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CHALLENGES OF THE HUNGARIAN AUTOMOTIVE INDUSTRY IN VIEW OF THE NEW CO2 EMISSION REGULATIONS

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List of abbreviations

CO_2	Carbon dioxide
EU	European Union
EV	Electric vehicle
BEV	Battery electric vehicle
PHEV	Plug-in hybrid vehicle
APV	Alternative Powered Vehicles
MEHV	mild Hybrid Electric Vehicle
ICE	Internal combustion engine
ICCT	International Council on Clean Transportation
NEDC	New European Driving Cycle
WLTP	Worldwide Harmonized Light-Duty Vehicles Test Procedure
OEM	Original Equipment Manufacturer
SUV	Sport Utility Vehicle
T&E	Transport & Environment
ACEA	European Automobile Manufacturers' Association
EC	European Commission
AC	Alternating Current
DC	Direct Current
R&D	Research and Development
UF	Utility Factor
GDP	Gross Domestic Product
HIPA	Hungarian Investment Promotion Agency
COMECON	Council for Mutual Economic Assistance

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1 Introduction

1.1 Background

The international automotive industry is going through a drastic change that Andreas Tschiesner Senior Partner at McKinsey & Company compares to the change from horse carriages to engine powered vehicles, he calls it "the second tipping point". What he is referring to is a transformation process that was last seen at the turn of the 20th century when people transferred from horse powered vehicles to engine powered ones. (Tschiesner, 2019) What we need to investigate following the argument that Tschiesner makes, is that while the first tipping point was purely due to economic and technological change, this new second one is more complex. There is a new variable in the equation that we could identify as the urge for global sustainability. As governments got more environmentally conscious and understood the direct and indirect effects of climate change it was clear that action was necessary. Plenty of studies identified that the key to slow down climate change was to reduce the emission of greenhouse gasses. The first ever collective agreement was signed in 2015 known as the Paris Agreement, which unified nations in the fight against climate change. As part of the European Union's commitment to the Paris Agreement, the European Green Deal was created which has the ambitious goal of going climate-neutral by 2050. Part of this policy is the drastic and systematic reduction of the main greenhouse gas CO_2. The European Commission claims that the tail pipe emission of road transport accounts for the majority of the total EU emission of CO_2. (EC, 2020) Therefore they introduced Regulation (EC) 443/2009, which set obligatory emission targets for new vehicles. The initial agenda was to gradually decrease the emission across the new car fleet in Europe leading up to 2050. The early approach of the OEMs was to develop new and improve already existing internal combustion engines, and adjust their powertrain mix across their fleet. What that means in practise is a shift from petrol to diesel, consequently achieving an immediate but marginal reduction across their fleet at minimal cost. However the unprecedented happened what today is commonly known as the "Dieselgate" scandal. Many of the leading manufacturers were accused of manipulating the emission drive cycle tests with a software that adjusted the vehicle's performance during the test to achieve compliant results. (Atiyeh, 2019) The key companies involved were Volkswagen, Audi, and Porsche. These giant German companies suffered backlash over their practises and were accused of fraud and manipulation and suffered a substantial decrease in sales, for example Volkswagen who just before the scandal had a diesel market share over 70% in the US, one of the biggest car markets of the world. At the same time following the global uproar against car manufacturers, the EU regulations got reworked and got stricter forcing an immediate change in approach and strategy to meet the emission standards. The European Parliament and Council adopted Regulation (EU) 2019/631 which set a standard of 130g of CO_2 / kilometre across the new car fleets in Europe between 2015 and 2019.

For 2020 and 2021 this standard is 95g of CO_2 / kilometre. (EC, 2020) This brings us to the "second tipping point", there is a clear shift in the power train mix of the European manufacturers. Alternatively Powered Vehicles are gaining ground at an unprecedented level. The European automotive industry that was the flagship for the manufacturing and development of the internal combustion engine as a whole has to adapt to the changes and come up with a solution to remain the key player in the European economy as it was the past 100 years.

1.2 The scope of the thesis

The objective of this thesis is to examine the current effects and the impact of the new emission regulations on the Hungarian car industry with a main focus on the OEMs. Analysing their corporate strategy, their current operations and recent production and sales volumes. Challenges they face in view of the electrification boom. Based on these I'm looking to answer the below questions.

1.2.1 Research questions

1. *What is the strategy of the OEMs in Hungary to meet the emission standards?*
2. *What are the challenges the Hungarian OEMs face in order to meet the goals set in the regulations?*
3. *Can this segment keep its leading role in the Hungarian economy?*
4. *How does the change in the powertrain mix affect the manufacturing in Hungary?*

1.2.2 Problem statement

The core problem of the Hungarian automotive industry in regards to the new emission regulations is the high dependency on the export of the produced internal combustion engines.

Upon formulating the problem statement I was able to identify the dependent and independent variables of the research. The dependent variable is the dependency on the internal combustion engine export and production while the independent variable is the thorough analysis and mapping of the challenges in connection with the emission regulations and the insight of the industry experts.

1.2.3 Methodology

This thesis was sourced from various primary and secondary sources. Primary sources include scheduled interviews with an automotive market analyst and a sales and distribution manager. Non-scheduled interviews with OEM employees across Europe who work or have worked in Hungary as they have the most insight and experience on the European and the Hungarian automotive industry. Analysis of the data provided by the above interviewees. Secondary sources include literature review and proceedings of conferences on the topic of the mobility industry.

I chose qualitative research as my primary research method as I was focusing on the effects of the emission regulations on the industry rather than the consumer. Asking the same question to all interviewees allowed me to identify their different perception or possible solution to the same problem or challenge which resulted in a more unique and diverse data. Two in-depth interviews were conducted with people who work in the industry, it was necessary that they both work in positions where they have an up to date information on global trends and regulatory changes. Additionally, it was important that they have expereience working in the region. My first interviewee was Juan Felipe Muñoz-Vieira, Global Automotive Analyst for JATO Dynamics. He was able to provide a world-wide and up to date picture of the industry given his track record and experience as an analyst. My second candidate was Marta Ciepłucha Sales Operation and Distribution Manager of Nissan in the CEE region. The interview questions were based around the research questions of the thesis.

2 Body

This segment is broken down to four major sections. Where the first section outlines the general challenges that the European automotive industry is facing following the new European emission regulations. The second section is going to follow the structure outlined in the first section and reflect these points following the analysis of Audi Hungaria. And the third section is a general mapping of the automotive ecosystem in Hungary and the final section shows the results of the primary research.

2.1 Challenges across Europe

2.1.1 Industrial challenges

2.1.1.1 Meeting the CO_2 targets

Statistically speaking road transport is one of the major contributors to GHG emission. According to the data from the European Environmental Agency this segment accounts for nearly 30% of Europe's total CO_2 emission, and within, the class of passenger cars are 60.7%. (Parliament, 2019) Therefore it comes as no surprise that the drastic reduction of CO_2 emission is one of the flagships of the EU policy to meet their carbon-neutral target of 2050. Regulation (EC) 443/2009 that was mentioned in the introduction fully applied from 2015 with a fleet cross average target of 130gCO_2/km based upon the NEDC laboratory test. The majority of the OEMs handled this target with ease and even achieved it during the phase in period leading up from 2012. It is important to highlight that the target may vary by manufacturer to manufacturer. This is due to the fact that the target is set by the average weight of their fleet, the heavier the fleet the higher the value allowed balancing the playing field across the OEMs. Another contributing factor to this early success was the high market share of diesel engines compared to petrol and that the average size of vehicles sold were also smaller since the global economy was recovering from the financial crisis of 2008 forcing the carmakers to downsize. Additionally, the drive cycle test in place at the time allowed manufacturers to produce better results due to the laboratory circumstances, results which not necessarily applied in everyday driving conditions. According to a report from European Federation for Transport and Environment later T&E,

this tendency of heavy reliance on diesel peaked around 2011 with a market share of 55% but shows a continuous drop following the Dieselgate scandal of 2015. (T&E, 2018) A clear shift from diesel to petrol occurred on the European market. Additionally as the economy regained strength, the downsizing stopped and a new segment the Sports Utility Vehicles later SUVs emerged. We could refer to the tendency of the market as "the bigger the better" this was true to engine power, weight and unfortunately emission values as high as in 2014. Following this timeline our next step is the introduction of the reworked policy that was adopted on 19th April 2019 and known as Regulation (EU) 2019/631. This new regulation applied as of 1st January 2020 and maintained the targets of 2020 set in (EC) 443/2009 but set new targets for 2025 and 2030, a significant increase of -37.5% reduction by 2030. (EC, 2019) The target of 2020 is 95gCO_2/km for new passenger cars, with 2020 being a phase-in period when only 95% of manufacturer's fleet needs to comply with the target. (European Council, 2013) This phase-in period ends with 2020 and is a 100% compliance from 2021 onward. Furthermore there are several flexibilities to make the transition feasible and several incentives to encourage carmakers to develop technologies in order to meet their target, resulting in the progress towards the carbon-neutral goal of 2050. With the targets clear OEMs are facing their biggest challenge in recent history. Most European OEMs consequently the ones present in Hungary made efforts to make their cars more fuel efficient and develop engine technologies to reduce tail pipe emission. However they are off-track meeting the targets of 2020 due to the counterweighing effect of the rise in sales of SUVs, decrease in diesel sales and lack of APVs in their portfolio. They have been ruling the ICE market for decades and were heavily invested on the R&D in that segment. They are facing a "Catch 22", give up the SUVs and shift from ICE to APV therefore lose profits, or keep the current powertrain mix and face enormous penalties from the EU.

2.1.1.2 Flexibilities in the regulation

<u>Phase-in period</u>

In order to help OEMs meet the targets, several different flexibilities were introduced into the regulation to facilitate fair competition and relieve some financial pressure. As earlier discussed 2020 is a 95% phase-in year. This allows the manufacturers to only include 95% of their total sold units. This way they could cut some bad performing units out up until 5%.

<u>Target set by manufacturer</u>

Another element is the target setting based on the average weight of their units sold. This levels the playing field across carmakers. For example a carmaker producing luxury sedans have a higher target than the counterpart who is mostly producing smaller urban vehicles.

Pooling

Another important section is pooling which allows manufacturers to form pools combining their sales and emission across their fleet. This results in the averaging out of their emission. One such pool is the one formed between Tesla and Fiat Chrysler Automobiles (FCA). This move helped FCA close the gap between its actual emission level and the target level therefore avoiding millions of euros in fines in 2019. For example a Jeep Wrangler a heavy polluter with around 197 gCO_2/km to 213 gCO_2/km depending on the powertrain (Prez, 2019) is averaged out with the emission of 0 gCO_2/km of a Tesla Model S and their combined result is nearly at the desired level of 95 gCO_2/km. Pooling is an unorthodox practice in the industry, however it is key tool for OEMs who are currently lacking APVs in their product range and an incentive at the same time for those who produce high volumes of low polluting units.

Super-credits

The most influential and controversial are super-credits. These are intended to be an incentive for OEMs to increase the production and sales volume of ultralow carbon vehicles (UCLVs) for example plug-in hybrids (PHEVs) and battery electric vehicles (BEVs). In 2020 these units are counted twice, in 2021 1.67 times and in 2022 1.33 times in the manufacturer's emission average, all units below 50g emitted are eligible for the super-credit. As mentioned in the opening statement of the paragraph not all are in favour of the super-credits. The reason for the controversy is on one hand that emission produced for the electricity in disregarded for the UCLVs and that by this schemes manufacturers can afford to keep selling high polluting units and still meet their emission targets, which as an end result not only weakens the environmental but the economic effect of the regulations. The end result is that fleet-wide the emission levels are decreasing mathematically, but are way off in real life.

Trading

Manufacturers are allowed to trade regulatory credits. The ones who are overachieving their targets could sell these to ones who need a push in order to meet their targets. The above mentioned Tesla reportedly earned 428 million dollars in these credits just in Q2 of 2020. (Beresford, 2020) One could argue that the revenue from these credits could be the pay-out for the early investment into the development of the technology and efforts for the future of mobility. Though these cross competition trades are beneficial for both parties at the moment they are likely to be over as soon as OEMs catch-up in the development of their own APVs.

Eco-innovations

These are incentives to drive innovation of fuel saving technologies. Manufacturers are rewarded for their development and deployment of such technologies as the more fuel efficient a vehicle gets the less emission it produces therefore it directly contributes to a lower emission level. There reason why these technologies are not included in the initial emission level is the fact that these cannot be measured during the standardized test cycle, for example advanced headlights that would allow drivers to drive more efficiently during the night, however this improvement cannot be measured as lights are switched off during the laboratory test. OEMs must apply for the Commission's approval of such technologies, so far roughly 20 such eco-innovations were approved. The fundamental idea is that these improvements must deliver real reduction in emission levels. Vehicles fitted with such technologies can reduce the average emission by the savings of the innovation with a cap of 7 gCO_2/km per year, the reason behind is to keep a healthy balance between the development of "non measureable" efficiency technologies and the ones that indeed could be measured during the emission cycle test. All in all applying for eco-innovation is among the most cost efficient ways to reach the CO_2 targets for the OEMs.

