ROUTE 2030

THE FAST PACE OF MOBILITY

by Educam

Preface: Look ahead!

In recent years, the landscape of the automotive industry has been evolving constantly. This has caused some turbulence on all levels. The automotive distribution and repair sector currently undergoes a trend in which activities are being concentrated. Our products and the way they are commercialised are also radically changing. In turn, Aftersales activities must suffer the consequences.

As the knowledge centre for the automotive sector and related sectors, EDUCAM believes that this is the right time to create a sequel to our Study 2020. As a result, we have decided to carry out a study titled 2030 to offer a new outlook for all participants in the industry. And as they say: there's no favourable wind for the sailor who doesn't know where he wants to go. That is why it seems important to us that we inform you about the future of our industry on the one hand, and about the future trends on the other hand, so that you can make informed decisions and can move in the right direction.

Everyone in the industry has many questions. We intend to formulate answers to all these questions by means of our study. Are we really evolving towards a mobility based on zero-emission vehicles, traffic with zero accidents and use with zero ownership? You will learn everything about this in this study based on "desk research", several surveys and numerous interviews with experts from the automotive industry and the academic world.

It doesn't matter which field you operate in and what your position in the value chain is, you need to ask yourself the right questions about your future, because that future won't be in line with your present. Even though our research suggests that the current distribution model still has some good days ahead, it is clear that the margins are under pressure and that we need to respond accordingly. Increasing the critical company size and resorting to management instruments such as "business intelligence" and even artificial intelligence as support for the decision process are certainly part of the actions that can be taken. This evolution will be just as drastic when it comes to the diversity in propulsion systems, the complexity of on-board electronics and, in a more recent development, the connectivity thereof. Even on this level, there is a risk of reducing cost-effectiveness. Also, the relationship with the client could be adapted to these new systems.

It goes without saying that the human factor is crucial to face all these challenges successfully. Updating your teams' competences becomes a necessity, either by recruiting new talent or by training your staff. This remains one of the keys to success. These changes will be applied on all levels. The coaching and training programs for your staff on every level are indispensable tools to implement all these changes as efficiently as possible. EDUCAM will assist you to do so more than ever, and will offer support as a sectoral training and support organism. Our range of trainings and services is permanently updated and expanded to anticipate to your needs. So don't hesitate to contact us. Talk to us about your projects and your ambitions, together we will find ways to put them into practice.

I hope that this study proves to be an interesting read. Hopefully it urges you to think about your own future.

Paul-Henri Gilissen

Group Managing Director

Management abstract

Companies in the automotive sector are subjected to quick changes that aim to make mobility more clean, efficient, safe, comfortable and economic. Various sources predict a switch to electric, autonomous, connected and shared mobility. EDUCAM (the sector fund for the automotive sector and related sectors) researched the attitudes, investments and needs these evolutions caused for companies in Belgian sectors. Business leaders and experts are questioned by means of structured surveys. Based on this research, EDUCAM develops services and products to aid companies in the automotive sector along their route towards the mobility of the future.

In 2030, we won't collectively drive vehicles that produce no emissions, are implicated in zero accidents and of which there is no private ownership. However, irreversible steps have already been taken to start these evolutions. The year 2030 is not a final deadline, but rather a horizon to look towards when making management decisions. Unexpected events – such as the corona pandemic at the time of writing – will always influence our planning. Still, the trends this study describes are rigid enough to survive unexpected fluctuations.

Companies in the sector are aware of the evolutions and are training their staff to deal with these new technologies. In doing so, companies are encouraging their employees to acquire the following competences:

1. Knowledge of vehicle-specific characteristics
2. Knowledge of infotainment, ICT and telecommunication technologies (bluetooth, internet connection,…)
3. Diagnosis of defects in the vehicle
4. Maintenance and repair of electrical systems
5. Calibration of driver assistance services

Despite their investments, companies consider the evolutions mentioned above as a threat to their business model. Experts agree that turnover and employment are under pressure for companies that don't take initiatives to develop new business models. According to them, the sector needs to invest in new services that facilitate evolutions. Experts are convinced that the turnover in the industry in 2030 will originate equally from sales, after-sales and mobility services. To do so, the sector needs additional non-technical skills:

1. Use of digital marketing channels
2. Organisation of mobility services
3. Negotiating with strategic partners

If the companies aren't successful, players from other sectors will penetrate the market and draw the profits towards them. To arm themselves against this, companies in the sector can proactively conclude partnerships with other players in the automotive industry:

1. Mobility service providers
2. Manufacturers
3. Leasing companies and fleet managers
4. Information and communication companies (ICT, Telecom,…)
5. Dealer groups

Based on these new competences and partnerships, companies can develop additional products and services to maintain their competitive advantage.

This situation demands a lot of flexibility from current staff members. All employees need to follow training continuously and look for opportunities themselves. The workload keeps getting bigger because companies fail to attract applicants with the right qualifications. In search of highly skilled staff, the automotive industry is competing with other industries on the market more than ever. That is why the advantages of working in the industry need to be put in the spotlight.

Table of Contents

Preface: Look ahead! 1
Management abstract 2
1 Context 6
2 Research method 6
3 The route to '0 emissions' 9
3.1 Propulsion 9
3.1.1 Key figures 10
3.1.2 Diesel engines 13
3.1.3 Petrol engines 14
3.1.4 Alternative fuels 14
3.1.5 Battery electric vehicles (BEVs) 15
3.1.6 Fuel cell electric vehicles (FCEV) 17
3.1.7 Supercapacitors 19
3.1.8 Hybrid vehicles 20
3.2 Use of materials 21
3.2.1 Construction 21
3.2.2 Recycling 22
3.3 Impact on the car dealership: more knowledge, less turnover 23
3.4 Survey results 24
4 The route to '0 incidents' 26
4.1 From driver assistance services to self-driving vehicles 26
4.2 Connected cars 28
4.3 Impact on the car dealership: less workshop visits, more expensive reparations 30
4.4 Survey results 31
5 The route to '0 property' 33
5.1 The new consumer: how demand changes 33
5.2 'Mobility as a Service': how the supply changes 34
5.3 New partnerships in and outside of the automotive sector 36
5.4 Impact on the car dealership 39
5.4.1 Impact on car sales and after-sales: customers are becoming stronger 39
5.4.2 Impact on strategic decisions: new power struggle, less dealers 42
5.5 Survey results 43
6 The labour market 47
7 Discussion 49
8 Sources 51

9 Annexes 59
9.1 Annex 1: results question form companies 59
9.2 Annex 2: results question form experts 59

1 Context

Andreas Tschiesner, Senior Partner at McKinsey & Co., spoke to the European automotive sector, and said the following: “We are currently at the second tipping point of the automotive industry”. The first tipping point took place one hundred years ago, when horses were replaced with cars as a means of transport. Today, the car industry is on the eve of a second tipping point. Even though it will be as radical as the first one, the change will be less unambiguous. It is driven by three evolutions, simultaneously breaking into the sector. Transport will become electric, autonomous and shared. This time not only technological, but also political, economic and social factors play a role in recreating the mobility landscape (ACEA Summit, 2019).

A survey conducted by Protolabs revealed that business managers of big players in the automotive industry are convinced they can face any change coming their way. More than half of these managers indicate that their competitors are not ready for the evolutions to come. This is mainly due to the fact that they experience difficulty attracting talented staff. Almost half of the managers say they now find it more difficult attracting qualitative employees than a decade ago. This makes it difficult for companies getting ready to face upcoming changes (Klaas, n.d.).

This literature study covers the evolutions in the automotive sector and related sectors in detail. The year 2030 is not a final deadline, but rather a horizon. Unexpected events – such as the corona pandemic at the time of writing – will always influence our planning. Still, the trends this study describes are rigid enough to survive unexpected fluctuations. The focus of the 'Route 2030' therefore also isn't to give a state of affairs about the industry in the year 2030. This study contributes to the literature by describing the impact of the upcoming evolutions on the sectors, and mainly focuses on the new competences needed by staff to prepare for the automotive landscape of 2030.

2 Research method

'Route 2030' was started by EDUCAM. EDUCAM is the Belgian sector fund for the automotive industry and related industries. Directed by the social partners, EDUCAM works toward a qualitative and safe work environment in these industries. EDUCAM can gather information about the trends in the industry because of its central position. This information is processed for knowledge and services that can be offered to the companies in the industry: additional training, advice and guidance. For the 'Route 2030' a study group is created that manages the evolution of the study. This study group consists of EDUCAM's management, the responsible for communication, the responsible for product marketing, the sales responsible and the entire department studies and marketing. The latter manages the daily progress of the study.

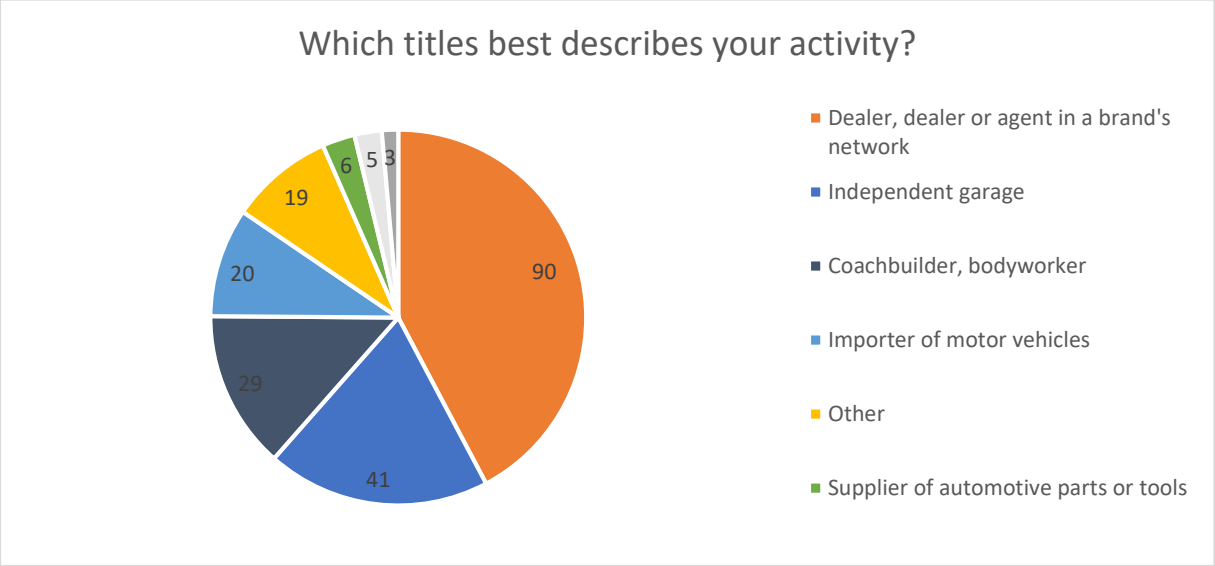
This study will be carried out by analysing existing and primary data. Based on the available data, the breakthrough of these predicted evolutions is estimated. These data were organised around three evolutions concerning the automotive industry and related industries:

1. Evolutions focusing on '0 emissions' of transport
2. Evolutions focusing on '0 incidents' in traffic
3. Evolutions focusing on '0 ownership' business models

For each chapter, the existing sources are discussed first. The bibliography lists the original articles. Then, the most important primary data are presented for these themes. These data were gathered by means of structured surveys. The surveys were developed based on sources from the literature study. This way, the theoretical evolutions are tested in realistic situations. Annexes 1 & 2 show the extensive results of the primary research.

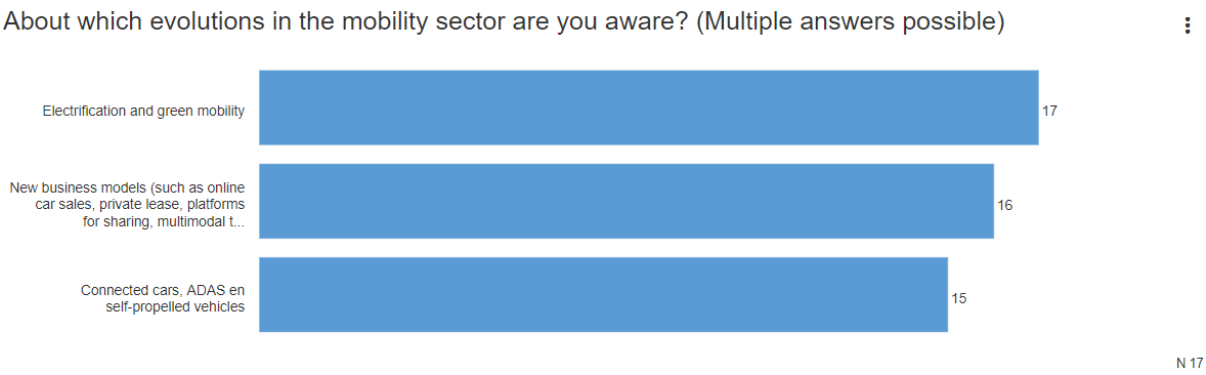
A first survey (see annex 1) was sent out to business managers and human resources managers in the garage and bodywork sectors, as well as to vehicle sellers. The respondents were filtered from EDUCAM's database of customer data. Two hundred and thirteen respondents filled in the survey. 42% among them works in brand-affiliated dealerships, 19% in independent dealerships, 14% in bodywork companies and 9% at importers. The remaining respondents work in affiliated industries (see figure 1). Based on this first survey, it's hard to estimate to what degree the companies in the sectors see these evolutions coming and respond to them. The additional needs are also mapped out. Hereby, special attention is given to the skills of the future.

Figure 1: Division respondents of company surveys



A second survey is sent out to experts that study (one of) these evolutions professionally. These respondents have a *'bird's eye'* overview of the industry or of a specific trend. The experts were selected among the personal connections of the study group 'Route 2030'. They take up prominent roles in academic institutions, politics, the corporate world or are affiliated with automotive associations. Their survey (see annex 2) is an adaptation of the first list on which the experts could indicate their exact field of expertise (see figure 2). With the help of this survey, the literature can be validated and applied to the context of the Belgian automotive industry. Experts can also determine whether the companies take enough action to prepare for the evolutions. This survey was taken by 17 experts from the sectors.

Figure 2: Experts' fields of expertise



The evolutions are mapped out by combining existing and primary data. Under the title 'Discussion', the primary data are being cross-checked with the existing sources. Like this, the situation in the sectors can be compared to the theory. This makes it possible to estimate the implications for the sectors and EDUCAM.

This written report is a first output of our ‘Route 2030’ study. This document outlines a top-down overview of the evolutions, in which the theory is discussed and illustrated with some practical examples. However, a written report has some limitations. Because of the statistical nature of this format, the developments that take place after the release of this report can no longer be included. Additionally, multiple of EDUCAM's target groups indicate that they don't have time to read this report completely and carefully. To counter these limitations, the written report is supplemented by a series of 'vlogs'. After the launch of the written version, vlogs will appear periodically on EDUCAM's Youtube channel. In these videos, the evolutions are shown using concrete examples in the workshop. Each vlog depicts 1 specific situation, and is presented to the target group in a storytelling manner. The vlogs will communicate the message of Route 2030 from a 'bottom-up' perspective. By watching all the vlogs, the target group will dispose of the same information as someone who has read the written report. In addition, the series of vlogs enables us to still implicate news items into the study after the written report's release.

3 The route to '0 emissions'

Greta Thunberg, a Swedish teen, has succeeded to put climate awareness on the global agenda. Her influence was very noticeable in our country: students organized weekly climate demonstrations. It seems clear that the consumer of the future wants to reduce global warming. Recent election results showed that consumers of voting age are less convinced by the necessity of these climate actions. However, governments on various levels have implemented measures to restrict climate change and environmental pollution (Connect4Climate, 2018; Verstraete, 2019).

In this respect, all eyes are on the transport industry. According to the European Environment Agency (2019), the transport industry is responsible for 27% of all greenhouse gasses (CO_2, methane and such) emitted within the European Union. Passenger cars are responsible for 9% of all harmful emissions. Shindell (2015) puts a price on these pollution effects. According to his calculations, the consumption of 1 gallon of petrol causes about $3,80 worth of environmental damage. For diesel, this translates to $4,8 per gallon. This is respectively €0,92 and €1,16 of environmental damage per litre. These effects are not fully incorporated in the price at the gas station. In addition, actions that favour the climate are not necessarily beneficial for the environment.

For example: CO_2 is a greenhouse gas that alters the climate, but it barely has an impact on the environment and isn't unhealthy to breathe in. Particulate matter (PM_x) and nitrogen oxides (NO_x) on the other hand, pollute the air locally and affect the lungs, but have a smaller impact on the climate.

That is why authorities need to make decisions that attune the interests on different levels (worldwide vs. locally) (Grigoratos & Martini, 2014; Porcelijn, 2017; JATO, 2019).

3.1 Propulsion

Conventional vehicles are driven by an internal combustion engine. Petrol and diesel engines especially are omnipresent in the automotive scene. These engines have been developed further to make the driver's experience as reliable, clean, and pleasant as possible. But lately, the combustion engine has been under attack. International climate agreements impose stringent emission standards on the transport sector. For example, new cars within Europe need to emit 37,5% less CO_2 by 2030. Additionally, manufacturers need to make sure that the average emission of all the vehicles they sell within the EU does not exceed certain limits. Starting 2021, the average fleet for example can't emit more than 95g CO_2 per kilometre. These limit values and standards are becoming more strict regularly, and any violations shall be penalised by the European Union. Local authorities are also making new demands for the vehicle fleet. Various cities are banning polluting vehicles to improve local air quality. Some countries (Netherlands, Iceland, Denmark, Ireland) are even prohibiting the sale of diesel vehicles by 2030. On top of this, climate marches and emission scandals plummet the public perception of the combustion engine (Vlaamse milieumaatschappij, 2018; Bebat, 2019; European Parliament, 2019; JATO, 2019).

Although combustion engines were never explicitly banned in Belgium, this market will still undergo changes. In this case, government policy plays a pivotal role on different levels when it comes to the vehicle fleet of the future. In addition, local authorities have the power to exclude certain vehicles from their territory. In Wallonia, polluting vehicles will be banned during smog alerts from 2020 onwards. During these periods, Euro 3 diesel vehicles and Euro 1 petrol driven vehicles are not allowed within the region. From 2023 onwards, all polluting vehicles will be banned permanently. First, all Euro 1 vehicles or lower will be banned from the region. From then on, the ban will be extended every year until 2030, when only Euro 5 petrol driven vehicles and Euro 6d-Temp diesel vehicles or higher will be allowed to circulate within the region. Municipal authorities are also imposing prohibitions. Antwerp

and Brussels have already created low emission zones (LEZ). Similar measures are planned for Ghent by 2020 (LEZ-Belgium.be, 2018; Wallonie, 2018). Brussels even has a 'zero-emission zone' planned. The set-up of a LEZ has a strong and local impact on the sales of vehicles that won't be able to enter the zone in the foreseeable future. Both the second hand market and new vehicle sales suffer from this. Furthermore, the regions are directing drivers towards the most desirable type of drive. The government is optimising the fiscal system and the tax reduction related to car inscription to make environment-friendly alternatives appeal more to the consumer (Vlaamse milieumaatschappij, 2018).

The overall consensus in literature is that the period of the all-powerful combustion engine is over. Despite fast developments, this technology will not single-handedly be able to meet all the demands and repair the reputational damage. Transport will no longer be dominated by one specific propulsion technology. For each application, there will be a preferred propulsion. As a result, the fleet of 2030 will be composed of mixed models with different powertrains. Combustion engines and electric powertrains will be combined or used individually to guarantee operational reliability and comfort in every situation (Vlaamse milieumaatschappij, 2018; KPMG, 2019). The most important technologies are discussed in this chapter, together with their specific advantages and flaws. Their relevance in certain situations in 2030 is estimated.

