University of Economics, Prague

Master's Thesis

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University of Economics, Prague

Faculty of Business Administration

Master´s Field: International Management

Title of the Master´s Thesis:

An Analysis of the e-Mobility Development and Strategy of Conventional and Emerging Car Manufacturers in the Automotive Industry

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Declaration of Authenticity

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Prague, May 15, 2019 Signature

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Abstract:

The purpose of this thesis is to identify commonalities and differences in e-mobility development and strategies between conventional car manufacturers and emerging car manufacturers. The analysis is based on Porter's Five Forces, the Innovator's Dilemma, a total of 12 expert interviews from the industry, and additional research to support the analysis and interpretation of the findings. The findings show that conventional manufacturers have generally underestimated the disruptive nature of e-mobility and are forced to act quickly, especially with regard to battery technology. In addition, these companies choose different electrification strategies for their product portfolio. In general, there is currently a growing focus on the creation of a (digital) ecosystem outshining the importance of car production. This creates a new generation of automotive companies that are very similar to companies in the smartphone industry. Last but not least, emerging manufacturers are setting the trend for vertical integration in parts of the enterprise, especially in production and the supply chain, which impacts suppliers and conventional manufacturers.

Key words:

Automotive industry, e-Mobility, strategy, development, car manufacturer

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1. Introduction

For years, humanity has discussed air pollution, global warming and the destruction of our planet. These problems are often portrayed with traffic jams, releasing emissions into the air that we humans inhale. What one has to remember is to not only blame the drivers, but also an entire industry – the automotive industry. In this regard, this industry has not stained with fame in the recent years.

As a result, over time, the call for environmentally friendly cars has been getting louder among the general public. However, the car industry has not shown much interest in changing its profitable business models and offering a different product to the market, answering to these calls.

As so often in history, a group of engineers in Silicon Valley had the revolutionary, but not new, idea of installing laptop batteries in cars to enable all-electric propulsion. This made it possible to eliminate the need for a combustion engine that consumes liters of gas every day and pollutes our air. It was not only the birth of Tesla, but also the beginning of a sustainable transformation of an entire industry. A transformation forcing governments and major powerful automakers to change what had not been imaginable before.

As revolutionary as it may sound, driving an automobile with electricity is not new. It has existed since 1881, but only became an issue with the founding of Tesla. Electric cars were even more dominant in the first decade of the 20th century. Then, there were far more electric cars than petrol cars. In the US, for example, 40% of automobiles were powered by steam, 38% by electricity and only 2% by combustion engines (Kuther, 2017). The reasons for the later success of the internal combustion engine, are still the same as today, namely the favorable availability of gasoline, the greater range of gasoline cars and the heavy batteries of electric vehicles. A century later, we still face the same challenges, but with more advanced technologies and a need for change.

Tesla's example was followed by other entrepreneurs and companies, which led to the establishment and investment of new emerging manufacturers wanting to compete with the large conventional manufacturers with the disruptive character of an electric car. For this reason, the term electro mobility is also used in this context, which is the central topic of this thesis.

Now, the exciting question remains how the traditional manufacturers, compared to the new manufacturers, are changing the industry and whether this has further implications for the future.

2. Terminology

In order to carry out an analysis of the industry and various companies, it is of relevance to explain important terminology and establish rules for the further analysis.

First of all, it is important to define the automotive industry in order to understand which stakeholders are actively involved. According to the German Association of the Automotive Industry, the term "automotive industry" refers to manufacturers of motor vehicles and engines, trailers and superstructures as well as manufacturers (suppliers) of automotive parts and accessories (Wallentowitz, Freialdenhoven, & Olschewski, 2009).

Subsequently, it is also important to define the term electro mobility (e-mobility) more precisely. E-mobility includes all vehicles that are electrically powered or partially powered by electrical energy. In this case, the vehicle can be driven either in combination of a combustion engine and an electric motor or only with an electric motor (Yay, 2010).

To define this more precisely it is important to take a closer look at the different powertrain models as well as narrow them down for the further purpose of this thesis.

Primary	Secondary	Primacy varies across models	Defined as EV in this thesis	Propulsion		Energy generation/source		
Name	**Explanation**			ICE	E-Motor	ICE	Plug-In	Fuel Cell
ICE: Internal Combustion Engine	Driving with conventional combustion engine only			●		●		
HEV: Hybrid Electric Vehicle	Driving with combustion engine and/or e-motor			●	○	●		
PHEV: Plug-in Hybrid Electric Vehicle	Driving with combustion engine and/ or e-motor, plug-in to recharge battery			◍	◍	●	●	
REEV: Range Extended Electric Vehicle	Driving with e-motor only, ICE & plug-in (or fuel cell) used to recharge battery				●	●	●	
BEV: Battery Electric Vehicle	Driving with e-motor only and storing energy in battery				●		●	
FCEV: Fuel Cell Electric Vehicle	Driving with e-motor only and storing energy in hydrogen				●		○	●

Figure 1: Portfolio of Powertrain Models
Source: Author's Chart, according to (McKinsey & Company, 2014)

In this context, as Figure 1 shows, various powertrain models exist, which, depending on the type, either primarily use a combustion engine or electric motor as the main drive source. It is very important to define whether the combustion engine is primarily responsible for propulsion, as in the context of this work, only powertrain models are considered as an Electric Vehicle (EV), which use an electric motor as the primary source of propulsion. Thus, neither Internal Combustion Engine models (ICE), or Hybrid Electric Vehicle models (HEV) are considered EVs. In addition, a distinction

can also be made between a micro, mild and full HEV based on the battery size. However, in order to reduce complexity, this will not be further considered. Consequently, the following powertrain models are seen as EVs: Plug-in Hybrid Electric Vehicle (PHEV), Range Extended Electric Vehicle (REEV), Battery Electric Vehicle (BEV), and Fuel Cell Electric Vehicle (FCEV).
More specifically, a PHEV is a powertrain model equipped with both a combustion engine and an electric motor. A larger battery is used, which can be recharged via the power grid. The primary drive supplier is the electric motor. If required, a combustion engine in a REEV generates electricity for the electric motor by means of a generator. The range is thus significantly extended. In a FCEV, the electricity for the electric motor is generated directly on board. In the fuel cell, the chemical energy of hydrogen is converted into electrical energy. BEVs are exclusively equipped with an electric motor and receive energy from a battery in the vehicle, which in turn is charged via the power grid (VDA, 2018).
In addition, the term Zero Emissions Vehicle (ZEV) is often used in this context to refer to the types PHEV, FCEV and BEV, which are seen as the future of the automotive industry (Retzer, Huber, & Wagner, 2018).

Moreover, the concept of vertical integration becomes important in the following chapters, for which a more detailed definition is necessary. The production of goods and services takes place through the sequencing of individual value-added activities. When defining its own activities, a company determines which part of the entire value chain it wants to perform inhouse and which activities it wants to obtain on the market. By deciding on the "make or buy" of each individual activity, a company defines its own manufacturing or service depth and thus its vertical company boundaries. Every company tries to optimize this as much as possible, in order to reduce costs. As a result, it is important to achieve vertical integration that delivers the greatest profit (Wirtz, 2006).
In the case of an EV and in connection with the e-mobility strategy of different manufacturers, the decision of the two main components, battery and powertrains, are examined more closely.

Outside-In Perspective: Buy / Make	Battery			Powertrain		
	Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model: XY						

Figure 2: Powertrain and Supply Chain Strategy for EVs - Example

To be more precise, the battery cell, the battery pack and the Battery Management System (BMS) are all contained in the battery component. In the case of powertrains, these are power electronics, motor, and transmission.

3. Research Question

As described in the introduction, the automotive industry is undergoing an electrical transformation. Although the automotive market has shown signs of electrification of vehicles throughout history, the actual electrical transformation only picked up speed with the founding and market entry of Tesla as well as with sustainability trends. This development has brought governments, policy makers, customers as well as forced conventional manufacturers to rethink the mobility of tomorrow.

BEVs also provided an opportunity for new and emerging car manufacturers to enter the market. Emerging manufacturers bring in new expertise and approaches to the development of vehicles as well as other factors within the automotive ecosystem. This also brings us directly to the central research question of this thesis:

What are the differences in strategy and development regarding electric mobility (e-mobility) between conventional and emerging car manufacturers?

The research question posed above deals mainly with the e-Mobility strategy and development of manufacturers. The first is logically very closely linked to the general corporate strategy. Here we are looking for answers to questions such as which vehicle concept, cooperation with other stakeholders, location of new product launches, diversification of the product portfolio for different segments, number of units. The aspect of development is more concerned with topics such as platform design, battery know-how in the company, vertical integration of the value chain and charging infrastructure. In this context, factors such as corporate history and structure/culture, know-how, and innovative strength play also an enormously important role.
The aim is to look at both groups separately, namely the conventional and the emerging producers, in order to identify either similarities/differences within the groups or similarities/differences between the two groups.

4. Methodology

In order to answer the research question, several topics within as well as outside the industry must first be examined more closely. **First**, an industry analysis will be developed with the help of Porter's Five Forces Framework. The goal is to bring the complex automotive industry closer to the reader, as well as to get a basic understanding for the different stakeholders in the industry. Since we will also analyze new and emerging manufacturers, the entry barriers of the automotive industry are of high relevance in this chapter. The implication of this chapter will become important in the further course of this thesis, especially in the analysis of emerging manufacturers. More precisely, the strategic orientation, as well as the business model of each manufacturer, are analyzed in combination with the entry barriers.

However, in order to see whether the new manufacturers have a chance of successfully overcoming the entry barriers, the subject "Innovator's Dilemma" by Clayton M. Christensen is presented and investigated in the **second** step. This analyses whether e-mobility has a disruptive character, which could turn the industry upside down.

In the **third** step, the aim is to bring the reader closer to the topics surrounding e-mobility, from the root causes of this development and solutions to the industry's pollution problem, the government's role with regard to regulations to incentives and critical examination of its activities. In order not to go beyond the scope of this thesis, the focus here is on the three automobile hubs, namely North America, Europe and Asia. A fundamentally important part of this analysis in the third step are also topics such as customer behavior and acceptance towards e-mobility, charging infrastructure and battery technology.

In the **fourth** and penultimate step of this thesis, we move towards the core of this thesis, namely the analysis of different manufacturers. Depending on the group (conventional or emerging), the analysis was carried out on the basis of various steps. For conventional manufacturers, a fundamental part of the analysis has been to assess the overall strategic direction regarding e-Mobility through annual reports and strategy presentation. Furthermore, a self-created matrix (VTD - Vehicle Type vs. Launch Date) has been used to determine whether companies neglected early electrification in line with the "Innovator's Dilemma" concept.
The focus for emerging manufacturers has first been on the business model and corporate strategy, which have also been evaluated in combination with the entry barriers. Consequently, it was examined which part of the business model has been used to overcome which entry barrier. Following this, the e-Mobility strategy and development have been assessed with the help of a product rollout plan.

All manufacturers have also been examined in connection with the topic of vertical integration for at least one vehicle model, which is brought up in combination with the conclusion of this thesis. In addition, all companies were interviewed and analyzed with regard to their charging infrastructure.

The analyses are based on technical literature, academic papers, reports, articles from technical journals, online presence of the companies and, last but not least, interviews with employees of important stakeholders. The latter is the most important source of information for the analyses. As a result, a total of 12 interviews have been conducted from different areas within the industry.

Conventional Manufacturers		Emerging Manufacturers		Other Stakeholders	
Company	Interviewee's Position	Company	Interviewee's Position	Company	Interviewee's Position
Volkswagen AG	Spokesperson Product Line E-Mobility	**Tesla**	Program Manager - Charging Infrastructure	**Vulog**	CEO
Toyota Motor Corporation	Product Communication	**NIO**	Director Public Relations Europe	**McKinsey & Company**	Head of Future Mobility
Ford Motor Company	Head of Product Communication	**Byton**	Director Public Relations Europe	**Capgemini Consulting**	Manager Automotive Digital
Daimler AG	Communication Future Powertrain & e-Mobility	**BYD Europe**	Deputy Managing Director		
		Uniti	Art Director & Co-Founder		

Table 1: Overview of Interviews

In the course of 30 to 60 minute interviews, all interviewees were asked various questions, specifically tailored to the company in question. Unfortunately, many of the companies only agreed to an interview if it was anonymous, non-recorded and non-published. Therefore, some interview partners cannot be named, and the interview could not be transcribed. Therefore, only notes could be taken during the interviews. All in all, only NIO and Byton agreed on a publication of the interviews (see Annexes). In addition, due to the confidentiality of the information, not all questions were answered, primarily by the conventional manufacturers. Hence, no qualitative content analysis with deductive category formation could be carried out. Nevertheless, new valuable insights could be gained from the information in the interview, which were anonymously incorporated and of high value for the analysis. In addition, in both groups, as many interviews were conducted until the point where an additional interview would not have generated any new insights.

In the **last step**, on the basis of the previous analysis, all similarities and differences between the two groups were identified, in order to find answers to the research question.

5. Industry Analysis

The megatrends of the last decades, pushing us to become digital, faster, more connected and more sustainable, have changed both our lifestyles and the environment we live enormously. However, these are just a few of the attributes describing our global society in this decade, and either it is, for example, the still-advancing globalization or ecological awareness. Society, as we know it today, as well as dominant industries acting within it, must continuously evolve and adapt to upcoming changes and threats in order to exist and function properly.

One of these dominant industries is the automotive industry, which undoubtedly has played an instrumental role for decades and has proven to be able to develop alongside trends and adapt new technologies on a constant basis. Even if this sector has survived the various crises and reorientations of the 20th century, it is now faced with new risks and opportunities that could potentially turn the industry upside down and restructure it from scratch.

In order to understand the automotive industry better and get a better overview of the current situation, the Michael Porter's 5 Forces Model is used as a basis of the analysis. According to Porter, the following five forces has to be analyzed: Bargaining power of suppliers, Threat of new entrants, Bargaining power of buyers, Threat of substitute products and services, Bargaining power of buyers (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). Lastly, risks and threats potentially emerging during the 21st century will be investigated.

5.1 Industry Analysis according to Michael Porter's 5 Forces

To start with, it is crucial to understand the power dynamics within the industry, by analyzing which companies that are dominating the space and what roles the various competitors play on an international scale. Huge conglomerates, multinationals and manufactures are working together in this global sector and have thus pushed the industry to evolve dramatically over the last century. In addition, the industry has come to play an integral part within emerging economies and the field as a whole has also seen companies from other industries entering it and taking part of its evolution. Manufacturers who produce vehicles with third-party accessories and market the end product under their own brand are known as Original Equipment Manufacturers (OEMs) in the industry (Diehlmann & Häcker, 2010).
Before we begin the Porter's Five Forces analysis, it is important to gain a general understanding of the dynamics of the automotive industry and market. As can be seen in Table 2, the German Volkswagen Group sold the most passenger cars in 2018, followed by the Japanese Toyota Group and the French Renault Nissan Alliance. From a geographical perspective, it is noticeable that there are a few regions in the world where most OEMs are concentrated: Europe, the United States, Asia, in particular Japan and South Korea.

Rank	Company	Sales (in units)	Country of Origin
1	Volkswagen Group	10.810.349	Germany
2	Toyota Group	10.435.420	Japan
3	Renault Nissan Alliance	10.436.982	France
4	General Motors	8.643.003	USA
5	Hyundai-Kia	7.416.346	South Korea
6	Ford Group	5.632.734	USA
7	Honda Motor	5.234.818	Japan
8	Fiat Chrysler Automobiles	4.825.446	Italy
9	PSA	4.084.845	France
10	Suzuki	3.306.242	Japan

Table 2: World Ranking - Best Selling Vehicle Manufacturer with Country of Origin in 2018
Source: Author's Chart, According to (Global Auto Database, 2019)

From an American perspective General Motors and Ford Group are the biggest manufacturers in regard to their sales. Moreover, since its economic upturn, China plays also an important role and has not only developed into an enormously important production hub, but also into the largest sales market for cars.

5.1.1 Threat of Entry

After identifying the main players on the global automotive market, it is of high relevance to see how these are interlinked and how OEMs interact with each other. The goal is to understand the current level of competitive rivalry and in which direction it might evolve. Generally, the more competitors entering an industry, the less market share is available per player. In order to enter a new industry, potential competitors must overcome certain barriers to gain a foothold in the industry. According to Porter (1998), there are various sources of barriers to entry. In the following chapter, the barriers to entry in the automotive industry will be evaluated in order to obtain a substantial overview of the risk of new entrants grabbing market share (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

5.1.2 Barriers to Entry

The first barrier a new competitor has to take into consideration is **economies of scale.** The manufacturing process in the automotive industry is linked to high production costs, which can impossibly be held down by flexibility. For this reason, manufacturers must apply economies of scale to efficiently produce the final product. As increasing output figures do not decrease the costs proportionally, a longer production run is needed to decrease the per-unit-costs over time. This has to be done until the minimum efficient scale of production is reached (Husan, 1997).

Moreover, a range of different vehicles inside an OEM product-line share various components such as identical motor units or steering wheels. These parts are produced and might be integrated in two different vehicles at the same time. Furthermore, in the case, that the demand for a certain type declines the component still can be integrated in the other models, this reduces risk and costs. On the one hand, one central problem that new competitors are facing is establishing a functional production line, allowing proper usage of economies of scale. On the other hand, there is the risk of determining the wrong number of output and producing at large scale. but a lack of production will in any case lead to a cost disadvantage. (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

Another barrier is **product differentiation**, where Porter refers to brand identification and customer loyalty, which established players have already obtained because of earlier investments (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). The specific entry barrier might vary depending on the targeted market and region. For instance, customers in developed countries can be assumed to have different preferences and to be brand loyal as they are less price sensitive than buyers in emerging markets or in countries without a historical automotive background. Additionally, in a highly competitive market as the automotive market, new entrants must take the risk of investments for overcoming existing customer loyalties into consideration (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

This leads to the next entry barrier, being **capital requirements.** The issue here is not to obtain capital on the capital markets, but rather the risk of incorrect investing and spending (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). As aforementioned, car production nowadays is only able to function properly with an established production line and economies of scale. This procedure alone requires vast amounts of capital. Moreover, one must also take into account that investments into Research and Development, raw materials, workforce expansion and advertising/marketing are needed. On top of this, globalization continues to force OEMs to outsource production and/or to produce in more than one country to keep production costs low in the long run. In order to achieve these multinational production processes, high expenditures for manufacturing plants and logistics are necessary in the beginning. One approach to improve the return on capital due to cost pressure can be consolidation, which can lower the competitive pressure and combine two or more manufacturing footprints into one (Parkin, Wilk, Hirsh, & Singh, 2017).

Additionally, Porter highlights **switching costs** as another barrier of entry, which may apply to certain industries. From a producer point of view, switching costs are realized when the supplier is changed, and the manufacturer, thus, have to take new

one-time costs into consideration (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). These costs include the transaction-specific know-how and skills, as well as components, which cannot be standardized. This, especially when launching new models. It requires longstanding experience and know-how of the suppliers and the OEM's workforce (Monteverde & J. Teece, 1982).

Access to distribution channels is another barrier to entry, which in this specific industry can be regarded as a high entry barrier. Firstly, a new entrant must find a dealership willing to sell their products, or pursue the nowadays more common approach, which is establishing own dealership (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). Many automobile companies have their own dealerships or contracts with large distributors willing to sell only their own brands. For instance, a dealership that only sells BMW branded cars such as MINI, BMW and Rolls Royce. One of the risks related with this, is that many dealers are not willing to accept new companies as existing contracts limit it. In addition, these dealerships already have a profitable business, and are thus not willing to take the risk of reducing their inventory for a new brand. An alternative to this is distributing online, which is becoming increasingly favorable. This year, for instance, Tesla switched to exclusively pursue online sales in order to lower costs (Korosec, 2019).

As previously mentioned, cost advantages can surface when proper economies of scale are not implemented. Similar to this, **independent of scale** poses a further barrier to entry (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). This can be understood as an advantage for already established firms, which is difficult or nearly impossible to replicate for new entrants. In the automotive industry, this can for example be proprietary product technology, meaning patents or certain know-how that new entrants cannot possibly obtain.

In the German market, one important example for cost advantages are government subsidies or purchases. From 2007 to 2017 the car industry received more than 1,15 billion Euros of subsidies from the German government. Primarily, well-established German automotive brands such as Daimler or Volkswagen sold vehicles worth more than 650 million Euros to the German government since 2012 (Becker, 2017). These vast numbers are almost impossible for new entrants to obtain, and thus they enforce the market advantage for the established players. Other factors can be favorable access to raw materials, favorable access to locations or the learning curve. All of these factors are applicable to the automotive industry (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). Especially, the latter factor is one of the most significant for businesses, involving highly skilled labor, performing complicated tasks and complex assembly operations, such as automotive or aircraft production. (Porter, Competitive Strategy: Techniques for

Analyzing Industries and Competitors, 1998). Tesla is currently facing the problem of establishing a well-functioning production line, as the manufacturer is having heavy delivery issues and delays (Dudenhöffer, 2016).

Lastly, one barrier that might make it difficult to enter a specific industry is **government policy**. This is highly applicable to the automotive industry as governments can establish regulation for production factors such as air and water pollution, raw materials, labor hours etc., directly impacting the industry. Furthermore, governments are also able to establish regulation regarding the final product. An overarching example, differing depending on the country, is safety regulation and/or regulation the emission of vehicles (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

To summarize, by analyzing the existing barriers, one can get a better grasp of the difficulties of overcoming barriers to entry for new entrants in the industry. The automotive industry entails high capital requirements, proper planning and forecasting, as well as a pressure of making the right decisions in order to gain a foothold.
Based on this, one could ask – are the established players in the automotive industry almost immune to new entrants? This quote from Michael E. Porter in Harvard Business Review from 1979 can perhaps describe the situation in the automobile industry to the point:

"[…] in the auto industry economies of scale increased enormously with post-World War II automation and vertical integration – virtually stopping successful new entry (Porter, How Competitive Forces Shape Strategy, 1979)."

Today, 40 years after this quote, the question is whether Porter's quote still holds or if the industry has come to a turning point, allowing new competitors to enter the market?

5.1.3 Intensity of Rivalry Among Existing Competitors

According to Porter, rivalry among existing competitors occurs when one or more companies feel pressure or is seizing the opportunity to improve its positioning in the market. In most industries, an action of a company leads to reactions amongst its competitors, meaning that these market actors are mutually dependent (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). This can be understood as a very dynamic surrounding. Firstly, it is important to understand if the competition is numerous or equally balanced.

In other words, one can see strong market dynamics. To get better insights into how these market dynamics work, it is first important to understand whether the competition is equally balanced amongst its actors. Looking only at the large corporations, which bundle a different number of brands competing in the industry,

the number is rather small. Also, considering only OEMs, with a production output of over three million unit during 2016, it sums up to ten large manufacturers (OICA, 2017).
Additionally, the growth in the automobile industry is rather slow, which forces market actors to keep competition intense to capture market share from each other. This is an indication of the high intensity of rivalry inside the industry (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). According to Porter (1998), another indicator can be obtained by observing the fixed or storage costs. Cars are bulky and large in size and weight, meaning that storing cars requires large storage spaces, which ultimately drives up the storage prices. However, nowadays the dealerships are responsible for storing cars before the sale. This means that producers are only responsible for their own stock of final goods and raw materials (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). Nevertheless, storing costs within the automotive industry are higher than in other industries, where final products are easier to store or produced in bulk. This extends to the fixed costs in the industry. Although output figures are very high, it is extremely difficult to reduce fixed costs or allocating them to the produced units. Rents for the massive facilities, including the production lines or office spaces, electricity, insurance or salaries are also reasons for high competitiveness in the industry (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).
On the other hand, the almost non-existing lack of differentiation might be a reason for a lower intensity of rivalry as every car is different from its competitors' cars. Nowadays, cars are almost a personalized good, owing to the endless customization possibilities. Due to these possibilities, producers do not have to fear price fights, as opposed to within industries producing and selling goods that are considered commodities (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).
In an extensively global industry such as the automotive industry, one can expect diverse competition. Companies within this industry not only have different origins, but also non-aligning strategies, relationships and visions. This is not only valid for competing producers, but also for brands inside portfolios or under the aegis of a specific mother company. Foreign competitors can add a certain diversity to industries, but the volatility of rivalry is clearly incremented (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).
One important factor impacting rivalry is **exit barriers.** As claimed by Porter (1998), if the exit barriers are high, the excess capacity stays within the industry and companies performing poorly do not give up. Instead, these companies continue to push performance and due to their weaknesses, they might even take on aggressive strategies (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). This can force the overall profitability of the industry to diminish. Moreover, barriers can exist as a result of specialized assets that are difficult to liquidate or because of fixed costs limiting exit opportunities, such as

labor agreements. In particular, two barriers affect the automotive industry; emotional barriers and government and/or social restrictions. Here, the emotional barriers refer to the long-lasting history of automotive production. Regarding government and/or social restrictions, this is clearly illustrated in Europe, where big car manufactures, such as VW, are responsible for the high number of jobs in the region, and thus giving a direct regional economic effect. To illustrate this further, one can evaluate Ford during 2014, when the company shut down a production site in Belgium, costing 11.800 jobs in the greater region, including local suppliers and logistics (Bartunek, Blenkinsop, & Potter, 2014). On top of this, the company was charged $750 million in financial settlement costs for the blue-collar workers (Ewing, 2013).

Competing firms in the automotive industry face both high entry and exit barriers. What does it mean for the industry when both of these are simultaneously applied?

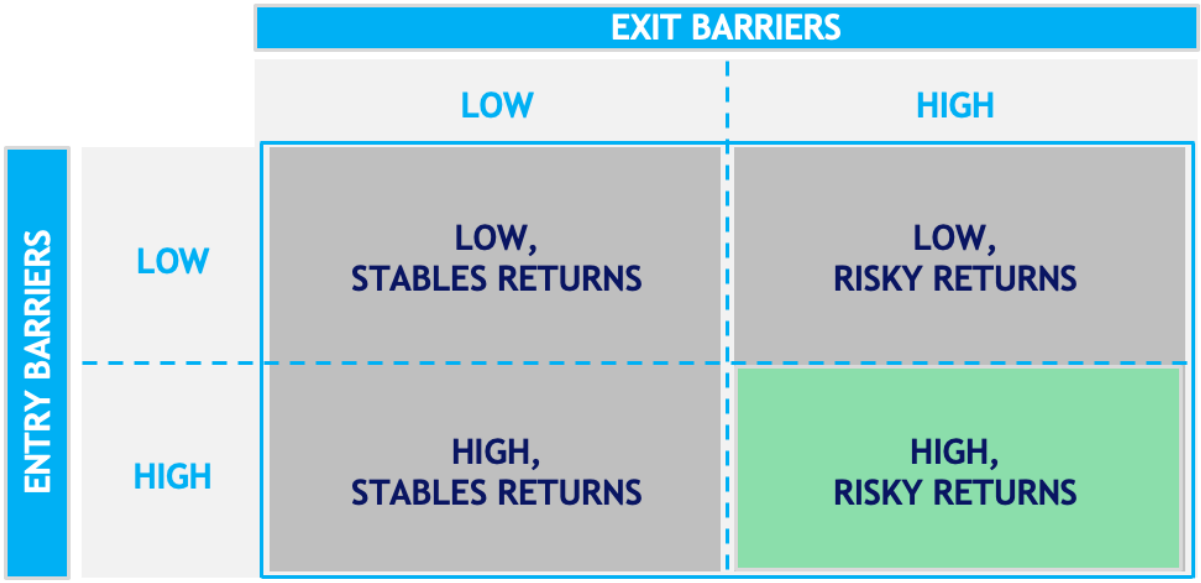


Figure 3: Barriers and Profitability
Source: Author's Chart, according to (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998)

Figure 3 demonstrates how barriers are linked to profitability. The area in the bottom right corner describes the automotive industry well. As previously discussed, the extremely high entry barriers can be argued to almost create an immunity towards new entrants for the established firms. However, if a new entrant successfully manages to enter the industry, this has an effect on the exit barriers. However, if a company manages to enter the industry the exit barrier that competitors may face, when leaving, are high as well. This is rewarded with high, but risky returns, as unsuccessful firms stay in the industry fighting for market share in order to avoid facing unfavorable exit barriers (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

5.1.4 Pressure from Substitute Products

Porter (1998) describes substitutes as products able to perform the same function as the products of the industry. Generally, a gas operated automobile's first purpose is to transport people or goods from one location to another. Considering transportation purposes, many substitutes exist, depending on the distance in question. For short distances, one can find both bike and car sharing services as well as public transport options. In the case of longer transportation distances, the main threats for the automotive industry are airplanes or trains. The main differences in these substitutes are that they have lower acquisition costs compared to customers buying a car. However, user demand is lower in terms of comfort, convenience and the purchase of a car can be a status symbol (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).
One can argue that the ongoing shared mobility trends can have a substantially negative impact on car sales. However, a recent report from McKinsey (2017) shows that this trend will be outpaced by vehicles sales in emerging markets.

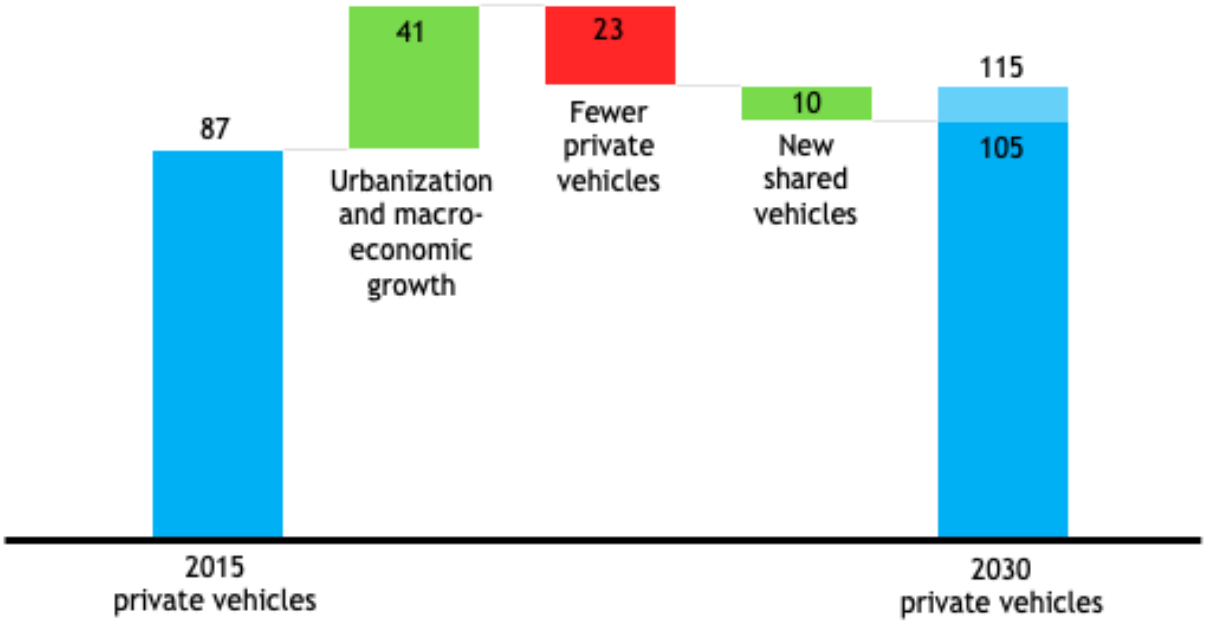


Figure 4: Annual Global Vehicle Sales in High-Disruption Scenario (millions of units)
Source: Author's Chart, according to (Grosse-Ophoff, Hausler, Heineke, & Möller, 2017)

The underlying reasons for this are the growth in Asia which is expected to be strong as well as the increased replacement frequency of shared vehicles due to higher wastage through more usage. Nonetheless, until 2030, one third of the expected rise in car sales due to the urbanization and macroeconomics growth of emerging countries, will likely not happen. This due to the greater use of shared mobility services (Grosse-Ophoff, Hausler, Heineke, & Möller, 2017).

On the other hand, Porter describes the substitutes as something that are able to perform the same function. Still, all the existing substitutes cannot replace the usage of a car completely. For instance, public transport might not drop you off exactly in

front of your destination (or any another wanted location). A bicycle is less comfortable and slower. Moreover, it lacks protection against weather conditions. Consumer switching costs might be low for car substitutes, but the substitute performance and quality are never equal or superior. To sum it up, it can be said that the pressure from substitute products increased over the past years but is still rather low (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

5.1.5 Bargaining Power of Buyers

As in every industry, the market is regulated by supply and demand. In some industries, sellers have more power and therefore they are able to charge higher prices and in other industries, it is vice versa, meaning that buyers have more pull over sellers and therefore are able to put pressure on prices. According to Porter (1998), certain factors are to be considered in order to see how strong the threat in the industry is in regard to the bargaining power of buyers. In this case, buyers are more concentrated than sellers, thus providing them with a greater choice and broader selection of sellers, leading buyers to gain a better positioning than the sellers (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

Taking a look at the at the OICA statistics on how many cars are in use globally, we identify the number of 1.28 billion (2015) cars worldwide (OICA, World Vehicles in Use - All Vehicles, 2019). This means that approximately 50 car manufacturers, account for over one billion vehicles worldwide. Consequently, this implies that the number of sellers is far more concentrated than the number of buyers. As a result, sellers are not in the most favorable position, however, at the same time, buyers' power is still limited.

Other factors that impact the power of the buyers are threats of backward integration. In the case of the automotive industry, this refers to buyers being able to assemble their own cars, which due to lack of resources and know-how is clearly impossible (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). For this this reason, backward integration does not pose a threat to the sellers.

Porter also (1980) mentions that the buyer power is low if the product is highly differentiated, which clearly is the case in the automotive industry. As already mentioned, nowadays vehicles are almost personalized goods with a high possibility of customization and differentiation. This makes it rather difficult for buyers to find adequate alternatives. Additionally, the final product is purchased in low volumes by buyers as end-consumers rarely tend to purchase vehicles in very large batches. An exception are companies or governments. Furthermore, there are also some attributes in the industry that may give the buyers a strong bargaining power.

One of the most important factors for this is that buyers often are very price sensitive, especially when it comes to investments requiring a significant fraction of the buyers' costs. This makes buyers much more selective and rational, as well as

prevents irrational and impulsive decisions. Lastly, buyers do not face significant switching costs when substituting a certain car brand or a vehicle for a substitute, meaning that their decision is facilitated (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

In summary, it can be said that the bargaining power of buyers on the market is rather low, since the arguments that keep purchasing power low are more present and predominate. Therefore, the threat of buyers deciding to stop buying automotive products is small.

5.1.6 Bargaining Power of Suppliers

Automobile producers do not only face threats by their potential customers, but also from the other side of the value chain: the suppliers. Suppliers are one of the most important groups in the value chain of car production, as every modern vehicle has third party parts implemented. This clearly gives suppliers a powerful positioning. Of course, car manufacturers could also face certain threats such as raising prices or quality reductions of supplies, etc. Porter also lists different factors and requirements that have to be examined in order to determine the risks that manufacturers face due to suppliers' power (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).
The factors being valid for the bargaining power of buyers can also be applied to the bargaining power of suppliers, however, applied vice versa. Logically, if the market would be dominated by a few suppliers, this would give these suppliers an advantage in their bargaining power against buyers (the car manufactures). By looking at a recent statistic from Automotive News, we can get the idea of how large this industry is. The reports list the top 100 suppliers on the globe ranked by sales of original equipment parts. Automotive suppliers are led by the German manufacturer Robert Bosch GmbH with total sales of $47,5 billion in 2017 (Chappell, 2018).

The study conveys the impression that there are plenty of suppliers from which manufacturers can buy products. However, in fact, most suppliers are specialized in certain parts or equipment categories. For example, certain suppliers such as Continental AG and Hyundai Mobis are focused on electronic parts, as for instance assistance systems or automotive electronics, whereas, there are suppliers focusing on engine and powertrain components. Examples, in this case, are Mahle GmbH or Federal-Mogul (Chappell, 2018). From that, one can conclude that even though suppliers outnumber manufacturers, suppliers must be distinguished due to their products and cannot be seen as direct competitors. However, their role is becoming less important and almost redundant, which we will see in the conclusion of this thesis.
This situation gives the individual suppliers bargaining power over manufacturers and could, thus, be a risk for the industry. Nevertheless, parts often are customized for manufacturers. Suppliers only have one customer, the car manufacturers, making

this relationship very dependent and leads to low bargaining power. However, some suppliers have diversified product portfolios such as Robert Bosch GmbH. As an example, this company supplies products to the solar industry and sells power tools to end-customers (Robert Bosch GmbH, 2019). In this case, Robert Bosch GmbH faces less dependency on their main source of revenue, namely the automotive business. Still, as the name suggests, automotive suppliers mainly make products that they supply to automotive manufacturers, which naturally is their main business. Thus, suppliers' fortunes are closely tied to the automotive industry. In order to keep their main source of income, they protect it through accessible prices and activities such as R&D and lobbying (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998).

In conclusion, the automotive manufacturing industry and the automotive supplying industry are closely related as they heavily rely on each other. On the one hand, the manufacturers should not expect vast price increases or decreasing quality in the acquired parts. On the other hand, the suppliers will not face significant price pressure or bargaining power from their customers. One argument that may reduce the supplier power and create a small imbalance in this relationship is the threat of backward integration by the manufacturer. In this scenario, backward integration takes place when a car manufacturer expands its expertise in order to fulfill the task of an automotive supplier. In most of the cases this happens by acquiring or merging with the other business. Of course, this does not exclude carmakers acquiring their own expertise by investing in their employees or by recruiting skillful labor (Kenton, 2019). Forward integration, meaning that an automotive supplier starts producing its own vehicles and become a competitor of established car companies is however doubtful. Rather the opposite can be seen in the industry, which will be explained further in the conclusion.

5.1.7 Government as a Force in Industry Competition

Porter (1998) lists governments as possible forces, as they have the ability to impact certain industries. The automotive industry is one of these industries, which, especially in the last few years, has been very influenced by governments. To clarify their impact, government can, for instance, act as suppliers or buyers (as already mentioned above) in the automotive industry and, therefore, they can have a significant influence on competition, both locally and globally (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). The true determining factors for the government, being a relevant force in the industry, are rather political than economic. An in-depth analysis of the governments' role in the automotive industry can be found under chapter 7.2

5.2 Conclusion of the Automotive Industry Analysis

After analyzing Porter's five forces and their impact on the car manufacturers, this can be evaluated. The goal is to obtain an understandable scenario for the

automotive industry. The pressure of new competition entering the industry is extremely low, due to the enormously high entry barriers and the risks that accompany the steps of entering (Porter, Competitive Strategy: Techniques for Analyzing Industries and Competitors, 1998). If we, for instance, think about how many relevant car manufacturers, gaining a significant market share, it is difficult to come up with more than three. The high entry barriers mean that companies already operating in the sector are protected by the high entry barriers and do not have to worry about new players entering the market.
On the contrary, when it comes to rivalry between existing companies, competing manufacturers fight for every existing percentage of market share. Carmakers are under a constant competitive threat and have therefore developed appropriate strategies to keep their dominance in their respective markets. However, these strategies are not always a recipe for success. A great example of how companies can lose dominance in a market is the how US American manufacturers got intensified competition from the Japanese car manufacturer Toyota. In 1962, the American manufacturer GM had a market share of 50,7% in the United States, leading them to being on an absolute peak point in the market. Due to their severe dominance, GM underestimated the threat of the foreign competitor Toyota. Toyota entered the market in the same period, and since then, GM's market share has decreased almost three times (Knoema, 2019). The American manufacturers neglected the seriousness of their Japanese competitors, mainly in form of Toyota. Reasons for this were the lower purchase price and the differences in quality between the cars (De Lorenzo, 2007).

Moreover, the bargaining power of buyers is still rather low. Final customers have the possibility to choose between different products and price ranges inside the industry. However, a proper substitute delivering the same quality and performance is not yet available. Thus, the threat of substitution is rather low. The trend towards a carless future rather lays in the nature of political or social trends. Furthermore, this trend tends to move buyers to alternate products such as bicycles or public transport. With this said, many people are still very dependent on cars.

The, probably, largest threat is the bargaining power of suppliers. Due to globalization and other factors, many suppliers are now able to sell their products to different buyers around the globe and produce cheaper than other manufacturers. Moreover, suppliers can increase prices thanks to new technologies with improved quality, and the know-how related to these technologies. Automotive suppliers are still naturally bound to manufacturers, as without the manufacturing industry, suppliers would be redundant. Therefore, the threat can be considered being the highest in the industry, but generically speaking, it cannot be seen as a significant endangerment for the industry.

6. The Innovator‘s Dilemma

At no point in time has conventional manufacturers in the automotive industry faced such a turnaround as during the previous years. Currently, the innovative strength of manufacturers is questioned and challenged by emerging manufacturers with the help of BEVs. Consequently, it is essential in this context to deal with the topic of innovation, and much more, disruptive innovation.
Innovation has long been discussed as a source of company-specific competitive advantages. However, in recent years, the influence of established and leading companies’ lack of innovation on the failure of and their reaction to it are investigated more intensively. Innovation research also teaches us that the ability to innovate tends to decrease with the growing size of a company. In general, smaller companies are more innovative than large corporations (Sammerl, 2006).
With the decline and failure of established companies, the concept of disruptive innovation, developed by Harvard Business School Professor Clayton Christensen, has become particularly important. With the book “The Innovator’s Dilemma” the Harvard Business School professor Clayton M. Christensen is considered to be the founder of the theory of disruption.
In his book, Christensen (2013) distinguishes between **sustaining and disruptive innovations**.
A company follows the path of **sustaining innovation**, when it improves a product’s performance. This can, for instance, be based on feedback from its customers. Usually it is about reducing defects or making a feature faster and more powerful. For instance, the wet razor gets a fifth blade, the TV or camera image becomes even sharper or the mobile phone gets even more powerful hardware. These product improvements represent incremental progress, but not major changes or breakthroughs (Christensen, 2013). Moreover, they target demanding high-end customers in existing markets and are only made available to less demanding low-end customers over time. As the more demanding high-end customers benefit most from the improved performance features, they are also more willing to purchase the improved and usually more expensive successor products (Albeck, 2015).
Unlike sustaining innovations, **disruptive innovations** do not aim to introduce improved products into existing markets. They differ from sustaining innovations primarily in their promise of benefits to customers (Albeck, 2015).

Compared with existing products, disruptive innovation initially exhibit lower performance in many of the key features valued by the market, at least in the near-term. However, they do have certain advantages over existing products in terms of features such as price, ease of use and size. For the majority of existing customers, however, these features are not essential or decisive for the purchase. Disruptive innovation, therefore, primarily address new or less demanding customer segments at the beginning, whose requirement profile differs from that of existing customers (Christensen, 2013).

The overall concept of disruptive innovation has been further refined over time and divided into "low-end disruptions" and "new-market disruptions". As we can see in Figure 5, established incumbents are continuously improving their existing offerings, as underserved customers are a supposedly secure source of sales for the new products. However, the constant improvement of traditional performance features can also become a problem for established companies. This is particularly true when the revised offerings exceed the performance expected by the customer and customers are not prepared to pay a higher price for the new products. The improved products are thus overengineered for a growing proportion of customers, as they exceed their price/performance requirements (Christensen, 2013).

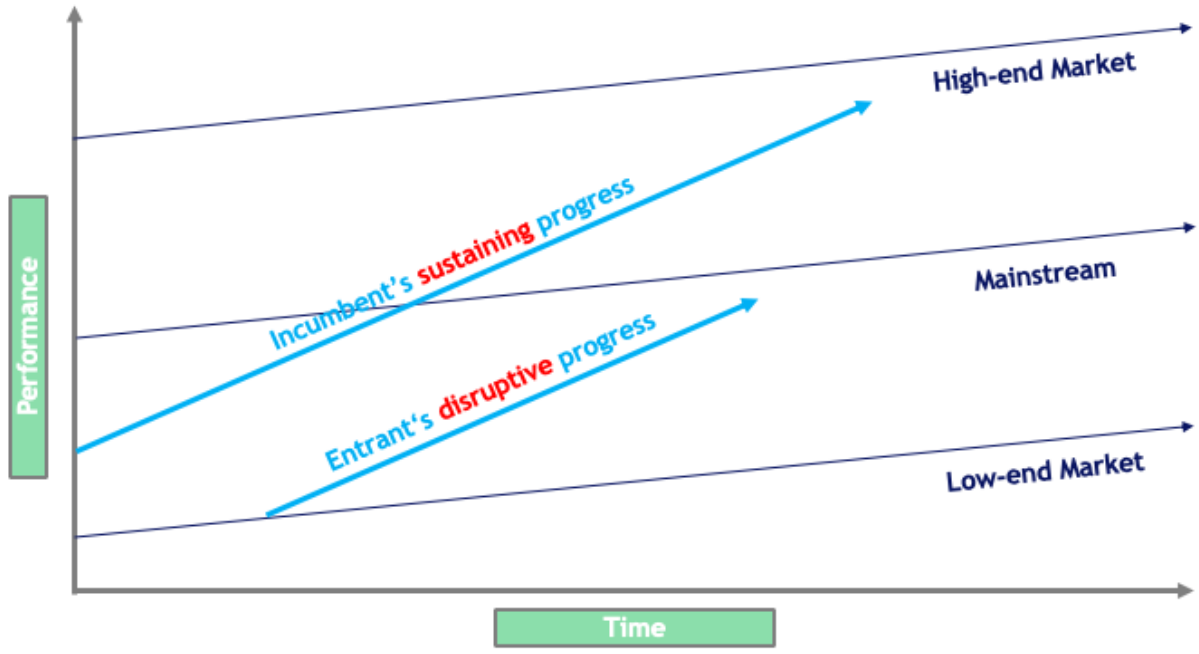


Figure 5: The Impact of Sustaining and Disruptive Technological Change
Source: Author's Chart, According to (Christensen, 2013)

The introduction of low-end or new-market disruptions now represents a real alternative to the overengineered and expensive offers of the established manufacturers for certain customers. As Figure 5 shows, at the beginning of their market launch, low-end disruptions are inferior to existing offers in terms of performance and functionality, but they beat the products of established providers with a lower selling price. Low-end disruptions are therefore initially aimed at price-sensitive buyers whose needs can also be satisfied with the lower range of services and redefine the product through a changed business model (Albeck, 2015). An example of this is Chinese automobile manufacturers serving the lower market in China or other emerging markets.

The second form of disruptive innovation, new-market disruption, can also pose a threat to established companies. In contrast to low-market disruptions, which are more demand-oriented. New-market disruptions are often technology-driven and completely new for producers and consumers (Albeck, 2015). Their performance characteristics therefore differ significantly from existing market requirements, as

they have different or new features that have not been satisfactorily or not at all offered by incumbents. At the same time, however, they have a lower performance capacity than incumbents' offerings in terms of the features previously considered essential. New-market disruptions are therefore not particularly attractive for traditional customers at the beginning of their market launch (Albeck, 2015). New-market disruptions, however, become a threat, for established companies in particular, when disruptive innovation becomes interesting for the majority of existing customers as a result of continuous improvements in traditional performance features.
In new-market disruptions, there are initially no direct competitors, since this form of disruptive innovation creates new markets and primarily targets existing non-consumers. As a result of the constant development of the new-market disruption, however, over time, these disruptions also represent a relevant purchase option for customers with higher demands.
Both low-end and new-market disruptions pose a threat to established companies, as they very often focus exclusively on the further development of their existing offerings and largely ignore the disruptive innovations in a low- or new-market (Albeck, 2015).

6.1 E-Mobility as a Disruptive Innovation

Looking at all points concerning the innovator's dilemma, it is of great importance, in the context of this thesis, to identify whether BEVs can actually be considered as disruptive innovation. Moreover, it is of great importance to identify whether conventional manufacturers have to fear disruption from business model generated by emerging car makers.
The automotive industry is regarded as a mature industry with incremental innovation, especially in the area of the ICEs. For example, engines are improved in terms of pollutant emissions. The hybridization and electrification of the powertrains, however, have resulted in developments of a potentially disruptive character. Already years back, Christensen (2013) discussed the potentially disruptive characteristics of EVs.
Traditional performance criteria of cars, such as engine performance, top speed, range and lifetime, are supplemented or even completely replaced by criteria such as CO_2 emissions, energy efficiency or noise emissions (Danneels, 2004) (Aggeri, Elmquist, & Pohl, 2009).

At first glance, electric cars seem to be delivering disruptive innovation, but in order to verify this, various criteria have to be met. In the following, the different criteria are briefly presented and applied to EVs. For each criteria, the main reasons for the fulfillment of the specific criteria will be identified and then assessed by using the scale from very high, high, medium, low to very low.

Nr.	CRITERIA	EXPLANATION
1.	Alternative benefit promise	• Enables new, previously non-existent benefits promises for customers • Changes the added value of a product/service
2.	New products and services	• Enables new product and service portfolios • Cannibalizes existing products and services
3.	New end customers	• Addresses new customers/customer groups beyond mainstream customers
4.	New markets	• Opens new geographic markets • Blurs industry boundaries and defines markets by the function of a product
5.	Changed value network	• Leads to market shifts in the value network • Creates new value network with a value proposition that over time becomes attractive to traditional customers as well
6.	Additional players	• Leads to the penetration of new players into the established value network
7.	Lower product performance	• Shows poorer product performance in traditional performance criteria
8.	Lower margin	• Is associated with low margins due to required investments and limited willingness of customers to pay

Table 3: Criteria for Disruptive Innovation
Source: Author's Chart, According to (Schneider, 2012)

1. Criteria: Alternative Benefit Promise

According to Christensen (2013), disruptive innovation occurs when the end customer can be offered an alternative benefit with an EV. The use of an EV allows a variety of beneficial promises. One of the most important promises of EVs is that they offer environmentally friendly and CO_2-free driving to the end customer (Christensen, 2013). However, it must definitely be taken into account that this also depends on the type of electricity generation. Emission-free driving is only possible if the electricity is ecologically produced (Schneider, 2012).
Furthermore, odorless and noiseless driving is an essential promise, especially in large cities. Anyone who has ever seen an EV on the road will quickly notice that the car is very quiet and does not emit any odors, compared to cars with combustion engines.
In addition, EVs have lower operating costs compared to conventional cars. This can be explained, for instance, by lower energy costs per kilometer driven or lower maintenance costs. Looking at a study from Canada, for example, Canadian households can on average save up to 71% fuel prices and maintenance costs with a BEV (Logtenberg, Pawley, & Saxifrage, 2018).
Nevertheless, the customer acquisition costs are still higher than for conventional cars (see 7.5 Battery Technology). However, what ultimately prevails depends on whether the manufacturers can offer the EVs at lower prices.

2. Criteria: New products and services

The second important criteria is that disruptive innovation enable new products and services. In this context, many authors often mention shared mobility services that

enable car sharing. Although car sharing with EVs reduces emissions in cities, the first services such as Car2Go and DriveNow were based on combustion cars. Therefore, this is not a new launch of services generated from the usage of EVs.
Something that has emerged with the increasing popularity of EVs is an ecosystem of players from the power generation industry to startups and joint ventures tackling charging infrastructure issues. An example for this is the Swedish startup Charge Amps, which manufactures chargers, charging cables and accessories for electric cars. In addition, in many countries electricity providers also build charging stations, which is a new business line for the companies. All this was not existent in this form with conventional vehicles.

3. Criteria: New end customers

The third criteria is met when an EV addresses new groups of end customers. In fact, EVs address several different end customer groups. In particular, end customers with strong ecological awareness are addressed. However, it cannot be fully assumed that this group can be motivated to switch, for example, from bicycles to cars as a means of transport due to new offering of EVs, since reasons such as safety or energy efficiency still play a role (Schneider, 2012).
Another group of end customer are the Early Adopters, being people with an affinity for technology and interest in trying new technologies as soon as they become available. These customers primarily buy an EV in order to belong to a technologically savvy group.
Moreover, as a result of the high prices of EVs in comparison to conventional cars, it is also clear that higher earners definitely belong to potential end customers. This customer group can afford to drive emission-free and sees itself as a customer segment with a distinct awareness for the environment. Nevertheless, with increasing reduction of the purchase price, also customers with medium high incomes can be addressed as customers, as considerable saving potential exists (Schneider, 2012).

4. Criteria: New markets

Entering new markets is another disruptive innovation criteria. This can refer to geographical scope, as well as the crossing of industry boundaries.
With regards to EVs, markets imposing bans on non-emission free cars pose a great opportunity. Even though no market has imposed this yet, global trends certainly point in this direction. For example, old diesel or gasoline vehicles are currently banned in Europe's metropolises, although this will change to ban more vehicles in a short future (ADAC, 2019).

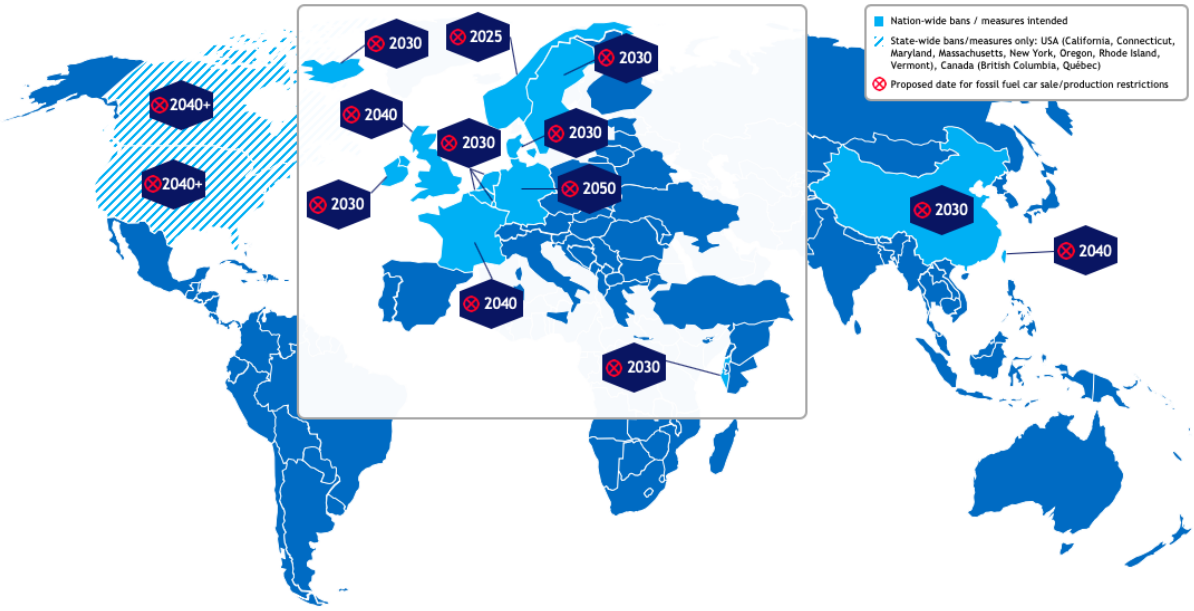


Figure 6: Global Sales & Registration Restrictions for ICE Vehicles Worldwide
Source: Author's Chart, According to (Berylls Strategy Advisors, 2018)

In many regions of the world, sales and registration restrictions for vehicles with combustion engines are planned from 2025-2030. This, of course, has drastic consequences for the automotive industry. In a scenario where these bans and restrictions were already in force today, around 50% of the current sales worldwide would have been affected (Berylls Strategy Advisors, 2018).
As aforementioned, EVs are very advantageous in cities and metropolises. Increased sales of EVs could, for instance, have an enormous effect in highly polluted cities in Asia. In the course of this thesis, we will get a better understanding of the massive popularity of EVs in China. Nevertheless, it is important to highlight that broad adaptation among the mass-market in these markets requires a price reduction, due to the lower purchasing power. In addition, as already mentioned, EVs contribute to the dissolution of industry boundaries. Electricity as fuel for EVs creates a large intersection with the energy supply industry. Therefore, new markets are also emerging here across industry boundaries.

5. Criteria: Changed value network

The adoption of EVs will lead to enormous shifts in power in the value network. It will lead to a displacement of the competence areas. The core competence of the OEMs, the combustion engines, becomes obsolete and new components, such as the batteries will become of increased importance. Following this development, big car manufacturers lose their biggest advantage. This is due to the fact that engines have, so far, represented a high barrier to entry due to high investments and economies of scale (see 5. Industry Analysis). In an EV, the battery plays an equally important role as a combustion engine in an ICE (Schneider, 2012). In addition, other industries start intersecting the network, such as the energy supply sector. In general, this means that EVs are shifting the current value network enormously.

6. Criteria: Additional players

An increased number of additional players on the market represents another criterion for the existence of a disruptive innovation (Christensen, The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, 2013). This aspect is clearly given by the market entry of companies such as Tesla, BYD, Byton or Uniti. With their clean-sheet designs and additional innovations, these companies are already competing with conventional manufacturers.

7. Criteria: Lower Product Performance

EVs are to be considered disruptive if they initially have a lower product performance in the traditional performance criteria. Probably the most important and traditional performance criteria, where EVs have a lower performance, is the range. However, this has also improved significantly over time and will continue to do so.

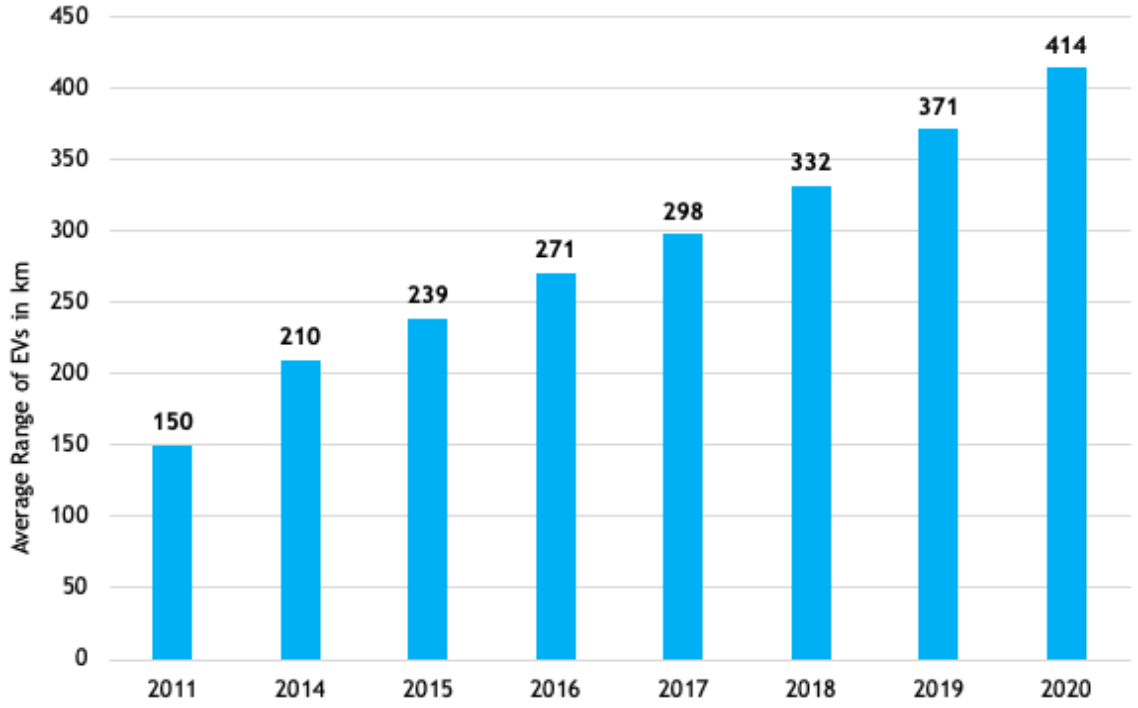


Figure 7: Range Development of EVs
Source: Author's Chart, According to (Horváth & Partners, 2018)

As illustrated in Figure 7 the reach of EVs has improved enormously over the last few years. The distance an EV can drive with fully charged battery today, in this thesis referred to as range, is already perfectly sufficient for city residents. If one now considers the range actually required, a large majority of people need a range of no more than 290 km in their EV (Miles, 2018). Such a range was already possible in 2017, as illustrated in Figure 7.

Another performance criterion is the lack of comfort when charging an EV. Today, it takes significantly longer time to charge an EV in comparison to refuel an ICE. Longer

waiting times are necessary. This is discussed in more detail in chapter 7.4 Charging Infrastructure.
Overall, an EV shows worse values for some of the traditional performance criteria. However, this will improve significantly over time with a higher adaptation. We can already see these tendencies in the example of batteries.

8. Criteria: Lower margin

The last criteria is met if EVs initially provide manufacturers with lower margins than conventional cars. Currently there is a big gap between EVs and conventional cars. As a result, most manufacturers today do not make a profit with the sales of EVs. In comparison to ICEs, producing an EV cost up to $12,000 more (see Figure 14). It does not represent a sustainable state for the manufacturers. Therefore, the OEMs have to compensate this with increased prices, which means that this criteria is clearly met (Baik, Hensley, & Hertzke, 2019).

Nr.	CRITERIA	DISRUPTION POTENTIAL
1.	Alternative benefit promise	VERY HIGH
2.	New products and services	MEDIUM
3.	New end customers	MEDIUM
4.	New markets	HIGH
5.	Changed value network	HIGH
6.	Additional players	VERY HIGH
7.	Lower product performance	HIGH
8.	Lower margin	VERY HIGH

Table 4: Criteria Assessment for a Disruptive Innovation
Source: Author's Chart

Based on the previous analysis, the potential for disruption of the individual criteria can now be assessed. In the right column each criteria has been evaluated. As we can clearly see, with the exception of the criteria "New products and services" and "New end customers", all criteria were rated "High" or "Very High". Therefore, it can be concluded that EVs represent disruptive innovation within automotive industry.

7. Business Environment for E-Mobility and its Development

7.1 Actual Situation in the Industry – Manufacturers "Quo Vadis?"

The best way to get a sophisticated overview over the current happenings within the automotive industry is by evaluating reports, trend forecasts, analyzing experts'

opinions and analyzing customer behavior and sales data. Different perspectives, analyses and facts shape the industry in different terms as it is characterized by being very dynamic and many factors today are having substantial impact on it.

7.1.1 An Overview of the Global Situation

First, it is important to obtain a principle idea of global vehicle sales over the past few years in relevant markets. The OICA report "Provisional Registrations or Sales of New Vehicles – All Types" leads us into a certain direction in order to get a better understanding of the actual situation in the automotive industry. Looking at the past years, there has been a significant increase in car sales every year. From 2007 until 2017, there was an increase from 71.557.035 total registered vehicles to 96.804.390. That is an increase of more than 25 million cars sold or 35,3 % in total. Sales only declined in 2008 and 2009, most likely as a consequence of the financial crisis (OICA, Provisional Registrations or Sales of new vehicles - All Types, 2019). These statistics might suggest that automotive sales are skyrocketing, and the growth rate prove healthy. Perhaps a deeper insight might be more revealing, when analyzing certain countries and specific years.

	2007	2008	2009	2010	2015	2016	2017
Germany	3.482.279	3.425.039	4.049.353	3.198.416	3.539.825	3.708.867	3.811.246
		-1,64%	18,23%	-21,01%	5,45%	4,78%	2,76%
USA	16.460.315	13.493.165	10.601.368	11.772.219	17.845.624	17.865.773	17.583.842
		-18,03%	-21,43%	11,04%	5,95%	0,11%	-1,58%
China	8.791.528	9.380.502	13.644.794	18.061.936	24.661.602	28.028.175	29.122.531
		6,70%	45,46%	32,37%	4,95%	13,65%	3,90%
Brazil	2.462.728	2.820.350	3.141.240	3.515.064	2.568.976	2.050.321	2.238.915
		14,52%	11,38%	11,90%	-26,56%	-20,19%	9,20%
Japan	5.309.200	5.082.233	4.609.333	4.956.148	5.046.510	4.970.260	5.238.888
		-4,27%	-9,30%	7,52%	-9,28%	-1,51%	5,40%
India	1.993.721	1.983.071	2.266.269	3.040.390	3.424.836	3.669.277	4.017.539
		-0,53%	14,28%	34,16%	7,80%	7,14%	9,49%

Table 5: Vehicle Sales According to OICA 2019
Source: Author's Chart, According to (OICA, Provisional Registrations or Sales of new vehicles - All Types, 2019)

Table 5 shows the number of sold cars per year in the corresponding country. Growth rates according to the previous year are in the line below. The countries are chosen because of their relevant locations, cultural differences, development status as well as political and economic importance of the last decades with regards to industry and automotive business.

Starting from top to bottom, by looking at Germany one point clearly stands out. In 2009, Germany, representing a very saturated market for vehicles, realized over 18% of growth in sales, even though this year was still heavily influenced by the financial crisis from 2007-2008. In order to boost sales and as a reaction to the crisis, the government launched a scrappage program called "Abwrackprämie" to stimulate the economy (Kaul, Pfeifer, & Witte, 2012). Other large economies, such as Japan and the United States, also offered similar programs. Still, these were not as successful as in Germany.
These programs put in place to dampen the negative effects of the financial crises, however they had minor financial impact, as demonstrated in the table's negative growth figures in 2009. On the contrary, in 2009, the Chinese market experienced a veritable boom in car sales compared to the previous year with an increase of over 45%. One main reason for this was the governmental "Automotive Industry Readjustment and Revitalization Plan" introduced in 2009 (Tang, 2009). This plan smoothed the way of making China a serious global market for domestic brands and foreign manufacturers entering the market. Foreign manufacturers had to enter the market in the form of joint ventures with Chinese brands. The numbers speak for itself. China is the only country in the table without a negative growth rate in sales. Moreover, in 2017, they managed to still realize a growth rate of almost 4%. This shows that the market is not saturated yet and offers great potential for both local and international vehicle producers.
The countries in the table above, which are having very clear growth rates in terms of sales, are China, Brazil as well as India. These countries are part of the so-called BRICS states (Brazil, Russia, India, China and South Africa). The definition by a report from the European Parliament describes this phenomenon reasonably accurate (Morazán, Knoke, Knoblauch, & Schäfer, 2012):

"The role of Brazil, Russia, India, China and South Africa (BRICS) as emerging protagonists in international development cooperation is significantly and rapidly changing. Over the last decade, BRICS have increased their financial as well as technical assistance […]"

The role of these countries and especially their automotive markets is becoming more and more important globally in terms of politics, economies and socio-cultural factors. Companies, in this case the automotive producers, see this development and focus on these new markets in order to grab more market share, as its rather difficult to abstract market share in saturated markets from existing competition.
The main conclusions one can draw from reviewing Table 5 is that the global automotive market is not saturated yet, especially, if we look at the rates from 2016 and 2017. Growing economies and the BRICS states offer great investment opportunities for car manufacturers. Even countries like Germany and Japan were able to realize positive figures, although these countries, with their long-lasting automotive history, are being penetrated by local manufacturers since the beginning. Hence, the potential of capturing further profit on a global scale is an option for manufacturers as these markets are not yet saturated, and even those

that show tendencies of becoming saturated show positive growth figures. However, one could ask what other influence possibilities or trends are there that shape the situation in the automotive industry?

7.1.2 Connectivity and the IoT in the Automotive Industry

Nowadays, when even washing machines and light switches are connected to the internet or smartphones, it becomes indispensable for car manufacturers to trail with the trend of making their products "smart". The main purpose of a vehicle always was and still is, being mobile. However, OEMs must adapt quickly to these new consumer demands in order not to miss the change in the industry. New challenges that may arise for OEMs, are shorting their product and service development cycles e.g. software updates. In addition, car producers do not always have the high level of sophisticated know-how, needed for creating apps, software and digital content. People hired at these car producers typically have an engineering background, instead of the currently needed IT background. Non-automotive IT companies might also be able to overcome the barriers of entry in the future (as they could earn vast capital resources over the past years) and compete in the industry with their different approaches to mobility or vehicles. As a result, they could become serious threats to conventional carmakers (Mohr, et al., 2013).
In a final scenario, this leads to the point where cars are so smart and connected that it makes the driver obsolete. Future technologies will be so advanced that cars will drive autonomously, as already seen for planes, metro wagons and ships (Dudenhöffer, 2016). This means that the sales arguments of many automakers must be revised. Often, they create a relationship between emotions and driving their products. For example, BMW advertises with its slogan "The Ultimate Driving Machine" or FIAT "Driven by Passion. FIAT". All these slogans often represent what these companies' values and how they market their products. With current, and ever improving, technologies posing a threat to automakers, one can argue that they have to rethink their mission and vision to keep a competitive stand. Even if these threats are not currently pushing traditional players off the market, future trends clearly point in this direction (Dudenhöffer, 2016).

7.1.3 Emissions and Pollution

In the past years, sustainability gained increasing attention and importance in many sectors, being everything from grocery shopping, to electronics, to picking the bicycle. In every good or service, producers, governments and organizations try to awaken our attention in regard to sustainability and pollution. However, there is probably no industry or product which has been getting as much attention in regard to this specific topic as the automotive industry. This, especially in the recent past with the "Dieselgate" scandal of VW in 2015. However, this was not the trigger for greening and emission-reduced engines – already earlier, especially from the 1990s onwards, the rise of CO_2 emissions has been intensely debated (Achtnicht, 2012).

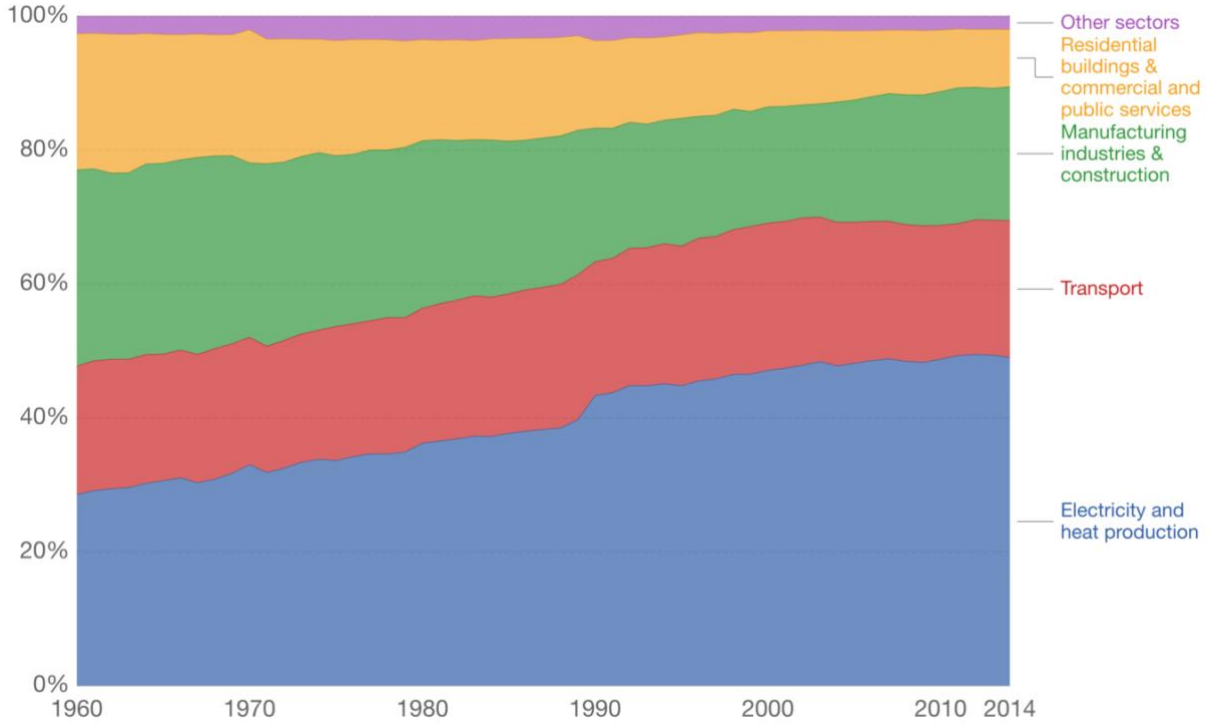


Figure 8: Carbon Dioxide (CO2) Emissions by Sector and Source, World (2017)
Source: (Achtnicht, 2012)

In order to understand the extent of the environmental impact of the automotive industry, we can evaluate Figure 8, which points different sectors contribution to carbon dioxide emissions between 1960-2014. Over the recent years, half of global emissions worldwide were due to the production of electricity and heat. Immediately thereafter, follows the transport and manufacturing industries, constituting 20% respectively of all emissions (Ritchie & Roser, 2017). This clearly demonstrates the negative impact of the car production and emission from combustion engines on the environment. This is just one of many studies identifying the automotive industry as a major polluter, and it being linked with the increase in CO2 emissions over the last decades.

As a response, the European Parliament and other governments started putting pressure on the automotive producers. This was done by setting emission performance standards for new passenger cars (Achtnicht, 2012). Porter (1980) describes this situation of government policy changes as a major factor having the potential of impacting the industry evolution heavily (Porter, 1998). Since that time, the industry has been under observation and carmakers started acting on it by improving production to comply with the new rules. New innovative engines, emissions-reduced cars and a new hype for alternative powertrain solutions started to raise.

