among their members. The Chairman of each Project team should report on its work to the Working Group and Commission services attending the Working Group meetings.
- GEAR 2030 shall build upon and use contributions from other relevant initiatiatives and will not duplicate the work currently performed or already accomplished.[3]
- All relevant documents on the activities carried out by the HLG and all its sub-groups (such as agendas, minutes and participants' submissions) will be made available *via* a link from the Register of Commission Expert Groups to a dedicated website [4] where the information can be found.

MEETINGS AND EXPENSES

The meetings of the HLG, Sherpa Group and Working Groups will be held in the Commission premises and chaired by a representative of the Commission. The Commission services[5] will provide secretarial support for all the levels.

Travel and subsistence expenses incurred by participants in the activities of the HLG and Sherpa group shall be reimbursed by the Commission in accordance with the provisions in force within the Commission. However, the reimbursment clause does not apply to the participants in the activities of Working Groups and Project Teams.

Participants in the activities of GEAR 2030 at all levels shall not be remunerated for the services they render.

[3] In particular, work currently performed on connectivity within the C-ITS platform and within the Round Table on Connected and Automated Driving, especially on security and on aspects linked to road infrastructure issues as well as road safety; on rresearch and innovation within Strategic Research and Innovation Agenda (STRIA) or on trade policy/strategy outlined in the Communication "Trade for all".

[4] http://ec.europa.eu/growth/sectors/automotive/policy-strategy/index_en.htm

[5] Contact point is DG GROW – Unit C4, e-mail : Grow-GEAR2030@ec.europa.eu

Annex 2
List of High Level Group participants

MEMBER STATES	
Belgium	
Phillipe Muyters	Flemish Minister for Work, Economy, Innovation and Sport
Czech Republic	
Jiri Havlicek	Minister of Industry and Trade
Austria	
Jürgen Streitner	Head of Department, Sustainable Economic Development, Austrian
Spain	
Begoña Cristeto	Secretary General of Industry and Small and Medium Enterprise
France	
Pascal Faure	Director General of Enterprises, Ministry of Economy, Industry and Digitalization
Italy	
Graziano Delrio	Minister of Infrastructure and Transport
Netherlands	
Tomas de Laat	Head of the Traffic policy division, Ministry for Infrastructure and the Environment
Germany	
Brigitte Zypries	Federal Minister for Economic, Affairs and Energy
Poland	
Jadwiga Emilewicz	Deputy Minister of development
Romania	
Sorana Baciu	Ministry of Economy
Slovak Republic	
Peter Žiga	Ministry of Economy

Sweden	
Mikael Damberg	Ministry for Enterprise and Innovation
United Kingdom	
Claire Perry MP	Minister of State for Industry Department for Business Energy and Industrial Strategy
INDUSTRY, REPRESENTATIVES OF CONSUMERS, TRADE UNIONS, ENVIRONMENTAL PROTECTION, ROAD SAFETY, ITC	
Erik Jonnaert	Secretary General, Association des Constructeurs Européens d'Automobile **(ACEA)**
Antonio Perlot	Secretary General, Association des Constructeurs Européens de Motocycles **(ACEM)**
Monique Goyens	Director General, The European Consumer Organisation **(BEUC)**
Sigrid de Vries	Secretary General, European Association of Automotive Suppliers **(CLEPA)**
Jean-Charles Herrenschmidt	President of the European Council for Motor Trades and Repair **(CECRA)**
Monika Sebold-Bender	Chair of Motor Working Group, **Insurance Europe**
Hartmut Röhl	President, The Federation of Automotive Aftermarket Distributors **(FIGIEFA)**
Luc Triangle	General-Secretary, **IndustriAll European Trade Union**
Thierry Willemarck	President, Fédération Internationale de l'Automobile **(FIA),** Region I
Christian Koetz	President, European Tyre & Rubber Manufacturers Association **(ETRMA)**
Oliver Carsten	Professor of Transport Safety, Member and Expert of European Transport Safety Council **(ETSC)**
Jacob Bangsgaard	CEO, European Road Transport Telematics Implementation Coordination Organisation **(ERTICO)**
William Todts	Executive Director, Transport & Environment **(T&E)**
OBSERVERS	
Marco Felisati	Delegate of the European Economic and Social Committee **(EESC)**
Dirk Bosteels	Executive Director, Association for Emissions Control by Catalyst **(AECC)**
Ximo Puig i Ferrer	President, Generalitat Valenciana, Committee of the Regions **(CoR)**
Marta Capelo Gaspar	Head of Public Policy, European Telecommunications Network Operators' Association **(ETNO)**
Patrice Chazerand	Director, **Digital Europe**