3.1.1 Key figures

New sales

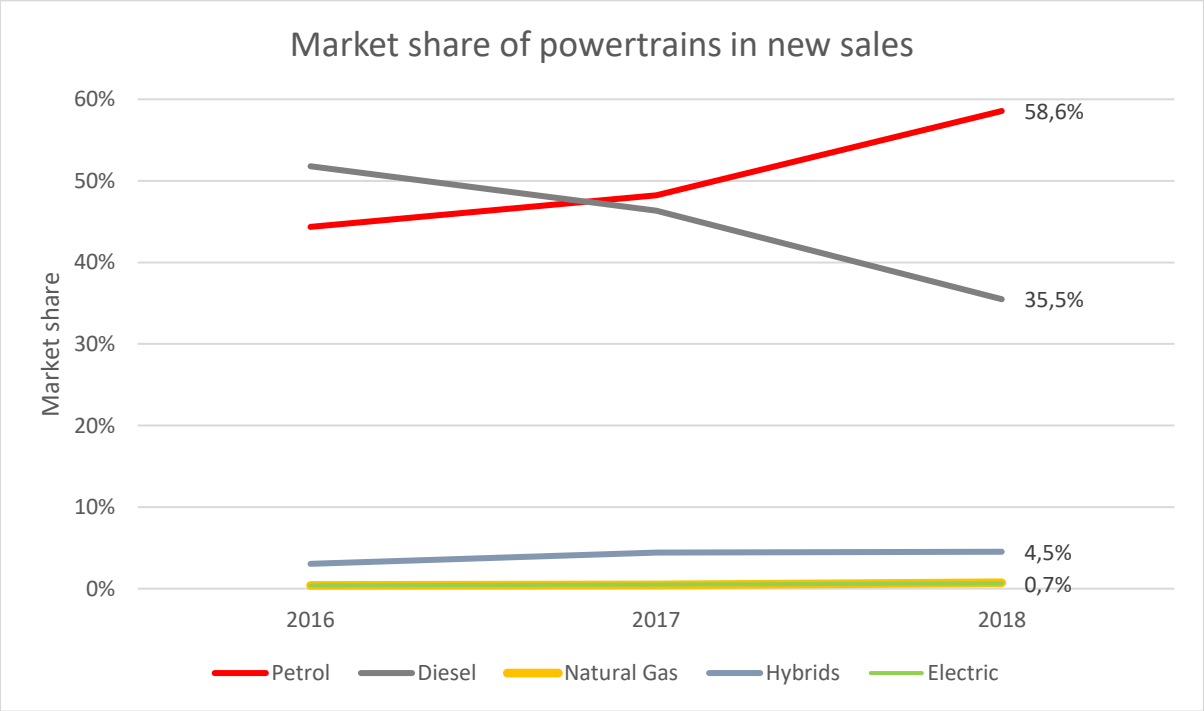
Table1: Total new sales

New sales	2016	2017	2018
TOTAL	539 519	546 558	549 632

Source: Febiac, 2019a

New vehicle sales are rising year after year (see table 1). Although various sources announce a 'peak car' within the next years, this peak doesn't yet seem to be attained in the Belgian market (EDUCAM, 2014; Harrop, 2019a&c).

Figure 3: Market share of powertrains in new sales



In 2018, traditional fossil fuels still represented almost 95% of new sales. What is striking is that diesel sales are rapidly declining in favour of petrol vehicles. Hybrid sales rise steadily. The amount of CNG and full EV vehicles is rising exponentially, but is still marginal at this time (see figure 3). Lpg and other propulsion methods were not included because their share in new sales is too small.

Cost of ownership

To determine the 'total cost of ownership' (TCO), the purchase price, the fuel price, the maintenance and the depreciation are taken into account.

Table 2 shows the purchase price of powertrains in 2019. New powertrains are still more expensive than traditional solutions. Petrol driven cars have the cheapest purchase price. This fuel is unpopular in heavy duty applications, where diesel is used as a reference fuel. Moreover, we expect some quick developments that will influence the cost of these technologies. That is why the following tables and titles discuss the expected trends for each propulsion individually.

Table2: Relative purchase price new vehicles per powertrain

Purchase price	Petrol	Diesel	Lpg	CNG	BEV	Hydrogen (H_2)
Vehicle	100%	110%	110%	115%	200%	250%
Truck	-	100%	110%	125%	250%	350%

Source: processed data based on information session Waterstofnet, 2019; US Department of Energy, n.d.

To compensate for investments in new 'zero emission vehicles' (ZEV), regional authorities are setting up financial incentives. In Flanders, green vehicles are the major focus (see table 3). In addition, the benefit in kind for zero emission vehicles is most appealing because of their limited CO_2 emission. The more a vehicle emits, the higher the costs in the table above will increase, and the more the tax deductibility will decrease.

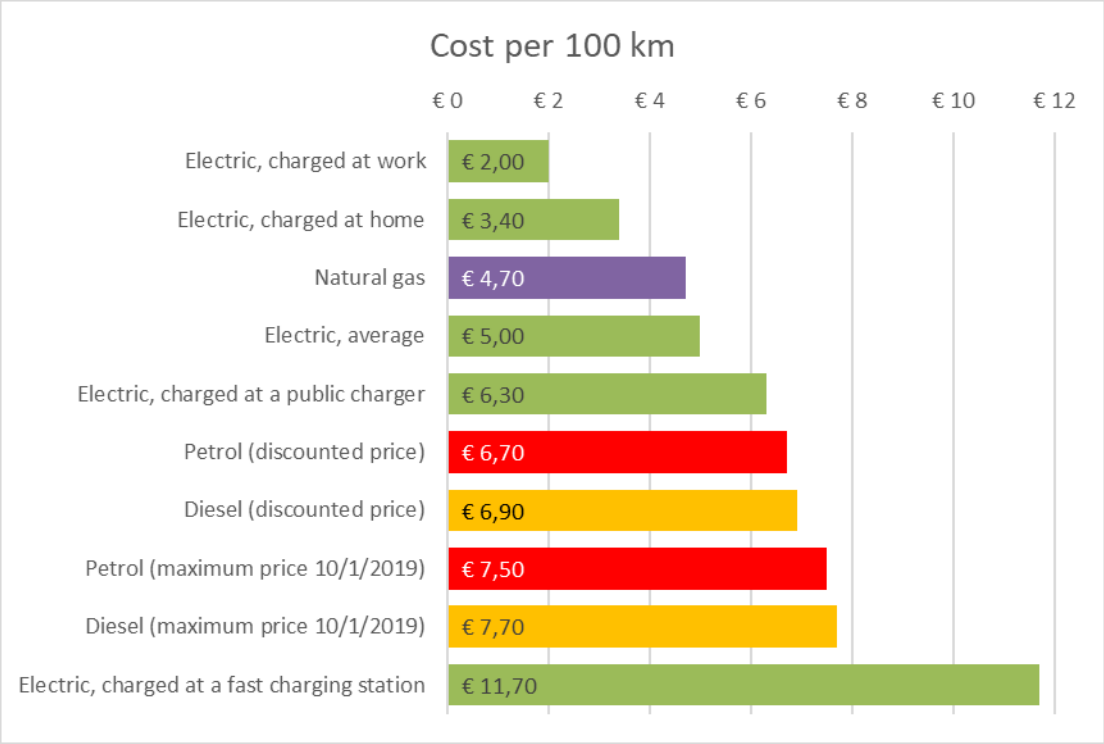
Table 3: Financial incentives for vehicles without exhaust emissions

Incentives ZEV 2020	Flanders	Brussels	Wallonia
Taxation	100% deductible	100% deductible	100% deductible
Car registration tax	Exempted	Minimum amount (€61,50)	Minimum amount (€61,50)
Road taxes	Exempted	Minimum amount (€77,35)	Minimum amount (€77,35)

Source: Febiac, 2019b

The tables above refer to the purchase price of a vehicle. But the TCO of transport mainly consists of variable costs. Figure 4 shows the average price of fuel or electricity to make a vehicle cover 100 kilometres. What stands out is that electric vehicles can both 'refuel' at the highest and the lowest cost, depending on where the charge takes place. If there is no need for a fast charge, an EV with a high mileage will eventually be cheaper than an equivalent vehicle running on traditional fuels. Lpg is not included in this calculation because this fuel's market share is too marginal and because there are no data available.

Figure 4: 'fuel' price per 100 kilometres driven



At the time of writing, no comparative studies were published about maintenance and amortisations that include all these technologies. These subjects will be discussed for each powertrain under the titles below.

Emissions

Figure 5: average emission of greenhouse gasses by electric and traditional powertrains per kilometre

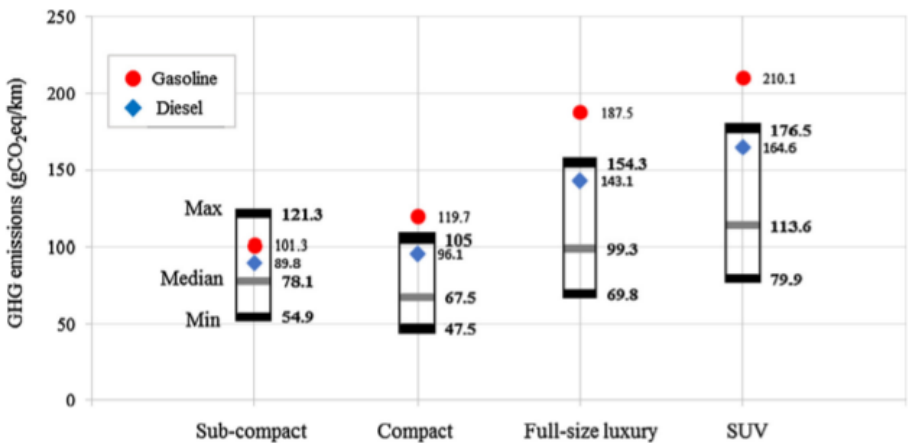


Fig. 2. Global GHG emissions by each vehicle category.

Source: Woo, et al., 2017

Woo (et al., 2017) did research on the 'well-to-wheel' emission of electric vehicles. This study compares the greenhouse gasses emitted by EVs during their full life cycle (production, usage and recycling) with those of traditional vehicles. It is remarkable that traditional fuels (mainly diesel) emit less than electric vehicles in some cases. This is caused by the polluting production process of an EV battery. Obviously, these results are highly dependent on the local energy mix. More than half of the

electric energy in Belgium comes from carbon neutral sources (nuclear, wind, water and sun) (Elia, 2019). That is why the production of our electrical energy emits significantly less than the global average. This means that our results are below the median. In our country, electric vehicles in all segments will have a smaller impact on climate compared to vehicles running on traditional fuels. This advantage for EV therefore depends on the specific situation. The environmental impact is clearly smaller for electric vehicles, even when the electricity they use to charge comes from polluting sources (Shindell, 2015).

3.1.2 Diesel engines

For a long time, diesel used to be the preferred fuel in the Belgian market. This was due to the self-ignition's relatively low consumption, in combination with cheap diesel. In addition, the CO_2 emission of diesel engines is significantly lower compared to similar petrol engines. This makes them fiscally attractive for the professional market. On top of that, bonuses were given with the purchase of a diesel vehicle until 2012. Because of this, the higher purchase price and diesel vehicles' more expensive maintenance was compensated largely if these vehicles travelled more than 25 000 kilometres yearly. As a result, more than 75% of all new registered vehicles 10 years ago ran on diesel (ALD Automotive, 2018; Febiac, 2019a).

Diesel vehicles get a lot of bad rep nowadays. Diesel engines emit a significant amount of NO_x and particulate matter. By emitting these substances, diesel vehicles cause more local air pollution than other powertrains. That is why (older) diesels are especially targeted in low emission zones. New diesel technology reduces this emission below the emission level of petrol engines. Some diesel emission scandals and climate marches have damaged this fuel's reputation. The financial advantage of diesel vehicles is also gone: The maximum price is now about the same as for petrol, and the road tax is higher at the moment when the vehicle is bought (Vlaamse Milieumaatschappij, 2018; Pauwels & Laenen, 2020).

This is mostly reflected in declining sales of second-hand diesels. The second hand market is currently facing an excess supply of diesel vehicles. That is why a model with a diesel engine will be sold at a much lower price compared to the same model with an equivalent gasoline engine, even though the initial purchase price is usually higher. The decreasing residual value means that diesels now undergo a stronger depreciation in relation to petrol vehicles. This means that the 'total cost of ownership' (TCO) is almost always higher for diesel. Diesel drivers can only recover their investment by driving a lot of (economical) kilometres. Leasing company ALD Automotive (2018) estimates that the purchase of a diesel vehicle in 2018 was only more favourable than a petrol vehicle if it ran on average 47 000 kilometres each year. This makes the tipping point at which diesels become interesting almost twice as high as a decade ago.

The sale of new diesels also suffers from this (see key figures, graph 1). Year after year, the market for diesel driven passenger cars shrinks about 8%. In 2017, for the first time in 20 years, petrol vehicles obtained higher sales volumes than diesels (Febiac, 2019a). In a survey by VAB (2018), only 10% of respondents claimed to consider diesel when buying their new car. Because the market is shrinking at an alarming rate, various manufacturers will no longer offer diesel engines in their line-up of passenger cars. For example, Toyota-Lexus, Honda, Hyundai-Kia, PSA, Nissan-Mitsubishi, Suzuki, Subaru, FCA, Volvo, Porsche, Bentley and Cadillac, have announced that they will phase-out their diesel technology by 2030. As opposed to this, the big German manufacturers hold on to diesel vehicles and are certain that they will still be sold after 2030 (Autoblog, 2019; Campbell, 2019).

It seems unthinkable that diesel engines will disappear in some vehicle segments. Long distance trucks and buses benefit greatly from this technology. Given that diesel consumption is low, they can travel

far with a heavy load without wasting time at gas stations. In addition to this, most countries are equipped with high quality diesel gas stations. The same arguments apply to heavy passenger cars and light commercial vehicles that cover big distances. For these applications, diesel technology will continue to be developed, meaning that consumption and pollution can be reduced further (ALD Automotive, 2018; McKinsey & Co, 2016).

3.1.3 Petrol engines

Traditionally, vehicles ran on diesel or on petrol. Petrol engines were suited for customers who drove less than 25 000 kilometres annually. The costs to purchase and maintain a petrol vehicle are relatively low. That is why the higher cost of petrol is compensated by its low mileage. Additionally, petrol is -just like diesel- available in every gas station, making the fuel highly accessible. In recent years, diesel bonuses were lifted and taxes gradually rose. As a result, there is no longer a significant price difference between petrol and diesel. Currently, the total cost of new petrol vehicles is also more advantageous for vehicles with a high mileage. This is why the market share of petrol vehicles has been rising tremendously since 2010. In 2017, petrol regained its pole position on the market as most popular fuel for new vehicles. There is consensus in the literature that petrol will maintain its position in 2030, unless the government takes a radically different approach (ALD Automotive, 2018; VAB ,2018; Duquesne, 2019; Febiac, 2019a).

In addition, the efficiency setbacks with regards to diesel are getting smaller. Technological developments such as direct injection lower the consumption and CO_2 emissions of petrol engines. But even the most advanced petrol engines can't compete with the CO_2 emissions of their diesel peers. Still, car dealers advise to purchase a petrol vehicle more often now. The reason behind this is that petrol technology is more appropriate for certain user profiles. Diesel particulate filters would clog when the vehicle is only used for short distances. Petrol engines do not experience this problem (Vlaamse Milieumaatschappij, 2018).

Furthermore, petrol was not subjected to the same reputational damage diesel engines suffered. In a survey by VAB (2018) on the public perception of different fuels, 48% of respondents indicated that they would consider petrol when buying a new car. On the other hand, only 10% of respondents are still interested in diesel fuelled vehicles. As a result of this shift, the CO_2 emission of the vehicle fleet is on the rise again (JATO, 2019).

3.1.4 Alternative fuels

Combustion engines driven by CNG (compressed natural gas), Lpg (liquefied petroleum gas), LNG (liquefied natural gas) or biofuels currently play a minor role. These fuels offer a cheap and -in case of natural gas and biogas- environmentally friendly alternative to petrol and diesel. Nevertheless, the Federaal Planbureau (2019) predicts that the market share of these fuels will remain small. VAB's survey (2018) on the fuel preferences of consumers confirms this statement. Only 2% of respondents indicated they would consider alternative fuels when buying a new car.

An important reason why we don't see these vehicles often is because the refuelling infrastructure is less dense. Belgium has about 100 CNG stations and 500 Lpg stations, as opposed to 3350 gas stations offering diesel and petrol (Traxio, 2018; Belgische Petroleum Federatie, n.d.). Biofuels are currently in an experimental phase, or only to be distributed after being mixed with another fuel. Moreover, these fuels are less efficient compared to their established counterparts. This is because they contain less energy per volume. As a result, engines running on alternative fuels are less powerful than their petrol- and diesel fuelled equivalents. A lower efficiency also means that both Lpg and CNG vehicles need to refuel more often than vehicles running on traditional fuels.

By converting natural gas to a fluid form (LNG), more energy can be stored within a small volume, but this is an inefficient and expensive process. That is why LNG is only suited for 'Heavy duty' applications that necessitate a large range. Diesel is still omnipresent on this market (US Department of Energy, n.d.; McKinsey & Co, 2016).

After all, the supply of vehicles running on alternative fuels is minimal. These vehicles are often petrol vehicles, which have been converted to allow the engine to run on alternative fuels. The engine is preserved, but an additional fuel tank needs to be installed. This installation reduces the vehicle's storage space. Additionally, the purchase price of alternatively fuelled vehicles is 10% higher (US Department of Energy, n.d.). However, low fuel prices compensate high purchase prices and consumption. According to research by VAB (2019), driving a CNG-powered vehicle is on average €2 cheaper per 100 kilometres, compared to a traditionally fuelled vehicle.

It seems as if alternative fuels don't gain in importance because they suffer from 'middle of the road' syndrome. Even though they offer a cheap and clean alternative, they won't generally break trough. They are not as comfortable to use as the established fossil fuel vehicles, and are considered to pollute more than electric vehicles. At the same time, the tax benefits for alternative fuels are lower compared to those for electric vehicles. Another setback is the distrust potential customers have with regards to government policy on taxation for clean mobility. The diesel saga has indeed shown that the government tends to react inconsistently when it comes to its fuel tax policy. If the taxes on fossil fuels would rise further, even alternative fuels would suddenly become unprofitable (VAB, 2018).

Natural gas has taken some heat recently. Research has shown that large amounts of methane leak into the atmosphere during the drilling process. Methane is a very potent greenhouse gas that warms the climate more than a comparable amount of CO_2. That is why the climate-friendly emission of CNG and LNG vehicles is being undone by the polluting production process of the gas (Pauwels & Laenen, 2020).

3.1.5 Battery electric vehicles (BEVs)

Because customers and governments focus more on zero emission driving, there is significantly more attention for electric vehicles. Electric vehicles produce less harmful substances during their lifetime compared to vehicles with a combustion engine. The reason behind this is that electric engines have zero emission during their use. The production and recycling of electric vehicles produces more CO_2, but this pollution is compensated largely when the vehicle covers more distance. Even when the emission caused by electricity production is taken into account, this will be more balanced in favour of EVs (Renault, 2011; De Paepe, 2018; Vlaamse Milieumaatschappij, 2018).

The Federaal Planbureau (2019) and Bebat (2019) estimate that about a third of newly sold vehicles will have some form of electric powertrain by 2030. In their opinion, full electric vehicles will represent a market share of 5% in new sales. 25% of newly sold vehicles will possess a hybrid powertrain. VIAS (2019) is more optimistic about the electrification of the vehicle fleet. In their survey, 16% of respondents indicated they would consider buying an electric car in the next 3 years. According to these sources, vehicles will in 2030 still be driven by combustion engines, but the interest for EVs will continue to rise.

BEVs are electric vehicles that store energy in battery packs. If there is high tension, one or multiple high-voltage electric engines will drive the wheels. This propulsion method is becoming more important in various segments. In 2030, battery technology will be responsible for the majority of electrically driven vehicles. From micromobility to 'heavy duty' vehicles, different markets are convinced by BEVs. Even the automotive sector recently came round. In the meantime, all established

car manufacturers have been experimenting with -fully or partly- electric powertrains (VMS-Insight, 2018; Bebat, 2019; Harrop, 2019a).

Almost every BEV uses lithium-ion batteries to store energy. this is the most developed electric storage technique to date, and it is easily applicable to fully electric vehicles. Some manufacturers, such as Volkswagen Group, BMW, Jaguar and Renault-Nissan have already launched battery-electric models, while others add hybrid vehicles to their product range (Hyundai-Kia, Toyota-Lexus, Volvo,...). Various new players have penetrated the market with an exclusively electric portfolio. Tesla is the best example of this, but recently different Chinese players followed in Tesla's footsteps: NIO, Byton, BYD, GAC, Geely, Lync & co, Maxus, MG, NEVS, JAC and Roewe (VMS-Insight, 2018; Bebat, 2019; Harrop, 2019b).

Manufacturers are preparing for a future with battery-electrically driven vehicles in it. Different groups of customers are currently making a switch towards electric mobility. Cyclists were the first to convert. Meanwhile, the electric bike has become the largest segment in the bicycle market, representing about 30% of total sales. Passenger buses will also make changes soon. Bus transport operators are frequently subjected to inspection by the government. By investing in electric buses, these governments can send a clear signal to the other road users. On top of that, buses often circulate in highly dense areas, where harmful emissions of (diesel) engines causes additional nuisance. That is the reason why drivers of light trucks will also quickly opt for battery-electric propulsion methods. When city authorities start to impose more and more emission restrictions, these vehicles will be equipped with less polluting propulsion methods. In this way, deliveries will remain possible within city limits (VMS-Insight, 2018; Bebat, 2019; Harrop, 2019b).

The choice to use batteries to store energy in vehicles is obvious. Batteries can store a lot of electrical energy in a relatively small space. This is due to their relatively high energy density per volume for electric vehicles. Additionally, BEVs can charge anywhere, as long as electricity is available. This technology still faces challenges. The main disadvantage of batteries is their weight. When a BEV's range enlarges, its battery will get heavier. Obviously more weight has to be transported, which reduces the range again. This explains the small range of EVs from the first generation. The theoretical action range of the current generation BEVs is between 100 km for town cars and 500 km for luxury cars. In reality however, most BEVs don't get further than 350 kilometres with a fully charged battery. This range depends on environmental factors, such as the temperature or the trajectory (WaterstofNet, 2019).

