Electric cars, the way towards sustainability in the German automotive sector?

Analysing the drivers and barriers of the eco-innovation electric car, to become a competitive private automobile alternative in Germany

Master Thesis (M.Sc.) – Urban Environmental Management

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I. Abstract

In this master thesis the status quo of the development process of the eco-innovation electric car in Germany is analysed. Starting from this general approach, this thesis investigates on relevant policies, technological factors, infrastructure and social factors explaining the mismatch between actual registration figures of electric cars and policy targets by the application of the Multi-Level perspective and a stakeholder analysis. Using these results, qualitative interviews with official retailers and customers are conducted to further enlighten the most recent barriers for this innovation. Based on these findings strengths, weaknesses, opportunities and threats are formulated to discuss recent key challenges, currently hampering this innovation. Especially the domestic automotive companies need to solve technological limitations with regard to recent battery and range capacities. Furthermore, prices of electric cars need to decrease, the national government needs to implement relevant infrastructure and supportive policies need to be set up for a successful future implementation of this innovation. Additionally, further research methods are advised to investigate the recent key obstacles in order to develop advanced theories for this innovation implementation in Germany in the future.

Key words*: Automotive industry, Electric cars, Germany, Eco-innovation, Innovation adaptation, Multi-Level perspective, Stakeholder Analysis, SWOT;*

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III. Management Summary

Being one of the biggest net contributors to climate change, transport and private automotive transportation sector enhance the problems of climate change, CO_2 emissions and resource depletion. Human behaviour and the usage of conventionally fuelled cars have a relevant impact on multiple environmental issues. Aiming to reduce this impact, recently the most promising alternative is the eco-innovation electric car. Supporting the innovations development, ambitious policies have been put in place in Germany. The national government formulated ambitious targets, spends money on R&D, subsidises the purchase of electric cars and guarantees customers of fully electric cars environmental tax exemptions for ten years. However, these incentives appear to be insufficient as policy goals are far away from being reached. About 25.000 electric cars are currently registered (2017) while the goal for 2020 aims at one million fully electric cars registered on German roads.

The following master thesis investigates the reasons for the recent mismatch. Furthermore, the major obstacles to make this eco-innovation competitive in the market are defined. The current situation is analysed from the Multi-Level perspective and the stakeholder analysis to discover the innovations development stage and to highlight the primary stakeholders influencing the innovations development. Based on these two analyses, the eco-innovation electric car is defined as a technological niche development, that needs to further evolve before it can reach relevant maturity to enter the automotive market as a competitive alternative. In this development process, the German automotive companies and the customers have been identified as the stakeholders who have the highest potential impact on the innovations velocity in future.

Aiming to further elucidate different challenges, hampering the innovations development, qualitative interviews have been conducted with official retailers of the domestic car brands and potential customers at the retailers' locations. This empirical research took placed within different cities of the Ruhr-Area (North-Rhine Westphalia) Germany.

The outcomes of the interviews strengthen the relevance to transform this sector with regard to environmental issues like diminishing natural resources and increasing CO_2 emissions. Furthermore, the interviews helped to understand the most recent challenges of this innovation which are connected to limited technological maturity, including battery and range capacities, the density of relevant charging infrastructure, the high product pricing, and the national policies to support this innovation. Additionally, the interlinkages between individual challenges are drawn. The analysis of the interview outcomes is summarized in a SWOT matrix to visualise and emphasise the strengths, weaknesses, opportunities and threats of this eco-innovation in the past and the future.

The discussion part of this work further elaborates on these individual strengths, weaknesses, opportunities and threats and analyses the innovations abilities to react to them. Furthermore, research limitations and advise for further research is provided.

Finally, this master thesis concludes that the eco-innovation electric car is not yet ready to enter the mass market and to displays a competitive alternative for the needs of customers due to the above-mentioned limitations. New models which tackle recent challenges will not be released before 2020. In line with that, the policy goals of the German national government for 2020 appear to be unrealistic to be achieved. However, this thesis also shed light on a lot of potential. For example, its ability to change the private automotive transportation sector in the nearer future. Both groups of interviewees, believe in the future of this technology and anticipated firm strategies indicate the same. The examined domestic automotive companies are planning to launch new product offerings, with improved technology and increased range capacities at affordable prices in the upcoming three to five years. This is expected to significantly change the market and tackle most of the recent challenges.

However, this thesis also strengthens the fact that the eco-innovation electric car is not a magic solution to all climate change and CO_2 related problems. Even if huge numbers of electric cars will enter the market, new challenges for German national energy politics are expected to arise. In case that Germany aims to decrease CO_2 emissions and tackle climate change, the national government also needs to foster a national renewable energy transition, displaying new challenges, also due to the increased demand for energy in general with higher amounts of electric cars.

IV. Contents

I. Abstract iii

II. Acknowledgement iv

III. Management Summary v

1. Introduction & Problem Statement 1

Table 1. CO_2 Emissions and Sources (Germany 1990-2014) 2

Table 2. CO_2 Emissions of the Transportation Sector (1990-2014) 3

1.1 Research Objective 5

1.2 Research Question and Sub-questions 6

1.3 Research Strategy 7

Figure 1. Research Framework 8

2. Theoretical framework 8

2.1 Key Concepts and Definition 8

2.1.1 System Innovation 8

2.1.2 Stakeholder 9

2.1.3 Eco-innovations 9

2.1.4 SWOT analysis 9

2.2 The Multi-Level Perspective 10

Figure 2. Multi-Level Perspective 12

2.3 The Current Situation of the automotive Industry – Stakeholder Analysis 12

2.3.1 German Car Manufacturers 13

2.3.2 German National Government 14

2.3.3 Scientists and Researchers 14

2.3.4 Customers 15

Table 3. Stakeholder table 16

3. Methodology 17

3.1 Data collection 17

3.2 Scientific approach 18

3.3 Interviews and Respondents 18

3.3.1 Sampling 19

3.3.2 Operationalization 20

Figure 3. Coding Scheme 21

4. Analysis of the Interviews 21

4.1 Landscape ... 22
4.1.1 Environmental Issues ... 22
4.2 Regime ... 23
4.2.1 Politics ... 23
4.2.2 Automotive companies ... 24
4.2.3 Customers ... 25
4.3 Niche – Challenges ... 25
4.3.1 Infrastructure ... 26
4.3.2 Technological maturity ... 27
4.3.3 Battery ... 28
4.3.4 Prices ... 29
Table 4. Summary of recent niche challenges ... 30
5. SWOT Analysis for electric cars in Germany ... 31
Figure 4. SWOT Analysis for the German Automotive Industry ... 32
6. Discussion ... 33
Figure 5. Graphical visualisation of the technological lock-in situation ... 36
Table 5. Development of charging infrastructure - Germany ... 37
6.1 Research Limitations ... 41
6.2 Suggestions for Further Research ... 42
7. Conclusion ... 44
V. References ... 45
VI. Appendix ... 49
Interview Guide - Official Retailers ... 49
Interview Guide - Customers ... 50
VII. Declaration of authenticity ... 51

1. Introduction & Problem Statement

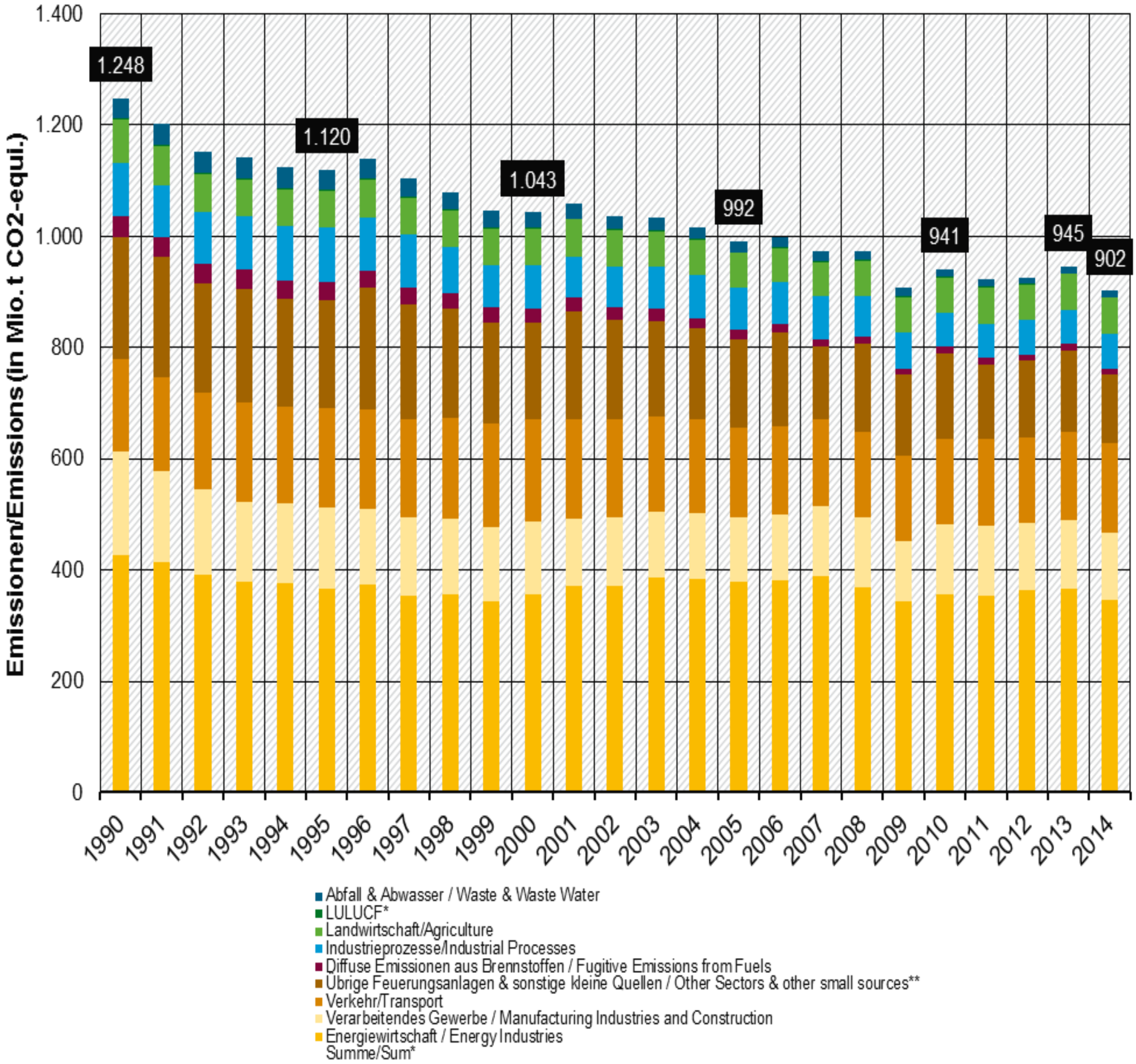
The concepts of sustainable development and sustainability as approaches to combat climate change and its effects have been increasingly high on the public and political agenda in the last few decades (Laes et al., 2014). New legislations and policies at national and international level steer companies and citizens towards sustainability and sustainable behaviour. Especially big multinational enterprises (MNE's) operating in highly polluting industries had an enormous influence on climate change. One of these industries is the automotive sector. According to the findings of Unger et al., (2010), the on-road transportation sector is the greatest net contributor to atmospheric warming. Furthermore, a study of Price Waterhouse Coopers (2007, p.27) states that: "*CO_2 emissions from transport alone have risen by 32% since 1990*."

In 2010, the German government set the ambitious goals to have one million fully electric cars registered by 2020 and six million by 2030 (Bundesregierung, 2010). These national policy plans to combat climate change and reduce emissions by triggering eco-innovations in the automotive industry, have been initiated even before changes in European legislation in 2011 have been decided. In the EU legislation the goal was set to "*Halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO_2-free city logistics in major urban centres by 2030.*" (EC, 2011, p.9). However, the targeted registration figures of the German National Government seem to be unrealistic. Most recent registration figures show, that in 2016 only 25.502 fully electric cars have been registered in Germany (Kraftfahrt-Bundesamt, 2016, p. 8), indicating a discrepancy.

