

MCKINSEY CENTER FOR FUTURE MOBILITY

# RACE 2050 – A VISION FOR THE EUROPEAN AUTOMOTIVE INDUSTRY

January 2019



# **RACE 2050 – A VISION FOR THE EUROPEAN AUTOMOTIVE INDUSTRY**

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# INTRODUCTION AND KEY MESSAGES

The European automotive sector has ascended to the top of the global industry. It has achieved record sales, and — as a major employer and a source of significant grant-making — it is an integral part of European society. Fundamental changes in the industry, however, are threatening Europe's lead position. If the European automotive sector is to stay ahead in this changing competitive landscape, leaders will need to make some tough decisions. Above all, a shared vision regarding the European automotive sector's positioning is needed.

Based on the results of a study that was conducted by McKinsey & Company, Inc., this report aims at providing the foundation of such a vision and at giving impulses for co-creating the next chapter for a successful European automotive industry.

As indicated by the report's title, RACE 2050, this vision for the European automotive sector imagines the industry as a Responsible Automotive Customer-centric Ecosystem. It is to be built on the "European way," leveraging Europe's diversity of mobility realities and strengths in technological innovation, talent, skills, and collaborative spirit to make the region the gateway of the global automotive future.

At the same time, multiple sources informed the insights presented in this report, including

- Proprietary knowledge, analyses, and research from the McKinsey Center for Future Mobility
- Interviews and several rounds of discussions with members of the European Automobile Manufacturers' Association (ACEA)
- Conversations with members of key European automotive-related associations, e.g., DigitalEurope, FuelsEurope, CLEPA, Eurelectric, FIA, and other industry leaders.

We express our appreciation and gratitude to all contributors to this report.

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<sup>1</sup> In the context of this report, the term "Europe" generally refers to the EU-28. However, some statistics relate to the EU-15 and are framed accordingly.

Three key messages have been distilled:

- Regions and players outside the traditional automotive set are gaining momentum, and a growing wave of technological megatrends is redefining mobility. The core competencies for future success are changing rapidly. European automotive players will need to develop these competencies and manage an employment transition if they are to maintain their position at the forefront of the industry.
- Placing the consumer at the core, leading in the area of sustainability, and leveraging the region's unique diversity of people and mobility realities as well as the strengths of its economies and technologies are fundamental to a vision for Europe's automotive industry.
- To activate this vision and actively shape the new mobility ecosystem, a speedup and a constructive engagement of policy makers, stakeholders, and automotive industry players are essential.

Each statement is explained in more detail in the following chapters.

## THE SUCCESSFUL EUROPEAN AUTOMOTIVE INDUSTRY IS CURRENTLY FACING UNPRECEDENTED CHANGES

The European automotive industry continues to be a huge success story but is currently facing strong headwinds: customer trust in the industry has recently suffered in light of the Diesel scandal, revenue pools are shifting strongly towards Asia, new players are entering the market, and the industry is facing disruptive megatrends of a new magnitude.

### 1.1 The automotive industry has been one of the most important growth engines for economic welfare in Europe

The European automotive industry has been on a successful trajectory and has ascended to be a global leader and driver of Europe's growth and prosperity. Both the passenger car – as a cornerstone for individual mobility – and the commercial vehicle – as the backbone of the European economy – contribute tremendously to society, environment, economic welfare, and growth in Europe. For a selection of performance indicators, please refer to Exhibit 1.

**Societal contribution – people.** The automotive industry has brought to people the freedom and access that come from mobility while also making it increasingly time efficient, safer, and more affordable. Today, of all journeys, more than 70 percent are made by car – and of public transport journeys over 55 percent are made by bus. Hazardous accidents involving passenger cars have been reduced by 40 percent since 2005, and fatalities involving commercial vehicles have been halved since 2001. Furthermore, average costs per covered kilometer of cars decreased by 65 percent over the past 40 years, making individual mobility more accessible to a larger share of the population in Europe.

**Environmental contribution – planet.** The automotive industry also contributes to environmental welfare – even if at first this seems contradictory as the number of cars Europe-wide increased by >50 percent over the last 20 years. At the same time, however, the industry was rather successful in keeping the detrimental impact on the environment of the steep increase in numbers of cars on the road in check – mainly through effective emission reductions. With almost 36 percent reduction in CO<sub>2</sub> emissions since 1995, today's European new cars are far more efficient than cars from 20 to 25 years ago. In the same time frame, commercial vehicles' CO<sub>2</sub> emissions per tkm have decreased by 14 percent. NOx emissions have been reduced for new cars by ~90 percent and by ~95 percent for commercial vehicles since the early 1990s. Despite the significant reduction of commercial vehicle emissions, however, the growth of the transport industry results in a higher share of transport sector emissions than 20 years ago. Today, the transport sector accounts for 24 percent of the EU's greenhouse gas emissions, in comparison to 17 percent in 1995.

**Economic contribution – profit.** The automotive sector is a strong industry with attractive job opportunities and a growth engine of Europe's economy. The turnover generated by the sector represents roughly 7 percent of the EU's GDP, and tax contributions related to the industry total EUR 410 billion in the EU-15 countries alone, equaling roughly 6 percent of their total tax income. With 5.4 million cars exported in 2017, the European automotive industry accounts for over 40 percent of global automotive value share, and commercial vehicles are the backbone of Europe's economy, transporting 75 percent of all land-carried goods and 90 percent of value transported. With an average profitability of ~7 percent return on sales in 2017, the industry is economically robust but with a clear gap to highly profitable industries, which achieve an average of ~22 percent return on sales.

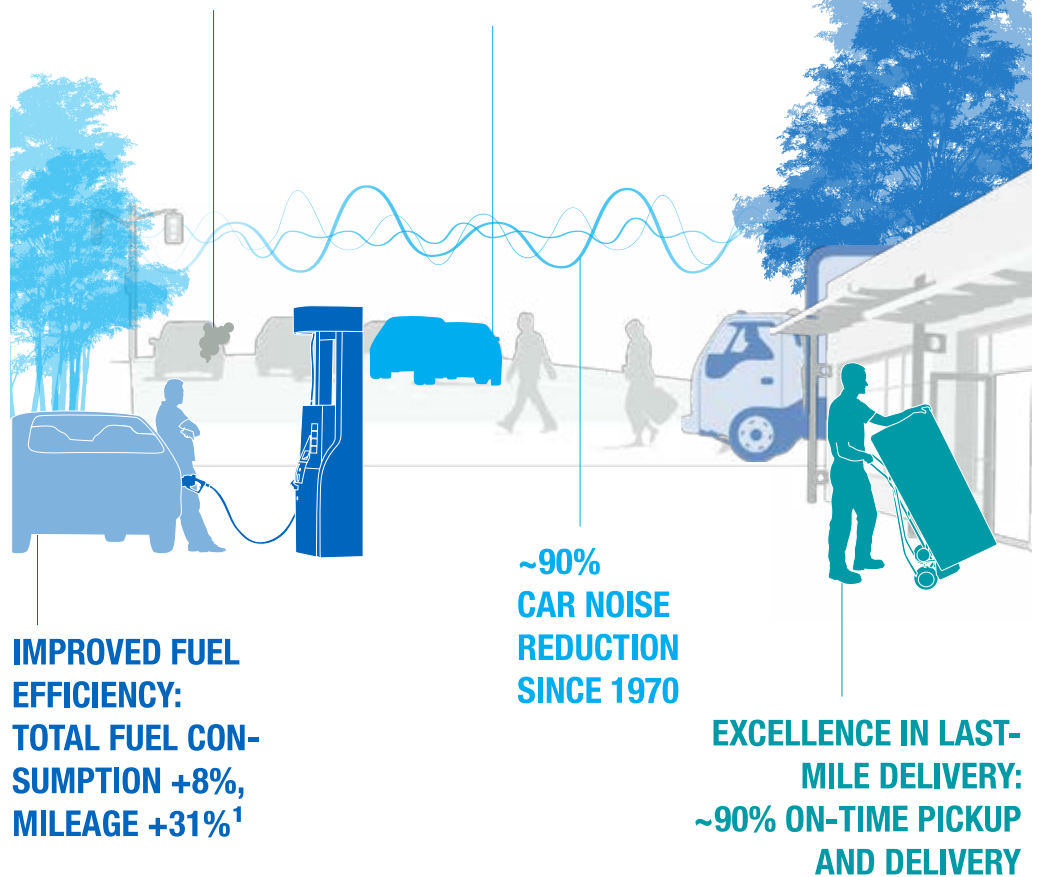


Exhibit 1

There are highlights galore in the European automotive success story  
Examples

**SINCE 1990, NO<sub>x</sub> EMISSIONS  
REDUCTION BY ~90% FOR  
NEW CARS AND ~95% FOR  
NEW COMMERCIAL VEHICLES**

**HAZARDOUS  
ACCIDENTS  
-42% SINCE  
2005**



**NO. 1 MANUFACTURING  
INVESTOR IN EUROPE PRO-  
VIDING ~8% OF THE EU'S  
MANUFACTURING GVA**



**ONE THE OF EU'S MOST  
IMPORTANT EMPLOYERS  
WITH A TOTAL OF  
13.3 M JOBS**



**EUR 410 BN TAX  
CONTRIBUTION IN 2015 =  
~7% OF TOTAL TAX  
INCOME (EU-15)**

<sup>1</sup> Example Germany

SOURCE: McKinsey Center for Future Mobility

Building on this success story, the European automotive industry is uniquely well situated to become a center for developing, testing, and eventually adopting new mobility technologies.

However, Europe's pioneer position in mobility is endangered, since regions and players outside the traditional set of automotive actors are gaining momentum, and the core competencies required for remaining successful are changing rapidly.

These changes are unprecedented compared to former evolutions in the automotive and mobility industry, as they are much more complex, dynamic, and disruptive.

When it comes to growth, the European automotive industry – with the exception of the recession in the early 1990s and the financial crisis in 2009 – has continuously been growing since 1980. However, it only (fully) recovered from the financial crisis in 2017, and recovery still remains fragile (Exhibit 2). This growth was enhanced by the development and implementation of technical innovations such as fuel-efficient vehicles and alternative powertrains (e.g., hybrid).

But while industry evolutions in the past served as accelerators to create an innovative economy, the European automotive industry is now at a tipping point. The disruptive path ahead includes value pools shifting dramatically to new business models and present market leaders having to redefine their role in the newly created ecosystem, not least because their technological leadership is at risk in these new business models. In other words, the success story of the European automotive industry is challenged by the combination of two revolutionary forces that together are fundamentally changing the industry: the current momentum beyond the traditional set of players and regions, and disruptive megatrends.