Exemptions and derogations

As earlier discussed the regulation sets the target based on the average weight of the units sold, but it does not take into account the overall size of the company. This is why the regulation contains several derogation elements. First, it allows small manufacturers who register less than 1000 units a year to be exempt from meeting the targets, it relieves financial and administrative pressure from small and medium businesses. Second, it recognizes manufacturers registering between 1 and 10 thousand passenger cars a year as "small volume" manufacturers. They can apply to the Commission for their own individual targets that makes it feasible for meeting the requirements based on their reduction possibility. And last, the option for "niche" carmakers who are registering between 10 and 300 thousand passenger cars a year. This allows them to meet targets that are set considering the type of vehicles they produce. For example manufacturers such as Jaguar and Land Rover benefit from these derogation standards. In 2020 they have to achieve a reduction of 45% from their 2007 levels. This allows them work towards the emission targets at their own pace, yet catch-up to the overall standard by 2030.

2.1.1.3 Compliance strategy – ICE or EV

After the overview of the regulatory framework, we need to examine the way OEMs react and approach this challenge. The options for the automotive industry to achieve the 2020/2021 targets differ from maker to maker. In a 2010 research that was commissioned by Greenpeace International, 4 different scenarios were projected for the industry to meet a target of 80 gCO_2/km (lower than set in the regulation today) by the end of 2020. (Wells, et al., 2010) The 4 scenarios are the following:

Scenario 1: Conventional vehicles – focus on the further improvement and optimization of the ICE car, development of hybrid engines and improving efficiency of non-powertrain items

Scenario 2: Electric vehicles – increase the proportion they are present in the powertrain mix

Scenario 3: Performance reduction – decrease the performance of cars to achieve lower CO_2 levels

Scenario 4: Market shift – restructuring of the segment mix to achieve the desired emission levels

Roughly 10 years later, we can identify Scenario 1 and 2 as the most accurate projections. However the industry in Europe as a whole follows a mix of strategies alongside the above given the flexibilities by the regulation. It is apparent however that OEMs will start with the adaptation of strategies that are the most cost effective and bear the least risk. The strategies that have the smallest immediate effect on their production therefore they tap into their expertise in the field of ICE and develop technologies that increase fuel efficiency. Complimentary strategies to the development of conventional vehicles with ICE are downsizing, driving customers to smaller vehicles brings an immediate marginal decrease in emission levels, and this could be supported with pricing strategies that drive customers to the direction of choosing lower emitting cars. In order to influence customers OEMs implemented different bonus systems for their dealerships for pushing the sales of low emitting models.

As scenario 2 suggested, turning to electric vehicles have the biggest impact on the overall average emission in a fleet, especially when we take the credit system into account. But in reality, a change this drastic is not easy for an industry that works with lead time as big as the automotive industry. It takes several years for a new car to get from the drawing board to the customer. This alone slows down the process of increased EV sales not mentioning the fact that European carmakers collectively were slow to join the electrification of the mobility industry. Therefore they are still in the early stages of development of their own technologies. That’s the reason behind such moves as the Tesla FCA pooling. It is clear that by increasing the share of EVs in sales mix, manufacturers can drastically decrease their emission values. The factors holding them back however are technology and cost. Most EU OEMs are working on ramping up the production of their own EVs, so that they could offer a wider variety of units and increase their share in their sales.

Based on the data and market trends we can state that OEMs will rely on making their ICE models more efficient while gradually ramping up production on EVs to fulfil their emission targets. Among EVs the projected best sellers are going to be PHEVs and BEVs. Carefully taking advantage of the credit system and pooling to balance their average emission result to meet the targets at the end of 2020.

2.1.1.4 Test procedures NEDC and WLTP

For decades vehicles have been tested in controlled laboratory circumstances to determine data such as their CO_2 levels and their fuel consumption. The aim was to establish a basis that could be reproduced and compared over and over again. Technicians can control several different factors from air temperature to tyre pressure. Currently there are two test procedures in place in Europe. The New European Drive Cycle (NEDC) and the Worldwide Harmonized Light Vehicles Test Procedure (WLTP). The later only introduced into the EU in 2017, following criticism to the validity of the NEDC test. Many argued that NEDC was producing misleading figures and was far from what the vehicle would produce in real life driving conditions. To close the gap between test and real emission the WTLP was designed. The goal was to include test elements that better represent real driving conditions and close some of the loopholes of NEDC that were exploited for example during Dieselgate. At the moment both NEDC and WLTP are present simultaneously as a phase-in period until the end of 2020. The twist and the challenge on the OEM side is that the emission targets are based on NEDC figures. One could ask why that is a challenge, the reason is that WLTP tends to produce a higher value than NEDC. This could make it harder for those manufacturers who are really close to reaching their target. A few grams of difference / unit could end up producing challenging numbers fleet wide.

<u>NEDC vs WLTP</u>

In this section we are going to analyse the differences between the two testing cycles and compare the different methods they use during the test cycle. As mentioned above WLTP is the latest introduced in 2017, while NEDC was designed back in the 1980s. WTLP test cycle brought a wide range of changes to the testing. The length of the test increased from 1180 seconds to 1800 seconds. What is more important is the increase from 2 phases (urban and extra-urban) to 4 phases (low, medium, high, extra high). This allows the testing to represent a more realistic driving condition therefore a more accurate CO_2 value. Additionally, the average and maximum speed increased from 34 km/h to 46 km/h while the maximum speed increased from 120 km/h to 125 km/h. The increased average and top speed combined with a longer testing time results in an increased distance the vehicle “travels”. Based on Volkswagen’s data this increase is from 10,966m to 23,274m. (Volkswagen, 2017) To represent more realistic and dynamic on the road driving condition idle time decreased from 27% to 13% while cruise time decreased from 38% to 4%. A further factor was an increase in acceleration and deceleration rates, from 20% to 44% and 14% to 40% respectively. Shifting is also changed from a fixed shifting point to a different shifting point depending on the vehicle. A beneficial change from OEM point of view is that with WLTP now features which are not directly measurable are now taken into account and are represented as eco innovation credits for example aero dynamic improvements or LED lights. The temperature during the test is also different between the test cycles. NEDC is measured at temperatures between 20 and 30°C while WLTP is measured at a fixed 23°C and CO_2 values are corrected to 14°C. (WLTPFACTS, 2017) These changes have a benefit both for the consumer and the environment as consumers get a better and more accurate data on fuel consumption therefore they are able to choose vehicles that match their needs the best while the environment is benefited from more realistic CO_2 values allowing policy makers to control the number of high emitting vehicles on the road with the fleet-wide emission targets.

ICE vs BEV under WTLP

Even though battery electric vehicles do not have tail pipe emission they are still required to get a type approval they need to be tested just as their internal combustion engine counterparts with the new WLTP test cycle. The BEVs undergo the test under the same conditions. They start with a fully charged battery, completes the test and immediately gets reconnected to a charger that measures not only the energy uptake of the battery but if any the energy lost during the charging procedure. Additionally, it is worth mentioning that in the case of plug-in hybrids which are somewhere in the middle between an ICE and a BEV as it has an internal combustion engine and an on-board battery therefore a mixed powertrain. In the case of a PHEV the test starts with a fully charged battery and repeated until the battery runs out of power. Once the battery is empty the test is repeated with the vehicle only using its internal combustion engine and if equipped with the regenerative breaking as a power source. This allows the test to not only identify the emission values more accurately but give a better picture of the vehicles electrical range. In order to calculate the CO_2 value in the case of PHEVs are calculated from the ratio of distanced travelled on the electric powertrain and distanced travelled on the combustion engine. Additionally a new variable had to be introduced which is the utility factor (UF) to better identify the capabilities of the plug-in solutions. The more the vehicle travels on the electric power source, the better the UF which results in lower emission values as the vehicle does not use its internal combustion engine. This high utility factor is among the reasons why PHEVs are an optimal solution for urban and short distance use. (VDA, 2017)

Disparity between the results

Following the 2017 roll out of the WLTP, the two test cycles were used at the same time making the transition feasible for both policy makers and carmakers. However as data was collected we can identify a disparity between the emission and fuel consumption values based on the NEDC and WLTP test. This is a result of the change test conditions as listed in the earlier section. As argued these figures are to the benefit of the consumer (more information on the vehicles, better decision making potential) and the environment but are challenging on the OEM and government side. As the test cycle was adjusted to better represent the real drive driving conditions the emission values increased and fuel efficiency decreased in most cases. According to JATO researchers, the gap between NEDC and WLTP values was 9.6 g/km in early 2018. (Hewitt, et al., 2018) This gap poses a risk for OEMs in meeting their emission targets in the future when WLTP becomes a standalone test cycle procedure in Europe, and puts them into a position where they could face fines for exceeding their CO_2 quotas. On the other hand, the higher emission values resulting from the WLTP test are threatening customers with increased taxes. For example in the case of Finland where WLTP was first implemented, the increase in vehicle tax decreased sales immediately as according to the Finnish regulations weight, powertrain and emission values are greatly influence the amount that has to be paid in the form of tax after every new registration. (Hawthorne, 2020) The tendency of reduced fuel efficiency under WTLP in internal combustion engine vehicles can be identified for electric vehicles too. With the increased average and total speed combined with the extended time the vehicle is measured EVs are showing significantly lower range than before measured under NEDC. Therefore we can identify the same tendency that we did earlier in the case of ICE vehicles. According to a 2019 JATO study based on 23 different BEVs from the Dutch market the research identified a difference of 27.45 km difference on average between the NEDC and WLTP test results. (Palthe, 2019) In his study Palthe examined the correlation between the decreased range and the increased battery size of the tested vehicles and their relation to the end price. According to his findings vehicles with no battery upgrade are not only more expensive by 1029.29 EUR bot have their range decreased by 80.45 km on average under WLTP. On the other hand models where a battery upgrade was available, these result are slightly different. Price increased on average by 2355.02 EUR while range increased by 37.33 km. (Palthe, 2019) These different readings can influence the consumer behaviour in the future on several different levels. First, in the case of a battery electric vehicles, customers must make a decision based on the range and the cost of this range from the increased battery. Second, in the case of internal combustion engine vehicles the increased emission value can result in higher CO_2 purchase and ownership tax.

2.1.1.5 Infrastructure

Another industrial challenge is infrastructure. This is most relevant from an EV deployment standpoint. In order to reduce “range anxiety” among customers it is necessary to develop the charging infrastructure across Europe. This so called “range anxiety” comes from the range disadvantage of EVs “on one tank” when compared to conventional vehicles. The expansion of the infrastructure is the common goal of manufacturers and governments. The reason for the joint-venture like approach is that it is a win-win situation for both governments and carmakers to facilitate the wide spread use of EVs. At the moment two major EVs use the charging stations. These are BEVs and PHEVs. While refuelling a conventional vehicle takes a few minutes regardless of the make or performance, EV charging is more complex. It depends on the battery and the plug type and the power level of the charging station itself. As of 2020, there are several different charging methods in development, but the most common and widespread are currently the wired charging stations. The concept is pretty much as if one would charge a phone. Plug it in, and wait until the battery is sufficiently charged. However the charging time is greatly influenced by the type of the charger. Within wired charging there are 3 levels, from level 1 to level 3. These can be simplified into two categories, fast and slow chargers. Slow charging (level 1 and 2) as the name suggests takes longer and is intended for overnight charging at home or charging while at work. It usually takes 6-8 hours. These slow chargers are the most widespread at the moment. On the other hand, there are fast charging stations that could become game changers when it comes to easing "range anxiety", with these improved chargers EVs could refuel in 10-30 minutes and could have their initial range extended significantly. When it comes to charging from a Level 1 or Level 2 station, the power transmitted from the charger is AC (alternate-current) which is then converted within the vehicle by a built-in inverter to DC (direct current). Once AC is inverted to DC, the battery could start charging. The upside of the slow chargers are the low investment cost and that they can be integrated into almost every household and workplace. Oppositely, Level 3 chargers use a different technology. The inverter is integrated into the charging station itself so when it receives the AC from the power grid it converts it to DC before transmitting it to the vehicle. This cuts the time of charging by directly providing DC to the batteries and it can operate at much higher powers further increasing the speed. However the downside of these Level 3 chargers are their cost. This is the key reason why majority of charging across Europe (see Appendix 2) is done by Level 1 and Level 2 chargers. McKinley estimates that in order to meet the demand Europe is required to establish 15 million chargers that would roughly be around 17 billion USD investment by 2030. (Hauke, et al., 2018) It is also worthy to note, that in order to encourage investment into the infrastructure these charging stations need to be commercially viable and backed by an electric system that could facilitate the projected increased demand.

2.1.1.6 China' case

When it comes to industrial challenges we cannot avoid the examination of the Chinese market trends and approach when it comes to the shift from conventional ICE vehicles. As the biggest single-country car market in the world what is happening in China has a direct effect on manufacturers around the world, especially to Europeans. The reason for that is European OEMs relied on exporting their vehicles to the Chinese market for a decade in order to stay profitable. The market there have been expanding by almost double digits on a yearly basis giving the possibility to ICE market leader EU firms to gain valuable market share and therefore profit. According to ACEA's 2019 fact sheet on Chinese-European automotive trade, Europe was the biggest exporter of vehicles to China accounting for 53.3% of total Chinese car imports, which on the other hand corresponded for 17.5% of total EU exports. (ACEA, 2019) Unfortunately this all might be at risk as Beijing announced in 2019, that EVs would represent 25% of the vehicle sales by 2030. This ambitious goal was backed by a series of incentive programs to help propel their national EV producing industry. These were a combination of subsidies to manufacturers and incentives for customers. Sales increased drastically until the end of 2018. On the back of these changes a whole industry grew and developed in a decade. What we can see happen is referred to as Leapfrogging by industry experts. It is described as "bypassing stages in capability building or investment through which countries were previously required to pass during the process of economic development" (Steinmueller, 2001) One example of this leapfrogging is the company of Build Your Dreams (BYD) who transitioned from the production of phone batteries to now not only producing batteries for BEVs but becoming a standalone OEM producing PHEVs and BEVs. Their approach is similarly to Tesla. They are more of a tech company focusing on technological innovation at first and then adapting that into products at a later stage. BYD is a global player in the EV industry swapping first and second place with Tesla year to year. But how does Europe come into the picture regards to the Chinese industry. Well the problem is that EU OEMs are likely to lose Chinese market share due to the Chinese government's ambition to reduce ICE sales therefore lose profit. To even complicate this equation, while EU firms are busy working towards their emission targets and reduction of their ICE sales, Chinese OEMs and battery manufacturers are ahead on the curve of EV deployment and could possibly reach a point where they turn the tables and start exporting their products to the European market. Additionally what is fascinating about the Chinese market is the approach they take towards EV deployment. Instead of following the EU standard of producing EVs that are trying to mimic their ICE counterparts resulting at a high cost. Chinese firms are more devoted to the production of EVs at affordable prices therefore allowing customers to make the transition resulting in higher market share of EVs.

In my interview with Felipe Munoz, we touched upon the topic of China from several different perspectives. He highlighted that the remarkable EV development of China as oppose to Europe is strongly thanks to the pace and structure of policy making differences. While the European automotive industry is slowed down by the regulations imposed by the European Commission, the Chinese industry is heavily backed by a government and centrally planned industry. In their recent white paper on the topic, JATO analysts refer to this as "China set out to win, and would stop at nothing to achieve its ambitions". He also highlighted the price gap of EVs of the major markets. According to the earlier mentioned white paper, the average retail price of an EV in the first half of 2020 in China was 29,895 USD as opposed to the 55,233 USD in the US and 48,080 USD in Europe. (Munoz, 2020) This price gap represents the approach difference of European and Chinese OEMs as mentioned in the earlier section. Ever since the introduction of the EV to the European market it was positioned as a high-end luxury item. This price tag alone managed to keep the majority of customers away from switching from their internal combustion engine vehicles. On the other hand to promote electrification Chinese OEMs chose to focus on affordability. Another difference is within the EV sector the model portfolio. On the Chinese market customers have to option to choose from a wider variety of models from several different segments, even fully electric SUVs while in Europe the focus was on mid-sized vehicles. Mr. Munoz also highlighted the difference between the European and Chinese customers and the market itself. He pointed out that the European market reached a point where the growth is stagnant, the market nearly reached full maturity. Contrarily most Asian markets therefore the Chinese are still growing and far from reaching full maturity giving the opportunity for carmakers to increase their local sales volumes. Similarly worth mentioning the customer behaviour differences between the two regions. While European customers are described as brand loyalists and risk averse therefore more resistant to change Chinese customers are not afraid of newcomers and willing to choose new products. Additionally, they are described as members of the smartphone generation and tech savvy. The change resistant approach from European customers is reflected in the registration figures of EVs across the continent. Their environmental consciousness is also highlighted in the white paper as opposed to the Chinese. The electric vehicle in Europe is looked at as a green solution and a tool to fight climate change while in Asia it is looked at as a new gadget, a new form of technology and a change to own a piece of high-tech product.

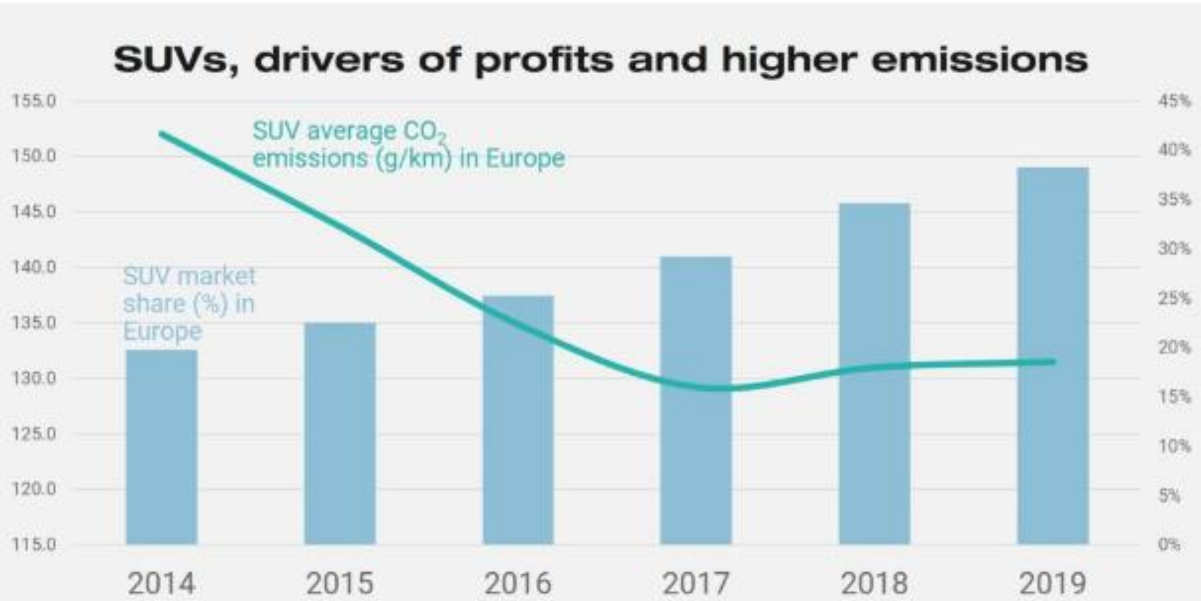
In relation to the Chinese approach we also took into account the possibility of Chinese companies venturing to the European market. In the past 10-18 months Chinese subsidiaries started the establishment of several different vehicle and battery manufacturing plants in Europe. When asked about the possibility of Chinese firms taking over the European market with their affordable EV vehicles Mr. Munoz highlighted that there is certainly a possibility of this happening but no in a direct way as one might think, but through mergers and acquisitions or with long term collaboration between the OEMs and battery suppliers. He also suggested that China has the potential to market its know-how to European manufacturers. The first option of Chinese companies venturing to Europe can already be examined. For example the electric performance car producer Polestar who is owned by Swedish carmaker Volvo. At first sight Polestar is European since it is closely related to Volvo but if examined closely the entire Volvo brand is owned by the Chinese giant Zhejiang Geely Holding Group commonly known as Geely. Furthermore the cars are developed and manufactured in China. So as Mr. Munoz suggests the Chinese overtake is already happening in some shape or form and likely to happen at even bigger scale in the future if the European automotive industry cannot reduce the competitive advantage of the Chinese OEMs.

2.1.2 Financial challenges

2.1.2.1 Penalties

Apart from the series of flexibilities Regulation (EU) 2019/631 includes a pivotal section. This is the penalty payments for excess emission. OEMs have to pay a penalty of 95 euros for each g/km that exceeds their total fleet-wide target. According to several industry news portals, this could add up to over 30 billion euros in 2021. (Campbell & McGee, 2019) Carmakers could potentially suffer a major financial loss if they cannot meet their targets. The factor that makes it difficult for them to achieve their targets is the popularity of the SUV segment in Europe. According to JATO research, OEMs are facing a dilemma between facing potential fines and giving up a segment with great profit margins and increasing sales volume. (Munoz, 2020) As seen on the graph below, the SUV sales have been increasing steadily for the past 10 years, but their emission values are far from the target with an average of 131.5 gCO_2/km.

Figure 1 SUV CO_2 Emission and market share evolution



Source: JATO (2020)

2.1.2.2 Research and development cost

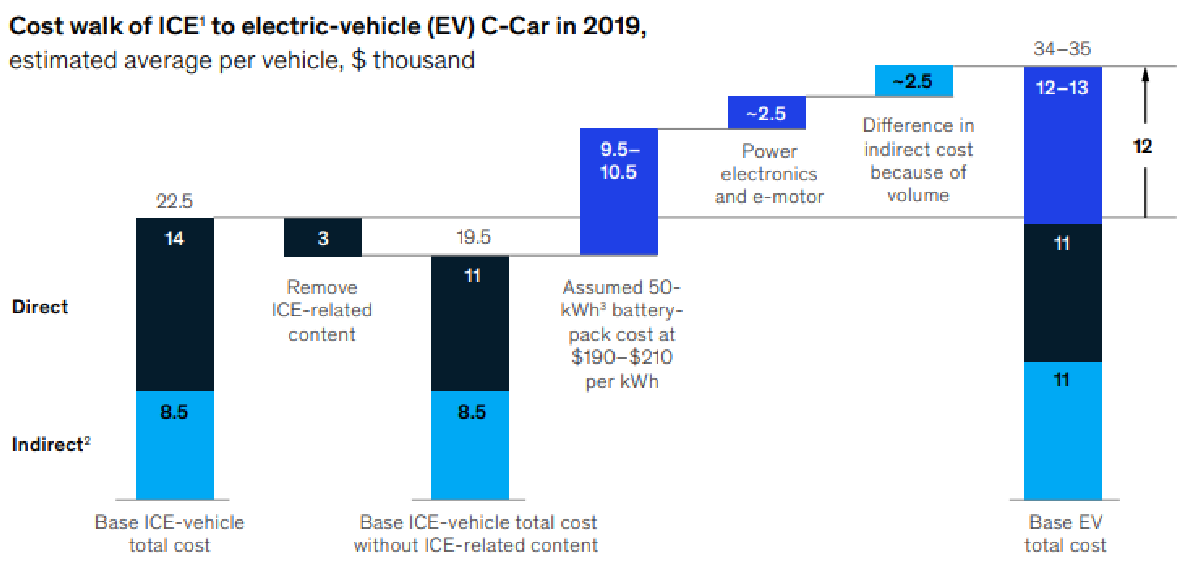
Most European carmakers are or were behind the curve when it comes to EV development and production. Ever since the first the emission regulation started applying, it was clear for OEMs that they needed to act and act quickly. Firstly, start the development of their own EVs to be able to considerably reduce the emission gap and therefore meet their targets, and secondly to be able to match the portfolio of their competition. The threat to be next Nokia is very real at this day and age of the automotive sector. The mobility industry is going through a change that forces carmakers to shift their focus from conventional vehicles. According to BDO European firms spent a significant 33.3 billion pounds on R&D in 2018/2019, 35% more than 2014/2015. (BDO, 2019) A substantial part of the

R&D efforts are focused on the long-term reduction of the dependency on fossil fuels making a step towards clean mobility that relies only on renewable energy sources. In the short-mid-term however the electrification is the most cost effective. Therefore at this time the emphasis is one the improvement and development of safe and affordable battery systems. Currently almost all BEVs operate on lithium-ion batteries. The goal is to maximize the performance and the longevity of the batteries while reducing the cost. Apart from the earlier three, there are several other areas where development is necessary when it comes to BEVs for example the energy supply for comfort functions such as on-board heating and air conditioning. For marginal improvements, OEMs research tools and technologies such as driver assistance and traffic management software and improvement of internal combustion engines that could accommodate alternative fuels such as biodiesel or hydrogen.

2.1.2.3 Production cost

Another contributor to the financial challenges is the production cost of APVs especially BEVs. As of 2020, the production of a BEV is considerably higher than a comparable ICE unit from the same segment. A 2019 article estimates a difference of 12000 dollars between the two units. (Baik, et al., 2019) Even though there is no conventional engine in a BEV and it consists of fewer components (no gearbox, exhaust, etc.) it is still more expensive to produce than an ICE. As we can see on the graph below the key reason behind the difference is the tremendous cost of the lithium-ion battery that can be almost 50% of the total production cost. (Tsang, et al., 2012) As for the new components such as the electric motor and electric components the cost is almost equivalent to the components left out like the mentioned exhaust system and gearbox.

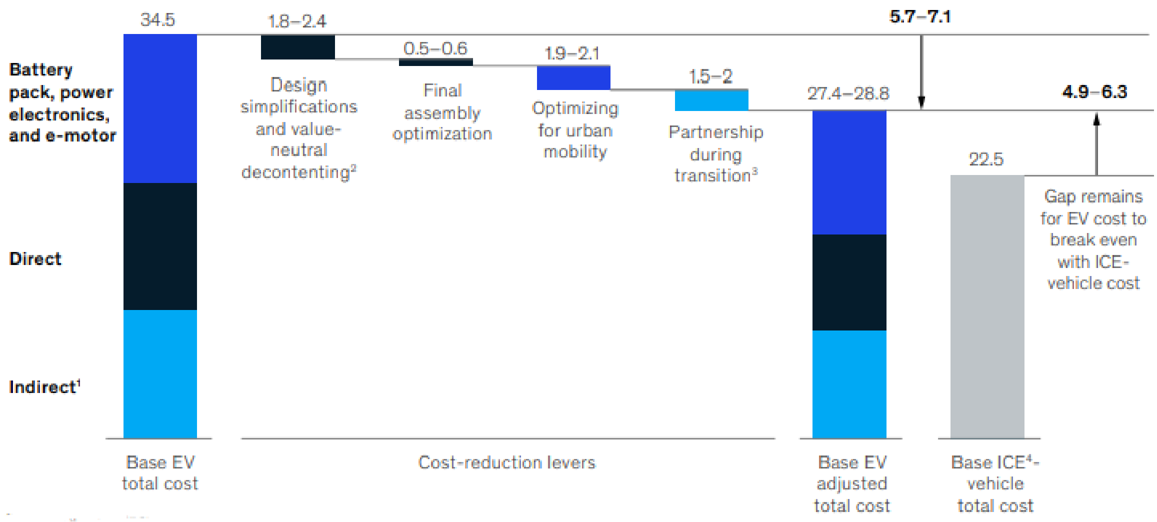
Figure 2 Cost of ICE compared to EV in a C-type vehicle in 2019



Source: McKinsey (2019).

The battery prices are projected to go down as a result of the global demand for lithium. Supply chains need to evolve in order to keep up with the increased production volumes. This break-even point is expected around 2030-2035, when the battery production plants and the related supply chain can realise the economies of scale to push prices even lower. (Miller, 2020) In the meantime carmakers have alternative ways to reduce the production cost by design. As illustrated on Figure 3, with this design approach could reduce the production price gap between EVs and ICE units. The simplification of the interior of the vehicle for example replacing most of the buttons and dashboard components with a central digital control panel as seen in Tesla models or using different materials for the seats or the interior design. In addition to the above mentioned, manufacturers can create dedicated EV platforms that better support the development needs. Obviously with an initial investment cost, but this investment could yield great returns in the long run. From an assembly point of view, there is no significant cost difference in the long-run. Although, short-medium term the reorganisation of the assembly plant and training of employees bares extra cost.

Figure 3 Base EV cost vs Adjusted EV cost in 2019



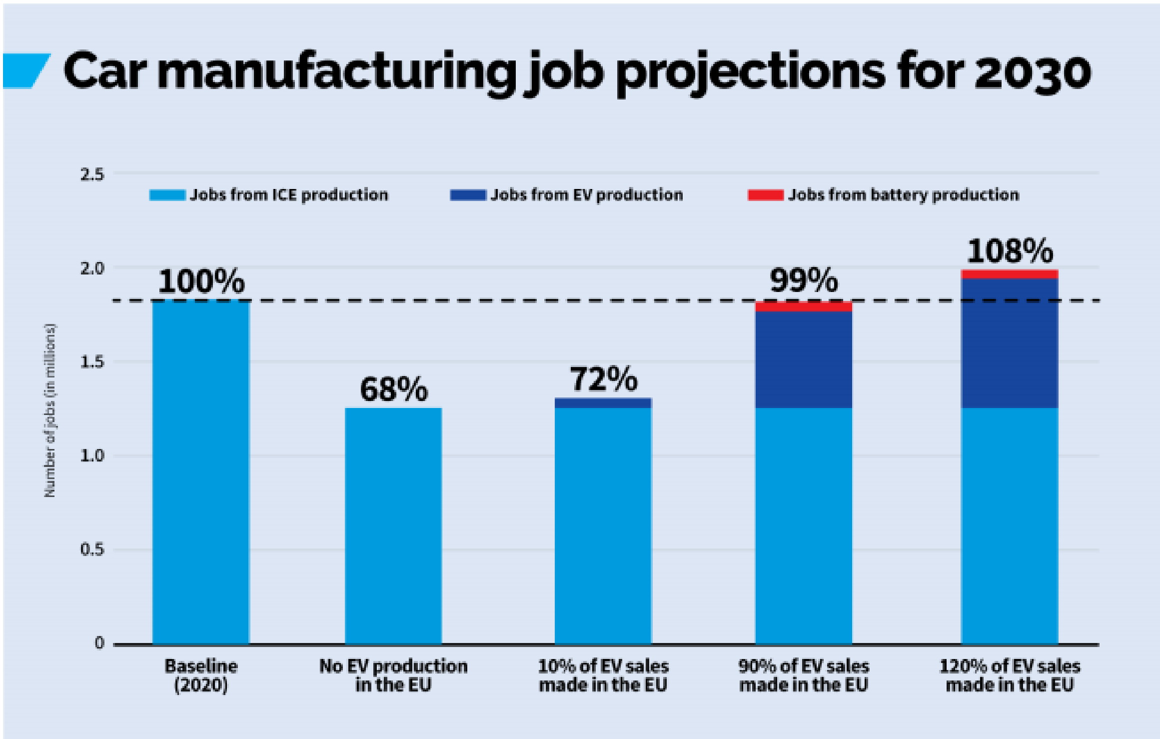
Source: McKinsey (2019)

The road to the profitable mass production to EVs is still long and challenging but until than OEMs are squeezed to produce units at much lower margins than they would normally do to meet their CO_2 targets and meet customer demand.

2.1.2.4 Labour force and labour cost

Closely related to production and one of the most important part are the employees. As mentioned in the previous paragraph the production of EVs are going to affect the workers in every OEM. From assembly point of view, electrification poses risk at numerous jobs as the assembly of an EV takes less working hours than an ICE vehicle due to the smaller number of components. (Cramer, 2017) In relation with the simplified production, automation is likely to gain more ground further reducing the workforce necessary. We could argue that this could on one hand reduce labour cost for manufacturers and on the other hand jeopardize the economic stability of Europe. Realistically the outcome of the production shift will depend on the strategy of the carmakers. The key is the battery production. Asian nations are currently dominating the battery production business. Countries like China, Japan and South Korea are producing most of the batteries for vehicles in Europe. However if EU EV sales and production ramps up as projected it is a crucial from an employment standpoint whether those units are produced in the EU or elsewhere. The below graph is a projection of T&E on the possible impact EV production on manufacturing jobs in 2030. These figures are based on the scenario when EVs account for 35% of total production in the EU. As we can see the option when the production happens outside the EU will result in major job losses throughout the industry. However if OEMs invest and develop plants to produce EVs within the EU jobs not only will remain on the current level, but new jobs will be created. And at this point we have to consider the labour cost factor for the OEMS. Employee will have to be moved in large numbers from ICE production to EV production. In order to be able to do that employees will have to be retrained. We can assume that this training will results in higher wages as workers gain new skills cruacial for production.

Figure 4 Car manufacturing job projections for 2030



Source: Transport & Environment (2017)

This new training will not only affect workers at the assembly line, but engineers and designers aswell. For OEMs to remain competetive the key is their own battery development and intergration. The same applies to the millions who work directly or indirectly in the automotive industry.

2.1.3 Commercial challenges

There are several factors that we could identify as a commercial challenge for the European therefore the Hungarian automotive industry in the view of the new emission regulations. Firstly, the price tag attached to their APVs which they are forced to increase production of. Secondly, a fluctuating demand in Europe. And third, autonomous driving and ride sharing.

2.1.3.1 Purchase price

As discussed in an earlier section, OEMs are facing increased production cost due to EVs. This increased cost translates into the price of the vehicles they introduce to the market. Generally speaking the car market is really price sensitive and for the past few years carmakers struggled to offer EVs at an affordable price. There was simply no alternative to a small city-car on EV side. Most of the early units had a hefty price tag on them and were looked at as luxury cars from customer point of view. According to JATO data, the average retail price of electric vehicles were 81% higher than conventional ones in 2019. (Munoz, 2019) The price difference amongs other factors like the so called “range anxiety” and poor infrastructure remain key obstacles for carmakers to penetrate the market with EVs. Additionally, ACEA data confirms that there is correlation between the GDP/capita of a country and the registration of EVs. (ACEA, 2020) The market penetration and uptake of EVs are higher in countries where there is higher disposable income and customers are less price sensitive. Western and nordic countries have the highest market share of EVs among the EU 27 member states, within these countries the GDP/Capita is also higher. What is also worth noting that 80% of total EU sales are shared between six western European countries. What offset the promising number of increasing ECV registrations is that while countries with higher GDP/Capita are increasing registrations, nations with 30000 euros or less GDP/Capita all have less than 1% ECV market share. (ACEA, 2020)

Figure 5 MS of APVs by country in 2019

MARKET SHARE OF ALTERNATIVELY-POWERED CARS, BY COUNTRY

	AT	BE	BG	CZ	DK	EE	FI	FR	DE	GR	HU	IE
ECVs	3.5%	3.2%	0.6%	0.5%	4.2%	0.3%	6.9%	2.8%	3.0%	0.4%	1.9%	4.1%
HEVs	4.4%	3.2%	4.8%	3.1%	4.4%	8.1%	13.6%	4.8%	5.4%	5.8%	5.8%	8.7%
FCEVs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NGVs	0.1%	0.6%	1.1%	0.7%	0.0%	2.1%	1.9%	0.0%	0.2%	1.4%	0.0%	0.0%
OTHER	0.0%	0.0%	4.3%	0.2%	0.0%	0.0%	0.0%	0.4%	0.2%	0.6%	0.0%	0.0%

	IT	LV	LT	NL	PL	PT	RO	SK	SI	ES	SE	GB
ECVs	0.9%	0.5%	0.4%	15.0%	0.5%	5.7%	0.9%	0.4%	0.9%	1.4%	11.3%	3.1%
HEVs	5.7%	7.5%	7.3%	6.5%	7.0%	4.2%	4.6%	4.2%	2.8%	8.6%	8.5%	6.8%
FCEVs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NGVs	2.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.4%	1.5%	0.0%
OTHER	7.1%	0.6%	0.0%	0.1%	1.5%	0.9%	0.9%	0.2%	0.1%	1.6%	0.2%	0.0%

ECVs = ELECTRICALLY-CHARGEABLE VEHICLES
HEVs = HYBRID ELECTRIC VEHICLES
FCEVs = FUEL CELL ELECTRIC VEHICLES
NGVs = NATURAL GAS VEHICLES (CNG)
OTHER = OTHER ALTERNATIVELY-POWERED VEHICLES (LPG + E85)

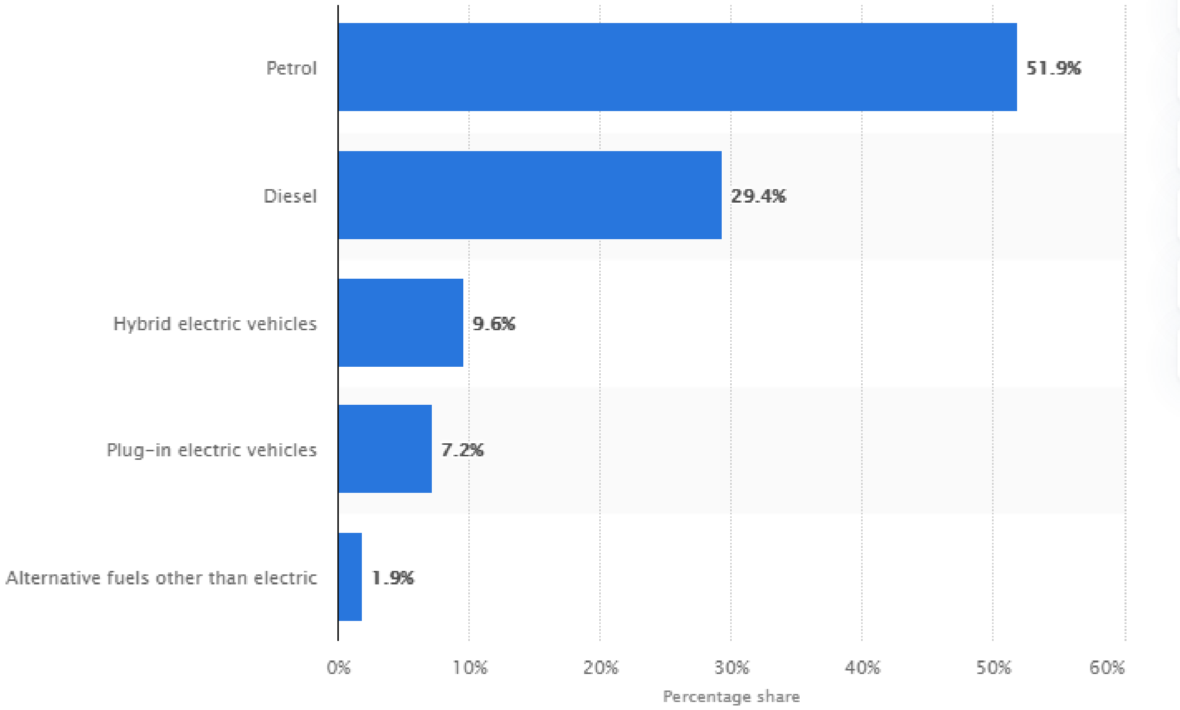
Source: ACEA

Unfortunately when purchasing a new car, customers are more concious about the purchase price than the overall cost of ownership thus making it difficult for OEMs to market their new models. However there are signs that this could change with battery prices going down on a yearly basis and manufacturers like Volkswagen introducing models like the ID.3, compact small urban vehicles at similar price as their comperable ICE counterparts.

2.1.3.2 Demand

Closely related to the pricing is the fluctuating demand of European customers. According to data from Statista, the market is still dominated by ICE vehicles running on fossil fuels. The latest data for Q2 of 2020 the fuel type mix was as we can see on below graph. (Wagner, 2020) From this statistical data we can conclude that 81.3% of all passenger cars were heavy polluters. Additionally, based on this graph we can also assume that majority of the European cutomers still choose ICE vehicles. Not to mention that customers still tend to distance themselves from Diesel making it even thougher for carmakers to comply with the targets.

Figure 6 European powertrain-mix in2019



Source: Transport & Environment 2020

The rise of the SUV segment is also a significant player in this demand side challenge. In order to comply with the regulatory targets OEMs need to drive customers towards APVs and still meet their demand. A possible solution for that could be the electrification of SUVs or the downsizing of them. The difficulty in the fuel type sales mix trends is that as T&E projected OEMs need to reach a total sales volume from their EVs between 5% and 7% to comply with the regulations, but as long as majority of customers turn to petrol as an alternative to diesel this forecasted value will increase therefore widening the gap between the actual and target emission values of carmakers. (T&E, 2019)

2.1.3.3 Ride sharing and autonomous driving

Although we could argue that autonomous driving and ride sharing is not directly a challenge from the new emission regulations it is worth mentioning as an outlook to the industry's future for the upcoming decades. As customers get more enviromentally concious their perception of mobility changes from the conventional that the industry was following for nearly 100 years. The concept of ownership is evolving, customers especially in urban areas tend to enjoy the benefits of ride sharing (ride hailing)apps such as Lyft and Uber. The emergence of mobility as a service is backed up by the younger urban living generations who do not necessary share the "original" idea of ownership. The tendency is shifting from pay and use to pay per use. In urban areas where space is limited and traffic is unpredictable not to mention the cost of ownership, many are in favor of ride sharing. The other mentioned in the title of the paragraph is autonomous driving. This has huge potential in terms of the future of the industry especially from mobility as a service point of view. Industry heads and policy makers have several different roles envisioned for autonomous driving. Among these are taxis and shuttle buses and even private vehicles. The goal is not necessarily that an owner could get from A to B while sleeping on the back seat, but to include these innovative vehicles into the urban traffic making it more seamless. (Hannon, et al., 2019)

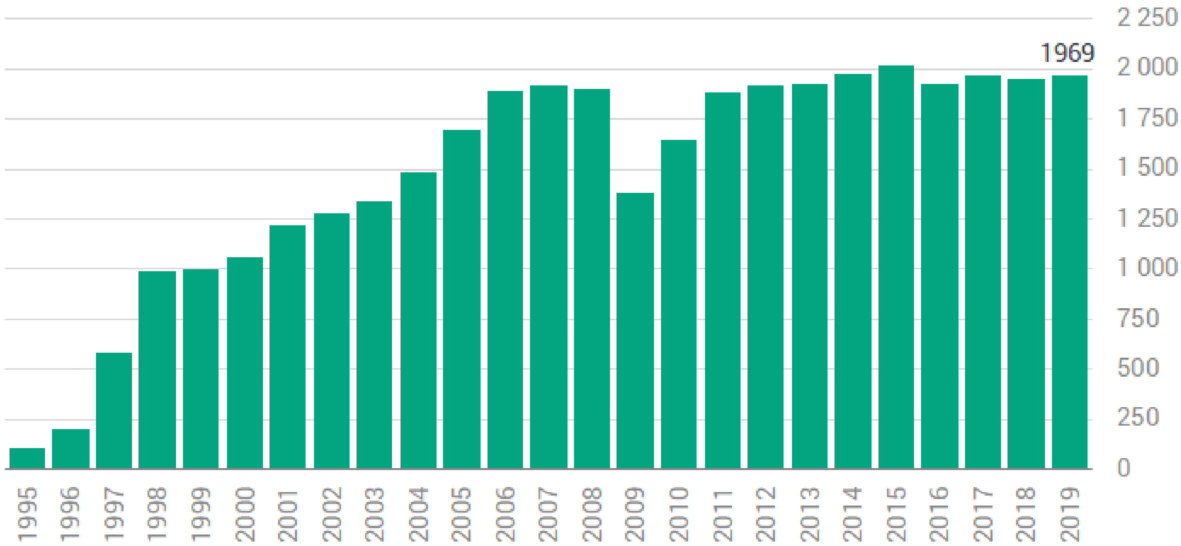
2.2 Audi Hungaria's take on the challenges

As discussed in earlier paragraphs, the industry is facing major challenges following the adaptation of the emission regulations. In this section I will examine the operations of Audi Hungaria and will analyse their potential strength and weaknesses when it comes to these challenges, their approach and strategy for compliance. I'm going to follow the same framework I followed in the introduction of the challenges. The reason for the focus on Audi, is that its Győr plant is clearly a market leader in Hungary in terms of production volume, turnover, and number of employees. Additionally, being part of the VW Group, the largest manufacturing group of the world lets us approach the problems and solutions at scale.

2.2.1 Background

The Hungarian plant of Audi was set up 1993 in the city of Győr in the north-western part of the country close to the Austrian and Slovakian borders. They took over the premises of the late Rába Magyar Vagon- és Gépgyár, a previously state owned industry plant. The plant initially produced internal combustion engines for the first 5 years. As the production plant grew gradually in size, and increased its importance as a supplier to the "parent" company Audi AG, production was extended to the assembly of passenger cars namely the Audi TT Coupe in 1998. This was followed with the assembly and production of new models both on the engine and vehicle side. In 2010, the company purchased additional property to expand the plant. In 2013, the expanded production plant was opened further cementing the role of the plant for the upcoming decades. As of 2020, the Győr plant is not only an assembly plant, but a complete passenger car production plant and their engine production and development plant is among the biggest in the world in terms of units produced annually. Up to date, the plant produced over 37 million engines. The company employs nearly 13,000 people, therefore is one of the top employers of the region. In the last complete financial year 2019, Audi reported the total revenue of 8,561 billion euros, a 16% increase compared to the previous 7,377 billion of 2018. From a production standpoint the emphasis is on the manufacturing of engines which totalled at an impressive 1,968.742 units in 2019. This total number of units adds up from the production of 1,370.316 petrol, 508,059 diesel and 90,367 electric motors. Within this the share is the following: 1,415.409 units of three or four cylinder diesel or petrol engines, 14,927 units of five cylinder petrol, 267,105 V6 engines, 11,938 V8 or V10, 168,996 units of 6 cylinder diesel and 90,367 units of electro motors. (AUDI, 2020) Based on these numbers we can state that majority of the operations are focused on the manufacturing of conventional engines, accounting for 95.41% of total units. Although the electric motor share of 4.59% is optimistic and could be significant in the future depending on the direction the company takes. As we can see from the graph below, there was an upward trend in the years leading up to the financial crisis, and since this flattened out in the past few years.

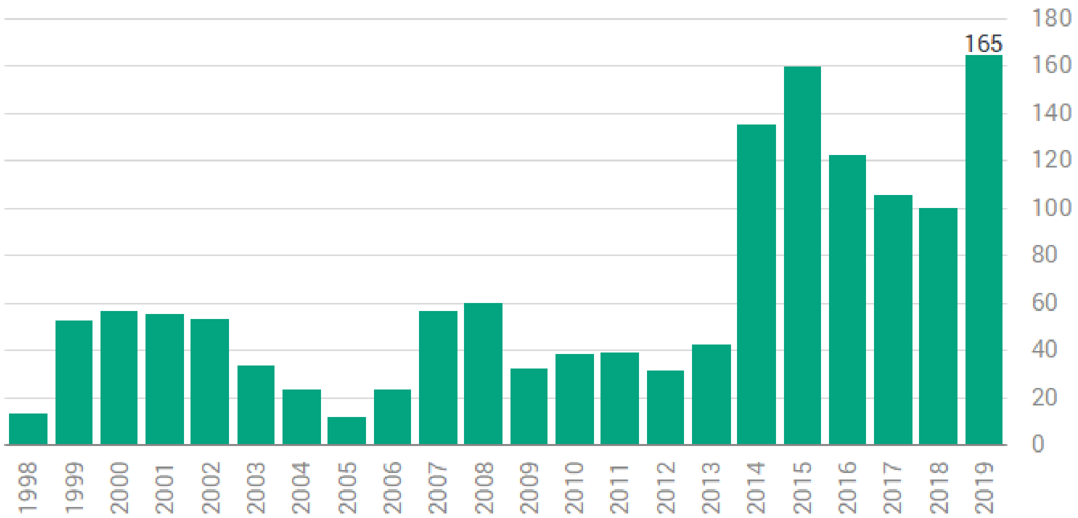
Figure 7 Total engine production in the Győr Audi plant



Source: Portolio.hu

Signalling that the plant is at a point where the production is almost maximized. But we need to note that this increase in production was also complemented by the capacity reduction in the western European plants of Audi. Complementary to the engine manufacturing is the production of passenger cars. For FY19, the plant produced 164,817 units. A significant increase to previous years.

Figure 8 Total vehicle production in the Győr Audi plant



Source: Portfolio.hu

The model portfolio was the following for 2019: 120,230 Audi Q3 units, 11,791 Audi TT Coupe and 3,208 Roadster from the A3 line 7,302 Cabriolet and 6,986 Limousine and 15,300 units of the last introduced model of the Audi Q3 Sportback. All the above mentioned units ran on internal combustion engines in the past, but in 2019 mild-hybrid versions of the Q3 and Q3 Sportback are in production. The just mentioned models belong to different segments within the passenger car category. Q3 to compact-SUV, TT to the sport coupé segment, A3 to subcompact executive car segment.

2.2.2 Industrial challenges (Audi)

2.2.2.1 Meeting the CO_2 targets

There is no specific individual emission target for Audi, the reason for that is that it is a member of the Volkswagen Group. Therefore we need to examine the whole group when analysing the compliance potential of Audi. According to the latest T&E study on the progress of EU OEMs reaching their emission targets, VW Group is behind their target by 5 gCO_2/km as of the first half of 2020, this margin puts them 4th from the bottom. (Mathieu & Poliscanova, 2020) We can assume this lag is due to the lack of previous APVs in the model portfolio. To close this gap VW started the production in November 2019 of their expected flagship pure electric car the ID.3 in Zwickau. The T&E report suggests that this mass-market BEV would bring down the overall CO_2 by 5 grams in 2020 and 11 by 2021. These are however forecasted numbers and do not guarantee compliance to the group at the end of 2020. What we can identify is that the group is heavily invested in the BEV technology as a future solution. Furthermore the Zwickau plant could be a future example for the Győr plant. A complete transition from conventional to electric across the whole plant. Thomas Ulbrich suggested that transformations such as the Zwickau plants will initiate a systematic change across the industry. (Volkswagen Germany,

2019) It is unclear whether this systematic change would involve all brands in the Volkswagen Group or just the brand Volkswagen. The operations in the Hungarian plant suggest that a complete transformation in the upcoming years is unlikely as the engine factory is supplying the entire VW Group with combustion engines. However the potential increase in electric motor and mild-hybrid production could contribute to the compliance of the entire group and solidify the plants current role for the future. Regarding the current models in production, meeting the targets could pose a challenge as all models are among the high polluting ones except for the units equipped with MHEV technology. We could argue that even those are far from compliant as they produce significantly higher emission values in real life conditions than during the laboratory test. However looking at the big picture, the Győr plant has potential to phase-in increased electric motor production to supply the increasing demand for its luxury models such as the all-electric e-tron. The real challenge is the phase-out of the internal combustion engine. However that likely won't happen in the next 10-15 years.

2.2.2.2 Flexibilities in the regulation

Phase-in period

As discussed in an earlier section, the phase-in period means that only 95% of total sales of 2020 will be counted in the final emission calculation. This allows manufacturers to exclude their highest emitting units up until 5%. Therefore the phase-in has a different direct effect on OEMs based on their average fleet weight and model portfolio. According to T&E's calculation, carmakers on average could benefit 3.4g CO_2/km from the phase-in period of 2020. (Mathieu & Poliscanova, 2020) For the VW Group they estimate a 4g/km benefit. This could help mitigate the emission values of sports cars such as the Audi TT.

Pooling

The VW Group, therefore Audi Hungaria is in an open pool with SAIC Motors of China. They joint forces late 2020. From SAIC's side SAIC Motors Europe and MG Motor from WV side the entire group is involved. It is unclear at this point whether there was any financial compensation on the sides for the pooling. Additionally, it is unclear who the beneficiary of this deal is, since VW is projected to meet its targets of 2020. The reason behind the joint forces could be more like an insurance on VW's side as MG sold 5700 BEV units this year, furthermore the two groups are working together in China developing MEB models. (Manthey, 2020) What is known for certain that as it stand the deal is for the period between 2020 and 2022.

Super-credits

The group is expected to reach the 7.5g cap of super-credits thanks to great sales volume of eligible units such as the Audi e-tron or the Volkswagen ID.3. If indeed they reach the cap they won't be able to use such credits again in 2021. T&E therefore expects a rising number of EV sales to balance out the loss of such credits after 2020.

Eco-innovations credits

As specified earlier these eco-innovations credits can be rewarded to OEMs for the development and implementation of technologies that reduce the emission of the vehicle but cannot be measured during the laboratory test. Research suggests that carmakers who benefit the most from these credits are such as BMW who sell their cars at a premium price, which allows them to include the cost of development. Audi was awarded eco credits for the implementation of an advanced LED light system.

2.2.2.3 Compliance strategy

According to the vision of Audi, the goal is the gradual shift to electrified models from conventional powered. They announced the introduction of 12 electrified models for 2020 out of which 5 are pure electric and 7 are plug-in hybrid. This number is to increase to 30 by 2030. The ultimate goal is to reach carbon neutrality by 2050. On a group level their aim is to be a market leader in sustainable mobility. According to the Audi sustainability report of 2019, the strategy in place is the following: by 2020 offer 7 PHEV models, by 2022 change 70% of new models sales from ICE to either MHEV or PHEV. Introduction of a Plug-in hybrid variant for each core segment by 2023 followed with the introduction of a battery-electric version in each core segment by 2025. (Audi, 2019) This strategy favours Audi Hungaria, as electric motor production is already in place combined with the production of MHEV equipped models. When looked at the whole WV Group, the outlook is even more promising as the MHEV technology can be incorporated into all existing ICE models with marginal extra cost. All which the Győr plant could delivery both on development and production side.