The statistical data collection of the Federal Environment Agency of Germany on greenhouse gas emissions (GHG) strengthens the relevance to make the transportation sector generally more sustainable. According to recent research, 95% of the emissions from the German transportation sector are emitted by road traffic, including cars. As a result, national and international institutional pressure arose on companies in the automotive industry to adapt these changes and to innovate their products to implement advanced sustainable private transportation solutions (UBA, 2010).

To achieve these targets, the strategies of automotive companies need to be changed, oriented towards sustainability including the production of sustainable automobile solutions. Fostering this innovation process, by developing cars that emit less or even zero emissions, automotive companies could play a substantial role in achieving global and national CO_2 reduction targets. The first efforts undertaken by the German car manufacturers to become more sustainable, was the production more resource efficient conventionally fuelled cars. This process lead to individual decreases of cars emissions, however individual savings have been compensated by general increasing car consumption patterns among all the German customers (UBA, 2010). These increased consumption patterns of more resource efficient cars, therefore resulted in approximately equal CO_2 emission rates over the past two decades (Table 1. & 2.). While CO_2 emissions in Germany in general have been decreased, the amount exceeded by the transportation sector stayed equal.

Table 1. CO_2 Emissions and Sources (Germany 1990-2014)



Source: (Umweltbundesamt, 2014)

Table 2. CO_2 Emissions of the Transportation Sector (1990-2014)

	Verkehr/Transport	Summe/Sum*
1990	164.4	1,248
1991	167.4	1,201
1992	173.4	1,151
1993	177.8	1,142
1994	173.9	1,124
1995	177.9	1,120
1996	177.8	1,138
1997	178.3	1,104
1998	181.7	1,078
1999	186.8	1,045
2000	182.8	1,043
2001	179.0	1,058
2002	176.7	1,036
2003	170.2	1,033
2004	169.8	1,017
2005	161.4	992
2006	157.4	999
2007	154.2	972
2008	154.0	974
2009	153.3	906
2010	154.2	941
2011	156.4	922
2012	154.9	926
2013	159.2	945
2014	161.1	902

Greenhouse Gas Emissions (in Mio. t CO2-equi.)

Source: (Umweltbundesamt, 2014)

This effect is called the *rebound effect*, where "*Technological progress makes equipment more energy efficient. Less energy is needed to produce the same amount of product, using the same amount of equipment — ceteris paribus*" (Berkhout et al., 2000, p.2). Applied to the automotive industry, this effect is the result of two possible scenarios, the direct and indirect rebound effect. The direct rebound effect can be measured when customers generally increase their car consumption patterns due to the fact that cars become more efficient and need less fuel for the same performance. The indirect rebound effect leads to a scenario in which, customers purchase models with bigger engines compared to former car choices. In this scenario, the bigger engines become as efficient as former car choices and use the same amount of fuel at a higher performance ratio (Borenstein, 2013). Counteracting rebound effects and steady CO_2 emission rates, automotive company's sustainability strategies cannot only focus on producing more resource efficient cars, as this will result in equal emission rates of CO_2. While overall CO_2 emission levels have been substantially reduced in Germany, the emissions of the automotive industry stayed more or less equal. This proves that energy efficiency measures did not work out in the anticipated way to reduce the industry's emissions (Table 2.).

Taking this into consideration, there is a need for developing technological innovations at which customer patterns no longer have an influence on the emissions produced by cars. In order to develop these innovations, research and development (R&D) by the automotive companies is necessary to discover the fullest technological and commercial potential of alternative technologies like electric cars (Herring & Roy 2007).

With a transformation towards alternative sources of power, increasing consumption rates of cars would no longer have a negative influence on global GHG emission rates including CO_2 emission rates. Additionally, with these new product developments, offering customers sustainable alternatives to the standard combustion engines, car manufactures can enter a whole new market segment. Being part of this technological transformation is also an opportunity for corporations to create competitive advantages by taking a leadership position among the new growing market segment of sustainable, fossil fuel independent cars (Pujari, 2006).

These technological innovations are defined within this thesis as eco-innovations, because they are "*...aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy*" (EC, 2007). Complementing the definition of eco-innovations, the general accepted definition of sustainable development is a "*...development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987, p.42).

Connecting these two concepts means for this case, that automotive companies have to steer with the implementation of eco-innovations towards a development at which resource consumption decreases to a responsible level, while environmental damage and emission rates are continually decreasing. The most prominent eco-innovation at the moment to tackle this problem is the electric car (Cowan & Hultén, 1996) (Hanschke et al., 2011).

Invented in the mid-19th century, increasing commercial interest in the potential of this innovation started just recently, in the beginning of this century. Because of that, the electric car still can be regarded as a recent innovation that is not yet developed to its fullest commercial and technological potential. Several issues with regard to battery capacity, high speeds, purchase costs and charging duration and locations are still uncertain and need to be solved over time (Høyer, 2008).

Due to these obstacles, a recent change moving away from the conventionally fuelled car towards electric cars appears to be difficult and problematic. This is why this change comprises not only the respective industry by solving technological obstacles, but also supportive policies by the government on different levels and new attitudes of customers.

Adaptation processes of electric cars evolve relatively slow amongst the customers due to a vicious circle. There is little R&D to further innovate electric cars, but companies also hesitate to invest too much money, as there is also a lack of current customer demand for this innovation, as most of the current product offerings are not competitive enough compared to the performances and features of conventional cars (Purificato, 2014).

In order to break through this vicious circle, automotive companies need to innovate and keep on developing solutions for current technological issues. By doing so, customer demands could be enhanced, as soon as the performance of electric cars increases and technological problems decrease. This could make customers considering a switch from using conventionally fuelled cars towards electric models, increasing the demand at the market for this innovation.

At the moment electric cars are only a co-existing innovation along the dominant technology of conventional cars. However, with the ongoing political pressure to make private transportation more sustainable and the depletion of natural resources like oil, the innovation electric car could possibly replace the current technology (Van Bree et al., 2010).

1.1 Research Objective

The aim of this thesis is to provide an overview of the current market situation of the German automotive sector, including the role and the future potential of electric cars to become a competitive alternative to conventionally fuelled cars in the market. Therefore, the key stakeholders influencing the supply and demand situation of the automotive industry will be analysed and their possible impact and interest in the process of implementing electric cars as sustainable, climate neutral substitutes to the conventional car.

Furthermore, reasons and roots for the mismatch between national policy goals (to have one million fully electric cars registered by 2020) and the actual registration figures are examined. Moreover, major obstacles that need to be addressed in order to let this eco-innovation breakthrough in future, will be investigated and extensively discussed.

The geographical scope of Germany has been chosen since the national policy targets appear to be challenging and not realistic to become achieved, due to recent low registration figures (Kraftfahrt-Bundesamt, 2016, p. 8). Discovering the reasons for that, in connection to the activities undertaken by the three biggest domestic car manufacturers of Germany (BMW AG, Daimler AG and VW AG) to support the development of the electric car, is expected to generate new knowledge about the future potential of e-mobility in the German automotive market. It has been decided to limit this research to only examining the big three domestic car manufacturers. The reason for that is, that German customers preferably tend to purchase domestic cars. The market share of domestic car models has been always above 64% since the 1990s (Schnell, 2015). Due to that, especially the activities undertaken by German automotive companies are crucial to achieve the targeted development of the German national government.

1.2 Research Question and Sub-questions

Based on this research objective, the following main research question and sub questions will be answered in this thesis:

Research Question

What are the major recent challenges hampering the development of the eco-innovation electric car, in the German domestic automotive market?

Sub-questions:

1. What is the current situation of the private automobile transportation system in Germany?
2. What are the primary stakeholders influencing the development process of electric-cars in Germany?

3. What are the main reasons for rather low registration figures of electric cars compared to German policy goals?

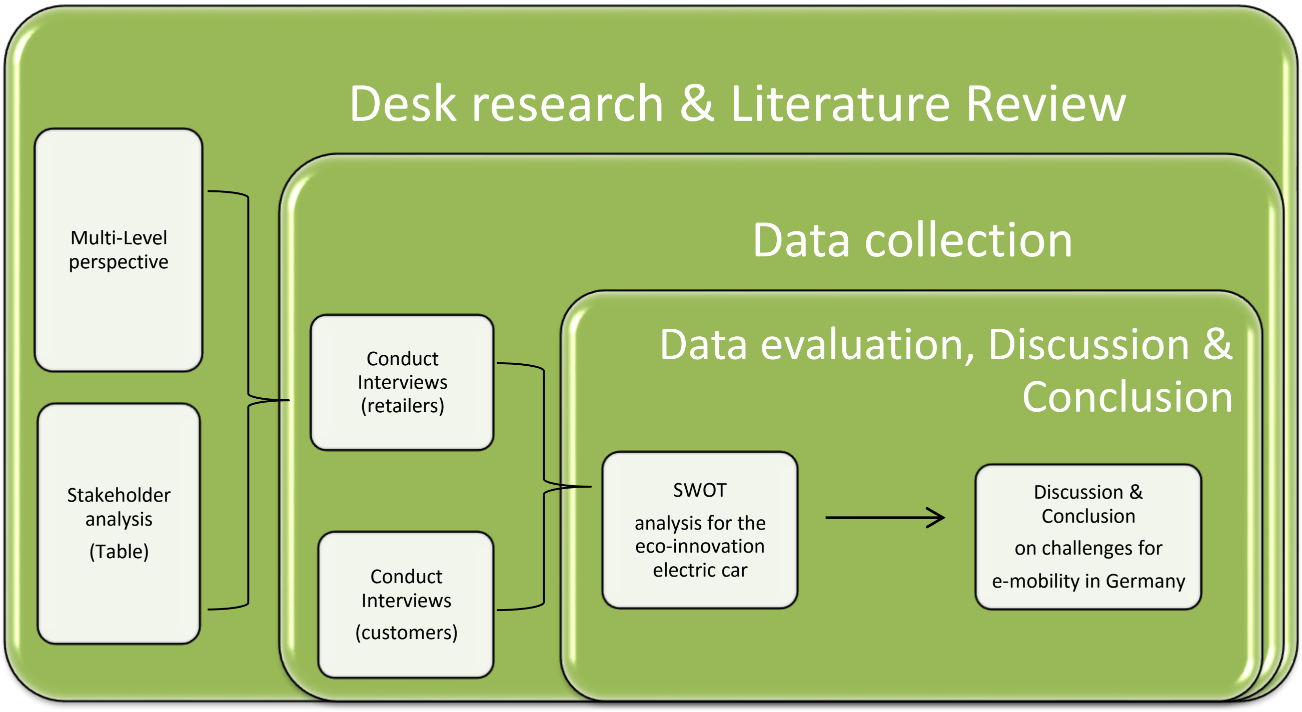
1.3 Research Strategy

In order to answer the main research question and sub questions of this thesis, the research framework, (Figure 1.) has been developed. This framework maps out the main strategy applied, dividing this thesis into three major phases: desk research, data collection, data evaluation and discussion and conclusion.

In the first phase, the desk research, secondary data is used to analyse the status quo of the German automotive market, including the current role of the electric car. The key concepts of this thesis are presented and a stakeholder analysis is done. This analysis emphasises the primary stakeholders of the German automotive industry that are associated to the development of the electric car. Furthermore, the potential impact and interest of these stakeholders in a technological breakthrough of this innovation is analysed. This provides basic knowledge about the current market situation and creates general understanding of the most important stakeholders and ongoing transitions with regard to this innovation.

Based on this information, the data collection phase starts off. Within this phase, interviews are conducted with official retailers of the examined companies, and potential customers at the retailer's locations. By consulting these stakeholders, relevant primary data is collected. The results of these interviews provide information about: current and future product offerings, individual company strategies, feasibility of policy plans, subsidies for e-mobility, customer attitudes, trends in sales and demand and the main advantages and disadvantages of electric cars. This data is then systematically analysed based on the levels of the Multi-Level perspective and summarized within a SWOT analysis. By doing so strengths, weaknesses, opportunities and threats of the eco-innovation electric car in Germany are emphasised. Based on that, the discussion further elaborates by the application of the Multi-Level perspective on major challenges, ongoing transitions and interactions in the German automotive market.