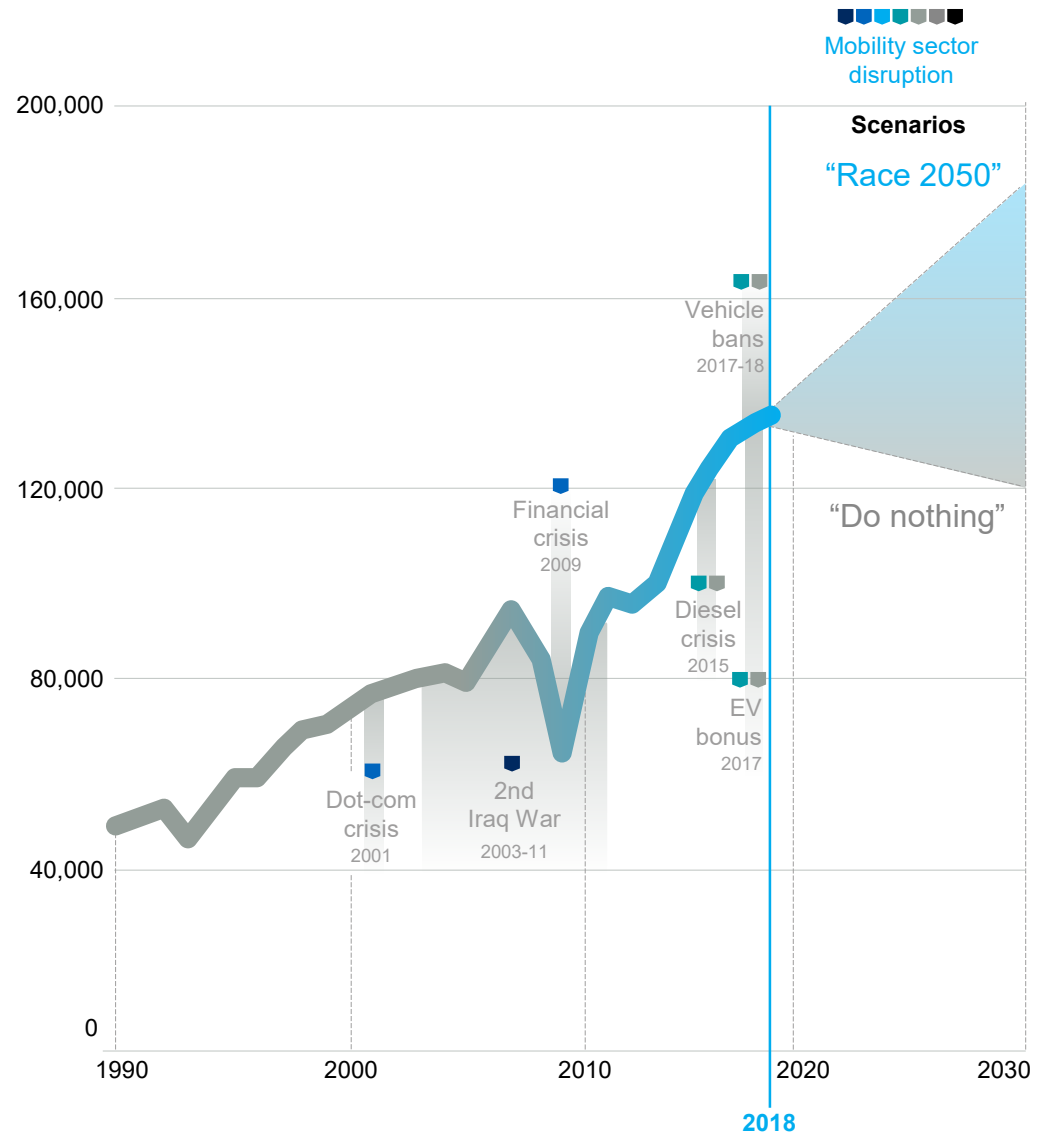
Exhibit 2

The global automotive industry is now facing a new multidimensional disruption

Example Europe

GDP contribution of the European<sup>1</sup> automotive industry

EUR millions



Dimensions of disruption

- Resource availability
- Financial investment
- Public subsidization
- Regulatory environment
- Technological progress
- Business model
- Market boundaries

<sup>1</sup> Western Europe

SOURCE: IHS

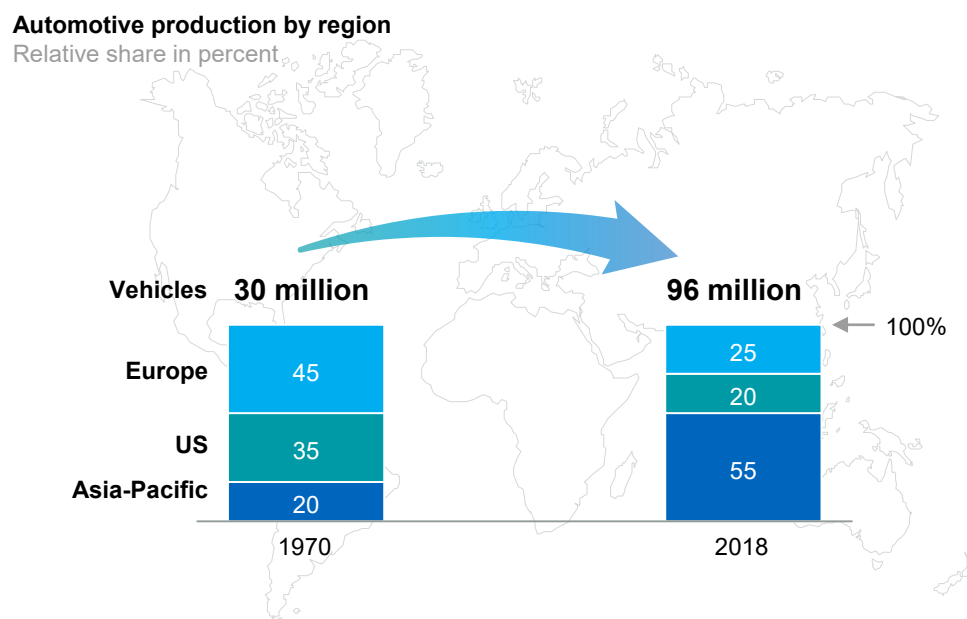
## 1.2 Europe's leading position in mobility is threatened by the enormous momentum of regions and players beyond the traditional set

The industry's global dependence and complexity has grown substantially. The total value of the flow of automotive goods around the world, including motor vehicles and vehicle components, increased by 13 times since 1990.

Measured by automotive production output, since 1970 the "economic center of gravity" has moved from the westernmost parts of Europe to Turkey and is further shifting towards Asia (Exhibit 3). This is primarily due to the increasing importance of the Chinese automotive market, which has grown from an annual production of 87,000 vehicles in 1970 to 28 million in 2018.

Exhibit 3

### In automotive production, the economic center of gravity is shifting towards Asia



Besides, the automotive industry has started to attract investors – such as tech companies as well as venture capital and private equity (VC/PE) players – from outside the industry. These players dominate the investment volume in automotive and mobility start-ups; since 2010, more than EUR 100 billion have been invested in mobility start-ups, of which 94 per cent originated from players outside of the automotive industry.

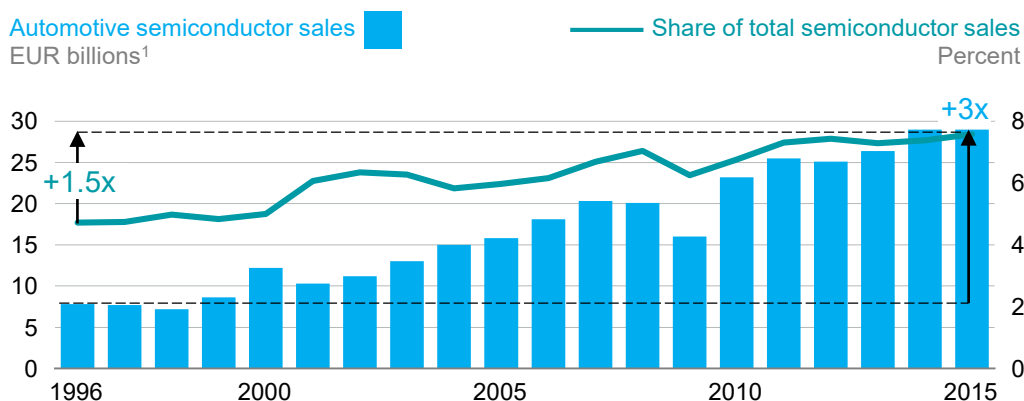
The mergers and acquisition (M&A) volume in automotive tech start-ups reached EUR 39 billion in the US and EUR 26 billion in Asia-Pacific between 2014 and 2017. This illustrates that investments from VC/PE players focused on the US and Asia, with Europe falling behind.

Additionally, the automotive product is changing with electronics and software playing a major part and representing significant value in the vehicle, requiring skills that have not, so far, been among the core competences of automotive engineering. The extent to which the importance of automotive electronics has increased over the last years, for example, can be derived from the threefold increase in automotive semiconductor sales over the last two decades (Exhibit 4). This increase will further accelerate: an average D segment (defined by the EU Commission as large passenger cars) vehicle's software content is estimated to grow with a compound annual growth rate of 11 percent and will make up 30 percent of the vehicle value in 2030. Electronics and electrical content will comprise 25 percent of the total vehicle value. Also, since the software development process in the automotive industry is not exactly state of the art, software complexity increased manifold as the following example shows. These days, an average modern high-end car has 100 million lines of code, 15 times more than Boeing 787 avionics.