Stephanie Pfeifer	Chief Executive, Institutional Investors Group on Climate Change **(IIGCC)**
John Chatterton-Ross	Federation Internationale de Motocyclisme **(FIM)** and FIM Europe - FIM Brussels Representative
Joop Hazenberg	Senior Manager European Advocacy, **GSMA Europe**
Laura Piovesan	Head of Innovative Industries Division, European Investment Bank **(EIB)**
Carlos Mur	European Parliament
COMMISSION	
Elżbieta Bieńkowska	Commissioner for Internal Market, Industry, Entrepreneurship and SMEs
Mariya Gabriel	Commissioner for Digital Economy and Society
Miguel Arias Cañete	Commissioner for Climate Action & Energy
Violeta Bulc	Commissioner for Transport
Marianne Thyssen	Commissioner for Employment, Social Affairs, Skills & Labour Mobility
Cecilia Malmström	Commissioner for Trade
Karmenu Vella	Commissioner for Environment, Maritime Affairs and Fisheries
Carlos Moedas	Commissioner for Research, Science and Innovation
Alexander Italianer	Secretary General
Andrus Ansip	Commissioner for Digital Single Market

Annex 3
Guidelines on Human machine interface for Automated and Connected vehicles

A) Human Machine interface (HMI) is very important for automated vehicles as these vehicles will have to interact with the driver (internal HMI) and with other road users (external HMI). In particular the level of the driver's attention required for the safe transfer of control between vehicle and driver is of particular importance for vehicles with drivers (levels 2, 3 and some levels 4 that still require a driver). For driverless vehicles (level 4 vehicles for limited traffic conditions/level 5 vehicles for all traffic conditions), internal HMI (with the driver) is less important but external HMI (with others) is more important.

B) The Commission should consider ways to regulate HMI where necessary. The Commission should ensure that the UN-ECE working groups (WP1 and WP29) are aware of the following principles and work on the coordination of the different Member State positions in these working groups. ISO standards should also be used an input.

C) The rules on HMI could be drafted around the following principles

1. There is an expectation by the public that automated vehicles will be safer than manual driving.. Thus, when operating under vehicle control (vehicle as the driver), vehicles shall behave in such a way that road safety is their primary concern.
2. The clarification of driving tasks between the driver and the vehicle requires a case-by-case analysis, depending on automated functions, driving environment, modalities through which automated systems receive and give back control from / to the driver, available minimum risk manoeuvres.
3. For automated vehicles with a driver (levels 2, 3 and 4) there is the risk of human operator confusion if the designs of HMIs are substantially different across vehicle makes and models. Therefore the major information and interaction features of the HMI should be designed in a way that allows intuitive and easy accessible control of the vehicle functions and must have a high level of commonality for drivers among cars and when crossing borders.
4. Requirements for HMI inside the vehicle are less important for driverless vehicles (levels 4/5) as there is no sharing of the driving tasks between the driver and the vehicle. However for all vehicles with a driver switching from driver as passenger (level 4/5) to driver driving), the principles established for levels 2, 3 and 4 shall apply.
5. The vehicle from SAE level 3 shall be capable of appropriate indication of its intentions in interactions with other road users. This for example may include using its indicators where a human driver should activate the indicators or sounding the horn to alert other road users, or other indications to replace those of the human if it is not expected that the driver is going to carry out this task. External HMI is even more important for driverless vehicles (Levels 4/5) to help in indicating the vehicle's intention and thereby reducing ambiguity in interaction of the automated vehicle with pedestrians, motorcyclists, cyclists, other drivers and police. It is very important for driverless vehicles as no interaction between the driver (e.g. eye contact) and other road users (e.g. pedestrians in urban road traffic) can be expected. Such external HMI is in addition to the normal use of the indicators and, where appropriate, the horn. Such HMI could include other technical solutions, e.g. . unique lighting indicating the autonomous driving mode, remote display. Here again, arguments can be made for a high degree of standardisation in order to prevent confusion. This is an area where urgent research is needed.
6. Vehicles would also, in any situation, have to take into account the presence of vulnerable road users, and have to comply with rules for zebra and other crossings. They shall also take into

account the potential risks of individuals choosing to "challenge" an automated vehicle, as well as e.g. children, putting themselves inadvertently into dangerous situations.