Nonetheless, in 2015, the automotive industry and its negative environmental impact was on the agenda again. The German automotive industry has been under severe damage after the Volkswagen affair in 2015.

Volkswagen AG sold diesel engines on a global scale, claiming them to be environmentally friendly. However, some engines sold to customers were modified,

and thus polluted considerably more than pledged by the company (Dudenhöffer, 2016). Fine dust, nitrogen oxide, and furious consumers made up articles in every newspaper article, TV reports and political discussion.
The scandal did not only disappoint customers and damage public trust, but it also damaged the reputation of the less polluting gas-engine. In retrospect, the involved brands can consider themselves fortunate. Manipulated diesel engines never had a significant impact outside of Europe and even if the aftermath is substantial, the scandal did not endanger the existence of the whole industry. Nevertheless, the diesel scandal was one of the precursors for the strong focus on EVs (Dudenhöffer, 2016).

7.1.4 Possible Solution to the Actual Situation

Car manufacturers are put under pressure from all sides and they have to adapt quickly to these changes and demands to not lose out on sales. What are possibilities that may arise now and how can conventional automotive producers present themselves in the proper light again? Is this turnaround offering a chance for new companies and startups to enter the market? Is the structure being rearranged in the automotive industry?
The established principles of the classic automotive industry are dissolving and posing new challenges for the entire industry. The classic concept of mobility as we knew it a few years ago and perhaps still know it today, is undergoing a dramatic change. Trends such as urbanization, climate change, demographic change and digitalization are the main drivers of this change, setting new mobility requirements (Kuhnert, Stürmer, & Koster, 2018).
Tomorrow's mobility will be characterized by increasing electrification, connectivity, automation and shared mobility. Electric powertrains, new storage and driving technologies, autonomous driving and a high affinity to digital platforms are increasing the pressure on established automobile manufacturers. However, it is not just the pressure that is affecting the traditional industry. These factors, together with the innovator’s dilemma described in Chapter 6., are also creating new opportunities for new manufacturers and new business models to enter the market.
Based on the previous chapters, we can conclude that the car manufacturers are facing problems related with the market, only partly being saturated. Today, there are both saturated and developed markets with established car production and sales, as well as markets where the purchasing power is too low to buy a car, but where the industry predicts high growth potential. Moreover, cars that are not, or only slowly, meeting the standards in terms of connectivity and digitalization as well as the vast pressure for clean and green vehicles. Industry experts and consulting agencies gave many approaches for possible solutions.
In this context it is very interesting to look at the approach of the German manufacturer Daimler AG. The company uses the acronym "CASE" in this context, serving the company as a guideline for the future of mobility. The Chairman of the Board of Management of Daimler AG, Dr. Dieter Zetsche, explains this strategic

approach as follows: *"Connected, Autonomous, Shared, Electric: Every one of these points has the potential to turn our industry upside down. The real revolution, however, lies in the connection of all this."* Hence, all new and future series of the company must meet the attributes described. This of course depends on the degree of regularization and technology (Daimler AG, 2019).
The management consultancy PwC goes one step further in this regard. In its latest automotive trend report, the company identified the change in the automotive sector as follows: *"[…] The automotive future is electrified, autonomous, shared, connected and yearly updated."* PwC uses the acronym "eascy" in order to describe it. The ***electrification*** of the drive train is the first step towards an emissions-free mobility, after which charging vehicles from renewable sources would be the next step (Kuhnert, Stürmer, & Koster, 2018). Making automobiles ***autonomous*** and driverless would be one way for tackling the lack of connectivity of cars and create a completely new IoT mobility experience. Nevertheless, this trend is not as close as the electrification due to autonomous driving regulations (Kuhnert, Stürmer, & Koster, 2018).
One opportunity is created where digitalization intersects with non-saturated, price-sensitive markets. To make cars more accessible, especially in developing countries with high potential (e.g. India or the Chinese countryside, see table above) the possibility to share a car between individuals or to just rent a vehicle short time via app would create a new mobility industry according to the PwC (2018) report. This leads to the last two points, ***connected*** cars that are ***yearly updated***. These connected vehicles could not only be connected to smart devices (which is already possible) but would also allow communication with other vehicles and smart streets or traffic lights. This development would create a completely new network of mobility and elevate the car to a new level (Kuhnert, Stürmer, & Koster, 2018). Shared, autonomous vehicles also require shorter innovation cycles, especially in regard to computer hard- and software, where experts from PwC (2018) see more necessary updates in the future. Currently these cycles last from five to eight years, but in the future, smaller, but more frequent updates will be offered to adjust the vehicle to contemporary technology. This trend will work especially for saturated, developed markets with less growth potential, as companies will be able to market and promote new features and thus create new revenue streams similar to the high-tech industry. Further implementation cases of conventional and emerging manufacturers will also be examined in more detail throughout the course of this paper.
Other trend reports, such as the one from McKinsey & Company (2016) made in collaboration with Stanford University, project similar tendencies for the automotive industry until 2030. Amongst other tendencies identified, the report identifies shifting markets and revenue pools, changes in mobility behavior, diffusion of advanced technology as well as new competition and corporation. We will focus on *diffusion of advanced technology*, which these experts subdivide into two parts - electrified vehicles and autonomous driving. The latter could affect 15% of car sales

until 2030 (Mohr, Kaas, Gao, Wee, & Möller, 2016). However, this forecast should be viewed with great caution. The outright hype regarding autonomous driving has slowed down in recent months. Reasons for this are, for instance, problems in technology development, lack of talent in companies, intellectual property and security (Wood, 2018).
According to the report of McKinsey & Company (2016), EVs will become viable and competitive. Nonetheless, the speed of their adaption will certainly be dependent on local factors (Mohr, Kaas, Gao, Wee, & Möller, 2016). A few years ago, EVs were considered utopian due to factors such as high battery costs, sparse charging possibilities, and mistrusting consumer behavior. However, these factors changed, and stricter emission regulations are creating a strong momentum for a penetration of the market (Mohr, Kaas, Gao, Wee, & Möller, 2016). The share of electrified vehicles could range from 10-50% in 2030. Many incentives from governments and cities are already trying to push sales with beneficial perks with the aim of achieving cleaner and less noisy environments. Nevertheless, the forecasted numbers are very vague and not only depend on consumers, but also on the products offered by the OEMs as well as particular regulations of the different markets. An adaptation on country sides and rural areas will certainly take longer time compared to urban areas. Especially, due to the fact that higher ranges are necessary. In these areas, an intermediary phase with hybrid engines (which still include conventional combustion engines) could be used, before complete electrification can take place (Mohr, Kaas, Gao, Wee, & Möller, 2016).
In order not to go beyond the scope of this work, the focus in the following chapters is on e-mobility rather than other trends such as connectivity, shared mobility and autonomous driving. This is also due to the research question of this paper.

7.2 Government Role & Regulations – Incentives and Pressure for the Industry

The following chapter will mainly focus on the subject of regulation and government incentives, as well as external pressure trying to encourage a revolution in the car industry. Moreover, the of the following part goal is to show which challenges and pressures that, especially conventional car manufacturers face.

7.2.1 Regulations Regarding Emissions and Fuel Consumption

Nowadays, OEMs have to deal with a new headwind from governments, particularly with regard to the cleanliness of their vehicles. The International Council on Clean Transportation (ICCT) is one of the leading independent nonprofit organization, providing research and information to policy makers and regulators. In its latest global update from 2018, ICCT compares different regulations and standards relevant for greenhouse gases and fuel economy in different regions of the world. As it is rather difficult to set global standards due to the different nature of the mobility structure around the globe, insights from ICCT will be used to create an overview of

the situation. In addition, the focus will be on light vehicles, i.e. passenger cars and vans.

Figure 9 below shows the trends of the CO_2 emissions values in key countries adjusted to the former New European Driving Cycle (NEDC) standards. Until 2017, the NEDC was responsible for the type testing of emissions and fuel consumption by the European Union and indicates CO_2 emissions in grams per kilometer. Furthermore, NEDC distinguishes itself from other tests that are common in other regions such as Japan or the United States (e.g. JC08, or the CAFE standards respectively) (Kühlwein, German, & Bandivadekar, 2014).

Each test uses different methods and environments, so the results may vary. However, the UN ECE (United Nations Economic Commission for Europe) has decided that the NEDC will be replaced by the Worldwide Harmonized Light Vehicles Test Procedure (WLTP) from September 2017, which is supposed to provide more accurate values for emissions and fuel consumption (Kühlwein, German, & Bandivadekar, 2014).

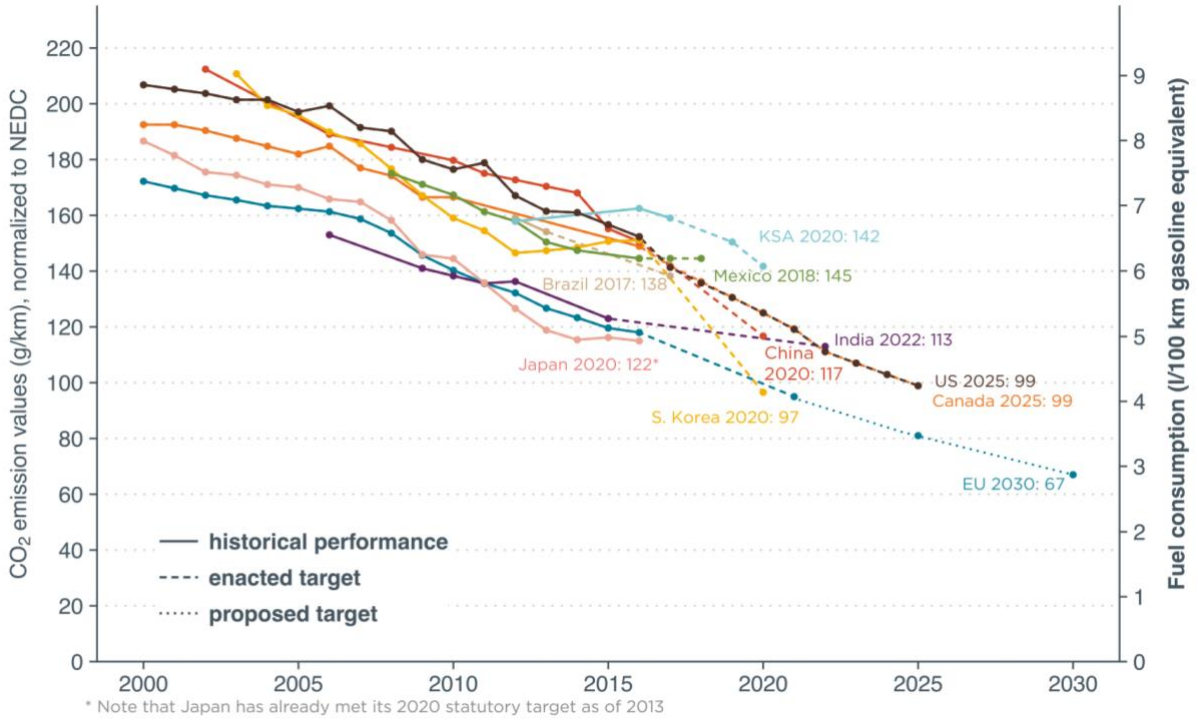


Figure 9: Passenger Car CO2 Emissions and Fuel Consumption, normalized to NEDC (April 2018)
Source: (Kühlwein, German, & Bandivadekar, 2014)

This change is also intended to give customers a more neutral overview and more realistic figures when buying a new vehicle. Since complete WLTP-based data is not yet available, Figure 9 shows the value converted to the NEDC standards, in particular for a global comparison. The most noticeable from the figure is that the global trend is clearly positive. Total emissions are clearly falling. Next to the country name, we obtain the enacted goal of each nation and year when it is due. In the following text, we will mainly look at three countries and regions in detail in order not to go beyond the scope of this paper.

Already in 2013, Japan reached its target of 122 g/km of CO_2 emissions set for 2020. This successful evolution is mainly a result of the Japanese government and Toyota, currently the most important car producer in Japan. In 2009, the CO_2 emissions declined sharply as the Japanese government introduced tax incentives and subsidy programs for the purchase of environmentally friendly vehicles, mainly hybrid vehicles (Japan Automobile Manufacturers Association, 2018). These incentives, combined with Toyota's strong hybrid offering, enabled the country to take early action and reach its goal quickly. This is also the main reason for the 7.52% growth rate in automobile sales in Table 5, which not only helped Japan to cope with the consequences of the financial crisis, but also helped to reduce emissions.
China presents a different situation. The country also reached its target at the beginning of the year 2018. Carbon dioxide emissions per unit of GDP were 46% lower than in 2005, which was one of the highest in the world along with the US and Brazil. This was made possible by a CO_2 emissions trading system in the power generation industry and subsidies for EVs, which are examined in more detail (UN Climate Change News, 2018). Nonetheless, since 2017 the Chinese government analyzed the option to ban sales of new fossil fuel cars. The plan of the largest automotive market in the world, was to force its own manufactures to develop and sell more electric cars. A ban of car sales built with combustion engines would be a very drastic step and would have enormous impact on the global automotive industry (Etherington, 2017). Although this very radical regulation has not yet been enforced, most likely due to the successful lobbying of the traditional car nations, it illustrates China's great ambitions and plans. China wants to lead the development of BEVs and sees this as a strategic opportunity to permanently gain a foothold in the automotive industry. Moreover, the country has surpassed the United States as the world's largest oil importer in 2017. Therefore, a transportation based on electricity would improve the country's energy security (Busch, 2018). Nevertheless, regulations for fossil fuel cars are still less strict than in Europe. It remains important for China to first strengthen its industry before strict regulations are enacted. The aforementioned plans serve more as incentives for the industry to focus on e-mobility.

The most remarkable aspect of EU here is that the target of 67 g/km is not only the lowest, but also what the EU has planned until 2030. From this, one can argue that the Japanese government is far more future-oriented than other governments.
Moreover, the Council of the European Union agreed earlier this year on stricter CO_2 standards. These related new regulations are designed to ensure that, by 2030, new passenger cars will emit on average 37.5% less and new vans 31% less CO_2 on average in comparison to 2021 (Pausch-Homblé, 2019). Nevertheless, the overall reduction of CO_2 emissions from cars compared with 2021 is exactly the middle between the targets originally set. While the EU Commission, on the one hand, did not initially target more than 30% and later in the negations a 35% reduction, the EU Parliament, on the other hand, first insisted on 40% (Manthey, 2018). Nonetheless, the impact of

this regulation will definitely have a lasting effect on Europe's automotive industry. According to Greg Archer, Transport and Environment (T&E) clean-vehicles director, this new law means that around 2030, a third of new vehicles will be either hydrogen or electric-powered (Stearns, 2018). T&E is a European non-governmental organization working on future sustainable transportation.

Due to the strong federal orientation of the United States, a unified statement on the United States in connection with regulations regarding emissions and fuel consumption is rather difficult to summarize and would go beyond the scope of this thesis. Therefore, the regulations in the United States are not dealt with in more detail here.

Stricter regulations such as the new WLTP standard and the emissions targets set by governments around the world, present conventional automobile manufacturers with many new challenges. The existence of general gasoline engines for OEMs is steadily declining and engine electrification is becoming inevitable.
But what are the implications of these regulations? In this context, we can look into the German market as an example.
As of September 1, 2017, approvals for new passenger car types in Europe can only be granted if the results of valid CO_2 measurements according to the new WLTP are available (VDA (Verband der Automobilindustrie), 2018). Nevertheless, this had only a very minor impact if looking at the figures. In 2018, 3.435.778 new passenger cars were registered in Germany. This was a slight decline of -0,2% compared with the previous year. As in 2017, the number of new registrations of diesel-powered passenger cars continued to fall (-16,9%) and the proportion fell by 6,5% to 32,3%. The number of new registrations of gasoline-powered passenger cars rose to over 2,14 million. This corresponds to a share of 62,4%. BEVs/PHEVs achieved a growth rate of +43,9% and hybrid vehicles +53,8 percent. Nevertheless, with a share of 1,0% (BEV & PHEV) and 3,8% (HEV) of the total volume of new registrations, respectively, both opportunities for driving are still not very present on the roads (Kraftfahrt-Bundesamt, 2019). However, policy makers and new regulations are capable of complicating the situation for the OEMs – and most probably manufacturers have to get used to this situation.

7.2.2 Government Incentives

One of the pioneer countries for EVs, besides China, is Norway. According to “Norsk Ebilforening”, being the Norwegian Electric Vehicle Association, the total market share of electrified vehicles was 39.2% in 2017 (BEVs: 30% and PHEVs: 19%) in Norway (Norsk elbilforening, Norwegian EV market, 2018). This is the highest market share in the world. In comparison, in a similar country such as Sweden, the market share of electrified vehicles was 8.1% in 2018 (EV Charge Plus, 2019). In France the situation is even worse, electrified vehicles only had a market share of 2.8% in 2018, representing the all-time record for electrified vehicles in France (Kane, 2018). How

can this enormous difference between countries be explained and what role does, for example, the Norwegian government play?
Firstly, the Norwegian government started taking action almost 30 years ago. Already in 1990, legislation pushed incentives for ZEV, granting zero purchase taxes on ZEVs. For petrol and diesel cars, this amounted to savings of about €10.000 (Haugneland, Lorentzen, Bu, & Hauge, 2017). In the following years, new benefits and incentives were created to encourage the purchase of zero-emission vehicles such as electric cars.

YEAR	INCENTIVES FOR ZEVs
1990	No purchase/import taxes
1996	Low annual road tax
1997	Exemption from road toll
1999	Free municipal parking
2000-2020	50% reduced company car tax
2001/2015	Exemption from 25% VAT on purchase/leasing
2003	Access to bus lanes
2009	Free access on state ferries

Table 6: Norwegian BEV Incentives Development
Source: Author's Chart, According to (Norsk elbilforening, Norwegian EV policy, 2019)

Table 6 shows all the incentives the government provided to encourage people to buy an ZEV. According to a survey conducted by Norwegian Electric Vehicle Association in 2012, Norwegian EV owners stated that the most important incentive for their purchase was the exemption of taxes (VAT, road toll etc.). In other words, monetary savings made the greatest impact on consumer decisions in Norway (Haugneland, Lorentzen, Bu, & Hauge, 2017). Moreover, the Norwegian government has decided to encourage the purchase of ZEVs until the end of 2021 (Norsk elbilforening, Norwegian EV policy, 2019).

Another example is shown in Germany where the government exempts owners of EVs from annual circulation tax for a period of ten years (purchase year before 2020). Additionally, since 2016, the government grants a bonus of €4.000 for BEVs and €3.000 for PHEVs (ACEA, 2018). Even though the government is trying to make the purchase of more ZEVs attractive, the overall share of electrified vehicles is rather low, as seen in Chapter 7.2.1. One might ask why there are such vast discrepancies between Germany and Norway, even though both states are offering tax exemptions and subsidies?
The reasons for this depend on two factors. Firstly, consumer behavior and preferences, which will be examined in more detail in Chapter 7.3 Consumer Behavior Expectations. Secondly, the difference in tax systems and retail prices for

new cars between the two countries. In March 2019, a new Volkswagen Golf "Highline" ICE in Germany has an advertised starting price of €27.230 on VW's German homepage (Volkswagen Germany, 2019). This in comparison to the electric Golf (BEV), which is promoted with a starting price of €35.900 (Volkswagen Germany, Die e-Volution des Autos geht weiter. Der e-Golf., 2019). If we look at the Norwegian VW homepage, a new Golf with similar equipment as the "Highline" Golf starts at NOK 345.400 (~ €36.000) (Volkswagen Norway, 2019). The same e-Golf as in Germany has an advertised starting price of NOK 335.400 (~ €35.000) (Volkswagen Norway, e-Golf - Årets beste bilkjøp 2018*, 2019). Not only is the price of a BEV in Norway lower than that of an ICE vehicle, but the government also subsidizes the purchase of BEVs to make the price even more attractive. The Norwegian taxation system is considered very progressive, so that the import duty depends on factors such as engine size, emissions, weight and other factors that can negatively affect pollution (Haugneland, Lorentzen, Bu, & Hauge, 2017). For an even more objective view, other vehicles from foreign manufacturers, such as the electric Nissan Leaf, are also available at lower rates in Norway, starting from NOK 287.900 (~ € 30.000) before VAT exemption (Nissan Norway, 2019). This whereas the price in Germany starts from € 36.800 (before € 2.000 subsidy) (Nissan Germany, 2019).
The price comparisons between different countries show a very clear difference between the various taxation systems and retail prices. Obviously, this leads to a different adaptation of EVs by the end consumer.

7.2.3 Critical Analysis of the Government's Role and Interests

Native manufacturers also represent a cause of the low adoption in some countries. Even though countries such as Italy and Germany have an important automotive industry, local manufactures such as Fiat and Daimler adopted and started the development of EVs at a late stage compared to foreign manufacturers (Sierzchula et al. 2014). Consequently, the interest of local governments was also not present from the beginning, as it was more important that national manufacturers perform on the profitable combustion engine business, as this provides jobs and tax payments.

As in the case of the regulation of CO_2 emissions and fuel consumption in Chapter 7.2.1, voices are repeatedly raised regarding the dilemma of politicians not regulating manufacturers more aggressively. Germany is a clear example of this. First of all, Germany politics is strongly intertwined with the automotive industry, as many important political actors have a professional background stemming from the automotive industry. This has led to very strong lobbying by the automotive industry in Germany (Eiden & Endt, 2017). In addition, the government in Germany has a protective hand over the automotive industry, as this is the most important industry for the country. As an example, in connection with the regulation of CO_2 emissions for vehicles, Angela Merkel pleaded and fought for not overwhelming the automobile industry with strict regulations (DPA, 2018). In recent years, especially after the

diesel scandal around VW, voices became louder and louder to impose a diesel ban in German cities. However, the government is reacting rather contrary to this opinion and presented a package of actions in 2018, which will make it more difficult to ban diesel vehicles in cities by law (Slavik, 2018).
What are the reasons for governments acting in this manner instead of taking action for a more sustainable automotive industry?
The reasons are twofold. Firstly, the automotive industry is one of the most important branches of industry in Germany and responsible for thousands of jobs. Since many German companies did not take the electrification of the automotive industry seriously and thus lagged behind, they try to make time to allow for better positioning of manufacturers. However, not only manufacturers are in need of more time, but also the government. A study conducted by the renowned Fraunhofer Institute, predicts that a total of 110.000 jobs will be lost by 2030 as a result of e-mobility. The reason for this is the changed design of a BEV. Whereas conventional diesel or gasoline powertrains require around 1.200 parts, an electric powertrain only requires around 200. The working time for the production of a BEV is reduced by a total of around one third (Vetter, 2018). As a result, fewer employees are needed in production and jobs are erased. This is naturally not in the interest of the government, which is therefore delaying an immediate turnaround in the automotive industry.
Secondly, the German government generates enormous revenue from taxes on the sale of gasoline and diesel. For petrol, the energy tax (formerly mineral oil tax) accounts for €0,65 per liter and for diesel it is €0,47 per liter. According to the Federal Ministry of Finance, the revenue from the energy tax (excluding VAT) in Germany amounted to almost €40 billion in 2015. Energy tax is one of the largest tax revenue driver and accounts for about 6,5% of total tax revenues. If EVs were to strongly penetrate the market, the government would be forced to come up with a solution. This, as according to the current tax system, electricity generates much less tax in proportion to the discussed energy tax. (Heidenreich, 2017).
Nevertheless, these topics have not yet been openly discussed in Germany, not even by politicians. With this said, it remains to be seen how the situation in Germany will change in the course of time and which solutions politicians will come up with. This is of course also the case for other car nations such as France, Italy and the USA.

7.3 Consumer Behavior and Expectations

In 2011, the consulting company Deloitte conducted a survey for the upcoming e-mobility trend with 13.000 individuals from 17 different countries being subject of the study. The survey exposed a deep gap between consumer expectations and what EVs were able to deliver at that time. Most of the concerns and challenges are more of an infrastructural and technical nature. All this shows the high complexity that goes hand in hand with the rollout of a new technologies that should be suitable for the masses.

In this context, the older survey by Deloitte was consciously chosen to, on the one hand understand the reasons for the low adaptation (see 5.2.3 Government Incentives & 5.2.1 Regulations Regarding Emissions and Fuel Consumption) and on the other hand, draw a comparison to today's figures. In addition, the sample of 13.000 people is very high, which provides a good basis for conclusions. Furthermore, this chapter will also be about

Deloitte first tried to identify groups or segments of potential customers among the interviewees with regard to their interest in EVs. Possible segments were potential first movers, buyers who might be willing to buy an EV, and lastly consumers who are unlikely to think of an electrically powered automobile (Giffi, Vitale Jr., Drew, & Sase, 2011).

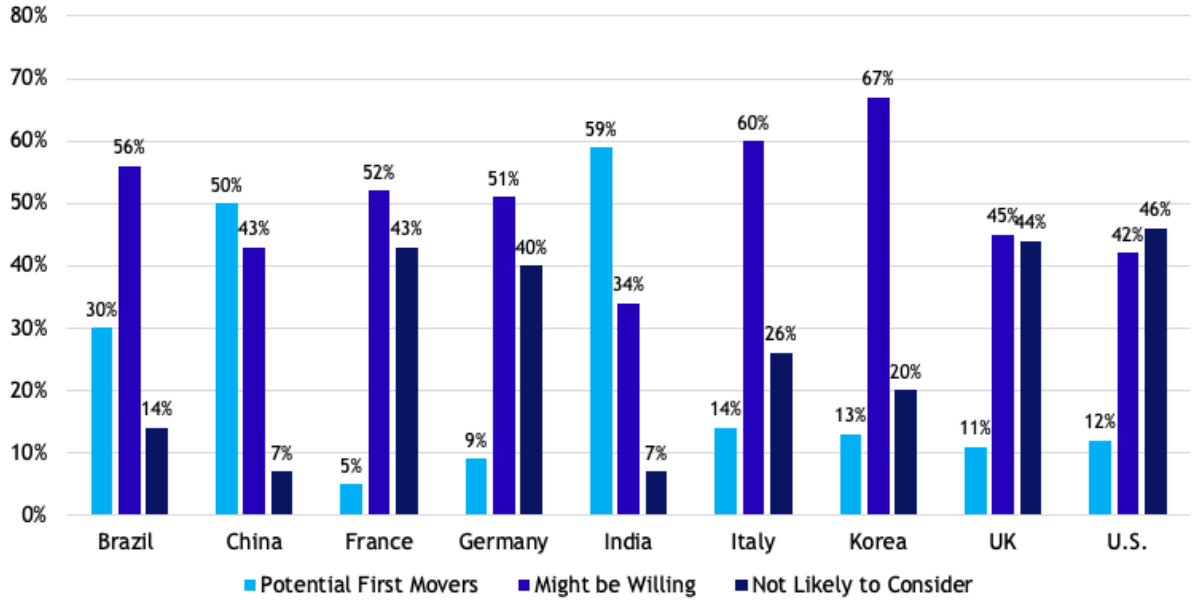


Figure 10: Global Consumer Segmentation for EVs in 2011 (in %)
Source: Author's Chart, According to (Giffi, Vitale Jr., Drew, & Sase, 2011)

As one can see in Figure 10, nations with a long-lasting automotive history had very high numbers for "Not Likely to Consider". For example, 40% of the individuals asked in Germany would not consider buying an EV, in the US 46% and in France 43%. Surprisingly, individuals from BRICS states such as China and India answered less conservatively. Both countries had the highest numbers of "potential first movers" with respectively 50% and 59%.

A lower discrepancy can be observed when looking at the results for purchasing criteria such as charge time and purchase price. Globally, the majority of consumers expect EVs to be charged quickly, preferably within a period of 30 minutes. Consumers also have high expectations with regard to price. The majority wants to pay either the same price or less for an EV compared to an ICE (Giffi, Vitale Jr., Drew, & Sase, 2011).

However, there are different opinions regarding the range. The interviewees were asked, for example: *"What is the minimum range that an electric vehicle would need before you would consider buying or leasing it?"*. The most cumulative percentage of respondents answered with around 480 km. The industry, on the

contrary, was and is still not technologically ready for these ranges. Therefore, this large gap between potential customers' expectations and actual offering regarding EVs in 2011 is with certainty one significant reason for the initial difficulties and late adaptation of EVs. Especially, in the so-called "auto nations" Germany and France only 13% and 16% would consider buying an EV with a 160 km range. However, the trend of BRICS states being early adaptors proceeds here. In India, 47% would accept a possible range of 160 km, followed by Brazil with 42% and Chinese potential buyers with 31%.

According to the survey, only 2-4% of the 13.000 respondents, had expectations regarding range, charge time and the purchase price met with the market offerings in 2011 (Giffi, Vitale Jr., Drew, & Sase, 2011). All these factors can be seen as reasons for the late adaptation of EVs in the world.

Nevertheless, not only is it the fault of the automotive industry, but research has also shown that consumers generally tend to have higher barriers for adaptation to new technologies, such as the lack of knowledge of potential users, initial costs which create uncertainty and very low tolerance to risk (Egbue & Long, 2012).

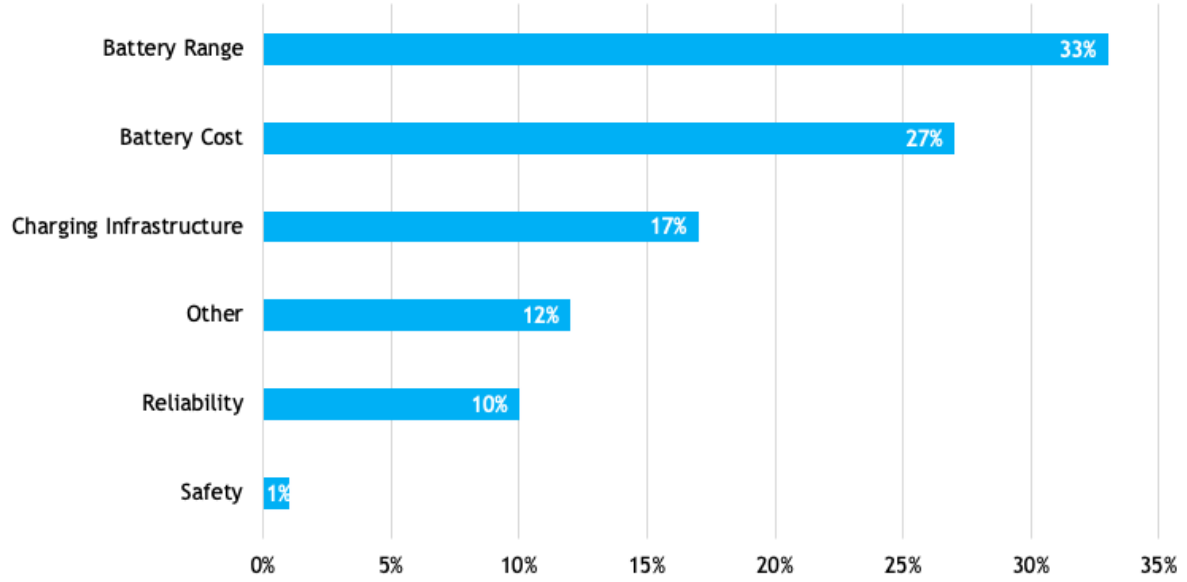


Figure 11: Concerns about EVs (in %)
Source: Author's Chart, According to (Egbue & Long, 2012)

Another survey conducted in 2012 (n=481) at the Missouri University of Science and Technology also examines consumer confidence and acceptance of EVs. As shown in Figure 11, the range is once again the biggest concern for EVs with 33%, followed by battery cost (27%) and charging infrastructure (17%). Mainly due to battery costs, EVs, especially PHEVs and BEVs, are significantly more expensive than ICEs. Consequently, the purchase prices are substantially more expensive, which as we have read above, does not meet the expectations of the consumers. The researchers describe their survey as above-average technology-oriented, but the uncertainty of battery technology and the sustainability of the fuel source are still present (Egbue & Long, 2012).

However, seven to eight years after the survey, technology has advanced and manufacturers have taken action. The average overall range of BEVs has increased and batteries have improved (see also Chapter 6.1). For example, the BMW i3, was one of the first European EVs to address the mass market with an alternative powertrain. In 2013, when the car was released, BMW declared that a range of 130 km was possible. Now, the new BMW i3 released in 2019, promises a range of 246 km (Korosec, The 2019 BMW i3 now has 153 miles of range thanks to a bigger battery, 2018). This trend can also be observed with other OEMs and their EVs. German manufacturers in particular have a lot of backlog demand. For instance, the newly introduced luxury SUV e-tron from Audi guarantees a range of over 400 km (Fischer, Götze, Kacher, & Wolff, 2018).

A further topic in the surveys of Deloitte (2011) and the Missouri University of Science and Technology (2012) is the opinion of consumers on the subject of charging. Whether it is the charging time or charging infrastructure, consumers have high expectations regarding the charging of EVs. The latter is the third biggest concern of consumers in the survey of Missouri University of Science and Technology (2012). In 2011, however, the reality was far more than 30 minutes charging time. Of course, there are quick chargers, which can charge a vehicle in up to 30 min. Unfortunately, quick chargers are difficult to find on traditional home chargers. The general public will probably charge at home with a charger that can take 3-8 hours to reach a fully charged vehicle, depending on battery size and type (Giffi, Vitale Jr., Drew, & Sase, 2011).
Comparing these values to the standards of today, these has not changed greatly. In fact, the most used “wallboxes” with ~3,6-22 kW may take 2-6 hours to fully recharge an EV. In this context, the conventional household socket takes the longest and is probably almost useless to many users. It can take up to 14 hours to fully recharge the vehicle. This makes it almost impossible for daily use (Meineke, 2018). Deloitte’s (2011) given figures for charging with a household socket were between 10 and 20 hours. In fact, these values have not improved over the years as the charging power remains at 2,3 kW, but batteries increased in size.
On the one hand, prices of EVs are slowly declining and manufacturers are focusing on offering affordable EVs with bigger batteries, allowing higher range. On the other hand, only expensive solutions are available to consumers wanting to recharge their vehicles in a short-time (e.g. Tesla Supercharger). Does this mean that charging could soon become the top barrier for EV adaptation?

In general, consumer expectations of EVs were already high and have not decreased by any means, even if, technically, these expectations tend to increase over time. Since vehicles with conventional powertrains set a very high standard in terms of range, price and comfort, it is becoming increasingly difficult to convince drivers to give up certain conveniences such as refueling in a short time at any available gas station. Owning and using an EV means planning where to charge, calculating your

range and rather stressing than relaxing when travelling. Manufactures and governments need to take away these new rising concerns that experts describe as "range-anxiety" by expanding the charging infrastructure and improving the ease of recharging. Moreover, manufacturers also need to educate their consumers about EVs. Although the perception of electric cars being a more sustainable future means of transport, many consumers simply know far too little about EVs compared to combustion cars. A very good example of this is Nissan. The company has introduced an education series on the topic of range to further market its Nissan LEAF model (Ratinaud, 2019).

7.4 Charging Infrastructure

The current options for charging EVs are everything from connecting to a normal socket to investing in a network of charging stations. Each option has a different charging level. Therefore, it is necessary to clarify the different levels. In total, there are three standard charging levels for EV charging.

Public charging stations for EVs will one day be the gas stations of tomorrow. As already mentioned, EVs require longer charging time than refueling a gas tank. The challenge now is to make charging as easy and available that drivers lose the so-called "range anxiety" and thus, confidence in EVs increases. This clearly leads to the questions of who's responsibility it is for making this possible, if it even is possible and how manufacturers can contribute to this evolution?

	Normal Chargers		Rapid Chargers
	Level 1	Level 2	Level 3
Voltage	100 - 120	208 - 240	480
Charge Power (kW)	1.8 - 1.9	3 - 20, typically 6	typically 50, occasionally 20
Estimated Charge Time	200 km : +/- **20 h** 400 km : +/- **43 h**	200 km : +/- **5 h** 400 km : +/- **11 h**	80% of 200 km : +/- **0,5 h** 80% of 400 km : +/- **1 h**
Estimated Price	$400 - $1.250 per port	$2.500 - $4.000 per port	$30.000 - $55.000 per port
Car Model	All EVs	All EVs	Only BEVs (mainly Tesla)

Table 7: Charging Level Summary
Source: Author's Chart, According to (Charge Hub, 2019)

Table 7 shows that these levels can differ in many different factors. As a consumer, it is particularly important to check beforehand whether the own car is compatible with the charging station and how quickly the charging process will be. Level 1 charging stations are usually very slow with charging times up to 40 hours and therefore not helpful for daily use. This improves significantly with level 2 and 3 stations. Only from level 3, the charging time corresponds to the demands of the

consumers with a time between 0,5h – 1h (County of Santa Clara, 2018). However, with an average price of $44.000 for the setup of the charging station, these are considerably more expensive than Level 1 and Level 2 ports. All in all, the driver must plan his or her journeys in advance in order to reach the desired destination. Not only the level of the charging stations must be considered, but also whether the connector type of the station is suitable for the car in question. Unfortunately, the manufacturers still do not use a standardized connector. Tesla, therefore, provides its customers with adapters to eliminate this barrier (Charge Hub, 2019).
All of these factors pose daily challenges to EV drivers, making it more difficult to comprehensively adapt EVs and making them less user-friendly. Nevertheless, there are initiatives to promote private charging stations at home, as well as collaborations between OEMs to build a network of shared charging stations. The main challenge is, therefore, to expand the charging infrastructure throughout entire regions.