Exhibit 4

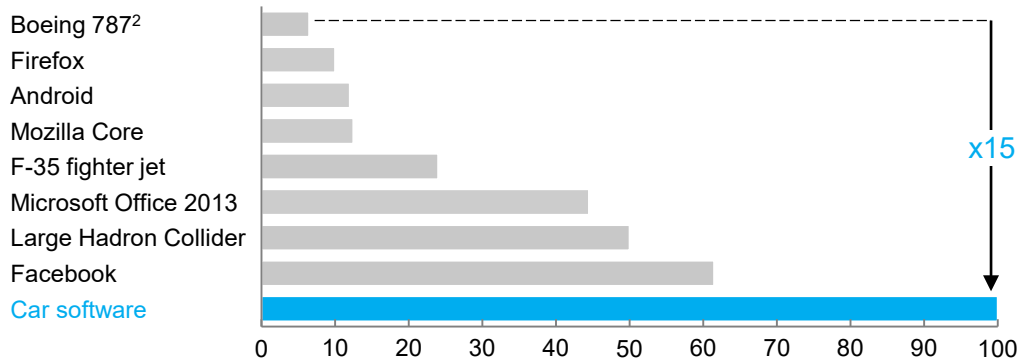
**Semiconductor sales increased threefold over the past 20 years and car software is one of the core complexity drivers**

**Semiconductor sales**



**Software complexity**

Lines of code, millions



1 FX rate USD to EUR based on average FX rate Jan-Oct 2017 (rate: 0.9), OANDA

2 Avionics and online support tools only. Total flight software has 14 million lines of code

SOURCE: IHS; <https://www.visualcapitalist.com/millions-lines-of-code/>; McKinsey Center for Future Mobility

Not only are automotive products changing, but production processes and players along the value chain are as well. While the European automotive industry is renowned for its fully integrated, global supply chain model, it is questionable whether this model is sustainable. Additional or higher tariffs might force the industry to focus on regional production processes; also, the increasing relevance of (big) data and IT solutions might lead to shifts in power between original equipment manufacturers (OEMs) and suppliers, e.g., high-tech or IT players.

Thus, the European automotive industry is now facing the challenge of fostering a new growth momentum in Europe to maintain the region's value generation. Furthermore, the region must handle increasing complexity and the influence of growing markets, i.e., Asia and the US, in the future. In addition, Europe needs to leverage its own technological and market strengths to stay abreast of market shifts, new products, and business models.

### 1.3 Disruptive megatrends require new core competencies, new actions, and a new way of thinking

Besides this momentum beyond the traditional set of players and regions, four technology-driven megatrends are disrupting the industry – Autonomous driving, Connectivity, Electrification, and Shared mobility (ACES) (Text box 1, Exhibit 2, and Exhibit 5).

Text box 1

#### Did you know ...

... that robotaxis will become a cheaper mobility option than private vehicles in urban environments in 2030?

... that in 2030, one car in ten sold could be a shared car, according to the McKinsey Urban Mobility 2030 Berlin case study?

... that in the McKinsey 2017 Consumer Survey, 67 percent of consumers currently using carsharing expect to increase their usage “a lot” in the next two years?

... that there are currently 61 Chinese brands selling electric vehicles?

... that Chinese government subsidies for electric vehicles reached EUR 4.8 billion in 2017?

... that the Chinese government plans to increase the number of public charging poles from 200,000 to 5 million by 2020?

... that the premium market share of traditional OEMs in the US decreased by 15 percent from 2013 to 2018, while Tesla's market share in the same time increased from 1 to 6 percent?

... that the US has led in total disclosed investments into future mobility technologies since 2010 with ~EUR 69 billion – followed by China with ~EUR 40 billion – and that the two European countries in the top 10 are the United Kingdom with EUR 2.3 billion and France with EUR 1.5 billion?

Exhibit 5

**The 4 technology-driven ACES trends are reinforcing each other and will disrupt the automotive industry**

**80%**  
of the top 10 OEMs plan to build highly autonomous vehicles

Truck platooning on the road expected by

**2022**

The percentage of consumers ready to change car brands for better connectivity

**doubled**

in the last 2 years

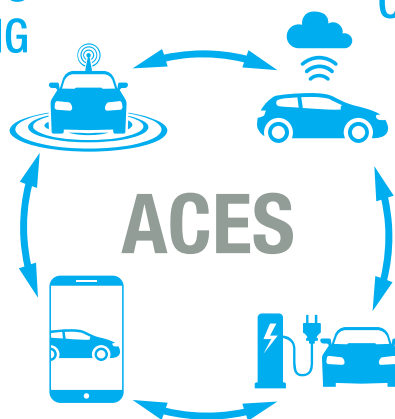
By 2030, connected trucks will make up

**~80%**

of the fleet

**AUTONOMOUS DRIVING**

**CONNECTIVITY**



**SHARED MOBILITY**

As of today, at least **EUR 55 bn** have been invested in ride-sharing start-ups

**ELECTRIFICATION**

**>40%** of models announced by 2021 will have EV<sup>1</sup> powertrains

Nearly

**50%**

of German consumers could imagine purchasing an EV<sup>1</sup> as their next personal car

1 Incl. battery EV (BEV) and plug-in hybrid EV (PHEV)

SOURCE: IHS; McKinsey Center for Future Mobility

Markets and revenue pools are shifting to new business models and new technologies, such as data-enabled services, advanced driver assistance systems (ADAS) technologies, and alternative powertrains. This development results in the emergence of new competitors as tech players, start-ups, and digital/e-commerce companies can be expected to grow rapidly. However, for established players this presents not only new threats but also new opportunities. To successfully shape these disruptive technologies, the industry will have to manage a significant employment transition, with accelerated importance of software and electronics engineering skills. Furthermore, industry collaborations are becoming increasingly relevant not only to gaining critical market shares, e.g., in cloud-based mobility services, but also to shaping the necessary infrastructure, e.g., with telecommunications or energy providers.

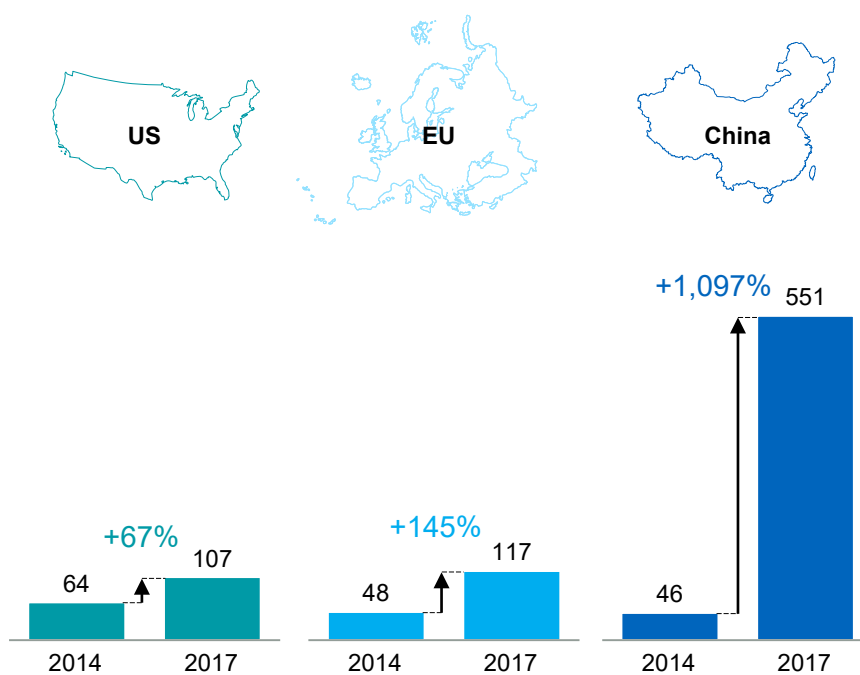
Finally, the four megatrends influence customers' mobility habits. Customers are beginning to demand innovative and individualized products, such as pay-per-use mobility packages or mobility as a service (MaaS), that integrate different modes of mobility according to individual needs. Furthermore, customer demand for sustainable mobility products is rapidly increasing. Thus, while China is clearly leading the market in recent years, there has been a 145 percent increase in new battery electric vehicle (BEV) registrations in the EU since 2014 (Exhibit 6).



Exhibit 6

**China expanded its market-leading position in BEV sales over the last years while the EU and the US are lagging behind**

**New BEV registrations by region/country, thousands**



SOURCE: EV Volumes; McKinsey Center for Future Mobility

# A LONG-TERM VISION FOR THE EUROPEAN AUTOMOTIVE INDUSTRY

To maintain its leadership position in the global automotive industry, a compelling narrative for the long-term vision of the European automotive sector is required. Included in this narrative is a clear understanding of the building blocks of the vision for 2050 (Text box 2).

Text box 2

## **RACE 2050 – A VISION FOR THE EUROPEAN AUTOMOTIVE INDUSTRY “TRANSFORM TODAY’S EUROPEAN AUTO- MOTIVE INDUSTRY INTO A FUTURE-PROOF EUROPEAN MOBILITY INDUSTRY THAT IS UNRIVALED IN THE WORLD IN TERMS OF ITS CONTRIBUTIONS TO SOCIETY, THE ENVIRON- MENT, AND THE ECONOMY.**

### **Milestones on the road to this future state include**

- Building a truly customer-centric European mobility industry to become the undisputed global leader in groundbreaking mobility innovations,
- Achieving front-runner position in sustainable mobility solutions with a clear plan of action for zero net-impact emissions in order to fulfill the industry’s obligation to people and planet, and
- Pursuing the unique “European way” to shape the global mobility industry of the future and continuing to create superior and sustainable economic value add for relevant stakeholders.

To this end, OEMs should leverage Europe’s traditional position as global export champion in the automotive space and the rich diversity of its mobility systems. Additionally, OEMs should build on the continent’s strengths in technology, talents, skills, and collaborative spirit in constructing a new automotive ecosystem of holistic and optimized mobility services and solutions.”

McKinsey's vision for the European automotive industry is built on the fundamental belief that the industry – currently a global leader in selling and exporting technologically advanced products – will have to master a paradigm shift from an automobile industry that sells and services vehicles to a mobility industry that offers myriad solutions for the transport of people and goods.

Three building blocks – customer orientation, environmental awareness, and economic value creation – have been the solid foundation for the success of the European automotive industry in the past (Exhibit 7). Looking ahead, these concepts – taken to the next level – also constitute the foundation of the vision for the future. In other words, the moves from customer orientation to customer centricity, from environmental awareness to sustainable mobility, and from profitability to positive economic value add the “European way” will be fundamental to creating the 2050 target state for the European automotive industry. The concept of the “European way” of future mobility is introduced with a clear value proposition for diverse, global mobility needs that the European automotive industry is in a strong position to satisfy.

## 2.1 Building a truly customer-centric European mobility industry

The customer is at the very heart of McKinsey's vision for 2050 for both individual mobility and commercial vehicles (Exhibit 7). In light of ubiquitous information and big data, a customer-centric approach to mobility (versus a technology-focused approach) is essential to winning the next generation of customers.

The number of fatal accidents in Europe has been immensely reduced (by over 40 percent) since 2005. Our vision is to achieve zero accidents by 2050. The EU mobility industry could be at the forefront of that vision, spurred by many innovations in active and passive safety as well as ADAS technologies.