Moreover, charging takes significantly longer compared to a classic refill. Using fast chargers, batteries can often be charged up to 80% in 40 minutes. The network of fast chargers in Belgium also remains limited (38 stations) and the procedure for building such chargers is subject to a lot of bureaucracy. It takes 3 years on average between a demand and the installation of a fast charger. When more than 80% charge is needed, or if only a regular charging station is available, the time needed to charge rises exponentially. These characteristics make batteries especially apt for passenger cars and small heavy duty vehicles (Laenen, 2019; WaterstofNet, 2019).

There are also some practical obstacles for BEV's to break through. The production process of these batteries is very polluting and some raw materials (cobalt and nickel) are dug up in conflict zones where working conditions are atrocious. This puts the moral justification for electromobility into question. According to Miedema (2019), using the current technology, there will only be enough lithium and cobalt available to electrify 20% of the European vehicle fleet. Recycling BEVs is also less simple compared to recycling vehicles with a combustion engine. It is actually very costly to recycle batteries. That is why manufacturers are held responsible for recycling as soon as the batteries are

marketed. They also have to report frequently on which batteries they marketed in each of the Belgian regions. This raises the cost of BEVs for the Belgian market (De Paepe, 2018; Bebat, 2019).

VAB (2018) identifies some other obstacles that could possibly hinder the breakthrough of BEVs: the absence of charging infrastructure (at home); the supply of EVs that doesn't satisfy the customer's demands,… Finally, almost half of customers fear that a massive adoption of electric vehicles will cause power shortages. On the ACEA summit (2019) someone stated that the fear of problems with electric charging infrastructure is mostly due to a lack of knowledge. Most EV drivers charge their cars at home or at work, and there are a lot of existing charging solutions on the market to this effect. However, Belgium is different because the electricity network is too old to charge EVs in some cities. It is much more expensive to charge via these old networks because a transformer is needed. This explains the small amount of charging stations in Brussels.

KPMG (2019) adds that BEVs will only fully penetrate the market when charging becomes just as easy as refuelling vehicles with a combustion engine. The 'fear' of users to run out of power must also be eliminated. In addition, the different charging plugs and -methods cause confusion on the market. Potential customers often are unsure about where to charge their EV and with which plug, what paying method to use, and if they need to charge AC or DC current. Finally, EDUCAM's (2014) 'Route 2020' already described a fire hazard EV batteries entail. A damaged battery can cause a chain reaction, which makes the fire difficult to extinguish. The fire can also re-ignite days after the original incident.

Because of these disadvantages, the private market for passenger cars reacts reserved to electrification. According to research by VAB (2018), 8% of customers would consider a fully electric vehicle when they purchase their next car. In addition, 15% of respondents indicate they would look for a hybrid vehicle. The main reason for this restraint is the high purchase price for these vehicles. Electric company cars are promoted more than private EV purchases. As a result, more than 4 out of 5 EV's in Belgium are registered by a company (Powerdale, 2019). Furthermore, respondents indicate that they feel unsure about the consistency of these fiscal incentives. We notice that potential buyers are interested in driving electric cars, but that their affordability becomes the main restraint. Occasional long trips -such as car vacations- are often cited as an argument in favour of a traditional engine over an electric drive (VAB, 2018).

These problems could possibly be solved by fast developments in battery technology. At present, the battery remains the most expensive component of a BEV, but thanks to technological developments, prices are going down fast. EV batteries are expected to store twice as much energy by 2030, and they will probably cost only one third of the current battery price. The battery pack's weight and volume will remain unchanged. 'Solid state' and graphene batteries are promising evolutions that could deliver. Currently, this technology isn't developed enough for practical applications, but various manufacturers are working on this. Vehicles with solid state batteries are expected to be seen by 2030. Manufacturers are also continuously looking for alternative ways to assemble batteries. Like this, lithium and cobalt supply chain issues can be avoided. Finally, experiments with charging while driving are taking place. Various brands have announced that solar panels can be placed on the roof of their electric vehicles, and multiple cities are testing tram rails on highways for heavy duty traffic (VMS-Insight, 2018; Blanco, 2019; Europese Commissie, 2019; Harrop, 2019c).

3.1.6 Fuel cell electric vehicles (FCEV)

Vehicles that are driven by 'Fuel Cells' are an alternative form of electric mobility. This technology doesn't store energy in battery packs, but in the form of hydrogen (H_2) in tanks. Just like a battery, hydrogen is an energy carrier. By combining hydrogen with oxygen in a fuel cell, electrical energy is

generated to power the vehicle. Hydrogen tanks weigh considerably less than batteries, but take up more volume (WaterstofNet, 2019)

Various industries are showing interest in energy storage by means of hydrogen. Hydrogen gas can easily be transported through pipelines and can be stored in tanks. This is why it offers potential to store electricity from green sources during peak periods, and to use it during off-peak hours. The attention for this technology from different sectors causes a 'spill over' effect. When other industries focus on H_2 storage these evolutions will penetrate the automotive industry, and vice versa. Numerous big car manufacturers (including Toyota, Honda, Hyundai, Mercedes-Benz, BMW, Renault,...) are showing interest in the technology and are already developing hydrogen-powered vehicles (WaterstofNet, 2019).

Additionally, Belgium is well located to accommodate the development of energy storage in hydrogen. Our country has a very dense pipeline network that can be used to transport hydrogen. Different local companies are joining WaterstofNet's (2019) 'power-to-gas' cluster in order to store their excess energy as H_2.

Within the automotive industry, hydrogen propulsion mostly has potential to play an important role in long-distance transport and on the heavy duty market. These vehicles obviously have enough space to store hydrogen tanks. It is also important that vehicles in this market aren't too heavy, because their maximal gross weight is determined legally. Heavy battery packs would lower the carrying capacity of the vehicle. Hydrogen is also more attractive for vehicles that need to remain operational for several consecutive hours. As it happens, H_2 vehicles have a large range and short refuel times. Also, heavy duty vehicles often operate within industrial areas where a hydrogen station could operate cost-effectively. That is because a large group of potential customers is located there. In addition, delivery vehicles need to conform to increasingly stringent emission standards, certainly if they circulate in low emission zones (Hydrogen Europe, et al., 2018; WaterstofNet, 2019).

Hydrogen-powered vehicles are potentially cleaner than BEVs. FCEVs emit less harmful substances, especially during their manufacturing phase. In theory, hydrogen can be produced from fully renewable sources. However, in reality the majority of hydrogen (95%) is obtained by steam reforming of natural gas, a process during which a substantial amount of CO_2 is released. In some industries, H_2 is released as a waste product. It can be collected and used to power vehicles. Hydrogen that isn't produced from renewable sources is called 'grey hydrogen'. This form of hydrogen is significantly cheaper to produce. To encourage users to opt for completely environmentally friendly 'green' hydrogen, the EU developed a CertifHy-label. Towards customers, this label indicates the origin of the hydrogen (Hydrogen Europe, et al., 2018; WaterstofNet, 2019).

Despite their potential, the Federaal Planbureau (2019) estimates that H_2 vehicles will only play a small role in the mobility landscape of 2030. According to the bureau, BEVs are the electric propulsion of the future. This is due to the fact that FCEVs have some drawbacks. The most important problem is that the necessary infrastructure is not yet present. There are not enough charging stations to make hydrogen vehicles attractive, and there are not enough FCEVs to justify the construction of new charging stations. Currently, there are two public hydrogen stations in Belgium: Air Liquide operates a station in Zaventem, and DATS 24 (part of Colruyt Group) has one in Halle. There is an additional station in the port of Antwerp where De Lijn's buses can load hydrogen coming from Solvay's production. In the coming years, DATS 24 will open stations in Wilrijk, Gent, Leuven and Liège. Belgium is clearly running behind on its neighbouring countries. For example, the number of hydrogen stations in Germany is in the double digits and more than 100 stations are expected to be operational around 2020 (WaterstofNet, 2019).

An additional disadvantage is that electricity storage in hydrogen is less efficient than in batteries. Storing energy in hydrogen is half as efficient as in batteries at best. A vehicle running on hydrogen therefore needs double the amount of energy to drive compared to a BEV. The energetic loss during the production of hydrogen causes 'refuelling' to be more expensive than charging a BEV. However, hydrogen tanks are easier to transport and don't spontaneously lose their charge (like batteries do). On the other hand, H_2 vehicles are more efficient compared to vehicles running on traditional fuels (Morrison, et al., 2018; WaterstofNet, 2019).

Hydrogen also has a bad image. It is odourless and colourless, volatile and highly inflammable. This combination caused some accidents in the past. Hydrogen bombs and exploding Zeppelins have painted the image of a life-threatening, unmanageable gas. Further image damage for FCEVs occurred when a hydrogen station exploded in Norway. In response to this incident, Toyota and Hyundai even stopped selling hydrogen vehicles and offered their customers to temporarily trade in their vehicle (WaterstofNet, 2019).

Presently, a sectoral framework for working safely on hydrogen vehicles is being established. This happens in analogy with sectoral legislation for safe work on hybrid and electric vehicles. Like this, employers guarantee that their workers don't have to work on FCEVs in dangerous situations without realizing it themselves. Still, hydrogen installations are relatively easy to handle using the right tools. If a leak occurs, hydrogen will rise quickly and will mix with the air, which significantly decreases the risk of fire. In reality, working with hydrogen is no more dangerous than working with traditional fuels (WaterstofNet, 2019; EDUCAM, 2020a).

To make hydrogen propulsion break through, government incentives are needed. Some government organisations are already facilitating the breakthrough of hydrogen vehicles. The 'Fuel Cell Hybrid Joint Undertaking' is a cooperation agreement between the EU and the industry to do research and organise conventions about FCEVs. Closer to home, WaterstofNet is building H_2 charging stations with the support of private and public organisations within the project 'H2BeNeLux'. The EU also grants financial aid for green vehicles and offers tax advantages for these vehicles in various countries (including Belgium). As a result, hydrogen mobility gets a competitive TCO (Hydrogen Europe, et al., 2018; WaterstofNet, 2019).

There are some examples of other countries that promote this technology. China invests millions in hydrogen stations to face local environmental issues. These investments also encourage car manufacturers to expand their product range. If there is more supply, more potential customers will find a hydrogen vehicle that suits their needs (Asia Times, 2019). Germany is a top player when it comes to hydrogen mobility because of government incentives destined for H2 stations and vehicles. That is why hydrogen prices are significantly higher in Belgium than in Germany. The price at DATS 24 is €10 for one kilogram, which is double the price than in Cologne. But DATS also indicates that this price will decrease as the scale gets bigger, and as environmental impacts are taken into account for the determination of fuel prices. This underlines the steering role the government has in the choice of fuel for the transport industry (Hydrogen Europe, et al., 2018; Electric Vehicles Research, 2019; WaterstofNet, 2019).

3.1.7 Supercapacitors

A third option is to store electrical energy in supercapacitors. The main difference with a battery is that supercapacitors can't store energy by means of a chemical reaction. Instead, charged ions are attracted to the capacitor's surface. The advantage of this technology is that charging and discharging can happen very fast, without any memory effect. Unfortunately, supercapacitors need a very big

surface to power vehicles. Nanotechnology makes it possible to wrap this surface up compactly, but the energy density per kilogram is still thirty times lower than in batteries (Buchmann, 2019).

The literature doesn't agree on whether this technology is going to break through in the automotive sector and related sectors. However, supercapacitors can be a valuable addition to batteries for electric propulsion. They can store braking energy more efficiently and can deliver more power in case the vehicle needs to accelerate quickly. This lowers the amount of short change cycles that the battery needs to undergo, which lengthens its lifespan considerably. This technology already attracted the automotive industry's attention, as evidenced by Tesla's take-over of Maxwell Technologies – the market leader in capacitors. Together with MIT, Lamborghini developed supercapacitors for electric supercars. Supercapacitors are also interesting to use in certain heavy duty applications. Buses in cities can drive short distances and load their capacitors at each bus stop (Buchmann, 2019 Harrop, 2019b; Lamborghini, 2019).

3.1.8 Hybrid vehicles

Hybrid vehicles combine multiple powertrains to drive more efficiently. Usually, a battery electric propulsion is combined with a combustion engine. In exceptional cases, a battery is combined with a diesel engine. Fuel cell vehicles also carry a high voltage battery, but FCEVs don't belong to the hybrid category and are therefore not discussed under this title. Other powertrain combinations are not common in the automotive landscape (EDUCAM, 2014; WaterstofNet, 2019).

Powertrains can have different configurations. In 'parallel hybrids', both engines can drive the wheels. The most efficient combination is chosen depending on the situation the vehicle is in. An alternative for this are 'serial hybrids', in which the wheels are only powered by an electric engine. The fuel aggregate will in this case only function as a 'range extender' to charge the battery. 'Combined hybrids' can function in series, as well as in parallel. Finally, there is a difference between 'mild hybrid' vehicles, 'plug-in hybrid' vehicles (PHEV) and 'full hybrids'. Mild hybrids support the combustion engine when starting and during acceleration. The batteries are charged by regeneration of braking energy. PHEV batteries can be charged using a conventional socket. They can store more energy than mild hybrids, and as a result, they can drive a few miles in fully electric mode. Full hybrids have the same electric range as a PHEV, without having to charge at a charging station. Just like mild hybrids, they get their energy from braking, or from a dynamo on the combustion engine (EDUCAM, 2014).

Most sources agree that hybrid vehicles will constitute a large part of the market in 2030. About 30% of the new cars sold will be hybrids. About 12% of newly sold hybrid vehicles have a plug. Hybrids are expected to offer better future prospects than alternative fuels (VMS|Insight, 2018; Federaal Planbureau, 2019).

The shift towards electrified vehicles did not come by chance. They are a good solution for consumers as well as manufacturers. Thanks to their partly electric propulsion, hybrids are allowed in low emission zones. Their range is just as big as for vehicles with combustion engines, but their consumption and emission are considerably lower when the electric propulsion is used. Additionally, fuelling up can be done in the same way. Even manufacturers are happy with the growth of hybrid vehicles. The combustion engine stays present in a hybrid drive, and is highly developed and cheap to produce. As a result, all manufacturers currently have hybrid versions of their models on display in their showroom (Harrop, 2019a).

Governments also promote the sale of hybrid vehicles. This is what makes it possible to comply with the (theoretical) emission standards. In addition, hybrid technology offers more learning effects to transition towards a mobility that is completely emission free. That is why hybrid models are highly

funded. Unfortunately, these incentives were often abused. PHEVs were often not being charged, which made them emit more harmful substances. The environmental advantages of mild hybrids were also smaller in reality than estimated at first. The first hybrid powertrain generations carry additional weight, which caused minimal environmental gain in realistic driving conditions. Additionally, the high voltage battery is subject to a very polluting production process, just like the BEV. Introducing a realistic emission test cycle (WLTP) and further developments in battery control technology alleviate these problems, but according to Harrop (2019a), hybrid vehicles remain compromised. In most cases, their electric range remains too narrow, and because of their extra weight compared to a singular drive, their environmental gains are limited. That is why hybrid sales aren't expected to rise further, and customers will probably switch to 'full EVs' when the range of the latter model expands (VMS|Insight, 2018; Harrop, 2019a).

3.2 Use of materials

The materials used to manufacture vehicles also influence their emissions. A vehicle that is made of light materials and therefore weighs less, will emit and consume less. Manufacturers make use of government and market incentives to try to minimise the consumption. The use of light materials often turns out to be an advantageous solution. The materials need to guarantee that the vehicle structure remains safe in case of an accident, and at the same time, they need to be economically interesting. By considering these demands, the sector experienced different evolutions in material use (Europese Commissie, 2000; Renault, 2011; Vlaamse milieumaatschappij, 2018).

3.2.1 Construction

To accelerate a vehicle, Newton's second law is applied: More mass means more energy needed to accelerate. Car manufacturers are encouraged to limit energy use and the emissions of their vehicles in different ways. That is why they try to keep the mass as low as possible. A lighter vehicle will consume -and emit- increasingly less than a comparable model that weighs more. That is why manufacturers opt for a stronger, weight-reducing design with light materials -like hard steel, aluminium or carbon- whereas they traditionally chose 'soft steel'. However, these materials are more expensive, and are therefore only used in higher vehicle segments. By using light materials selectively on certain parts of the bodywork, the vehicle's centre of gravity is moved. Like this, the manufacturer can also improve its driving behaviour and avoid costs (EDUCAM, 2014).

Still, new vehicles often weigh more than their older counterparts. This is the case because they need to comply to more stringent safety requirements. Crumple zones, impact beams, air bags, sensors and other safety requirements built in by manufacturers add weight to the vehicle. Additionally, SUVs have become more popular than ever. This type of bodywork typically outweighs a comparable hatchback or station wagon. Trends like these compensate for the lighter vehicle build. Since 2013, the average weight of new vehicles therefore remains unchanged (Vlaamse Milieumaatschappij, 2018; JATO, 2019).

Next to the specific weight, the choice of materials for certain parts has an environmental impact. All parts that experience friction are subject to wear. Mainly the brakes and tires wear during use. This causes certain emissions that are harmful for the environment. Usually, governments only evaluate exhaust emissions. This is why players in the automotive industry -and related industries- don't focus on reducing non-exhaust emissions. Nevertheless, Grigoratos & Martini (2014) showed that pollution from non-exhaust emissions takes the same proportions as that in modern diesel vehicles. Particulate matter is what mostly harms the air quality. Especially in cities, tire damage is the primary culprit. Tire wear causes more than just local air pollution. While driving, microplastics are released from the tires.

These plastics stick to the road surface until they are washed away by rain. This is why tires are an important cause of microplastics in surface water and in oceans (EU Science Hub, 2018).

Finally, different materials impact the environment and our climate, even before they come into contact with a vehicle. We already mentioned the polluting exploitation of metals to manufacture EV battery packs. Even though the production of traditional vehicles is less harmful for the environment, it also causes pollution. That is because metals need to be exploited for each new vehicle. The exact impact of this is hard to determine, because it relies heavily on the local energy mix and transport needs. One vehicle takes on average the same amount of energy to produce than to drive it for 5 years (Porcelijn, 2017). Moreover, the refining process of petroleum is a very energy intensive process. Burkert (2019) claims that creating 6 litres of diesel and driving 200 kilometres with an electric vehicle demand the same amount of energy.

3.2.2 Recycling

The EU has introduced a guideline in 2015, which causes minimally 95% of (the weight of) each discarded vehicle to be reused, recycled or processed. This guideline applies to all motorised land vehicles, apart from vehicles for agricultural purposes (EU, 2000). Every vehicle undergoes the same treatment steps at the end of its life (Renault, 2011; Febelauto, 2018):

- Preconditioning: removing fluids, air bags and converters. All batteries are removed from the vehicle.
- Dismantlement: disassembly of reusable or recyclable parts such as bumpers, glass and seats.
- Compacting and shredding: the vehicle gets destroyed.
- Sorting: iron metal is separated from the other metals. Valuable raw materials are reused as ground materials by the industry. The residue (5 to 10% of the mass) is pressed together.
- Residue treatment: compressed materials are energetically recovered (by incineration).

While manufacturers comply with European guidelines, recycled materials often don't find their way back to the automotive industry. Renault (2011) says that only 10% of the steel in a new vehicle originates from a recycled source. As a result, a lot of new source materials are used to manufacture a vehicle. It is precisely this exploitation of ores that is a huge cause of CO_2 emissions and other pollution (Porcelijn, 2017).

Electric vehicles also have to comply to the European Guideline (EU, 2000). This doesn't mean that the treatment of an EV happens in the same way. Special attention needs to be given to the battery pack during the recycling process. Legally, there are no additional guidelines established at this time for the treatment of EV batteries. They need to be processed the same way regular batteries are treated (EU, 2006). But, the industry did decide that recyclers need to possess a 'HEV' certificate. When handling a high voltage battery, there is a serious electrocution risk. Additionally, individual cells can explode when they aren't treated properly, which causes a chain reaction (EDUCAM, 2014).

As soon as the battery loses 20 to 30% of its original capacity, it is no longer appropriate for use in automotive applications. At that moment, the manufacturer or importer is held responsible for the recollection of the battery pack. First, the battery is removed from the vehicle. After this, there are several possibilities. If the battery isn't damaged, the manufacturer could decide to reuse it in mobile or static applications. In most cases, this isn't an easy process because the battery was designed according to the (formal) requirements of the first application. Usually an external processing plant that has a permit in each of the three Belgian regions is appointed. This company then is in charge of dismantling and recycling the battery. As opposed to the lead starting battery of a classical vehicle, recycling EV lithium-ion batteries isn't profitable. The reason for this is that the costs of transport and

treatment are higher than the value of the raw materials. This is an expense for the manufacturer. This means that it often takes a long time before battery packs are treated (Febelauto, 2018; Bebat, 2019).

3.3 Impact on the car dealership: more knowledge, less turnover

To make a large-scale roll-out of electric vehicles possible, qualified staff needs to maintain these vehicles. In conventional combustion engines, mechanics don't come in contact with components under high voltage. In EVs, these new systems pose serious risks (electrocution, fire, chemical and magnetic risks) when they are treated in the wrong manner. A burning EV battery is also difficult to extinguish. To guarantee the quality and safety of the work, a large-scale retraining of mechanics is needed. Since 2011, a sectoral certificate 'HEV' is issued to mechanics that are authorized to work on hybrid and electric vehicles. Electrified vehicle sales rise exponentially each year. As a result, hybrids and full EVs are now entering workshops (EDUCAM, 2014; VMS|Insight, 2018).