7. Automation shall not be enabled on roads, in situations or in circumstances that it is not capable of handling. Traffic rules may need to be adapted for that. The vehicles from level 3 shall therefore restrict the use of automation to road types, road layouts and road geometry that it can handle. All vehicles level 3-5 shall also recognise performance degradations which prevent safe operation, such as reduced visibility, lack of connectivity, sensor failure, etc. On encountering situations that it cannot handle, it shall hand over driving to the human or automatically perform a minimum risk manoeuvre. Vehicles will need to detect safety-related faults and respond appropriately
8. The vehicle shall ascertain that the driver is ready to take over when required by the system, this includes driver availability, engagement, and attention to the road and traffic situation. If the vehicle determines that the human is not able or willing to resume control when required to do so, then the vehicle shall take appropriate action. Depending on the SAE level, the vehicle shall warn the driver and/or perform a minimum risk manoeuvre in which it secures as little danger as possible to the vehicle occupants and other road users.
9. When operating under vehicle control (vehicle as the driver), vehicles shall obey all relevant regulations, including local regulations. This would include, for example, speed limits (fixed, variable and dynamic), access restrictions, lane restrictions, traffic signal instructions, road works regulations and passenger restraint use. Levels3-4 vehicles would have to obey instructions from the police or other relevant authorities. Based on the fact that the vehicle is driving, then the passenger in the driving seat may be allowed to engage in activities that are currently forbidden, for example mobile phone use. Traffic rules, for example on minimum following distance (e.g. for trucks in platooning), may need to be amended as automated vehicles may be able to cope with shorter braking distances (i.e. shorter reaction time/humans).
10. Given that seat positioning may be variable in levels 4-5, e.g. allowing front seat occupants to face to the rear, the assessment of occupant protection may require new procedures or modifications to existing procedures and regulations.
11. Rules and transparent procedures for system assessment and approval and rules for periodic inspection will have to be developed in order to ensure that vehicles meet the requirements stemming from these principles.
12. Training and education of drivers is crucial in view to the successful implementation of highly automated vehicles. The general principles applying to driving licences should be kept (simple, universal)
13. Further research is needed to further develop the rules implementing the abovementioned principles. Existing calls in Horizon 2020 (e.g. call on automated road transport) are foreseen for some of the issues listed above and could be used.

Annex 4
Building blocks for testing of automated and connected vehicles (V2-26/09/2017)

Overview experiment procedures:

- Some requirements are specific per country
- Some requirements are the same
- It gives a general understanding what countries are looking for.
- Combined logically, building blocks can be derived using those requirements that are used by more countries

For allowing experiments, most countries want certainty over:

- The applicant/testing organization
- The driver / monitor / supervisor
- The vehicle
- The infrastructure
- Behaviour
- Documentation
- Admittance testing
- The exemption
- Field operational tests
- Code of practice

Rule versus performance based:

Some countries use rule based requirements for experiments. This leaves less room for innovation. Example:
"At any stage of automated driving, driver override must be detected after applying a maximum torque of 10 Nm at the wheel"

Proposition: use performance based requirements for experiments. Hereby focusing on the 'what' and not the 'how'. Example:
"The driver is demonstrably able to oversee risk situations and mitigate successfully"

The torque of 10 Nm is than an 'acceptable means of compliance', but other mitigation measures are now possible (what if a vehicle does not have a steering wheel?).

Building blocks for multi-national use and cross border testing exemptions:

The Applicant
Contact details known.
Is demonstrably insured for the intended FOT.

The Driver / Monitor / Supervisor
Can demonstrably operate the system and intervene if necessary.
Is demonstrably able to oversee risky situations and to mitigate them successfully.
Is demonstrably entitled to drive a vehicle on public roads.

The Vehicle
Is uniquely identifiable.
Is fully described.
Demonstrably meets the legal requirements, if applicable.

The Infrastructure
The required infrastructure is described.

Behaviour
The transition H-M or M-H is smooth.
The vehicle behaves predictably to other traffic.

Documentation
The applicant shall provide a thorough risk analysis.
The applicant shall provide the results of EMC testing.
The applicant shall provide a description of the to be tested functions.
The applicant shall provide a description of how the functions are tested.

Admittance testing
It is assessed that, where possible, the vehicle complies with the relevant existing regulations.
It is assessed that, for the parts that do not comply with the relevant existing regulations, safe operation is shown.
It is assessed that, for the parts prone to cyber security, safe operation is shown.
is assessed that the transition in foreseeable and unforeseeable situations, expires predictable and secure.
The results of the admittance tests have been described by an independent technical service.

Documentation
The applicant shall provide a thorough risk analysis.
The applicant shall provide the results of EMC testing.
The applicant shall provide a description of the to be tested functions.
The applicant shall provide a description of how the functions are tested.

Admittance testing
It is assessed that, where possible, the vehicle complies with the relevant existing regulations.
It is assessed that, for the parts that do not comply with the relevant existing regulations, safe operation is shown.
It is assessed that, for the parts prone to cyber security, safe operation is shown.
is assessed that the transition in foreseeable and unforeseeable situations, expires predictable and secure.
The results of the admittance tests have been described by an independent technical service.