Additionally, individual mobility will be accessible to a higher share of the population, i.e., up to ~90 percent (including disabled people, teenagers, and senior citizens), compared to the current ~60 to 70 percent. Mobility costs could decrease down to 10 cents/km for certain use cases through technological advancements, new powertrains, and optimized shared mobility services. Thus, lower-income groups can be reached. But also, the usage of individual mobility by younger (<18 years) and older age groups as well as by people with partial disabilities will increase through advanced ADAS systems and, ultimately, connected and autonomous vehicles.

Above all, with the AV technologies-related innovations mentioned above, 50 percent of commuting time will probably shift to value add time. People can use the time during rides more efficiently and also differently – depending on whether they take a connected and autonomous vehicle or make use of shared mobility services such as ridesharing. The potential economic impact of freed-up time is impressive. The average EU citizen spends 40 minutes of her/his daily time in a car. 100 million people in cars every day equals ~65 million hours spent. Assuming that 50 percent of that time could be used for efficient working, the shift in commuting could have a macroeconomic impact of roughly EUR 1 billion (890 million) per day in Europe.

It should not be overlooked that until today, the industry has created not only a significant amount but also a diverse set of employment opportunities. A dense network of universities, dual-system education, apprenticeship as well as professional development opportunities offered by automotive companies have resulted in an essential asset for the industry: a highly qualified workforce and world-class engineering that spurs the technical progress of the automotive industry. To remain an innovation leader along the ACES megatrends, different skills in automotive will become increasingly important, e.g., software, advanced data analytics, artificial intelligence, electrical engineering, and electro-chemistry to name a few. McKinsey envisions the European mobility industry continuing to be a significant talent and job engine for Europe that successfully manages a fundamental employment transition from a mechanical and automotive engineering focus to a software and mobility engineering focus. The third chapter of this report further outlines important cornerstones along this long-term transition process.

**The 2050 vision for the European mobility industry builds on objectives related to people, planet, and profit**

**Benefits for the mobility customer of 2050**

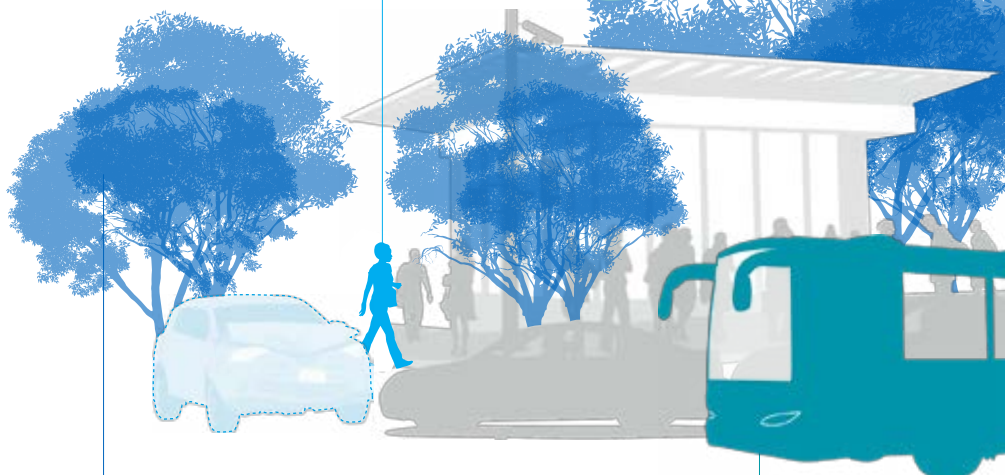
Zero fatalities and accidents

Individual mobility accessible to up to 90% of population

Shift of 50% of commuting time to value add time

Mobility companies as best places to work for

**PEOPLE**



**PLANET**

Zero emissions in cities

Net zero well-to-wheel emissions

20-30% of traffic space transferred into livable spaces

Optimized traffic flow and 20% less congestion

**PROFIT**

Mobility costs might decrease down to ~10 cents/km

Transportation costs -40% per km due to autonomous vehicles

Attractive job opportunities with above-average salaries

## 2.2 Achieving front-runner position in sustainable mobility

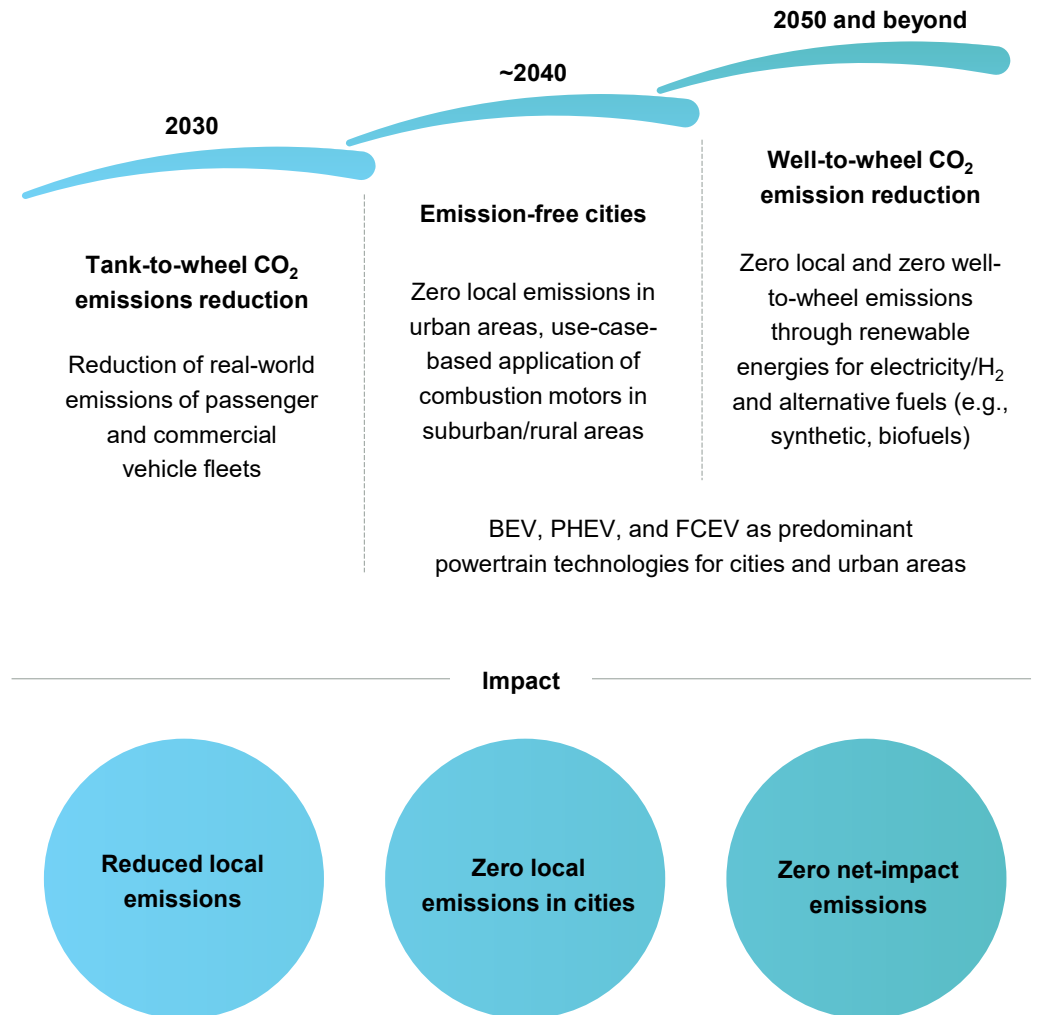
Despite the ongoing important discussions about emission compliance, it is a fact that passenger and commercial vehicle fuel consumption and CO<sub>2</sub> emissions per vehicle are today much lower than they were 20 to 30 years ago (for more details, see the relevant KPIs in Chapter 1.1). Nevertheless, this is not enough by far. Our vision goes beyond the 2030 targets and the Paris Agreement as well as beyond the United Nations Environment Program and its 2030 agenda, aiming at realizing zero net-impact emissions, including emission-free cities as well as carbon-neutral fuels and green electricity for further suburban and rural mobility and transport applications. Zero net-impact emissions mean that the use of the automobile leads to zero emissions in total, either due to tank-to-wheel emission with green electricity or hydrogen, or, in the case of local emissions, because the fuel is carbon-neutral (e.g., biofuels, e-fuels). The automotive industry could furthermore contribute to an effective carbon abatement across industries through either demanding renewable energy sources for hydrogen or electricity, or alternatively through an effective emission certificate trading system to maximize the emission reduction per Euro spent. The second core element of our vision is to contribute at large to the protection of the environment for future generations.

The RACE 2050 vision aims to create a sustainable mobility industry by being the undisputable front runner in emission reduction that achieves zero net-impact emissions by 2050, alongside the three subsequent transformational steps of tank-to-wheel CO<sub>2</sub> emissions reduction, emission-free cities, and well-to-wheel CO<sub>2</sub> emission reduction (Exhibit 8) for both passenger cars and commercial vehicles.

In our vision, clean cities with zero local emissions become reality by utilizing, for example, fuel cell, electric, and hybrid cars, buses, and commercial vehicles for last-mile transport. In suburban areas, the future state depicts a powertrain portfolio composed of predominantly electrified powertrains (including hydrogen) but also carbon-neutrally fueled internal combustion engines that are each best suited to a specific use case. McKinsey also envisions zero well-to-wheel emissions through renewable energy sources for electricity and hydrogen, as well as alternative fuels with zero-carbon footprint (e.g., synthetic fuels, biofuels, e-fuels) complemented by carbon capture storage. Europe should strive for a diverse powertrain portfolio optimizing power consumption, environmental protection, customer usability, and economic contribution.