Figure 1. Research Framework



2. Theoretical framework

In the following chapter, the outcomes of the literature study are provided. This information is perceived as the necessary basic knowledge to understand the current market situation of private transportation in Germany and the associated primary stakeholders involved.

2.1 Key Concepts and Definition

The following section provides general definitions of the most important concepts and tools applied within this thesis. These definitions are necessary to ensure author and reader have the same level of knowledge. The definitions provided, are based on different research studies and other relevant documents.

2.1.1 System Innovation

"*System innovations are defined as large-scale transformations in the way how societal functions such as transportation, communication, housing, feeding are fulfilled*." (Elzen et al., 2004, p. 19). Taking this into consideration, the innovation electric car is an innovation that has the potential to change the transportation in the future. According to Laes et al., 2014 such a systemic change includes that "*Technologies, institutions, (political) culture, and social practices should be reformed in a coordinated way in order to guarantee a more environmentally sound and equitable development trajectory" (*Laes et al., 2014, p. 1130). This means that in case, this innovation becomes the regime or a relevant part of the regime, not only the cars themselves need to change but also the associated infrastructure and the respective policies.

2.1.2 Stakeholder

The term stakeholder first appeared in management in literature in 1963, to generalize the term stockholder, which was the only actor to that a company needed to be responsive (Freeman, 1984). Today a stakeholder should be seen as "*any identifiable group or individual who can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives*" (Freeman & Reed, 1983, p.91). However, within this thesis, the interest is not about the relation of stakeholders to an organization but about their relation to the eco-innovation electric car. In addition to that, Clarkson (1995) divides stakeholders in to two different groups, the primary and the secondary stakeholders. Primary stakeholders are crucial for the survival and successful development of an innovation, while secondary stakeholders can have an influence on the success but are not vital for its survival (Clarkson, 1995).

2.1.3 Eco-innovations

Eco-innovations are defined as "*...any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy*" (EC, 2007). Fuel efficiency innovations of the automotive companies also appear to match this definition, as they make conventional cars more resource efficient. However due to the fact that more fuel efficient cars do not have a positive influence on the use of natural resources (oil) and as they do not decrease CO_2 emissions in the long-run because of customer´s behavioural changes (Table 1. & Table 2.), these techniques are excluded from the definition of an eco-innovation within this research.

2.1.4 SWOT Analysis

The SWOT analysis is a comprehensive approach to analyse the strengths, weaknesses, opportunities and threats of an organization. The main advantage of this diagnosing tool is that it does not only enlist strengths, weaknesses opportunities and threats, but also assesses the organizations capabilities to respond to them (Hayes, 2014). Strengths are defined as positive tangible and intangible attributes, weaknesses are negative factors that can undermine desired goals, opportunities are external factors that can benefit and threats are jeopardizing factors (Hayes, 2014). However, in this work the SWOT analysis addresses the development of the innovation electric vehicle in the case of Germany and not in an organisational context.

2.2 The Multi-Level Perspective

The following section introduces the Multi-Level perspective. *"Transitions are conceptualized as a co-evolutionary (or, more accurately, co-dynamic) interplay between processes functioning at the different levels of landscape, regimes and niches, which gave rise to the nickname "Multi-Level Perspective" (MLP) for the corresponding research stream. The MLP framework has been applied to understand a wide range of historical and hypothetical/future regime change processes"* (Van den Bergh et al., 2011, p.10). In order to describe the level of the innovation electric car and its interplay with the existing structures, the Multi-Level perspective is applied as a key tool within this thesis. This tool distinguishes in general between three different levels. These levels are described as in the landscape level, the regime level and the niche level (Geels, 2002) (Figure 2.).

The highest level in this theory is described by the landscape developments. This level describes ongoing changes within the society such as climate change or resource depletion having a certain impact on several independent regimes.

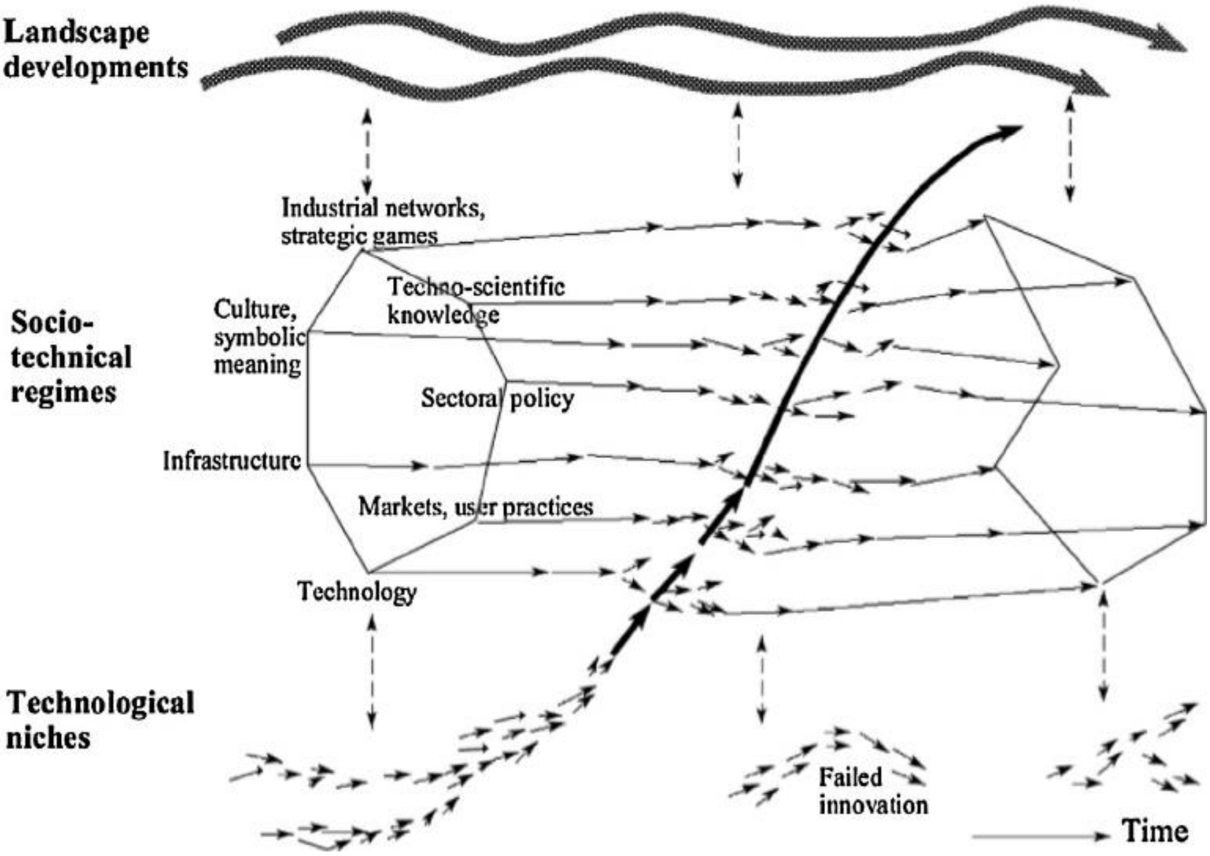
The regime is defined as *"...the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures*" (Rip and Kemp, 1998, p. 340) In the context of this thesis, the traditional car with an internal combustion engine describes the current dominant regime technology. However, the regime is not only defined by the dominating technology. The regime comprises also the associated customers, related infrastructure, sectoral politics, knowledge and culture (Geels, 2002). According to Geels (2002), actors of the regime are usually the ones in the market who create only incremental innovations, such as the fuel efficiency innovations for internal combustion engines.

A technological innovation starts off from the niche level, at which they can either be successful and break through or fail. Multiple niches (innovations) can develop independently from each other as different technological innovations (e.g. electric car, hydrogen car etc.) and try to become part of the regime which is the next higher level. Considering the definition that "*niches are cast as "exceptional" spaces, providing scope for innovative products and* *practices to emerge*" (Maassen, 2014, p.443) this means that different alternative eco-innovations can develop individually from each other in niches, aiming to break through and to become either the new regime or part of the current regime (Figure 2.). In order to do so, they develop individually from each other in "*protected spaces where new technologies and/or practices are not exposed to the full selective pressures operating in the incumbent regime*" (Laes et al., 2014, p. 1131), comprising e.g. electric cars, hydrogen cars or cars running on biofuels. Nevertheless, niches "*... initially suffer from poor alignment of their various components (technologies, institutions, user practices) to the overall system configuration*" (Van den Bergh et al., 2011, p. 10), these innovations aim to change the current regime in a more sustainable one. This is a future regime which is no longer dependent on fossil fuels and reduces the impact on the environment by decreasing CO_2 emissions. The particular niche development analysed is the niche of the electric car.

The radical innovations that are leading to recognizable technological shifts are developed in the niches. This is possible because niches *"...are protected or insulated from 'normal' market selection in the regime. They act as 'incubation rooms"* (Geels, 2002, p. 1261). This special kind of protection is necessary for the innovations to properly develop over time and to achieve higher technological maturity. In case they would have to compete in a real market situation from the first development stages, they would not be competitive. This is due to lower performances ratios and features of current regime technologies which would make them unable to survive in the market (Geels, 2002).

Ultimately, the objective of a niche is either to co-exist with the current regime or even to take it over as the new regime. According to Kemp et al. (2001), these shifts can happen in case that the current regime is not able to adapt to ongoing changes happening on the landscape level. The levels described within this framework, including the interlinkages among them (Figure 2.) will be applied within this thesis to analyse the development status of the eco-innovation electric car. This analysis is used to elucidate the existing landscape developments and the existing regime of private automobile transportation in Germany. The niche is analysed from the perspective of electric cars.

Figure 2. Multi-Level Perspective



Source: (Geels, 2002).

2.3 The Current Situation of the Automotive Industry – Stakeholder Analysis

By discovering the innovation development process of the electric car, many stakeholders with different interest and levels of power are involved in, and influenced by, the implementation process of electric cars. To further investigate these stakeholders and their motivations, the following chapter provides a stakeholder analysis for this industry, analysing those who are the most involved and affected by this transition process. This starts with the general definition of a stakeholder and the differentiation between primary and secondary stakeholders. Afterwards, the main stakeholders are presented and mapped out in a stakeholder table.

As already mentioned before, a stakeholder is defined as "*any identifiable group or individual who can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives*" (Freeman & Reed, 1983, p.91). However, the particular interest of this thesis is about the interest and influence of a stakeholder on the development process of the eco-innovation electric car and not towards an organization. Stakeholders are separated in to two different groups, the primary and the secondary stakeholders according to the definitions of Clarkson (1995). The primary stakeholders are crucial for the survival and successful development of an innovation, while secondary stakeholders do have the potential to have a particular influence on the success of an innovation but are not vital for its survival (Clarkson, 1995). For the following analysis, secondary stakeholders are excluded as only the primary stakeholders are the ones who are vital and decisive for either success or failure.

Primary Stakeholders

Based on the definition of a primary stakeholder by Clarkson, (1995) and the findings of the introduction chapter of this thesis, the German car manufacturers, the German national government, scientists & researchers and the German customers can be identified as primary stakeholders. These are the actors who define the rules, provide technology and create the supply and demand situation for this market.

2.3.1 German Car Manufacturers

The German automotive companies examined in this research (BMW, Daimler and Volkswagen) represent from the Multi-Level perspective both, actors of the regime and the niche. The current regime is dominated by conventionally fuelled cars with internal combustion engines which are still manufactured by the German automotive companies. However, all of the companies also take current landscape changes into consideration with regard to their product strategies.

Sustainability and the evolution of the electric car are ongoing processes. For this reason, the examined companies start to put efforts in the development and implementation process of both electric cars and conventional cars. This strategy is followed to sustain their regime position in the present and in the future market. BMW and Volkswagen have been the first of the examined companies who entered the niche market in 2013 with the launch of fully electric car models (T-online, 2013). One year later, Daimler reacted and also released its first fully electric car in 2014 (Autobild, 2014). By the production of electric cars, these actors play a major role in the implementation process of this technology. Furthermore, the borders between the niche and the regime become increasingly smoother due to the niche adaptation. Car manufacturers have a major influence on the velocity of this innovation diffusion process, as they have the power to decide when new electric models will become available at the market and how much money they decide to spend on respective R&D.