The Exemption
The exemption covers the specific FOT: for this applicant, these vehicles, these drivers, on that infrastructure, for these functions to be tested.
Depending on the findings during the admission process and the intended FOT may be included restrictions.
The exemption authority has the right to extend, modify, or terminate the exemption.

Field Operational Tests
The FOT may only start when it is safe.
The FOT demonstrably delivers the actual operation of the functions.
Accidents must be reported.
The FOT is stopped in unsafe situations.
During the FOT, the applicant will keep a log.
During the FOT, a black box is mandatory.
After the FOT, an evaluation will be made.

Code of Practice
During the FOT, traffic rules are followed.
Of the area / route in the exemption the (local) trafficrules are known.
During the FOT, other traffic is not compromised.

Current status of the building blocks for testing of automated and connected vehicles

	Netherlands	Germany	Sweden	Denmark	Belgium	Spain	UK	California	NHTSA
Applicant:									
The applicant is the owner of the vehicles	x							x	
Contact details of the applicant	x	x	x	x	x	x			
Is sufficiently insured against accidents	x	x			x	x		x	
Driver/monitor									
is employed by the applicant								x	
has been trained to use the system	x	x	x		x		x	x	x
is able to intervene/has experience of dealing with risky situations	x	x	x		x		x	x	
is known by name	x		x		x		x	x	
has had a driving licence for X number of years	x	x	x	x	x		x	x	
has not been banned from driving in the past X years								x	
A human driver is always present			x (inside or outside of the vehicle)				x (can be outside)		
Vehicle									
Unique vehicle identification number (VIN + licence plate)	x		x					x	
Description of the vehicles	x	x	x	x	x				
Basis complies with the legal rules	x	x	x	x	x				
Specific equipment requirements (indicator light, warning panel, striping)		x							
Prototype licence plate									
Software version known						x	x		
Infrastructure / route									
Description of route to be followed	x	x	x		x				
Authorised for all roads				x			x		
Driving behaviour									
Transition of control (HMI)	x		x (allowed in mixed traffic)		x				
Interaction with other traffic	x								
Documentation									
Risk analysis	x	x	x		x	x	x		
EMC requirements	x	x	x			x			
Description of the vehicle + functions	x		x			x			
Test scenarios known						x			
Test scenarios which must be avoided are known						x			
Licensing tests									
Vehicle licensing on the basis of existing rules	x		x			x			
Safe operation is demonstrated / HARA	x	x	x		x	x			
Cybersecurity requirements	x				x	x			
Testing the changeover from manual to automatic and vice versa					x	x			
Testing by an independent testing body	x	x			x	x			
Testing the recognition of infrastructure (signs etc.) / depending on the infrastructure required						x			
Exemption									
Exemption necessary	x	x	x		x			x	x
Restricted validity of the waiver	x	x	x	x	x			x	
Exemption can be withdrawn unilaterally	x		x		x			x	
Self-certification			x	x					
An authorisation						x			
Maximum number of trips		x							
Exemption not transferable	x	x	x		x			x	
Exemption must be present in the vehicle	x	x			x				
Extension of exemption possible		x	x						
Test areas described	x		x						
Type of practical tests are described	x		x						
Costs for testing and exemption	x	x	x			x		x	
Field Operational Tests									
Accidents must be reported		x	x					x	x
Errors in the system must be discussed in detail								x	x
Error message if system fails							x		
Updating software versions							x		
Applicant sends periodical reports/keeps a log	x	x	x (yearly or if incident occurs)		x			x	x
Log can be consulted for up to two years after testing		x							
Maximum speed of 100 km/h		x							
System must indicate when it is not working well							x		x
It must be possible to turn off the system	x							x	x
Sensor data available 30 seconds before accident								x	
Switches on only when safe		x		x					
Switches off under certain conditions (e.g. slippery road, restricted view, traffic queue, roadworks, etc.)	x	x			x				
Code of practice									
Complies with traffic rules	x	x	x				x		x
Is aware of (local) traffic rules	x		x		x		x		
Does not pose a danger to other road users	x		x		x		x		

x: stated

empty: not stated or not known

Explanations:

- In the UK, testers can conduct tests without the need for any applications as long as they comply with national law.
- Exemptions are only for vehicles with automated functions that do not comply with type approval legislation
- The applicant is always responsible for the changes made to a vehicle (but does not have to own the vehicle).