Mechanics, bodyworkers and recyclers suddenly all need knowledge about high-voltage systems. Everyone working on an electric vehicle needs to be aware of the procedures. Companies that offer road assistance after an accident or a breakdown now also face these challenges. To ensure their workers' safety, they need theoretical knowledge about electric and electronic systems. Additionally, they have to get acquainted with safety equipment, diagnostic tools and installation equipment to be able to use these tools. On EDUCAM's website, all the sectoral standards are written out for each situation. Each manufacturer prescribes specific safety standards for this purpose (EDUCAM, 2014; KPMG, 2019).

Various manufacturers use lightweight materials in their vehicles. This is because the additional security systems and the electric propulsion make the vehicle heavier. The more this can be compensated, the better the vehicle will function. New materials demand new knowledge from bodyworkers. They need to be aware of the possible joining techniques for each material. Traditional soft steel joining techniques can damage the structure of other materials. If a bodyworker isn't aware of this, safety systems (such as airbags) could potentially have a low reaction speed. This poses a big safety risk for the passengers. In addition, bodyworkers need to be familiar with electric systems before they are allowed to work on EVs. In recent years, their job demands much more competences (EDUCAM, 2014).

Car vendors also need to be aware of the new products and the complications they entail. A lot of customers are interested in electric vehicles, but still have questions about charging, range or other concerns. Still, car salesmen tend to recommend traditional combustion engines. This is a solid technology, and the margins -and accompanying commissions- are often higher for these vehicles (Weller & Jackowski, 2017; VAB, 2018).

The electrification of vehicles also impacts the strategic policy of the companies in the sectors. For example, the shift from combustion engines towards electric engines will cause different after-sales income sources to disappear. Electric engines have a less complex build and demand less maintenance. When the vehicle fleet converts to EV models, profitable oil changes will be a thing of the past. Damaged parts will also sooner be replaced than repaired. As a result, the turnover coming from maintenance on electric vehicles is 50% lower than that of traditional vehicles. Only tyre wear will increase by 10%, due to the increased weight. The penetration grade of EVs will therefore have a big influence on the dealerships' turnover (VMS|Insight, 2018; KPMG, 2019).

Dealerships specialise to counter this development. Some players can focus on specific niches (such as old vehicles with a combustion engine), but most invest in new technology. By equipping a

specialised workshop for electric vehicles, dealerships are establishing a competitive advantage. This also means that new services can be developed to respond to the deficiencies of electric vehicles. In this way, flexible charging solutions are answering questions the sector has only recently came in contact with (VMS|Insight, 2018; KPMG, 2019).

These new services demand that companies partner up across sectors. In the viewpoint of electric vehicles, the collaboration between the car sector and the energy sector is given a new dimension. Previously, vehicles only used energy from fossil fuels. Now that the switch to electricity is happening, electrical energy becomes more relevant. By working together with operators from the electrical network, smart charging solutions came into being. An EV can now, for example, charge when rates are low. But it doesn't have to end there. Today, experiments on smart charging and discharging of vehicles are being carried out. If an EV isn't used for a long period of time, its battery can serve as temporary storage for green energy surpluses. That way, this energy doesn't have to be used immediately after its production. By this synergy with the network, charging EVs will be even more profitable (EVBox, 2019).

3.4 Survey results

Business leaders and experts agree that the market share of electrified vehicles will expand in the 10 years to come. According to garage owners, almost half of the vehicles will dispose of some form of electrification on board. Experts think this breakthrough will even be more extreme: according to them, electrified cars will account for more than 60% of new car sales. The respondents believe that the combustion engine's market share will be reduced, but all stakeholders are convinced that traditional engines won't have disappeared completely from the mobility landscape.

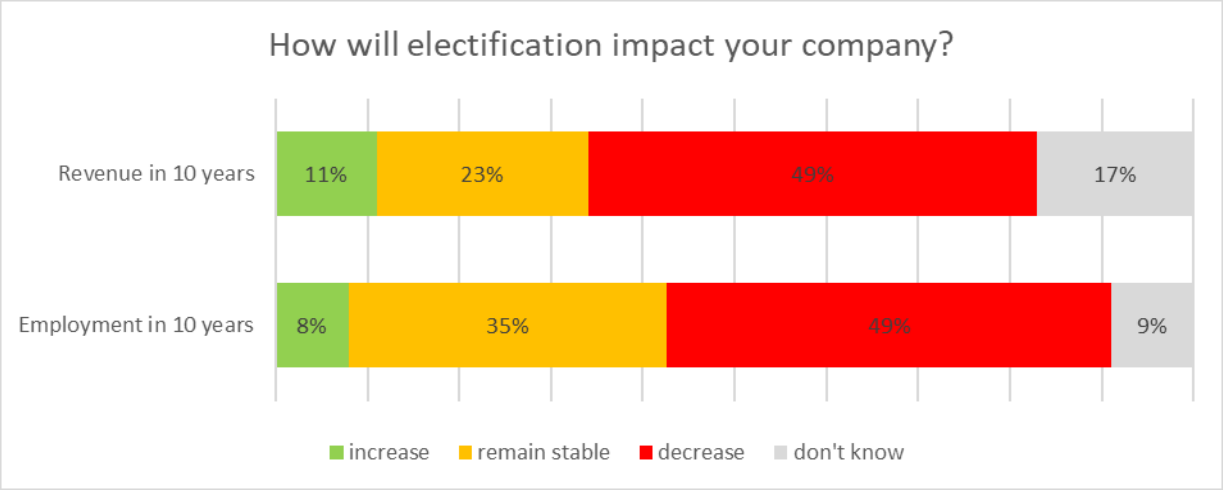
Training is the most important investment companies need to carry out in order to prepare for an electrified future. Eighty percent of companies indicate that they already invest in EV trainings for their employees. According to experts, this is urgently needed. They almost unanimously claim that the employees in the industry will need additional training to prepare for electrification. In addition, experts think that the industry needs to invest in new services to facilitate the EV evolution. Only 38% of companies indicate already doing so.

There is little doubt about the required skills. In decreasing order of popularity, companies indicated the following competence needs for working on electrified vehicles:

1. **Knowledge of electric vehicle specifications (84%)**
2. **Diagnosis of defects in the vehicle (73%)**
3. **Maintenance and repair of electrical systems (72%)**
4. **Knowledge of services and accessories for electric vehicles (62%)**

Based on the answers, we can deduce that business leaders are not welcoming this evolution with open arms. Especially the dealers and garage owners feel this way. Almost half of the respondents think their turnover will decrease during the next 10 years (see figure 6). Some are also fearing less employment. Only a few of these respondents see electrification as an opportunity to increase their turnover and their employment rates. This negative attitude is illustrated by a quote from a garage owner: *"The necessary qualification level will be higher, which causes an increase of internal costs and a decreased cost-effectiveness. Electrification will also impact the margin because of a decrease in sales of maintenance products (oils, filters)".*

Figure 6: Impact electrification according to companies



4 The route to '0 incidents'

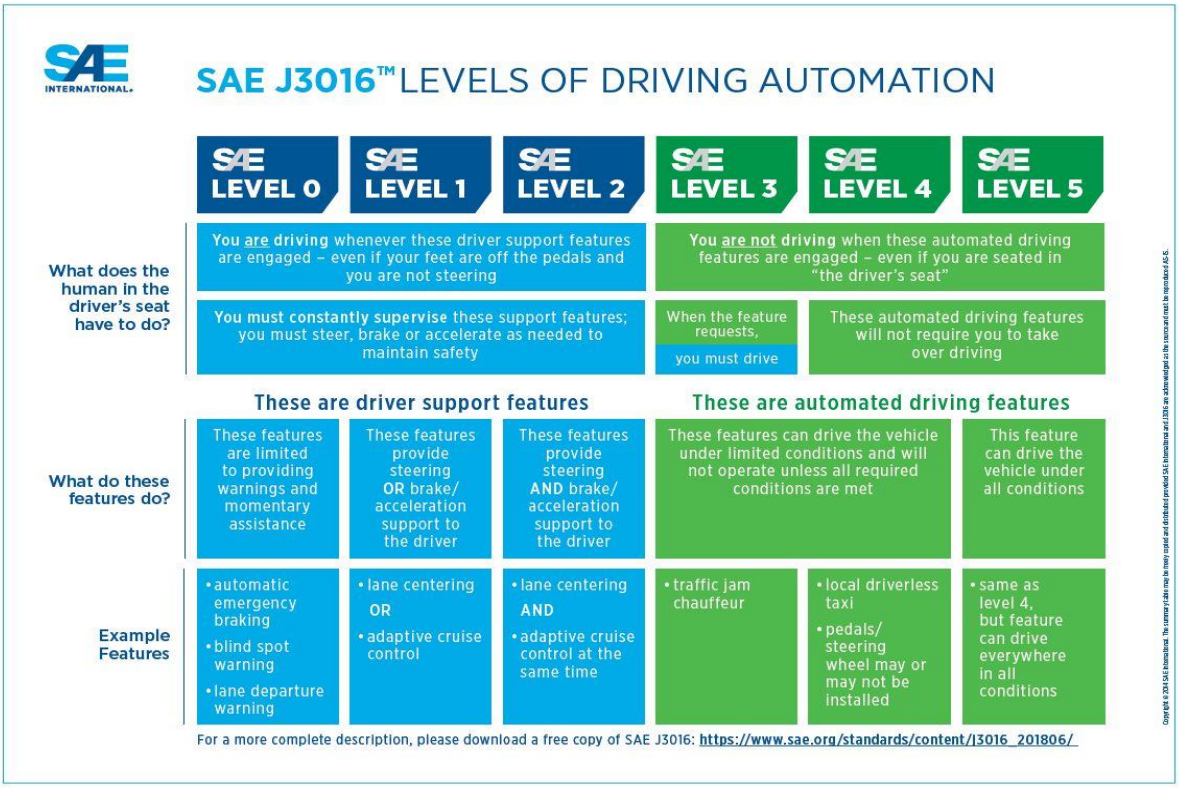
In this chapter, both self-driving vehicles and connected mobility will be discussed. These are separate evolutions that both have their impact on the mobility sector. A true evolution in safety and comfort can only be achieved when driver assistance systems can communicate with the different road users encountered by the vehicle. This is the only way towards a fully automated mobility network (Vanacker & Dheedene, 2019).

4.1 From driver assistance services to self-driving vehicles

'Advanced Driver Assistance Systems (ADAS) help the driver with his task, or take care of certain parts. They consist of a network of sensors and computers. In many cases, ADAS serve as 'extra senses' to continually monitor the traffic around the vehicle and to inform the driver about possible obstacles, for example while overtaking or while parking. Certain systems are very sophisticated and intervene when the driver performs a dangerous manoeuvre (e.g. emergency brake assistance or 'lane keep assist'). Finally, systems like (adaptive) cruise control were developed to increase the driver's comfort. As suggested by the term 'ADAS', the driver remains in control of the vehicle at all times. In further stages, the vehicle will make decisions autonomously. This is an example of autonomous mobility (SAE International, 2019).

The Society of Automotive Engineers (SAE International, 2019) divides these systems into the categories below (figure 7). ADAS are limited to SAE levels 0, 1 and 2. Level 3 and up consist of (conditional) autonomous mobility. Level 5 vehicles drive completely autonomously in all possible situations (SAE International, 2019).

Figure 7: SAE International (2019) levels of autonomous mobility



At present, technology isn't ready for level 5 autonomy. The driver is currently human, and is assisted by computers. In this case a smooth transition between a human driver and computerized transport is the biggest challenge. Various developers skip the third and fourth stadia, because they fear that drivers aren't attentive enough to take over control. Others develop systems to monitor the driver's reactions. The steering wheel can only become (conditionally) hands-free when the driver is paying attention (Bigelow, 2019).

At the time of writing, especially ADAS are becoming more prominent in traffic. Different interest groups promote these systems to improve safety and traffic flow. In the Netherlands, insurance companies, leasing companies, the government and suppliers of these systems joined forces to establish an ADAS alliance. Together they pursue the large scale implementation of ADAS in new vehicles. In Belgium, these interest groups are currently forming an alliance (TRAXIO, 2019).

By 2022, the European Commission will make the installation of ADAS in new vehicles compulsory. Quite specifically, these are systems which detect the drivers inattention, an intelligent speed alert, a reversing camera or sensors and a black box that gathers data in case of an accident. Furthermore, some driver assistance systems will be obligatory for certain vehicle types. Passenger cars and delivery vehicles need to be equipped with lane keep assist, an emergency braking system and belt tensioners that anticipate possible accidents. Buses and trucks need to dispose of systems that can prevent blind spot accidents. If another road user is located in the vehicle's blind spot, the system will warn the driver. If he still starts the manoeuvre, the warning will become more explicit. Earlier, the EU has already obligated ESP, ABS and eCall for all vehicles and lane assist technology for buses and trucks (European Commission, 2019).

These obligations are expected to save 25 000 lives and prevent 140 000 serious injuries by 2038. 90% of all accidents are caused by human errors, which can be prevented by these ADAS. By 2050, the EU would like to reach its target: no traffic-related deaths or serious injuries. Additionally, these systems will make the public more used to automated mobility (European Commission, 2019).

The systems need to be calibrated again after every repair or maintenance. If the sensors aren't correctly adjusted, they can misjudge the traffic situation, which could lead to incorrect and dangerous guidelines. The ADAS are recalibrated after minor bodywork repairs or even an alignment, which significantly increases the costs because of the additional working time and the specialised calibration equipment required for this action (TRAXIO, 2019).

Despite these concerns, different companies are developing this technology towards fully autonomous vehicles. (e.g. Mercedes, Tesla, GM, NVIDIA, Argo AI, Aurora Innovation, Google's Waymo and Uber focus on this.) It is striking that only some of these organisations currently operate within the traditional car industry, most of them are technology companies (Jiao, et al., 2019).

Clearly, a lot of new technology is needed for autonomous vehicles. Vehicles can form an even better image of their environment by a combination of radar, lidar, camera and ultrasonic sensors. Autonomous test vehicles already travelled millions of virtual and real kilometres. By analysing these data, developers create artificial intelligence that can drive vehicles. This intelligence is becoming more alert and can take decisions more quickly than a human driver. (Jiao, e.a., 2019).

A former Uber manager warns that the accident statistics of autonomous vehicles show a too optimistic image. While it is correct that AVs are in less accidents in which they act wrong legally, they are on average involved in a higher number of accidents overall. Statistically, EVs encounter more accidents than human drivers, but they are significantly less often 'at fault'. This is explained by the way the vehicle software is programmed. An accident where the vehicle is 'at fault' will be avoided at

all costs, without taking the reactions of other road users into account. Human drivers have difficulty estimating the behaviour of EVs, which causes more accidents. Usually, they are caused by an autonomous vehicle braking unnecessarily hard because an obstacle is detected and the traffic behind has trouble anticipating on this. This illustrates that the technology needs to be refined further before implementing it. These problems can be solved by tests in broader traffic situations. By integrating situations from the real world into these simulations, they become more reliable. That is why the German government -in the context of their Pegasus project- has gathered real traffic data and is integrating it into simulations (Bigelow, 2019; fka GmbH, 2019).

Automated mobility is expected to break through for commercial vehicles first, in the form of robot taxis. The transport of goods constitutes, after all, the biggest efficiency gain. In addition, the public opinion is less sensitive to tests with non-human transport, as opposed to transport with human passengers. This presumption is illustrated by the investment delivery company UPS Ventures made in TuSimple. UPS already tested TuSimple's automated trucks, and now wants to buy their knowledge on autonomous mobility. This means that the amount of ADAS in vehicles will expand in the foreseeable future (Reuters, 2019).

Currently, there are no fully autonomous commercial vehicles driving around in Belgium. The technology isn't quite perfect yet, and the legal framework hasn't been drawn up yet. There has been a lot of confusion about who is responsible when an autonomous vehicle is involved in an accident. Additionally, the reactions of an AV when faced with a dangerous situation are programmed in advance. This brings along new ethical questions: does the vehicle need to protect the passengers at all times, or does the chance that someone dies in an accident need to be minimised (Lin, 2015; Oponeo, 2019; Vanacker & Dheedene, 2019).

To solve these dilemma's, a human driver needs to be present in each vehicle on the public road. This driver is ultimately responsible for all the actions undertaken by the vehicle. Exceptions to this are possible under strict conditions. On some clear-cut trajectories, test projects with unmanned AVs are started up. Automated shuttles are already driving around in Brussels Airport and in Han-sur-Lesse (Oponeo, 2019).

We also need to ask ourselves if autonomous mobility is even favourable for traffic. Research by Bosch (2018) shows that less than a third of Belgians think a self-driving function makes a car more attractive. In addition, critics say that autonomous cars give cause for more kilometres travelled in traffic. When AVs become accessible, people that don't have access to a car will suddenly be able to take part in traffic. Children, elderly people or even objects will be transported more easily. Trips are also perceived to be less frustrating, which can lead to further urban sprawl. The road network will probably become even more saturated than today. That is why shared mobility needs to be stimulated, together with automated vehicles (Oponeo, 2019; Vanacker & Dheedene, 2019).

4.2 Connected cars

Traffic will only be really safe and run smooth once all road users are part of a connected mobility network. If sensors on vehicles can exchange information with local and global actors within the network, transport can be efficiently managed. This is made possible by the advanced 'internet of things' technology (IOT). By means of ameliorated -online- communication options, vehicles are connected to suppliers (V2G), infrastructure (V2I) and other users of the road network (V2V). All these communication networks are called 'vehicle to everything' (V2X) communication (5G Automotive Association, 2017).

In the previous chapter, smart charging of EVs was discussed. By means of 'vehicle to grid' (V2G) connectivity, electric vehicles can charge (and discharge) at times when rates are favourable. To do this, the vehicle exchanges data with the charging stations and the electricity network. This is how the expected charge and energy prices are aligned (EVBox, 2019; Jedlix, 2019). The connectivity of new vehicles doesn't end there, either.

Various brands are already developing a direct communication channel with their vehicles. This way, they can communicate about 'over the air' (OTA) error codes and carry out updates. This way, a problem can be diagnosed without having the vehicle physically present in the workshop. In addition, the error codes can be deleted online. This facilitates long-distance maintenance and repairs (Schmitt, 2019).

Tesla is the most prominent brand that works with OTA data transmission and updates. The company gathers information about traffic through OTA communication, and measures the reactions of human drivers and Tesla's autopilot. Like this, they can create an immense data file in order to develop software for autonomous mobility, without having to send vehicles out on the road themselves. The customer is always responsible for driving the vehicle. Tesla also uses OTA communication in the opposite direction. The purpose of this is to order certain services and options (such as the autopilot) later. Since these adaptations are for software only, the driver doesn't have to go to a dealership, and the updates are carried out automatically. In some situations, Tesla even enlarged the range of certain vehicles without having to physically manage them. In several countries -including Belgium-, these updates are unfortunately not always possible. Because if the characteristics of a vehicle change, it needs to be ratified again (Schmitt, 2019).

'Vehicle-to-vehicle' communication facilitates a smooth traffic flow. If vehicles can share their exact location, speed and information on their environment with other road users, these parties can interact with each other. Even traffic information can be passed on quicker, so that the drivers behind the vehicle can find another route. These V2V functionalities are already possible in smartphone apps like Google Maps and Waze, but will be further integrated into the vehicles themselves (Vanacker & Dheedene, 2019).

Traffic is made safer by transferring local information to other road users. At intersections, connected vehicles can anticipate on each other long before they enter into each other's sight. This is how abrupt manoeuvres are avoided. In case something unexpected happens on the road, these vehicles will immediately share their observations with each other. That is why all vehicles in the local network can immediately adapt their actions to each other and take the safest decisions. Connected vehicles can also drive closer to each other at a faster speed compared to vehicles with human drivers. This could result in more road capacity, without having to alter the road surface (Vanacker & Dheedene, 2019).

Various truck manufacturers are experimenting with these local communication networks. During 'truck platooning', several trucks drive in one single file, at a short distance from each other. The first truck is driven by a human driver, the others follow his command automatically. Using V2V communication, they can immediately respond to the driver's input. That way, they can drive close to each other without danger of collisions. This reduces the air resistance of the trucks at the back, which also lowers their consumption. In addition, the drivers at the back can rest in their vehicle or perform administrative tasks. When the driver in front needs to rest, the trucks can switch places, eliminating the obligatory breaks (Bebat, 2019).

Still, V2V communication also faces some opposition. 'Vehicle-to-vehicle' navigation apps (like Google Maps and Waze) give users the opportunity to optimize their individual route in traffic. When road

users continuously opt for the fastest route, traffic diversion is created. Saturated main roads are being avoided and traffic is being diverted towards smaller roads that aren't designed for this traffic flow. This leads to atmospheric pollution in residential areas and unsafe, long-distance traffic in areas with a lot of vulnerable road users. The social cost of long-distance traffic coming through these areas is bigger in most cases than the individual gain of the user. V2V navigation didn't cause these problems, but it does make their impact bigger (Baert, 2019).