2.2.2.4 Infrastructure

From an EV charging standpoint, Audi is working together with partners such as IONITY to expand the electric vehicle charging infrastructure in Europe and in the US. Further to move this process forward they are implementing technologies that ensure the safe and easy use of chargers and plug-in solutions. Additionally the company is working towards carbon neutrality not only by working towards the reduction of tailpipe emission from their vehicles, but improving their plants and logistics infrastructure. In October, 2020 Audi revealed Europe's biggest rooftop solar plant. With the installation of over 36,400 solar panels covering a whopping 160,000 square meters on the plant's roof, Audi could supply itself with the power capacity of over 12 megawatts. (Portfolio, 2020)

Complementing its solar energy park, the plant has been using geothermal energy for heating for the past 8 years. We might argue that this investment project is not tightly connected to the emission regulations, but if we look ahead green plants are clearly a way for the future and could potentially put the Győr plant in a favourable place in the future.

2.2.3 Financial challenges (Audi)

2.2.3.1 Penalties

The Volkswagen Group therefore Audi is likely to avoid fines for exceeding the emission target in 2020. This is due to the open-pool formed with SAIC Motors and the popularity of models such as the Volkswagen ID.3 and the Audi e-tron.

2.2.3.2 Production cost

If the compliance strategy remains as communicated, the Győr plant is facing no significant extra cost from production. The implementation of the mild-hybrid technology is the cheapest way of electrification from both production and sales point of view. The technology is already in place at the plant with capacity to increase the volume. The production would however increase dramatically if the plant would shift to the production of BEVs, which is unlikely to happen in the next 5-10 years.

2.2.3.3 Research and development cost

From a research and development standpoint Audi Hungaria spent over 6 billion forints on the establishment of a new R&D centre. The mission is the development of new e-motors and improvement of internal combustion engines. This investment cost is partly paid by the Hungarian government. The R&D cost of BEV technology is less likely to directly impact Audi Hungaria.

2.2.3.4 Labour force and labour cost

Audi reportedly employs nearly 13,000 people. The plant is already widely equipped with autonomous technology. From assembly robots to material handling self-driven trolleys. Therefore a drastic layoff is not expected due the changes in production driven by the emission regulations. The company has history of nearly 25 years, and well established itself in the region with ongoing higher education partnerships and training centre for its employees. Labour cost however could be an issue in the upcoming years. In 2019, the employees of the plant went on a 156 hour long strike to force management to increase salaries. The strike was allegedly the biggest of its kind in Hungary since the change of the regime. (Stubnya, 2019) This upset regarding the wages might arise again in the near future if we consider the ongoing investments in the country or wages of industry workers in countries like Slovakia. The new operations will force the company to train employees to meet the new standards of production, but could potentially put them at risk if wages are not satisfactory for employees. We can assume that Audi will indeed take this question seriously as the last strike resulted in more loss in revenue than the total salary increase of the employees.

2.2.4 Commercial challenges (Audi)

2.2.4.1 Purchase price

The purchase price of the vehicles is a common challenge across industry players. As argued earlier, the new models that are in production equipped with the emission reduction technologies are more expensive than the conventional ones. The increased production and development cost reflects in the list price of these units, making it difficult for OEMs to market these new technologies to price sensitive consumers. However this price sensitivity is slightly more elastic when we examine high-end brands such as Audi. Historically their model portfolio consists of luxury vehicles that attract a different customer who are less sensitive to price changes. This is a potential opportunity for Audi to execute their sustainability strategy of replacing all ICE units for APVs by 2050. When it comes to pricing of vehicles it is worthy to note that from a profit standpoint those manufacturers who are offering high-end vehicles and focus on quality over volume were doing better operating profit wise than those who pushed high production with lower price. The reason for this argument is that as the industry is today, there is and there will be a price increase across OEMs to off-set the cost resulting from the adjustment of the powertrain-mix. If we create a scenario based on the operating profits reported in 2019, we could come to the conclusion that those who are more focused on quality than quantity are better off from an operating profit standpoint, therefore Audi could have an opportunity rather than a challenge from a pricing standpoint. According to an article on 2019 operating profits, Ferrari was a clear leader profiting 86,369 euros from 1 unit delivered. To put this into perspective Ford had to deliver 908 units to match this margin. (Munoz, 2020) The industry is forecasting a downward trend in the total of units sold for the upcoming years therefore the opportunity for generating profit from mass selling with low margins is not sustainable.

2.2.4.2 Demand

If we examine Audi Hungaria's real position from a demand standpoint we must break it down into two parts. Engine production and vehicle production. First, if we take a look at the trend of total engine production at the Győr plant, there is an upward trend in the past 3 years. If Audi follows the announced strategy there is no expected immediate decrease in demand for engines as all MHEVs and PHEVs are equipped with ICE engines. In addition, the plant already produced nearly 100,000 electric motors in 2019 allowing the plant to shift production volumes to avoid loss in demand. Alternatively the production capacity and the concept of "too big to fail" could secure its regional position in the Volkswagen group's future as a leading engine manufacturing plant. Secondly, from a vehicle production standpoint the outlook is slightly different. If the current production portfolio is unchanged it could pose a risk at the plant in the long run. Fortunately if we take the Audi Q3 as an example the company already has an alternative strategy in place. The past year there is a simultaneous production of the popular Q3 with different powertrains, firstly the conventional equipped with ICE engine only and an alternative model equipped with MHEV technology. This is beneficial on two fronts. The company is already producing an APV version of the unit with the highest production volume, the model that has the highest regional demand from the portfolio and is using technology that was produced on sight at the engine manufacturing unit. Looking at the big picture what is also promising is that there is an increasing demand for high-end electric models of Audi. The Audi e-tron is among the best selling vehicles on the Nordic market, and their engines are produced in Győr.

2.2.4.3 Ride sharing and autonomous driving

The concept of car ownership will change the mobility industry in the upcoming years. For OEMs, such as Audi it is important to develop solutions that satisfy the needs of the new generation of customers. Audi's take on this was the launch of the mobility service called "Audi on demand". The idea and the concept is to allow customers access to a wide range of different Audi models that fit their needs on demand. With a phone app users can choose between several different models depending on the region they are in, from pure electric sedans to ICE SUVs. The goal is to enable the customer to choose a specific vehicle based on their destination or activity. For example if a customer is planning on a ski trip to the mountains, the app allows him or her to book an SUV with a ski rack on top and a concierge will deliver the car to a location chosen by the customer. Audi on demand allows the user to access an Audi model from each and every segment without owning any. There is no initial subscription fee, the model is based on a pay as you go concept. Additionally, the app allows the consumer to customize the vehicle to a certain point based on their needs, this customization provides an edge over traditional rental services where the customer is forced to choose from a set line-up. The core concept of Audi on demand is the same as the Audi brand. Providing the customer with quality, design and luxury every time they sit behind the wheel of an Audi.

From an autonomous driving and mobility future standpoint Audi is committed to develop new technologies that could compliment already existing ones. The challenge is that not only there are several different levels of autonomous driving but their adaptation into all road circumstances. The technology that works on the well organised roads of Western Europe do not necessarily work in the hectic conditions of Asian megacities. Additionally, educating the customers is also a challenge. In 2019 Audi conducted a survey where 21,000 people were asked on the topic of autonomous driving. The results show that there is a clear interest and excitement towards this new technology, 82% showed strong interest and 62% were curious. The survey highlights that people saw the potential of the new technology in regards of easier access of mobility (76%), convenience (72%) and safety (59%). On the other hand many of them highlighted concerns, namely the fear of loss of control (70%) unavoidable residual risks (66%) and 41% was suspicious about the technology. (Peters, 2019) There are certainly benefits to autonomous driving especially in urban areas. The goal of Audi is to tackle the urban challenges via autonomous driving. Resulting in a more sustainable urban environment.

2.3 Automotive ecosystem in Hungary

2.3.1 Key figures and background of the Hungarian automotive industry

To understand the magnitude and overall significance of the automotive industry in the Hungarian economy we must look at some of the key figures first. After the change of the regime, and the increasing globalisation efforts, Hungary became an attractive choice for FDI in the Central Eastern European region. Thanks to relatively good infrastructure, cheap and skilled labour force and a range of privileges by the government, it managed to be among the first countries to benefit from the trend of moving low value-added steps of production into the transition countries. (Torlak, 2004) The industry came a long way from the ground-breaking 1990 establishment of the Opel plant in Szentgotthárd and shows a steady growth both in production and number of new developments in the past 30 years. It is often referred to as the "Detroit East" for its exceptional and continuous growth in importance to the regional and national economy. (Józsa, 2015) As of 2020, there are 4+1 OEMs (the construction of the Debrecen plant of BMW is delayed due to the COVID-19 pandemic) present in the country with individual manufacturing locations, and over 700 suppliers. Therefore the national industry is deeply connected into the global-value chain on multiple levels. According to the annual industry survey of HIPA, the Hungarian Investment Promotion Agency, the automotive segment employs over 172,500 people, which accounts for 3.9% of the total employment. (HIPA, 2019) This number is most likely to increase with a number of new development and expansion projects announced which I will expand on in a later section. It is safe to say that large number of people depend on the industry's success directly or indirectly. From a production standpoint, the emphasis is on parts, engines and passenger cars and buses. Based on the last data of the Hungarian Central Statistical Office, close to 3 million engines and half a million passenger cars were produced in 2019. Over 90% of these products were exported to our major trading partners with Germany being the number one export destination. It is important to highlight that the automotive industry accounts for nearly 30% of the manufacturing output and therefore close to 20% of the total exports. (KSH, 2019) The reason for such high export volumes is the fact that as a standalone market Hungary is not as profitable as the major European markets such as Germany, France or the UK. Combined elements of relatively small size, lower GDP than the major markets, and lower levels of disposable income force the manufacturers to export rather than sell locally. In view of the levels of export we can reason that the growth and direction of the local industry is interconnected with the growth and overall market performance of the "mother companies" and the economy of destination countries.

2.3.2 Hungary vs. Slovakia and Romania

To get the best picture possible on the state of the Hungarian automotive industry, we must observe the industry performance of neighbouring countries especially the ones like Romania and Slovakia who had similar background being members of COMECON. The progress comparison is the most truthful when compared to these ex-COMECON members since their overall economic and political background was similar leading up to the privatisation. According to the annual report of ACEA, the automotive industry has a key role in both the Slovakian and Romanian manufacturing industry with a 15.8% employment share in the total manufacturing sector. That translates to a direct employment of 81,000 in Slovakia and 191,000 in Romania. (ACEA, 2020) The direct employment levels are slightly higher in both these countries than Hungary (12.9%), however they are all above the EU average of 8.5%. Even though the employment rates are roughly the same there is a difference when it comes to number of units produced. Slovakia is far ahead of Hungary and Romania. Over 1 million passenger cars were manufactured in 2019 alone while the other two had roughly 500,000 units each. This production volume puts Slovakia on the top of the leader boards for number of cars produced per 1,000 inhabitants. All 3 nations primarily focus on the production of passenger cars, it is worthy to note that Romania is also producing a number of different commercial vehicles such as busses and trucks. Another common characteristic is that the production is dominated by multinational OEMS. In Romania there are two, Ford and Dacia. We could argue that Dacia is not multinational but since it is no longer state owned, but owned by Renault it should be looked at as an international OEM. As discussed in an earlier section in Hungary there are currently 4 OEMs in operation and 1 in the middle of the construction of its plant, these are Audi, Mercedes, Opel, Suzuki and BMW. In Slovakia there are 4 major players and these are Volkswagen, KIA, PSA and Jaguar Land Rover. There are several different factors why OEMs invest into these countries. Historically labour cost was among the top motives, but we could argue that this is changing or at least does not apply on the same level as before. For example in the case of Slovakia where the currency is euro, labour is not necessarily as cheap as in Romania but the common currency with Western European players mean a reduction in currency exchange risk. Still there are more OEMs present and more investment announced for the upcoming years than in Romania. A major contributor to this is the Slovakian investment promotion policy that welcomes FDI with open arms and facilitates cooperation in the long-run. Another contributing factor is geographical location. The close proximity to destination markets such as Germany and France is a key factor as products need to be produced close to the market they are sold to keep profitability as high as possible. Additionally their EU membership can be looked at as an insurance policy for investors, both from financial and legislative point of view. Similarity among these countries are their export centric production. This trade represents a significant share in their national economies therefore making them vulnerable to changes at the destination markets.

2.3.3 Suppliers

Apart from the OEMs present in Hungary, it is worthy to investigate some of the key players in the background that play a vital role in the operations of the Hungarian automotive industry. First of all, the wide network of suppliers. We differentiate three tiers when it comes to suppliers. First, the Tier1 supplier, these companies employ over 300 people and are independent entities with close bond to the different OEMs, manufacturing and supplying a wide range of components from wiring to chairs or braking systems. On the next level we find Tier2 suppliers, these companies employ between 20 and 300 people, they are tightly connected to Tier1 suppliers, supplying them with components and materials. On the bottom tier we find Tier3s, they are practically small enterprises with less than 30 people, still independent entities with obligations to the entire chain. There are over 700 suppliers in the Hungarian automotive segment, both foreign and local owned. (HIPA, 2019) Some of the global market leading suppliers have a Hungarian subsidiary, for example Valeo, Robert Bosch, ThyssenKrupp, and Michelin. From top to bottom tier, the operational change is inevitable for many of the suppliers due to the changes forced on the OEMs. The magnitude of this change however depends on their field of operations. For simplicity, we can divide suppliers into three categories to project the effect of change. (Ádám, 2018) First, suppliers who are producing components directly connected to ICE engines, for example exhaust pipes, gearboxes. Second, those who are producing and developing products and components related to APVs, for example electric motors or batteries. And third, we can identify those who are so to say in the middle of this. Suppliers involved in the production of products that are independent from the powertrain of the vehicle. For example mirrors, windows or seats. These three groups are impacted on different levels. Group 1 who are heavily focused on ICE, are going to be negatively impacted in the short to mid-term due to the breakthrough of APVs. The second group who are involved in EV technology, are going to have an immediate positive effect from the changes of mobility. The last group, the powertrain neutral supplier, the effect of change is expected in the long-run and projected to be in relation with global vehicle demand rather than the powertrain.

2.3.4 Ongoing developments

To complement the analysis of the ecosystem we must touch upon the ongoing or announced developments in relation to the automotive industry. Both from OEM and supplier perspective. First of all as mentioned in an earlier section as the “+1 OEM” the BMW plant in Debrecen. The construction of the plant was delayed due to the COVID19 pandemic. However according to the latest announcements on the progress, the investors are still committed to the plant despite the unforeseen delays. (MTI-Hungary, 2020) The plant is expected to have an annual production capacity of over 150,000 units and would employ around 1,000 people. The future production portfolio is still unknown but BMW is expected to produce electric vehicles in the Debrecen plant. This plant has a huge potential for the future of the Hungarian automotive industry. Not only from the employment created but from an investment point of view. Prestigious carmakers such as BMW could attract not only new suppliers to the region but new OEMs too. The initial 1 billion euros invested by BMW was back with an additional 34.7 million from the Hungarian government.

2.3.5 Battery manufacturing

The key to a widespread electrification is the battery. Asian companies have been market leaders in this segment for the past decade and expected to remain in this position in the foreseeable future. These Asian companies started expending on the European market due to the expected market opportunity derived from the growth in electric car production and sales. As the demand for electrified vehicles grows so does the demand for batteries. OEMs are continuously rolling out new EVs and improving already existing technology to meet both the emission targets and customer demand. Battery manufacturing companies are investing in European countries such as Slovakia and Hungary for the same reason as western European OEMs did 15-20 years ago, labour cost and the proximity to the destination market. This trend is an opportunity to the Hungarian automotive industry, creating new jobs and strengthening the regional role of the country in the segment of the industry. Currently there are 3 major battery manufacturing companies in Hungary. The South Korean SK Innovation in Komárom and Samsung SDI in Göd and the Japanese YS Yuasa in Miskolc. SK Innovation and Samsung SDI has just recently announced a further expansion to their respective plants. Both investments are massive in size and future output potential. Also they are different from the Japanese company as these two are not only assembly plants. From a sheer size point of view these two plants are often referred to as “Gigafactories”. (Kiss, 2020) Considering the potential of these plants Hungary could become a major regional player in battery production. All these investments are backed by the Hungarian government as part of their policy measures to solidify the future of the industry in the national economy.

2.3.6 Government policies and subsidies

As stated earlier, to reach the ambitious goal of the latest EU emission regulations OEMs and European governments have to cooperate. The goal is allowing customers to change from ICE vehicles to APVs. The task is complex, therefore the cooperation is necessary. On the one hand, the carmakers need to produce these APVs while maintaining their profitability, and on the other hand the customers need to purchase these vehicles in order to be carbon neutral by 2050. But as stated, the costs are significant on both end. This is where government policies come into the picture. OEMs need government support in order to reduce the price gap between ICE and APV. Governments across Europe use several different policies to facilitate this shift. In the form of purchase incentives, tax breaks, or other benefits such as free access to parking or certain urban areas (see Appendix 1). These incentives drive people towards the purchase of APVs. Apart from the economic incentives there are other areas where the government support is necessary. For example the charging infrastructure to facilitate the wide use of electric vehicles, a nationwide public infrastructure is necessary. This could come in several different forms. Direct investment into the infrastructure, therefore the deployment of charging station that are available for the public, or the re-structuring of policies such as building codes that would require new building projects such as apartment complexes or office buildings to include electric charging stations. Governments and OEMS must provide a solid charging infrastructure in order to relieve the range anxiety and increase public acceptance towards EVs.

Hungary was among the first European countries to introduce a dedicated electro mobility policy, the government policy in place is called the "Jedlik Ányos terv". Following the framework of the "Jedlik Ányos terv" (JAK) the government invested 4 million euros into the development of charging infrastructure in 2016 and 6.5 million into direct price subsidies for the purchase of pure electric cars followed with an extra 9.7 million investment in 2017. The price subsidy is the following for the purchase of a new pure electric vehicle in 2020:

1. Purchase price between 1-11 million forints: 50% of the purchase price of the vehicle, capped at 2.5 million forints
2. Purchase price between 11-15 million forints: 500,000 forints
3. Purchase price above 15 million forints: No subsidy

There is an additional purchase subsidy for taxi companies. The purchase price is capped at 15 million forints and the subsidy is capped at 8.25 million forints. From the price range/subsidy combination we can clearly see the angle where the Hungarian government approaches the electrification. Their goal is to drive people towards the purchase of smaller urban pure electric vehicles. In addition to the purchase subsidies there are other incentives in the policy. Those who purchase new pure electric vehicles are exempt from registration tax, ownership tax and if they are used as company cars they are exempt from company car tax too.

2.4 Expert insight – interviews

Limiting the number of fixed questions allowed my interviewees to give detailed and complex answers to my questions, an created a more comprehensive discussion around topics where it was necessary. To provide the results and findings from the interviews I chose to categorize them following the research questions formulated at the beginning.

<u>Can this segment keep its leading role in the Hungarian economy?</u>

According to my findings, the Hungarian automotive industry is at a point where the changes resulting from the emission regulations could be either positive or negative based on the strategy the OEMs take. Generally suggested was that if the current model was followed in the long term that would have negative consequences. For the past 20 years the Hungarian automotive industry was on a positive growth path due to the expansion of the global market. The focus was on the increase of production volume both on engine and vehicle manufacturing side. Low value added steps of production can be identified for most players apart from the few exceptions such as the engine development centre of Audi. According to industry projections 2019 could have been the tipping point of total number of units sold worldwide with nearly 100 million vehicles. Even though the global population is increasing and expected to reach 9.7 billion by 2050 the car market is not expected to follow this pattern. (UN, 2019) Due to the changing approach towards car ownership and other demand factors we can state that simply increasing production is not sustainable for the profitability of the automotive industry. This decrease in demand would negatively affect Hungary in the long-run. Not to mention the fact that CEE countries such as Hungary are no longer the most cost effective from a labour cost point of view. North African and South Asian countries reached a point in their development where they could facilitate similar production volumes at significantly lower cost. Therefore the suggested solution for Hungary would be to increase the value added in the production. Additionally, it is advised to start a specialization in a segment related to the new era of mobility to remain attractive for investment. Following the example of France and Germany who are heavily focused on the research and development of electric vehicles, or the UK where they are banking on the future of autonomous driving. The reliance on production only would drive Hungary to lose competitiveness. It is necessary to follow a path that leads to an increased efficiency. Considering the ongoing developments in the battery manufacturing field Hungary could potentially shift towards this area from vehicle and engine production. However what is important to get integrated in the research and development so it can keep up with the changes in the long run. My interviewees suggested that Hungary's strength in the region is its history with the western OEMs. For the past 20 years Hungary delivered high quality and quantity with a timely manner and has a stable and auto industry supporting government. The prestige from the production of high quality luxury cars such as Audi and Mercedes combined with a supporting and auto industry oriented government makes the country an attractive destination for investors. Although not confirmed but these factors could be the reason why Asian manufacturers choose Hungary as their European location. We can conclude that the automotive industry can remain a strong player in the Hungarian economy, as long as they rely competitive regionally and are forward thinking and increase efficiency.

What is the strategy of the OEMs in Hungary to meet the emission standards?

As discussed in an earlier section, we cannot talk about the strategy of the Hungarian OEMs individually as they are directly affected by the direction their respective "mother" company is taking. What is generally true to all of them is the electrification of their model portfolio. They approach electrification from different ways depending on their background, size and market position. First, hybridization is the path most of the OEMs choose to take. The common reason for this is the cost of the technology compared to a BEV. Hybrids have the advantage of being cheaper to implement and that they still use an ICE engine. Therefore allowing carmakers to re-package their already existing models from polluting to enviromentally friendly. Hybrids offer an immediate solution to OEMs in terms of emission reduction. Second, the BEV technology. When compared to hybrids the cost of production is higher however it allows the carmakers to further benefit from the flexibilities of the emission regulations. In addition to the immediate electrification of their fleet, many OEMs benefit from pooling.

How does the change in the powertrain mix affect the manufacturing in Hungary?

Based on my interviews I could further support my findings of the literature review. My sources suggested that the change in the powertrain mix will have no immediate negative effect on the Hungarian manufacturing. However my experts noted that the production volumes will gradually decrease over the next 5-10 years due to the change in global demand in the new vehicles segment. On the other hand, the industry wide electrification efforts could potentially create new opportunites in terms of models produced and technology produced in the Hungarian plants of the OEMs. This was highlighted in the case of Audi Hungaria where electric motor and MHEV Q3 are already in mass production. Additionally, with the presence of the battery manufacturing companies Hungary could be in a favourable position. Not only these plants create new employment but make the country attractive for investment in the electrification sector. As mentioned in the beginning of the paragraph the industry projects a decrease in overall new vehicle demand. One might make the argument that this decrease could be disastrous for the Hungarian industry however if we examine the OEMs and their strategy the outlook is not that dark. Out of the OEMs present in the country 3 (BMW, Mercedes, Audi) are in the luxury category. Manufacturers in this segment are better equipped to react to the industry wide changes and are impacted by the volume changes differently. In the latest strategy update Ola Källenius head of Mercedes highlighted that for the future they must focus on electrification and move away from the reliance on ever increasing sales volume in favour of higher operating profits. (Daimler, 2020) Additionally, this strategy report projects that the luxury sector will grow the fastest. This strategical approach is followed by the majority of the luxury brands therefore the ones in Hungary.

<u>What are the challenges the Hungarian OEMs face in order to meet the goals set in the regulations?</u>

In my interview with Felipe Munoz he argued that the biggest challenge of the OEMs present in Hungary are derived from the challenges of electrification. The key challenge is to make EVs a popular option for the consumers and at the same time accelerate the gap closing between the price of a new EV and a new ICE vehicle. Additionally, the lead time is an extra challenging factor. For example for the largest carmaker of the world Volkswagen it took over a year to roll out their mass-market EV the ID.3. From a regulatory standpoint the emission targets are definetly a major challenge but as introduced in an earlier section these targets are not introduced for every single stakeholder but are calculated on fleet-level. Therefore it is hard to quantify the level on which the new emission targets are affecting the Hungarian OEMS. However we can conclude that as of now the challenge is to facilitate the shift from ICE to APV both on the Research & Development and production side. The task is to roll out new low emitting vehicles and technologies that help the brands close the gap between their real emission values and their target values.

3 Conclusion and recommendations

3.1 Conclusion

During the research of my thesis I gained a better undestanding and in depth knowledge of new European emission regulations and its direct and indirect effects on the Hungarian automotive industry. My goal was to identify the key points set in Regulation (EU) 2019/631 and use them as pillars to map out the possible challenges this could pose to the automotive industry in Hungary. Following this mind map I divided these challenges into 3 categories. In the first section I focused on the procedural introduction of the rules and regulations following the outline of financial, industrial and commercial challenges. Once these points were discussed and the key points introduced and identified I used them as a tool to analyse the Hungarian automotive industry through the analysis of the market leading Hungarian OEM Audi Hungaria. The reason for choosing Audi was to examine the challenges at scale while investigating all operations in connection with the industry. Research and development, engine and vehicle production can be analysed with the analysis of Audi. Based on the data evaluated and primary research I was able to identify and highlight the challenges the Hungarian automotive industry facing following the new emission regulations. I was able to answer my research questions that relate to the future of this key industry segment in the Hungarian economy. It is important to note that these answers are limited and are based on the findings of the thesis therefore not representative. The scale of recent foreign and government investment into the sector however supports my findings that the Hungarian automotive industry can remain a strong contributor to the national economy in the upcoming years. The exact way however is hard to define as the industry is surrounded by uncertainty and constant changes. What we can conclude is that in order to remain successful the automotive industry in Hungary needs to be flexible and keep up to date with the technological changes.

3.2 Recommendations

As previously argued this research had limitations on several levels. First being the relative early stage of the transformation process that involves the entire industry. Therefore more data is expected in the following years that would allow the researcher to get a better understanding of the market. While the second being the relative confidentiality of information regarding the OEMs and their internal strategy. The avoidance of conflicts of interest was a limiting factor. Further research is recommended in this field to determine the short-midterm effects of the changes and follow-up if any changes are made to the regulations as we get closer to the initial target year of 2050.