Annex 5

Guidelines on financial incentives: Promoting energy efficient vehicles

The Guidelines on financial incentives: promoting energy efficient vehicles were prepared in the wake of the economic crisis and finally published in 2013. The primary objective was to ensure that support schemes to encourage vehicle purchasing were fair and proportionate. As part of the GEAR 2030 process the guidelines were reviewed by Working Group 1, Project Team 2 on Zero Emission Vehicles to consider their current relevance. The following reflects the consensus views of the group.

1. The Mandatory Principles in the guidance remain relevant and appropriate. These are:
    a. **Non-discrimination** with regard to the origin of the vehicle concerned
    b. Compatibility with the **EU type-approval legislation**
    c. Non-violation of **EU state-aid rules**
    d. Taking of **public procurement provisions** into account (Directive 2009/33/EC)
    e. Respecting **mutual recognition** by notifying incentives (Directive 98/34/EC).
2. The best practice principle of **technological neutrality** – that incentives should not be limited to certain category of vehicles (e.g. combustion engine, hybrid, electric etc.) - should continue to be respected. It was noted that many Member State incentive schemes fail to do this. For example: where support is given for "electric vehicles" this should rather encompass "zero emission vehicles."
3. With respect to the principle of making **reference to a common performance-criteria** this principle remains relevant although the criteria have changed along with a need to incentivise both low and zero emission vehicles with respect to both air pollution and CO2 emissions. With respect to CO2 emissions the group recognise the WLTP should be used going forward and for nitrogen oxide emissions real world driving emissions.
4. With regard to the principle of **Proportionality** (that the incentive granted should be proportional to performance improvement) the group recognised that:
    a. Proportionality remains relevant in so much as the greatest incentives should be given to zero emission vehicles; less for zero emission capable vehicles (PHEVs); and that lower carbon conventional vehicles should also continue to be incentivised through differential taxes.
    b. For zero emission capable vehicles the importance of the vehicle being regularly recharged was emphasised and that incentives should be linked to using the zero emission capability of the vehicle not just purchase support in light of the low level of electric driving experienced in the Netherlands.
    c. More important than proportionality is the sustainability of an incentive. Specifically that lower tax rates and utility benefits (preferential access arrangements) should be guaranteed for a minimum of 4 years.
5. In relation to the principle of an **adequate incentive size** this was now felt to be less relevant and that member states should be free to choose depending upon their policy priorities. However there was agreement in deciding the level of incentive both additional purchase costs and total cost of ownership should be considered along with avoiding big threshold effects – particularly for zero emission capable vehicles. Also there was agreement that incentives should apply to both company and fleet purchasers and private buyers.
6. Finally concerning the best practice principle of making **reference to EU CO2 limits** - thresholds for the financial incentives, this was no longer felt to be relevant given that a new CO2 regulation will shortly be designed.

Annex 6
Definitions

For the sake of clarity and mutual understanding, Project Team 1 members agreed on common definitions for the terms used during the elaboration process of the scenarios.

"**Zero emissions vehicles**" (ZEVs) should be understood as a vehicles which produce no emissions while driving (e.g., Battery Electric Vehicles (BEVs) or hydrogen fuel cell).

"**Battery electric vehicles**" (BEVs) refers to an electrically chargeable vehicles with no other energy source than the battery, whose autonomy ranges from 110km to 600km.

"**Plug-in hybrid vehicles**" (PHEVs, also so-called "zero-emission capable" vehicles) covers vehicles using battery as one source of energy among other sources. The battery should be rechargeable from the grid.

"**Alternatively powered vehicles**" include technologies using diverse range of low carbon and renewable energy sources

"**Battery production**" relates to the production of battery cells and modules or pack assembly.

"**Automated Driving**" encompasses vehicles using on-board equipment to perform one or more advanced driving tasks automatically corresponding to level 4 of SAE International's Levels of Driving Automation for On-Road Vehicle[1].

"**Connected vehicles**" definition applies to vehicles relying on communication through external servers, with other vehicles, third party applications, personal devices (e.g. smart phones) or the surrounding traffic infrastructure to exchange information and perform driving tasks or allow companies to provide remote services.

"**Vehicle ownership**" means the purchasing & disposing of a vehicle

"**Access to data"** should be understood as the access & use by the economic operator(s) to specific data generated by the use of connected vehicles for a given purpose.

"**Car online sale"** is the situation when a car purchase is substantially initiated online

"**Shared mobility services"** relates to on-demand mobility service provided by professional service providers or private individuals.

"**Mobility as a Service"** (MaaS) refers to the integration of various forms of transport services into a single mobility service accessible on demand.

[1] Level 4 – High Automation: The driving mode-specific performance by an Automated Driving System of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene