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Innovation in E-mobility: Obstacles and its management in the German automotive sector

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ABSTRACT

Electric mobility, also called e-mobility, is perceived as an innovation which revolutionizes the way we travel, transport, and navigate through today's world. It aims to provide a sustainable alternative to traditional combustion engines, decrease dependency on oil, overcome mobility issues in urban and suburban areas, while also enhancing the consumer experience.

Though a transition towards e-mobility presents significant opportunities for society, environment and economy, it is faced with substantial challenges.

This thesis discusses the rising use and acceptance of electric vehicles in Germany, subsequently, barriers will be evaluated and presented. It is to question, how and to which extend, factors such as low cost-effectiveness, socio-cultural and infrastructural obstacles play a role in today's development. The aim of this thesis consists not only of disclosing barriers, but also propound its management to accomplish a successful market diffusion.

By adopting a holistic approach, this thesis explores obstacles through interviews with different stakeholders. Data is gathered from reliable sources and the theoretical model is assessed using a qualitative model.

A key outcome of this thesis are the barriers, such as limited vehicle range, long waiting times at charging stations, high upfront cost, the lack in battery technology and a confusing charging infrastructure. While Germany demonstrates a willingness towards change and invest in the development of electro mobility, societal conservatism and questions about the sustainability of electric vehicles remain dominant. To address these challenges, an increased political involvement is needed, such as increasing tax rates for vehicles with a traditional combustion engine, implementation of subsidiaries and an increased transparency in processes.

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1. INTRODUCTION

This thesis discusses the rising use and acceptance of electric vehicles across Germany. It aims to answer the research question: which obstacles arise in the transition towards electro mobility and how can these barriers effectively be managed to establish a thriving market?

The objective of this thesis consists of disclosing barriers that restrict the transition towards electro mobility in Germany and propose strategies to effectively manage those. By giving key insights into the perspectives of different stakeholders, the research aims to highlight areas where electro mobility is lacking and identify opportunities for improvement.

In this paper, "e-mobility" specifically refers to electric vehicles (BEVs), other forms of battery powered transport, such as e-scooters and e-bikes, are not considered. Moreover, information provided focuses solely on the private sector.

Germany's automotive industry

Germany is renowned for its large automotive industry. Brands such as BMW, Mercedes-Benz and Volkswagen have become major players in the global vehicle market by setting standards in performance and quality, while also innovating and rethinking the idea of mobility. In 2023, Germany produced around 4.1 million vehicles, many of which were exported to other countries around the globe (CEIC, 2023). Motor vehicles and parts thereof are Germany's most important export product, accounting for approximately 17 % of total exports in 2023 (Statistisches Bundesamt, n.d.).

Approximately 465 thousand people worked in the automotive sector in 2023, yet millions of jobs are created through the industry and its associated sub-companies, highlighting the importance and influence of this market on the country's GDP as well as today's society.

The countries large automotive sector supports a vast network of suppliers, businesses and service providers, thereby fostering economic stability (VDA, German Association of the Automotive Industry, 2024).

Climate change and an increasing emphasis on sustainability have accelerated a shift in the automotive landscape. Increasing cost of petrol and diesel, which already have multiplied by eight since 1950s, scarcity of finite resources and a growing world population play an important role (Ritchie & Rosado, 2022). Additionally, there is a growing demand to decrease pollutant emissions and sustain a liveable environment in urban and sub-urban regions (World Health Organization, n.d.).

The transition towards electro mobility is driven by regulatory policies aimed at reducing greenhouse gas emissions and environmental concerns. Electric vehicles are perceived as a sustainable alternative, which reduces CO2 emissions, because of which Germany and the EU foster this development through incentives. Through Germany's initiatives, as well as benefits of electric vehicles, cars without a traditional combustion engine gained significant importance across society, car manufacturers and politics.

Indicators of disruption became increasingly visible with urban and suburban infrastructural development to ensure support for current and future needs, large investments in battery technology and an increasing acceptance of sustainable transportation methods across society (UN environment programme, n.d.).

The importance of this topic lies in its potential to reshape the future German automotive landscape (Puls, 2020). Evaluating the development of electrification in the German vehicle market and disclosing occurring barriers, presents an understanding of the countries position in the global automotive industry and incentives to implement changes.

E-mobility might provide a sustainable pathway; however, its relevance and impact should be critically questioned.

Definitions

The concepts of innovation, sustainability and electromobility vary from filed to field, leading actors to interpret the terms in various ways, which may result in misunderstandings, misappropriation, or conflict.

The following paragraphs provide relevant definitions of key concepts, so that there is a common understanding of the argumentation presented in this thesis.

Innovation

Innovation can be defined as the practical creation and implementation of new ideas in existing practices. It results in the enhancement of existing goods, introduction of new services, realization of new products or application of new processes. Implementation and practical creation of new ideas can provide additional value, possibly resulting in a positive impact on markets, society, and organizations. Innovation plays a crucial role for companies and is oftentimes associated with growth, while improving sustainable development and the competitiveness of a firm. Spendings, policy and research expenses are oftentimes adjusted and influenced through innovation, moreover it can lead to radical changes and repositioning of a firm (Tidd & Bessant, 2021).

Sustainability

Sustainability describes the ability of an organization to operate in a market, while not depleting vital resources and preserving the integrity of today's global ecosystem.

Today, sustainability is commonly linked to the Brundtland Report, which defines sustainable development as: "following the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987).

It is important to differentiate between sustainability and sustainable development. Dresner describes sustainability as the main aim of a sustainable society, meaning an ideal equilibrium condition over different dimensions, such as the environmental, economic and social sphere. Sustainable development on the other hand describes the transition of a current unsustainable societal system to such equilibrium (Sarkis et al., 2010). Some stakeholders distinguish between two types of sustainability. Narrow sustainability describes the aim of enhancing environmental efficiency through continuous innovation, advancements in environmental management and reorganization of societal structures.

Broad sustainability is based upon the idea of technological innovation to fix unsustainable behaviour. The latter can be seen as a minimal solution that merely extends the lifespan of unsustainable socio-economic systems (Sarkis et al., 2010).

A sustainable future is based upon a balanced interaction between society, businesses, and the environment. Today's market faces a sustainable challenge, partially due to business activities producing significant negative impacts on society and environment, while its positive effects are not enough to offset these drawbacks (Santamarta et al., 2022).

E-mobility

Electromobility, also referred to as e-mobility, defines the concept of using an electric powertrain to transport goods and/or people between destinations.

The German Federal Government defines e-mobility as the use of vehicles that are powered by electric motors and receive their energy from the electrical grid, meaning they are recharged externally. This definition comprises plug-in hybrid vehicles (PHEV), electric vehicles (BEV) and vehicles combining an electric motor with a combustion engine (REEV).

However, e-mobility can also be related to numerous vehicle concepts used in individual mobility, some of which can also include Pedelecs, E-Motorcycles, E-Mopeds and E-Scooters (Die Bundesregierung, 2009).

Vehicles utilizing electric powertrains offer quieter, cleaner and a more sustainable alternative to cars with an internal combustion engine. Additionally, electromobility offers cheaper running costs, less emission and improved performance.

Electromobility comprises of more than an electric powertrain. It includes a greater ecosystem of sustainable energy production, charging infrastructure, grid integration and the need to implement new processes and supply chains.

E-mobility is seen as a crucial element in today's society to shift to a low-carbon transportation (McKinsey & Company, 2023).

Methodology

Research approach

The first section of the thesis consists of a literature review, which presents facts in figures about electro mobility, innovation and sustainability. Information provided throughout this chapter focuses on Germany, as well as the European Union.

The second section adopts a qualitative research design. This part of the thesis utilizes semi-structured interviews to gather information of different key stakeholders on the demand and supply side of e-mobility. Its objective is to gain a comprehensive understanding of multiple departments. Subsequently, the key outcomes of the interviews are being evaluated and presented. "Main findings" consist of information, which an individual has highlighted or if statements doubled throughout multiple interviews.

A qualitative approach is chosen to explore the interviewees underlying emotions, attitudes and to gather extensive information on the individual's perception towards the covered topic.

The last section of this paper discloses the obstacles of electro mobility and possible approaches to manage those. Information presented in the last chapter of this thesis is based upon the findings of the previous two sections.

Conducted Interviews

Each interview conducted follows an identical scheme.

The semi-structured format incorporates a set of predefined questions to steer the conversation, while also allowing flexibility to explore topics that emerge throughout the discussion. This approach ensures that key topics are covered, but also allows the interview to remain open to capture further insights and perspectives.

To gain a comprehensive understanding, this paper utilizes the "MIT Innovation Ecosystem Model", which states that an innovation draws value from five different stakeholders.

These include entrepreneurs, corporations, investors, governments and research institutions (Budden et al., 2019). At least one interviewee has been chosen to present the perspectives of the individual stakeholders just mentioned. Individuals from research institutions were no willing to be interviewed.

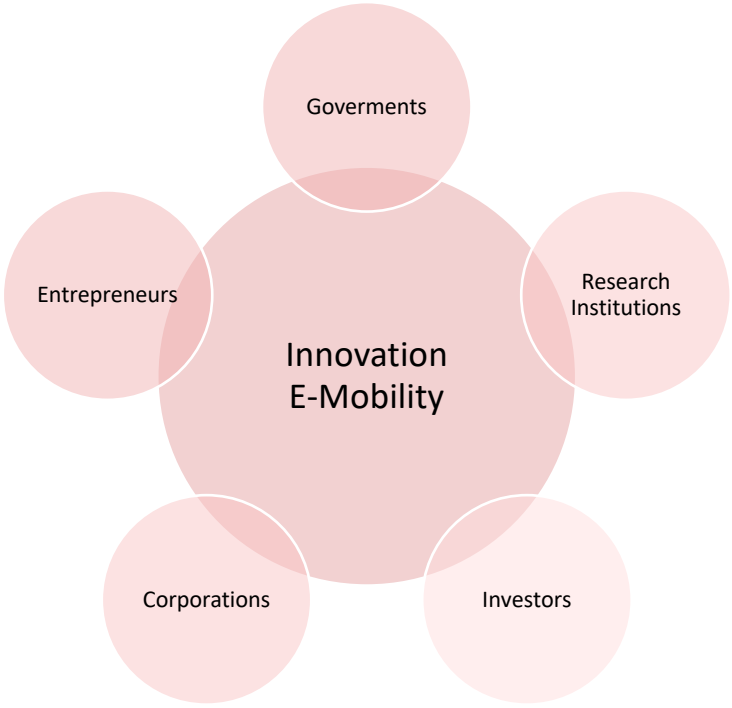

Figure 1: MIT Innovation Ecosystem Model

Data Collection

The paper conducts data of different sources. This includes interviews, academical papers as well as books, newspaper articles and magazines. Information gathered can be categorized in primary and secondary sources.

Primary data was collected through a qualitative research method, specifically utilizing semi structured interviews. Data is collected throughout this process is non-numeric and discloses insights into consumer perception and acceptance.

Secondary data provides an analytical and numeric perspective. It was sourced from articles, books, publications, and academic papers.

2. CLIMATE CRISIS AN IMPULSE FOR CHANGE

The shift towards electromobility is caused by a range of contributing factors. Today's industry is tied to global markets, shaped by societal demands, governmental policies and various groups of interest. Each factor significantly impacts the development of electro mobility in Germany.

However, it can be stated that a major catalyst in the shift towards electro mobility happen to be climate change and its impact on society, economy, and today's politics (Die Bundesregierung, 2024).

The main driver of climate change is the increase of greenhouse gases within the Earth's atmosphere. Carbon dioxide (CO2) is the most impactful of these gases and is generated by burning fossil fuels, such as oil, gas or coal, to produce energy for the transportation, industry, and household sectors (National Geographic, n.d.).

The following chapters disclose external influences, such as European climate laws and objectives, which influence, and frame, the shift towards electromobility in Germany. By presenting the objectives and impulses given through governmental policies, goals and obstacles can be identified.

European Context

Around three-quarters of the European Union's (EU) greenhouse gas emissions are generated through heavy energy-sectors, such as transportation, industry, and households. In 2021, the emission of these sectors comprised of approximately 2.7 billion tons CO2. To meet the climate targets for 2030 and achieve climate neutral environment by 2050, the European Commission intends to decarbonize each sector of the economy. This will involve increasing the proportion of renewable energy and enhancing energy efficiency (Statistisches Bundesamt, 2023).

Today, the transportation sector is experiencing the fastest growth in energy demand. The number of passenger cars in the EU increased from approximately 218 million in 2011 to roughly 253 million in 2021.

Road traffic contributes to about one-fifth of all greenhouse gas emissions in the EU. In 2021, these emissions totalled around 748 million metric tons of CO2 equivalents, representing a 21 % increase from 1990 levels. Approximately 60 % of these emissions are created though motorcycles and passenger cars. The EU energy consumption in road traffic amounted to approximately 259 million tonnes of oil equivalents in 2021. Compared to 1990, the annual consumption increased by approximately 28 % (Statistisches Bundesamt, 2023).

To reach climate neutrality by 2050, it is crucial to establish conditions that support zero-emission or low-emission mobility. Today, more than 90 % of energy consumed in road transport originates from fossil fuels. Electric vehicles play only a minor role, currently. In 2021, electricity represented 0.23 % of the energy consumed in road transport throughout the EU (Statistisches Bundesamt, 2023).

According to the Paris Climate Conference, greenhouse gas emissions from transportation would rise by approximately 20 % until 2030 and up to 50 % before 2050, if no significant measures are being implemented (Greenhouse Gas Emissions, 2023).

Germany Context

Germany's commitment towards sustainability is deeply rooted in its national agenda and politics. Through its commitment towards sustainable funding and practices, Germany leads the global dialogue on climate change. Today, it serves as a prominent example of proactive measures and goals designed to address environmental challenges (Germany's Sustainable Development Strategy, 2022).

Germany reduced its greenhouse gas emissions by 27 % between 2000 and 2021 (Deutschlandfunk, 2023). In 2023, Germany emitted 673 million tons of CO2, approximately 49 million tons below the legal limit. Compared to 2022, emissions were reduced by around 10.1 %, or about 76 million tons.

The decrease in CO2 emissions was driven by an increased production of renewable energy and represents the lowest level since the 1950s. Moreover it amounts to the largest decline since 1990 (Bündnis90 Die Grünen, 2024).

In 2023, solar and wind energy generated approximately 50 % of the country's energy consumption (Deutsche Welle, 2024), which increased to 73 % in 2024 (Norddeutscher Rundfunk, 2024).

In 2022, coal continued to be the primary energy source for electricity generation in Germany. Electricity generated through coal increased by approximately 8.4 %, compared to the rate in 2021 (Statistisches Bundesamt, 2023).

The Expert Council on Climate Issues indicates that road traffic is responsible for around 97 % of the total emissions in the transport sector. Passenger cars are responsible for 60 % of emissions in road traffic, representing the largest portion of the sector's total CO2 emissions (Deutschlandfunk, 2023).

In 2021, the transport sector emitted approximately 148 million tons of CO2, exceeding the original target by three million tons. According to a report from the Expert Council on Climate Issues, Germany has cut its greenhouse gas emissions in the transport sector by 18 % in 2023.

The modified Climate Protection Act of 2021 stipulates that the transport sector is allowed to emit only 85 million tons of CO2 by 2030.

EU Climate Goals

The EU has set standards throughout its member states to ensure consistency in environmental policies, energy efficiency and emission regulations.

Figure 2: European Union Climate Goals

It increasingly framed climate policies in Germany, as well as other countries, not only withing the EU but also outside of the country.

European climate goals are primarily directed through the European Climate Law. Regulations that strengthen and promote Europe's commitment to sustainability work together in a complementary and mutually reinforcing way (European Commission, n.d.).

The most important ones include:

1. Agenda 2030 and SDG's
2. European Green Deal
3. 8th Environment Action Program (Wates, 2019)

Agenda 2030 and SDG's

The terms "Agenda 2030" and "SDGs - Sustainable Development Goals of the United Nations", also called "UN Sustainability Goals", refer to 17 defined goals, which aim to establish a sustainable system. This includes the reduction of global inequalities and damages done to the environment.

"Agenda 2030" has been adopted by all nations throughout the European Union to ensure the end of poverty and hunger, the lasting protection of the planet through sustainable management, cautious use of natural resources, immediate action against climate change, and the construction of peaceful societies.

Nowadays, the core of the "Agenda 2030" consists of 17 global sustainability goals and is based on the "Millennium Development Goals" (MDGs), which were valid until the end of 2015. "Agenda 2030" is specified by 169 sub-targets, each of which is equally relevant for industrialized, developing, and emerging countries, and creates a shared framework for all nations (Wates, 2019).

The European Green Deal & "Fit For 55"

The European Green Deal was introduced by the European Commission in December 2019 and directs its 27 EU member states to achieve climate neutrality by 2050, decouple the European development from depletable resources and ensure equal progress for all regions. It comprises of multiple initiatives such as the European Climate Law, EU Biodiversity for 2030 and European Industrial Strategy, which is supposed to shape a sustainable economy.

To foster climate neutrality, the EU has established legally binding climate targets that cover all key economic sectors. This package features targets for cutting emissions, funding programs to promote CO2 reductions and an updated emissions trading system. Additionally, it provides financial support for individuals and small businesses (Europäische Kommission, n.d.)

The initiative "Fit for 55" is considered the most prominent objective of the European Green Deal. Much of this initiative is directed to update and revise the European legislation. Moreover, it features new approaches and initiatives to align the EU's actions with the goals previously set by the European Council and Parliament. This initiative covers the promotion of sustainable mobility by reducing the use of coal and implementing new standards in the real-estate sector.

Its target consists of decreasing greenhouse gas emissions by 55 % until 2030, compared to 1990 levels. Achieving this goal requires substantial adjustments in multiple sectors throughout economy and society (The Federal Government, n.d.).

The 8th Environment Action Program

The 8th Environment Action Programme, which spans from 2021 to 2030, is a joint commitment by the Commission, Council, and the European Parliament. It is a long-term objective and aims to create a sustainable as well as climate neutral Europe until the year 2050.

The 8th Environment Action Programme follows six primary objectives until 2023:

1. Climate neutrality by 2050
2. Lowering greenhouse gas emissions until 2030 by 55 %
3. Achieving the United Nations' 2030 Agenda and SDGs
4. Accelerating the transition towards circular economy
5. Reducing vulnerability to climate change
6. Decoupling economic growth from resource use

The Commission conducts an annual monitoring and evaluation on the progress of each of the program's six priority objectives (European Commission, n.d.).

Subsidy schemes in Germany

Subsidies play an important role in the development of an environmental landscape. These can support the design of different sectors such as transportation, renewable energy and further push the development of electric vehicles. By offering subsidies, Germany aims to promote sustainable development, reduce greenhouse gas emissions, and encourage technological innovation.

The following abstract focuses exclusively on the major subsidiaries in the electro mobility sector.

Exemption from vehicle tax

In Germany, owners of electric vehicles are eligible for an exemption from the Governmental vehicle tax, known as the Kfz-tax. This initiative is part of a broader initiative by the German Federal Government to encourage the adoption of electric vehicles throughout Germany. Its goal is to reduce greenhouse gas emissions and promote environmental sustainability.

Individuals which purchase and register an electric vehicle by the end of 2025 can apply for a tax concession to be exempted from the German Kfz-tax until the year 2030. Starting on January 1, 2031, the tax will be based on the total weight of the individual vehicle and approximately 50 % lower, compared to vehicles with a traditional combustion engine (The Federal Government, 2020).

Environment Bonus

The German government promoted the purchase or leasing of electric vehicles through a one-time subsidy known as the environmental bonus. This initiative aimed to encourage the shift to low-emission vehicles. It ended on December 17th, 2023. Customers were able to purchase a vehicle at reduced cost due to a contribution of the federal government and the individual manufacturer.

The environmental bonus applied to both new vehicles, whether purchased or leased, as well as to used ones, provided the individual was the registered owner (Federal Ministry for Economic Affairs and Climate Action, n.d.).

PRICING LIST

	Net List Price	Federal Share	Manufacturer Share	Environmental bonus
Vehicle A	>40.000	4.500	2.250	6.750
Vehicle B	<40.000	3.000	1.500	4.500

Table 1: Pricing list environmental bonus

Other tax benefits

Consumers in Germany, which purchase and install a wallbox - a wall-mounted charging station to charge electric vehicles at home – are able to claim a tax deduction of up to 20 % and reclaim approximately 20 % of the costs.

Employees which charge their electric vehicles at a workplace charging station can benefit from tax advantages. If the employer provides charging for free or at a discounted rate, employees are not required to pay taxes. Social security contributions amount to 50 €/month since 2022 (Federal Ministry for Economic Affairs and Climate Action, n.d.).

Oil and its meaning for today's mobility in Germany

Germany's mobility sector has been deeply influenced by oil, especially automotive transportation. As home to one of the world's largest and most advanced automotive markets, the country has developed a significant dependence on oil for both vehicle production and transportation. This dependence carries costs, such as environmental degradation and geopolitical vulnerability (McDougall, 2022).

The shift towards electric vehicles presents new opportunities for diversification, reduces dependence, and lessens environmental impact. Crude oil has been extracted for more than 150 years and until 2021 approximately 44 oil fields across Germany were in production. Currently, crude oil accounts for approximately 32 % of Germany's energy consumption, making it the countries primary energy source (D-EITI, 2023).

Even though Germany is one of the largest consumers of mineral oil, the value of crude oil produced in 2021 accounts only for two million tonnes, representing 2 % of the country's annual consumption and 0.02 % of its national GDP (788 million €). In 2022, Germany's transport sector consumed approximately 110 million tons of oil, predominantly used for road transport (Federal Ministry for Economic Affairs and Climate Action, n.d.).

Due to its high use and, in perspective, relatively small production, Germany depends heavily on imports. In 2023, the country imported 81 million tonnes of oil, which were valued at approximately 35 billion €.

Oil is gathered from more than 30 countries, however 56 % of crude oil was imported by Russia. Other countries included Kazakhstan and the US (D-EITI, 2023).

Oil is used in a variety of different forms, such as diesel gasoline and aviation fuel. Throughout the last couple of years, oil has accounted for 93 % of energy consumption in the transport sector and 60 % of the country's total oil consumption. In 2019, Germany consumed approximately 2.4 million barrels of oil per day, underlining its heavy reliance on fossil fuels for mobility.

Due to the rising use of alternative drive trains, improvement of fuel efficiency in combustion engine vehicles and growing acceptance of mobility shared services, oil demand will peak globally in 2027 (Scott, 2019).

3. E-MOBILITY: A DISRUPTIVE INNOVATION

In recent years traditional engines, powered by fuel such as diesel, have come under increasing criticism. Particularly the Diesel Emission Scandal in 2015, in which the Volkswagen Group had manipulated their emission standards through a special software, created significant pressure on car manufacturers (Hotten, 2015).

Today, many foresee an energy transition in the transportation sector, in which the internal combustion engine is replaced through battery powered vehicles (World Health Organization, n.d.).

The following chapter will examine electromobility as an innovation. It covers major differences between electric vehicles and gasoline-powered cars.

The Concept of Innovation

Information of this chapter is based upon the source of Tidd et al from 2021.

Innovation is a process which consist of a multidisciplinary approach, requiring close cooperation and contact between different departments and stakeholders. Moreover, innovation can occur both incrementally, through step-by-step improvements, and disruptively, through radical changes.

Incremental innovation describes gradual improvements of existing concepts, products, or services. These are implemented in a continuous manner and without significant notice. Disruptive innovation, also called paradigm-shifting, affects the production and management methods. It is far-reaching and covers extensive changes in the techno-economic scenario.

A distinction can be made between four types of innovation, these include:

1. Product Innovation

   Product innovation describes the process of introducing new or enhanced goods as well as services to a specific market. It involves the development of a distinctive design, capabilities and/or features, which sets the innovation apart from competing goods or services.

2. Process Innovation

   Process innovation describes the activity of restructuring an organization's internal process. It is closely connected to the desire of improving efficiency, increase productivity and lower costs.

3. Paradigm Innovation

   In an industry, paradigm innovation is defined as fundamental shift or breakthrough which restructures beliefs or assumptions. It involves the implementation of adjustments and new approaches.

4. Position Innovation

   Redefining a product or service's value proposition, branding, or market positioning in order to obtain a competitive edge or seize new market segments, is known as position innovation. It focuses on offering differentiation through creative price structures, distribution methods, marketing techniques, and customer experiences.

Innovation Management

Innovation management describes the guidance of innovation processes within a company or predefined environment. The term originates from the latin word "innovatio", which stands for renewal, and management, rooting from the latin word manus meaning "hand". Managing something originally implied controlling it with hands.

Innovation Management is considered a crucial part of corporate leadership and defines the art of steering an innovation process and transforming ideas into commercially viable products to penetrate a market. The goal of innovation management is to create value for an organization and, in most cases, become the market leader.

A differentiation is made between two types of innovation. Improvements which arise through opportunities in the market are considered to be "pull", improvements which are made through refinements on the company' side and then released to the market are titled "push". Both terms will be further presented in detail throughout the next chapter.

A successful innovation requires a strategic approach, in result innovation activities need to be planned accurately. These can include the use of an innovation roadmap, which involves defining goals, visions, and strategic directions for innovation.

The process of transforming an idea into a successful innovation includes several key stages. The initial stage focuses on concept development, in which detailed concepts are created from ideas. The second stage includes the design of a business plan. The third stage includes solution development, where solutions are developed and refined. Additional steps include prototyping, to build and test, implementation, in which innovation is introduced to the market, commercialization, where strategies for the launch are put in place, and the final step, in which a product is released into the market.

Managing patents and intellectual property rights is crucial to protect innovations and ensure competitive advantage. Innovation networks and open innovation involve the use of internal and external resources for innovation, these can include the collaboration with other organizations, research institutions, or individuals.

Lastly, change management in the context of innovation projects is necessary to manage organizational changes. When implementing new innovations, it is essential to ensure that these changes are successfully adopted and integrated into the organization (Tidd et al, 2021).

Push and Pull

The concepts of push and pull are crucial to establish a product successfully in the market. Both terms describe different strategies, which influence the innovation process and market demand.

Push

An innovation described as "Push" is driven by research and originates from within an organization. The emphasis is on the supply side and innovation is driven into the market with the expectation to generate its own demand.

Pull Innovation

An innovation described as "Pull" is driven by market demand and consumer needs. First particular problems or needs are identified in the market and then solutions are developed to address them. The demand for innovation "pulls" new products and technologies into the market.

This type of innovation is increasingly responsive to market signals and involves close interaction with customers to understand their needs and preferences.

Balance between push and pull

To successfully innovate, a balance between push and pull strategies is needed. Companies innovation management consists of large investments in research and development to create groundbreaking technologies (push) while also conducting regular analyses to tailor their innovations to market needs and consumer preferences (pull) (Szeliga, 1996).

Electromobility

Electric vehicles appear to be very similar to traditional cars with a combustion engine, however technology and operational characteristics differ. The internal construction of an electric vehicle reveals a different construction concept, power source and use of components.

Though both types of drives use chemical reactions to generate momentum and are powered by an external source, traditional combustion engines rely on depletable resources, such as diesel, which is burned to create mechanical energy. While sustainable fuels are available, they continue produce a minimum of CO2 emissions.

In contrast, an electric vehicle operates on a battery and the electric motor can be powered using renewable electricity, resulting in no CO2 emissions (Nissan USA, 2022).

Composition

The main components of an electric vehicle include the inverter, electric traction motor, charge port, electric powertrain and traction battery pack.

Inverters transform the battery pack's Direct Current (DC) into Alternating Current (AC), which is used to power the electric motor.

Moreover, inverters regulate the frequency of alternative current sent to the engine, which influences the speed of the electric vehicles.

Charging ports enable the electric vehicle, more specifically the battery of the car, to receive energy from an external power source. Charging stations and other equipment for charging is also known as electric vehicle supply equipment (EVSE) (Nissan USA, 2022).

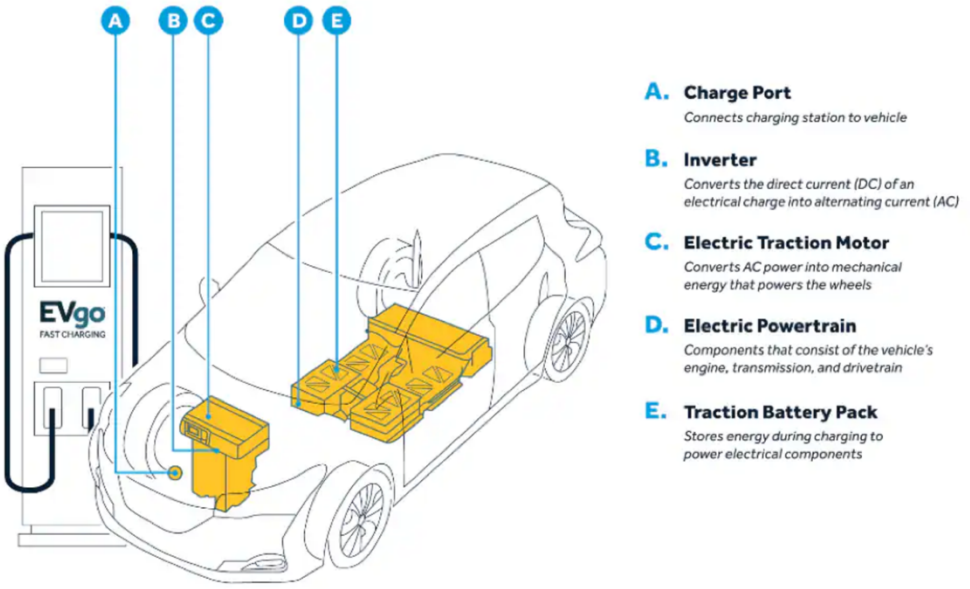

Figure 3: Key Components of an Electric Car

An electric traction motor receives energy through the inverter and creates momentum to move the individual vehicle. When AC electrons travel through the inverter and reach the motor, a rotating magnetic field is generated, causing the motor to spin. Electric motors are highly energy-efficient, with efficiency rates exceeding up to 90 %. In contrast, a traditional internal combustion engine reaches a maximum efficiency of approximately 40 % and is limited to a narrow torque-speed (European Commission, 2024).

The primary role of an electric vehicle's battery pack is to store energy, which can then be used to power the motor and other electrical components. Most electric vehicles utilize lithium-ion batteries due to their high energy density.

Electric vehicles also have a simpler design compared to conventional vehicles, requiring significantly less maintenance, resulting in a much lower operating cost. Their motors can take advantage of regenerative breaking, allowing the battery to recharge through regeneration. It also reduces the wear of brakes and operates with high energy efficiency and low consumption rates (Lovell, 2020).

Range

Battery technology is advancing rapidly due to ongoing research. Nowadays, batteries can withstand thousands of charge and discharge cycles, significantly enhancing their lifespan.

The driving range of electric vehicles has seen a considerable improvement over the past decades. In 2022, 34 % of electric vehicles could travel between 235 and 384 km on a single charge, while 57% had a range exceeding 385 km (European Commission, 2024). The average German vehicle user covered a distance of 39 km in 2017 (Bundesministerium für Verkehr und digitale Infrastruktur, 2018).

Environmental impact

Electric vehicles emit no pollutants during operation and are therefore classified as zero emission vehicles. Promoting climate-friendly policies benefits particularly the industrial, transportation, and energy sectors, since the sale of electric vehicles helps lower the overall CO2 emissions of a company. To evaluate the energy chain and overall energy consumption, manufacturers are conducting a "well-to-wheel" analysis (Linder et al., 2023).

CO2 emissions from battery-powered vehicles primarily are originated from three sources:

1. Electricity used for charging
2. Production
3. Disposal

Electricity used for charging

The CO2 footprint and environmental impact of electric vehicles depend on how the electricity for charging is produced. If electricity is generated from depletable resources, such as gas or coal, CO2 emissions are merely shifted and result in a reduced sustainable value.

If consumers are charging their vehicle at home, solar panels can offer a zero-emission solution or promote low-carbon use (Reichelt, n.d.).

Battery production

The most common batteries used in today's electric vehicles are Lithium-ion batteries. Their wide acceptance throughout the vehicle industry resulted in continues optimization, through which the lithium-ion battery gained quick momentum and achieved significant technological progress. Today lithium batteries are estimated to have a lifespan of approximately eight to ten years, if properly maintained. Especially high temperatures and frequent charging impact battery endurance. Most manufacturers guarantee a mileage between 100,000 and 160,000 km.

The prices of battery cells have decreased by 88 % since the last ten years (Sustainable Energy Authority of Ireland, 2023).

Today, battery production accounts for approximatley 40-50 % of greenhouse gas emissions over the entire life cycle of an electric vehicle. While the manufacturing processes and battery types differ, it is estimated that producing one kWh generates between 40 and 350 kg of CO2 emissions. Due to research and technological advancements, battery-powered vehicles are anticipated to have a significantly lower environmental impact than internal combustion engine vehicles in almost all impact categories by 2050 (Linder et al., 2023).

Lithium-ion batteries are renowned for their high performance, lifespan, energy density and low cost. Vital resources in the production of batteries are lithium, silicon and cobalt. About half of the world's lithium extraction is used for electric vehicle batteries, with 80 % of global lithium production occurring in Chile and Australia (Essential Minerals Association, n.d.).

Cobalt is mainly sourced from Congo, which contributes nearly two-thirds of the global supply. The extraction of these raw materials in South America and Africa often occurs under inhumane conditions, coupled with significant environmental destruction in these regions (Responsible Institute, n.d.).

Disposal

The rising demand for electric vehicles leads to an increased need of raw metals. Proper disposal will become crucial for sustainability, as raw metals can be recycled. Conversely, fossil fuels cannot be reused after combustion.

Nickel and cobalt can be recycled with a recovery rate of over 90 %. The EU Battery Regulation requires a minimum recycling rate of 95 % for nickel and cobalt, 80 % for lithium, and 70 % for lithium-ion and lithium batteries by 2031 (Deutsche Umwelthilfe e.V., 2023).

Evaluating the environmental impact of both types of drives can be challenging and varies depending on the calculation methods used. While electric drives produce no emissions, the extraction of raw materials from developing countries can jeopardize human rights and force indigenous populations to relocate. Furthermore, it is to question how each material is obtained and if the environment is damaged throughout this process.

The EU Supply Chain Act50 and EU Batter Regulation are put into place to create transparency and push operating companies to sustainable practices and take responsibility for human rights (Responsible Institute, n.d.).