Appendices

Appendix 1 Tax benefits for electrically-chargeable vehicles by country 2020

Country	Acquisition	Ownership	Company car	Incentives
Austria	Yes	Yes	Yes	Yes
Belgium	Yes	Yes	Yes	No
Bulgaria	No	Yes	No	No
Croatia	Yes	Yes	No	Yes
Cyprus	Yes	Yes	No	No
Czech Republic	Yes	Yes	No	Yes
Denmark	Yes	Yes	Yes	No
Estonia	No	No	No	Yes
Finland	Yes	Yes	No	Yes
France	Yes	No	Yes	Yes
Germany	Yes	Yes	Yes	Yes
Greece	Yes	Yes	Yes	Yes
Hungary	Yes	Yes	Yes	Yes
Ireland	Yes	Yes	Yes	Yes
Italy	No	Yes	No	Yes
Latvia	Yes	Yes	Yes	No
Lithuania	No	No	No	No
Luxembourg	No	Yes	Yes	Yes
Malta	Yes	Yes	No	No
Netherlands	Yes	Yes	Yes	Yes
Poland	Yes	No	No	Yes
Portugal	Yes	Yes	Yes	Yes
Romania	No	Yes	No	Yes
Slovakia	Yes	Yes	No	Yes
Slovenia	Yes	No	No	Yes
Spain	Yes	Yes	No	Yes
Sweden	No	Yes	Yes	Yes

Source: ACEA Tax Guide (2020)

Appendix 2 Charging points across the EU by type in 2019

Country	Normal *(<22kW)*	Fast *(>22kW)*
Austria	3742	701
Belgium	6070	481
Bulgaria	70	65
Croatia	479	150
Cyprus	38	0
Czech Republic	410	398
Denmark	2244	573
Estonia	202	189
Finland	1786	359
France	27661	2706
Germany	34203	6314
Greece	40	21
Hungary	592	143
Ireland	818	258
Italy	8312	1058
Latvia	83	223
Lithuania	79	123
Luxembourg	900	13
Malta	102	0
Netherlands	49520	1304
Poland	509	375
Portugal	1471	320
Romania	211	133
Slovakia	350	299
Slovenia	452	176
Spain	4500	1269
Sweden	4036	4756

Source: European Alternative Fuels Observatory (2019)

List of references

ACEA, 2019. *European Automobile Manufacturers Association.* [Online]
Available at: https://www.acea.be/uploads/news_documents/EU-China_automobile_trade-facts_figures.pdf
[Accessed 7 October 2020].

ACEA, 2020. *European Automobile Manufacturers Association.* [Online]
Available at: https://www.acea.be/news/article/interactive-map-affordability-of-electric-cars-correlation-between-market-u
[Accessed 17 October 2020].

ACEA, 2020. *The Automotive Industry Pocket Guide 2020-2021,* Brussels: ACEA.

Ádám, K. É., 2018. A magyar autóipar az elektromos autó tükrében.. *Prosperitas,* V.(ISSN 2064-759X), pp. 7-20.

Atiyeh, C., 2019. *Car and Driver.* [Online]
Available at: https://www.caranddriver.com/news/a15339250/everything-you-need-to-know-about-the-vw-diesel-emissions-scandal/
[Accessed 1 October 2020].

Audi, 2019. *Audi.com.* [Online]
Available at: https://www.audi.com/en/company/sustainability.html
[Accessed 7 November 2020].

AUDI, 2020. *Audi Hungaria.* [Online]
Available at: https://audi.hu/hu/hirek/eves-jelentes/2019/reszletek/az-audi-hungaria-eredmenyes-uzleti-evet-zart
[Accessed 3 November 2020].

Baik, Y., Hensley, R., Hertzke, P. & Knupfer, S., 2019. *Making electric vehicles profitable,* Chicago: McKinsey Center for Future Mobility.

BDO, 2019. *BDO UK.* [Online]
Available at: https://www.bdo.co.uk/en-gb/news/2019/top-20-carmakers-r-d-spend-tops-70bn-in-a-year
[Accessed 15 October 2020].

Beresford, C., 2020. *Car and Driver.* [Online]
Available at: https://www.caranddriver.com/news/a32346670/other-automakers-paid-tesla-record-354-million/
[Accessed 1 October 2020].

Campbell, P. & McGee, P., 2019. *Financial Times.* [Online]
Available at: https://www.ft.com/content/74c04dc2-5b9c-11e9-9dde-7aedca0a081a
[Accessed 1 October 2020].

Cramer, A., 2017. *Automotive News Europe.* [Online]
Available at: https://europe.autonews.com/article/20170718/ANE/170719710/combustion-engine-

ban-would-put-600-000-german-jobs-at-risk-study-says
[Accessed 22 October 2020].

Daimler, 2020. *daimler.com.* [Online]
Available at: https://www.daimler.com/dokumente/investoren/praesentationen/daimler-ir-mercedes-benz-strategy-update-2020-presentation.pdf
[Accessed 15 November 2020].

EC, 2019. *European Comission.* [Online]
Available at: https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en
[Accessed 1 October 2020].

EC, 2020. *European Comission.* [Online]
Available at: https://ec.europa.eu/clima/policies/transport/vehicles/cars_en
[Accessed 1 October 2020].

European Automobile Manufacturers Association, 2020. *European Automobile Manufacturers Association.* [Online]
Available at: https://www.acea.be/publications/article/acea-pocket-guide
[Accessed 1 October 2020].

European Council, 2013. *European Council.* [Online]
Available at:
https://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/envir/139786.pdf
[Accessed 1 October 2020].

Hannon, E. et al., 2019. *AN INTEGRATED PERSPECTIVE ON THE FUTURE OF MOBILITY, PART 3: SETTING THE DIRECTION TOWARD SEAMLESS MOBILITY.* [Online]
Available at:
https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/the%20road%20to%20seamless%20urban%20mobility/an-integrated-perspective-on-the-future-of-mobility-part-3-vf.pdf
[Accessed 1 November 2020].

Hauke, E., Hensley, R., Knupfer, S. & Sahdev, S., 2018. *CHARGING AHEAD: ELECTRICVEHICLE INFRASTRUCTURE,* New York: McKinsey&Company.

Hawthorne, D., 2020. *JATO.* [Online]
Available at: https://www.jato.com/embracing-wltp-survive-or-thrive/
[Accessed 1 November 2020].

Hewitt, L., Munoz, F. & Eagar, L., 2018. *JATO.* [Online]
Available at: https://www.jato.com/wp-content/uploads/2018/08/JATO_WLTP-press-release-Aug-2018-FINAL-.docx
[Accessed 28 October 2020].

HIPA, 2019. *Automotive Industry Hungary 2019,* Budapest: HIPA – Hungarian Investment Promotion Agency.

Józsa, V., 2015. *Change in the mindset? - Empirical evidence on the role of multinational companies in the evolution process of SMEs.* Gödöllő, Szent István University Publishing House.

Kiss, S. Á., 2020. *Mérce.* [Online]
Available at: https://merce.hu/2020/05/16/autoipari-forradalom-zajlik-magyarorszagon-csak-epp-a-lenyeg-nem-valtozik/
[Accessed 28 October 2020].

KSH, 2019. *Magyarország számokban 2019,* Budapest: Központi Statisztikai Hivatal.

Manthey, N., 2020. *electrive.com.* [Online]
Available at: https://www.electrive.com/2020/09/20/co2-pooling-vw-merges-fleets-with-saic-and-ford/
[Accessed 11 November 2020].

Mathieu, L. & Poliscanova, J., 2020. *Mission (almost) accomplished,* Brussels: European Federation for Transport and Environment AISBL.

Miller, J., 2020. *Financial Times.* [Online]
Available at: https://www.ft.com/content/a7e58ce7-4fab-424a-b1fa-f833ce948cb7
[Accessed 20 October 2020].

MTI-Hungary, 2020. *Hungary Today.* [Online]
Available at: https://hungarytoday.hu/coronavirus-bmw-debrecen-move-forward-amendments/
[Accessed 17 November 2020].

Munoz, F., 2019. *JATO Dynamics.* [Online]
Available at: https://www.jato.com/electric-cars-cost-double-the-price-of-other-cars-on-the-market-today/
[Accessed 8 October 2020].

Munoz, F., 2020. *Fiat Group World.* [Online]
Available at: https://fiatgroupworld.com/2020/04/03/operating-profits-fell-by-11-in-2019-for-all-major-oems/
[Accessed 18 November 2020].

Munoz, F., 2020. *Rise in SUVs hold OEMs back from meeting CO2 targets.* [Online]
Available at: https://www.jato.com/rise-in-suvs-hold-oems-back-from-meeting-co2-targets/
[Accessed 9 October 2020].

Munoz, F., 2020. *The race for EV leadership: Lessons learned from China.* [Online]
Available at: https://www.jato.com/wp-content/uploads/2020/10/JATO-Dynamics-RACE-FOR-EV-LEADERSHIP-1.pdf
[Accessed 7 November 2020].

Palthe, M., 2019. *JATO.* [Online]
Available at: https://www.jato.com/jato-study-bev-average-range-decreases-under-wltp/
[Accessed 7 November 2020].

Parliament, E., 2019. *European Parliament.* [Online]
Available at: https://www.europarl.europa.eu/news/en/headlines/society/20190313STO31218/co2-emissions-from-cars-facts-and-figures-infographics
[Accessed 1 October 2020].

Peters, M.-B., 2019. *Audi MediaCenter.* [Online]
Available at: https://www.audi-mediacenter.com/en/press-releases/audi-publishes-user-typology-

and-emotional-landscape-of-autonomous-driving-12115/download
[Accessed 8 Novembe 2020].

Portfolio, 2020. *Portfolio.hu.* [Online]
Available at: https://www.portfolio.hu/uzlet/20201007/gyorben-adtak-at-europa-legnagyobb-teton-kialakitott-napelemparkjat-451894
[Accessed 15 October 2020].

Prez, M. d., 2019. *Fleet News.* [Online]
Available at: https://www.fleetnews.co.uk/news/manufacturer-news/2019/02/20/jeep-wrangler-prices-specifications-and-co2-emissions
[Accessed 1 October 2020].

Steinmueller, W. E., 2001. ICTs and the possibilities for leapfrogging by developing countries. *International LabourReview,* 140(2), p. 193–210.

Stubnya, B., 2019. *Index.hu.* [Online]
Available at:
https://index.hu/gazdasag/2019/02/02/audi_sztrajk_szakszervezet_partok_bertargyalas/
[Accessed 27 October 2020].

T&E, 2018. *Transport & Environment.* [Online]
Available at:
https://www.transportenvironment.org/sites/te/files/publications/2018_04_CO2_emissions_cars_The_facts_report_final_0_0.pdf
[Accessed 1 October 2020].

T&E, 2019. *Transport & Environment,* Brussels: European Federation for Transport and Environment AISBL.

Torlak, E., 2004. *Foreign Direct Investment, Technology Transfer and Productivity Growth: Empirical Evidence for Hungary, Poland, Romania, Bulgaria and the Czech Republic.* Hamburg: Hamburg Institute of International Economics.

Tsang, . F., Pedersen, J. S., Wooding, S. & Potoglou, D., 2012. *Bringing the electric vehicle to the mass market: a review of barriers, facilitators and policy interventions,* Santa Monica: RAND Europe's Direct Investment Programme.

Tschiesner, A., 2019. *https://www.acea.be/news/article/future-of-the-eu-auto-industry-summit-brings-together-thought-leaders-on-mo.* [Online]
Available at: https://www.acea.be/news/article/future-of-the-eu-auto-industry-summit-brings-together-thought-leaders-on-mo
[Accessed 1 October 2020].

UN, 2019. *United Nations.* [Online]
Available at: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html
[Accessed 1 November 2020].

VDA, 2017. *Verband der Automobilindustrie.* [Online]
Available at: https://www.vda.de/en/topics/environment-and-climate/Global-WLTP-roll-out-for-more-realistic-results-in-fuel-consumption/WLTP-How-are-plug-in-hybrids-and-electric-cars-

measured.html
[Accessed 3 November 2020].

Volkswagen Germany, 2019. *Volkswagen-Newsroom.* [Online]
Available at: https://www.volkswagen-newsroom.com/en/production-start-of-volkswagen-id3-6348
[Accessed 15 November 2020].

Volkswagen, 2017. *volkswagenag.com.* [Online]
Available at: https://www.volkswagenag.com/presence/konzern/group-fleet/dokumente/wltp/GFI_WTLP_Broschuere_EN_A_New_Standard_WEB.pdf
[Accessed 27 October 2020].

Wagner, I., 2020. *Statista.com.* [Online]
Available at: https://www.statista.com/statistics/1128792/passenger-car-registrations-in-europe-by-fuel-type/
[Accessed 16 October 2020].

Wells, P., Nieuwenhuis, P., Nash, H. & Frater, L., 2010. *Lowering the bar: options for,* Cardiff: s.n.

WLTPFACTS, 2017. *wltpfacts.* [Online]
Available at: https://www.wltpfacts.eu/from-nedc-to-wltp-change/
[Accessed 28 October 2020].

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I, the undersigned Daniel Lükő aware of my criminal responsibility, I declare that the facts and figures contained in my dissertation correspond to reality and that it describes the results of my own independent work.

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Budapest, 2020.December.07

Daniel Lükő s.k.
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