Exhibit 8

**Leading in sustainable mobility puts Europe on a path towards zero net-impact emissions of passenger cars and commercial vehicles**



SOURCE: McKinsey Center for Future Mobility

### 2.3 Creating superior and sustainable economic value add the “European way”

Economic value contribution is one of the core requirements to create a profitable future mobility industry and to maintain relevance as a global export industry. Revenue pools and – even more radically – profit pools are expected to switch from traditional business models of classic vehicle sales and aftermarket towards disruptive business models, including mobility as a service, data-enabled services, as well as connected and autonomous vehicles (AV) and electrified vehicles. According to the McKinsey Auto 2030 model, European automotive revenues based on consumer spend will almost double from EUR 850 billion in 2016 to EUR 1,400 billion in 2030. Over the same timeframe, the share of data-enabled services and shared mobility will increase from 0.2 to 27 percent of total automotive revenues. To capture a relevant share of the industry profit pool, European automotive players need to secure several of the so-called industry control points, i.e., technologies that make full or partial control of entire processes and systems feasible. Potential player-specific control points include battery cells, battery management systems, intelligent eDrive systems, fuel cell systems, AI software for AVs, and mobility platforms. On the commercial vehicle side of the vision, reduction of inefficiencies through multimodal optimization of holistic transport ecosystems is key. As surface freight intensity is expected to increase by 40 percent through 2050, and intelligent transport mobility solutions are being developed (e.g., moving parcel lockers), our vision is a 100 percent on-time, cost-efficient, and customer-focused delivery. Based on the technology of autonomous commercial vehicles, transport costs may, in some use cases, even decline by up to 40 percent through 2050.

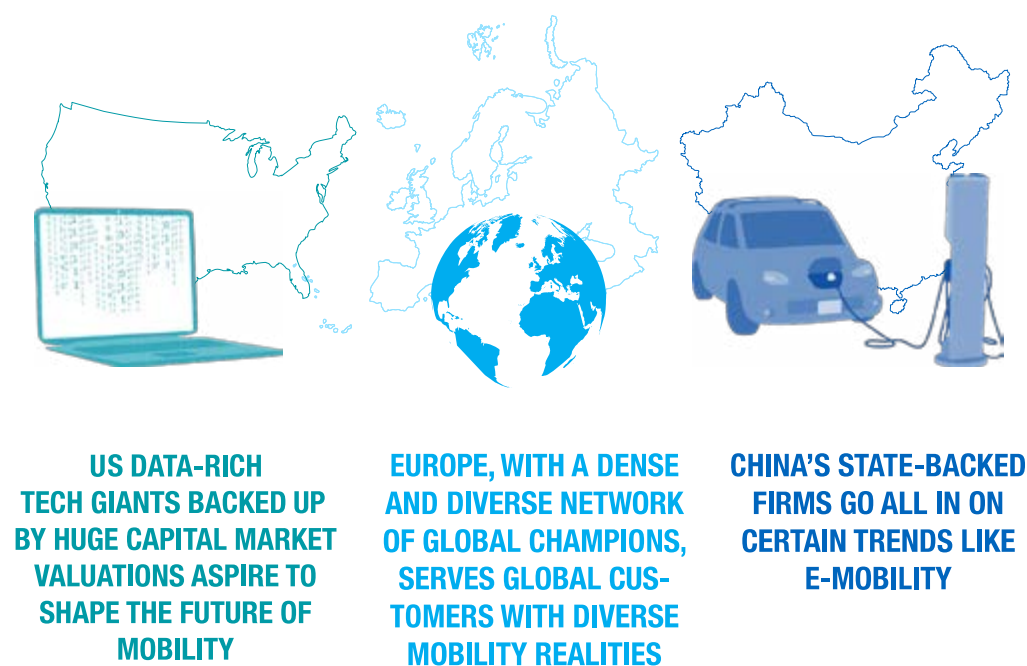
The position of Europe's automotive industry is unique in the world and is comparable to neither the US nor to China. In the US, data-rich tech giants seem to set the trend for the future of mobility. Due to their high valuation at capital markets, new models can be freely developed without them needing to be immediately profitable. In China, on the other hand, state-backed companies clearly follow the top-down direction supported by policy makers. Therefore, Chinese companies do not take a risk when they exclusively concentrate on e-mobility. Neither strategy is a possibility for Europe with its grown automotive industry and its democratic and federal system. Thus, in our vision, the European mobility industry needs to follow its own path of success: the “European way” (Exhibit 9).

The “European way” can be described as a way to serve global citizens and their diverse set of mobility needs by developing optimized solutions locally and scaling them globally. Europe is a diverse breeding ground for future mobility solutions. This diversity is a strength. Because Europe is already enjoying the future of mobility on a small scale – and solutions that work well in Europe have the potential to be rolled out globally. Its diversity can be manifested along four dimensions: people, economies, technology, and mobility realities.



Exhibit 9

**Europe's automotive sector should pursue the unique "European way" to shape the global mobility industry**



SOURCE: McKinsey Center for Future Mobility

**Diversity of people.** More than 500 million people live in the EU's 28 countries, each with several distinct regions. This diversity is a huge asset for the overall economy and individual companies in terms of the availability of a large and diverse pool of profiles and talent – and eventually the richest and most diverse pool of consumer data. The integrated customer base of the EU-28's market is also uniquely multinational: ~2 million people commute to work across borders, and there are ~1.3 billion crossings yearly in the Schengen area.

**Diversity of economies.** In 2018, the total economy of the EU-28 at EUR 15.8 trillion was ~39% bigger than China's economy of EUR 11.3 trillion and only ~9 percent smaller than the US economy at EUR 17.2 trillion. What is more, EU-28 road freight transport increased 9 percent from 2012 to 2016 and reached 1.85 trillion tkm. Intra-EU trade was valued at EUR 3.3 trillion in 2017. That is 5.8 times more trade value than European trade with China at ~EUR 570 billion per year. Furthermore, commercial vehicles have largely contributed to an integrated automotive manufacturing industry connecting plants in Eastern Europe with the consumer markets in Western Europe.

**Diversity of technology.** Europe is home to several global players, each a champion in a particular market or consumer segment. A collaborative spirit among these tech leaders is a foundation for future global success. Furthermore, Europe is home to numerous market-leading “hidden champions.” Depending on the definition, up to 75 percent of hidden global champions specialized in a diversity of technologies have their roots in Europe. The sheer innovation power of the region can be illustrated by the fact that roughly 60 percent of all global patents in autonomous driving are filed by European players.

**Diversity of mobility realities.** As Europe is unparalleled across the globe in terms of the diversity of its traffic and mobility systems, it has the opportunity to offer a variety of mobility solutions. In our vision, this constitutes the essence of Europe’s unique customer-centric perspective; several examples illustrate the details and scope of this variety:

- Europe has a number of low-income, dense cities (e.g., Bucharest, Athens) in which shared multimodal trips centered on human-driven cars, two-wheelers, (electrified) minibuses, and micromobility are most likely to be close to the future state in 2050.
- In high-income cities with a suburban sprawl like Brussels or Munich, private cars might maintain their dominance as the central element of mobility, and connected and autonomous vehicles will allow passengers to use time in traffic for business or pleasure.
- In high-income, dense cities such as London, Paris, or Berlin, rapid social change, system coordination, and deployment of mobility solutions may result in a radically different mobility system. With a fast public transport system as a backbone, a fleet of shared, self-driving, and electrified cars providing on-demand, door-to-door mobility is most likely to be the reality in these cities in 2050.
- About a quarter of the European population lives in rural areas. Their mobility needs differ from those of the urban population and depend more on individual mobility. In high-income rural areas, private mobility may resemble suburban areas. Mobility solutions may have to target groups that have no access to mobility now, e.g., youth, elderly, and (partially) disabled persons. For low-income areas, (electrified) minibuses could be part of the mobility solution. While mobility infrastructure in rural areas cannot be changed as quickly and effectively as in cities, in the long term, hydrogen and alternative CO<sub>2</sub>-neutral fuels will play an important role.

Medieval city centers in Europe add a further element of complexity and diversity to future mobility requirements. Innovative electric micromobility solutions (e.g., e-bikes, e-scooters, new forms of electric two-wheelers) will become an important cornerstone of Europe's future mobility portfolio with different requirements ranging from narrow-street medieval city centers to congested megacity traffic arteries.

Other regions show a different mobility pattern than Europe: In the US, suburban traffic represents the majority of automotive mobility; in China, big-city mobility solutions are dominant as the average driving distances are less than 40 to 50 km per day. In other parts of the world, however, the mobility reality will become as diverse as it is in Europe.

Clearly, the automotive industry and its underlying value pools are currently changing dramatically. To be able to secure a big share of the sector's future revenue and profit pools, Europe's automotive industry should leverage its diversity-based strengths to adjust to and actively shape the ongoing disruption and megatrends in Europe's and the world's mobility landscape.

Today, automotive revenues are mainly generated through classic businesses (vehicle sales) and aftermarket services (2017: ~EUR 3,000 billion, globally). Our analyses show that global automotive revenues will nearly double to ~EUR 5,500 billion in 2030 and will mainly originate from disruptive business models such as mobility as a service (MaaS) or data-enabled services. At the same time, profit pools will shift even more towards new technologies and services, with more than 80 percent of the industry profit pool originating from ACES technologies and new business models. Therefore, the European automotive industry will have to secure control points to maintain a profitable position in the future and to participate in the changing revenue and profit pools.

Accordingly, Europe's position as global leader and the strengths of the "European way" should be leveraged to create optimal mobility solutions for the different needs of global consumers and customers based on Europe's unique diversity of mobility realities, talents, and technology. By following the "European way," the European automotive industry has the power to actively shape the global mobility ecosystem by creating and establishing groundbreaking mobility innovations along the four key future dimensions of innovation (Exhibit 10):

**Sustainable mobility portfolio.** In 2050, there could be an optimal powertrain for each application, e.g., long-distance commercial freight transport via biofuels or hydrogen versus urban last-mile delivery via battery electric powertrains or hybrid vehicles. Accordingly, there will likely be no "one size fits all" energy source, and Europe should focus on building a sustainable portfolio of powertrains, including a technology-neutral evaluation. This portfolio would include optimized solutions for each use case and matching local energy supply with demand on a global scale, comprising gasoline, diesel, hybrids of all forms, (compressed) natural gas, synthetic fuels, and fuel cells.

**New technology innovation.** Europe should act as an innovation and technology leader for future mobility – in particular with regard to autonomous driving and connectivity – by leveraging its position at the forefront of ADAS research (~50 percent of global automotive R&D volume in 2016). Europe's automotive companies – as symbols of quality and safety – are probably in the best position to shape and introduce those technologies.

**Business model innovation.** The European automotive industry should establish a framework enabling OEMs to set up and run various business models such as new mobility services like pay per use, location-based advertising, or over-the-air updates for connected vehicles. This framework would include technological and regulatory standards to provide a fruitful breeding ground for innovative solutions by OEMs and start-ups.