2.3.2 German National Government

The national government of Germany played a major role in the initiation process and first stages of implementing electric cars, as it was very proactive with its policies. It formulated national policies in 2011 to support the development of electric cars, even before the EU legislation decided to reduce conventionally fuelled cars (Bundesregierung, 2010, & EC, 2011). This action shows the sustainability- and future-oriented direction of domestic policies. However, the national government has an interest in a well-functioning automotive regime not only in the present situation but also in the future, as this is also important for the national economy (Bundesregierung, 2006).

For this reason, they support and assist the niche development of the electric cars by the implementation of different policies and subsidies (See chapter 3.2). Due to the Paris climate agreement, which has to be ratified by all EU member states, climate policies and increasing CO_2 regulations will be even more on the political agenda in the upcoming years, probably also having a positive influence on the development of electric cars. Currently, the automotive sector is one of the main contributors to climate change by the production of greenhouse gas emissions, which is likely to be changed as climate policies are expected to put increasing pressure on the industry (Unger et al., 2010).

The German national government has more legislative options than just putting pressure on the industry. They can facilitate the innovation diffusion by providing customers with financial incentives. Purchasing an electric car is rewarded by tax exemptions and purchase subsidies (Tagesschau, 2016). Political support protects the development of the niche, triggers media attention and makes increasingly more customer familiar with the technology.

2.3.3 Scientists and Researchers

Scientists and researchers can be defined as key stakeholders as they continually work on the technological improvement to reduce weaknesses of this technique. They are crucial in solving issues like battery and range capacities, charging duration, improved usage materials or additional applications (Schwanen et al., 2011). Furthermore, they do not only discover the technical aspects and innovations, scientists from different fields also examine the influence of the electric vehicle on the natural and social environment. This means, that experts from very different backgrounds are involved in the development and implementation process of this niche development (Schwanen et al., 2011). By doing so, it is important to consider not only technological, social and environmental issues but also customer needs. The most advanced technology is nothing worth if no one is willing to purchase or use it (Herbig & Day, 1992).

2.3.4 Customers

The customers have a very different power compared to the other primary stakeholders presented. They have the opportunity by either adopting or neglecting electric vehicles, to determine the general diffusion rate, and the velocity of the innovation (Chojnacki, 2000). For this reason, customers either belong to the regime or to the niche depending on their choices. Based on the current registration figures, customers appear to be rather sceptical about the innovation electric car as they stick to the regime and conventional cars. However, the power of the customers is very high, as soon as the acceptance and demand for electric cars increases, they have the major influence on the automotive companies to produce types of cars according to their demands.

Summary

Based on the findings of this analysis, the primary stakeholders are mapped out as followed (Table 3). The domestic car manufacturers and the customers appear to have the greatest potential impact on the diffusion process and velocity, as these stakeholders create the demand and supply. Car manufacturers have an interest to comply to customer demands, which finally does these two stakeholders let determine of what is available on the market and which types of vehicles are purchased.

The government has also a considerable influence on the process, but they can rather support and supplement the process by providing incentives to the automotive companies by investing in R&D and to the customers by financial rewards and subsidies for purchasing this innovation. However, they cannot force customers to purchase electric cars, or force automotive companies to immediately stop the production of conventionally fuelled cars. The possible impact of scientists and researchers remains uncertain at this point of time. By discovering new technological break troughs on major issues, they have the potential to have recognizable influence on the diffusion of electric cars and the technological maturity. In this scenario, their impact would increase. However, in case that researchers and scientists are unable to make recognizable technological progress, or to solve key issues, their impact as a key stakeholder remains low.

Due to the fact that the manufacturers and the customers have the highest potential impact to let this innovation breakthrough, these stakeholders are addressed in the empirical data collection of this research. They have the highest potential impact, so their opinions and perceptions will be used to analyse the reasons, why the electric car is not that far yet compared to the policy goals of the German national government. This information is used in the end to emphasise the main obstacles that need to be addressed in the nearer future to successfully implement the eco-innovation electric car and to become part of the regime.

Table 3. Stakeholder Table

Primary Stakeholders	Influence & Power	Potential Impact	Main Interest
German Car Manufactures	• Producing conventional cars • Producing electric vehicle	++	Responding to customer demands Sustaining their position in the regime
National Government	• Legislator • Setting environmental Standards • Financial support (subsidies, tax exemptions & R&D)	+	Combat climate change Reach targeted registration figures (2020 & 2030)
Scientists & Researcher	• Improve the innovation • Offer expertise • Investigate challenges	+-	Discovering potential solutions for current obstacles Contributing to the innovation process
Customers	• Purchase electric or conventional car • Actively contribute to environmental issues	++	Having a sustainable automobile with comparable performance ratios to conventional cars

3. Methodology

The following chapter describes and discusses the methodology applied in this master thesis.

There are two main types of methods to collect analyse data, which are distinguished into quantitative and qualitative research strategies. The application of quantitative research strategies involves the quantification or measuring by counting through the application of mathematics and statistics. This means that collected data is transformed into numbers which can be empirically tested to examine relationships and to draw conclusions. Quantitative methods are numerical interpretations to test theories and hypotheses. Qualitative research approaches do not rely on mathematical methods, but rather on language and the interpretation of meanings and the involvement of humans in order to develop and create theories (Walliman, 2006).

By the application of qualitative methods for data collection, this thesis considers a broad picture of the current problems associated to the development of electric cars. This approach is suitable, since this thesis researches different, technological, social and political factors which are mutually reinforcing each other, hampering the development process of electric cars resulting in low registration figures. By studying the official retailers as representatives of the German car manufacturers, and the perceptions of customers concerning this technology, this research is expected to create new understanding regarding the main obstacles hampering this innovation to break through. It has been chosen to interview these stakeholders as they are easy to access and as they were the only ones who were open for interviews. The German automotive companies themselves were not cooperative with regard to this research and did not agreed to participate. They did not allow the researcher to conduct interviews at the respective sustainability or R&D departments which were the first targeted interview respondents. Even with agreements guaranteeing fullest confidentiality to internal information, no cooperation was offered. In order to still conduct relevant qualitative primary data, the researcher decided to address official retailers and customers as interview respondents.

3.1 Data Collection

For this research, both primary and secondary data was collected and found application within the problem analysis. The primary data of this research was gathered by the researcher himself. This was done by conducting interviews with the official retailers of the examined companies and potential customers at the retailers' locations. The secondary data that is applied has been collected from different books, scientific articles, reports, and newspaper articles to obtain better insights into the current situation of the automotive industry and the development stage of the innovation electric car. All interviews have been conducted at official retailers' locations and showrooms in Germany, particularly in the Ruhr-area (North-Rhine Westphalia) for logistical reasons.

3.2 Scientific Approach

In science, there is a distinction between two main research approaches to describe the relationship between chosen theory and research. The two approaches are inductive and the deductive research design. In order to distinguish between these two types of research, it is important to consider if the collected data is used to test existing theories or to develop new theories.

Deductive Approach: Existing theory is tested by observations/findings.

Inductive Approach: Gathering observations/findings to develop a theory.

In this research an inductive approach is performed. The researcher is gathering empirical information originating from the qualitative interviews to develop theories and to draw conclusions by discovering the recent obstacles for the eco-innovation electric car that hamper it to become a competitive alternative in the German automotive market.

3.3 Interviews and Respondents

Due to the complexity of the examined problem, there is a need to collect significant primary data from the official retailers and potential customers of electric cars. The chosen method for this data collection is qualitative interviews. One of the main advantages of qualitative interviewing is the flexibility. The interviewer is able to adjust and respond to the interviewees individually, while collecting all information needed. The main interest is to receive the respondent's point of view with regard to the addressed topics (Walliman, 2006).

Within this research design, two different approaches of qualitative interviewing have been applied. These are semi-structured interviewing and structured interviewing. Semi-structured interviews were conducted with 17 official retailers, which belong to the German automotive companies (BMW AG, Daimler AG and VW AG). All of the addressed retailers are located in the Ruhr-area in North-Rhine Westphalia due to logistical advantages. Interviews have been conducted between the 30.01.2017 and the 03.02.2017. By conducting the interviews, the researcher followed a checklist of topics and questions to make sure all relevant information and topics are covered (VI. Appendix). The method of semi-structured interview has the main advantage that there is no fixed order. Furthermore, respondents can expand on ideas and speak very detailed about their individual subjects of interest. This method displays a flexible conversation in which the researcher can work through the topics of interest. The interview is only organized in terms of general topics, follow-up questions depend on the statements of the interviewee (Walliman, 2006).

The structured interviewing method was applied to interview 16 potential customers at the different retailers' locations inside the showrooms or outside on the retailers' property. The timeframe and geographical area was the same as for the official retailers, all interviews took place at the examined retailers located in the Ruhr-area in North-Rhine Westphalia. These interviews have been conducted in the same period of time between the 30.01.2017 and the 03.02.2017. As these respondents are usually less involved into the topic of e-mobility on their daily basis, the researcher made use of a more guided interview format. In this approach, questions are standardized and asked in the same way to obtain sincere information about customers' perceptions with regard to this innovation. This approach facilitates faster interviews that can be more easily analysed and compared. The answers to these questions were given in both, open and closed format (VI. Appendix).

In order to increase the reliability of the empirical data, all interviews with the retailers have been recorded acoustically and handwritten notes have been made. By doing so, interviews can be transcribed more reliable. As the interviews with the customers were way more structured, the researcher took only notes. This has also been done as some of the retailers did not wanted their customers being recorded for this research.

3.3.1 Sampling

Defining the respondents who are included and excluded from a research is defined as sampling. By collecting information from the retailers and customers a non-probability sampling has been applied, meaning that the addressed interviews respondents have been chosen on a non-random selection (Walliman, 2006). This research addresses the parts of population who are good accessible and still have relevant knowledge about the development and current trends of this innovation (automotive companies represented by retailers).

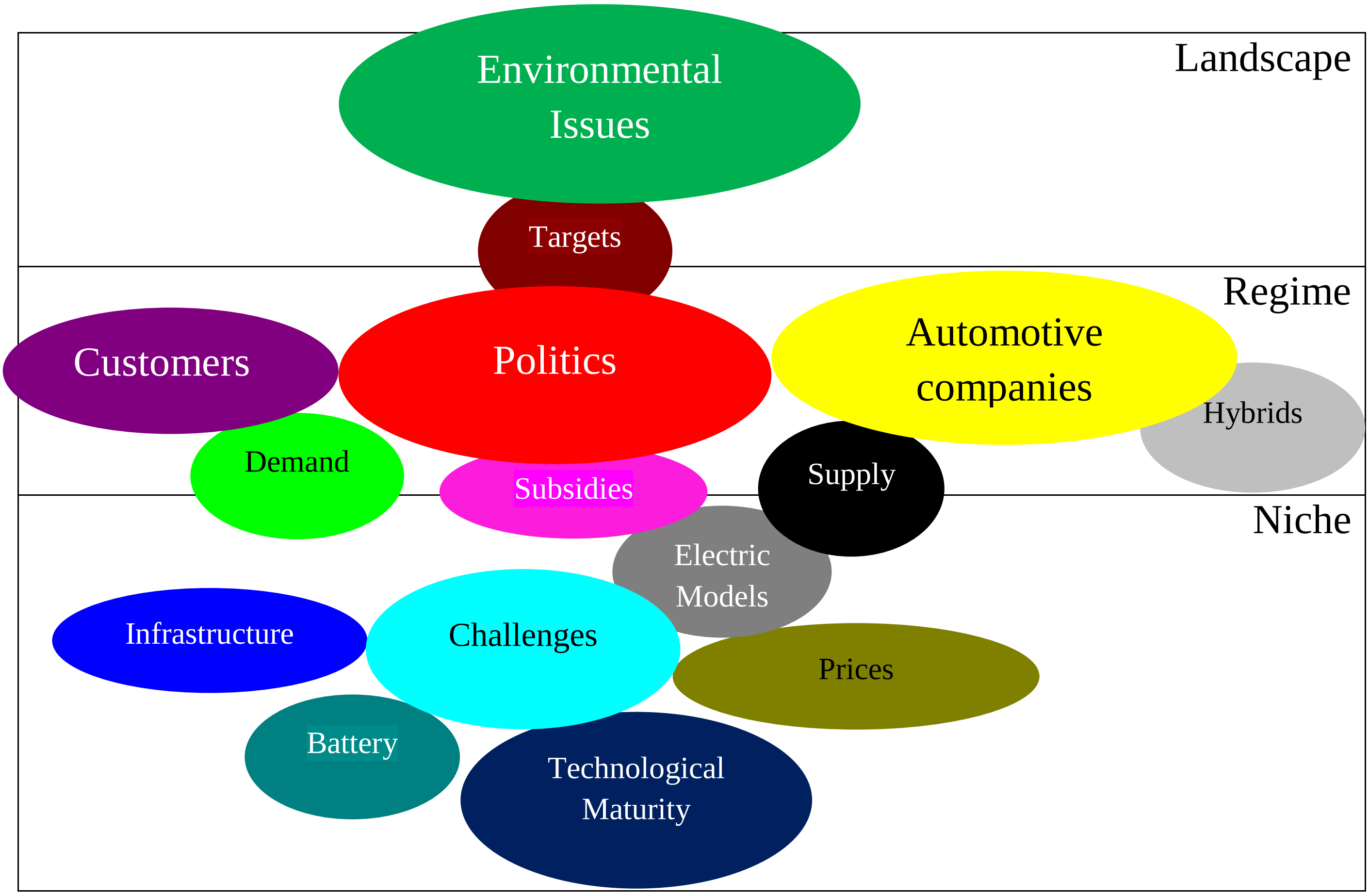
Furthermore, the respondents are interviewed who are most affected and concerned about this topic (automotive companies represented by retailers and the customers). For this reason, theoretical sampling has been applied (Robinson, 2014). Due to the fact, that this thesis is based on a qualitative research design, where statistical prove is not desired, theoretical sampling displays a suitable method for conducting this research (Walliman, 2006).

3.3.2 Operationalization

The interview transcripts were analysed in terms of mentioned categories and perceptions of the interview participants on the topic of electric cars, to investigate the main present and future obstacles for this innovation. In order to identify these factors, the method of coding has been applied. The main categories were derived from the theoretical framework introduced in chapter two.

These categories were translated into codes and assigned to specific colours. To analyse the data of this research, the transcripts were marked with the appropriate colours. This has been done manually by the researcher without the usage of software to get a better overview on the addressed categories but also to identify interlinkages between certain categories. The following visualisation shows the applied categories and the associated colours:

Figure 3. Coding Scheme



As the main intention of these interviews was the creation of hypotheses and new understanding regarding the main obstacles hampering this innovation to break through from the niche level to the regime, the researcher provides a summary and interpretation of the interview outcomes in the following chapter, structured according to the Multi-Level perspective.

4. Analysis of the Interviews

The following chapter provides the analyses of the interviews conducted for this thesis. This information which was collected as qualitative interviews conducted as described in Chapter 3. The outcomes of the interviews are summarized in the following with regard to the main research question and to provide information on the resulting challenges and obstacles for this eco-innovation to become a relevant part of the German automotive market in the future. This chapter is structured according to the Multi-Level perspective. The first section elaborates on the findings about the landscape including environmental issues. The second part deals with the outcomes on the regime comprising the current market situation and the demand and supply situation by customers and automotive companies and the relevant domestic policies. The last part provides the findings on the different challenges for the niche development of the electric car.

4.1 Landscape

Since a few decades, the landscape is dominated by increasing environmental issues like global warming, climate change and diminishing resources. As already elaborated before, the automotive industry contributes to these developments by producing cars running on fossil fuels. With the implementation of electric cars, this negative contribution could be considerably decreased. For this reason, the following section provides the interviews outcomes on environmental issues addressed by the interviewed retailers and customers.

4.1.1 Environmental Issues

The development of electric cars in relation to environmental issues was brought up by some of the retailers and by nearly every customer as a major advantage of this technology. In case it was addressed, retailers strengthened the relevance to act and defined e-mobility as the market of the future. With increasing regulations and environmental norms, they perceive this as the right way to go, for sustainable individual private automobile transportation, especially with regard to steady CO_2 emissions and decreasing fossil resources (Retailer 8, 11 & 13, 2017).

BMWi, the sustainable innovation sub brand of BMW, does not only aim for sustainable electric cars, but also for the production of these vehicles with renewable energies. This comprises special production plants, running on wind and water energy, but also the used materials for manufacturing these cars. BMWi includes as much recycled materials into its cars as possible (Retailer 13, 2017).

In connection to environmental issues, the retailers are partly critical about the policies and subsidies introduced by the German national government. This is why not only e-mobility is subsidised by the government, but also cars running on diesel fuel. One retailer named it a subsidy for environmental pollution (Retailer 5, 2017). Additionally, some retailers proposed the idea to relaunch a scrappage bonus as implemented in 2009. At this time, customers received a financial reward for scrapping their old car and purchasing a new more environmental friendly one. In case this action is repeated, the retailers propose a scrappage bonus only for the purchase of electric vehicles to trigger this innovation. The retailers had the idea that this action was not only good for the automotive industry, but also for the environment as old cars have been displaced by new more resource efficient cars (Retailer 6 & 13, 2017). Additional, more detailed elaborations on politics are provided in a separate section in the following (Chapter 4.8).

The interviewed customers perceive the eco-innovation electric car as a forward-looking technology as it contributes to a better environment. The customers define this as the major advantage of this eco-innovation. In relation to that, topics as decreasing resource depletion, resource independency, CO_2 emission reductions and less noise pollution have been frequently mentioned during the interviews (Customer 1, 3, 6, 7, 8, 10, 11, 12, 13 & 16, 2017).

4.2 Regime

The regime comprises the accepted system by the society. In this research, the regime actors include the government, the German automotive companies and customers associated to the technology of the traditionally fuelled car. Therefore, the following three subchapters provide the interview outcomes on relevant politics, the German automotive companies and the German customers with regard to the innovation development of the electric car.

4.2.1 Politics

The highest share of the interviewed retailers was rather positive about the implemented policies and think that financial subsidies to the customers for purchasing an electric car including tax exemptions are a good start. This makes electric cars more attractive to the customers, as they are not economically viable at the moment (Retailer 5 & 10, 2017). However, there was also consensus among the retailers that policy goals, with regard to the registration figures are far away from being reached in the targeted timeframe. For this reason, there was also criticism regarding the role and activities undertaken by the politics. The subsidies are too low and still not relevant to make electric cars as economical as conventionally fuelled cars (Retailer 15, 2017). Furthermore, different political measure could help to accelerate this change according to the retailers. This would comprise e.g. restrictions or bans of conventionally fuelled cars or an additional financial bonus as the already introduced scrappage bonus for the purchase of an electric car (Retailer 6, 7 & 13, 2017).

Moreover, politics are criticised by one interviewed retailer, as too much responsibility is shifted away from politics to the industry (Retailer 12, 2017). This retailer sees the main share of the automotive industry, in the research and development process of electric cars to solve several technological issues and the product pricing. Recently this is not achieved accordingly to the targets of the national government, but according to him on a good path. The technological development is further elaborated in the chapters of technological maturity and battery in the following. New models will be released with higher range capacities and at moderate prices.

However, the retailers perceive it as not okay to expect the industry to be held responsible for implementing the relevant infrastructure which is already partly taking place. They perceive this as a task of either the politics or energy companies (Retailer 12 & 16, 2017).

4.2.2 Automotive Companies

The automotive companies are the main actors in the market who have an influence on what specific models and types of engines are available on the market, and what technological improvements and innovations will be released in the upcoming years. At the moment, the examined domestic automotive companies offer three major kinds of vehicles: conventionally fuelled cars (diesel & gasoline), semi-electric cars (plug-in Hybrids) and fully electric cars. Most of the currently sold models are still equipped with an internal combustion engine. While the hybrid engine solutions can be purchased in nearly every offered model, the supply of fully electric cars is still very limited. Customers who are interested in this innovation, only have a limited choice, as there are only a few fully electric options available which hampers the velocity of this innovation (Retailer 6, 2017).

Furthermore, the official retailers are not always allowed to exhibit fully electric models, as their locations and employees need to fulfil different criteria set by the producers. This has been reported by different interviewees especially from the Volkswagen AG and BMW AG (Retailer 1 & 4, 2017). These criteria are connected to the sizes of the retailers' showrooms and the employees. In order to exhibit the fully electric models, a certain amount of square metres is prescribed. This means that an official dealer's showroom needs to comply with these requirements, otherwise this location is not allowed to exhibit the fully electric product offerings of the respective producer. Additionally, employees need to follow a special training program about electric cars (Retailer 1, 2017).

In order to promote the technology of electric cars, retailers who are allowed to exhibit fully electric cars, try to make this technology as attractive as possible to the customers by offering non-binding test drives and do also provide financial subsidies to the customers. These subsidies are accounted on top of the subsidies provided by the government (Retailer 2, 2017). Furthermore, these locations set up relevant charging infrastructure for electric cars outside their locations (Retailer 5 & 14, 2017).

4.2.3 Customers

As the recent registration figures already indicate a rather low interest among the German customers in this technology (Kraftfahrt-Bundesamt, 2016, p. 8), most of the official retailers addressed in this research have been able to confirm this trend. Based on the retailers' opinions, the low registration figures are not only related to the limited product offerings but also to different interwoven challenges. The customers are not yet convinced about this technology, its maturity and infrastructure and therefore hesitate to purchase electric cars. Some of the interviewees even said that the German customers are afraid of making this change (Retailer 7, 2017).

Due to the mentioned uncertainties, the retailers reported that customer prefer hybrid options with an additional internal combustion engine at the moment (Retailer 6, 2017). With this technological option, short distances can be driven environmental friendly and fully electric, while private mobility on longer distances is still ensured due to the internal combustion engine on board. This preference also was confirmed by the addressed customers. Those who consider electrified cars, prefer hybrid options as they fear several different uncertainties (Customer 4, 5, 7, 8 & 12, 2017). These uncertainties and challenges for the eco- are further elaborated in the following sections.

4.3 Niche – Challenges

Most of the retailers addressed in this research, reported on very little demand among the German customers with regard to the eco-innovation electric car, confirming the official registration figures (Kraftfahrt-Bundesamt, 2016, p. 8). The limited choice for customers due to the little product offerings by the automotive companies might play a role in this slow adaptation process (Retailer 4 & 7, 2017). However, in line with that nearly all interviewees comprising the addressed retailers and customers mentioned different infrastructural, financial and technological uncertainties, that hamper the politically desired development of this innovation. The following sections elaborate more detailed on the individual problems that are connected to infrastructure, technological maturity, battery capacity and current product pricing.

4.3.1 Infrastructure

The infrastructural problems are multi-layered and very complex according to the retailers. At first there is the uncertainty of who is responsible for implementing it, who pays for it, how is it accessible and what is the general accepted payment method (Retailer 15, 2017). The technology electric car, and also plug-in hybrids are depended on charging infrastructure. Most of the addressed retailers reported that the infrastructural development is on a good path, especially in urbanised areas and big cities, such as the Ruhr-area. Here the network is already very dense and energy companies like RWE already even developed a smartphone app to guide users to the next available charging point (Retailer 14, 2017). However, in more remote and rural areas infrastructure is less developed and insufficient (Retailer 6, 2017). Furthermore, fast charging infrastructure among the major roads and motorways in Germany still needs to be intensified to make this technology more attractive, especially to the group of customers who need to travel long distances regularly (Retailer 6, 2017).

In order to implement further charging infrastructure, there was consensus among the retailers and the customers that either the German national government or domestic energy companies are the stakeholders responsible to implement a dense infrastructural network of charging points (Retailer 16, 2017). Due to the fact that this is not taking place accordingly, the domestic automotive companies just recently started to cooperate together with Ford, to implement further charging infrastructure, to make the network denser increasing the technology's attractiveness to their customers (Retailer 9, 2017). One of the retailers was not happy about this development, stating that either politics or energy companies should take responsibilities for that. He states, that it would be comparable to a situation in which the automotive companies would be the responsible actors for a dense network of gas stations along the roads (Retailer 16, 2017).