An efficient traffic network can only be attained when all road users can be coordinated. To do this, V2I connectivity offers solutions. Dynamic traffic signs are now installed on different highways. These signs adapt the speed limits to the traffic situation. It gets interesting once vehicles communicate with the infrastructure on the intersection. Intelligent traffic lights can then alter their timing in function of oncoming traffic to minimize waiting times. When all vehicles are connected to each other, the traffic light will probably not be necessary for vehicles to communicate about the intersections on their route. Finally, other vehicles can also communicate to the owner about the condition of the road and other infrastructure (KPMG, 2019; Vanacker & Dheedene, 2019).

These data are being collected by the sensors in the vehicle. They provide information about traffic, but also about the conduct of other drivers. They can be shared with a third party, such as route planners, insurers or governments. Deloitte's survey showed that 74% of consumers are willing to share traffic data if it makes them arrive faster at their destination. This could pose a threat to their privacy if their data are being used to personalise premiums or taxes. In the same survey, 40% of respondents indicated that they fear not having control over their traffic data (Desomer, 2019).

All the V2X interactions demand very fast and mobile communication technologies. So far, vehicles in Belgium/Europe aren't equipped with the necessary technology for V2X interactions. Only 10% of European vehicles dispose of an internet connection or SIM card. This percentage will rise in the near future, mainly because e-Call has become obligatory for new European vehicles (Alonso, et al., 2017).

Apart from the absence of technology, the current applications do not suffice for V2X interactions. This is caused by insufficient bandwidth or a slower transfer of very precise data. In addition, communication with different actors will demand suitable communication technology every time. The most appropriate method depends on the range needed, the speed and the reliability for each situation (Alonso, et al., 2017; KPMG, 2019).

Investments in mobile means of communication are needed. The reaction speed of communication technology is especially important for security systems. This is why experts are currently busy developing mobile and short-range communication technologies. Examples of this are the 'Near Field communications' (NFC) and the 'Dedicated Short Range Communications' (DSRC). In 2020, the 5G network will also be launched. This will enable vehicles to communicate over longer distances, for example with manufacturers, dealer networks or grid operators. At present, only satellites, 3G and 4G (LTE) are being used as a means of communication. In regards to V2I communication, the European Union is setting up some 'Cooperative Intelligent Transport Systems' (C-ITS) in which road users and traffic managers can align their actions. This way, vehicles can communicate among themselves and with infrastructure (Alonso, et al., 2017; KPMG, 2019).

4.3 Impact on the car dealership: less workshop visits, more expensive reparations

ADAS decrease the amount of damage claims. For garage owners, this means that less vehicles are entering their workshop for bodywork repairs. If a damaged vehicle is brought in, ADAS entail additional concerns. Every sensor that is possibly hit needs to be examined and calibrated. This

requires extra time, knowledge and investments. Calibration equipment is expensive, and car parts with sensors are usually more expensive than their 'unintelligent' counterparts. Additionally, complex parts are often difficult to repair, which makes it cheaper to fully replace them. Currently, garage owners are unsure about the extent to which they can pass on costs to their customers. Simple reparations, such as replacing a windshield, now cost a multitude of the price customers are used to paying (VMS|Insight, 2019).

BOVAG (VMS|Insight, 2019) estimated a reduction of revenue for 9% of garage owners as a result of ADAS. This estimation is based on a realistic scenario on the Dutch market. The consultancy firm predicts that the effects of ADAS will be minimal on short term, and that companies will only start to feel the consequences on long term. Still, investing in knowledge is already necessary. A dealership that is unable to work with vehicles equipped with ADAS, will be able to repair up to 40% less cases than today. Moreover, the brand recognition in repairs is more important than ever. To guarantee their products' quality, various brands stipulate that only registered garage owners can work with these ADAS.

'Connected cars' will always be linked to the manufacturer. Errors can immediately be communicated to the repairman, who can in his turn prepare the reparation. In addition, the customer doesn't have to be physically present in the workshop during diagnostics. Some updates will also happen completely 'over the air'. These are new services garage owners can offer online (EDUCAM, 2014; Weller & Jackowski, 2017).

Connected cars are also able to communicate online with the manufacturer. This way, the manufacturer can offer updates and other services directly to the customer. Because of this direct connection between the manufacturer and the customer, the dealer sees his role in after-sales diminish. This poses a threat to a lot of dealers, since these after-sales services are their primary source of income. That is why it would be advisable to enter into agreements with the manufacturer or the importer to discuss their role in the process (Weller & Jackowski, 2017). More about this new power struggle caused by the evolution will be discussed in the next chapter 1.3.4.

The possibility to gather data is also causing new companies to enter the automotive industry. These are particularly internet and dataproviders, data management companies and data protection companies. That is why Apple & Google have already presented themselves on the automotive market. They have the necessary expertise to develop autonomous, communicating vehicles. In addition to companies specialised in data management, vehicle brands will be forced to rely on programmers, as systems designed for safety, comfort, driver assistance, navigation and entertainment need software and updates in order to function (Alonso, et al., 2017; KPMG, 2019).

4.4 Survey results

Business owners and experts agree that the vehicle fleet will be increasingly equipped with driver assistance systems. Three-quarters of the experts estimate that in some situations, the vehicles on our roads will drive in a completely autonomous way within the next 10 years. Business owners are more hesitant, half of them believe we will still be in the ADAS-stage by 2030.

At the same time, all respondents foresee an increase in connectivity of the vehicle fleet in the coming 10 years. It is certain that more vehicles will be connected to a larger digital network, but there is still some discussion about the actors they will be connected to. The opinions are especially divided when it comes to the breakthrough of V2I and V2V connectivity. However, the experts are convinced that almost nine out of 10 new vehicles will be connected to the manufacturer or the workshop in 2030.

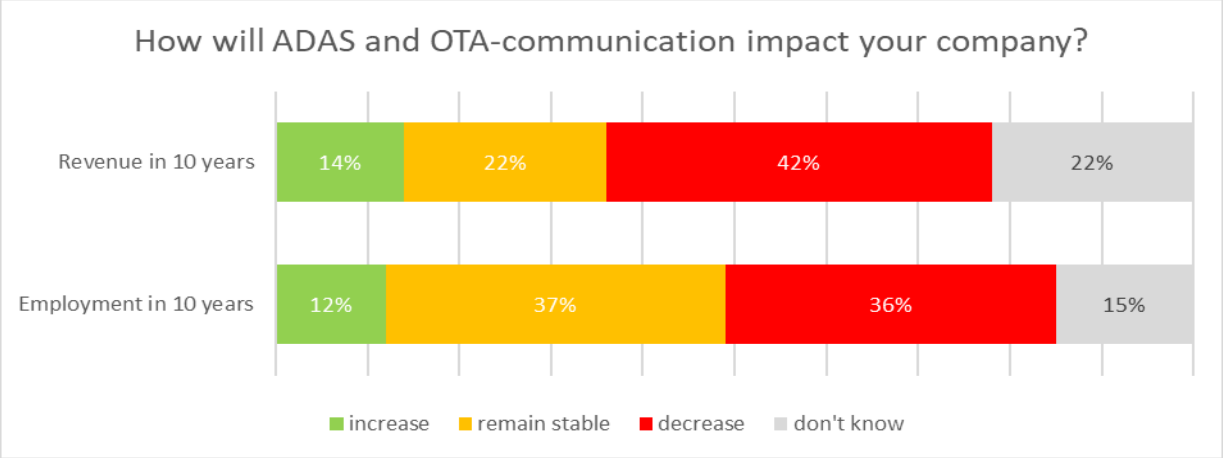
Business owners mainly invest in training to prepare their current employees for a future of connected vehicles full of driver assistance systems. More than two-thirds of the companies offer training in these themes, but experts unanimously agree that additional investments in training are necessary. They also insist that companies in the sector need to invest in new services and OTA communication to achieve customer loyalty.

It is clear that new skills are needed in the industry to work with driver assistance systems and connected vehicles. The companies and experts largely agreed on the industry needing the following additional skills (in decreasing order of popularity):

1. **Knowledge of infotainment, ICT and telecommunication technologies (bluetooth, internet connection,...) (83%)**
2. **Knowledge of the vehicle specifications (76%)**
3. **Diagnosis of defects in the vehicle (69%)**
4. **Calibration of driver assistance systems (68%)**
5. **Maintenance and repair of electronic systems (59%)**

Companies and experts don't agree on the possible threat driver assistance systems and connectivity can pose for the industry. Still, most business leaders don't see their turnover and employment rate rise in light of these evolutions (see figure 8). More than three-quarter of them currently invest extra to follow up these developments. Some business leaders used the open space in the survey to ask about the return these investments will generate: *"The support for driver assistance systems will increase, but we can't pass this cost on so the turnover will decrease. Less frequent maintenance is needed, which has the same effect [...]", "[…] The vehicle can be updated – repaired on the spot. Basic versions of vehicles are ordered online (showroom?). Some options are activated for a certain period of time if the customer needs them."*

Figure1: Impact driver assistance systems and OTA according to companies



5 The route to '0 property'

Consumer confidence is decreasing slightly, which makes consumers put off their purchases (NBB, 2019). Actually, flexible methods of payment make it easier to share purchases. What is more, various products -such as vehicles- that were bought to use before, can now be shared with a third party to tremendously lower their cost of use. The consumer has been getting used to the ease of internet sales through online webshops such as Amazon and Zalando. This digitalisation of the retail sector has now also found its way to the automotive industry. According to Klaas (n.d.) 71% of company administrators in the automotive industry agree that they need to implement digital processes to survive. This is the case for traditional sales, but even more for flexible payments of shared use. These macro evolutions create a new consumer that is more demanding than ever. This customer wants instant gratification and expects a transparent exchange of information and a fast delivery. To comply with these demands, product providers need to work together with specialists when it comes to ICT and data management. This seems to be an insurmountable challenge for most. If information management is carried out successfully, suppliers can contact the consumer directly and understand him better. Former competitors are now more often investing together to achieve economies of scale, so they can meet these fast-evolving standards (KPMG, 2019; McKinsey & Co., 2019; Vertongen, 2019).

This is a situation the dealer of the future needs to resolve. Thanks to new services, they can reshape the sector and re-emphasise the original purpose of a vehicle: fast, safe and comfortable transport of people. This future is not too far away. Even though new car sales are still on the rise, these vehicles are used less often. In the last 3 years, the amount of kilometres driven per vehicle has lowered. When vehicles are used less often, dealerships will need to reinvent themselves to offer more value to their customers (Vertongen, 2019; Febiac, 2019a).

5.1 The new consumer: how demand changes

In 2018, the number of new car registrations was at its highest point since 2011. It is clear that customers are interested in new cars again. 45% of all registrations were for a vehicle that hasn't been registered before. This also is the highest result since the record year 2011. Naturally, the shift from a NEDC to WLTP-emission measuring cycle has contributed to this result. Many vehicles had to be registered before September 2018 in order to comply with the emission standards that became effective that year. However, new car sales were already rising before the WLTP cycle was announced. This confirms the suspicion that customers are sincerely interested in purchasing a new vehicle (Febiac, 2019).

Various sources expect private car ownership to decrease. McKinsey & Co. (2019) predicts a 17% decrease in sales of new vehicles to private individuals in the next ten years. Because of increasing urbanisation, it is less attractive for people to own their car. In several cities, parking spots are disappearing and wide boulevards are turned into car free zones. Alternative modes of transport are becoming cheaper than a privately owned car. According to KPMG (2019), autonomous mobility services will be up to 40% cheaper than private car ownership.

Desomer (2019) adds that the quick decrease of private car ownership is mostly caused by a generation gap. A privately owned vehicle traditionally represents the freedom and status of its owner. But now, young people are considering giving up this ownership for usage. They are also less interested in driving a car. This is reflected in a decrease of the number of driving licences. In the last 10 years, the amount of driver's licences dropped by 20%, and the strongest decrease was in the youngest age category (Cardone, 2019).

The new consumer chooses the ideal means of transport differently. The most important factors are the travel time and the costs. Young people opt for the transport that gets them at their destination fast, and according to their budget. In addition, new forms of mobility are making it hard to combine transport methods to travel as efficiently as possible. For each individual trip, the customer can choose between different mobility solutions to find the most apt one. Travel comfort, safety, sound and connectivity are all part of this decision. These factors are secondary to the travel time and the costs, but can eventually make them opt for a certain means of transport (Polzin, et al., 2014; Desomer, 2019).

two thirds of current car owners use their vehicle to commute to work. More than half of them doesn't see an alternative for their car as a working tool. By means of government initiatives such as the mobility budget (or the former 'cash for cars'), the government encourages their staff to drive environmentally friendly alternatives. If these initiatives benefit the users in reality, they won't choose for their company car, in favour of new mobility solutions (De Prez, 2019; Edenred, 2019).

Shared mobility is a central pillar in our future professional trips together. For short trips, other means of transport (e-bike, e-scooter,... can be used. 44% of e-scooter users indicate that they sometimes use their scooter instead of their car (De Standaard, 2019a). Even for longer distances, alternative means of transport offer attractive solutions. Traffic jams can be avoided thanks to electric bikes, scooters and speed pedelecs. The use of these forms of transport strongly depends on road safety. Separate (bicycle) lanes make more people want to use these new forms of mobility. Moreover, more and more employees are allowed to work from home, making travel unnecessary. The combination of government stimulation for alternative mobility solutions and flexible workplaces will reduce the company fleet. This evolution is further facilitated through 'mobility vouchers' offered by financial intermediaries. Just like for meal vouchers, mobility vouchers can be used to immediately pay for alternative mobility. Still, potential customers cling to the company car because they have doubts about the consistency of the mobility policy over the years (Polzin, et al., 2014; De Prez, 2019; Edenred, 2019; Kanne & Visser, 2019; KPMG, 2019; Van Apeldoorn, 2019).

The government can also influence vehicle use outside of the vehicle company spectrum. Various governments are considering to replace the inscription tax by a smart kilometre-based charge to further influence the transport demand. This charge would discourage the use of a vehicle during peak periods and on busy locations. Different experts call for a kilometre-based charge that takes into account the location, time and possible emissions of the vehicle. That way, problems with traffic jams and emissions could be reduced significantly. Road users who make use of the infrastructure during peak hour, will possibly think about other means of transport because going by car has become too expensive. Still, it is far from certain that a smart kilometre-based charge is going to be introduced. The regions can't come to an agreement and the representatives of the automotive industry fear this measure is therefore infeasible. Transportation would become increasingly more expensive for socially vulnerable groups, and the administration for traffic between the regions would become confusing. In 2016, the kilometre-based charge was already put into force for freight traffic. Some analysis about the impact of this was not yet published at the time of writing. As a result, the different Belgian governments have not yet reached a conclusion about the desirability of a smart kilometre-based charge for passenger cars, and no specific plans were worked out (De Roo, 2018; Beeckman, 2019; Sofico, n.d.).

5.2 'Mobility as a Service': how the supply changes

Different industries notice that the users of their products are not necessarily the buyers of these products. Customers no longer feel the need to own various products. Thanks to evolutions in IT-

technology and e-commerce different industries such as the food, entertainment and clothing industry underwent a transformation. In the automotive sector, company cars were already being sold in leasing-constructions where the owner is not the user of the vehicle. Still, the industry was long spared from a real 'mobility on demand' revolution (De Prez, 2019).

Traditional users still like to use their own car. A vehicle that is adapted to a specific user, is often seen as an extension of this user's home: it is always available and personal belongings are stored in it. Car owners aren't inclined to willingly renounce this comfort. However, individual, non-communal car property is the main cause of different problems concerning emissions and road congestion. This is the reason why various governments focus on shared mobility. According to 56% of business managers in the automotive industry, the consumer will start to share his vehicle instead of buying it (ICDP, 2018; De Prez, 2019; KPMG, 2019; Klaas, n.d.).

The main new form of mobility services are sharing platforms for cars, bikes and micromobility. Users will be able to book a shared vehicle trough online platforms to reach their destination. Some platforms specialise in a certain mode of transport (e.g. Cambio focuses on cars; Scooty on e-motorbikes; Bird on e-scooters), other platforms are putting together a portfolio of vehicles for their customers. Through Uber, Poppy, or other incorporated mobility services, users can combine different means of transport to travel as efficiently as possible. To do this, they only need to use 1 platform. These services have already drawn the attention of leasing companies, that now also offer it in combination with a lease vehicle. This approach also offers peace of mind for cities that are dealing with road congestion. Professor Alexander D'Hooge calls for 'mobility hubs' on the urban periphery, where users can easily switch between different transport modes (Weller & Jackowski, 2017; De Standaard, 2019b).

Most of these sharing platforms were developed by players outside of the automotive industry. Often, big technology and software companies invested in them. They have expertise in processing the 'big data' needed to make a sharing platform function appropriately. Data management never belonged to the core business of traditional car manufacturers, which means they needed to catch up to remain relevant in the sharing economy (Weller & Jackowski, 2017).

Traditional players in the automotive industry are becoming aware that ownership of relevant data is useful, especially with the rise of 'connected cars' and sharing platforms. When the interest in car ownership decreases, they will be able to build a new business model for their data management. That is why they compete with the sharing platforms of software giants and strictly protect their own data. For example, BMW manages the sharing platform 'DriveNow' with Daimler, and D'Ieteren established 'Poppy'. Despite the fact that these platforms are not profitable right now, they are appreciated by their owners (Weller & Jackowski, 2017).

Shared bikes, scooters, motorbikes and vehicles can be found on each street corner, so that subscribers of a certain platform can always make use of this. With the new wide range of 'free fleet' sharing platforms, cities can become saturated. In their fight for the biggest market share, these different platforms are overloading the streets. That is why some cities -including Brussels- are introducing a permit for recognized platforms (BRUZZ, 2018).

Another form of mobility service is 'ride-hailing'. In this concept, customers that wish to travel are linked to a professional driver that can transport them in 'real time'. Within this concept, the users of transport are no longer the drivers. The concept is comparable with a centrally controlled taxi service in which the drivers are freelancers and dispose of their own vehicle. In January 2019, the commercial court of justice in Brussels confirmed that UberX's model isn't legally a taxi service, and since then,

UberX is allowed to operate as a ride-hailing pioneer in various Belgian regions. This way, the American mobility concept can break through in our region (Hendrikx, 2019).

Even though ride-hailing is just a small part of primary transport (only 2% of commuters mainly use ride-hailing services), the use for occasional transport is rising quickly (Desomer, 2019). KPMG's research (2019) shows that different entrepreneurs in the industry think ride-hailing will become popular by 2030. The executives even expect that public transport will be replaced by 'on-demand' autonomous transport capsules. Currently, a lot of discussion still arises about the desirability of ride-hailing in traffic. That is because most of these vehicles are driving around empty, looking for passengers. For each kilometre driven, there are on average 0,8 passengers present in the car. Consequently, the concept has risen the amount of kilometres driven per trip by more than 80% (Henao & Marshall, 2018). Studies in San Francisco have shown that the increased road congestion is largely due to ride-hailing platforms. Together with the extra trips and traffic jams, harmful emissions from ride-hailing are also increasing (Bowers, 2019).

The growing interest in the sharing economy is now also penetrating the automotive industry. The car sharing app 'Turo' is often called "the AirBnB for cars". With this app, vehicle owners can rent out their car when they don't need it. This way, the car generates income for the owner, and the renter has a bigger choice of vehicles. In addition, this 'peer-to-peer' rental is taxed differently than classical car rental companies. This means that Turo is very competitive in a multitude of markets. At this time, the platform doesn't yet exist in continental Europe, but thanks to the interest in the sharing economy, the application is growing at a fast pace. Dégage! vzw developed a similar peer-to-peer car sharing concept in Belgium (Dégage! vzw, n.d.; The Wall Street Journal, 2019; Turo, 2019).

Dealers can also offer specific services, 'tailored' to certain customers. The CEO of Ginion cites an example about a rental car with a combustion engine to the owner of an i3 who wanted to go on vacation by car (Van Apeldoorn, 2019). In addition, dealers can now also plan maintenance or cleaning activities during the off-peak hours of car sharing platforms. Like this, their customers can continue to use the vehicles during the most lucrative hours (Vertongen, 2019).

5.3 New partnerships in and outside of the automotive sector

Companies are closing partnerships on different levels in the automotive sector. That is how they collect valuable knowledge and assets to prepare for coming evolutions (McKinsey & Co., 2019).

Manufacturers are working together to create new technologies. The research and development of EVs, connected and autonomous vehicles is very expensive and is a novelty in the industry. Additionally, manufacturers invest massively in measures to comply with emission and safety standards. That is why vehicles are becoming more complex and more expensive. As a result, even the biggest groups don't have enough cash to prepare for all these evolutions. If brands start to work together, they can create economies of scale to spread out their expenses (Rechtin, 2019). This is why for example Ford and Volkswagen, Honda and General Motors, BMW and Daimler, Toyota and Suzuki joined forces (Harloff & Stegmaier, 2019). Fiat Chrysler Automobiles and PSA Group are even announcing that they will completely join their respective groups to prepare for the future (Sylvers, et al., 2019).

In addition, the EV market currently isn't developed enough to recover the costs quickly. Nevertheless, manufacturers want to finish their electrical platform as soon as possible. This is a big challenge, because different brands don't yet have experience with high voltage propulsion systems. Therefore, the competition between brands keeps getting stronger. Not a single manufacturer can afford to lag

behind when electromobility breaks through. The collaborations (that seemed impossible before) are now unavoidable (Harrop, 2019a).