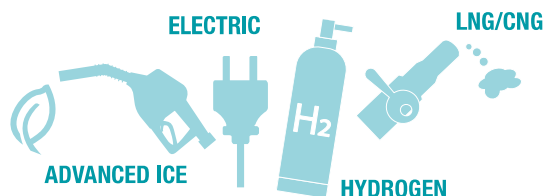
**Targeted solutions for each mobility reality.** Another source of diversity, distinctiveness, and "dominance" can be the so-called multimodal mobility lab that provides the basis for establishing Europe as the leader in designing automotive solutions for different city archetypes around the world. This would imply developing standardized mobility and transport solutions, which can be easily adapted and exported to diverse cities or rural areas worldwide with their unique conditions (e.g., population density, infrastructure, energy supply, GDP). By building on the "European way" and actively shaping a new automotive ecosystem alongside the above-mentioned dimensions of innovation, Europe will continue to have the power to create positive economic value.

Exhibit 10

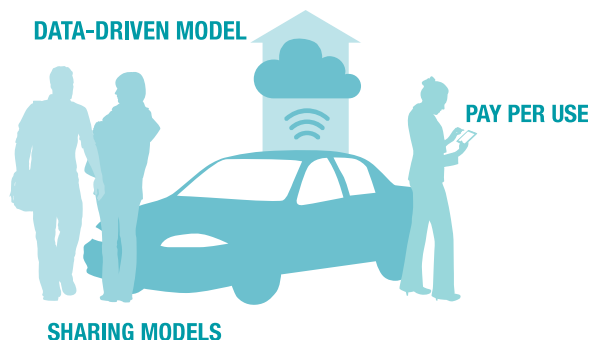
The 2050 vision includes innovations across powertrain portfolio, business models, technologies, and mobility-type-specific solutions  
Selected examples by dimension

### SUSTAINABLE MOBILITY PORTFOLIO

We consider multiple powertrain solutions, energy supply chains, and ecosystems



### DATA-DRIVEN MODEL

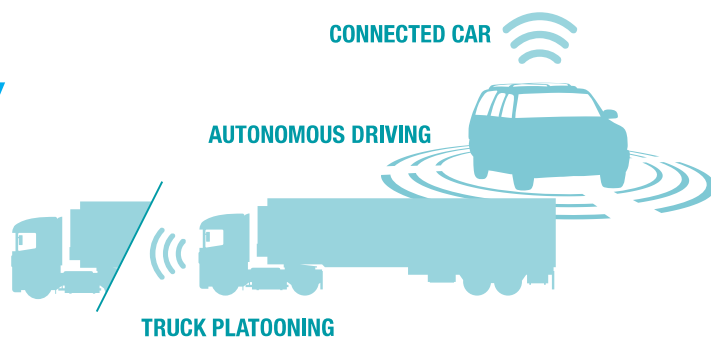


### BUSINESS MODEL INNOVATION

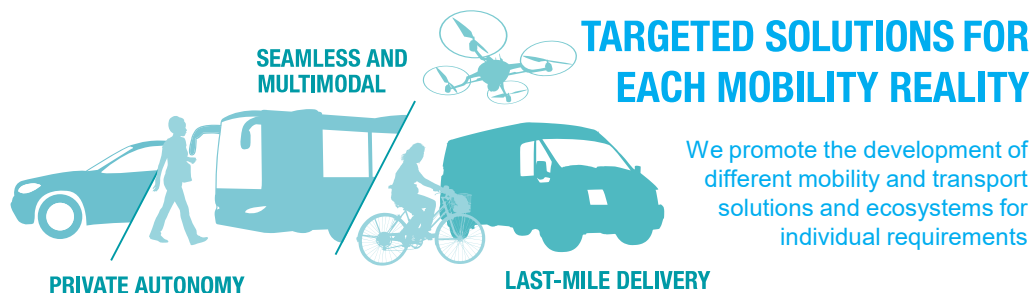
We create a framework for offering innovative business models that benefit the mobility consumers

### NEW TECHNOLOGY INNOVATION

We build an ecosystem for leading the development and rollout of future high-tech solutions



### SEAMLESS AND MULTIMODAL TARGETED SOLUTIONS FOR EACH MOBILITY REALITY



We promote the development of different mobility and transport solutions and ecosystems for individual requirements

SOURCE: McKinsey Center for Future Mobility

# FIVE CLUSTERS OF INITIATIVES TO PAVE THE WAY TOWARDS THE VISION

With its diverse cultural background, integrated economy, strength of innovation, and rich talent, Europe is in the prime position to design optimal solutions for the diverse future mobility ecosystem. Over the next years and decades, the automotive industry will undergo a disruptive transformation towards a mobility industry. Many forces within and from outside the industry will try to transform the sector. The automotive ecosystem will open up, new players will enter, and industry boundaries will become fluid or even start disappearing. In other words, we are going to see a global industry reshuffle.

In Chapter 2, a visionary target state in which the European automotive industry occupies a central role in the mobility ecosystem was described. Although the RACE 2050 vision is still far out in the future, with many uncertainties ahead, the next few years are essential for the long-term success of the European automotive industry. Paving the way towards the RACE 2050 vision of Europe's automotive industry requires a speedup involving automotive companies, adjacent industry stakeholders, and policy makers. Multiple measures, initiatives, and regulatory efforts have been debated. The industry currently appears to be driving without a clear long-term vision and at the risk of players from outside the industry taking over.


Besides what the acronym stands for, RACE 2050 also suggests a fast catch-up with competitive industries. Out of a large pool of potential measures, McKinsey distilled five clusters of initiatives, which are crucial and indisputably needed to write the next chapter of Europe's success story in mobility (Exhibit 11). While some of these may need to be adapted to conditions in the member states, all of them need to be tackled now to make the European automotive industry fit for the future.

Exhibit 11

## Speedup – 5 clusters of initiatives to pave the way towards our vision

  
**Cluster 1**  
**EUROPEAN “MOBILITY VALLEY”  
AND EMPLOYMENT TRANSITION**

  
**Cluster 3**  
**NEW FORMS OF COOPERATION  
AND ALLIANCES**

  
**Cluster 5**  
**SUPPORT OF CITIES AND  
DISTRICTS THROUGH  
MOBILITY SOLUTIONS**

  
**Cluster 2**  
**SYNCHRONIZED APPROACH TO  
DECARBONIZE TRANSPORT OF  
GOODS AND PEOPLE**

  
**Cluster 4**  
**“FUTURE MOBILITY  
REGULATORY FORUM”**

SOURCE: McKinsey Center for Future Mobility

## Cluster 1 – European “Mobility Valley” and employment transition

In a post-Sputnik moment during the Cold War, a combination of public investments into a diverse set of education, research, and engineering institutions and organizations, together with private enterprises in pursuit of a national vision, ultimately gave birth to Silicon Valley. Today, Silicon Valley strives for excellence by engaging four major asset categories: top research institutions (e.g., Stanford, Berkeley), innovative corporations (e.g., Alphabet, Apple), government support and direction, and a vibrant start-up and venture capital scene. How can Europe, which in our vision is at the forefront of future mobility innovations, create a Silicon Valley for mobility? Europe should recognize its own strength in these categories with regard to mobility and bundle its forces, acting in accord towards a long-term vision.

**Top research institutions.** Europe has the right talent and human capital to continue successful automotive innovations and has a number of globally leading universities along the ACES trends: 13 out of 17 universities globally leading in the area of electrification are based in Europe; also 4 out of 17 in autonomous driving and 8 out of 19 in connectivity.

**Innovative corporations/R&D powerhouse.** Europe is the birthplace of the automobile and has a long history of developing breakthrough innovations. The European automotive industry invests >EUR 50 billion in R&D annually. Representing 27 percent of the region’s total R&D investments, the automotive industry is Europe’s largest R&D investor.

**Government support and direction.** The EU fund “Smart, Green, and Integrated Transport” is a good first step towards realizing the RACE 2050 vision. Its goal to “boost the competitiveness of the European transport industries and achieve a European transport system that is resource efficient, climate and environmentally friendly, safe and seamless for the benefit of all citizens, the economy and society” puts the customer at its very center and promotes sustainable mobility. Against this backdrop, McKinsey envisions a next-level public and/or private “mobility fund” that is used to support pilot projects and accelerate the development of new business models at a cross-OEM/industry level (compare Clusters 4 and 5).

**Vibrant start-up and venture capital scene.** In recent years, both independent and OEM-led mobility start-ups have appeared on the European mobility landscape (e.g., BlaBlaCar, Waze, mytaxi, car2go). There is a large data void that OEMs, start-ups, and digital attackers want to tap into; the battle around the data that will be generated by the future mobility customer has just started. Securing Europe’s leadership around the customer’s mobility data should be a top priority of OEMs and policy makers. McKinsey envisions a “Mobility Valley,” where OEMs, VCs, and start-ups find the right conditions, talent, capital, and incentives to turn ideas into innovative and successful businesses.

To take automotive innovation even further, McKinsey suggests the establishment of a European “Mobility Valley.” This does not necessarily mean a geographically co-located center of innovation, but instead aims at a breeding ground with healthy boundary conditions for ideas and innovation. Most importantly, bureaucratic processes and taxes for business creation need to be simplified and harmonized across the EU and Europe. What is more, the success of an innovation hub largely depends on linking research and enterprise development to foster mobility innovations and mobility software excellence

in Europe and to stop the brain drain of top talent in Europe's mobility industry. Overall, in the upcoming years, Europeans should work towards an innovation-friendly European mobility landscape that cultivates mobility innovations. Accordingly, the associations representing the European automotive industry should expand their reach by 2050 and welcome new mobility members that have been established in Europe.

Realizing the goal of a European "Mobility Valley" as a global center for future mobility innovations implies mastering a fundamental employment transition. Across industries and geographies, job profiles in manufacturing will radically shift over the next decade. Overall, half of today's work activities could be automated by 2050+, and the mobility industry is not exempt from this trend. However, while automation may threaten certain jobs, other accompanying trends offer a new set of employment opportunities.

What does this imply for the European automotive industry? Automotive is one of Europe's most important employers with about 13.3 million employees, broken down into 2.5 million jobs in direct manufacturing, 0.9 million in indirect manufacturing, 4.4 million in automobile use, 4.8 million in transport, and 0.7 million in construction. Against this background, the following focuses on the implications for the combined 3.4 million jobs in direct and indirect manufacturing in the European automotive industry. While a projection of how the automotive labor market might shift by 2050 would still be highly speculative, a medium-term, fact-based analysis of the quantitative impact of the ACES megatrends on today's direct and indirect automotive manufacturing by 2030 can already be provided (Exhibit 12).