The problems of public accessible infrastructure are only one side of the coin. The private infrastructure is the other one. The retailers and customers reported, that especially in urban areas increasingly more people live in flats without private ownership of a garage or a private parking spot. This limits private charging opportunities, as there is no guarantee that customers can charge their vehicle overnight (Retailer 3, 2017). In order to make fully electric cars also attractive to these potential customers, one retailer suggested a model where street lights can be used for charging electric cars recently tested in Munich (Retailer 2, 2017).

Another big problem associated to the infrastructure is the payment for energy. Currently, the business model of the charging points is somehow unsure, and the payment methods vary with the different providers and regions (Retailer 15, 2017). Therefore, interviewees from both sides, customers and retailers see room for improvement with regard to the infrastructure to make the network denser, to make it accessible to customers and to find solutions for a standardized payment method for charging the vehicles.

4.3.2 Technological Maturity

With regard to the technological maturity the overarching problem mentioned by all interviewees, comprising retailers and customers, was connected with the recent range capacities of electric cars. There is consensus, that the recent models on the market have too little range capacities to position themselves as competitive alternatives in the market (Retailer 4 & 8, 2017). The technological features are still very limited compared to a car with an internal combustion engine and to the distances people are used to travel with conventionally fuelled cars.

For this reason, the plug-in hybrids are way more popular among the customers at the moment (Customer 4 & 6, 2017). This is not only the outcome of the interviews but also perceived by the retailers and indicated by recent the registration figures. For some of the retailers, the technological problem of range capacities is also partly a social problem. One retailer states, that for most of the customers, current ranges would be completely sufficient to travel their daily distances. The real problem is the uncertain private mobility and the knowledge that an electric car takes away flexibility. People cannot get up in the morning and decide to travel to Hamburg and back within the same day (Retailer 5, 2017).

Whether current range capacities are a technological problem, or a problem of societal acceptance does not matter for the German automotive companies. All of the domestic car manufacturers are planning to solve this problem technologically and will release new fully electric models in the upcoming years with higher range capacities. Furthermore, recent electric models will be revised with new improved batteries (Retailer 10, 13 & 17, 2017). One interviewee also reported about considerations among the domestic automotive companies to start cooperating with Tesla Inc., in order to improve the technological maturity of electric cars produced by the German automotive companies. The domestic car manufacturers aim for this cooperation, as Tesla INC. has technological advantages with regard to the overall performance, including higher battery and range capacities and shorter charging durations.

This interviewee emphasised the need for the amalgamation of knowledge by different automotive companies to improve the technology of products. This is crucial to replace conventionally fuelled cars by electric cars in the future market. However, he is aware of the fact that bringing these companies together also displays a huge challenge, as this cooperation would be based on sharing technologies and knowledge which are the best kept secrets of every company (Retailer 12, 2017).

4.3.3 Battery

Considering the technological maturity of electric cars, one of the major issues associated is the battery technology. According to the interviews with customers and retailers, the current charging cycles are taking too much time, and the battery capacities limit the possible range of these vehicles displaying one major issues (Retailers 1 & 3, 2017) (Customer 2 & 10, 2017). Retailers reported that customers are also afraid, that the average charging duration of eight hours is limiting their daily usage of these cars, without considering the fact that these cars can easily be recharged overnight or during working hours. Assumed the respective infrastructure is in place and accessible (Retailer 5, 2017).

The performance of current batteries is highly dependent on external environmental factors. This means the capacity is worse as soon as the outside temperatures fall. The consequence for customers is, that they do not have the same range capacities during the winter times displaying another problem to be solved in future (Retailer 11 & 14, 2017).

Furthermore, there are several issues and uncertainties with regard to the reverse logistics and recycling or disposal process at the end of the battery lifecycle. These problems need to be solved by the producers soon (Retailer 3, 2017). In line with that, the expected lifetime of batteries is still uncertain. This is why lifetimes are highly dependent on different factors such as charging frequency and way of charging (slow vs fast charging). Another factor to consider is that it is not yet determined what kind of technological incidents are treated as a gesture of goodwill by the automotive companies (Retailer 3, 2017).

However, with regard to the battery technology, most of the interviewed retailers were very positive that at least some of the above mentioned problems can be solved in the nearer future. Especially the battery capacity is already evolving and in the upcoming years the retailers expect that new models realistically reach ranges between 300km to 500km if the battery is fully charged (Retailer 7, 10, 12 & 16, 2017).

4.3.4 Prices

All of the interviewed retailers and also potential customers reported that the current prices of electric cars are way too high in comparison to conventionally fuelled cars creating an entry barrier for customers to invest into the technology. As elaborated before, the few available options in the market are from a technological perspective still very limited due to long charging durations and short range capacities, but on top of that, the producers ask prices that are a few thousand euros more expensive compared to the same model with an internal combustion engine (Retailer 1, 2017).

Even with different subsidies provided by the producers and the German national government, including ten years of tax exemptions, electric cars are not economically viable at the moment. Purchasing an electric car means extra costs for the customers, includes technological limitations due to short ranges and brings different uncertainties with regard to the batteries (Retailer 10, 2017). This means that not only technological solutions need to be found for the current issues of infrastructure, ranges and battery capacity, but also prices need to decrease to convince rational acting customers. At the moment, it is impossible to drive more economically with an electric car. The people who currently purchase electric cars, do not act rationally from an economic and technological perspective. Recent customers can be defined as pioneers who are willing to take extra financial costs and technological limitations in favour for the environment (Retailer 12 & 15, 2017). Furthermore, a few companies purchase or lease electric cars as well. These are used image carriers to underline the company's commitment to the environment (Retailer 10, 2017).

In order to dismantle the entry barrier of disproportionate prices in the next two to five years, the domestic companies are planning to release new models with higher ranges and adjusted moderate prices. One interviewee is convinced that the more people work on it, the cheaper it will become and the more suitable for masses, which is at the moment one major point of criticism (Retailer 10, 2017).

The recent challenges for the niche are summarized in the following table to highlight the outcomes that emerged from the coding of the interviews:

Table 4. Summary of Recent Niche Challenges

Key factors	Implications
Infrastructure	- who is responsible for implementation - who pays for implementation - accessibility - payment method - evolving especially in urban areas - public vs. private infrastructure
Technological Maturity	- little range capacities - little flexibility - less private mobility - cooperation of German manufacturers with Tesla - sharing knowledge is important but difficult - higher range capacities are expected with the next series of models
Battery	- charging duration - little capacities - vulnerable to low temperatures - reverse logistics and disposal uncertain - lifetime unsure and dependent on customer patterns - unsure which technological incidents are treated as goodwill by the producers - batteries are expected to evolve soon
Prices	- too high compared to technological limitations - subsidies are too low to make electric cars economically viable - new models with adjusted prices are expected

5. SWOT Analysis for Electric Cars in Germany

By the application of the SWOT analysis, strengths, weaknesses, opportunities and threats of/for the eco-innovation electric vehicle in Germany are visually summarized. The following findings only speak for the outcomes of the conducted interviews and display the opinions of the retailers and potential customers.

Strengths describe the already existing qualities and advantages of electric cars, while the opportunities comprise the external influences that can positively influence the adoption and implementation of this innovation. The section of weaknesses highlights the recent problems and disadvantages, while the threats describe external factors that can possibly have a negative influence on the recent and future development of electric cars in Germany. Based on that, the discussion of this master thesis assesses the innovations capabilities to respond and react to them individually in order to become a competitive private automobile alternative to conventionally fuelled cars in the German market.

Figure 4. SWOT Analysis for the German Automotive Industry

STRENGTHS

- Environmental friendly in terms of CO_2 emission and resource depletion
- No noise pollution
- Resource independent private transport solution
- Relevant charging infrastructure already in place compared to other niche developments
- Governmental support

WEAKNESSES

- Charging infrastructure not dense enough yet
- Low battery capacities
- Short range capacities
- Higher prices compared to conventionally fuelled cars
- Current charging durations
- Little product choice

OPPORTUNITIES

- Climate change
- Resource depletion and increasing oil prices
- Multiple levels of governments raise awareness concerning climate challenges
- The German national government provides subsidies to encourage customers to purchase electric cars
- Tax exemptions for electric cars
- New product offerings by the German automotive companies are planned for the upcoming years
- Technological improvement and increasing ranges due to new batteries

THREATS

- Little acceptance among the customers, preferences are still towards conventionally fuelled cars
- Customers are not convinced about technological maturity
- Relatively small market
- R&D is a time consuming and expensive process
- Responsibilities about expansion of charging infrastructure remains uncertain
- Foreign companies have competitive advantage in terms of technological maturity (Tesla)
- No economic benefits of driving or purchasing an electric car at the moment

6. Discussion

In this chapter, the results of the conducted research will be extensively discussed and compared to the findings of further studies about the adaptation and implementation process of electric cars. Moreover, the limitations of this thesis will also be addressed throughout this section.

In the beginning of this research project, the most recent registration figures, current CO_2 statistics and the different technological limitations did not indicate a positive trend for the eco-innovation electric car and its future. Adaptation among the German customers is evolving relatively slow and the factors hampering this development appear to be complex and interwoven. However, the need for change is already identified, not only by the politics, but also by the German automotive companies. All of the examined German automotive companies launch sustainable sub-brands. At these sub-brands they are either already offering, or planning to offer new fully electric models, at affordable prices also to increase the market. This process is not completely realised yet by all of the examined companies, but at least part of the nearer future companies' strategies. Based on that, recent technological challenges comprising battery capacities, range capacities and the pricing are expected to be improved by the companies in the nearer future. Discussing the commercial potential of e-mobility and the opportunities to become a competitive private transportation alternative in the German automotive market, further problems associated to supportive policies, infrastructure and customer acceptance are also in place while not being part of the automotive companies' main responsibilities.

The current landscape is dominated by increasing environmental issues like global warming, climate change, CO_2 emissions, resource depletion like oil and gas. There is increasing awareness of these problems, not only on political levels, but also among the population. A recent survey among German citizens shows that 78% perceive the problem and consequences of climate change as very dramatic (Statista, 2017). Projecting these landscape issues on the automotive regime, problems become more obvious as the current situation is determined *"by the use of petroleum as a fuel source; and by a mobility paradigm informed by the private ownership and use of passenger cars"* (Wells & Nieuwenhuis, 2012, p. 1682)

The current private transportation sector is highly dependent on the supply of natural resources like oil and gas, while the ongoing and irreversible transitions in the landscape ask for a change in the regime as "*socio-technical change is an outcome of exogenous landscapes putting pressure on the stability of the existing regimes"* (Maassen, 2012, p.446). Most likely this change will affect the current technologies in the regime. *"Changes at the landscape level, for instance, may put pressure on the regime, and create openings for new technologies"* (Geels, 2002, p.1262). This explains the different niche developments seeking for alternative sources of power and general growing interest in eco-innovations like the electric car.

The current regime of private automotive transportation is embedded in the institutions and infrastructures and based on conventionally fuelled cars with an internal combustion engine, running on fossil fuels which constantly emit CO_2 emissions to the environment. In other words, it is *"a dominant set of stable but continuously evolving artefacts, actors and institutions"* (Laes et al., 2014, p. 1131). This dominance of cars with an internal combustion engine is also confirmed by recent registration figures of cars in Germany, where 25.500 electric cars are opposed by 45 million conventionally fuelled cars running on fossil fuels (Statista, 2016).