Next to collaborations on a strategic level, competitors are also concluding more and more partnerships with regard to specific vehicle models. For example, the new BMW Z4 and Toyota Supra share their platform, and the Smart Forfour and Renault Twingo stand on the same basis. This makes it possible to share the development costs of a component or platform, and to spread them out over a bigger market. For years, this type of partnerships have been common in the industry. These collaborations are becoming increasingly more popular, because they allow brands to share the development costs of a component or platform (Harloff & Stegmaier, 2019).

Manufacturers are also maintaining closer partnerships with their suppliers. They especially target suppliers of EV batteries. The reason for this is that the raw materials of Li-ion batteries are scarce, and several car manufacturers fear that they won't be able to meet the demand. Besides, some battery manufacturers already cash in on big customers in the form of cellphone and computer manufacturers. To nip this heavy competition in the bud, Tesla has already concluded a deal with Panasonic in 2014 to produce in the 'gigafactory' together. Other manufacturers are also concluding agreements with battery producers: VW & Northvolt, Renault & LG-Chem,… (Harrop, 2019c; Volkswagen AG, 2019).

Suppliers of -electric- vehicles also support the network of charging stations, for without these charging options, their vehicles wouldn't appeal to the customer. Some car brands invest in these partnerships for the deployment of charging stations on the public road. But mainly (groups of) dealers are investing in charging stations. That is because they can take away the customer's concerns about charging if they offer a charging station with the purchase of their EV. Like this, they can also integrate the invoicing system for the customer into this charging solution, no matter which kind of charging station is used (Van Apeldoorn, 2019).

To prepare for various evolutions, car manufacturers need the industry's new knowledge. IT-services are especially needed to comply with the changing market demands. That is why manufacturers invest in established IT companies. The development of autonomous vehicles in particular is something for which partnerships across sectoral borders are being concluded. Manufacturers are good at collecting data about their users, but they need new knowledge to transform these data into models for automated vehicles. Both Ford and Volkswagen have invested billions into Argo AI, a start-up that develops artificial intelligence in the context of autonomous mobility (KPMG, 2019).

Effective data management also enables a seamless transition between various forms of mobility. It enables to choose the best route across different modes of transport. For example, a passenger car can bring customers to a train station, after which they travel to the city using public transport, to eventually arrive at their destination with shared electric scooters. This transition isn't yet happening smoothly, but several cities are investing in projects to make it possible (Carpenter, 2019).

Thanks to the integration of information technology in the logistics industry, goods are being delivered more efficiently than ever. Home deliveries are already a familiar sight, and this industry is expected to expand further once new forms of mobility are developed. At this moment, various forms of last-mile delivery are being experimented with. From drones to autonomous 'pods' delivering packages at home, different new delivery methods have been springing up everywhere. Data analysis allows us to choose the right delivery method for each package. Moreover, the vehicles can be developed in a polyvalent manner. Mercedes and Renault among others are experimenting with autonomous pods

that can transport people during peak hours, and packages during off-peak hours. Like this, vehicles are being used optimally, and various customer groups can be addressed (Vertongen, 2019).

Because of the closer contact between manufacturers and users of vehicles, manufacturers are also working more closely with companies that offer funding for the users. Most manufacturers develop their own leasing system, or promote their vehicles to leasing companies (KPMG, 2019). New forms of insurance are also developing: products are offered for a specific route instead of for a single means of transport. This makes the breakthrough of shared cars possible. Users of sharing platforms can insure themselves per kilometre they drive themselves (Mobly, 2019).

On a geographical level, the industry is also in full movement. Dealerships are strengthening their position on the market by operating in a larger region. This movement has been present abroad for some years. Potent international dealers are now penetrating the Belgian market. For example, the Dutch group Van Mossel, the Swiss Emil Frey and Swedish Hedin Automotive are all operating in Belgium. These international dealer groups achieve tremendous economies of scale and can spread their commercial risks over (geographically) different markets (EDUCAM, 2019a).

A lot of manufacturers are aiming towards China at the moment. The Chinese market has been the biggest market for vehicles worldwide, because of the rapid expansion of the middle class. Western markets are saturated, and a lot of car manufacturers see China as an enormously big market for their models. Even though the Chinese market is bigger than its counterparts in the US and the EU combined, it is also less stable. The Chinese market outlet is currently shrinking, despite the many investments and public subsidies (KPMG, 2019; Westbrook, 2019).

China's production figures are also higher than those of the EU, the United States and Japan combined. The reason behind this is that the Chinese government only wants to open up the market for foreign brands if a local joint venture is being established to produce vehicles in China. These joint ventures are subject to China's legislation, which is changing fast to deal with pollution in cities. As a result, foreign manufacturers are adapting their models to strengthen their position on the biggest market. But not only Western joint ventures are becoming successful in China. Chinese car brands are also planning their breakthrough in the Western markets. There are already electric taxi's of the BYD brand driving around in Brussels, and Greely has an important share in Western brands like Volvo and Lotus (Blanco, 2019; KPMG, 2019).

In addition, China currently controls the majority of raw materials used for the production of electric vehicles. Chinese companies have major interests in the markets of raw materials that are essential in Li-ion battery packs. Lithium is mined mainly in China and the Congolese cobalt mines are almost without exception in Chinese hands. Foreign players therefore risk to become dependent on Chinese policies for the production of EVs. The possible trade war between the United States and China can interfere strongly with the trade of vehicles or car parts. To protect themselves against this, recycling batteries is essential for non-Chinese manufacturers (De Paepe, 2018).

In other geographical markets, we also notice fast movements in the automotive industry. In the next years, India's population will outnumber China's. India has an expanding middle class and is facing increasing urbanisation. Still, Indians generally don't opt for -luxurious- cars like the Chinese do, but cling to two-wheelers. That is why car manufacturers are focusing less on this market, but it is essential for motorbike manufacturers. About 45% of all motor bikes in the world are sold in India. The government aims to electrify 30% of these sales. This is an opportunity for India to be a pioneer when it comes to electric motorcycles (Wenschinek, 2019).

Finally, Brexit is disrupting the automotive landscape. If the United Kingdom (UK) leaves the EU without a trade deal, the British automotive industry will suffer a blow. Because of the high degree of globalisation in the automotive industry, English vehicles and motorbikes will lose their competitive power fast. Various groups -like Toyota, JLR and Mini- already announced to move some manufacturing capacity to other countries. Foreign brands will also have to specifically have their models approved for the UK and the EU using separate procedures (Els, 2019).

5.4 Impact on the car dealership

Smart mobility enables us to meet our need for mobility with less vehicles in traffic. After all, road users can share transport modes. In addition, more people without a driver's licence will be able to travel thanks to these new mobility forms. Developments such as MaaS or alternative forms of transport are paving the way for a wider range of mobility options. As transport is becoming more accessible, more people will make use of it. That is why the total turnover of the mobility sector is expected to increase (Skeeled, 2019). Meanwhile, some established companies are running the risk of losing extra turnover. It is currently still unclear which role traditional car companies will play in mobility services (De Prez, 2019).

Thanks to smart mobility, less road users will possess their own vehicle. Still, these evolutions don't mean that vehicle sales will suddenly drop. This is because our vehicles are too deeply ingrained in Western culture, for more than 70% of the kilometres travelled in Belgium are currently done by car. Most users still want to have a car available for special circumstances, but one car for each family will suffice in most cases. People will only completely let go of their private vehicle when ownership of it becomes too expensive and the alternatives are efficient enough. These effects have a smaller impact on younger generations. The decreasing amount of driver's licences can be an omen that we are reaching "peak car", meaning a peak in car sales. In the longer term, these evolutions will certainly break through. This time frame gives dealers the opportunity to adapt and to receive a prominent position in the new mobility landscape (De Prez, 2019; Harrop, 2019a; VIAS, 2019).

5.4.1 Impact on car sales and after-sales: customers are becoming stronger

Brand manufacturers tried to disregard non-affiliated workshops by only delivering their vehicles and car parts through a certified industry. To prevent this from happening, the European Union has adapted their competition law. Now, all workshops can buy vehicles and spare parts from all brands. This increases competition between brand-affiliated and independent dealers in sales as well as in after-sales (EU, 2010).

The addition of online showrooms and configuration of vehicles causes an increased digitalisation of sales. For some brands, it is already possible to order a preconfigured vehicle directly from the website. Tesla pioneered this sales model, but Polestar and Porsche will also offer their cars via the internet in 2020. Additionally, online platforms that aren't linked to a certain brand are being established. Especially second hand websites and auctions are successful, because they can connect the seller efficiently to potential buyers. Because of digitalisation, customers have more access to information when choosing their vehicle. That way, consumers can compare their options better. After-sales are also more transparent because of digitalisation. Independent websites (such as AUTODOC, 2019) offer access to large databases with car parts from different brands. Like this, customers can easily compare the prices of various sellers. Additionally, they can estimate how much car parts are worth when a vehicle is being repaired in the official network. The high level of transparency causes intense competition and harmonises the prices for the entirety of sellers (McKinsey & Co., 2019).

To counter the effects of the independent second-hand market, different brands are also incorporating the trade of second hand vehicles. By also selling second hand vehicles next to their new cars, they can diversify and expand their customer portfolio, given that more second hand vehicles are being sold in Belgium compared to new vehicles. Moreover, poor new car sales numbers can be compensated by selling more second hand cars. Brands offer online and offline sales channels for second hand vehicles, and concessions subscribe to this. By examining second hand vehicles from different viewpoints and then certifying them, they add extra value for the customer. As it happens, the customer trusts the vehicle more when it is certified by an official distribution chain. Even in the second hand market, manufacturers are experimenting with new sales channels such as private lease. Apart from constructors, (groups of) dealers are launching second hand platforms for the same reason (Weller & Jackowski, 2017; De Prez, 2019; Van Apeldoorn, 2019).

The high degree of digitalisation in other industries raises the standard the service of a car company needs to adhere to. New customers demand a quicker response, which necessitates car companies to invest in online platforms. They can meet the evolving demands of their customers only by building a strong online presence. All brands develop and integrate online marketing, CRM, sales and after-sales channels. Because of the digitalisation of vehicle sales, the company needs to rely less on their traditional sales staff. Customers can now find a plethora of information on online marketing and sales channels. As a result, the sales staff is partly replaced by online support in the initial phase of customer contact (Weller & Jackowski, 2017; McKinsey & Co., 2019).

Digitalisation also results in data communication and software updates for vehicles happening 'over the air', and vehicles being diagnosed online. We already discussed these evolutions in the previous chapter. This has major consequences for the after-sales market. Traditionally, these activities took place at dealerships and workshops, but now manufacturers are also demanding their share. These evolutions created a new division of roles in the company chain. Software accessories (such as navigation systems) will for example no longer be delivered by garage owners, the manufacturer will directly deliver this to the customer via internet (OTA). Garage owners will focus more on maintenance and reparations. OTA also offers advantages for dealers and garage owners. When the vehicle is directly communicating with them, their task planning can be automated (Weller & Jackowski, 2017).

However, the industry's digital efforts have proven to be insufficient until now. The (independent) dealers in particular are scoring poorly when it comes to digitalisation. In a survey among Belgian car companies, they claim being highly digitalised. In reality, only big dealers are working with online marketing channels and data management through CRM systems. This leads to the consumer searching contact with other players differently. Manufacturers set aside large funds for these channels. As a result, communication happens directly between the manufacturer and the customer. If dealers don't continue to focus on digital customer contact, customers will bond with the manufacturer and not with them. They can focus on digital training or attract digital profiles to better prepare for this evolution. But, they do need to be convinced that this investment will prove lucrative (EDUCAM, 2017; McKinsey & Co., 2019).

However, most companies in the industry are convinced that the classical sales model won't disappear. A lot of customers want to physically test the vehicle, and have more trust in personal contact with the dealer when they make a big purchase. Still, the amount of dealer visits before a sale is decreasing rapidly. Today, a customer enters a physical showroom on average 2,3 times before deciding. That is a 50% decrease in less than 10 years (McKinsey & Co., 2014; Cox Automotive, 2019).

Car sellers are experimenting with new cash flow models to sell vehicles. Leasing contracts are being drawn up to increase customer loyalty and to combine services. Like this, they can count on their solid

customer base, independent of the changes in the mobility landscape. The company car market is more advanced in this aspect than the private leasing market. Both markets evolve towards a lease model where the seller fully manages the vehicle -and all complementary services-. Because of the evolution from car ownership to car use, sellers will have to focus more on after-sales services. This means that the traditional seller is becoming a 'service advisor'. In this new role, he takes away customer's concerns by offering after-sales contracts for reparations and maintenance. The social skills of the service advisor are more important here than his technical skills (EDUCAM, 2014; De Prez, 2019).

Leasing is especially recommended for BEVs. Using this structure, customers can reduce the risk of growing pains and manufacturers can manage the residual value of the vehicles. The higher purchase price of electric vehicles can be spread out. Test-aankoop notices that in reality, it is often cheaper for the customer to buy his own vehicle. Private lease is especially interesting for users that don't want to deal with paperwork, maintenance or repairs (VMS|Insight, 2018; De Prez, 2019; Test-aankoop, 2019).

The switch from private ownership to lease contracts works in favour of independent dealers. That's because they want to conclude contracts and are ready to offer appealing discounts and additional services to reach this goal. Independent dealers can simplify the leasing company's paperwork for various contracts by invoicing centrally. This is even possible when these contracts are related to vehicles from different brands. Even in after-sales, independent garage owners can work more easily on different brands. In addition, they often work with one regular contact for the leasing company. Brand related dealers can't do this because leasing companies want to offer their customers multiple car brands, and would need a contact person for each brand (TRAXIO, 2019).

The fast digitalisation makes multi-modality -combining different transport modes efficiently- possible. As customers choose alternative mobility solutions instead of a private car, the traditional sales model will further lose its popularity. Cars will continue to play a role in this mobility landscape. Still, providers of shared cars have other demands for their cars then private customers. The respective customer segments of ride-hailing and car sharing companies have a unique profile. These platforms often have special lease or rental agreements which drivers are able to subscribe to. In most cases, these cars are well equipped with options (that are lucrative for the dealer). These deals have maintenance agreements linked to them, which are often more exhaustive than private agreements. In addition, shared cars always have to look and be in top condition, since this is part of the sales arguments of the mobility service. Since shared vehicles cover significantly more distance than a private car, they are an interesting opportunity for car manufacturers. thanks to shared vehicles we will need less cars on our roads, but car companies can still perform well. The consumer does have a clearer view on the total costs of his driving behaviour when he is using a shared vehicle, because he only pays for his own usage. This possibly causes him to make less trips than if he were to possess a personal vehicle (EDUCAM, 2014; Stowe, 2019).

To prepare for this, dealers need new knowledge about the different forms of mobility such as ride-hailing and car sharing platforms. Like this, they can answer complex questions from institutional customers and reel in big contracts. In addition, these customers will be willing to pay a different price then private individuals for the desired treatment. Because of the size of their purchase, they will expect a lower price, but due to the demanded operational reliability they will be ready to pay more for fast or flexible service. Since the agreements with institutional players are big, dealers will have to include more services into their portfolio. This ranges from flexible reparations and maintenance to washing cars during off-peak hours. The traditional salesman is less concerned with transactions in this context, but will manage relationships with loyal customers more often. The usual sales activities

such as informing, configuring and concluding sales will be digitalized. That way, sales staff can be centralized more and will evolve to account managers that can customize products for important customers. They will act as 'single point of contact' for a specific customer (VMS|Insight, 2018; KPMG, 2019; Stowe, 2019; Vertongen, 2019).

5.4.2 Impact on strategic decisions: new power struggle, less dealers

The new business models provoke a power struggle between the different players in the industry: manufacturers, importers and dealers, fleet managers and consumers.

As discussed under the previous title, customers are getting more negotiating power. The customer gets more power thanks to the shift from private ownership to fleet managers. Car companies are coming in contact with less customers, but they negotiate larger deals with each customer. That is why each customer in contact with the company is of higher importance. Additionally, customers are better informed because of the increasing digitalisation of society. It so happens that better (digitally) informed customers are better negotiators (Weller & Jackowski, 2017; De Prez, 2019; Stowe, 2019).

On the other side, manufacturers are strengthening their power over the industry. With the help of digital sales platforms, they are building a direct relationship with the customer. This causes a power struggle between the different players in the industry: manufacturers, importers and garage owners. If every link in the chain can reach the customer directly, their roles will resemble more closely. The players need to make clear agreements among them about who is responsible for new orders (Weller & Jackowski, 2017; McKinsey & Co., 2019).

In some cases, this can lead to closer partnerships or consolidations between the parties within an industry. Every player will have to focus on their core business. Concessions can be turned into 'experience centres' in which the customer can experience the brand. Car brands use these experience centres to transfer their history and their values on to (potential) customers in hope of igniting passion for the brand (Van Apeldoorn, 2019). Alternatively, concessions can specialise further in certain reparations or tuning of vehicles. The implementation of digital platforms simplifies the performance management for the entire branch. Every chain is managed by numbers through 'dealer management software'. This software also enables to follow the customer during all phases: from purchase to ownership and additional services to resale (Weller & Jackowski, 2017; McKinsey & Co., 2019).

In other cases, this power struggle will distance players from each other. Dealers and importers will regroup to build a bigger (multi-brand) portfolio. That way, they don't have to depend on a single manufacturer. With the so-called 'dealer groups', large investments can be spread out across dealers. That way, then can offer a greater value to the customer and, at the same time, counter the manufacturers. Some dealer groups even operate on an international level to realise further economies of scale and to spread out local risks. At this time, more international dealer groups are entering the Belgian market than vice versa. Manufacturers are reacting to this evolution by addressing various dealer groups for the distribution of their vehicles (EDUCAM, 2019a; KPMG, 2019; McKinsey & Co., 2019; Vertongen, 2019).

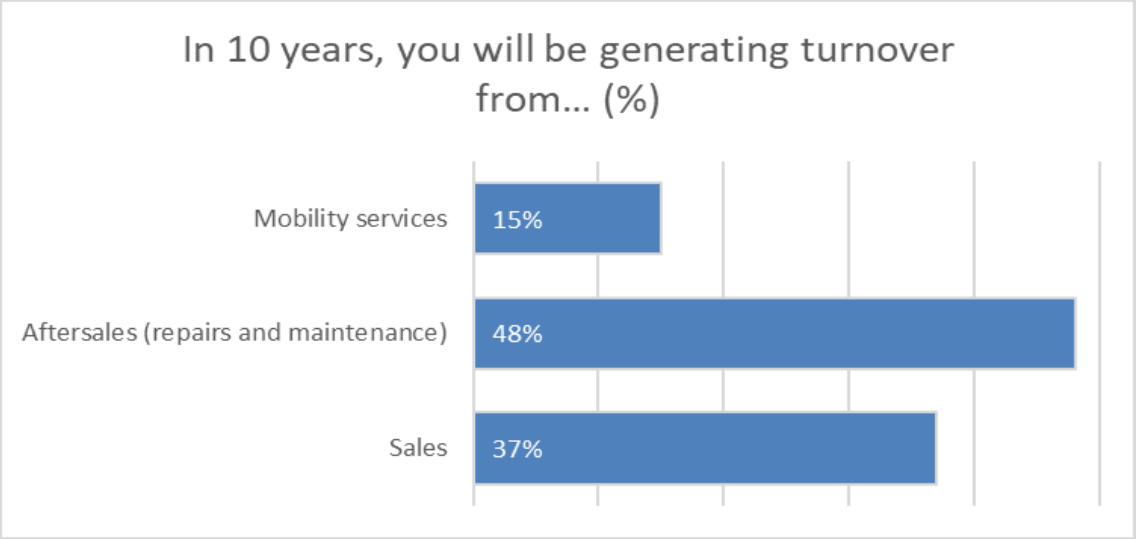
Some dealer groups even actively compete with the manufacturer. Ginion -which distributes BMW, among others- is establishing its own platform. To do this, they joined forces with Drive Now, the sharing platform of the BMW group. Ginion takes care of the maintenance of their fleet, while the manufacturer is directly responsible for the vehicles of Drive Now. Stéphane Sertang (CEO of Ginion) adds that the dealers are more qualified for fleet management and financing these projects, since they aren't listed. Because of this, they can make investments that will only be lucrative on the long term.

Listed public limited-liability companies -such as the manufacturers- are having trouble with this, because they need to justify their actions to the shareholders periodically (Van Apeldoorn, 2019).

5.5 Survey results

According to different respondents, this evolution will be the most disruptive for the mobility sector: *"Not technology, but the possibilities it creates to deploy other business models is our greatest challenge."*

Figure 2: Distribution channels in 2030, according to companies



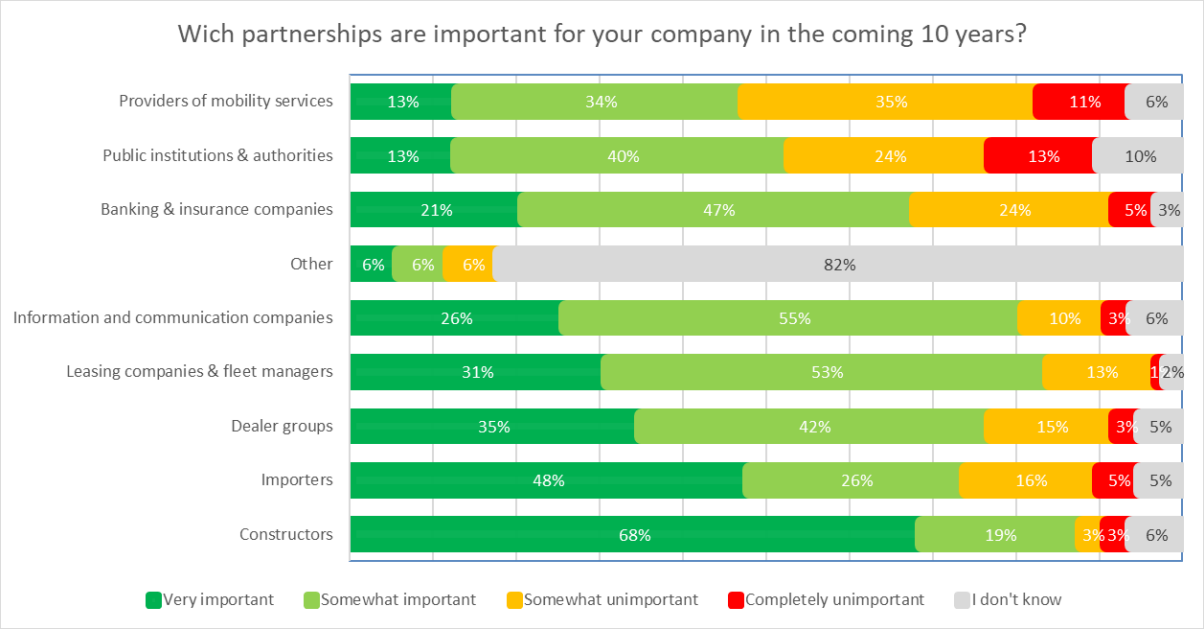
Business leaders and experts have the strongest differences in opinion in this area. That is because business leaders continue to look at maintenance and repairs as their most important activities. Companies estimate that only 15% of their turnover will be generated by mobility services in 10 years time (see figure 9) while experts think this will constitute more than a third of the industry's turnover. Experts are convinced that the turnover in the industry in 2030 will originate equally from sales, after-sales and mobility services. In addition, companies believe a third of these sales will be generated online. The experts judge that the online turnover will be even higher (43%).

According to experts, the companies in the industry will need to conclude partnerships with various stakeholders in the next 10 years (in decreasing order of 'importance'):

1. Mobility service providers (54%)
2. Manufacturers (46%)
3. Leasing companies and fleet managers (38%)
4. Information and communication companies (ICT, Telecom,...) (23%)
5. Dealer groups (23%)

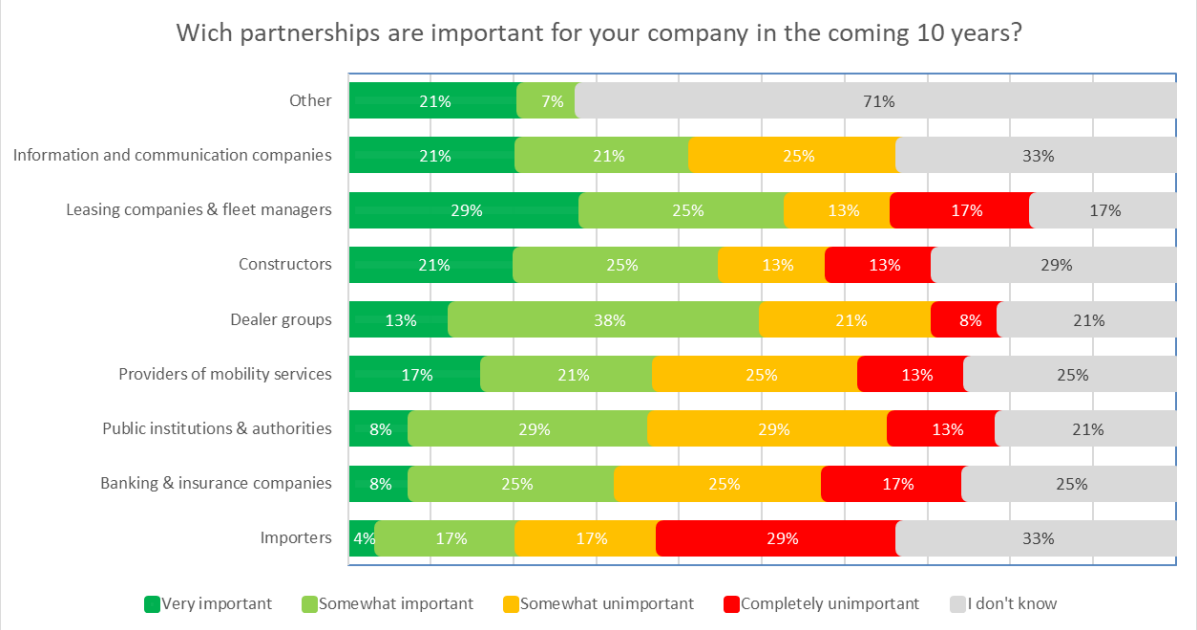
The partnerships envisaged by business leaders differ greatly when it comes to their activity. Figure 10 clearly shows that brand-affiliated dealers mostly look towards the manufacturer (68%) and the importer (48%). To a lesser extent, they are approaching dealer groups (35%) and leasing companies and fleet managers (31%). Finally, more than one quarter of the brand-affiliated market indicate that they look towards information and communication companies as very important partners.

Figure3: Partnerships brand-affiliated dealers



The independent market is obviously less interested in partnerships (see figure 11). Leasing companies and fleet managers receive most of their attention (29%). It is striking that their opinions about dealer groups are very divided. Only 13% of independent dealerships think it is very important to partner up with dealer groups, but 38% keeps a close watch on them and is interested. Finally, bodyworkers are predominantly interested in banks and insurance companies (72%).

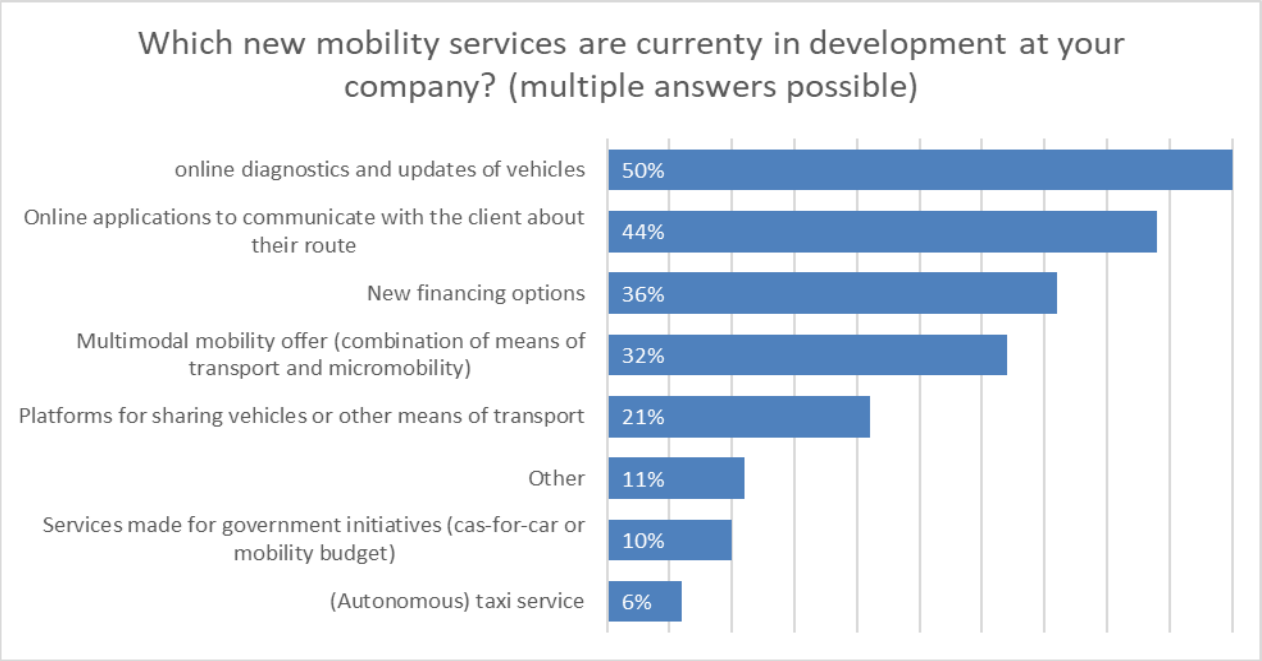
Figure4: Partnerships independent market



A small minority of these companies develops their own new mobility services (29%). Most employers only prepare for this evolution to a limited extent. More than half of business leaders invest in training for their current staff (57%). Two out of five companies is now investing in digitalisation, and for importers, digitalisation is even a primary source of investment. More than one fifth of respondents does not invest in mobility services (22%).

Companies that do invest in these services, are mostly aimed towards online customer contact. Half of them focus on online diagnosis and updates of vehicles, and 44% develop online applications to communicate with customers. Various companies also develop alternatives for personal vehicles (see figure 12). Some respondents interpreted mobility services as 'offering replacement vehicles or bikes when customers bring in their vehicle'.

Figure 5: Mobility services developed by companies in late 2019

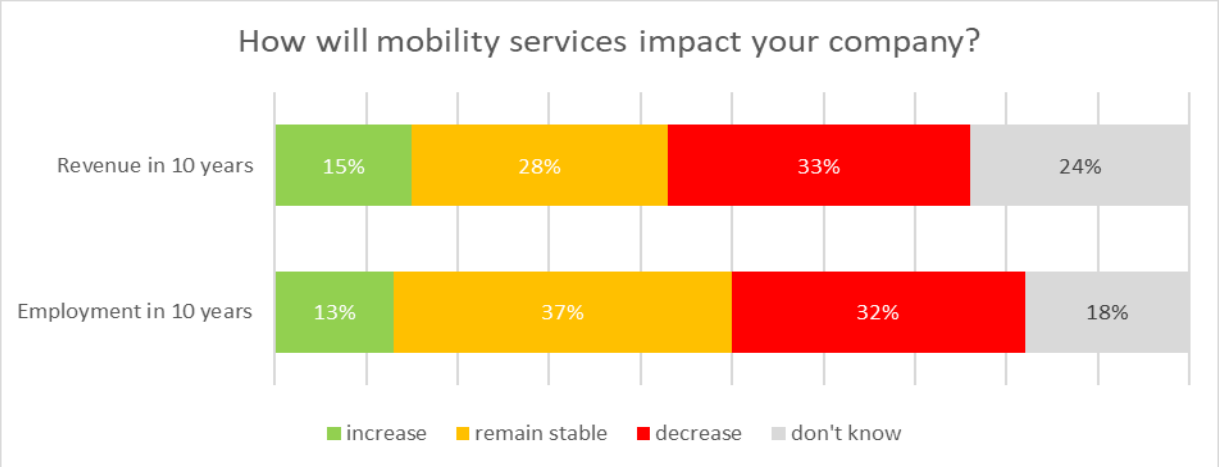


Business leaders and experts agree about which skills the industry needs the most to deploy mobility services successfully, even though their view on the importance of these individual skills differs. For example, the experts unanimously agree that the industry needs digital marketing skills. In a corporate environment, this need is less apparent. There will be an additional need for the following skills (in decreasing order of popularity with business leaders):

1. **Organising mobility services (57%)**
2. **Selling services (56%)**
3. **Use of digital marketing channels (55%)**
4. **Negotiating with strategic partners (54%)**
5. **Online follow up of customers and detecting their needs (54%)**

While the companies are looking towards this evolution as a threat (see figure 13), the experts expect that mobility services will have a small positive effect on the industry. They see an untapped market for new business models. These will secure the turnover and employment in the industry. An expert warns that the industry needs to take matters in its own hands to take advantage of this: *"Most players that focus on mobility services are companies that weren't active in the industry as of today. The biggest risk is that they will take up the largest share if the industry doesn't develop and/or commercializes this on its own".* A brand-affiliated business leader illustrates the wait-and-see attitude that a lot of companies in the industry are adopting today: *"The manufacturer chooses what he would like to sell, and this is a decisive factor for us. We can only sell what the manufacturer and, afterwards, the importer offer us."*

Figure 6: Impact of mobility services according to companies



6 The labour market

In Belgium, about 100,000 jobs are directly linked to the automotive sector. This involves 52,000 workers and 48,000 employees in the garage and bodywork industry and related sectors (EDUCAM, 2019b; Belgische Federale Overheidsdiensten, 2020). This does not mean that the excess of vacancies in the automotive industry has been filled in. Automotive technology is evolving fast and the current staff needs to retrain constantly. Despite the large amount of promotional activity, not enough young people are attracted to fill in the spots on the job market. Manufacturers, importers and dealers are all suffering because of these issues (Skeeled, 2019).

The evolutions influence the way companies in the industry manage their employees. Since less low-skilled workers are needed, recruiters are focused on finding engineers with digital expertise. Moreover, technical staff needs a wide range of competences, which increases the number of job openings for polyvalent workers. In the traditional automotive industry, candidates were recruited for a narrowly defined task, while workers in the new mobility landscape also need to possess social, creative and cognitive skills. These 'hybrid jobs' combine technical skills with 'soft skills' (Skeeled, 2019).

EDUCAM focuses on training mechanics, sales representatives and managers to acquire these new skills. When retraining proves to be ineffective, new candidates need to be attracted. Unfortunately, the industry isn't a strong player in the 'war for talent'. The companies in the industry are competing with organisations from other technology-based industries. These technology companies can offer candidates more attractive propositions than traditional automotive companies. When they are faced with interesting job offers in alternative industries, the biggest talents won't end up in the automotive industry. Especially women are quick to refuse a job offer in the automotive industry (EDUCAM, 2017; Skeeled, 2019).

Even within the industry, the competition on the labour market is fierce. The turnover at dealerships is particularly high. More than half of the sales staff leaves their employer within the first year, and more than 40% of administrative assistants leave just as soon. The turnover is so high that dealers constantly have to post urgent vacancies and therefore don't have time to spend on strategic human resources management (Skeeled, 2019).

To address these issues in a structural manner, the automotive industry needs to improve its image. Both men and women in STEM (Science, Technology, Engineering and Maths) need to feel more attracted to mobility. One way to achieve this, is to launch campaigns on social media. Job offers need to be drawn up with the career prospects of the candidate in mind. Talents are best recruited based on functions in which they can unleash their full potential. Employees also want to have access to lifelong learning, for example though internships and retraining. Moreover, millennials want to work in a stimulating environment with dynamic colleagues and flexible working hours, to complement their flexible lifestyle. Young people aren't looking job offer that focuses on high pay. For them, developing their 'soft skills' is more important than hard data. In addition, millennials aren't looking for a commission-based pay system, but want their pay to be consistent. Unfortunately, these solutions won't resolve the pressing shortage of employees today. For urgent vacancies, an 'applicant tracking system' can be developed using artificial intelligence. That way, interested candidates can be tracked down quickly (Skeeled, 2019).

Forem (2020) is publishing a database with professions for which there is a shortage in Belgium. From the above it is clear that technical professions still form the industry's weak spot (see table 4):

Table 4: Belgian shortage professions in the automotive industry. Our own adaptation based on Forem, 2020.

Job description
(Maintenance) mechanic vehicles: passenger cars, light commercial vehicles and heavy duty transport
- **Vehicle expert**
- **Electromechanical technician and vehicle diagnostician**
- **Tyre fitter**
- **Polyvalent mechanic**
Bodyworker
- **Bodywork repairer**
- **Bodywork panel beater**
- **Bodywork painter**
- **Assembler bodywork and windows**
Receptionist car companies

To bring the educational system and the daily practice closer together, EDUCAM distributes sectoral certificates. These certificates prove that students' competences are tailored to the industry's need for skills. Every year, about 500 people obtain a sectoral certificate. Analysis of the tests leading up to this certificate have shown that a lot of young people struggle with some basic technical skills. The subject 'basic electricity' seems to be a key issue for them. These basic skills also often need to be revised during retraining for workers in these sectors (EDUCAM, 2020b).

Skeeled (2019) adds that recruiters in the automotive sector also have to focus on soft skills:

For manufacturers

- Leadership & strategic management
- Operational expertise
- Creativity
- Critical thinking
- Problem-solving
- Emotional intelligence
- Analytical capabilities
- Cyber security

For dealers

- Sales & negotiations
- Financial knowledge
- Verbal communication
- Commitment to customers
- Resilience

7 Discussion

It's quite obvious that the automotive industry and related industries are at a turning point. Evolutions are succeeding one another at a fast pace, and various new players have directed towards the mobility market. All stakeholders in the industries agree that large investments are needed to make traditional companies 'future proof'. The brand-affiliated market in particular is preparing for electric, autonomous, concentrated and -to lesser extent- shared vehicles.

Most companies in the industry are now focusing on electrical mobility. New EV sales are growing exponentially, and according to the literature and experts, will continue to do so, as manufacturers need to comply to the CO_2 guidelines drawn up by the EU, and customers are increasingly more environmentally conscious. As a result, eighty percent of companies provides training, so that their staff can work on electrified vehicles.

Companies are also providing extra funding to work on driver assistance systems and connected vehicles. All of them see the use of these technologies rise in their workshops, and the workers need extra competences to work on these systems successfully. Independent companies in particular see this evolution as a problem, because working on these systems is highly regulated by the manufacturer.

Despite the investments, companies fear that their turnover and employment rate will decrease as a result of these evolutions. Electric vehicles need less maintenance, and driver assistance systems make the amount of damage repairs decrease. In addition, it is unclear whether companies can charge these additional investments in knowledge and materials to the customers with these vehicles. This takes a bite out of the industry's -already limited- profit margins. As a result, companies will have a negative outlook towards these evolutions.

According to experts, changing business models in the sectors pose the largest threat for traditional companies, as more brands are focusing on selling their vehicles online. This facilitates direct communication between the manufacturer and the client. This connection is maintained when the vehicle is connected to the internet (V2X). Only one out of five dealers invests in digitalisation. EDUCAM's study (2017) about digital maturity has already shown that most companies don't give a lot of attention to their online communication. Therefore some of their tasks risk to be taken over by the manufacturer.

Experts insist that the companies in the industry need to take the lead and experiment with business models. The new evolutions offer opportunities for the development of new services, that will gain importance as soon as consumers are open to other mobility solutions than the private car.

Dealers often can't bear these investments individually, but in conjunction with big dealer groups or with companies from other industries (software, telecommunications, finances,...), they have more possibilities. Garage owners often depend on other players in their industry and only execute what was developed higher up in the hierarchy.

These evolutions demand a lot of flexibility from people in these businesses. They need to process a lot of knowledge, be creative and be open to change. As the companies indicate themselves, the training of staff is essential to prepare for the route to 2030. The rapid succession of evolutions in the sector means that the staff needs to retrain themselves at a faster pace. This required an open mindset and the desire to keep learning. The companies in the industry are mostly in need of the following skills (in decreasing order of popularity):

1. Knowledge of vehicle-specific characteristics

2. Knowledge of infotainment, ICT and telecommunication technologies (bluetooth, internet connection,…)
3. Diagnosis of defects in the vehicle
4. Maintenance and repair of electrical systems
5. Calibration of driver assistance services

Business leaders are mostly focusing on technical skills. Experts also emphasise that the industry needs non-technical skills to prepare for a new mobility paradigm (in decreasing order of popularity):

1. Use of digital marketing channels
2. Organisation of mobility services
3. Negotiating with strategic partners

In some cases, training the current staff doesn't suffice and companies need to recruit additional workers from the labour market. The mobility industry is competing more and more with other high technology sectors. The companies of these other sectors often offer more attractive deals to applicants, which makes it harder for companies in the automotive industry and related industries to find qualified staff for professions with a shortage. As a result, the current employees of a lot of companies are put under pressure.