7.4.1 Home Charging

Many cars remain parked at night, meaning that situation by nature poses an opportunity for charging EVs. Nevertheless, a carport and a private charging box are necessary. However, to achieve this, customers need to have a lifestyle suiting the charging behavior. The installation of wallboxes in garages and carports is very simple. Additionally, it is the cheapest way of charging, as in most countries, residential electricity is cheaper than industrial or commercial electricity. Furthermore, overnight electricity prices are, until now, lower (Engel, Hensley, Knupfer, & Sahdev, 2018). Another benefit of installed residential charging station is that these automatically expands the charging infrastructure. Shared charging stations, for instance with neighbors, make the station available to even more people and improve thus make it easier to own an EV. The Swiss startup eCarUp even monetizes this idea. Similar to Airbnb's business model, users can provide their own charging stations on a platform for other EV drivers in exchange for a fee (Gerding, 2018).
In many countries, governments already offer subsidies when installing a charging station. For example, the German partly city-owned electricity distributor N-ERGIE in the city of Nuremberg offers its customers a subsidy of €250 for the installation of a private charging station (N-ERGIE, 2019). However, as access to a private home and/or a carport is of crucial importance, EVs are more suitable for people living in non-urban areas.
According to McKinsey & Company (2018), charging will move from home charging stations to more public stations, especially in Europe. The reasons behind this is that more and more people from middle- and lower-income households will be EV owners in the future (Engel, Hensley, Knupfer, & Sahdev, 2018).

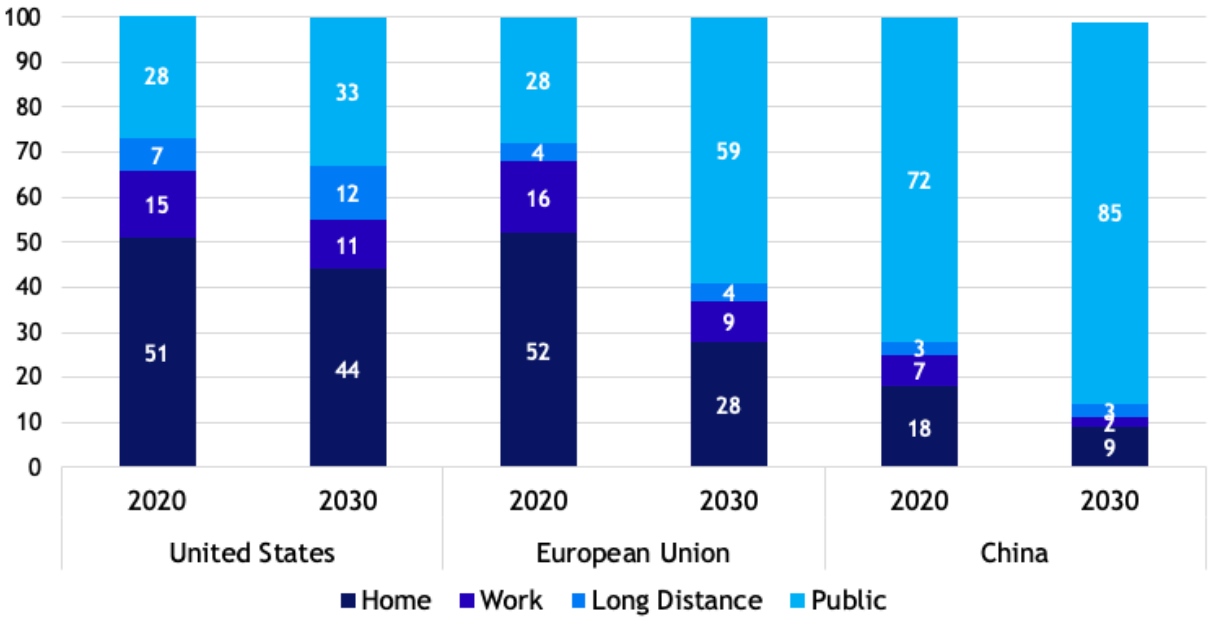


Figure 12: Public Centred Scenario for EV Charging by Region (in %)
Source: Author's Chart, According to (Engel, Hensley, Knupfer, & Sahdev, 2018)

In a public centered scenario, the predicted number of home-charged EVs in 2020 in the European Union will be 52%. However, this figure is expected to shrink to about 28% by 2030. The same scenario is predicted for China, where the importance of public charging is already high and, in the future, will increase from around 72% in 2020 to approximately 85% by 2030. This is due to the structural boundaries of high-density urban cities, which have a larger share of street and garage parking lots. Both factors are the catalysts for increased public demand. A similar scenario is also expected in the United States, where no tremendous change is expected (Engel, Hensley, Knupfer, & Sahdev, 2018). Consequently, the trend is toward public charging, as EVs go mainstream.

7.4.2 Public Charging

With regards to public charging stations, there are different approaches to promote the expansion of the grid. In order not to exceed the scope of the thesis, the most prominent examples from important regions for the automotive industry are discussed below.
Besides having level 1 or 2 chargers at home, EV drivers may use publicly available charging stations. However, an improvement and expansion of the charging grids are necessary. This can be expensive for governments and municipalities. For example, it may cost the greater Seattle area from $500 to $5.000 per vehicle depending on which type of charging station is installed and how many EVs are available (Neubauer & Wood, 2014). According to McKinsey & Company (2018), by 2030 the number of required chargers in the US alone will be around 13 million, which would require a capital investment of $11 billion. 19 million charging stations are projected to be available across Europe, China and the US by 2025. This figure is expected to grow

to 42 million in 2030. In order to realize this, these three regions are required to invest approximately $47 billion (Engel, Hensley, Knupfer, & Sahdev, 2018).
This raises the question of who will provide the enormous amounts of capital necessary to close the charging gap?
In Germany (as of April 4, 2019), for example, 8.446 charging stations are available with 16.736 charging points, meaning an average of two EVs being able to charge at the same time at one station (Bundesnetzagentur, 2019). Most of these stations are installed by private electricity companies or on a municipal level. In 2017, the German government started a program for an expansion of the charging grid with the goal of 15.000 installed charging stations around the country. However, the government does not install the charging stations itself, but supports the installation with subsidies from a fund of €300 million (Brien, 2018).
In addition, in China, the expansion of the charging infrastructure is in full swing. The central government chooses different pilot cities such as Beijing, Shenzhen and Shanghai. These cities should provide one charge point for every eighth EV in the city. Furthermore, these should be located with a maximum distance of 1 km from each other within city center areas (Hall & Lutsey, 2017). These cities and the national utility "State Grid Corporation of China" are working closely together to achieve the goal and provide sufficient charging stations in the cities. This should also be implemented in smaller cities in the future in order to ensure a satisfactory network of stations in the most important Chinese cities. As mentioned, such an approach is particularly necessary as China has a more concentrated population in urban areas.
The Norwegian approach for its highly needed charging grid is mainly offered by Enova, a state-owned company committed to environmentally friendly energy production. Even though Norway has a high EV share in the national fleet, the grid is not yet sufficient, especially in the less populated north. Unlike in China, many people mainly charge their EVs at home, where charging boxes are installed (Hall & Lutsey, 2017).
A different approach can be that EV producers also install stations. Tesla proves a good example as the company is setting up a worldwide network of fast charging stations, some of which are free for its customers and can be used for other EV drivers for a fee. In this context, Daimler, BMW, Ford and VW (incl. Porsche and Audi) joined forces to create the joint venture IONITY. Their goal is to build a high-power network of stations for EVs on major highways in Europe. Here, the focus is more on longer distance travelling (IONITY, 2019).

A combination between governments, privately owned companies and automotive manufacturers could be the step in the right direction. Similar to having gas-station from different providers at the moment, the future could offer a broad charging grid from different providers.

7.5 Battery Technology

Probably the most important component in an electric car is the battery. Current battery systems not only have a limited range but are also expensive to purchase (see Figure 14). The lifecycle is in need of improvement and the subsequent environmentally friendly disposal of the replaced batteries is not yet sufficiently implemented. Furthermore, the battery also poses the biggest challenge for OEMs, as it is a component that has not been relevant for ICEs and also requires completely new know-how in terms of materials, production, safety etc. At first, it is important to get a basic understanding of current EV batteries and alternative technologies.

Currently, most EVs have integrated lithium-ion batteries. These are high-voltage batteries, which provide the electrical energy for driving an EV. They are also known as traction batteries and consists of three main components: the battery cells due to their function as energy storage devices, the battery package with protection and cooling function and the battery management systems for monitoring the state of charge of individual modules or cells. On the process side, the production of high-voltage batteries for EVs requires development of expertise in various areas, depending on the value creation strategy (Schnettler, Vallée, & Kampker, 2018).

Given the, still, limited range that battery electric vehicles can achieve today, fuel cell vehicles are still the subject of public debate. The higher energy density, with which the hydrogen can be stored in the tank compared to the electrical energy in the battery, offers the advantage of higher ranges. However, the principle of the fuel cell vehicle has not yet established itself on the market. In addition to the high acquisition costs of the vehicles, the poorly developed refueling infrastructure and the safety concerns of customers with regard to the pressurized storage of hydrogen are particularly inhibiting factors (Schnettler, Vallée, & Kampker, 2018).
In the next step, it is of importance to examine the suppliers of lithium-ion batteries and cost structure in EV production of more closely.

Lithium-ion batteries use rare earth elements, such as cobalt or nickel, to store energy (Heymann, Koppel, & Puls, 2013). Currently, these batteries are mainly produced in Asia. As we can see in Figure 13, the top seven manufacturers, based on market share, are Japanese, Chinese and Korean companies such as CATL (Contemporary Amperex Technology) or Panasonic Sayo (Holzmann, 2018).

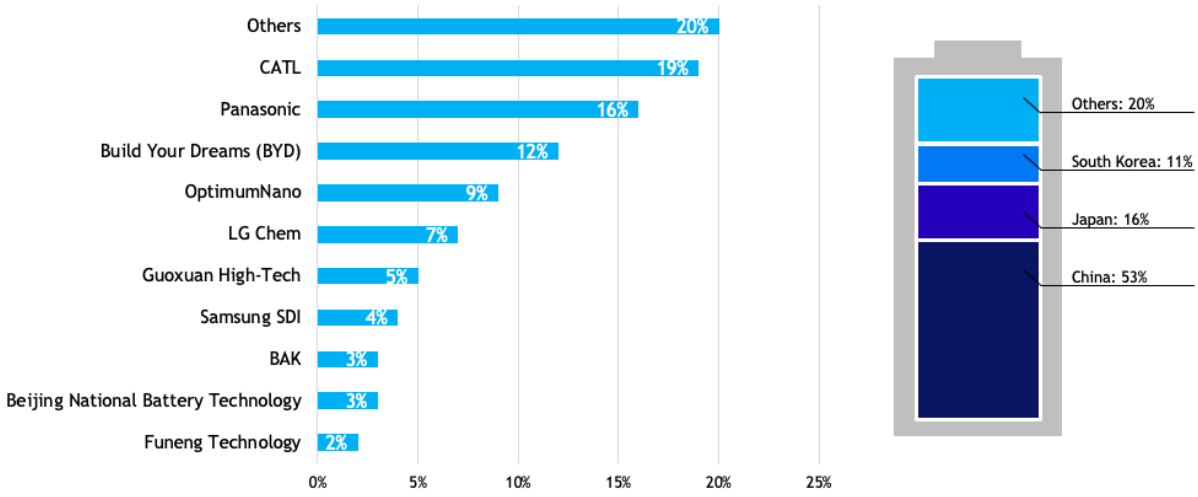


Figure 13: EV Battery Global Market Share in 2017 (in %)
Source: Author's Chart, According to (Holzmann, 2018)

Also, according to predictions from Bloomberg, China will be the country taking the lead in battery production. By 2021, China will produce 70% of the world's EV batteries (Tanaka, Kawakami, & Omoto, 2018). This is due to the fact that China is dominating the supply of rare earths. In 2018, around 80% of the world's supply came from Chinese suppliers (Roskill, 2018). Logically, this results in a dependency on Asian or more precisely on Chinese suppliers for many car manufacturers in Europe and the United States.

Looking at the cost structure in EV production in the next step, it becomes clear how precarious the situation is for Western manufacturers.

In 2018, lithium-ion batteries cost about €135 per kilowatt hour (kWh). Accordingly, a battery pack with 25 kWh, which enables an electrically driven range of up to 280 km, will cost around €3.500 in production costs. However, the price of batteries has already fallen significantly in recent years. As a result of product and process innovation, the battery price has fallen by 140 €/kwh from 2015 to 2018 (Horváth & Partners, 2018). However, how large is the share of the battery in the manufacturing costs of an EV?

By comparing manufacturing costs of an ICE with those of an EV, it becomes very clear that the battery is the largest cost factor in EV production.

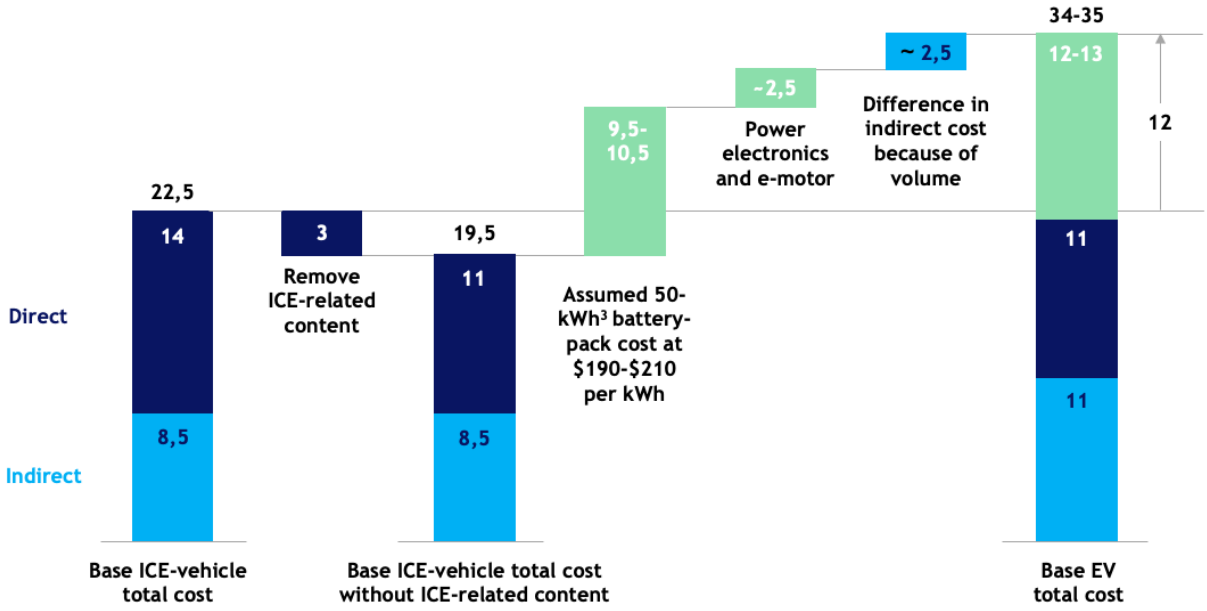


Figure 14: Cost-Walk of ICE to EV in 2019 (in $ thousand)
Source: Author's Chart, According to (Baik, Hensley, & Hertzke, 2019)

At a cost of $9.500 - $10.500, the battery accounts for about 30% of the total cost when producing an EV. In an ICE the main component is the combustion engine, whereas in an EV, the e-motor plays a less important role. At approximately $2.500, the cost of the electric motor is comparatively low compared to the battery.
Conversely, this means a shift of the most important component in the car. The focus of an ICE is definitely placed on the combustion engine as the most important component. With EVs, however, this is clearly on the battery. A shift in the core component, hence, also requires a shift in the core competence of car manufacturers. Thus, many established manufacturers have to build up this core competence in order to be successful on the market. This creates a strong dependency on suppliers and lowers the margin of sales. This since the battery has to be purchased from a third party charging a higher price, which ultimately leads to lower generated revenues.
Consequently, based on these market circumstances, it can be concluded that traditional manufacturers must build up strong competencies in this area quickly in order to end their dependence on Asian suppliers.

Still, there is uncertainty among experts and the public regarding the use of batteries and their charging structure. Two fundamentally different approaches are currently emerging in this area; on the one hand, there are many supporters of permanently installed batteries in vehicles that are regularly recharged. On the other hand, concepts based on interchangeable systems are considered in order to address the problem of range. With these systems, the batteries in the vehicle are not recharged, but replaced regularly at service stations. The arguments for an exchange system (problem of range is partly solved) are countered by the justified objections that such systems involve high logistics and storage costs and cause high infrastructure costs (Schnettler, Vallée, & Kampker, 2018). Against a fixed battery, however,

speaks the fact that the problem of continuous loss of power with lithium-ion batteries has not yet been solved. This problem is also known from smartphones and laptops, where the lithium-ion battery performance deteriorates over time. Another alternative is battery leasing, in which the battery can be leased from the manufacturer and promises permanent maximum battery performance. This significantly reduces the price of an EV, as the battery is only leased and can be replaced if the performance is reduced (Schnettler, Vallée, & Kampker, 2018).

7.6 Battery Electric Vehicle Specifications

One term that is often used in connection with BEVs is the EV platform. In the case of automobiles, a platform is a technical basis on which various models are externally based. These include inner parts of the wheel arches and the electronic architecture as well as other components that are not directly visible, such as parts of the chassis and heating. The platform is also used to build the vehicle's interior. Technical components, such as the engine or transmission, can be assembled on the platform from a modular system, so that individual technical developments can be used in several models (Braess & Seiffert, 2003).
Car manufacturers want to produce a maximum of different types and variants on the same technical basis with a minimum of development and investment costs. In addition, purchasing conditions and production costs are improved as a result of the large number of platform parts produced (Braess & Seiffert, 2003).
Regarding platform development, there are two possible concepts: Purpose-Design and Conversion Design. The first means that an independent new vehicle is developed around a new platform. In conversion design, however, an existing ICE platform is used as the basis for the development of an EV (Karle, 2015).
Here, e-mobility, with its relatively smaller size and contours of the electric motor and battery components, offers the opportunity to develop a vehicle platform that can be equipped with a variety of body components and produce a variety of vehicle concepts. However, for this reason, EV platforms look very different and consequently makes it very difficult to produce an EV based on an ICE platform. This finding also poses major challenges for conventional manufacturers at present, which becomes very clear in the course of the analysis.

In addition, with regard to the sale of BEVs, the business model of all manufacturers needs to be rethought. For example, if we look at the sale of ICE models, they are very dependent on expensive upgrades in the vehicle composition at the time of purchase. The price of a basic version of a vehicle can therefore be increased by upgrading the engine, safety or comfort, etc. The idea to increase the profitability of a low-margin, basic version with optional high-margin features, does not work with BEVs anymore.
There are two reasons for this. Firstly, there are no big differences in performance, so there is little room for expensive upgrades, and secondly, the basic BEV versions already contain many options, as the customer must be offered attractive features

due to the high BEV prices (Erriquez, Morel, & Moulière, 2017). Consequently, it remains interesting to see how both manufacturer groups deal with this development and what solution they provide for it.

8. Analysis of the e-Mobility Strategy of Conventional Car Manufacturers

After understanding the complex structure of the automotive industry and, in particular, its newly growing e-mobility field, it is important to understand how manufacturers are addressing all these new challenges. E-mobility as a trend puts external pressure on OEMs, such as different requirements and challenges from governments, customers, competition and many more market actors. It forces manufacturers to reposition and rethink their strategy.
Product portfolios need to be realigned and scrutinized, as many manufacturers have difficulty meeting consumer needs. In addition, difficulties associated with the creation of new zero-emission powertrains pose new challenges. In public opinion and also in media, established car manufacturers are strongly criticized for addressing this task too late and for having rested on their market power and strong market entry barriers. However, this has changed enormously with the disruptive character of the EV. New emerging manufacturers shake up the industry and force a historical transformation of the automotive industry.

Consequently, it is interesting to see which approach emerging and conventional manufacturers are taking on to tackle this transformation. In order to obtain a differentiated overview of the manufacturers' approaches to these new challenges, their strategy regarding product portfolio, battery technology and charging infrastructure will be evaluated closely. This will help to see how certain manufacturers face these challenges and what their perceived answer is to succeed on the market. In order to assess manufacturers in a similar way, it is necessary to compare them from a global perspective and observe specific patterns.
The emphasis will also be on the manufacturer as a whole, its nature as a company and its surrounding business. In order not to go beyond the scope of the thesis, the focus will be put on passenger vehicles that are suitable for the masses in terms of price, availability, velocity, design, space and range.

The reasoning behind the selection of the investigated companies will differ in the group of the emerging manufacturers compared to the group of conventional manufacturers. In the latter case, the selection is based on the geographical origin and headquarters of the producer. To obtain a global overview, manufacturers are selected from the world's three major automotive hubs, namely North America, Europe and Asia.
The selection in the case of emerging manufacturers cannot be made based on these criteria. This due to for instance, difference in the state interest, as well as the

nature of the automobile hub. For example, there is currently no manufacturer in Europe with a global orientation that aims to expand its product portfolio. Manufacturers such as Streetscooter or Uniti are much more active in niche markets or highly specialized segments because of their value proposition. China, however, is home to many new producers, some of whom are state-owned or highly subsidized by the government. Consequently, factors such as the size of the portfolio, access to information or the state of development are also taken into account.

8.1 Conventional Manufacturers

Firstly, it is important to define conventional manufacturers more precisely and how they differ from non-conventional manufacturers. What specific characteristics do they have compared to emerging manufacturers?
An essential aspect is that conventional manufacturers are the companies that founded the automotive industry and had a very important influence on the industry - i.e. these companies exist from the beginning, the terminology of the car and these companies go hand in hand. Their history and simply their long-lasting existence make them conventional. Examples of these are companies such as Daimler AG, Ford Motor Co., Volkswagen AG, Toyota Motor Corp. and Fiat Chrysler Automobiles. All these companies have hugely contributed towards the auto industry as it is known today – and they are still contributing to an important part. As aforementioned, these conglomerates globally still account for millions of sold vehicles.
Another key aspect is that it lays in the nature of these manufacturers to use internal combustion engines for their vehicles as their main driving trains. Partly also because of their historical background as many of these companies started as engine manufacturers.
Moreover, many of these companies were part of the complete rollout of the auto industry as it is known today. This, no matter if it is Toyota's lean manufacturing, Henry Ford's mass production or the boxer engine invented by Carl Benz. Every car brand had a significant era in the last century and contributed its part to the automotive industry so that it can exist as it is known today.
Nevertheless, many conventional manufacturers did not recognize the disruptive nature of EV early enough and are now struggling with the electrical transformation of their product portfolio. Therefore, it is also interesting to analyze the product portfolio of each manufacturer in regard to its electrification. The aim is to see whether these companies are too late in entering the market with EVs compared to the new manufacturers.

As aforementioned, the selection of the analyzed manufacturers is based on, among other reasons, the geographical location of the company. This as the particular home markets differ with regard to the requirements or the corporate culture, which has a considerable influence on the strategy and innovative strength of the company. This will become obvious in the course of this chapter. In addition, the requirements of the governments in the countries of origin differ with regard to CO_2 emissions or

incentives/subsidies. All these factors have enormous influence on the electrification of the product portfolio. Consequently, one company each in North America, Europe and Asia will be analyzed.
In order to carry out a selection in the individual automobile hubs of the world, we first look at a list of the largest automobile manufacturers. From this a selection of the companies can be carried out. For this purpose, we look at the data of the Global Auto Database, more precisely their ranking in terms of the bestselling manufacturers of light vehicles (cars & vans) in 2018.

Rank	Company	Sales (in units)	Share
1	Volkswagen Group	10.810.349	11,6%
2	Toyota Group	10.435.420	11,2%
3	Renault Nissan Alliance	10.436.982	11,1%
4	General Motors	8.643.003	9,2%
5	Hyundai-Kia	7.416.346	7,9%
6	Ford Group	5.632.734	6,0%
7	Honda Motor	5.234.818	5,6%
8	Fiat Chrysler Automobiles	4.825.446	5,2%
9	PSA	4.084.845	4,4%
10	Suzuki	3.306.242	3,5%

Table 8: World Ranking - Best Selling Vehicle Manufacturer with Market Share in 2018
Source: Author's Chart, According to (Global Auto Database, 2019)

As can be seen in Table 8, despite the diesel scandal in September 2015, Volkswagen sold the most light vehicles in 2018 worldwide. Consequently, it is logical to take a closer look at Volkswagen as a European representative. Close behind is the Japanese manufacturer Toyota, which, as an Asian company, the next company that will be analyzed. On place four follows General Motors and on six Ford, as North American representatives among the car manufacturers. According to the logic applied, an analysis of General Motors would have to be carried out. However, since Ford has done very little in the field of e-mobility in recent years and finally presented its e-mobility strategy at the beginning of April 2019, Ford will be analyzed in the following chapters. This is due to Ford's problems regarding the electrification of their product portfolio and the timeliness of their strategy.
Before we move on to the analysis of the individual conventional manufacturers, it is important to introduce the self-created Vehicle Type vs. Launch Date Matrix (VTD-Matrix). The purpose of this matrix is to analyze the electrical product portfolio (only passenger vehicles) in combination with the timing of the sales launch. This means that the electrical models are placed in relation to other manufacturers and the

market conditions with the help of their launch dates. The aim is to find out whether the companies have not recognized the disruptive nature of EVs and are entering the market too late with their models.

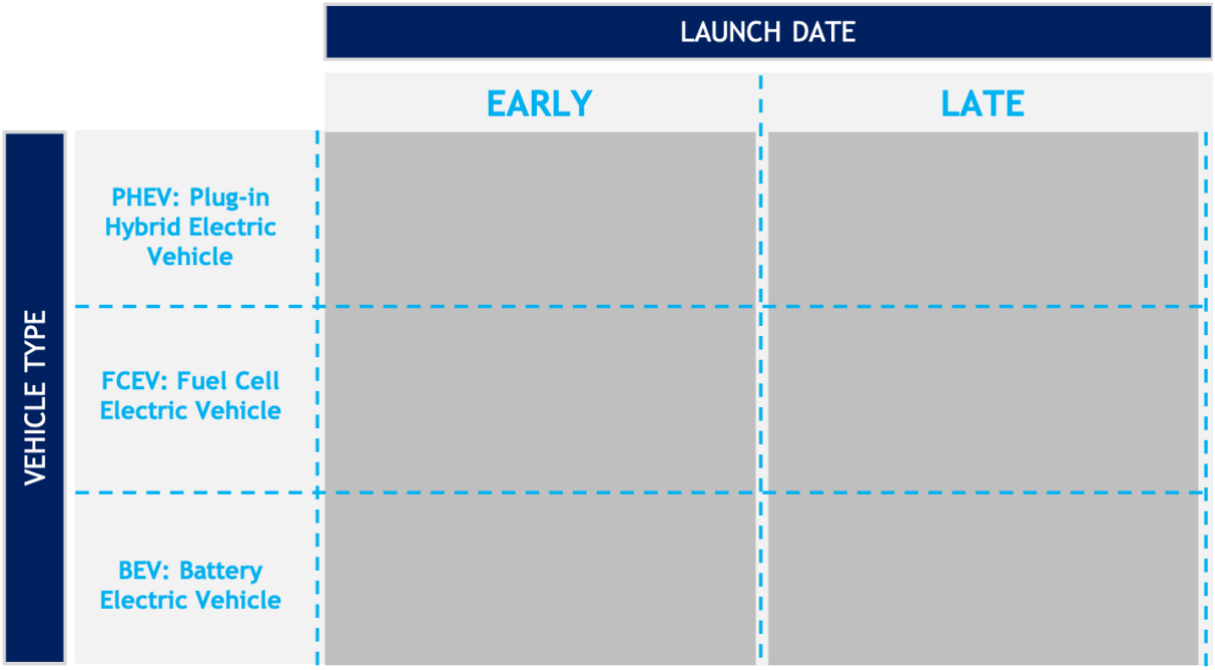


Figure 15: VTD-Matrix (Vehicle Type vs. Launch Date)
Source: Author's Chart

To remove complexity, we only consider three possible powertrain types – PHEV, FCEV and BEV in the matrix. The reason for selecting these three vehicle types is that they are seen as the future of the automotive industry and fall under the category ZEV.

Regarding the time component with the attributes "Early" and "Late", we look at the more recent history of EVs. Here, the American company Tesla must be taken into consideration, as the Tesla Roadster is considered a pioneer and is responsible for the start of the electrification of the automotive industry. The Tesla Roadster was introduced in 2006 and went into series production in 2008 (Kuther, 2017).

If we know now that the development of a new car takes three to four years and is then sold for six to eight years, then in the BEV category we can speak of "Late" market entry when the model is presented five years after the launch of the Tesla Roadster (Grünweg, 2013). In the case of an ICE, three years would already be very late, however two more years have been added, since BEVs constitute disruptive innovation and new expertise has to be acquired. Hence, all market launches after 2011 fall into the category "Late".

Although Toyota developed the first HEV car ever created, it was Renault that introduced the first PHEV car to the market in 2003. Renault used a nickel-cadmium battery for its electric version of the Kangoo van, but this had more of an experimental character and the production was already terminated in 2007. GM then introduced the Chevy Volt, with the first commercially available PHEV for sale in 2010 (U.S. Department of Energy, 2019). Due to the commercialization, the GM

Chevy Volt is therefore taken as the benchmark for PHEVs. As PHEV models do not make the combustion engine redundant, and are not in need of complete transformation, all PHEV models which were launched three years after GM in 2010 are considered “Late”.

For the fuel cell technology, however, the history is younger. Toyota brought the first commercial model “Miari” on the market in 2014 (Qin, Raissi, & Brooker, 2014). As this technology is still not mature enough and experimentation is still ongoing, models created five years after the first Toyota model, are considered "Late".

8.2 Volkswagen Group – “Together – Strategy 2025”

What distinguishes Volkswagen from for example, Ford or Daimler, is that Volkswagen did not contribute to the creation or improvement of the vehicle in the early days of industry. Volkswagen's main intention can rather be abstracted from its name. In German the word “Volk” stands for people and “Wagen” for vehicle, meaning that the company builds its products based on the very basic idea to create cars for “all people”. The reasons behind this come from the Nazi dictatorship of the time, leading the vision of building cars with the main attributes of being reliable, affordable, practical and allowing mobility for everyone. However, over the past decades, Volkswagen abandoned this main idea. This especially when looking at the current portfolio, where the company offers cheaper cars simultaneously as offering top-range sedans and SUVs.
Over the past decades, the company has developed into the largest European manufacturer with the help of many acquisitions and successful growth strategies. Thus, the company sells cars under brands such as Audi, Bentley, Porsche, SEAT and Škoda. Since many years, VW and Toyota are battling for the leading position in the global market in terms of highest sales figures. Volkswagen could consolidate its position in 2018 of being the manufacturer with the most sold light vehicles globally, according to Table 8.
Nevertheless, the German car maker has lost a lot of its charm. This not only for underdelivering on its promise of offering true “people cars”, but also for its numerous scandals, such as the most recent “Dieselgate”. Germany’s biggest employer is forced to act, as governmental and consumer pressure as well as financial problems pose great challenges for VW.
In the following part, we first examine the strategy of the VW Group and then focus on the VW brand, which is the most important brand in the company’s portfolio.
The following analysis is extracted from VW Group’s strategy presentations, press releases and an interview conducted with VW Group's e-Mobility press spokesperson. The company strategy focuses on more factors than electrification and alternative mobility, for example, financing strategies and modular building kit solutions. However, in the following the emphasis will lay on VW AG’s strategy regarding electrification.

VW's old strategy, which was valid between 2008-2018, came to an end and besides that, the allegations stemming from the "Dieselgate" scandal in 2016 forced Volkswagen to restructure and rethink its strategy from scratch. A new chairman took charge of the group and a new strategy "Together – Strategy 2025" was launched to work on the upcoming challenges and new competence fields. Four building blocks define the strategy and consist of the following:

1. Transform Core Business
2. Build Mobility Solutions Business
3. Secure Funding
4. Strengthen Innovation Power

Moreover, 16 different key initiatives were created and allocated to the four pillars in order to show the goals for "Together – Strategy 2025" (Volkswagen Group, 2018). Many of these initiatives focus on new strategic capabilities in regard to electric mobility and autonomous driving. One key goal for the VW Group is to develop battery technology as a new core competency. The logical reason for this is to end the dependence on Asian suppliers who currently supply the VW Group with batteries for their EVs and to earn higher margins with their BEV sales. In addition, another key objective is to advance the electrification of its product portfolio across all its brands. VW wants to be a driving force behind the expansion of e-mobility and EVs are supposed to become the new hallmark of the group. With its electrification offense, VW plans to launch more than 30 new BEV models before 2025 and additionally plans that 20-25% of their total sales will come from EVs (2-3 million vehicles p.a.).
Moreover, the company has also changed its vision and mission statements. VW Group's vision currently is; "*We are a globally leading prover of sustainable mobility.*". The terminology *sustainable* shows a clear focus towards greener, less- or non-polluting mobility such as electric driven, hybrid driven or fuel cell driven powertrain solutions (Volkswagen Group, 2018).
In regard to electrification, this strategy creates the framework for the whole VW Group and the affiliated brands to build their strategies inside this framework with an extra focus on different competences, targets and customer groups.

8.2.1 Volkswagen Brand – Strategy and E-Mobility Initiatives

Shortly after presenting the "Together – Strategy 2025", the VW brand also launched a new strategy, which is aligned with the VW Group's future business plans. "Transform 2025+" is the new brand strategy for the manufacturer, which schedules until 2025 and consists of three mains phases:

1. Radical Conversion (2015 – 2020)
2. Leap to the Top of Electric Mobility (2020 – 2025)
3. Major Transformation (2025 – 2030)

The first part of the strategy mainly focuses on organizational structures and reorganization in order to enforce its global brand position as a manufacturer with the aim to have the highest sales volume on a global scale. Moreover, this phase should create the base for the aimed market leadership in e-mobility and connectivity, which will be of high importance in the next two phases.
From 2020 onwards, the main focus is put on the electrification of the product portfolio. However, this does not mean that the conventional portfolio will be abandoned, because VW's strategy is to produce and sell ICEs until 2030 and most likely beyond. VW wants to be the first choice for the ambitious middleclass and wants to lead the transformation in the industry. Expressed in figures, VW wants to be the first manufacturer with 1 million EVs on the streets (Volkswagen, 2016).

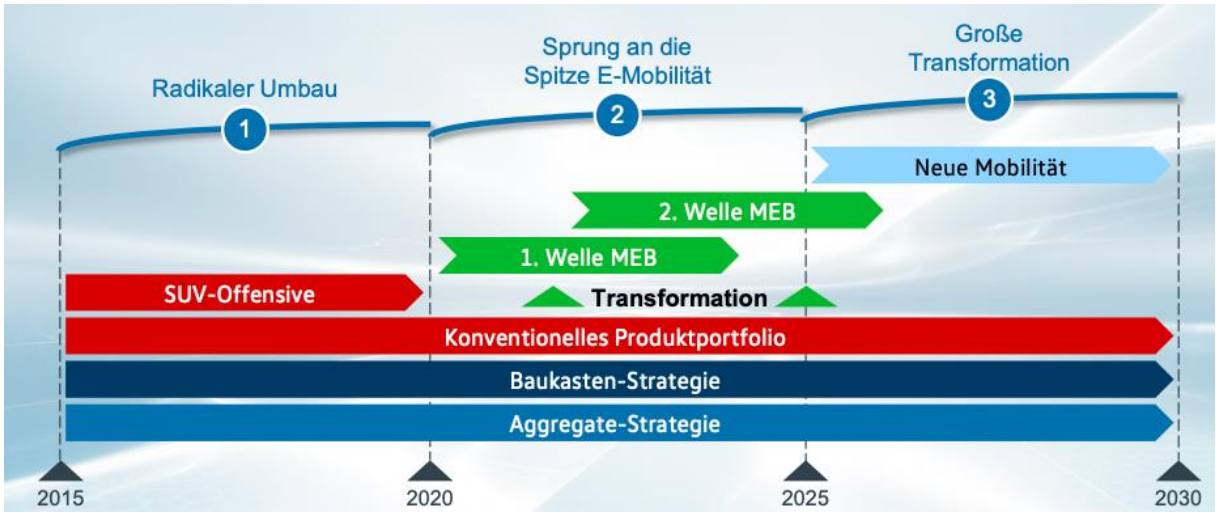


Figure 16: Volkswagen Brand - Product Strategy
Source: (Volkswagen, 2016)

The final step consists of measures enabling VW to have a leading mobility environment and a functioning business model for autonomous driving, profitable development of new mobility fields and emission-free driving. As we can see in Figure 16, Volkswagen planned to start with its “SUV-Wave”, as Sport Utility Vehicles are becoming more and more popular and relevant in the main hubs Europe, USA and China (Schaal, 2017). Clearly, the aim is to achieve a better positioning in this product segment. It can currently be observed that VW has successfully implemented its ambitions and target, with new SUV models such as the “T-Cross” and its EV platform, within the first phase.
With the start of the second phase “Leap to the top of electric mobility” the German manufacturer is going to shift the production process to only two modular car platforms. According to VW, the benefits will be enormous as this reduction in complexity leads to lower expenditures, frees resources, increases productivity and ultimately creates enormous economies of scale. It is planned that Volkswagen will use only two modular platforms for its models from 2026 onwards. One is the conventional toolkit MQB (Modularer Querbaukasten), which is used for conventional ICEs and is already in use today for models such as the “Golf 7” or the sister company's Audi “A3” and “Q2”. Second, the MEB (Modularer Elektrobaukasten) will

shape the future and set the new basis for all future BEVs that VW will launch. The main target for the introduction of the MEB is to make EVs affordable and profitable. In order to achieve that, VW mentions the following key measures; With the usage of the MEB in the whole VW Group, economies of scale are planned to be improved and with its "design for manufacturing", higher productivity and shorter manufacturing time should be possible. Furthermore, the MEB requires lower material and distribution costs compared to old modular toolkits and makes an early involvement of suppliers possible. This is all topped off with a significant reduction in the number of models and a concept that is beneficial for the customer and for the implementation of e-components (Volkswagen, 2016).

8.2.2 Volkswagen Brand – E-Product Portfolio and EV Production

However, before we take a detailed look at the value chain of VW's EV production, it is interesting to first analyze the electrical product portfolio. For this we consider the current and future electrical product portfolio of VW, based on the VTD matrix.

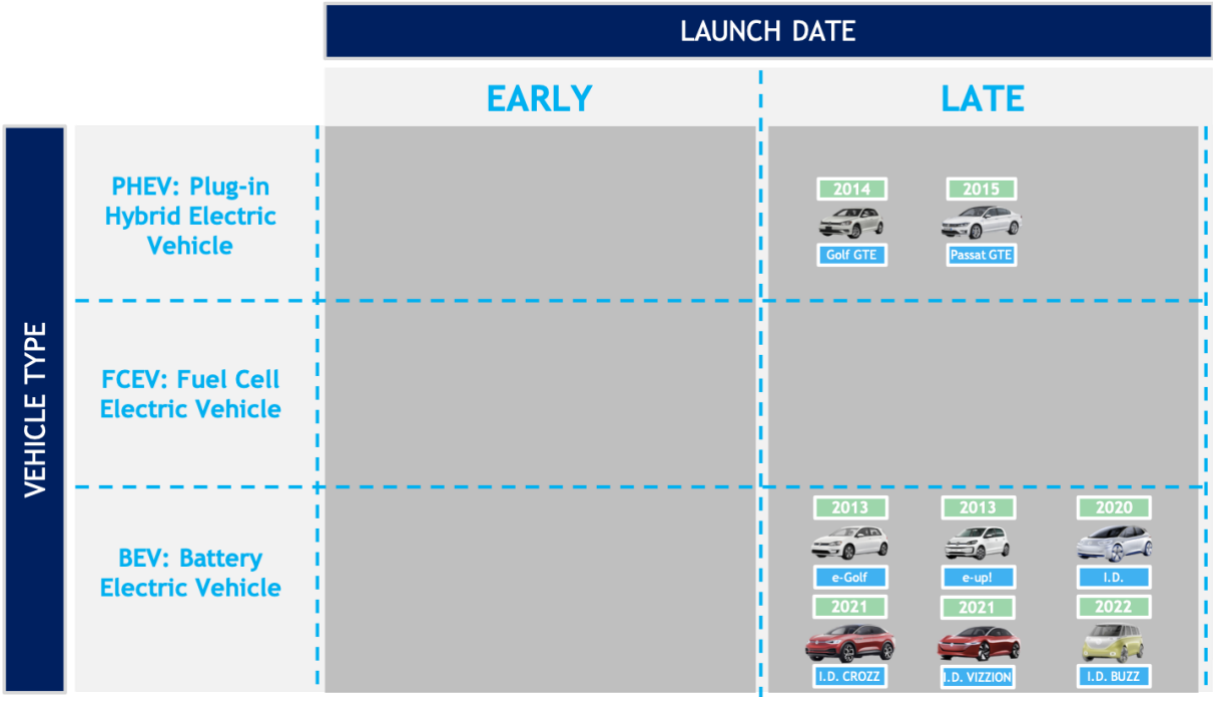


Figure 17: Vehicle Type vs. Launch Date – Volkswagen
Source: Author's Chart

Based on the VTD matrix, one can conclude that VW did not recognize the disruptive character of EVs at an early stage. Even PHEV models, which were offered at a very early stage by their main competitor Toyota, did not encourage VW to act in time. In addition, no new BEV model was introduced between 2013 and today. This can be explained by the fact that the development of new competencies in EV production has taken the group by surprise. Furthermore, the company was also financially surprised by the diesel affair, which claimed the necessary funds for an electrical change in the portfolio. As a late starter, the "BEV-Wave" can now also be explained in its "Transform 2025+" strategy. With this BEV strategy, the company wants to

change its core competency as quickly as possible and be recognized as an EV manufacturer in order not to lose the connection in the industry.
In the next step it is interesting to take a closer look at the portfolio. The VW Golf is probably the most famous and generally known VW model. The company took its most popular car and transformed it into an electric version, the so-called “e-Golf”. The feeling of something new and innovative is difficult to achieve if one takes an existing model and changes it only slightly, especially visually. However, the biggest change happened under the bonnet, where the combustion engine has been replaced with a silent electric motor for the e-Golf. It is not clear whether the e-Golf was more of an experimental project to get to know electric mobility better, or whether it was a real market penetration. The popularity of the electrified version of the e-Golf has fluctuated and continues to do so globally. In January 2018 in Western Europe, the e-Golf was on the top of EVs sold (1.985 units), whereas in the US market the electric flagship of VW only got sold 178 times. In comparison, similar competitor cars such as the Chevrolet Bolt EV and the Tesla Model 3 was sold 1.177 and 1.875 times respectively (EVObsession, 2019).
Even though the e-Golf achieved good sales figures in Europe, especially thanks to the facelift that improved its range, VW's goal of making an electric "world car" accessible to all was unsuccessful. A rather low range, a comparatively high price and an outdated design (extreme similarities with the ICE Golf 7) could be the reasons why the e-Golf is not a revolutionary car - as it was once intended for VW models such as the Golf 1.
VW now wants to change this with its BEV offensive. The first new designs based on the MEB platform are the I.D. models, which are to be launched on the market from 2020. Thomas Ulbrich, Member of the VW Board of Management responsible for e-mobility, explains that the mission of I.D. family is "E-Mobility for All" and that these upcoming BEVs will not only maximize the possibilities of this technology, but will also have a similar pricing as the current diesel models (Volkswagen, “E-Mobility for All”, 2018). At the Paris Motor Show in 2016, VW presented the concept of the upcoming VW I.D., which is the base model of the I.D. family and is supposed to be the electric car for everyone. According to VW, the vehicle is supposed to have a 125-kW battery pack and cover distances between 400 and 600 kilometers depending on driving style and other conditions – making range-anxiety obsolete. Moreover, depending on customer requirements, the I.D. can be equipped with different battery sizes.
After the introduction of the first I.D., VW plans to extend the model range with three more I.D. family members. VW plans to launch large SUV “I.D. CROZZ” (2021), the luxury sports sedan “I.D. VIZZION” and, last but not least, the “I.D. BUZZ” (2022), a van based on the design of VW’s T1 (also known as Bulli).
In the area of fuel cells, apart from a few rather experimental models, Volkswagen has not yet launched a commercial car on the market. However, in the end of 2018, for example, the commercial vehicle “Crafter HyMotion” had its world premiere

(Green Car Congress, 2018). On this topic, VW does not publicly disclose more information than that, even in the conducted interview.
Lastly, the biggest advantage VW plans to achieve with its electric offensive is the selling price. Thomas Ulbrich promises an unprecedented cost-benefit ratio for the I.D., starting from approximately €25.000 in Europe. This would be a huge competitive advantage, as competing models such as the Nissan Leaf or the BMW i3 are priced €5.000-€10.000 and higher (Eschment, 2018).

Apart from the portfolio, the value chain in BEV production is also of high relevance. If one looks at the VW e-Golf or e-Up! value chain, the most important components in the production come from third parties.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Models	e-Golf	Panasonic	VW	Panasonic	Bosch	VW	VW
	e-Up!	Panasonic	VW	Panasonic	Bosch	VW	VW
	I.D. Family	Samsung LG Chem CATL SK Innovation	VW	Samsung LG Chem CATL SK Innovation	Bosch	VW	VW

Figure 18: Powertrain and Supply Chain Strategy for EVs - Volkswagen
Source: Author's Chart, According to (Erriquez, Morel, & Moulière, 2017)

Looking at Figure 18, many important components come from suppliers both in the battery and in the powertrain. Consequently, the company has a rather low degree of vertical integration in production. This results in higher production costs, which is not an ideal situation especially in the production of BEVs, as we know that customers are very price-sensitive for BEVs.
Also, in case of the I.D. family, the cells of the batteries will not come from VW. They will be supplied by the major Korean and Chinese companies. VW has already secured the necessary cell quotas by contracts. Otherwise, figures such as 1 million sold BEVs in the next years, would be difficult to communicate. As a result, the company has an enormous dependency that will impact the profitability of its business if a timely solution is not found. Currently, the company is simply forced to purchase these components externally.
As part of its "Together – Strategy 2025" strategy, the VW Group aims to develop battery technology as a core competence. VW is also making progress in this area. The company is part of a project which was founded a year ago by the EU with the aim of establishing lithium-ion cell factories in Europe. The company has announced that it will push ahead with the construction of a cell factory together with the Swedish startup Northvolt. For this purpose, VW is joining forces with other partners to form the "European Battery Union" consortium. The consortium, which is also applying for EU subsidies, is led by VW and Northvolt (Eckl-Dorna & Sorge, 2019). Detailed information regarding the realization is not known at the moment.

8.2.3 Volkswagen Brand – Charging Infrastructure

VW has set an internal goal that charging its BEV models will be as easy and natural as connecting the smartphone to the power supply in the evening. Furthermore, in the future it will, according to VW, be the exception rather than the rule to drive or even take a detour to the charging station.
This is why the VW brand is building its own charging and energy ecosystem of hardware and software around the car. VW wants to be involved in all areas of application; at home, at work, in public spaces and on motorways. As many activities as possible are planned to be bundled in-house in order to ensure the quality of all services.
As part of this, VW will be offering a modular range of wallboxes that can be installed at home in the carport or garage as well as in company car parks. The price for the VW wallboxes will start at around €300 excluding installation costs (Volkswagen, Ladeinfrastruktur, 2018).
The expansion of the charging infrastructure is of crucial importance. The joint venture IONITY, is an important building block in this process. In cooperation with the BMW Group, Daimler AG and Ford Motor Company, Volkswagen is working via IONITY to set up a reliable network of extremely powerful and fast charging stations along European highways. By 2020, 400 charging stations of this kind will be in operation as "gas stations of the future". In addition, all 4.000 European VW dealers will be equipped with charging stations (Volkswagen, Ladeinfrastruktur, 2018).
Payments for all services will be processed centrally via the future mobility platform "WE", via which the customer can, for instance, also use the car sharing service "WeShare".
Compared to for instance Tesla, the company started working on the charging infrastructure very late. Tesla began building high-performance charging stations under its own name "Tesla Supercharger" as early as 2012. For a long time, VW considered expanding the charging infrastructure as more of an obligation for the German government. It was only later, when the pressure became too great due to the expansion of the Tesla charging stations, that VW began to work on this issue. Now, similar to Tesla, the company is trying to win customers for the new BEV models with the above described charging ecosystem around the car.

8.3 Toyota – “Popularizing Electric Vehicles”

Founded in Japan in 1937, Toyota is today one of the world's largest automobile manufacturers. However, for many years, Toyota was the world's largest manufacturer, competing head-to-head for first place with Volkswagen. Toyota is considered the world's first automaker to produce more than 10 million cars per year (FAZ, 2014). The well-known Toyota brands include Lexus, Scion, Daihatsu and Hino (commercial vehicles). In the area of hybrid vehicles, the Japanese manufacturer has occupied an exceptional position for many years. The success of the brand has its origin in Toyota City and is primarily associated with the success factors in

production, supplier management and human resources management. Toyota is considered a pioneer in innovations such as just-in-time production and lean management - approaches that are used in companies worldwide today. Consequently, Toyota has played an enormously important role in the development of the automotive industry in recent decades.
In the following chapters, we first look at the Group's e-mobility strategy, electrical product portfolio, EV production, and charging infrastructure. The information used is extracted from annual reports, press conference, press releases and an interview with the spokesperson for product communication at Toyota Europe in Brussels.

8.3.1 Toyota – E-Mobility Initiatives and Strategy

Toyota has a very clear goal regarding the reduction of CO_2 emissions of its vehicles. Compared to other manufacturers, this is clearly in the foreground. In 2030, the company plans to sell more than 5,5 million EVs per year worldwide. In this context, Toyota mentions, not only its targets for BEVs, but also those for FCEVs, which illustrates the importance of this type of vehicle (Toyota, 2019).
As part of the company's own "Environmental Challenge 2050", which was launched in 2015, Toyota has set the goal of reducing the global average CO_2 emissions of its vehicles in 2050 by up to 90% compared to the 2010 level. This new initiative, launched in December 2017, serves as a medium- to long-term measure to achieve the desired goal (Toyota, 2019). As a mass producer, Toyota underlines the importance of its responsibility and mission to ensure a wide spread of EVs in all its communication channels.

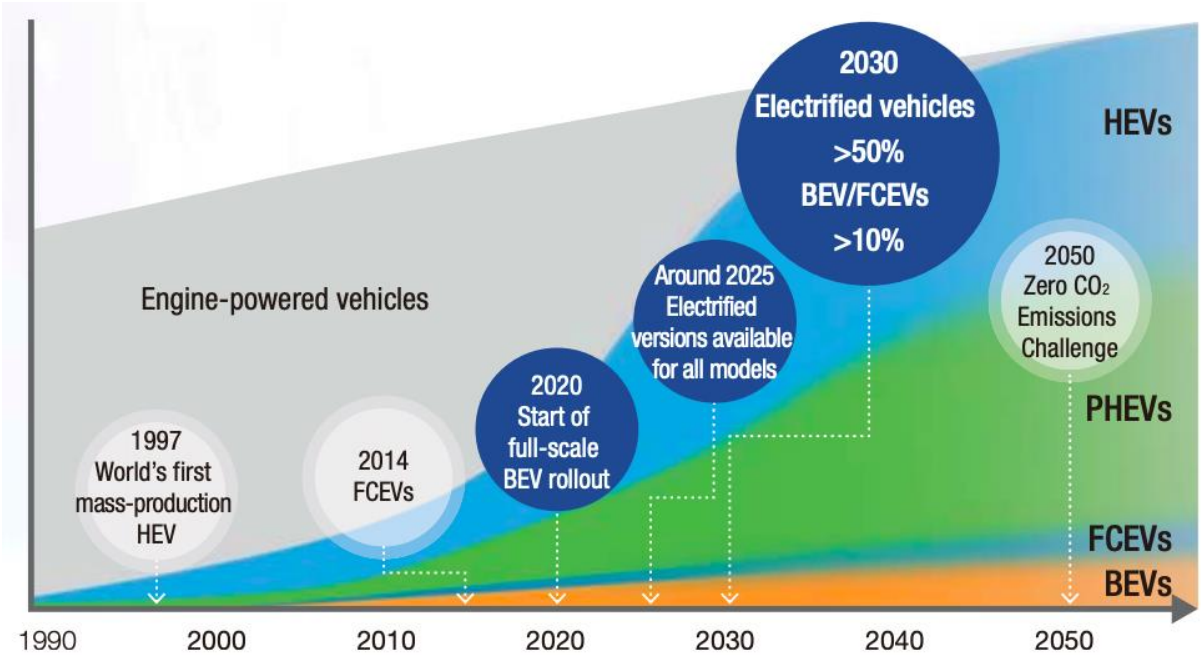


Figure 19: Vehicle Electrification Milestones – Toyota
Source: (Toyota, 2019)

Similar to Volkswagen, Toyota has set concrete goals until 2030, which will be measured by three milestones. The first milestone will be the full-scale introduction

of BEV models from 2020 onwards. BEVs specifically designed for the mass market will be sold, first in China and then to Japan, India, the United States and Europe (Toyota, 2019). As the rollout starts in China, it is noticeable that the domestic market is not the first to be targeted. Possible reasons for this are that China is the most important automotive market in the world and consequently the demand for EVs is the highest. In addition, the market is dominated by Chinese manufacturers, because most major manufacturers have not yet reached the stage of full-scale rollout of EVs in recent years. Toyota also plans to introduce more than 10 BEV models within the five upcoming years. As a next step, Toyota intends to offer electric versions for all its models. In concrete terms, the goal is to have no more models without an electric option by about 2025. Although other manufacturers (e.g. VW) have not had much success with the electrification of existing models, Toyota nevertheless sets this as its target for 2025 (Toyota, 2019). As a result, Toyota is currently only striving for electrification of the current models, but less for completely new model ranges for BEVs, which did not previously exist as ICEs or HEVs. In addition, Toyota models have a reputation among customers for being sustainable and environmentally friendly, which makes the development of a new model series or even brand appear unnecessary. Furthermore, this is also probably because Toyota hopes for greater market penetration and acceptance of EVs by 2025, that the factor "new" will no longer be necessary as a selling point for EVs.
Based on current sales figures, Toyota has set the target of selling 5.5 million "electrified vehicles" a year by 2030. Accordingly, the target is that at least 50% of all vehicles sold are “electrified vehicles” and more than 10% are either BEVs or FCEVs. The company distinguishes between the time categories "electrified vehicles" and "electric vehicles", whereby the former includes the following types: HEV, PHEV, BEV and FCEV. By contrast, "electric vehicles" are only BEVs for Toyota. As aforementioned in Chapter 2., HEVs are not seen as EVs in connection with this thesis, since primarily the combustion engine is used for the powertrain and the e-motor plays only a minor role. Consequently, the figure of 5.5 million by 2030 must be viewed with caution. In addition, Toyota believes in a sharp decline in sales of ICE models, which still will continue to exist until around 2050 (Toyota, 2019).

The history and association of hybrid cars goes hand in hand with the company. The most famous Toyota model, the Prius, which is an HEV, was introduced in 1997 and sold more than 12 million times worldwide during the last two decades. Compared to many manufacturers, Toyota recognized the electrical transformation and trend in the industry very early and has consequently developed great expertise first for HEVs and second for PHEVs. This as well as for a successful establishment in mass production of “electrified vehicles” over the last two decades. Currently, Toyota offers a vast portfolio of 36 “electrified vehicles”, which will be analyzed in the next chapter (Toyota, 2019).
The early focus on HEVs and the development of an appropriate platform for mass production is an enormous advantage for Toyota. Unlike many companies, Toyota did

not need to create a new platform for BEVs or FCEVs first, because the complete electrical transformation from ICEs or HEVs to PHEVs/BEVs/FCEVs can be made on the same platform. Moreover, completely new BEV/FCEV model series can also be produced on this platform on a large scale (Toyota, 2019). This saves a lot of time and money in development, as the platform has been continuously optimized for years and has proven successful for mass production. In comparison with its new platform, VW still has no experience in mass production, which has to be made up for at a high cost.

8.3.2 Toyota Brand – E-Product Portfolio and EV Production

As a pioneer in hybrid technology, Toyota has a large portfolio of 36 HEV and PHEV models across all Toyota brands according to the company's annual report. In this context, it is therefore important to identify which of these models that are offered as PHEVs and apply them to the VTD matrix.

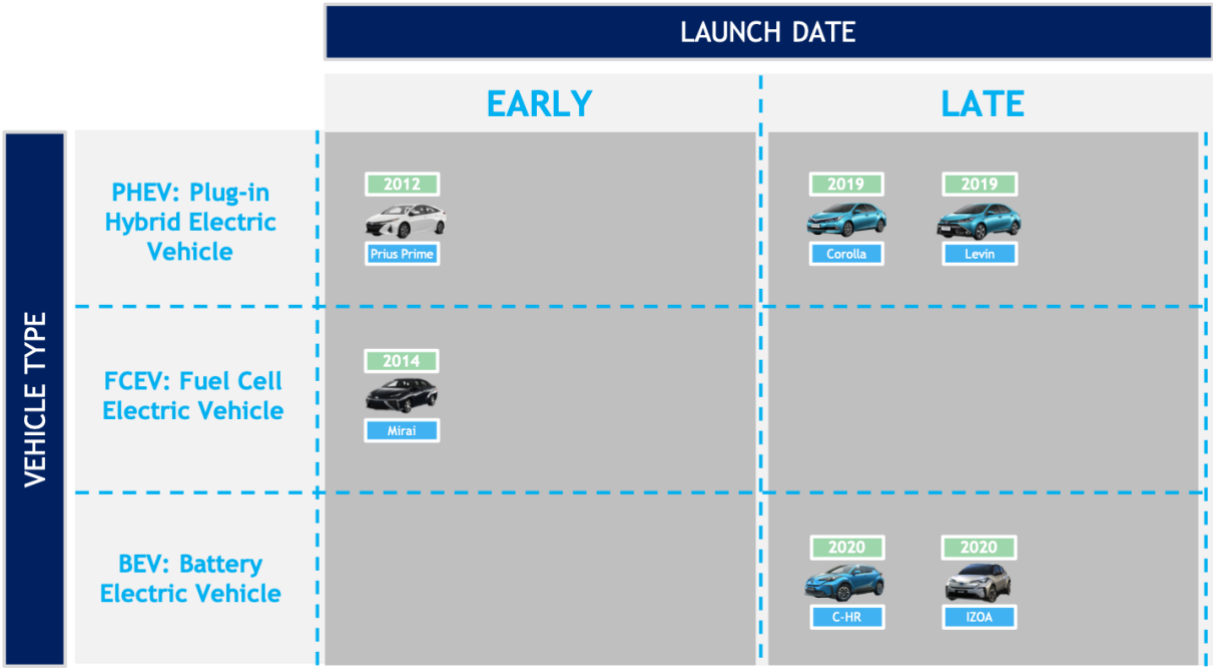


Figure 20: Vehicle Type vs. Launch Date – Toyota
Source: Author's Chart

However, in the case of Toyota, the result of the VTD matrix is very surprising. Although the company already had a wide portfolio of HEVs, the first commercial PHEV vehicle came relatively late in 2012. Consequently, even Toyota is taking action relatively late on trend of using models primary having electrical energy as their source of energy.

This is very surprising due to the history and expertise of the company. Until last year, Toyota only had two models, Prius Prime and Mirai, in its product portfolio falling under the NEV category. One reason for this surprising development is that Toyota has long seen hybrids (HEVs) as a "bridge technology" for FCEV models. For a long time BEVs were disregarded as they were considered impractical and expensive.

However, this has changed over time as batteries have become cheaper and governments are pushing for stronger and faster electrification (Muller, 2017).
Nevertheless, Toyota does not intend to give up on hydrogen fuel cell technology for FCEV models. Even though there is still only one FCEV model from Toyota on the market, Toyota promises to bring FCEV passenger and commercial vehicles onto the market in the next decade in its annual report (Toyota, 2019). Thus, over the last two years, Toyota has conducted many tests on the "Mirai" series in China, investigating possible applications of its fuel cell technology (Toyota Newsroom, 2019). However, to date, the company has not succeeded in achieving a breakthrough enabling mass production.

As part of its electric rollout, Toyota launched the PHEV versions of the “Corolla” and “Levin” in China this year. As announced in strategy reports, Toyota sees the start of its electrification offensive in China. Toyota also strengthened its local R&D and productions facilities in the recent years and will also open a new battery testing facility in China (Toyota Global, 2018).
Together with its local joint venture partners in China, Toyota has also worked on its two new BEVs, which were previously also available as ICEs. The “C-HR” BEV comes from the joint venture with the Chinese manufacturer GAC, the “Izoa” is a product of the cooperation with the FAW Group. Both models will come onto the market in 2020, but only in China at first. However, this is also the only concrete information that Toyota has provided on both models. For now, the performance values, ranges and other key technical data are remaining secret. Furthermore, Toyota plans to introduce 10 NEVs in China, including these four, by the end of 2020 (Harloff, 2019).
The rollout of Toyota's electrical portfolio shows that Toyota's e-Mobility strategy has a more regional approach, tailoring its offerings based on customer preferences and regulatory requirements in each country. In China, for example, the preference of customers and government demands are clearly pushing for BEVs, whereas in Europe 40% of Toyota sales are HEVs (Muller, 2017). Accordingly, the launch of the new BEV models is first planned for the Chinese market.

Another part of its e-Mobility strategy is being more widely positioned in the future. Thus, Toyota is aiming for a very diversified product portfolio in the future, leading the company to offer its customers mobility solutions in a variety of segments.

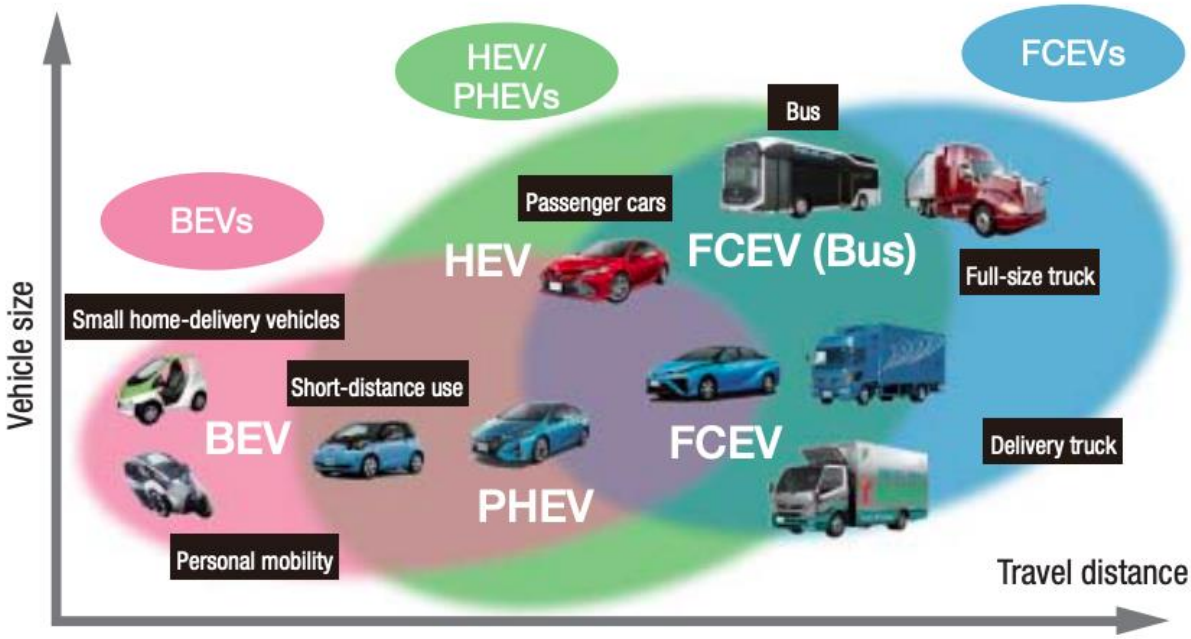


Figure 21: Diversified Electrified Vehicles – Toyota
Source: (Toyota, 2019)

If one looks at the entire future product portfolio of Toyota, one finds products in mini-, mid-size and fullsize segments. In Figure 21, for example, one can find a segment in the lower left corner in which Toyota was not active before. With the BEV i-ROAD concept, Toyota has developed a mobility solution that meets customer needs for equipment, size and range that were not previously served. As Figure 21 shows, the future portfolio will range from micro/mini mobility solutions such as the i-ROAD to trucks and buses powered by fuel cells (Toyota, 2019). This is due to the fact that Toyota no longer sees itself as a pure car manufacturer but as a mobility provider in all its possible forms (e.g. wide portfolio, sharing services, etc.). Therefore, Toyota launched the "Mobility For All" campaign early last year in order to also bring this message closer to the customer. In addition, Toyota sees the use for BEV models rather for short distances, PHEV models for medium distances, and for longer distances the company relies on FCEV models as shown in Figure 21.

When it comes to battery technology, Toyota has a clear advantage over other manufacturers. Toyota has a very old history in battery manufacturing and has been involved in the development of batteries very early. For example, in 1939, two years after its foundation, Toyota had already established a battery research laboratory. In addition, the company also has a very long and strong partnership with the Japanese battery manufacturer Panasonic. For example, both partners founded the joint venture back in 1996, which was used for the joint development of nickel-metal hybrid batteries (NiMH) for Toyota's hybrid models. The joint venture is also currently developing the main components for PHEV/BEV batteries such as lithium-ion batteries and BMS (Primearth EV Energy, 2019). This partnership was further strengthened at the end of 2017 when an agreement was reached to explore the feasibility of cooperation on lithium-ion batteries, solid-state batteries, and next-

generation batteries. The manufactured products will also be sold to other automobile manufacturers via Panasonic (Parkinson, 2019).
With this strong partnership, Toyota has positioned itself very well for an electric future. Unlike other manufacturers, Toyota has many important components in the value chain under its own supervision.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model	Prius Prime	Joint Venture with Panasonic	Joint Venture with Panasonic	Joint Venture with Panasonic	Toyota	Toyota	Aisin*

*Toyota 30% stake owner

Figure 22: Powertrain and Supply Chain Strategy for EVs - Toyota
Source: Author's Chart

Everything considering the battery is developed and supplied by the joint venture with Panasonic. Power Electronics and the electric motor have been produced in-house by the company since the first HEVs. Only the transmission is supplied by the Japanese supplier Aisin, where Toyota holds 30% of the company, which leads to a strong position with the supplier. As a result, Toyota has managed to achieve an almost complete vertical integration in value creation through effective partnerships, agreements and investments. This reduces the dependency on other manufacturers in BEV production.
Nevertheless, it must be emphasized that Toyota is too late to launch BEVs and even for PHEVs, the company does not have the appropriate models on the market. However, the company has the opportunity to catch up on this faster than other manufacturers.

8.3.3 Toyota – Charging Infrastructure

Compared to other manufacturers, Toyota is very passive in the expansion of charging stations. Toyota is currently not taking any strong initiative to actively build charging stations, not even in its home market Japan or the focused market China. On the contrary, Toyota leaves the construction of charging stations to other manufacturers and the government. On the Toyota homepage, as with all other manufacturers, only wallboxes and other charging stations for office buildings can be purchased. No other projects or solutions are advertised. In addition, Fast Chargers can also be ordered online, which can be set up by private individuals.
However, Toyota has other plans for installed charging stations by individuals and therefore founded the company Nippon Charge Service with the manufacturers Nissan Motor Co., Ltd., Honda Motor Co., Ltd., and Mitsubishi Motors Corporation in 2014. The drivers of the different vehicle models can purchase a Charging Card with which they can charge at the stations, for which the respective car manufacturer has acquired the rights (Toyota Motor Corporation, 2014). This concept is currently only

available in Japan and there is nothing yet known about an expansion into other countries.
Toyota focuses much more on an infrastructure for FCEV models and therefore invests in hydrogen refueling stations. Consequently, Toyota is, since 2015, part of the Hydrogen Mobility Europe project, giving drivers of FCEV models access to a pan-European network of hydrogen refueling stations (Toyota Europe, 2019). This makes it once again very clear that Toyota sees fuel cells as the future technology in the automotive industry.

8.4 Ford Motor Company – "Go Further"

Probably no other manufacturer is so close to the terminology "conventional manufacturer" as Ford. Already in 1896, Henry Ford built his first vehicle and only seven years later in 1903 the Ford Motor Company was incorporated. Soon the mass production started when Henry Ford introduced its Model T, which was the first affordable and durable automobile for the masses.
Until today, Ford produces vehicles and distributes them around the globe, however, Ford's success is kept within limits. This becomes very clear when one looks at sales in 2018 by regions. Last year, Ford generated 65% of its sales in its home market in the United States and only 31.3% in Europe, and even less in the important growth market of Asia Pacific with 8% (Ford Motor Company, 2019). For many large manufacturers, China is the most important and largest market, but in the case of Ford, only less than a fifth of sales came from China last year. One of Ford's biggest issues is that the car supply in China is old and drivers are losing interest (Shance, 2018). For a manufacturer as global as Ford, this is frightening, especially as it clearly hampers the company's growth. With a lack of growth and lower profits, the electrification of the product portfolio is correspondingly more difficult as the necessary money for investments is lacking.
In addition, Ford has not yet launched anything concrete in regard to an electrical offensive in recent years compared to the other major manufacturers, despite numerous investments in EVs in the last two decades. However, Ford Europe finally presented its e-Mobility strategy at the beginning of April 2019.

8.4.1 Ford – E-Mobility Strategy and Initiatives

Jim Hackett, Ford's CEO and William Clay Ford Jr. stated the company's objectives summarized in a letter to customers and shareholders in Ford's Sustainability Report 2017/18. The executives state that Ford wants to build smart vehicles for a smart world and impact climate. In order to do that, $11 billion should be invested to put 24 hybrid (HEV/PHEV) and 16 fully electric vehicles (BEV) on the road by 2022 (Ford Global, 2017).
Ford has almost 20 years of experience in the EVs sector, as it introduced hybrid models to the market at a very early stage. The aim is to ensure the supply of affordable electric vehicles to the greatest scale possible. Similar to Toyota, Ford drives the strategy to electrify its most popular and well-known models. Ford, in

contrast to German manufacturers, primarily Volkswagen, has avoided emission scandals and customer trust issues. Consequently, this strategy is a very good first major step in the electrification of the product portfolio. To this end, Ford has also made internal changes and created a task force called “Team Edison” in order to speed up the design and creation of EVs (Ford Global, Scaling up Electrification, 2017).

In comparison to Toyota or Volkswagen, however, Ford has no precise and clear long-term strategy. This is particularly evident in their China EV strategy.

In order to address the aforementioned problems in China, Ford also provided an electrification plan specifically for China in 2017. In the world's largest car market, Ford wanted to bring at least 15 new HEV, PHEV and BEV models to its customers by 2025. For this purpose, the American manufacturer entered into a joint venture with Chinese manufacturers such as Chongqing Changan Automobile Company and Zotye International. With the former, Ford planned to bring a BEV SUV onto the Chinese market. The goal was that by 2025, all models manufactured in China by Changan Ford and 70% of all other Ford models in the country should also have electrified options. Together with its other partner, Zotye International, the company planned to offer a range of affordable BEVs for Chinese customers under a new brand (Ford Global, Scaling up Electrification, 2017).

However, nothing concrete has happened since then. On the contrary, Ford has redefined its strategy for China. According to the company, 30 models are expected to be presented in China within the next three years, however, only ten of them will be BEVs or PHEVs. From ambitious plans in the area of EVs in 2017, Ford now also speaks of a not purely electrical strategy for China. In addition, the company has also significantly reduced its number of EVs by five until 2025 (Randall, 2019).

Moreover, in 2018, Ford installed a new leadership team with a new vision for China in order to improve the situation. The domestic partners Changan Automobile and Jiangling Motors should be better integrated into the vehicle development for the Chinese market. Both partners will work together with Ford on designing and developing the next generation of models. Concretely, the first BEV model will be presented in 2019 together with Jiangling Motors (Randall, 2019). However, as the recent history of Ford and China has shown, it remains to be seen whether this will happen as promised.

In Europe, however, the situation is different. In the second largest sales market for Ford, the company presented all its new models at a major event, which will be launched in 2019 and the following years. A total of 16 new models were presented at the beginning of April 2019 under the motto "Ford Goes Electric in Europe". It consists of 10 passenger vehicles and 6 commercial vehicles, which will be marketed as either mHEVs, HEVs, PHEVs or BEVs. What at first glance seems to be very ambitious and optimistic, is in reality rather disappointing in the context of this thesis. On closer examination, only two PHEVs in the passenger vehicle segment were presented (Ford Europe, 2019).

Unfortunately, the first BEV in this segment is not expected in the short future. Also, at the presentation in April 2019, only the teaser of the first BEV was shown, which was already released in September 2018. The teaser shows a car from the back that seems to be inspired by Ford's Mustang models, which are rather famous for having large engines. Regarding specifications, Ford is not releasing any statement or setting any targets.
This once again shows that the company is currently experiencing problems with the electrification of its portfolio, despite years of experience in this field. Now one wonders how this development came about and what the problems are behind it. In order to make this analysis, it is important to take a closer look at the product portfolio over the last few years.

8.4.2 Ford Brand – E-Product Portfolio and EV Production

In 2011, Ford already had a significant global electrification strategy. At that point the strategy was "Power of Choice", which similar to the current approach, was an electrification plan of the existing model range, rather than creating completely new electrified vehicles. This gave consumers the opportunity to choose between different solutions for one model, e.g. the Ford Focus as an ICE (diesel), PHEV or BEV. At that time, Ford was planning this strategy based on its platform design for ICEs, i.e. all vehicle types would be manufactured on the same platform, no matter ICE, PHEV or BEV (Hughes-Cromwick, 2011).
This approach poses great challenges to any manufacturer, as EVs developed on an ICE platform have less space for the battery, which can significantly shorten the range. For an EV battery, it can generally be said that the larger the battery, the greater the range. In order to build a marketable BEV, it is therefore of fundamental importance to develop a special EV platform for production and not to rely on old ICE platforms (Erriquez, Morel, & Moulière, 2017).

Nevertheless, in the next step it is important to look at Ford's product portfolio in terms of electrification on the basis of VTD Matrix. In this context, models, which are no longer on the market, are also considered as the development plays an important role for the VTD matrix.

As can be seen in the VTD matrix below, Ford pioneered in the electrification of the automotive industry very early on. With the "Power of Choice", the American company was able to launch two EVs on the market at an early stage.
However, the "Focus Electric", which was released in 2011, failed to succeed and was never properly updated. One of the main drawbacks of the BEV was the limited cargo space, making it unpopular among customers. This problem was due to the battery, which had to be integrated into the ICE platform and therefore made the cargo space smaller. The Ford C-Max PHEV was even canceled in 2017 as the car was hardly sold and was no longer profitable for Ford.

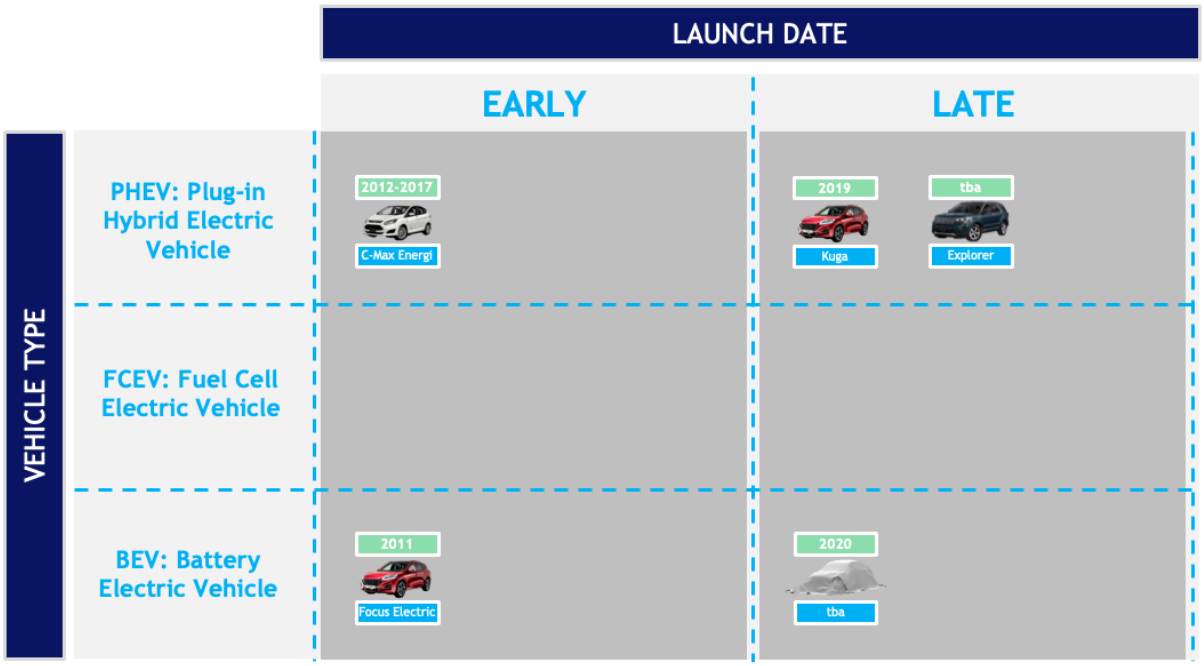


Figure 23: Vehicle Type vs. Launch Date – Ford
Source: Author's Chart

Former Ford CEO Mark Fields was not hiding his opinion towards electric vehicles. According to Fields, there was no demand for EVs and therefore Ford did not see any necessity in investing in this business field. Field's did not take into consideration to dock on Ford's 2011 electrification plans, but rather focused on keeping Ford's shareholders pleased (Hanley, 2017).
In recent years, Ford has also done little in the fuel cell field. This apart from a model with an experimental character, which was presented in 2000 and proved no success. Also, the joint venture established with Daimler to develop fuel cell technology for motor vehicles was also dissolved, as both companies wanted to work on this technology in-house (White, 2018).

Looking at the current situation of the American manufacturer, there is no clear direction in the field of e-mobility. Also, the EV offensive of Ford Europe is not a real offensive, in comparison to other manufacturers, which causes turmoil.
Not only is the unclear line in management the problem, but Ford also has enormous technological problems. To date, the company has not achieved a breakthrough in the development of an EV platform, which, as mentioned earlier, is fundamentally important. Consequently, a cooperation with VW is under discussion, which will enable Ford to build its EVs on the VW MEB Platform (Hetzner, 2018).
In addition, Ford has invested $500 million in the American startup Rivian, which focuses on commercial vehicles. One of the main reasons for the investment is that Ford now can build its own models based on Rivian's EV platform (Gitlin, 2019). This means that Ford is currently trying to push ahead with its electrification strategy by external investments.
Furthermore, Ford has not made any statements regarding the acquisition of battery technology expertise in its strategic orientation compared to other manufacturers.

It is also still unknown who will supply Ford with batteries for their upcoming BEV models. The only thing Ford has announced to the public on this issue is the investment in a startup working on the development of solid-state batteries (Loveday, 2019). In the industry, these are seen as the next generation of batteries for which there has been no breakthrough in development to date.

8.4.3 Ford Brand – Charging Infrastructure

In addition, Ford neither offers a direct solution for charging stations. In 2013, the company chose the American technology company AeroVironment Inc. as its preferred installation partner and authorized charging station supplier (Faughnder, 2013). Consequently, Ford also outsources home charging to other providers.
In the field of public charging, however, Ford is one of the founding partners of IONITY, as aforementioned. All in all, Ford is lagging behind in this area as well, and is relying on the installation of charging stations by other stakeholders such as the government or other automobile manufacturers.

9. Analysis of the e-Mobility Strategy of Emerging Car Manufacturers

Emerging manufacturers can also be described as unconventional or revolutionary manufacturers. With their disruptive character, they are observed and welcomed with excitement by the public. Starting with the purely electric drive and its promise for the environment, they are very well received in many parts of the world. Especially Tesla, a pioneer and revolutionary actor in the automotive industry, received rising interest around the brand and founder of the company.
Nevertheless, there is no adequate description available, but the emerging manufacturers could be described as companies, which are not supposed to be pure automotive companies in first place, as they remove industry boundaries and offer services in other areas. This will become very clear in the course of the next chapters Moreover, unlike Volkswagen, Toyota and Ford, emerging manufacturers do not have long-lasting automobile heritage.
With the founding of Tesla in 2003, the foundation of new companies began, which made use of e-mobility as disruptive innovation in order to enter the market. Consequently, emerging manufacturers are in most of the cases only focused on mobility that solely uses electricity as its power source. Therefore, they also do not have strong elements of building combustion engines inside their company's DNA.
This is probably the most important distinguishing criteria between the two groups.
Another characteristic differentiating conventional manufacturers from new comers are sales figures and markets. Since the first creation of the automobile, conventional OEMs have been in the industry and solely focused on producing, improving their vehicles and making these available in most global markets. Emerging manufactures are currently rather available in their home markets (except Tesla) or

in specific areas around the globe and only hardly reach five-figures production numbers.
Also, most emerging manufactures, referred to as startup companies, are known among industry-experts, but not among the general public. This is due to the very clear pattern that all manufacturers are striving for when entering the market. As mentioned in Chapter 3.1, a distinction can be made between "low-market" disruption and "new-market" disruption. In the case of emerging manufacturers, this is clearly a new-market disruption, as they initially address customers whose requirements and needs have not been met by existing manufacturers. An EV clearly has different or new characteristics due to the use of electricity and the sustainability concept, which were not satisfactorily or offered by the established producers. At the same time, however, BEVs are less efficient than ICE models of established manufacturers in terms of the characteristics previously considered essential (range, flexibility, price, etc.). BEVs were therefore not particularly attractive to traditional customers at the beginning of their market launch. However, due to the continuous improvement of BEVs, emerging manufacturers have now also become very serious competitors to established manufacturers, which, as aforementioned, has led to a major shift in the industry towards e-mobility.
Although emerging manufacturers do not have a long history or an elementary share in the founding of the industry, they have forced a complete industry to transform with the help of a disruptive innovation, which will also have lasting consequences.

9.1 Emerging Manufacturers

In the next step, it is important to look at the emerging manufacturers in detail in order to make an analysis of their e-mobility development and strategy compared to conventional manufacturers. As aforementioned, the selection of the analyzed emerging manufacturers is based on different criteria.
Hence, all currently discussed and established emerging manufacturers will be compared on the basis of different criteria to make a selection of three manufacturers, which will then be analyzed in more detail. A more detailed description of each manufacturer can be read in the Annex 1.

In Table 9 one can see the selection of emerging manufacturers, which are the most discussed and advanced in regard to the EV production. In order to gain insight into this category of manufacturers, it is therefore important to analyze a manufacturer, which can provide cars for a broad and diversified group of customers in the future.

Company	HQ	Founding Year	Main characteristic or achievement	Niche Market	Further Analysis
Tesla	Palo Alto, USA	2003	Pioneer in EV production	No	Yes
Xiaopeng Motors	Guangzhou, China	2014	Tech-funded startup	No	Yes
Faraday Future	Los Angeles, USA	2014	Tech-funded startup	No	Yes
Byton	Nanjing, China	2016	Tech-funded startup	No	Yes
Lucid Motors	Newark, USA	2007	Produces Luxury cars & Saudi Arabian financial support	Yes	No
Streetscooter	Aachen, Germany	2010	Produces all-electric vans	Yes	No
Uniti	Lund, Sweden	2016	Mini car segment and equity-crowdfunding	Yes	No
NIO	Shanghai, China	2014	Tech-funded startup	No	Yes
BYD Auto	Shenzhen, China	2003	Leading EV manufacturer in China	No	Yes
Rivian	Plymouth, USA	2009	Commercial Vehicles	Yes	No

Table 9: Selection and Evaluation of Emerging Manufactures I
Source: Author's Chart

As a result, all manufacturers that are mainly active in a niche market such as mini- or luxury car segments as well as commercial vehicles (vans, pick-ups etc.) are not further analyzed.

Company	HQ	Founding Year	Main characteristic or achievement	IPO	Interview	Further Analysis
Tesla	Palo Alto, USA	2003	Pioneer in EV production	Yes	Yes	Yes
Xiaopeng Motors	Guangzhou, China	2014	Tech-funded startup	No	No	No
Faraday Future	Los Angeles, USA	2014	Tech-funded startup	No	No	No
Byton	Nanjing, China	2016	Tech-funded startup	No	Yes	Yes
NIO	Shanghai, China	2014	Tech-funded startup	Yes	Yes	Yes
BYD Auto	Shenzhen, China	2003	Leading EV manufacturer in China	Yes	Yes	Yes

Table 10: Selection and Evaluation of Emerging Manufactures II
Source: Author's Chart

In addition, the access to and collection of information play an enormously important role in creating a detailed analysis. Companies listed on the stock exchange have an obligation to provide company data and information, which therefore enables a deeper analysis. In order to gain more information about the companies, interviews with employees were also conducted. Based on the IPO status and the interviews conducted, four companies have been picked for further analysis, namely Tesla, Byton, NIO and BYD. In the case of BYD, only an interview could be organized with BYD Europe, which mainly focuses on electric buses. As this segment was excluded

for the analysis in this thesis, the analysis of BYD passenger vehicles can be found in the annexes.
Apart from BYD, starting as a smartphone battery manufacturer and later developing to a car manufacturer through acquisitions, Tesla, Byton and NIO are pursuing the same go-to-market strategy.
More precisely, like with most new technology products, having high unit costs before they can be optimized and improved, electric cars show a similar evolution. The strategy of these players is to enter the market through the upper ends, where customers are willing to pay a premium. After penetrating this market, the goal is to offer EVs to a larger customer base as quickly as possible to reach higher volumes of cars and thus be able to lower prices for each consecutive model (Musk, 2006).

In addition, a clear trend in the industry, predominantly present in China, is for technology companies to invest in startups, or set up their own automotive startups to promote their products and diversify their business models. As demonstrated in Table 9, four out of ten companies fall into this category. Media tends to refer to these companies as copy cats of Tesla, but this can clearly be disproved via closer look in the following analysis.
Within this analysis we first consider, in connection with the corporate strategy, how emerging manufacturers are mastering the barriers to entry (Chapter 5.1.2 Barriers to Entry) into the automotive industry. We also take a closer look at the investors in order to identify possible advantages for the establishment of an automotive company. Afterwards, we look more closely at the e-Mobility strategy and development, taking into account the product portfolio and the vehicle rollout plan. Finally, as with conventional manufacturers, both the degree of vertical integration and the charging infrastructure are also assessed.

9.2 Tesla

“Rule-breaker Tesla”. That is how Dudenhöffer (2016) describes the emerging manufacturer from California. However, this has no negative overtone, quite the contrary. According to Dudenhöfer (2016), every new technology needs an entrepreneur or an inventor who breaks outdated norms and changes the world therewith. In the automotive industry, this could be Tesla.
Founded in 2003, Tesla is the youngest U.S. automaker to be engaged in volume production of automobiles. From the very beginning, the founders Elon Musk, Martin Eberhard, Marc Tarpenning, JB Straubel and Ian Wright had the goal of helping e-mobility achieve its breakthrough and set it as their most important corporate goal. The idea was born when JB Straubel asked himself whether one could not simply combine many laptop lithium-ion batteries into one large battery pack in order to use this as a drive for a car. As a result, 80% of the total weight of the first Tesla test models was accounted for by the battery. This has been optimized for and refined over time until the first models went into series production (Kuther, 2017).

Consequently, Tesla is considered the founder of a disruptive innovation, namely e-mobility through BEVs with a lithium-ion battery. Tesla is a pioneer of the many new automotive startups paving the way, all jointly responsible for the electrical transformation of the automotive industry. However, it is clear that Tesla has made a major contribution to the history of the automotive industry.

As Tesla has been on the market for some time, the company can be analyzed with regard to its strategy of entering at the top end of the market and working its way down with each additional model line until a price is achieved being acceptable to many customers in order to reduce cost and to achieve economies of scale.
However, the question of how Tesla managed to overcome the barriers to entry into the automotive industry still remains unanswered. For this reason, the corporate strategy is combined with an analysis of Tesla's strategies to overcome barriers to entry. This analysis also has important implications for Tesla's e-Mobility strategy, which will be carried out in the final step. The analysis is based on Tesla's web presence, online articles, reports, and mainly an interview with the Program Manager for Tesla's Charging Infrastructure.

9.2.1 Tesla - Company Strategy

Tesla, making it to the top in less than 15 years, is a pioneer in BEVs as well as in autonomous driving solutions. In 2006, Elon Musk (Co-Founder & CEO of Tesla) wrote a letter to the shareholders called "The Secret Tesla Motors Master Plan (just between you and me)", where Musk states;

"[…] some readers may not be aware of the fact that our long-term plan is to build a wide range of models, including affordably priced family cars (Musk, 2006)."

This is clearly an indication of Tesla's ambitions, to not only to be a premium manufacturer in the future, but also to offer affordable cars in lower segments. In 2006, the Tesla "Roadster" was presented as the first model, which was later delivered to customers in 2008. The Roadster is supposed to be a car without compromises, beating an ICE driven sports car. The reason Tesla chose to produce a sports car is to overcome the barriers of entry in the car industry. A high-end product, such as the premium performance Roadster, allows Tesla to generate high revenues and then strategically increase the unit volumes and lower the prices to attract customers from other segments. The letter finishes with the following statement, putting Tesla's business and product strategy straight:

"Build sports car
Use that money to build an affordable car
Use that money to build an even more affordable car
While doing above, also provide zero emission electric power generation options (Musk, 2006)"

The "affordable car" mentioned back in 2006, later became known as the Tesla "Model S" and the "even more affordable car" is known today as the Tesla "Model

3", which is available in North America since the end of 2018. Now, after more than a decade, it can be verified whether Tesla's plan was successful.

CAR MODEL	PRESENTED	LAUNCHED	SEGMENT	PRICE
Roadster	2006	2008	Sports Car	$200.000
Model S	2009	2012	Luxury Car	$78.000
Model 3	2016	2018	Mid-Size Car	$39.500

Table 11: Tesla – Product and Price Development
Source: Author's Chart, According to (Tesla, 2019)

Looking at the price development of the Tesla models in Table 11, one can see a significant reduction in the price over the last few years. There are many reasons for this, such as higher levels of economies of scale and more efficient production, as well as lower battery costs. As a result, Tesla's plan was successful with regards to price and thus enabled barriers to entry such as **economies of scale or capital requirements**.

Nevertheless, the plan of becoming a mass manufacturer like VW or Toyota via the basic version of its Model 3, is not successful yet. This to the extent that the company even withdrew this model, priced at $35,000, a few weeks after the online offer.

The reason behind this problem was the demand being much lower than expected. According to Tesla, significantly more customers buy more expensive versions of the Model 3 (Spiegel, 2019). Nonetheless, since 2018, Tesla has become the global top one seller of BEVs. In total, Tesla has sold 233,760 BEVs, of which 146,310 were Model 3 BEVs alone (Hommen, 2019). This clearly reflects the success of the company, despite the sales problems of the Model 3 basic version.

Also, in the area of sales and **sales network**, Tesla has pioneered in a completely new approach, compared to its conventional competitors. As is generally known, the BEVs can be bought or reserved online and on top of this, Tesla has opened its own physical stores.

Tesla's stores are more similar to boutiques than to conventional car dealerships and are located in city centers and high visibility retail venues instead of in industrial areas. Potential customers can come by and interact with the sales staff, examine the cars and receive information while having a normal shopping experience – to the contrary when buyers visit conventional dealerships, they already have a certain model and manufacturer in mind.

According to Tesla, having vehicles available at conventional car dealerships would cause conflicts of interests as sellers of these dealerships earn most revenue from gasoline vehicles (Tesla, 2012).

This different method of direct selling reduces costs, as no inventory is necessary, and it allows for Tesla to give potential and customers a first-hand experience and an interaction with Tesla's products.

However, the idea of the boutique-like car dealership is losing importance in the company. At the beginning of 2019, Tesla decided to close most of its stores and focus completely on online sales in order to save operating costs. Some stores in

crowded locations will continue to exist, such as in information centers, galleries and showcases (Hawkins, 2019).

This leads us to the next entry barrier, namely **brand identification and customer loyalty**. Through the boutique-like shops, Tesla also tried to convey a different atmosphere and message to the customer, supposedly strengthening customers' interest and own identification with the company. Tesla understands itself, not as classical automobile manufacturer, but more as a technology and design company, which is bound to innovative energy solutions. Instead of focusing on the production of vehicles, the focus lays more on the mobility solution itself and provoking emotions with its products. This is deeply rooted in the DNA, which the first car clearly illustrates. Instead of focusing on a conventional sedan or a compact car, Tesla's first vehicle was a two-seat convertible sports car. This is most likely the most difficult design to market to a broader public, as the targets are rather wealthy customers owning more than one car and that do not need any practicalities. The same applies to Tesla's Model S that offered more practicalities but was hardly affordable for the most target groups. Similar to Ferrari or Porsche, Tesla wants to create emotions, but with emission-free, silent and intelligent dynamic and innovation (Dudenhöffer, 2016). All this contributed to a very strong brand identification and will most probably contribute to strong customer loyalty.

Apart from the battery cells and the transmission, Tesla develops all the important components of an EV in-house. In addition, Tesla has a strong partnership with Panasonic for battery cell production, which additionally reduces the **switching costs** in the long term, as Tesla will not terminate the partnership in the foreseeable future.

Ten years after Musk's first letter, he wrote another one, called "Master Plan, Part Deux" describing the second part of Tesla's strategy. The letter focuses on four major topics and Musk finishes the letter with four simple sentences to briefly explain the second part of the plan:

> *"Create stunning solar roofs with seamlessly integrated battery storage*
> *Expand the electric vehicle product line to address all major segments*
> *Develop a self-driving capability that is 10X safer than manual via massive fleet learning*
> *Enable your car to make money for you when you aren't using it (Musk, Master Plan, Part Deux, 2016)"*

One of his points focuses on vehicles in different segments than passenger vehicles, as it is aimed to expand major forms of terrestrial transport. This means that Tesla wants to expand its range with two more vehicles in the heavy-duty trucks category and high passenger-density urban transport in order to reduce emissions and costs for cargo and public transport. Accordingly, in 2017, Tesla released its first truck, the Tesla "Semi-Truck". Moreover, another point of Tesla's plans is that every vehicle in its portfolio should drive autonomously. This paves the way for Tesla's next step, which is shared mobility, meaning that Tesla vehicles can be used by other people when the owner is not in need of it, all possible thanks to Tesla's shared fleet app.

Tesla has also made further progress in this area and presented its "Robotaxi" system in April 2019, which will be launched in 2020 if approve by the authorities (Werwitzke, 2019).
The first point of Musk plays an enormously important role in connection with e-mobility, because through the solar panels offered by Tesla, not only can electricity be generated, but also stored for later use. This has significant advantages for every BEV driver, so the energy generated can be used to charge the BEVs in their own home. In a future scenario, the car will be charged overnight with the energy generated during the day. The driver remains in Tesla's ecosystem and does not even leave the ecosystem when charging his BEV and uses the energy from local energy providers. Even if the trend, as shown in Chapter 7.4.1, is towards public charging, home charging will never become obsolete.

9.2.2 Tesla – E-Mobility Strategy

Elon Musk's plans in the previous chapter, it becomes apparent that Tesla wants to expand its portfolio into further segments in the sense of a conventional manufacturer and not just remain with passenger cars. In addition to the already mentioned truck, Tesla is currently also in talks with Mercedes Benz regarding a collaboration in the large-van segment, which will obviously be fully electrically driven (Karius, 2019).
Regarding the battery of its BEV models, Tesla can rely on a long and strong partnership with the Japanese battery manufacturer. Since the company's inception, Panasonic has been at Tesla's side, reliably supplying battery cells for its vehicles.
Furthermore, in order to obtain the competitive advantage of low cost batteries, Tesla and Panasonic created the "Gigafactory 1" in Nevada, USA which in 2018 reached a rate of roughly 20 GWh per year, making it the highest volume battery plant in the world and having a larger output of batteries than all other car makers combined (Tesla Inc., 2019). Moreover, Tesla is currently building another Gigafactory in Shanghai and is planning to build another one in Europe, preferably in Germany (Hebermehl, 2019).

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model	Model S	Panasonic*	Tesla	Tesla	Tesla	Tesla	BorgWarner

*Joint partnership and production at the Tesla Gigafactories

Figure 24: Powertrain and Supply Chain Strategy for EVs - Tesla
Source: Author's Chart, According to (Erriquez, Morel, & Moulière, 2017)

Now looking at the production of the Tesla Model S with the knowledge of Tesla's partnership with Panasonic, one comes to the conclusion that Tesla shows a very high

vertical integration regarding its vehicle production. This vertical integration can go even further if one includes the offered solar panels.
In a future scenario, a Tesla BEV could now run on electricity, which was produced in Tesla's solar panels and stored in their energy storage system. Consequently, Tesla is not only providing the vehicle, but also the electricity, at least in case of home charging.

As mentioned in the previous chapter, Tesla offers its vehicles at different prices to compensate for the lower margin on EVs. Consequently, the vehicles differ in range and performance. In addition, Tesla already offers several autonomous options that can further increase the price. Tesla has not yet planned much more in this context, so it remains exciting to see how Tesla deals with this topic in the future.

9.2.3 Tesla – Charging Infrastructure

In addition to the standard wallbox solution, Tesla is actively involved in the expansion of their own charging infrastructure. Tesla's own charging stations are called "Tesla Supercharger" and can be found worldwide. Owners of Model S and Model X can use one of 12.888 Superchargers in 1.441 Supercharger Stations free of charge (up to 400 kWh (~1600 km) annually). Model 3 owners are supposed to pay a small fee for charging. The grid is constantly expanding and of course it is also possible to recharge a Tesla at a conventional charging station. The main reason behind the Tesla Supercharger is that Tesla users can make longer trips, for example holiday trips with their Tesla without having range-anxiety. In urban areas users are still depended on home charging or slower public chargers.
What distinguishes the Tesla Supercharger from other conventional charging stations is its charging speed, as it uses 480-volt DC (direct current) fast-charging technology. According to the manufacturer it takes 20 minutes to recharge a Model S (85 kWh) to 50% and 40 minutes to recharge to 80% (Tesla, Charge on the Road, 2019).

9.3 Byton – "Bytes on Wheels"

With the goal of promoting electrification and innovation in the automotive industry, the Chinese company Future Mobility Corporation (FMC) founded the "Byton" brand in 2017, which can be allocated in the premium segment.
FMC is a startup founded by Tencent and Foxconn. The former is a conglomerate, which is, among other services, the founder of the chat-service "WeChat". Foxconn is the world-wide largest manufacturer of electronics and computer parts and supplies products to for instance Apple. Consequently, Byton has a very strong background of technology companies with a focus on online services and smart devices. Byton is the synonym for "Bytes on Wheels", which will be very obvious in the later course of the analysis.
With the founding of Byton, the company quickly brought many experts from the automotive industry into the company. Byton was founded in Nanjing (China) by the

experienced managers Carsten Breitfeld and Daniel Kirchert, who could draw on experience from BMW, Nissan and Tesla.
The Chinese startup was set up from the beginning according to the "China Root, Global Reach" strategy. As a result, besides the headquarters in Nanjing and other offices in China, research centers and offices in Munich and Santa Clara were established within a few years. According to the former CEO, Byton needs designers in Germany and developers in the Silicon Valley in order to compete with German manufactures in the premium segment. However, in order to offer the product at an affordable price, the car must be produced in China (Walford, 2018). These are just some of the reasons for the international orientation of the company.
Byton is more a mix of an automobile manufacturer and a technology company than a pure automobile manufacturer, as the company sees the car as a smart device, an "iPhone on wheels" so to speak. The manufacturer pursues the idea of seeing the car as a platform that brings content to the customer, which can clearly be traced back to the founding companies.

The analysis is below based on Byton's web presence, online articles, reports, and mainly an interview with the spokesperson of Byton Europe (see Annex 2).

9.3.1 Byton - Company Strategy

Byton does not regard itself as a pure automobile manufacturer, but much more as a technology startup. The Byton BEVs are seen as high-tech cars, which do not only focus on the car as a means of transport. Technologies such as Artificial Intelligence (AI), facial recognition and data analytics play an important role here.
Alongside the car, a core component of the company is the Byton mobile application. It is used by customers to create profiles, customer support, purchase cars and other services.
As aforementioned, according to Porter (1998), the access to dealerships is one of barriers for entry. However, similar to other startups, Byton sees the non-existent **sales network** more as an opportunity rather than an entry barrier. According to the company, the sales network is seen more as an enormous problem in the industry rather than an entry barrier. Firstly, the operation of a sales network is a huge cost factor and secondly, there is no data transfer between the customer and the manufacturer, which can be used to create individual services for the customer by applying data analytics. The classic way of selling a car in Europe or the US, for example, is for manufacturers to sell the cars to their retail partners and they resell them to the customer. This means the retail partner is the customer's sales partner. Therefore, the contact and partner for the potential data exchange is the dealership and not the manufacturer.
However, if a company wants to offer its customers tailor-made offers, it needs certain information from the customer. In this case, both the app and the car are the data suppliers. It is instrumental that manufacturers are contractual partners with the customer, so that an individual service can be offered, and data exchange

can take place. According to Byton, this is currently the great difficulty in traditional dealer networks. For Byton it is, therefore, a great opportunity not to have so many large sales networks to negotiate with, but to be able to design it from the ground up in their digital business areas.
In addition to online distribution, Byton is building a modern dealership network similar to many emerging manufacturers. This is seen by the startup as a great opportunity and is not really comparable to the classic car dealerships. The so-called "Byton Places" are more like a lounge or a café, where the primary aim is not to sell cars, but to give the customer a positive experience with the Byton brand. At Byton Places, the focus is more on technologies that customers can try out in a positive and informal atmosphere in order to create the image of a high-tech brand. With this, the Chinese startup wants to overcome the next barrier to entry, namely the problem of non-existent **brand identification and customer loyalty**. The Byton Places are considered a getaway for all Byton drivers, where customers should feel comfortable and meet other people with the same interests. Byton Places are clearly used to connect the customer with the brand in order to develop customer identification and brand identity. Moreover, Byton invites customers, who have already reserved a BEV, to its co-creation events. This management tool is used with the goal to engage the customer directly in the beginning and to let them part of the R&D process in the long-term. This logically contributes to a higher brand identification and gives the customer the feeling that the manufacturer is "more accessible".
The automotive industry is a very **capital-intensive** industry, which is generally known as a high entry barrier. Byton has also developed a strategic solution for this from the outset. Looking at the list of investors, it is striking that Byton has chosen its investors very strategically and with a clear forward-thinking.

INVESTOR NAME	LEAD INVESTOR	FUNDING ROUND
CATL	No	Series B
Tusholdings	No	Series B
FAW Group	Yes	Series B
Suning Holdings Group	Yes	Venture Round
Fullshare Holdings	Yes	Venture Round
Tencent Holdings	Yes	Series A
Foxconn Technology Group	No	Series A
China Harmony New Energy Auto	No	Series A

Table 12: Byton Investors
Source: Author's Chart, According to (Crunchbase, 2019)

In total, Byton was able to raise $700 million fund in several investment rounds. In its Series B funding round, Byton attracted both the battery manufacturer CATL and the state-owned automobile manufacturer FAW Group as investors. According to Byton's spokesperson, the company also has very good access to the expertise of its

investors. As the largest battery manufacturer in China, CATL supplies the batteries for the BEVs and thus facilitates this supply. For Byton, the problem surrounding the battery has therefore been solved very rapidly. The company is therefore not in need of building any expertise in this area and can focus fully on its digital services.
In addition, Byton has access to FAW's entire supplier network, which is usually much more difficult as a standalone startup with lower volumes. At the same time, the company also gets more favorable conditions from the suppliers, which reduces costs. As a result, Byton can more easily afford its own production factory and produce its own cars.
In addition, the startup has the advantage of being located in Nanjing, where they get enormous support from the provincial government. For example, the construction of the production plant took significantly less time than in Europe, as the local government has approved the necessary licenses much faster. The local government also supports the company financially in the form of subsidies.
All in all, according to the press spokesman, the entry barrier of capital requirements is not so strong in the case of Byton.
Another barrier, often being identified are **switching costs**, in case the company has to change the supplier, for instance. First of all, the production of an EV is much less complex compared to an ICE model, which significantly reduces production risks (Erriquez, Morel, & Moulière, 2017). If one looks at the Byton BEVs as a vehicle concept, then it is first of all a relatively classic car (in terms of materials, doors, etc.), which means no complex components such as gullwing doors. This avoids creating complexity that cannot be mastered later. This significantly simplifies production and minimizes switching costs.

For Byton, the Unique Selling Point (USP) is defined via the user experience and digital solutions, rather than the car itself. Similarly to Apple, Byton is trying to develop a digital ecosystem in which all digital services are offered and where customers are constantly connected to the company. Applications, data and intelligent devices are linked via the digital platform, called "Byton Life". AI is used to serve certain preferences of the current driver, such as appointment reminders or online shopping interests. Drivers are identified via voice and facial recognition. As a result, all data remains centrally in the digital ecosystem, which is stored on the customer's profile. This means that tailor-made services can be offered on the one hand and the data can be used for a better user experience on the other.

If one looks at the Byton models, there is no classic dashboard with hard buttons, but instead a large screen replacing it. Assuming the customer opens the door and is recognized as a driver based on his or her voice and face, the car automatically adapts to the customer's preference, which is stored centrally in the ecosystem. As a result, the seat position and the screen/dashboard change. The screen can be compared to the screen of a smartphone, which can be designed flexibly and

individually. This is also the reason why the company name is derived from "Bytes on Wheels".
The screen has two important advantages. Not only can the car's software be updated easily and frequently similarly to a smartphone, but also, the driver always feels like driving in his/her car in the case of sharing use, because all settings adapt automatically. In a future scenario, this takes away the customer's feeling of not being in his/her own car.

Furthermore, the BEVs has already been designed for an autonomous and shared future. Consequently, it can be concluded that the revenues are not only supposed to be generated from car sales, but more from digital solutions.

9.3.2 Byton – Product Portfolio and E-Mobility Strategy

For the production of its cars, Byton has almost finished its assembly factory in Nanjing and wants to take production in their own hands with this step.
Currently, the Chinese startup has presented two models, the fully electric SUV "M-Byte" and the fully electric sedan "K-Byte". Production of the M-Byte is scheduled to start in April, delivery will start in mid-2019 and the rollout in Europe will follow in 2020. After the M-Byte, the already introduced K-Byte is supposed to go into series in 2021. Additionally, Byton has already announced a third model for 2023 (AutoBild, 2019).

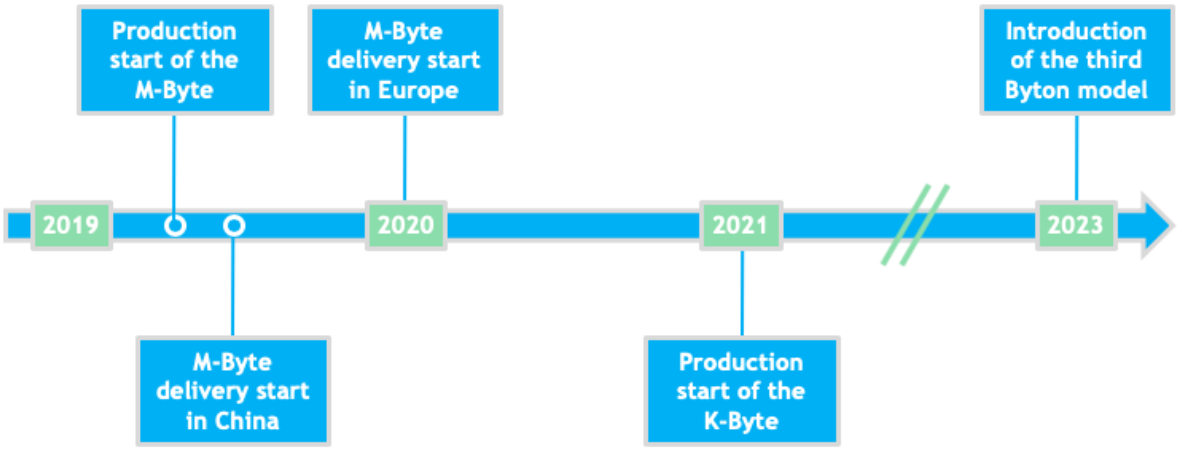


Figure 25: Byton's Future Rollout Plan
Source: Author's Chart, According to (AutoBild, 2019)

The cars are all designed on the same EV platform developed by Byton. However, the aim is not to differentiate themselves with their EV platform. The EV platform does not differ much from the general practices in the industry and is, for instance, comparable to the VW MEB platform. According to Byton's spokesman, the platform has a high standard, but is still on an automotive standard. Therefore, it is nothing completely new or experimental like Tesla did for its models. The aim is to be able to offer an attractive price and reduce risk. The investments that Byton saves are invested in user experience.

In addition, the startup wants to address the lower margins for BEVs compared to ICE models (see Chapter 7.6) with two approaches. Firstly, the EV platform is very flexible, allowing different battery sizes to be installed with a considerable range of either 400 kilometers or 520 kilometers. In addition, the customer can also choose between a rear wheel and all-wheel drive. This allows the customer to choose between different battery sizes and drive trains, which are offered at different prices.
Secondly, the focus is on the user experience around the digital ecosystem Byton Life. For Byton, this represents the differentiation factor between other manufacturers. All extra technology features such as voice recognition or additional customer services are monetized separately according to customer needs in different packages, which are used for Byton to achieve a high margin for each car sold. Exact price packages or price strategies have not yet been disclosed by Byton and have not been communicated during the conducted interview.

As with conventional manufacturers, it is also relevant for new manufacturers to look at their supply chain strategy.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model	M-Byte	CATL*	CATL*	CATL*	Byton	Byton	Information n/a

*Series B Investor of Byton

Figure 26: Powertrain and Supply Chain Strategy for EVs - Byton
Source: Author's Chart

As mentioned above, Byton has a huge advantage as a result of its investors. Looking at the production of the most important EV components, one can see that Byton has created a fully vertical integration due to the expertise and product of the battery manufacturer and investor CATL.

Regarding the charging infrastructure, Byton takes a completely different approach to many manufacturers. The company does not want to invest in the charging infrastructure itself but would like to enter into partnerships. Therefore, Byton currently analyzes charging network partners, which they can join in order to offer their customers access to charging stations. However, they offer their customers high-end charging solutions (e.g. wallboxes), which have a benchmark charging performance, like the top premium OEMs in the world. In spite of the partnerships, charging should still remain part of the ecosystem. In other words, communication with the charging stations or the billing of the various network operators can all be carried out via the Byton App, leading to a whole rounded customer experience.

9.4 NIO – "Blue Sky Coming"

Another very widely discussed startup in the automotive industry is NIO. The Chinese startup was founded by William Li in 2014 and was able to immediately attract investor interest. Similar to Tesla, NIO introduced a sports car (EP9) in 2016, as its first vehicle, with electric drive. Meanwhile, the company has also set up a Formula E team in order to showcase its technological expertise.
The Chinese name of NIO, Weilai, meaning Blue Sky Coming, reflects the startup's vision and commitment to a greener and more sustainable future. With this approach, well-known companies such as Lenovo, Tencent and Baidu were convinced to invest into NIO. Baidu is hardly known in Europe or the USA because of the dominance of Google but considered the Chinese counterpart of Google. In addition, in the case of NIO, a strong presence of modern technology companies can very quickly be seen among their investors. NIO also ventured quickly, due to the high capital intensity in the industry, in order to go public and has been traded on the New York Stock Exchange since the end of 2018 (Kauper, 2018).
The company has also very quickly established an international presence with offices and R&D centers in San Jose, Munich, London and Shanghai. With this strategy, NIO not only wants to target the Chinese domestic market, but also expand into foreign markets. As in the case of Byton, NIO wants also to be closer to automotive and technology hubs around the world.

In the next step, similar to the other manufacturers, the corporate strategy is analyzed in combination with barriers to entry into the automotive industry. Subsequently, the focus will be on the e-Mobility strategy and the innovative charging solutions. The main resources will be the corporate website and the conducted interview with the spokesperson of NIO Europe (see Annex 3).

9.4.1 NIO - Company Strategy

By looking at NIO's business strategy, one can see many parallels with Byton, however, the key challenges are addressed differently.
Similar to Byton, NIO is no longer a pure car manufacturer, but focuses on the user experience. This, especially when it comes to providing a holistic vehicle ownership experience and providing services outside the vehicle. NIO is therefore aiming to establish a digital ecosystem around the car that focuses on the user experience.
Within a cloud solution, vehicles are connected to NIO's mobile application, which gives customers direct access to customer service and other features. Although the strategic also focus is on technologies, such as speech recognition and artificial intelligence, the aim is to create a certain lifestyle around the NIO brand and the ecosystem.
An important pillar is the "NIO House", which resembles a clubhouse for NIO drivers, where users and friends can meet and pursue different activities. The exclusive NIO Houses are divided into seven different areas for activities such as business meetings

or restaurant visits. The aim is clearly to strengthen **brand identification and customer loyalty** and to create a sense of community among NIO drivers. Here, the mobile application has a very important supporting aspect, as the customers are connected to each other via the application and further strengthen the community concept. With this, NIO logically wants to overcome the entry barrier and create strong customer loyalty right from the beginning. In a perfect scenario, the NIO Houses are part of the daily routine of the customers and offer space for free development alongside their home and workplace. In order to further promote the lifestyle aspect, fashion collections by famous designers are also featured by NIO in order to achieve a higher level of exclusivity.
NIO also relies on online sales as well as consulting in NIO Houses as its primary **sales channels**. This also allows the user experience to be better controlled and centrally managed. Additionally, NIO also intends to avoid the loss of sales resulting from a dealer network, since in the classic case, a considerable part of the sales goes to the dealers (Linyan, 2019). Consequently, NIO sees it more as a chance not to have a dealer network, but rather to keep it in their own company with their own channels.
Compared to other emerging manufacturers, NIO has a different approach to the high **capital requirement** and **intensity** in car production. In the field of assembly and production, the company believes that there is no need to reinvent approaches and development. Obtaining a production license in China usually takes a long time and is very complex. Moreover, NIO does not have any automobile manufacturer with skills or the network to simplify the process, among its investor base. Therefore, the Chinese startup decided to leave the production and assembly of its BEVs to the Chinese automobile manufacturer JAC Motors. This logically reduces the risk of being caught in a similar dilemma like Tesla and allows the firm to focus on the user experience in sales and after sales. The concept of contract assembly is very unusual in the car industry and has a revolutionary character. It is much more common in the smartphone industry, where, for instance, Apple does not produce its iPhones and focuses more on areas such as R&D, Sales and After Sales.
Nevertheless, this does not seem to be the most optimal solution, as NIO pays a high price for it. NIO has to pay a fee for every vehicle produced and pay for operating losses of JAC Motors. Moreover, the company has also placed 200 managers and quality engineers at JAC's assembly plants in order to overlook the assembly of its cars (O'Kane, 2019). Due to the low-end quality and poor reputation of JAC Motors, this is seen by many experts as a strategic mistake, so it remains interesting to see how this will develop in the future. However, this strategy made it possible for NIO to get on the road much faster than the normal case (Greimel, 2019).
Hence, for now, economies of scale and switching costs do not represent an entry barrier for the Chinese startup.

Another important pillar of the ecosystem is the "NIO Service" concept, which is part of the car purchase process. Besides free quality control services, NIO also offers free and regular maintenance up to 60.000 driven kilometers, as well as lifelong free

breakdown service. For simple repair and maintenance requests, the service mobile van can drive to the customer and thus significantly improve the user experience. This service further reduces the “pain points” a driver usually has and increases customer satisfaction significantly.

9.4.2 NIO – Product Portfolio and E-Mobility Strategy

As aforementioned, NIO chooses a completely different assembly approach as they leave the assembly to another manufacturer. In the first step, however, we look at NIO's rollout plan for its BEVs.

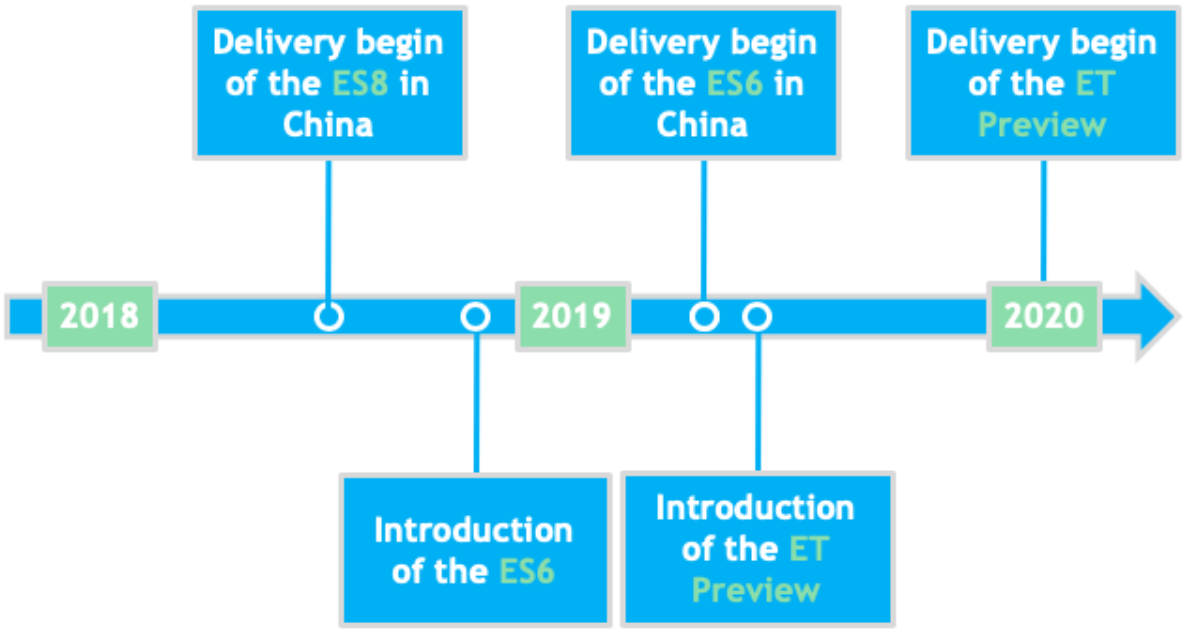


Figure 27: NIO’s Vehicle Rollout Plan
Source: Author’s Chart, According to (Linyan, 2019)

At the end of April 2019, NIO already presented its third BEV model at the Shanghai Auto Show. With the “PT Preview”, NIO expands its product portfolio with a sedan and the delivery is scheduled for 2020. According to NIO’s spokesperson, all BEVs will initially only be available in China, as the company first wants to establish itself on the domestic market and start internationalizing later.
NIO had already successfully presented its first model (apart from the sports car) in Beijing at the end of 2017. In 2018, NIO began with the external production of the “ES8” BEV-SUV and has been delivering its first vehicles since June. With initial difficulties, a total of 15,337 vehicles have now been sold since the start of delivery (Rosevear, 2019). NIO's vehicles are also particularly convincing in terms of range, as vehicles achieve a range of up to 425 km (NEDC range) per full charge. With a price of €60.000, the ES8 can clearly be placed in the premium segment. Except for the number of seats, the ES8 does not offer a higher degree of flexibility to achieve a higher margin. However, this is not the case with the SUV "ES6" presented in December 2018. For the ES6, NIO offers three versions for sale: the Premier Edition, the Performance Version, and the Standard Version. The former will even be limited

to 6,000 vehicles in order to increase exclusivity. In this case, the vehicles differ in the technological equipment. In addition, similar to all other manufacturers, NIO also wants to increase the margin of BEVs with various battery sizes at different prices.
According to the company, the individual price packages are to be further diversified in the future with the help of new implemented technologies and features. This in order to achieve a comparable situation as with ICE models, which have a low-margin base vehicle with high-margin optional features.

A flexible EV platform, however, is seen by NIO as a core competence and is consequently developed by its subsidiary XPT and produced in Nanjing. In this case, NIO chooses a similar path to Byton and does not see the need to reinvent an EV platform and therefore orientates here on the MEB of VW.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model	ES8	CATL[1]	XPT[2]	XPT[2]	NIO	NIO	Magna

[1]NIO is Investor in CATL

[2]Subsidiary of NIO

Figure 28: Powertrain and Supply Chain Strategy for EVs - NIO
Source: Author's Chart

Looking at the strategic orientation of the supply chain for the production of the ES8, it immediately becomes clear that NIO is also following the current trend in the automotive industry. With the exception of the transmission, all important components of the ES8 are either developed in-house or supplied by subsidiaries. This means that NIO has managed, with strategic investments and R&D, to create almost complete vertical integration.

9.4.3 NIO – Charging Infrastructure

In the area of charging infrastructure, NIO is breaking new and innovative ground. In addition to the classic offer of wallboxes, the company also offers the possibility of battery replacement. In so-called "Battery Swapping Stations", the battery of the NIO BEVs can be changed within 3-5 minutes. The stations are only three car parking spaces in size and can therefore also be installed in garages. Currently, NIO has set up the stations on two different highways in China and a total of 1.100 exchange stations should be active by 2020. Due to the lack of space in large Chinese cities, these stations are more likely to be a solution for highways. In urban areas, in contrast, customers have access to home and public charging stations (Gomoll, 2018). However, this can be a convenient option for BEV drivers in different parts of the world, since it is as quick as refueling at the gas station.

In order to provide a charging option for every situation, NIO offers its customers "One Click for Power" via its app, where customers can call so-called "Power Vans", which charge the vehicle for the customer. In February 2019, 510 "Power Vans" were already on the road in major Chinese cities and are to be further increased in the coming months (Linyan, 2019).
In this context it is important to once again highlight that these are solutions for the premium market, which can only be realized in the mass market after a very high EV market penetration.

10. Conclusion and Discussion of Results

For years, the car industry has been treated as an industry with very high entry barriers. Consequently, only a few new manufacturers have tried to enter the automotive market, mainly Chinese state-subsidized companies. With the founding of Tesla, however, this changed drastically. The idea of installing laptop batteries in cars and letting these cars run on electricity, was the starting shot for the electrical transformation.
Many conventional manufacturers such as Daimler/Mercedes-Benz did not initially perceive Tesla as a threat, and even supported the startup financially. With enormous media and public interest and the worldwide sustainability trend behind it, Tesla was able to establish itself as a new manufacturer in the automotive market relatively quickly, similar to Apple's first iPhone in the smartphone industry.
This was also the reason for discussing the Innovator's Dilemma, developed by Christensen and to analyze whether e-Mobility is a disruptive innovation that can fundamentally change an entire industry. In fact, with a new market disruption, Tesla managed and is still managing to serve a new market with customers whose needs have not yet been satisfactorily met by conventional manufacturers, which was also clearly examined by a deeper analysis within this thesis.
As is well known, the automotive industry is undergoing a major transformation. Within this transformation, e-mobility plays a central role alongside autonomous driving, connectivity and shared mobility.
This development has also not gone unnoticed by politicians. After initial hesitation, e-mobility is now also on the political agenda in many countries. Also, due to the enormous emissions produced by the cars and pressure from society, many countries are now targeting bans on new registrations of ICEs. This logically increases the political pressure on conventional manufacturers to transform the industry. Governments in car nations such as Germany are doing what they can to support the electrical transformation of their own industry with subsidies and the expansion of the charging infrastructure. And this is also because of the growing fear that new emerging manufacturers, especially from China, will outperform conventional manufacturers in the future.
Over many years, China has established a great strategic starting position for itself in the field of e-mobility. With many different state subsidies, the Chinese government has very efficiently supported national initiatives, be it with battery

production, which is an enormously important component in BEVs, with a market share of almost 80%, or the establishment of new tech-funded startups.
The fact that China is the largest car sales market in the world is well known, but now the country has also developed into the largest EV market. This has very interesting impact, as the Japanese company Toyota has focused on launching all its new BEV models first in China and expanding globally. Logically, this is also the rationale of the new startups as Byton and NIO.

Coming to the conventional manufacturers, we also consider Mercedes-Benz in the further conclusion. Since Mercedes Benz's approach to its e-Mobility strategy is very similar to Volkswagen's, an in-depth analysis has been omitted. Nonetheless, Mercedes Benz is included in parts of the conclusion again in order to support the analysis.
Regarding conventional manufacturers, it can be said that, in general, all conventional manufacturers are intensively and seriously dealing with the topic of e-mobility. After years of hesitation, also these players have recognized the disruptive nature of e-mobility and are all finally making progress. In general, all manufacturers have set ambitious goals and promise to transform the industry sustainably.
However, in the connection with the electrification of the product portfolio, they generally take two different paths.

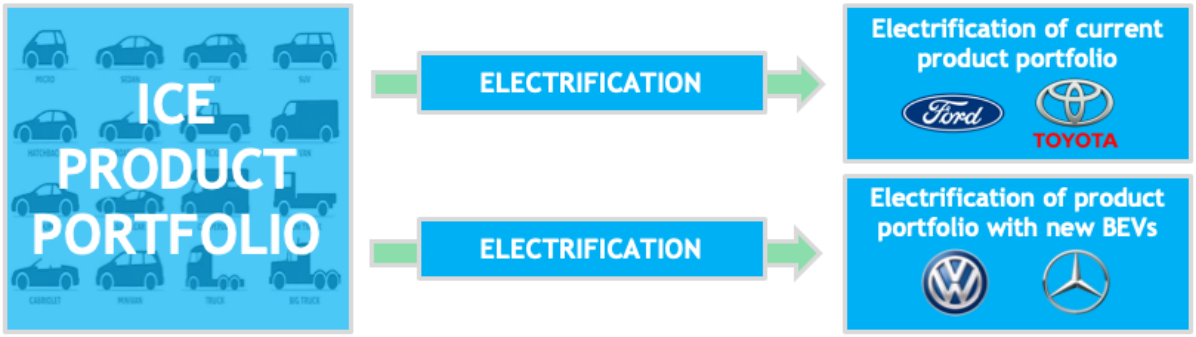


Figure 29: Electrification Strategies
Source: Author's Chart

As one can see in Figure 29, on the one hand, companies like Toyota and Ford are trying to electrify their existing vehicles, while on the other hand, manufacturers like Volkswagen or Mercedes-Benz, are launching completely new BEVs.
The background to the first strategy is that manufacturers such as Toyota, which were able to both gain experience in HEV or PHEV models at an early stage and build up on their expertise, enabling them to produce their BEV models on the same platform.
In the case of Ford, however, a similar strategy was difficult to execute due to lack of any experience in this field in the early 2010s. However, the company still tries to operate based on this strategy. As Ford does not have its own EV platform, the company is trying to integrate it into the company through investments.
Volkswagen, the largest manufacturer in the world in terms of sales figures, has announced that, within the next few years, it will dedicate a completely new family

model series (VW I.D.) to the electrification of its portfolio. Mercedes-Benz even goes one step further and launches completely new cars under a new sub-brand called Mercedes-Benz EQ.
In the case of the second strategy of the German manufacturers Volkswagen and Mercedes-Benz, it is rather due to the fact that the German car industry has lost a lot of trust due to scandals such as "Dieselgate" and wants to send a signal with a completely new BEV in a new design and thus regain customer confidence.

In the automotive industry, the term "digital ecosystem" is now being used more frequently, which is supposed to centrally bundle all services offered by the manufacturer such as carsharing or EV charging. This can logically be centrally controlled via an application, connected to the BEV. With this strategic shift from a car manufacturer to an e-mobility service provider with a high technological affinity, the importance of vehicle production falls further and further into unimportance.
If one now considers the corporate and e-mobility strategy in view of the new trend of digital ecosystems and the lower importance of vehicle production, all manufacturers can be divided into different groups or in this case generations of car manufacturers.

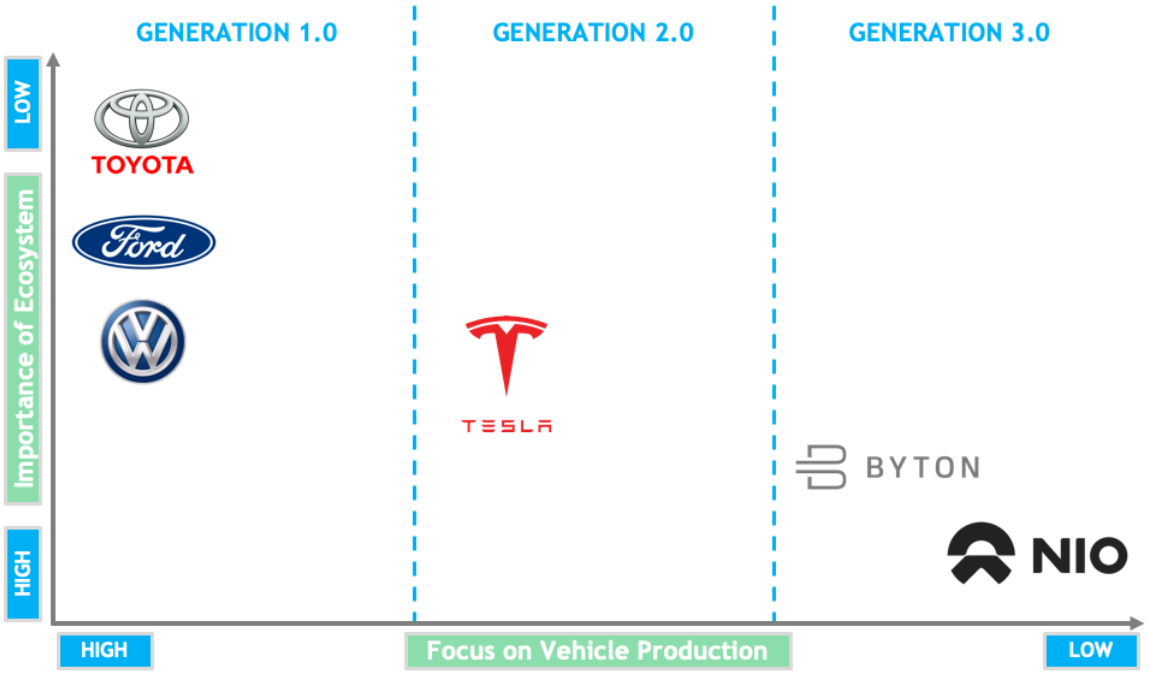


Figure 30: Vehicle Production vs. Ecosystem
Source: Author's Chart

By looking at Figure 30, the conventional manufacturers can logically be allocated in the first generation of car manufacturers. They have a very high focus on the vehicle production and less of a focus on the digital ecosystem around the car. All companies in this generation also have a very deep product portfolio, with which they serve many different vehicle segments. However, VW is also increasingly focusing on the digital ecosystem, with its new ecosystem called "WE" launched in September 2018. Ford and Toyota are also working on offering additional services to their portfolios

around the car itself, nevertheless these are not yet integrated into one ecosystem. Their position differs, as Ford is also investing more and more into shared mobility and other new business models, whereas Toyota is not so far yet.
The second generation is driven by Tesla, which has tried to create an ecosystem from company's infancy. This starts very early, from offering solar panels generating electricity to charge the cars, to all services related to charging and finally to Tesla repair services, which are centrally integrated into one application. Also, as aforementioned, the company will also offer car sharing services in the future. However, Tesla still has a very high focus on vehicle production, as production is still in-house and because Tesla is trying to create a deeper portfolio with full electric trucks and vans.
In the third generation, there is a very high focus on the ecosystem and less on production or the depth of the portfolio. For example, NIO has completely outsourced its production and has its cars produced by another manufacturer. NIO follows the example of Apple, which also has its products produced by other manufacturers in order to focus more on other areas. Moreover, neither NIO and Byton have the intention to expand their product portfolio into segments such as trucks or vans.
The reason for the increasing focus on the ecosystem is the lower margins that BEVs generate. As mentioned in chapter 7.6 Battery Electric Vehicle Specifications, it is not possible to use the old business model of a low-margin, basic version with optional high-margin features for BEVs. Thus, companies try to compensate for this with other services within one ecosystem. In the case of VW, for example, there are different price categories within the WE ecosystem. In addition, the companies are trying to increase customer satisfaction as everything can be offered from a single source. This means that customers are locked into the sticky ecosystem, similar to the one of Apple, making it difficult to change to another manufacturer.

Furthermore, it is also possible to create an overview of all charging solutions in order to draw conclusions. In this context, we can consider all manufacturers in the same chart.
Figure 31 demonstrates the general concern of charging stations across all manufacturers, with a focus on not only limiting range anxiety, but also keeping charging solutions inside the aforementioned ecosystems.

	Conventional Manufacturers			Emerging Manufacturers		
	Volkswagen	Toyota	Ford	Tesla	Byton	NIO
Social/3rd Party Charging Infrastructure	✓	✓	✓	✓	✓	✓
Home Charging (wallboxes)	✓	✓	✓	✓	✓	✓
Brand-Operated Fast-Charging System	✓	✗	✓	✓	✗	✓
Brand-Operated Battery Swap Stations	✗	✗	✗	✗	✗	✓
Mobile Charging Vehicles	✗	✗	✗	✗	✗	✓

Figure 31: Overview of Charging Infrastructure Services
Source: Author's Chart

However, not all manufacturers deal with this issue with the same intensity. For example, Byton shows little interest of investing in this area and leaves this to other manufacturers for cost reasons. Surprisingly, even Toyota has neither invested in this area, nor participated in the construction of charging stations. In other words, manufacturers act differently with regards to charging infrastructure.
It is surprising, however, that NIO has invested a great deal in this area. This is very strongly linked to developments in Norway. As a country with a high market penetration of BEVs, there is a change of perception from range anxiety to issues regarding the charging infrastructure supply. This means that there are too few charging stations for the number of BEVs available and that drivers constantly have to worry about finding a charging station (Harms, 2017).
Consequently, it is arguable that early investments into this area at an early stage is of importance for a manufacturer in order to deliver a good customer experience from the beginning. NIO recognized this development at an early stage and can therefore offer innovative and very customer-friendly solutions. However, in the case of the "Mobile Charging Vehicle" this will most likely remain an exclusive and high-priced feature due to the high operating costs.

Throughout this thesis, vertical integration of at least one model from each manufacturer (except Ford) has also been analyzed to see how companies currently are positioned, especially in terms of the vast cost-driven battery production.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Models	BYD E6	BYD	BYD	BYD	BYD	BYD	Information n/a
	NIO ES8	CATL[1]	NIO	NIO	NIO	NIO	Magna
	Tesla Model S	Panasonic[2]	Tesla	Tesla	Tesla	Tesla	BorgWarner
	Byton M-Byte	CATL[3]	CATL[3]	CATL[3]	Byton	Byton	Information n/a
	Toyota Prius Prime	Panasonic[4]	Panasonic[4]	Panasonic[4]	Toyota	Toyota	Aisin[5]
	VW e-Golf	Panasonic	VW	Panasonic	Bosch	VW	VW
	Chevrolet Spark	A123	GM	A123	GM	GM	Information n/a
	Nissan Leaf	AESC	AESC	Clasonic Kansei	Clasonic Kansei	Nissan	Aichi
	Opel Ampera-e	LG	LG	LG	LG	LG	LG

Degree of Vertical Integration

[1] NIO is Investor in CATL
[2] Joint partnership and production at the Tesla Gigafactories
[3] Series B Investor of Byton
[4] Joint Venture between Toyota and Panasonic
[5] Toyota 30% stake owner

Figure 32: Powertrain and Supply Chain Strategy for EVs - All Manufacturers
Source: Author's Chart

Looking at Figure 32 from top to bottom, it is immediately apparent that as part of their e-mobility strategy, emerging manufacturers have chosen a higher degree of vertical integration than conventional manufacturers. This has various implications.

BYD, the leading BEV manufacturer in China, even has an almost complete vertical integration regarding the most important components in the BEV. One reason for this is that BYD has a history as a battery manufacturer for smartphones and has entered the automotive industry through acquisitions. Therefore, the expertise in battery production is used to a greater extent for BEVs, which gives the company a competitive advantage in the market.
This point is of high relevance as batteries represent the most expensive component in BEVs, and that these are expensive to acquire for manufacturers lacking in-house expertise. Consequently, the sales price of BEVs has to be set much higher. As a result, conventional manufacturers, such as VW, have launched a new offensive in this area in order to rapidly change the situation. To strategically face this problem, Tesla and Toyota have therefore entered into partnerships with Panasonic. In this regard, one can see that emerging manufacturers are much better positioned based on Figure 32.

The trend towards an increased degree of vertical integration among emerging manufacturers and increasingly also among conventional manufacturers poses a threat to suppliers. This is because more and more components are being produced in-house by manufacturers or subsidiaries, leading to enormous revenue decreases. The reason for the increased takeover of many parts of the supply chain is the

significantly lower complexity of a BEV powertrain compared to the ICE powertrain. In addition, only 200 parts are required for a BEV powertrain compared to 1.200 parts for an ICE powertrain. The reduced complexity poses a threat not only to suppliers, but also to conventional manufacturers. Over the years, these manufacturers have differentiated themselves by the driving performance, which is now simpler to reproduce and no longer represents an advantage. This is also one of the reasons for the success of Tesla and, in the future, probably also of Byton and NIO.

In connection with the increased degree of vertical integration, the topic of ecosystems is once again on the agenda. In this case, not only digitally, but also along the supply chain. The idea of a digital ecosystem is to centrally bundle all services and offer these to the customer, which can now be thought of further. To explain this in more detail, BYD can serve as a very good example. BYD has invested heavily in solar power to become the energy supplier for its BEVs and has developed energy storage systems that can store the generated electricity. On top of this, BYD also integrates other services into the digital ecosystem similar to other manufacturers. Complete vertical integration is achieved when the key components of the BEV are produced in-house and self-produced energy is used to charge the BEVs, which customers can access through the digital ecosystem.

11. Suggestions for Further Research

The focus on the ecosystem, which is centered around BEV models and smartphones, will definitely become an increasingly important aspect for all manufacturers. Companies are heavily investing in this area and are moving away from purely being an automobile manufacturer, towards becoming an e-mobility service provider. With regard to further research, it would be of great interest to follow this trend and determine whether the desired ambitions in terms of customer loyalty and increased sales can be achieved, which are supposed to compensate for lower margins for BEVs.

Regarding further research, it can be interesting to see how successful the companies are when they choose different approaches to electrifying their product portfolios. For instance, looking at the VW e-Golf, which is the BEV version of the ICE, satisfactory sales figures could not be achieved. Consequently, it remains interesting to see whether the greater effort of companies, such as VW or Mercedes-Benz, is worthwhile compared to Toyota and Ford, which are electrifying existing models.

In addition, it must be further investigated whether a high focus on infrastructure with the expansion of charging stations and other services is worthwhile for companies or whether this goes unnoticed by customers and does not represent a differentiation factor when purchasing.
It also remains interesting to see whether the strategic orientation of new tech-funded manufacturers, as in the case of NIO, to completely outsource production and have a low focus on vehicle production, will prove to be successful or whether

it will prove to be a mistake. In general, one sees a very strong orientation towards the smartphone industry in this context, or more precisely towards Apple. Hence it will be interesting to see how successful this approach is for the automotive industry.

Furthermore, investments in the development of expertise in battery technology play an enormously important role, therefore the development in this area must be observed to see if the European and American manufacturers manage to overcome the Asian dependency and produce their own batteries.
This also leads us to the next field where further research is necessary, the trend towards vertical integration in BEV production. In this context, it is necessary to examine how automotive suppliers are facing up to this problem and how they will position themselves in the future. In addition, the reduced complexity in BEV powertrains has also led to an enormous increase in the number of car manufacturers. The success of the new manufacturers, especially Chinese ones, is still uncertain and needs to be further analyzed in this context. It must be observed whether they can stand up to the European and American manufacturers or whether it remains a purely regional phenomenon with rather little success outside China.

Finally, the development of fuel cells, as an alternative form of propulsion, must also be pursued with great relevance, in particular that of Toyota, which has invested a lot in this area in recent years and will continue to do so.

Annexes

Annex 1: Detailed description of current emerging manufacturers

- *Tesla:* U.S. company that manufactures and distributes electric cars, storage and photovoltaic systems. The company's goal is to "accelerate the transition to sustainable energy". The company name is based on the physicist and inventor Nikola Tesla.
- *Xiaopeng Motors:* Chinese automotive startup headquartered in Guangzhou with offices in Mountain View, California, USA. The electric car company was founded in 2014 by former UC browser founder He Xiaopeng together with Xia Heng. The company was funded by companies such as Alibaba , Foxconn and IDG Capital in 2018.
- *Faraday Future:* Faraday Future is a US electric vehicle company founded in 2014, a subsidiary of the Chinese company Leshi Internet Information & Technology based in Gardena, California.
- *Byton:* Automotive brand of the Chinese company Future Mobility Corporation (FMC), headquartered in Nanjing. Electric cars are to be produced under the brand name. The startup was founded in 2017.
- *Lucid Motors:* Founded in 2007 and based in Newark, California, Lucid Motors is a company specializing in the production of batteries. In 2014, however, it decided to focus on the development of electric cars.
- *Streetscooter:* The Streetscooter GmbH in Aachen is a German manufacturer of Electric vehicles and was founded in 2010. The company is a subsidiary of Deutsche Post. In Aachen and Düren, it produces fully electric vans as well as electric load wheels for predominantly inner-city use.
- *Uniti:* Swedish automotive startup founded in January 2016 by Lewis Horne (CEO) and developing a high-tech electric city car in Lund, Sweden. Uniti started as an open innovation project at the University of Lund and developed into an independent startup in January 2016. The company's goal is to change the automobile codes by redesigning the entire car, removing the steering wheel and most of the mechanical system and producing the first sustainable car.
- *NIO:* Chinese start-up (founded in 2014) based in Shanghai that specializes in the production of electric cars. In 2018, NIO employed more than 5000 people at 19 locations worldwide.
- *BYD Auto:* Car manufacturer based in Shenzhen, Guangdong Province, People's Republic of China and a subsidiary of BYD Company Ltd, one of China's largest car manufacturers and listed on the Hong Kong Stock Exchange. In the field of e-mobility, it is regarded as one of the most innovative companies - not least due to the market launch of the world's first electric semitrailer tractor, the first electric articulated bus and the first electric double-decker bus.
- *Rivian:* American automotive manufacturer and automotive engineering company. The company was founded in 2009 and develops vehicles, products and services related to sustainable transportation.

Annex 2: Interview with Byton

Interview with Oliver Strohbach – Director Public Relations Byton Europe

1.) One key goal that VW mentions is to create battery technology as a core expertise for example. Whereas Byton's batteries are coming from the Chinese manufacturer CATL. How does Byton's strategy and ambitions regarding the battery technology look like?

Unser USP und das Hauptthemenfeld, mit dem wir uns beschäftigen ist die User Experience mit der Mobilität von Byton im Auto und drum herum. Daher braucht man natürlich eine Kernexpertise, wenn es um den Antrieb, Batteriezellen, e-Motoren und die Leistungselektronik. Wir sehen dies aber nicht als großen Unterscheidungsmerkmal. Also müssen wir die Qualität sicherstellen, die Leistungsfähigkeit muss sichergestellt sein. Aber in unserer frühen Phase, in der wir sind, hilft uns unser Investor (CATL),

als Zulieferer für die Batteriezellen extrem weiter, weil wir da die Batterie auf einem hohen Standard bekommen.
Unser Unterscheidungsmerkmal ist die User Experience, nicht zu sehr der Antrieb. Deswegen haben wir uns da starke Partner gesucht, CATL für die Zellen, Bosch für den Antrieb insgesamt. Die Batterie als Ganzes machen wir dann in unserer Fabrik, weil es ein inkrementeller (aufeinander aufbauend) Teil des Fahrzeuges ist. Hier bauen wir alles zusammen und konstruieren es natürlich entsprechend und sichern das ab. Aber als Zukaufteil, ist es genau das was wir brauchen.

2.) Byton plans to manufacture three models based on its Smart EV Platform. What are in your point of the outstanding factors or advantages of Byton's EV platform compared to other manufacturers?

Es geht in die Richtung wie bei der ersten Frage. Es geht uns nicht darum, uns durch eine EV Plattform zu differenzieren, sondern die besten Synergieeffekte und beste Industrialisierung zu gewährleisten und hinzubekommen. Eine Plattform-Logik ist relativ komplex, weil man in der Konzeptphase, die Plattform definiert und dann schon sehr tief einsteigen muss in die Modelle und die Model-Charakteristik, sowohl auch in die Produktion der Modelle. Das ist hier unser Ansatz, weil wir die größten Effekte erzielen wollen, was die Kosten, Effizienz, und Qualität angeht. Aber die Plattform an sich, ist vom Gedanken her genau das was man allgemein in die Industrie aktuell sieht (Modulare Elektrobaukasten bei VW etc.) Das ist genau die Logik, die man verfolgen muss, weil die Investments in die Batterietechnologie so hoch sind, dass man gucken muss, wo man die Synergien am besten holt. Unsere Plattform hat einen hohen Standard, aber Automotive Standard. Ist also nichts komplett Neues oder Experimentelles wie es Tesla mit den Modellen gemacht hat. Ziel es damit auch einen attraktiven Preis anbieten zu können. Die Investition, die wir da sparen, die werden in die User Experience investiert.

Die Plattform ist zwar relativ simpel aufgebaut, aber trotzdem wurde hierbei eine gewisse Variabilität mit hineingebracht.
Wir bieten zwei Antriebsformen (Hinterrad und Allrad Antrieb) sowie zwei Batteriegrößen an, welche sich mit der Plattform verbinden lassen. Hierdurch bekommen wir zwar keine Komplexitätsreduzierung hin, aber dafür ein relativ großes Angebot, damit die Kunden auch die Wahlmöglichkeiten haben.

Blicken wir zum Beispiel nach Norwegen, hier steigen die Autokäufer relativ hoch an, was die Ausstattung angeht. Hier kann man sehr stark erwarten, dass diese auf den Allrad Antrieb und große Batterie zurückgreifen. Den gleichen Trend sieht man aktuell auch in China, da die allgemeine Überzeugung ist, dass ein dynamischer Antrieb nur über einem Allrad-Antrieb möglich ist.

3.) If we look at Tesla or the big German OEMs, they all work on building charging stations for their customers. How do you handle this at Byton? Are there any initiatives or partnerships?

Ja, wir haben Partnerschaften. Wir arbeiten zusammen mit den größten Netzwerken in China, USA und Europa. In den USA mit „Electrified America" zum Beispiel. In China gibt es ebenfalls eine Reihe von Netzwerken, an der wir uns beteiligen. In Europa gibt es auch einige, es ist auch nicht so, dass jeder sein eigenes Netzwerk aufbaut, sondern jetzt wo die Standards da sind, dass man schaut das die Verteilung der Ladesäulen gut funktioniert. Auch hier passen wir uns dem Standard an und nutzen die Netzwerke.
Wir bauen aber nicht mit anderen zusammen Ladestationen. Wir analysieren gerade die Netzwerkpartner, die es aktuell gibt und schauen wo wir da miteinsteigen. Wir bauen keine eigenen Schnellladestationen. Wir bieten aber unseren Kunden high-end Ladelösungen an (e.g. Wallboxes). Auch hier werden wir eine Benchmark Ladeleistung haben, von den top Premium OEMs die man in Deutschland kennt. Wir halten aber nicht viel davon als Hersteller in die Infrastruktur zu investieren, sondern die Standards für die Kunden so zu nutzen, dass sie die Ladesäulen, die es gibt, nutzen können und den genau gleichen Zugang haben wie die Premium-Kunden in Deutschland auch. Am besten, aber etwas vereinfachter, das heißt das wir die Kommunikation mit den Ladesäulen, die Abrechnung und die verschiedenen Netzbetreiber alle zusammenführen über unsere Byton App und der Kunde nur noch eine Experience hat.

4.) How does Byton intend to overcome challenges related to a very capital-intensive industry with enormous entry barriers, especially regarding the production (economies of scale)? At the moment, Tesla's example shows that this is not so easy.

Klar Antwort in diesem Zusammenhang. Wir machen eine maximale Risikoreduzierung. Das bedeutet, das Werk, das wir gerade bauen ist Industrie 4.0 Standard mit einem hohen Automatisierungsgrad, aber Industriestandard. Also das heißt das Werk wie wir es aufbauen, würde genauso aussehen wie wenn es ein anderer Premium OEM, momentan neu bauen würde. Wir machen eben nicht die Philosophie wie es zum Beispiel Tesla gemacht hat mit der Logik „Maschinen bauen Maschinen" und wollen einen 100% Automatisierungsgrad hinbekommen. Denn dann kommt man zu Problemen in der Produktion. Dies wollen wir verhindern.
Es gibt hier viel Ansätze, welche sich durchziehen im Zusammenhang mit der Reduzierungsminimierung. Zunächst haben wir top Leute von Anfang an dabei. Zum Beispiel Byton's „Head of Production" hat mehrere Werke für Toyota eröffnet oder für Tesla die Model S Fabrikation hochgezogen und er weiß wie man sowas macht, weil er schon oft getan hat. Das zweite ist, dass wir unser Produkt so auslegen, das diese gut in hoher Qualität und hoher Stückzahl zu fertigen sind. Wenn man sich den M Byton anschaut, als Fahrzeugkonzept, dann ist es zunächst ein relativ klassisches Auto (bezüglich Materialien, Türen etc.), also keine „fancy" Feature wie jetzt Flügeltüren. Hierdurch wird vermieden eine Komplexität zu erzeugen, welche man später nicht beherrschen kann.

Also diese Komplexitätsreduzierung oder Risikominimierung ist die Logik bei uns. Grund hierfür ist, dass wir alles neu machen. Wir bauen ein neues Werk, wir entwickeln eine neue Plattform, wir bauen neue Autos etc. Dies kann nur funktionieren, wenn man die Risiken so klein hält wie nur möglich, besonders in der Produktion.

Folglich haben wir Partner wie Kuka für Roboter, Dürr für die Lakierstraße etc. Also alles die Top-Anbieter, welche in diesem Bereich aktiv sind. Das Lay-out unseres Werkes ist auch so ausgelegt, dass man einen sehr guten Industriestandard erfüllen kann.

Darüber hinaus haben wir den Vorteil, dass wir in Nanjing sind und uns die Provinzregierung extrem unterstützt. Wir haben vom ersten Gespräch mit der Provinzregierung bis zum fertig funktionierenden Prototypenwerk, in welcher wir anfangen haben unsere Prototypen zu bauen (im letzten Sommer), dies hat 18 Monate gedauert (mit allen Regularien, Bauvorschriften etc.). Dies ist nur in China möglich. In Europe würde dies viele Jahre dauern. Dies geht nur in China und wenn man die Unterstützung von der Provinzregierung bekommt, sowohl finanziell als auch bürokratisch. Folglich sind die Entry Barriers nicht so stark ausgeprägt.

5.) Another very strong entry barrier for new car makers are the new establishment of a sales network. You have opened lately a new direct-sales store. Apart from that you have also the opportunity to purchase online. Lastly, you have also planned to establish agreements with partners. What is your view regarding an efficient sales network.

Wir sehen es nicht als Barriere, für uns ist es eher eine riesen Chance. Wir haben nämlich nicht dieses Salesnetzwerk, welche aktuell die konventionellen Hersteller vor enormen Herausforderungen stellen. Erstens ist dies ein riesiger Kostenfaktor für die Betreibung eines Verkaufsnetzwerks und das zweite ist Datentransfer und individuelle Dienste für den Kunden. Wenn man zum Beispiel auf klassischem Weg in Europa oder den USA ein Auto verkauft, dann ist es so, dass die Hersteller die Autos an die Retailpartner verkaufen und diese dann an den Kunden verkaufen. Der Retailpartner ist als der Verkaufspartner des Kunden. Daher ist mein Ansprechpartner und mein Partner für den potenziellen Datenaustausch auch das Autohaus und nicht der Hersteller. Wenn man aber dem Kunden individuelle Dienste anbieten möchte oder maßgeschneiderte Angebote machen möchte, dann braucht man einige Informationen von dem Kunden (natürlich, wenn diese zur Verfügung gestellt werden). So machen wir das mit dem Auto auch. Grundsätzlich ist wichtig, dass wir als Hersteller Vertragspartner mit dem Kunden sind, damit wir die individuellen Dienste natürlich anbieten können und auch um in den Datenaustausch mit dem Kunden treten können. Nur wer die Kundendaten hat, kann die auch nutzen. Dies ist aktuell die große Schwierigkeit in den traditionellen Händlernetzwerken.

Für Byton ist es folglich eine große Chance, nicht so viele große Verkaufsnetzwerke zu haben mit denen man verhandeln muss, sondern dass wir es von Grund auf unsere digitalen Geschäftsfelder auslegen können. Darüber hinaus ist das Kundeerlebnis bei einem Retailpartner heutzutage, eher negativ assoziiert wird. Meistens haben viele nicht die große Erfahrung oder den Service. Das heißt man hat eine Gewisse Bürde mit solchen Netzwerken. Diese haben wir glücklicherweise und können

unsere Flagship Stores „Byton Places“ genauso aufbauen, dass wir ein positives Kundenerlebnis haben. Wir haben in Shanghai den ersten eröffnet und schaut man sich diesen an, dass sieht das eher aus wie eine Lounge oder Kaffeebar. Ziel ist es, dass wir einfach potenzielle Kunden ansprechen möchten einfach mit uns in Kontakt zu treten ohne gleich ein Geschäft zu tätigen. Dies ist ein anderer Zugang zum Kunden, was das Erlebnis angeht.
Hierdurch sind wir sehr effizient. Wir bieten unsere Dienste über eine Plattform an, auf welcher wir alle Informationen zur Verfügung stellen. Dies passiert über unsere Byton App. Ich kann mich über die Modelle informieren und auch aktuell schon ein Auto reservieren. Dies werden auch zu Events wie den Byton Co-Creation Events etc. eingeladen. Wir möchten mit Kunden der Zukunft gemeinsam an Schraubstellen arbeiten. Die Kunden haben die Möglichkeit Ding mit zu entwickeln oder Ideen einzubringen. Hierrüber ist der Kundenkontakt schon sehr intensiv.
Und was das offline Erlebnis angeht, brauchen wir die Byton Places. Hier kann man dann mit unseren Mitarbeitern gemeinsam durch die Byton Journey gehen.
Darüber hinaus gibt es noch viele Service-Partner Netzwerke, welche gerade in der Entwicklung sind. Hierbei haben wir ebenfalls zwei Angebote. Einen Stützpunkt- Partner haben, die speziell ausgerüstet sind für alles was aufwendige arbeiten angeht (z.B. Batterietausch, Hardware Updates etc.). Und das andere Angebot ist für klassische Service-Angebote. Über

Extra Questions: Tesla now wants to close most of his stores. How do you see this change?

Gucken man zum Beispiel in die Schweiz oder Österreich, dann findet man jede Menge Tesla Stores vor. Hier geht es darum die Kosten in den Griff zu bekommen und nicht zu viel zu investieren. Also ein riesen Netzwerk, welches man eigentlich gar nicht braucht. Dies ist im Prinzip unsere Logik, was wir mit den Byton Places machen. Wir gucken uns genau an, wo müssen wir präsent sein, wo müssen wir einen offline Store haben. Alles aber mit einer Dichte und Menge an Byton Places die händelbar sind und die Kosten nicht komplett ausufern.

Annex 3: Interview with NIO

Interview with Philipp-Maximilian Erdmannsdorffer - Senior Manager Communications & Public Affairs at NIO Europe

1.) Battery Swapping seems very interesting in theory but seems in my opinion very optimistic in practice. Why do you think that battery swapping is a feasible idea? Would this be possible in a large scale already today?

Zunächst zu NIO's Kundeanspruch bzw. User Approach. Wir haben uns vor Gründung des Unternehmens angeschaut, wo sind die größten „Pain Points“ im Bereich e-Mobilität bzw. Mobilität im Allgemeinen und darauf basierend Services konzipiert. Im Bereich e-Mobilität ist es auf jeden Fall die Reichweiten-Angst, welches immer noch der größter „Abschrecker“ vor dem Kauf eines EVs ist.
Dies hat aber zum Beispiel eine andere Entwicklung in Norwegen genommen, wo der Kunde weniger Angst vor der Reichweite hat, sondern eher die Angst besteht vor der nächsten Ladung. Folglich findet ein Wandel bzw. Wahrnehmungswechsel statt in Länder wo Kunden schon an EVs gewöhnt sind und es normal ist. In Norwegen haben EVs eine hohe Marktdurchdringung, mit zum Beispiel 60% EVs in Oslo zum Beispiel.
Es findet also ein Wahrnehmungswechsel statt, von der Reichweitenangst hin zur Ladeinfrastrukturversorgung. Der Kunden sorgen sich nicht mehr darum wie weit soe mit dem Auto kommt, sondern wie das Auto ab sofort geladen werden kann. Dies ist aber der Fall in einem Ökosystem wo e-Mobilität normal ist.
Das ist aber noch nicht der Fall im Rest der Welt, hier ist immer noch die Reichweitenangst an oberster Stelle. Einfach dem geschuldet, dass die Ladeinfrastruktur noch zu wenig ausgebaut ist. Das war für uns der Ansatz, dem Kunden eine Möglichkeit bieten, wie er schnellst möglich, sein Auto laden kann und dafür haben wir das System von "Better Place" nochmal aufgegriffen und es skaliert (kleiner gemacht). Es braucht drei Parkplätze und ist klein und kompakt. Es kann in zum Beispiel in eine Tiefgarage eingebaut werden. Es liefert auch die Möglichkeit, in 3-5 min komplett den Akkutausch durchzuführen. Das System ist natürlich auch einsetzbar auf Fernstraßen, das wäre das Überlandsszenario.

Wir müssen bei NIO natürlich immer sehr stark vom chinesischen Markt ausgehen, das heißt wir haben die chinesische Mega-City mit 20 Mio. Einwohner und somit nicht den nötigen Platz haben, um das eigene Auto in die eigene Garage zu stellen. Der Fall ist sehr selten. Daher hat der Kunde auch hier die Möglichkeit im täglichen Straßengebrauch, ohne daheim eine Tiefgarage zu haben, wo das Fahrzeug geladen werden kann, schnell an neue Energie zu kommen.
Dazu bieten wir Cloud Solutions für unsere User an, dass verschiedene Möglichkeiten gegeben werden, die Batterie zu wechseln bzw. wie man schnellsten an neue Strommöglichkeiten kommt. Das skaliert sich vom „Vallet Charging“ bis hin zum „Charging Mobile“, wenn der Kunde außerhalb einer Lademöglichkeit ist.
NIO ist bezüglich des Batterie-Swapping Systems noch in der empirischen Erprobung und können daher noch keine validen Daten liefern, wie die Nutzungsszenarien sind. Natürlich lässt sich das System nach oben, eskalieren, das heißt wir haben momentan zwei Fernverbindungsstraßen ausgebaut in China (Peking - Shanghai; Peking -Shenzen), wo der Kunde alle 50 km im Schnitt eine Swapping Station haben und auf Überlandstrecken Batterien getauscht werden können.
Die Kunden nehmen es auch relativ gut an. Die chinesischen Kunden fahren zum Beispiel nicht wie in Deutschland von Berlin nach München, wo der Kunde sehr autoaffin ist, sondern in China sind die Strecken viel länger, bei der eher auf den Zug oder das Flugzeug zurückgegriffen wird. Dies ist also kein oft genutztes Szenario. Nichtsdestotrotz wurde dies trotzdem gut angenommen bei Wochenendausflügen oder an Feiertagen.

2.) Why did NIO abandon plans to build its own production plants and instead chose JAC as its producer? Are NIO's plans to become a real car manufacturer or are you planning and focusing on taking further steps around the car (additional services)?

Die Überlegung ist zum einen, dass man in China Zeit braucht, um eine eigene Produktionslizenz zu bekommen. Dies ist ein relativ komplexer Prozess und dauert einfach länger. Darüber hinaus konsolidiert die chinesische Regierung aktuell den Wildwuchs der verschiedenen e-Mobility Startups in China, welches die Ausgangslage weiter erschwert. Aber grundsätzlich war die Überlegung, dass man sich auf die beiden inneren Wertschöpfungsketten konzentriert. Zum einen natürlich R&D, um die Entwicklungsschritte selber zu tätigen. Wir haben hier auch große Entwicklungsteams in Shanghai oder San Jose sitzen. Und zum anderen Sales and Aftersales bzw. Kundenservice als Ende der Wertschöpfungskette. Wir brauchen Dinge nicht neu zu erfinden. JAC ist Produktionspartner von Volkswagen und fertigen in einer vernünftigen Qualität und Geschwindigkeit. Das heißt wir bei NIO brauchen uns in diesen Themen nicht ressourcenintensiv befassen und können uns eben auf Forschung und Entwicklung uns konzentrieren, bzw. auf Sales & After Sales sowohl Service, welche rundum die Marke geboten werden (NIO House, NIO Life etc.) Wir sind der Meinung, dass wir viele Dinge nicht neu erfinden bzw. entwickeln müssen im Auto und folglich keinen Grund sehen, warum wir nicht auf die Produkte und Services die auf dem Markt sind zurückgreifen sollen. Dies sind alles Kosten, die wir sparen können, die wir am Ende im Preis weitergeben können.

3.) Is NIO using the battery technology and EV platform of JAC in order to produce its cars? Or is the platform developed by NIO?

Genau das ist der Fall hier und ist Kernkompetenz. Der Powertrain ist eine in-House Entwicklung und wird auch in-house von unserer Tochterfirma XPT produziert. Das heißt alles rundum Batterie und Antriebstechnik, kommt aus der eigenen Produktion. Wie beim ICE sind Verbrennergetriebe und Motor die Know-How-Träger und bei EVs ist es der Powertrain. Dieser wird von JAC nicht gefertigt, aber verbaut und von XPT gebaut.

Die Batterieproduktion ja, aber die Batteriezelle wird aber von CATL zugekauft. NIO ist aber auch einer der Investoren von CATL.

4.) The interior decoration details of ES8 is perceived to be somehow low-end due to the manufacturing ability of the JAC, which is the actual OEM of ES8. And how does NIO approach this problem?

Wir platzieren unsere Produkte im Premium Segment. Daher möchten wir auch aus diesem Vorurteil rauskommen, da tatsächlich die Verarbeitung bei vielen chinesischen Hersteller nicht auf dem Niveau wie in Zentraleuropa. Wir versuchen auf dem Premium-Niveau zu sein und dies klappt mit JAC auch eigentlich ganz gut, da wir in der Fertigung auch unsere Qualitätsansprüche sicherstellen. Des

Weiteren arbeiten wir hier natürlich auch mit globalen Herstellern im Bereich der Innenraumausstattung. Wir haben zum Beispiel den gleichen Lederlieferanten wie die Mercedes etc., selbiges gilt auch im Antrieb- oder Lenkungsbereich.

5.) Similar to other manufacturers, NIO has adopted the business approach of "top to bottom". Starting with the highest-performing cars and then making the mass-market cars will be easier. However, If I look at the current business model with this very high premium standard and exclusivity, is this the real goal of NIO?

Genau, das ist auch unser Approach. Alle unsere Autos sind im Premiumbereich angesiedelt. Dies ist wichtig, da es in China noch nicht wirklich eine hohe Affinität zu Flottenlösungen gibt, sondern immer noch Ownership als ein wichtiger Aspekt im chinesischen Markt gesehen wird. Hierbei möchten die Kunden auch ihren Status zeigen in der Zielgruppe, wo wir unsere Fahrzeuge angesiedelt haben. Aber auch unserer Services sind im Premiumbereich und sollen auch in diesem Bereich bleiben. Folglich verwenden wir auch hochwertige Materialien in der Fertigung. Dies vermitteln wir auch unseren Usern. Zum gegenwärtigen Zeitpunkt, welches sich aber natürlich ändern kann, möchten wir auch in der Zukunft im Premiumsegment bleiben.

6.) Current OEMs business models rely heavily on customers upgrading the base vehicle with an additional engine, comfort, and safety feature as well as on aftermarket parts and services to boost profitability. Meaning the traditional model of low-margin base vehicles with high-margin optional features. However, this does not apply to today's EVs. For EVs, there is little room for differentiation by performance and base EV configurations already contain many options. How does NIO want to cope with that in the future?

Auch hier wieder, die am Anfang geäußerte Absicht, dass wir versuchen wollen so wenig „Pain Points" wie möglich für den User zu haben im Bereich Fahrzeugnutzung. Wir haben von vorherein gesagt, wir schauen, dass wir eine größtmögliche Service Deckung haben. Man hat hier über Cloud Solutions Die Möglichkeit mit dem Servicepersonal in Kontakt zu treten, falls mit dem Fahrzeug etwas sein sollte. Zum anderen ist NIO Service „autolebenslang" Ansprechpartner für den Kunden. Darüber hinaus werden alles Software Updates, auch über Cloud Solutions ausführt. Das heißt man muss nicht in die Werkstatt gehen und zahlen. Wir wollen folglich dem Kunden eine gute User Experience ermöglichen. Auf der anderen Seite, besteht auch die Möglichkeit eines Batterieupgrade. Hier können ebenfalls zusätzlich Einnahmen realisiert werden.

Annex 4: Analysis of BYD Auto

Build Your Dreams – BYD Auto

In the last decade, China has experienced an enormous growth rate in GDP and population. China as an economy with the same number of inhabitants as the EU and whose citizens are more willing to take money into their hands and drive consumption continuously. At the same time, China is also home to many companies with higher revenues than global players from the Western world. Nevertheless, many people in Western society, except for companies like Ali Baba or Huawei, have not yet heard much about many Chinese companies, especially from the automotive industry. China has been trying to gain a foothold in the automotive industry for several years. With the help of regulations (e.g. joint venture obligation for foreign car manufacturers) and subsidies, the government is trying to establish and promote Chinese companies. BYD seamlessly joins these ranks of state-supported companies.

BYD stands for Build Your Dreams and owns a subsidy named BYD Auto Co., Ltd. which was founded in 2003. Although BYD Company was already founded in 1995 its car manufacturing subsidy can be considered a new coming manufacturer as it exists for less than 20 years and is unknown yet, especially in the Western world. Nevertheless, BYD cannot be considered a classical start-up, as Uniti or Byton. In spite of this, BYD was a pioneer in 2008 with the world's first mass-

produced plug-in hybrid, the F3DM. With a range of approx. 60 km the F3DM was truly a pioneer at that time (Pasternack, 2008). Now the question arises how can a company that seems so unknown achieve milestones that some of the largest car companies in the world are not able to achieve until today?
Probably the biggest advantage of BYD Auto is that the main business of the parent company was and is producing lithium-ion batteries, especially for mobile phones, and thereby BYD Auto gained its knowledge in producing larger vehicle batteries (ChinaAutoWeb, 2016). As we have already seen in Figure XX, the company has managed to secure a large market share in global battery production. With 12% market share, the company is among the top three manufacturers worldwide. BYD also plans to make its batteries available to other manufacturers.
Moreover, as we have already seen in Figure XX (Refer to chapter 7) that BYD is currently leading with a market share of 20,4% the local Chinese EV market. BYD is also the only Chinese company who is among the favored EV brands for Chinese customers, as most of them still prefer cars from the established Western manufacturers. And this despite the fact that most global manufacturers have not yet presented their EV models in China. The current situation could therefore also change very quickly for BYD (FT Confidential Research, 2018).

As aforementioned, the Chinese government changed the regulations for EVs as well as the rules for subsidies, which obviously has an influence on BYD's business. Additionally, due to the aggressive strategies of European and American OEMs the local manufacturers must prepare to consolidate their positions in their local market. In the following we look at BYD's current strategy with a focus on e-Mobility, the current electrical product portfolio, EV production, charging infrastructure and, last but not least, the company's strategy to capture global market share. The following analysis is extracted from the BYD's online presence, press releases and an interview conducted with BYD's Deputy Managing Director at BYD Europe B.V.

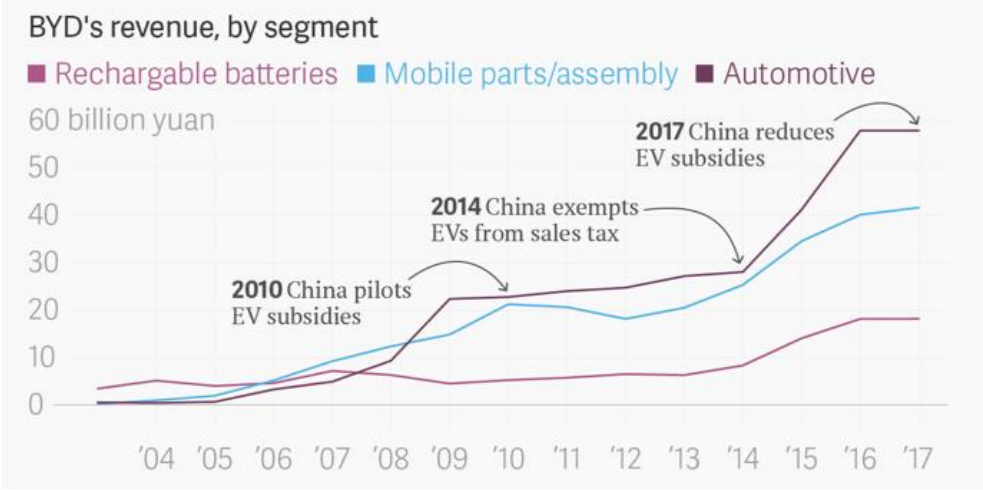
BYD Auto's Strategy and the Government's Role

Since 1995 the average growth rate of BYW has been at 70% per year, which is a remarkably high rate that can only be achieved with the right strategy (Masiero, Ogasavara, Jussanic, & Risso, 2016). Initially, BYD combined its battery manufacturing expertise with that of the acquired Tsinchuan Automobile Company, which later became BYD Auto. In 2009, BYD combined automobile and battery production, resulting in its first crossover sedan, the "e6", which is still in production today. Moreover, this year was important for the Chinese economy and society as the government released new regulations and incentives in order to reduce pollution, increase e-mobility in Chinese streets and obtain a dominating position for the rollout of EVs (Bradsher, 2009). Chinese carmakers saw this as their chance to establish themselves in the global market because Western manufacturers were not yet prepared for e-mobility.
Besides its passenger BEV "e6", BYD Auto also launched a fully electric transportation bus, which both later were acquired by the government in large numbers to use them in public transportation (Masiero, Ogasavara, Jussanic, & Risso, 2016). In Shenzhen, where BYD's headquarters is located, was the world's first city obtaining an electrified taxi fleet. And to this day, the Chinese government is pushing for the electrification of public and private transport vehicles. The latter has been promoted in recent years by subsidizing manufacturers and granting buyers a reduced price (no longer in force).
In 2015 BYD gave its strategy the terminology of "7+4" which refers to an electrification of all on- and off-road transportation routes. BYD defines the seven ways of on-road transportation as following: urban transit, taxis, private cars, tourism and commuting coaches, garbage trucks, urban goods logistics and urban construction logistics (BYD, 2018).

The other four specialized types of transportation happen on off-road environments such as harbor, warehouse, mining and airport. This, broad and diversified strategy shows that BYD does not focus only on one type of vehicle or mobility solution. The aim is to achieve a complete electrification of global mobility. Unlike many conventional manufacturers or, above all, new emerging manufacturers, BYD strives for a broad diversification of its product portfolio. Almost according to the principle, wherever mobility is, we want to be involved if possible, BYD expands its portfolio.

Moreover, part the company's strategy is to build an ecosystem around its vehicles. BYD's divides its goals, which are called "Green Dreams", into three parts: Solar power, energy storage systems, and electrified transportation. The first goal refers to the ambition of BYD to become a large-scale solar panel manufacturer. In recent years, enormous investments have already been made in this area. In addition, BYD focuses to facilitate a more efficient energy storage system. Last but not least, the focus is on EVs in all segments. The goal behind this is to create a complete vertical integration for EVs, but more about this in the next chapter.

However, the Chinese EV producers are depending on government policies and regulations, aforementioned. The reconstruction of the subsidy system, from subsidies for EV sales to subsidies which promote EVs with a certain range has the potential to influence EV sales in China, as many customers stated that the price reduction due to subsidies were a huge purchasing incentive. However, receiving discounts through subsidies was only the second most important reason for Chinese customers (FT Confidential Research, 2018).
As China has a lottery system for license plates, people often have long qualifying periods to obtain a plate, especially in high-density cities with air quality issues such as Beijing or Shanghai. Therefore, many buyers choose fully electric driven cars in order to obtain license plates easier and faster. However, the extent to which BYD is dependent on government subsidies can be easily seen in figure below



BYD's Revenue and Dependency on Subsidies

The company's annual growth rate of 70% could probably only be achieved with the help of government incentives. Above all, BYD Auto benefited the most from this, with each government incentive the sales figures rose very strongly. Consequently, with the end of subsidies on EV purchases, the company faces a major challenge.
Nevertheless, the company enjoys great popularity in China, which is a huge advantage against many Chinese competitors. BYD is one of the brands that Chinese customers prefer when buying

an EY. Directly behind Volkswagen and after companies like Toyota or BMW, BYD ranks as the second most popular brand for EVs in China (FT Confidential Research, 2018).
Even though the best-selling EV in 2018 with 90,637 units comes from the direct competitor and state-owned BAIC with the EC180 model, BYD is still among the top five with two EVs. However, the BYD models are also the most expensive EVs in the top ten, which clearly shows the popularity of BYD EVs as consumers are willing to pay more. BYD's models in the top ten are the PHEV "Qin", from which 47.424 units were sold last year at a price of 31,000€ (without subsidies) (Kane, China Amazes With 180,000 Plug-In Electric Car Sales In December, 2019). However, with the new subsidies, which are favoring EVs with a range of over 300 km, a Chinese customer can for instance buy the new BYD SUV "Song" for only 24.000€ (wattEV2Buy, 2019).

In order to cope with the new restricted subsidy payments, BYD Auto chose two paths for its EV strategy. As the German manufacturers are being held in high esteem in China, BYD created a joint venture with the traditional German car manufacturer Daimler and launched the new premium brand Shenzhen DENZA New Energy Automotive Co, Ltd. Denza combines German premium manufacturing and Chinese battery know-how to offer an EV to Chinese customers with interests in the top-of-range cars.
Up to now, the brand has only offered one model, the Denza 500, the successor to the Denza 400. With a starting price at €49.000 the Denza 500 definitely can be allocated in the premium segment of the Chinese EV market. Both companies hope that it will follow the growth rate of 2017, where the 400-model got sold 85% more than in the previous year (2016) (Illi, 2018).
The other path chosen by BYD is that the company, untypical for a Chinese car manufacturer, started to export its own products, which is a clear signal of an expansion strategy towards oversea markets. BYD already offers its EVs in several Asian and South American countries. For instance, BYD has signed cooperation agreements with taxi fleet provider in Uruguay or Colombia (Masiero, Ogasavara, Jussanic, & Risso, 2016). The reason is that these countries are less brand bound and more price sensitive due to lower incomes. Moreover, it has also entered successfully the electric bus segment with sales in the Netherlands, Spain or USA (BYD, BYD Rolls Out its 50,000th Pure Electric Bus, 2019). In the electric bus segment, the competition is lower and the market for cars is not saturated yet.
However, this has to be viewed with caution, as it remains to be seen whether BYD will also successfully penetrate the oversea markets for passenger vehicles.

BYD – E-Product Portfolio and EV Production

Even though BYD does not play a significant role in the Chinese industry, when it comes to ICE vehicles, where more conventional manufactures or joint ventures such as SAIC, Volkswagen or BAIC have higher market shares. Nevertheless, BYD has a relatively high share in the new energy sector with its BEVs and PHEVs, as stated in the previous chapter.
In line with the "7+4" strategy, the company offers a variety of models in different segments such as SUVs, compact cars or vans. The latest model, the BYD Yuan EV360
was introduced in mid-2018 and has a starting price of RMB 79.900 (before subsidy deduction), which is around €10.000 for a fully electric compact SUV (Gasgoo, 2018).
The "360" stands for its electric range in kilometers and is achievable if the vehicle is constantly driven at 60 km/h, according to BYD. The reason for the increase and improvement in range, compared to previous models is the mentioned change in government subsidy payment policy.
As China is not being reprieved by the SUV and crossover trend, BYD took the decision to put even more emphasis on the rollout of these models. Typical for BYD is that most of its models are always offered with different drive trains such as BEV, PHEV or ICE. The BYD Yuan was already available with a combustion engine since 2016 and received the electric treatment in July 2018.

With regard to the exterior design of the Yuan EV360, BYD chooses a more conventional path, so that at first glance it does not stand out as an EV, but is very similar to the ICE model. Where the Yuan EV360 shines more is in terms of charging time, the crossover can gain 80% of its power in around thirty minutes (Medium, 2019). This is very similar to what Tesla promises and is probably due to BYD's distinctive battery know-how.
However, weaknesses are shown when looking inside the vehicle. Even though the technology and the offered equipment can be considered modern and up-to-date, the workmanship and the materials appeal not be on the level to European manufacturers or more premium Chinese producers. The Cockpit material are dominated by plastic and outmoded buttons and regulators. This clearly poses the big issue for Chinese manufacturers who want to be successful in markets such as Europe or the USA. In the eyes of Western customers, Chinese cars are of inferior quality, although this is not necessarily true in terms of performance, range or charging. However, even with this model, customers will feel confirmed if one looks only at the interior.

In connection with this thesis, however, it is very interesting to have a look at the EV production at BYD. Compared to other manufacturers, but also due to its history as a battery producer, BYD has a fully vertical integration in its production of the most important components in EVs.

Outside-In Perspective: Buy / Make		Battery			Powertrain		
		Battery Cell	Battery Pack	BMS	Power Electronics	Motor	Transmission
Selected Model	BYD e6 (2015)	BYD	BYD	BYD	BYD	BYD	Information n/a

Value Chain in BEV Production – BYD (Erriquez, Morel, & Moulière, 2017)

In comparison to VW or other established manufacturers, BYD already has a core competence in battery production and hence does not have to buy it expensive from third parties. Therefore, BYD has a clear competitive advantage over conventional Western manufacturers, which must develop these skills with high investments in order to avoid the high battery prices.
In addition, BYD is also very experienced in vertical integration, in other areas. The company had already established a successful vertical integration in battery production for mobile phones. This experience was later regarded as the foundation and best practice for the production of cars (Quan, Loon, & Sanderson, 2018). In this context, BYD goes one step further, which brings us to the "3 Green Dreams" of the company: Solar power, energy storage systems, and electrified transportation. The idea behind it is that BYD wants to achieve the goal of becoming the first fully vertically integrated manufacturer of EVs. Consequently, solar power should be used to generate electricity, which is stored in energy storage systems and used for the own EVs. Through this, BYD wants to take over the entire value chain in the use of EVs and thus makes energy suppliers obsolete.
Already today the solar business segment generates around $500m in revenues plus another $70m through energy storage. In total it accounts for around 10% of BYD's total revenue. In 2017, for example, BYD built the first solar farm without any subsidies in Bedfordshire, UK (Holder, 2018). In a future scenario, an electric bus fleet in Bedfordshire provided by BYD could now run on electricity, stored in BYD's energy storage systems and produced in BYD's solar farm. However, whether a fully vertical integration of the value chain can be realized or even makes sense can only be seen in the future. In case of success, BYD would definitely have a great first mover advantage.

BYD Auto – Charging Infrastructure

As early as 2014, BYD presented its vision and various charging solutions to the public. In addition to standard solutions, BYD has interesting approaches for future charging possibilities. With these approaches, BYD is much more experimental than other manufacturers, especially in comparison to conventional manufacturers.
Besides the conventional wallboxes or charging stations, which can be installed either at home, on company car parks or in public spaces, BYD surprises with a “Two Storey Charging Station”, “Vertical Charging Station”, and “Charging Tower”. With the help of the "two storey charging station" two cars or buses can be loaded on top of each other at the same time in order to save space and promises low investments in charging infrastructure.
However, it becomes more futuristic with the "Vertical Charging Carousel", with which 36 EVs can be charged simultaneously according to BYD. The carousel turns on command to the EV with the highest charging status, which is supposed to be more efficient for taxi fleets, for instance. In addition, the company plans to build a "Charging Tower", similar to a multi-storey car park only for EV charging, which will be able to charge up to 400 EVs on ten floors. This will, logically, be combined with workshops for BYDs and entertainment during the charging period (BYD Company, 2014).
The realization of the last two solutions is obviously still pending, as there are no results when searching for built towers or carousels. Nevertheless, these charging solutions are aligned with BYD’s “3 Green Dreams” and “7+4” strategy, as they are fully integrated into the grid of the solar panels and the energy storage system. Furthermore, all solutions are compatible for the wide product portfolio of BYD (BYD Global, 2019). Also, the sizes and capacities of the turbocharging solutions are definitely designed for masses of cars, which further illustrates the company's orientation to offer EVs to the broad masses. Currently, it is only known that BYD has so far only built charging stations in Singapore. Other partnerships or participations are not known at this point. In terms of strategic direction and goals, BYD itself would need to actively participate in an expansion of the charging stations in order to create the hoped-for ecosystem around BYD EVs.

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