Over the next decade, the ACES megatrends will shift the employment profile of direct and indirect manufacturing jobs in the automotive industry towards electronics and software competences. Analysis shows that overall employment levels of direct and indirect manufacturing will slightly decrease by ~10 percent. This net impact results from a ~25 percent decrease in demand for mechanical (engineering) workforce and a ~15 percent increase in demand for software, electrical, and electronics workforce. This is the combined result of more granular shifts triggered by the following three trends:

- **Automation.** Generally speaking, automation will lead to a 15-percent decrease in the number of direct manufacturing jobs according to the MGI report "Jobs lost, jobs gained." All manufacturing jobs will not be affected equally, however, and the specific impact will depend on the particulars of the job. Against this backdrop, automation, which can also be expected to shift a limited number of low-skill jobs to high(er)-skill jobs, is expected to result in a net reduction of ~0.4 million, newly created positions to supervise or repair robots already taken into account.
- **Electrification.** Based on the findings of the 2018 Fraunhofer IAO study "ELAB 2.0," alternative powertrains are less labor intensive than conventional combustion engines due to less complexity and a higher share of automation in production and assembly. With PHEV and BEV accounting for 40 percent of the powertrain mix in 2030, electrification could result – depending on the vertical integration of today's automotive OEMs and suppliers in e-mobility – in a net impact of 0.3 million fewer direct and indirect manufacturing jobs in Europe in 2030 compared to 2018.

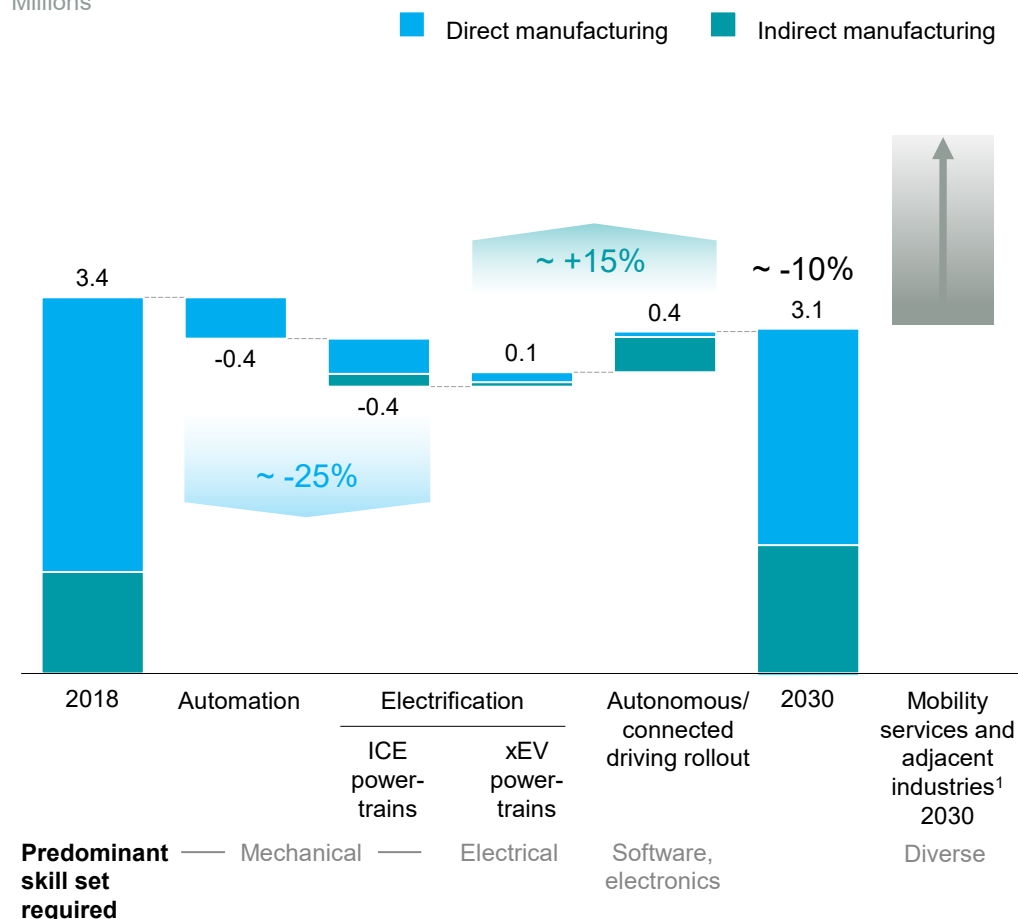


Exhibit 12

## A shift of manufacturing-related employment within the EU automotive industry 2018-30 can already be projected

### Manufacturing jobs in the EU automotive industry

Millions



<sup>1</sup> E.g., Energy, Infrastructure, Chemicals

SOURCE: McKinsey Center for Future Mobility

- Connected and autonomous vehicles.** In today's automotive industry, nonsoftware engineers still outnumber software engineers nearly 11:1, an unsustainable ratio as connectivity becomes increasingly important. According to our estimates, the value composition of vehicles will significantly change, with software components increasing their share of vehicle value by 4 times and electronics by 1.5 times. An average C/D segment vehicle will then include a software value share of ~EUR 5,100 and an electronics value share of ~EUR 4,400. This could imply an increase of ~0.4 million new jobs. Consequently, today's shortage of software engineers in the automotive industry is very likely to turn into a serious competitive disadvantage over the next decade.

What is more, the automotive industry is at the same time transitioning into a mobility industry, and while jobs in manufacturing will decrease, the mobility industry could become a job engine for adjacent industries. High-skill IT jobs related to mobility services and data-enabled business models alone (not shown in Exhibit 12) could overcompensate for the decrease in manufacturing-related jobs. Also, a large number of jobs will likely be created in adjacent industries, such as infrastructure (e.g., charging, grid, 5G, control towers), energy (e.g., renewables, alternative fuels) and chemicals (e.g., advanced materials, battery cell chemistry). In sum, McKinsey envisions a European automotive industry that remains one of Europe's most important employers and becomes even more of a job creator for adjacent industries than it is today.

In view of these foreseeable developments, what is required now is setting up a thorough plan for mastering this employment transition challenge in Europe. Increasing the industry's chances of a successful transition is the substantial leadtime it has for mastering the disruption. This shift is clearly foreseeable, and industry players, including relevant stakeholders, have ample time to develop a plan on the European level for maneuvering successfully through this transition over the next decade. The plan for mastering the employment transition challenge should include tackling education and reskilling as well as increasing the industry's attractiveness to new types of employees. As a first element, this plan needs to comprise a broad-scale reskilling program for companies focusing on the (re)training of their current employees. A logical second element is education in line with areas of future mobility innovations. Universities and apprenticeship programs – with a focus on ACES-triggered innovations – need to be backed by appropriate public and private support. The third element required is the promotion of the mobility industry as the most desirable place to work for the engineers of tomorrow – an “employer of choice” that boasts a rich diversity of positions, an intensely innovative culture, and a global reach.

## **Cluster 2 – Synchronized approach to decarbonize transport of goods and people**

Building on Cluster 1 and driven by the vision of sustainable mobility with zero net-impact emissions in 2050, a synchronized approach to decarbonize the transport of goods and people is necessary along with three key enablers:

First, a smooth powertrain transition is necessary, which is based on an economically healthy rollout of new powertrains, for example electrified mobility. This implies that all industry stakeholders are able to generate sufficient return on investment in electric mobility. For example, OEMs and suppliers sell electric and plug-in electric cars, which customers are willing to pay a premium for. A smooth transition also requires a secured supply of required batteries and raw materials (to avoid fly-ups of battery prices) and a timely rollout of charging infrastructure that is geographically synchronized with the targeted OEM EV model pipeline and sales targets. Ideally building on the synergies with the energy sector, this helps ensure that the necessary utilization of charging stations and payback are quickly achieved. Finally achieving a low-carbon footprint of electrified cars requires availability of sufficient renewable energy and is only feasible in cooperation with the energy sector. Exhibit 13 shows an integrated ecosystem view of the EU Council's proposal on emission regulation targets. To reach this proposed target with BEV and PHEV, additional green electricity equaling the output of 3,500 to 4,500 windmills in the North Sea is needed.

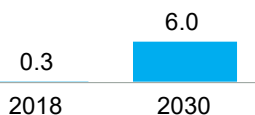
Exhibit 13

Achieving a 35% reduction in CO<sub>2</sub> emissions<sup>1</sup> by 2030, as proposed by the EU Council<sup>1</sup>, has target and volume implications across the mobility ecosystem

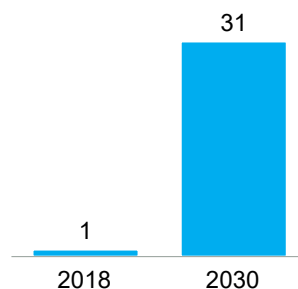
**Required electrification in 2030**



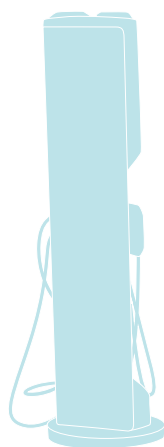
**Required xEV<sup>2</sup> sales**  
Million vehicles p.a.



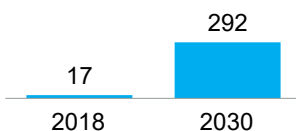
**Resulting xEV<sup>2</sup> car park**  
Million vehicles



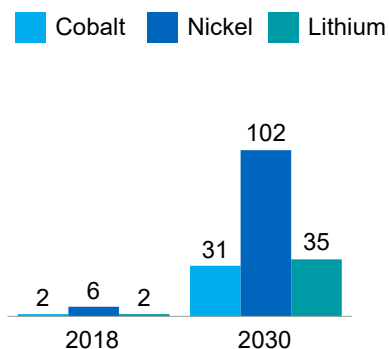
**Required e-mobility ecosystem**



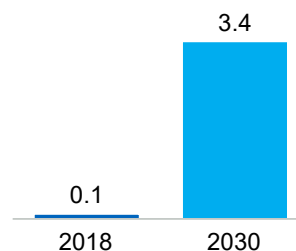
**Battery supply**  
GWh p.a.



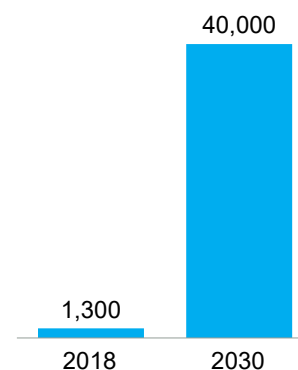
**Raw materials demand**  
kt p.a.



**Public charging stations**  
Number, millions



**Electricity demand**  
GWh p.a.



<sup>1</sup> Decision of the Environment Council on October 9, 2018, in Luxembourg; final decision to be negotiated with European Commission (proposing 30%) and European Parliament (proposing 40%)

<sup>2</sup> Incl. BEV and PHEV, assuming BEV and PHEV will contribute predominantly to reducing fleet CO<sub>2</sub> emission

SOURCE: ACEA; Eurostat; EEA; <http://www.eafo.eu>; McKinsey Center for Future Mobility

Second, a holistic approach to overall emission reduction of the entire transport sector is required. To this end, there are four different levers:

- Reducing tank-to-wheel emissions (e.g., 48V, hybridization, electrification)
- Reducing well-to-wheel emissions (e.g., biofuels, renewable energies for electricity)
- Reducing lifecycle emissions (e.g., emissions related to the manufacturing and recycling of vehicles and batteries)
- Reducing the transport sector's systemic emission intensity (e.g., through intelligent transport solutions, shared mobility).

A thorough holistic analysis of emission abatement measures along these four dimensions with regard to their environmental impact (i.e., emission reduction) and associated ecosystem cost (i.e., cost per kg of avoided CO<sub>2</sub> emission) is necessary to select and prioritize the most impactful sustainability measures over the period from 2020 to 2050.

Third, a clear road map of alternative powertrains is needed, including optimized ICE/alternative fuels, electrified vehicles, hybrids, and fuel-cell vehicles towards the 2050 zero net-impact emissions target. A use-case-based approach to alternative powertrains helps identify the optimal powertrain for each mobility use case (e.g., urban buses and shuttles, long-haul transport solutions, private suburban mobility) with regard to local and total emission performance, mobility cost, customer convenience, and regulatory requirements. For instance, hydrogen is advantageous for vehicles with long range, mileage, and heavy payloads. According to the Hydrogen Council reference scenario for 2030, beyond 55 kWh, FCEV powertrains are less expensive than BEV powertrains. A technology-neutral analysis of each powertrain solution provides the basis for a nonbiased comparison.

### **Cluster 3 – New forms of cooperation and alliances**

We envision new forms of cooperation and alliances among the major industry players of the European mobility industry. Collaboration could be important to shape the large disruptions in the industry, especially regarding the development of autonomous and connected vehicles, the infrastructure for electric and connected vehicles, the production of battery cells, compliance, and secured supply along the battery raw materials supply chain, vehicle operating systems, and further data-enabled mobility platforms. The following paragraphs outline how collaboration along certain elements of autonomous vehicles – especially those along the nondifferentiating layers of the AV technology stack – could help accelerate the development and implementation of connected and autonomous vehicles. Thus, collaboration could secure Europe's leading position in automotive innovations.

Specifically, collaboration could facilitate the development of AV hardware and software components in several ways:

- First, industry collaboration could take place in areas where costs can be saved, and differentiation is negligible. Currently, European automotive OEMs might be overspending in the development of AV systems. This is suggested by the fact that despite making substantial investments in these systems, they still lag behind technology companies, such as Waymo, which have made significant technical gains with smaller R&D budgets. Areas of such collaboration could be the standardization of communication protocols and of sensor interfaces to simplify the integration of new sensors, or the validation of AV functions.
- Second, industry collaboration could take place where greater scale and the creation of big databases would enable a more robust and faster development process. With almost all players developing their own software/algorithms and also running their own test kilometers, the industry is falling behind major global tech players that are well advanced in their development of autonomous vehicle systems. Thus, in areas where economies of scale are essential (e.g., development and continuous actualization of localization layers, testing experience, edge case database), industry players should collaborate to the extent possible under antitrust law so that they can utilize rich databases and speed up the development. We envision an open innovation model that leverages a strong joint database for facilitating the development of cutting-edge innovations in artificial intelligence and autonomous driving software algorithms.
- Third, industry collaboration could take place where economy of scale helps save costs. Such areas could be the installation of required infrastructure (e.g., joint definition of standards and APIs, use of common pickup/drop-off zones and common sensors at crossroads) or basic vehicle operations (e.g., parking, cleaning, maintenance).

To accelerate the development of connected and autonomous vehicles in Europe, the EU Commission could further adapt existing guidelines on cross-OEM collaboration to the context of autonomous driving. Such collaboration should include a platform to engage with all stakeholders across the value chain and across the sectors involved to collaborate on precompetitive research and innovation actions to advance and accelerate the technological progress (in Europe) and drive standardization. Examples from other industries show how precompetitive collaborations can benefit all parties involved. For example, vertical consortia in the steel industry contribute significantly to the development of innovative technologies.

Early large-scale piloting of disruptive technology is essential for a fast introduction of solutions with series maturity into the market and has been started already. Starting now with pilot projects is a way to showcase first successes and to demonstrate the overall impact of new technologies. For example, a successful autonomous vehicle pilot in Europe might not only speed up joint development of AV in Europe but could also help Europe secure a reputation for AV technology and implementation leadership. McKinsey envisions a pilot project for urban MaaS/autonomy as a service (AaaS), starting out of a geofenced area in a European city. Core milestones towards successful demonstration of a cross-OEM AV/robotaxi fleet in Europe would include: installment of control towers for the geofenced area, upgrade of telecommunication infrastructure, development of an open AV platform, and development of a customer interaction app.

#### Cluster 4 – “Future mobility regulatory forum”

As the automotive industry is transforming from an automobile to a mobility industry with transforming boundaries, the complexity of the ecosystem and the number of parties involved are increasing. Future regulation on topics such as lifecycle emissions, circular economy, safety and liability of connected and autonomous vehicles, and vehicle and driver data privacy involve more stakeholders than just the automotive companies. The scope of regulation will comprise telecommunication and insurance companies for connected and autonomous vehicles, utilities, and infrastructure players for lifecycle emission consideration, and Tier-1 to Tier-3 suppliers for battery compliance and CSR-related risks.

To enable regulation that not only benefits the mobility customer but also ranks sustainable mobility as a top priority and represents the interests of additional industry stakeholders, McKinsey recommends establishing a “future mobility regulatory forum” (Exhibit 14). While taking a holistic view of the mobility ecosystem, the forum’s objective should be to discuss and find an optimal solution for all stakeholders, particularly the mobility customer. A single point of contact for all mobility-related topics, e.g., a Mobility Commissioner, could facilitate this multistakeholder dialog.

Exhibit 14

#### The increased complexity of the future mobility landscape requires a revision of the regulatory process

Dimension	From	To
<b>Industry scope</b>	Automotive industry	Mobility ecosystem
<b>Focus topics</b>	Vehicle focus: vehicle emissions, safety	Holistic and systemic focus on solutions
<b>Target setting</b>	Top-down emission target setting by EU Commission	Vision-led target setting based on a holistic approach
<b>Contact</b>	Transport, Industry, Climate Action, and Energy Commissioners	Mobility Commissioner

SOURCE: McKinsey Center for Future Mobility

### Cluster 5 – Support of cities and districts through mobility solutions

Already in the near future, the business model of OEMs will fundamentally change from selling vehicles to offering mobility solutions for the transport of people and goods. As people are more and more moving into urban areas, winning the customer of the future primarily implies offering the best mobility solutions for city dwellers. McKinsey fundamentally believes that Europe's mobility players will be in a privileged position to serve citizens of the next decades globally. This is because in Europe, in particular, cities are developed around citizens. Already today, there are not only vehicle-free city centers and efficient public transport systems but there is also an increasing amount of livable inner-city space. Many city dwellers use micromobility for this kind of space, i.e., they move around by walking, (e-)biking, using the subway, etc. The future mobility industry should include such solutions in its holistic vision.

With regard to realizing a customer-centric vision, McKinsey believes that European OEMs should prioritize the development of world-class mobility solutions for different types of cities and rural areas. Mobility solutions comprise both an optimized powertrain mix as well as a portfolio of use-case-specific and technology-enabled services, such as multimodal/shared electrified mobility, efficient and last-mile green delivery, rural advanced ICE bus network, etc. These concepts and solutions should be optimized for Europe's cities and rural areas and then exported to global markets ("optimize locally, scale globally"), similar to the successful exportation of vehicles over the past decades.

Policy makers and stakeholders could be involved in supporting cities with the planning and implementation of future mobility and transport solutions. The status quo, however, is that cities are requesting tailored solutions for their specific technical standards and systems. Since developing mobility solutions and the underlying services as well as their subsequent implementation are extremely complex and expensive, it would be appropriate to develop and offer standardized mobility solutions.

As a consequence, industry players would be able to develop more target-oriented and traffic-optimized mobility solutions for cities. To choose the optimal solution, cities should be clustered in archetypes (e.g., by size and density, technological and environmental advancement) for which holistically optimized multimodal transport systems (for people and goods) could be developed. Policy makers and stakeholders could be of particular help in setting standards along the dimensions of, for example, infrastructure and communication technology, as well as in establishing IT standards and interfaces.

Developing tailored mobility solutions applies equally to rural areas. Today, about 25 percent of the European population lives in rural areas that constitute around 50 percent of Europe. While the rural population share is forecast to decrease to 20 percent, these people and areas are also in need of mobility solutions.

In the end, the development and implementation of standardized mobility solutions would be more efficient and could help European automotive industry players lead the global market with cutting-edge mobility solutions.

# OUTLOOK

All in all, to maintain its global leadership position in the global automotive industry, European OEMs need a compelling vision for the European automotive industry in 2050. To that end, the industry needs to embark on a speedup which includes a new fabric of collaboration and a new strategic approach to transportation.

It is our vision that 30 years from now, the European automotive industry can say that its industry leaders used the momentum to adapt to significant paradigm shifts along several dimensions:

- From a focus on hardware to software and mobility solutions
- From stable value chains to a dynamic ecosystem with fluid industry boundaries
- From a stable set of leading players to a changed set of market players with new entrants and industry dynamics from China, start-ups, and digital giants
- From a relatively stable global regulatory framework to increasing regulatory volatility and uncertainty
- From serving the traditional form of personal automobile ownership with strong emotional ties to meeting the changing preferences of digital consumers
- From a static delivery system to a dynamic, integrated transport network optimized in real time.





# CONTRIBUTORS

The ideas and information in this publication of the McKinsey Center for Future Mobility are the result of many months of work by numerous McKinsey & Company consultants, who made this fresh perspective on the future of the European automotive industry possible.

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