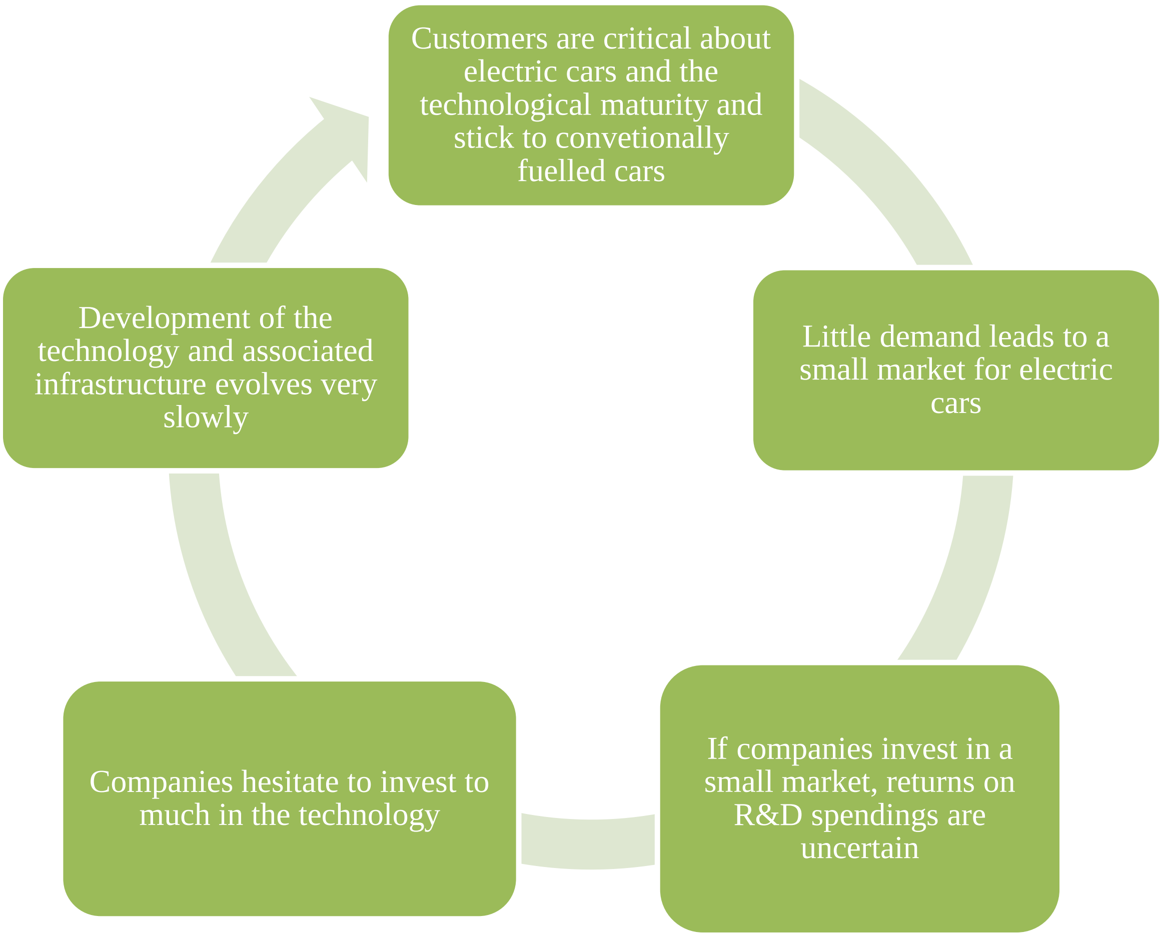
These statistics indicate that the majority of German car owners is currently dependent on the supply of fossil fuels as gasoline. This dependency makes them unable to react to price fluctuations at the market, because gasoline ensures personal mobility for nearly every citizen. At the moment this dependency is not a big problem as prices are more or less stable. Furthermore, the density of gas stations in Germany is very high preventing monopolistic price policies. In total there are 14.531 gas stations (MVV, 2016) on 620.000 kilometres road network (Jesgulke, 2016). This settles on average a gas station at every 42 kilometres. Taking this into consideration, the current dependency is not problematic for car owners, as there is sufficient competition at the market. Additionally, the current regime and its dominant technology also bring several advantages to the customers. The conventionally fuelled car is filled up within a few minutes at a gas station, the purchased amount of gas can be paid easily by card or cash within seconds, and people can get back on the road again. By switching from fossil fuels as the main source of power to electricity, a whole new network of charging infrastructure has to replace current infrastructure in the long-run. This will include the adjustment of a conventional gas station, including changes for the customers and their practices in using and refilling their car leading to a system transition. In case that technological change, changes existing networks, but also transforms societal actions and practices it is defined as a system change or system innovation (Elzen et al., 2004).

Another factor to consider is that people use their cars as symbols and as some kind of self-expression to show their own identity (Case, 1992), this is the reason why people tend to drive big cars with big engines as status icons and to show off their wealth.

Within the last few decades, no major changes took place among the existing regime technology besides of some efficiency measures, in order to comply to new CO_2 emission regulations. The basic technology of the internal combustion engine is the dominant technology for decades, while no new technology has been able to replace or co-exist next to it as part of the existing regime. This leads to the effect that people are used to the fact that cars are running on fossil fuels, making it even harder to convince considerable amounts of the population to switch towards an electric vehicle. People in general tend to resist change especially towards unknown technologies (Ram & Sheth, 1989). According to Van den Bergh et al., (2011, p. 10) "*Changes in the regime are triggered either by increasing pressure from the societal context (landscape forces) on the regime or by upcoming, rivalling socio-technical configurations.*"

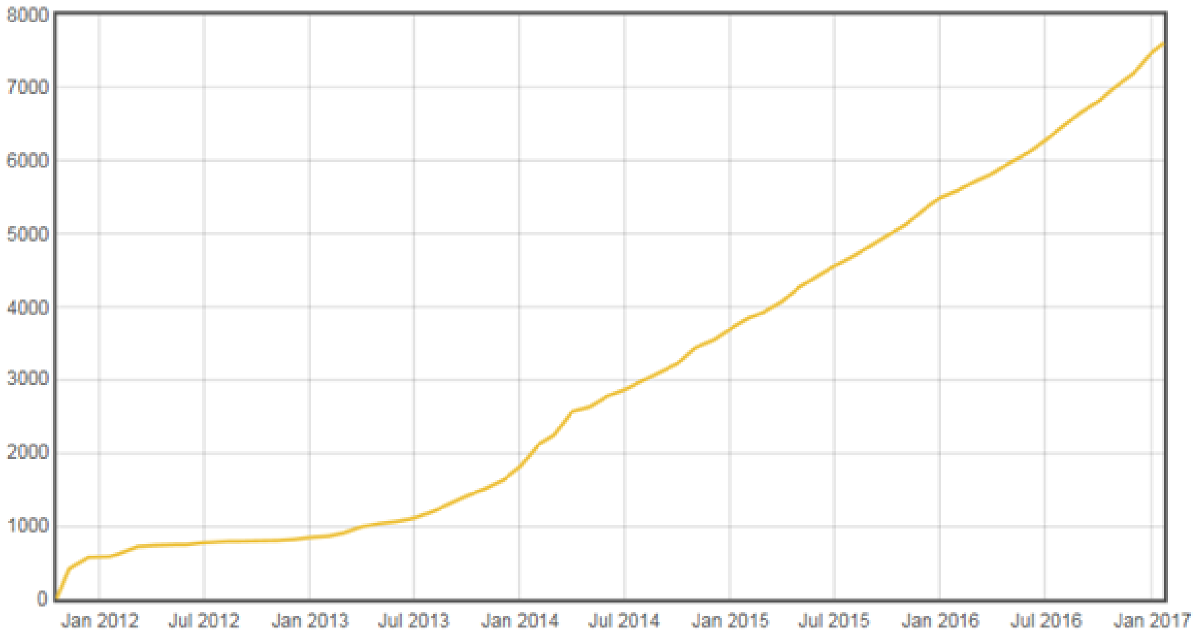
Taking this into consideration the recently well-functioning system built around conventionally fuelled cars, leads to a lock-in situation as visualized in (Figure 5.). A lock-in situation describes a vicious-circle in which the current regime is captured. Getting out of this circle or 'locking-out' is difficult and economically uncertain. For the producers, high R&D costs paired with uncertain customer acceptance display major threats, while customers are uncertain whether the new concept and technology of electric cars will be successful. Furthermore, with new techniques, customers have a tendency to first wait and see if additional technological break troughs within the next years change the market situation again (Purificato, 2014). As politics belong to regime as well, they can support a lock-out, by setting up relevant policies (Unruh, 2000). Laes et al., (2014, p. 1147) ask for governments that *"...are credibly committed to the long-term visions they set out. Precisely because processes of long-term structural change are rife with uncertainty"*. The fact that policies should be long-term designed and flexible, adaptive and reflexive to be supportive for a technological shift is also highlighted by the findings of Van den Bergh et al., (2011).

Figure 5. Graphical Visualisation of the Technological Lock-in Situation



Implementing the niche technology electric car within the current regime can be seen as a race of different innovations. As already mentioned, other niches have the same objective to become part of the regime and evolve at the same time in their independent niches. In the end, the most competitive niche development with the highest technological maturity and customer acceptance will turn out to be successful (Foxon et al., 2005). One of the main advantages, bringing the electric car in a leading position (compared to others niches), is that infrastructure such as public charging points for electric cars are already existing and continually evolving in Germany, from less than 1000 in 2012 to more than 7000 in 2017 (Table 5.).

Table 5. Development of Charging Infrastructure - Germany



Source: (GoingElectric, 2017)

Additionally, on top of the already existing and evolving infrastructure, the electric car has also competitive advantages towards e.g. the hydrogen car with regard to security issues. In case of a crash or collision, it is much more likely that a hydrogen will explode compared to either electric cars or even current technologies like gasoline or diesel vehicles (Shinnar, 2003).

Due to the fact that a fully electric car does no longer need an internal combustion engine, implementing this technology as part of the regime is not only expected to have a tremendous influence on decreasing CO_2 emissions, but also on reduced noise pollution from road traffic (Helmers & Marx, 2012).

The combination of these different advantages might be the reason why the niche development of the electric car is also prioritised by the German national government compared to others. In order to trigger this innovation and to contribute towards the goal of having 1 million fully electric cars registered by 2020 (Bundesregierung, 2010), the German national government invests 180€ million in R&D until 2020 (Bundesregierung, 2017). In line with that, customers are provided with financial incentives to purchase an electric car. The purchase of a fully electric car is subsidised with 4000€ and additionally rewarded by tax exemptions for 10 years (Tagesschau, 2016).

As this niche is already for years on the public agenda and has the most attention in the media compared to other innovations, the development of electric cars is also prioritised by the German car manufacturers. All of them already launched fully electric models and plan to increase the product variety of electric vehicles within the next years. The examined automotive manufacturers also work collectively together, to improve the charging infrastructure for electric cars by implementing new fast charging points among the most important highways and routes in Germany since 2017 (Zeit, 2016). Considering this, the niche development of electric cars also comprises parts of the already existing regime which is not unusual (Smith, 2007).

"In order to understand how technological novelty emerges, stabilizes and proliferates, it is necessary to understand the nature of "niche–regime interactions" (Maassen, 2012, p.443). These interactions are provided in the following. Based on the findings of the previous sections, it becomes clear that developments taking place in the landscape influence industrial transformations interlinking the regime and the niche. The current regime cannot continue the way as it operates now in the long-term future. Current technologies are harmful to the environment, contribute to climate change with steady levels of CO_2 emission and lead to ongoing resource depletion of natural oil and gas. These issues ask for a transition that can only be achieved by collective action of the current regime, in collaboration with the promising niche development of the electric car.

This niche, offers a technological private transport innovation that can possibly solve the problems of the landscape, while providing sustainable automobile transportation to the customers. However, neither the problems nor the innovation of the electric car are completely new. Considering the idea that, *"transitions" which are understood as "innovation journeys [that] need to be sustained for long periods of time, often decades rather than years*" (Geels et al., 2008, p. 524), it can be interpreted that the electric car is still on its innovation journey.

The status-quo is a regime that is still locked-in as displayed above (Figure. 5). Landscape developments as climate change and resource depletion are unavoidable, and if the regime sticks to the technology of internal combustion engines, this situation is unlike to be changed. The later the change of the technology will take place, the more the tensions in the current regime will be enforced. In the last few years, this message also reached the car manufacturers, as big parts of the regime are starting to adapt the niche development and consider electric cars as parts of future product strategies, to not lose their position within the regime. As a matter of that, the lines between regime and niche actors are somehow blurred which is not unusual according to Smith (2007, p. 447) who states that "in practice niche–regime distinctions are rarely so clear cut".

Due to the findings of this thesis, the politics made good start by setting targets and providing financial subsidies and tax exemptions. "*However, target-setting alone will not suffice to "steer" investment decisions in the appropriate direction: in particular, the coherence of policy implementation (...) with the overall energy transition goals needs to be ensured"* (Laes et al., 2014, p. 1147). This was also reported among the interviewed retailers, some of them had the idea that other governments of European countries introduced superior polices to support the successful implementation of the electric car, compared to Germany. The countries which were named most frequently are Norway and the Netherlands. The Norwegian government provides the customers of electric cars with many different benefits. Incentives are that high, that already 18% of the recent new registered cars are electric ones. This comprises amongst different subsidies and tax exemptions, free charging opportunities, relevant infrastructure, free parking places and more. The subsidies and tax exemptions are so determining, that an electric VW Golf is 8800€ cheaper compared to a conventionally fuelled VW Golf (Handelsbatt, 2015).

The Dutch politics followed a comparable strategy and both countries are currently considering the opportunities to prohibit conventionally fuelled cars from 2025 on (Dittmer, 2016). These two examples show that the possible influence of the government on the velocity of this innovation could be way higher than it is recently in Germany. The effect of politics on innovation stimulation is also broadly investigated by environmental economics, *"...taxes, standards and tradable permits) perform best in terms of speed of innovation, maintaining technological diversity, and avoiding early lock-in. It is widely accepted that price incentives through taxes or tradable permits provide a continuous, dynamic incentive for firms to adopt more environmentally efficient technologies if these become cheaper over time"* (Van den Bergh et al., 2011, p. 5-6) indicating that Germany, Norway and the Netherlands took relevant measures. However, the financial incentives in Germany are still too low to make the electric car economically viable. The goals connected to registration figures have been formulated for the years 2020 and 2030 (Bundesregierung, 2010), but measurements and policies showing the dedication of the government to really push this innovation by providing real financial advantages and fostering a strict and fast enforcement such as in Norway are not there yet.

Discussing reasons for the differences in policies, there is one major argument for the rather defensive Germany policies. Neither the Netherlands, nor Norway have a domestic automotive manufacturing industry or domestic automotive brands. This means, intervening in the automotive market does not display risks to domestic companies and the national economy. The German government has an interest in implementing the electric car as part of the regime in future, however they also need to consider possible influences of policies on the present national economy and the associated domestic companies, as already mentioned in chapter 2.3.2.

According to the national government, every 7th German citizens is working directly or indirectly in the automotive industry sector, which makes it the most important sector of the German national economy (Bundesregierung, 2006). Fostering the transition towards e-mobility as radical as it is done in Norway or the Netherlands, could push the innovation's development, but also endanger the German working force of this industry. Many people working in this sector, especially in the manufacturing part, could lose their current jobs in future. This is why electric engines are way less complex than combustion engines and transmissions are no longer necessary for electric cars. This makes the production process of a car less complex reducing the necessary working force (Bellberg, 2016).

To reduce these risks and to develop future strategies for this industry, to adapt to this transition could be the reason why the technological change is anticipated a bit more defensive in Germany. Considering the impacts of transitions is relevant, not only in the interest of the transition itself, but also to understand who are the potential winners and losers of the transition once it is realised (Van den Bergh et al., 2011).

The problems associated to the infrastructure are very complex for different reasons. The network is already increasing, but still not as dense as in the Netherlands or Norway. The payment methods for charging can vary with the charging point and the provider making it difficult for customers to choose an appropriate charging location Furthermore, the responsibilities of who is in charge to take care of a dense network remains uncertain and is still divided among governments, energy companies and the automotive companies at the moment (Specht, 2016). However, maybe the problem of low density is maybe only a recent problem probably dissolving itself in future. All of the German automotive companies are planning to release models with improved batteries and higher range capacities. Meaning that people will have to charge less frequently. The only problems remaining are the questions of responsibility for implementation and maintenance and a generalised payment method. Once these problems are solved, infrastructure is no longer one major problem.

This is also found out by Hannisdahl et. al, (2013) *"... it seems infrastructure alone is not enough to get a break through for EVs. Only when the sum of incentives makes it profitable to buy EVs, do the incentives pay off*" (Hannisdahl et al., 2013, p.999). This study also investigated the drivers and barriers for electric cars, coming to the conclusion that "*you need both push and pull factors within your incentive schemes – success will not come otherwise. A policy mix which contains financial incentives, access to bus lanes, free parking/no toll road and charging infrastructure – is indeed a receipt for BEV success*." (Hannisdahl et al., 2013, p.1003).

Another study in the field of customer acceptance for electric cars found out that *"...purchase cost reduction to be the strongest incentive in promoting BEV* (battery electric vehicles) *adoption. These incentives are prominent among most BEV users and fairly undebated because they strongly increase the market competitiveness of BEVs* "(Bjerkan et. al, 2016). Based on that, there is high indication that customer acceptance increases automatically as soon as recent technological problem can be decreased and the cars become financial viable to the customers.

By comparing and contrasting the general findings of this thesis with other studies, it has been discovered that the major problems identified addressed in this thesis appear to be relevant. The mix of different social, technological and political problems is currently hampering the velocity and diffusion of the eco-innovation electric car in Germany.

6.1 Research Limitations

Methodologically, it has been chosen to apply a qualitative research design by conducting qualitative interviews with retailers and customers. This has been done to develop and expand on theories and not to prove facts. The researcher thesis is aware of the fact that the findings and outcomes generated are not generable and only speak for the examined cases. It has been chosen to address the German customers and the official retailers as they are both acting at the basis representing parts of the demand and supply. Moreover, these two groups of interviewees represent primary stakeholders who were willing to participate in this study. As already mentioned in the methodology, the German automotive companies have not been cooperative and did not allow interviews with sustainability or R&D managers for this thesis.

The retailers' showrooms are the locations, where customers usually choose their next car, so these actors can report the best of what is demanded and supplied. Furthermore, these interviewees had interesting perceptions of why the transition is not taking place according to policy goals. By using the perceptions of these two groups of interviewees, the findings of this thesis differ from official company statements and trained PR experts. However, to complete the picture and to make the outcomes of this thesis more reliable and generable, additional interviews with the relevant departments would have increased the reliability and validity of this work. These interviews could have comprised relevant actors from the German politics, the management levels of the automotive companies including respective R&D departments and domestic energy companies. However, due to the limitations of accessibility, time and scope it was not possible to integrate further stakeholders into this thesis.

6.2 Suggestions for Further Research

Discussing the possible potential of e-mobility, it appears to be a very promising innovation to reduce CO_2 emissions and climate change effects and to decrease the pressure on natural resources. Offering the German customers zero emission cars sounds very positive on the first sight, but considerations about energy producing sources for the necessary electricity need to be done as well. Although Laes et al. (2014), state that Germany is perceived as a "*climate frontrunner*" (Laes et al. 2014, p.1137), the recent national energy mix of Germany speaks a different language. At the moment, 23% of the German energy is based on lignite, 17 % on hard coal and 12% on natural gas (CLEW, 2016). This adds up to more than 50% of the German energy produced by fossil resources which negatively influence domestic emission levels including climate change and resource depletion.

Considering this energy mix, implementing increasing numbers of electric cars cannot be seen as a magic solution that solves all CO_2 and climate change related problems. "*Solving environmental problems with innovative technologies is difficult is that they always result in unintended second-order effects, referred to as energy and environmental rebound"* (Van den Bergh et al., 2011, p.4). There is a need for the whole country to adapt. Especially the domestic energy sector and a shift towards increasingly more renewable energy sources in the national energy mix needs to be anticipated. Otherwise emissions are only shifted away from the individual cars to the energy production plants which is not a solution to the environmental problems. This means if electric cars, should become climate neutral automobile alternatives displaying no harm the natural environment, the energy they need has to be produced sustainable.

By discussing this, further research studies with regard to the German energy transition is advised to investigate:

- The necessary amount of energy needed, if all cars registered in Germany become electric in the future.
- The investment to implement relevant energy producing infrastructure, producing this amount of energy renewable?
- How the phase out conventionally fuelled cars can be realized, with regard to the challenges of the energy sector?

Furthermore, with regard to the title of this research: “Electric cars, the way towards sustainability in the German automotive sector?” All dimensions of sustainability need to be taken into consideration. This comprises environmental, social and economic sustainability. This leaves space for further research investigating the following topics:

- Life-cycle assessments and the implications of reverse logistics and correct disposal of batteries of electric cars, which is more or less undiscovered yet.
- How can the automotive sector sustain the current amount of employees once the electric car becomes the dominant technology? As the manufacturing process needs less labour force (Bellberg, 2016)
- What is the right policy-mix for a country like Germany, that is highly dependent on its automotive industry, to economically sustainable replace the current regime technology of conventionally fuelled cars by electric cars?

7. Conclusion

This thesis supports the Multi-Level perspective as a valid theoretical tool to understand the development of technological niches. In this work interlinkages between and challenges for the niche development electric car to the recent regime and recent landscape developments in Germany have been discovered and emphasised. The landscape developments of climate change and resource depletion have major influences on changing the technological regime of conventionally fuelled cars. This results in growing interest for niche developments like the electric car, aiming to solve these landscape problems and to become the future regime. The application of the chosen theories and methods to investigate this innovations´ development process offered new insights and discovered relevant knowledge gaps further research studies.

"In innovation studies it is often assumed that innovations are good per se and signify a relatively easy and cheap solution to pressing environmental problems, notably climate change. However, this is not necessarily the case, for a number of reasons. Innovation takes much time, requires costly investments in R&D, and involves many failed efforts to realize market up-scaling" (Van den Bergh et al., 2011, p. 4).

Setting this quote in the context of this research it appears to fit the recent development stage of the electric car in Germany. It cannot be perceived as an easy solution to ongoing landscape problems of diminishing resources, climate change and CO_2 emissions. This innovation needs more time to develop, is costly for customers, costly in terms of R&D and not yet ready to enter the mass market as a competitive alternative to conventionally fuelled cars. Technological maturity including battery and range capacities, expensive prices, little product variety and low density of relevant charging infrastructure display major recent challenges. Additionally, the institutional context and the importance of the automotive sector to the German national economy influence domestic policies and explain the defensive approach of the Germany national government compared to e.g. Norway or the Netherlands.

Targeted registration figures by the national government for 2020 probably fail to be reached. The niche electric car needs more time to evolve and to improve on current obstacles, but as soon as the electric sub-brands of the German automotive companies launch new models with improved technology at affordable prices, this niche can possibly reach a turning point as technological issues are expected to be solved and the innovation eventually can become a relevant part of the regime.

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VI. Appendix

Interview Guide - Official Retailers

Company Name:

Okay with recording the Interview? Yes/No

Date:

Company related questions

1. Tell me about e-mobility in your company?

2. What are the current and future electric options available at your company?

3. How would you describe the vision of your company concerning the development and future of electric cars?

4. Tell me about your company's strategy to make electric cars more attractive to the customers?

5. What are the biggest challenges for e-mobility at the moment?

Policy related questions

Germany's national policy goals are formulated in 2011 to have 1 million fully electric cars registered until 2020. At the moment, there are around 25.000 electric cars registered in Germany. More than half the way (timewise) goals are far from being achieved.

6. What is your opinion about the feasibility of these policy goals?

7. What is your opinion about current policies and subsidies to trigger the development of e-mobility?

Customer related question

8. How would you describe customer attitudes towards electric cars at your store?

9. Did you experience a certain trend for electric cars in terms of demand and sales?

Interview Guide - Customers

Company (location):

Date:

Current car choice

1. What brand, model and engine is your current car?
2. Are you planning to purchase a new car?
3. If yes, do you consider electric opportunities?
4. Why?

Current opinion about electric cars

5. What do know about the advantages and disadvantages of electric cars?

Future choices

6. What are the main characteristics that could influence your choice to buy an electric car in the future?

VII. Declaration of authenticity

Herewith, I declare that all the materials and findings presented in this master thesis are my own work or completely acknowledged whenever took over from other sources. Therefore, I comprehend that if at any point of time, it is proven that I have significantly misrepresented material presented in this Master thesis, any degree awarded to me on the basis of it may be withdrawn. I proclaim that all information and statements contained herein are true and accurate to the best of my knowledge.

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Lukas Rydzek