8 Sources

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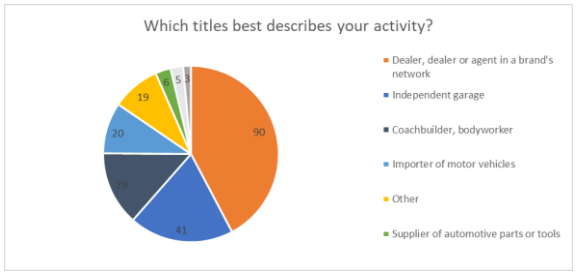
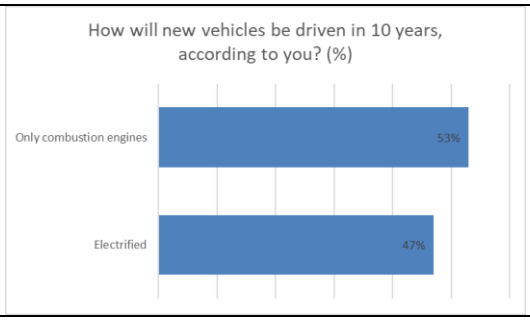
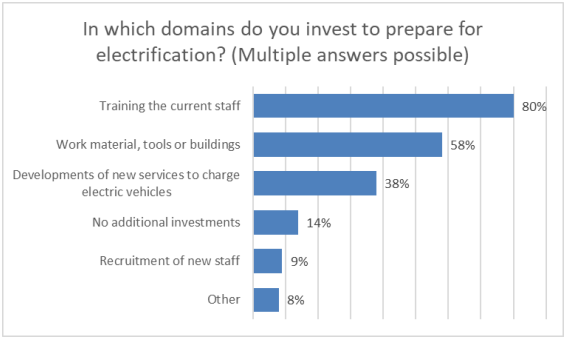
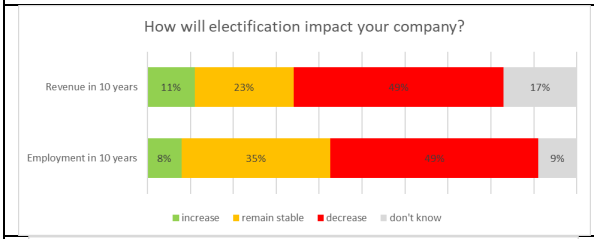
9 Annexes

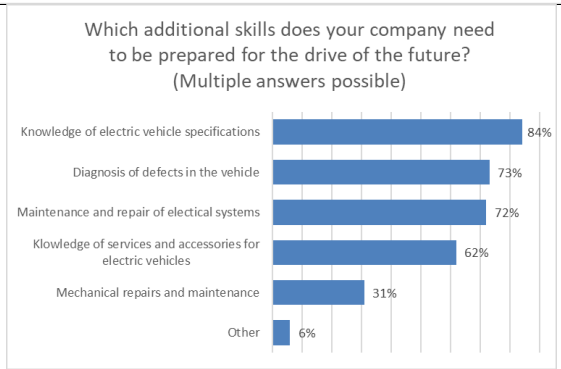
9.1 Annex 1: results question form companies



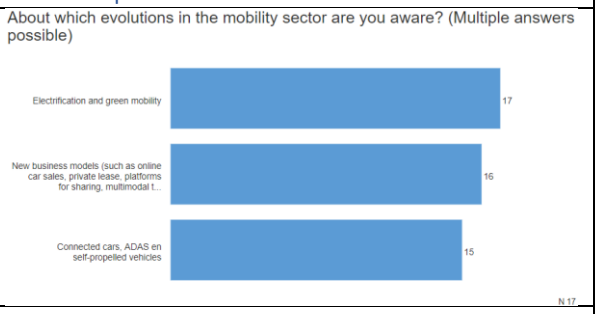


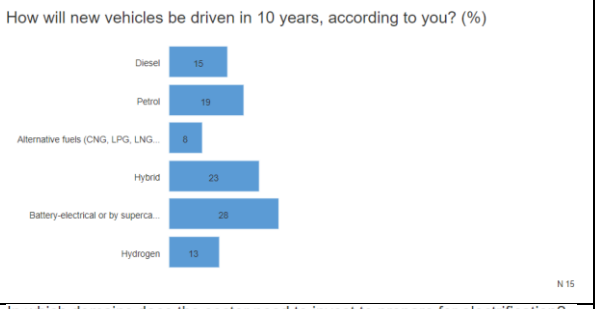


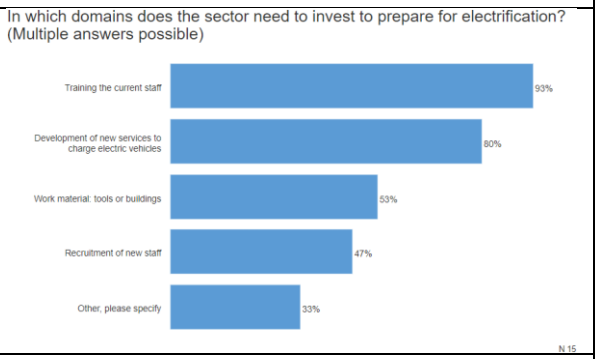


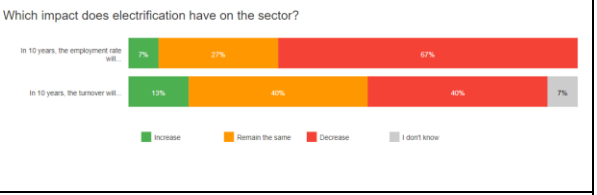


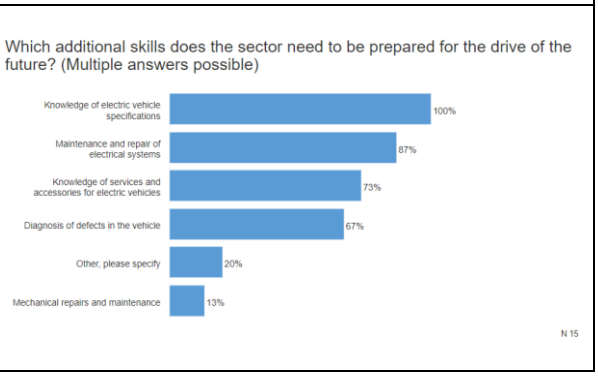
9.2 Annex 2: results question form experts

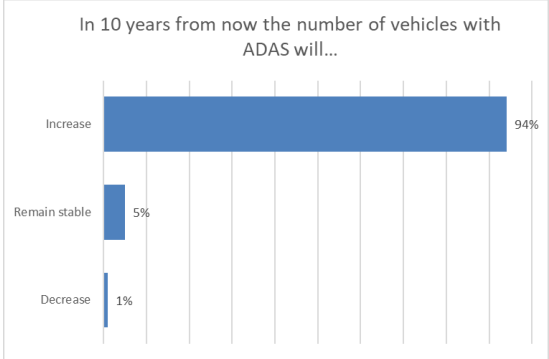
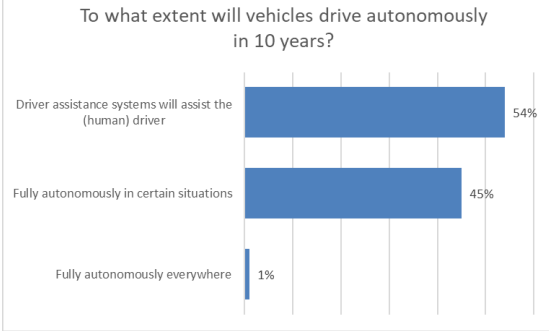
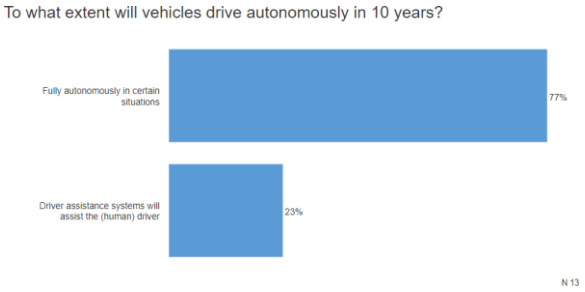
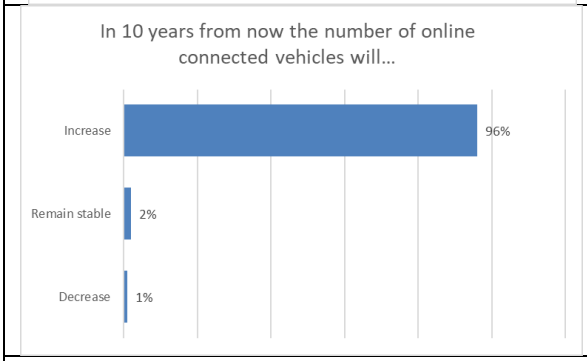
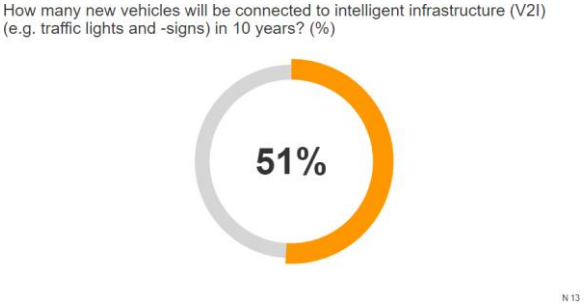
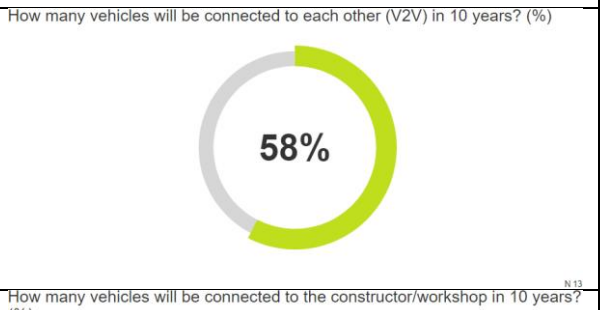


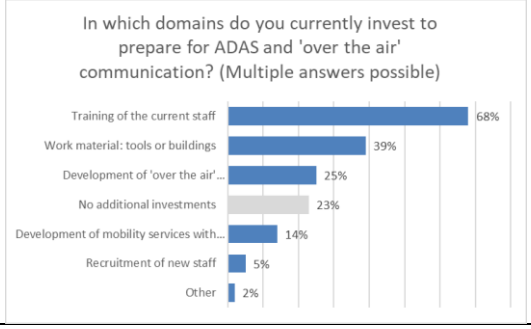
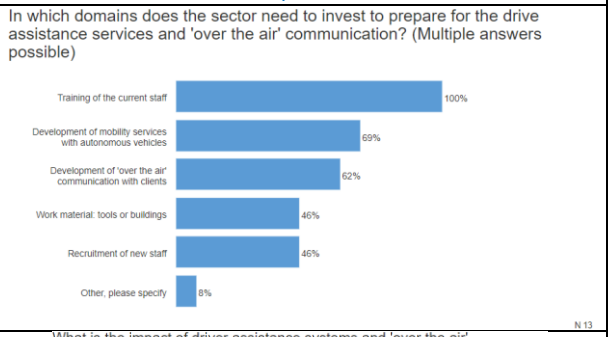
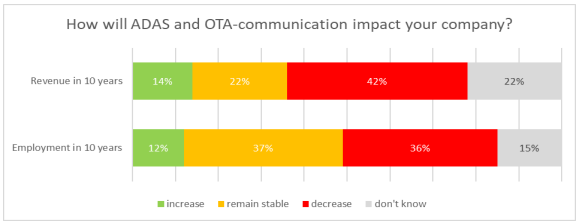
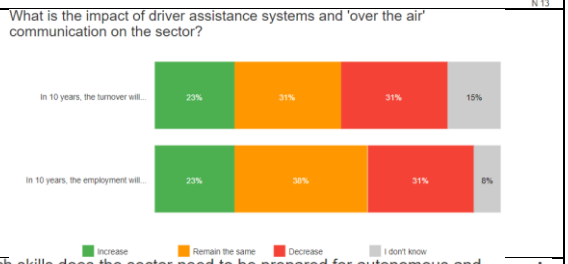
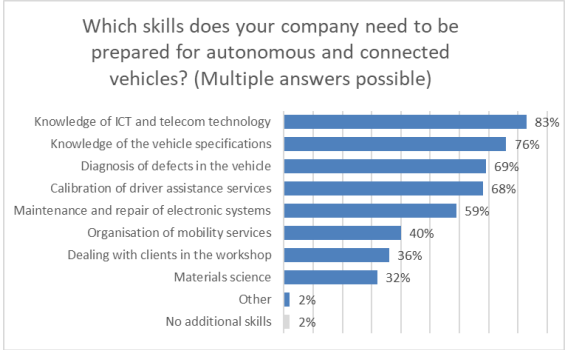
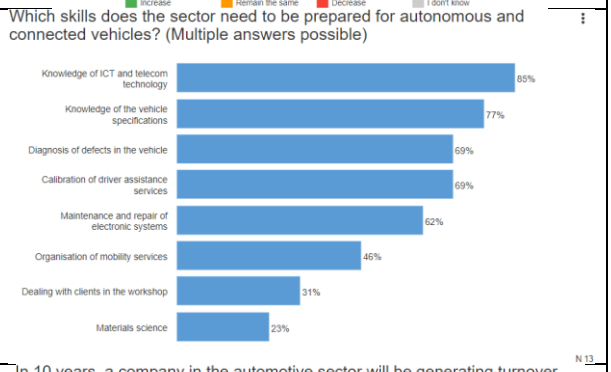
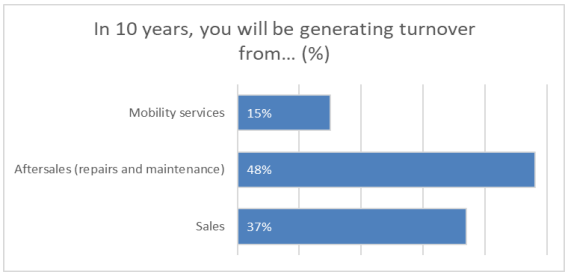
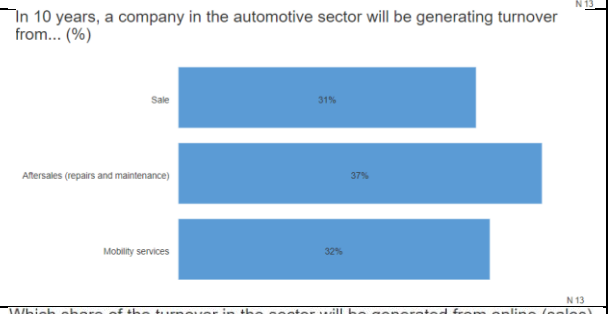
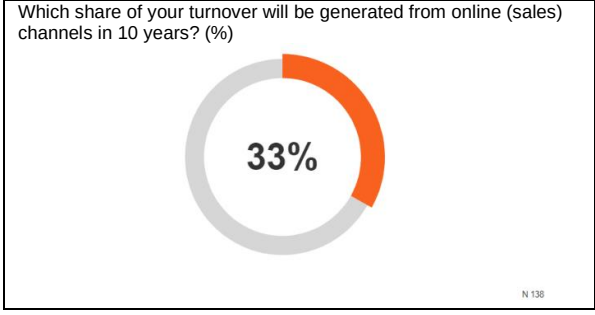
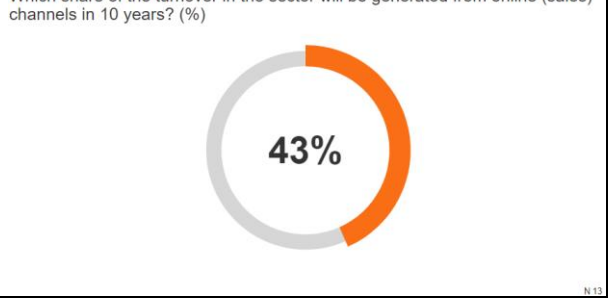




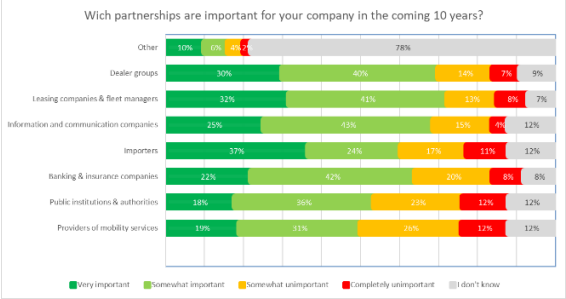


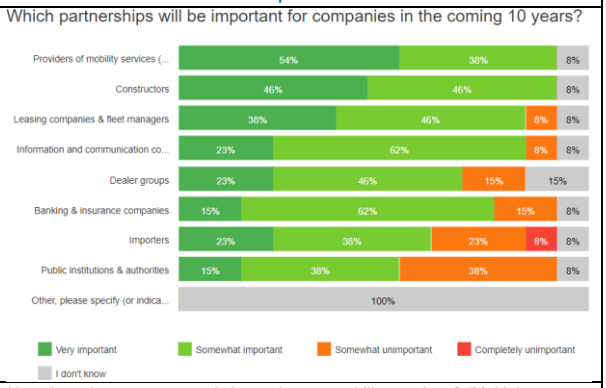


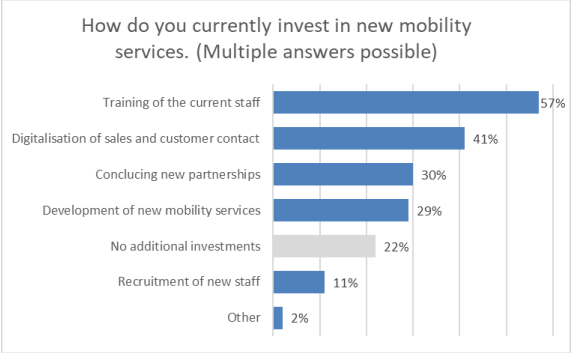
Companies	Experts
	
	
	
	
	

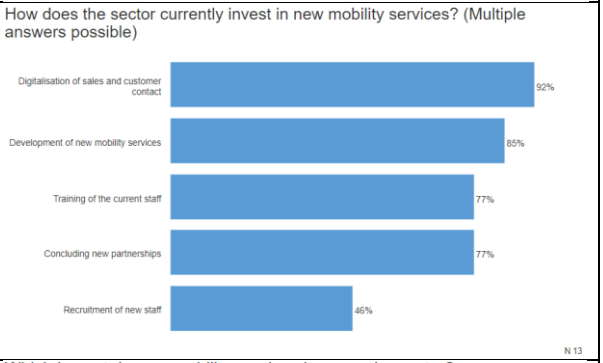
Companies	Experts
	
	
	
	
	

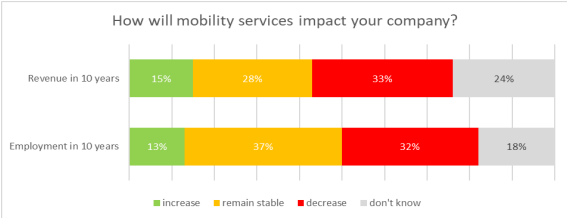
Companies	Experts

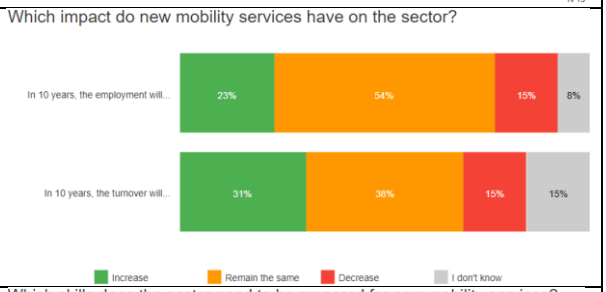


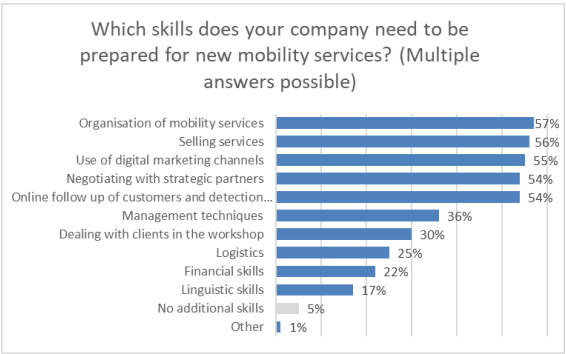


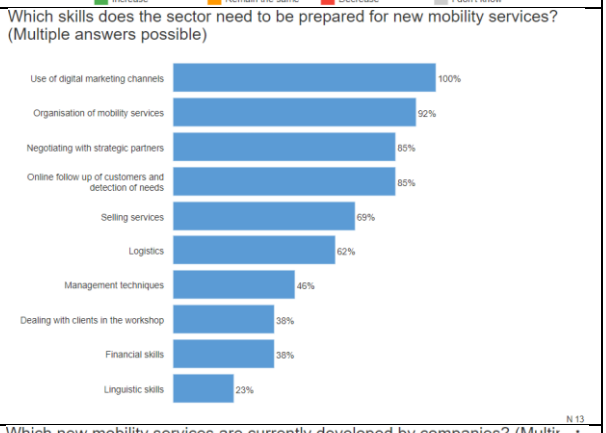


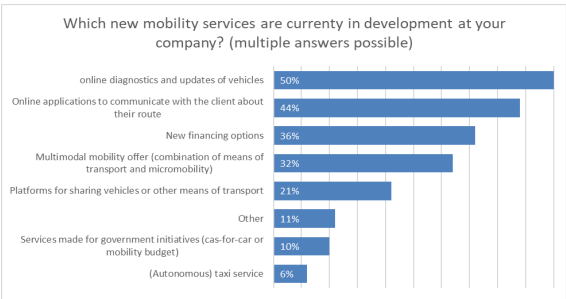


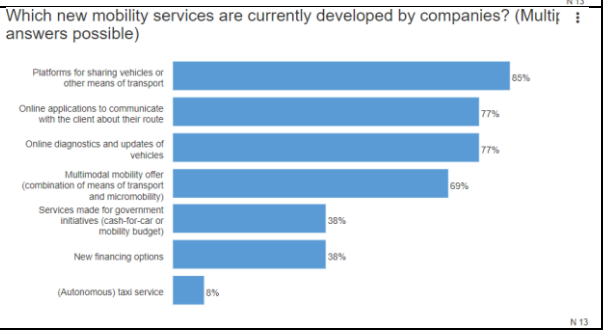












ROUTE 2030