Charging Stations

This chapter outlines the current status and discloses the types of available charging stations in Germany. A distinction is made between two types of charging stations: public and private.

Public charging represents a crucial component because it addresses the limited range of electric vehicles, enabling drivers to recharge their batteries while being away from home.

Private charging stations play a key role in the widespread adoption of electric cars, since most consumers prefer to charge their vehicles at home, allowing for a greater convenience factor. In fact, 42 % of global respondents are unwilling to consider electric vehicles purchase until the amount of chargers equals the amount of gas station (McKinsey&Company).

Vehicle manufacturers operate globally, necessitating a standardized infrastructure for EV charging. The International Electrotechnical Commission (IEC) oversees the various charging modes and vehicle connector types, as specified in the IEC 62196-1 standard. A distinction is made between four different types of charging modes (Electrical Installation Wiki, n.d.).

Mode 1 – Standard outlet socket

Charging mode one involves using a household outlet, which is commonly secured by a residual current device (RCD). The charger is connected between an ordinary power socket and the individual vehicle. In mode one, no communication link between the charging infrastructure and vehicle exists. Since no charge control or protection in place, this type of charging mode is considered illegal in many countries. The power from an ordinary outlet is limited. Consumers are faced with high charging durations (Energuide.be, n.d.).

Mode 2 – Standard outlet socket and monitoring device

In charging mode two, consumers charge their vehicle at a household socket using a standardized in-cable Control Box (ICCB) cable. It includes protection and control features. The charger is connected to the car and ensures a secure connection, avoiding the risk of overloading and overheating. Charging times account for an average of 8 h (MobilityPlus, n.d.).

Mode 3 – Charging station and wall box

Charging mode three utilizes a home-mounted wall box or a public charging station. In both cases, electric vehicles are supplied with alternating current (AC) through a dedicated electricity circuit. In some cases, the cable is provided though the charging station or wall box, eliminating the need for other electrical equipment.

Mode three charging enables smart charging, through which the charging power is adapted. This ensures a charging process coordinated to the needs of the individual vehicle. It allows for a much higher power supply than mode one and two. Charging times in this mode account between 0,8 and 4,6 h/100 km.

Investment costs for these types of chargers are high (MobilityPlus, n.d.).

Mode 4 – Ultra fast charging

Mode four, commonly known as direct current (DC) or fast charging, is located in public locations. These chargers are supplied with high voltage, enabling them to charge 100 km in up to 4,5 min. The charging station integrates a protection device and charging cable, which eliminates the need for other electrical equipment.

Investment costs for these types of chargers are very high (MobilityPlus, n.d.).

Cost of charging in Germany

Today, five providers dominate the German charging-station-market:

1. EnBW mobility + AG und Co.Kg
2. E.On Drive GmbH
3. Tesla Germany GmbH
4. Mercedes Benz AG
5. EWE Go GmbH (Bundesnetzargentur, 2024).

Each provider differs in their offering, including varying basic charge, minimum charging prices, AC and AD charging rates, blocking fees and payment methods. Moreover, some providers offer lower rates for consumers driving a specific vehicle manufacturer or have home electricity supplied by the same provider.

The access on the charging terminals is done through an app or card, electricity is charged either on a monthly basis or directly via card (GoingElectric, n.d.).

According to the European Commission, the average price for AC charging in Germany is 0.58 €/kWh, while public DC charging costs 0.72 €/kWh. Private charging comes with a reduced price, averaging 0.32 €/kWh. The average price for charging can decrease up to 0,51 €/kWh for AC and 0,61 €/kWh for DC charging, depending on the location in Germany.

Home charging is the most cost-effective option. In Europe, over 70 % of EV charging is conducted either at home or at the workplace (European Commission, 2024).

In Germany, the Volkswagen ID.3 Pro S and Tesla Model 3 are among the most popular electric vehicle models.

On average, charging the Volkswagen ID.3 Pro S from 10 to 80 percent at a DC charging station costs 31,8 €, providing a range of 315 kilometers. In the same scenario, charging the Tesla Model 3 costs an average of 3.75 € and provides a range of 266 km (European Commission, 2024,f).

In 2017, the average German traveled 39 km/day (Bundesministerium für Verkehr und digitale Infrastruktur, 2018), amounting to roughly 1,170 km/month (European Commission, 2024). Consequently, the monthly charging cost for the ID.3 Pro S would be approximately 118 €, while for the Tesla Model 3 it would be around 104 €.

4. GERMANY'S E-MOBILITY SECTOR

Economy

Germany's car market has expanded over the past few years and is facing significant change due to rising pressure, demand and intensive research. As of January 2024, nearly 49 million vehicles were registered in Germany, which represents an increase of approximately 350 thousand vehicles to the previous year. According to the Statistisches Bundesamt, the market reached a record high in 2022, with a car density of 585 vehicles per 1,000 inhabitants, exceeding the EU average. As shown in Figure five, Italy leads with the highest car density, having approximately 684 vehicles per 1,000 inhabitants. France has the lowest car density, with a rate of 565 vehicles per 1,000 inhabitants.

No further data available for 2023 and 2024 (Statistisches Bundesamt, 2023).

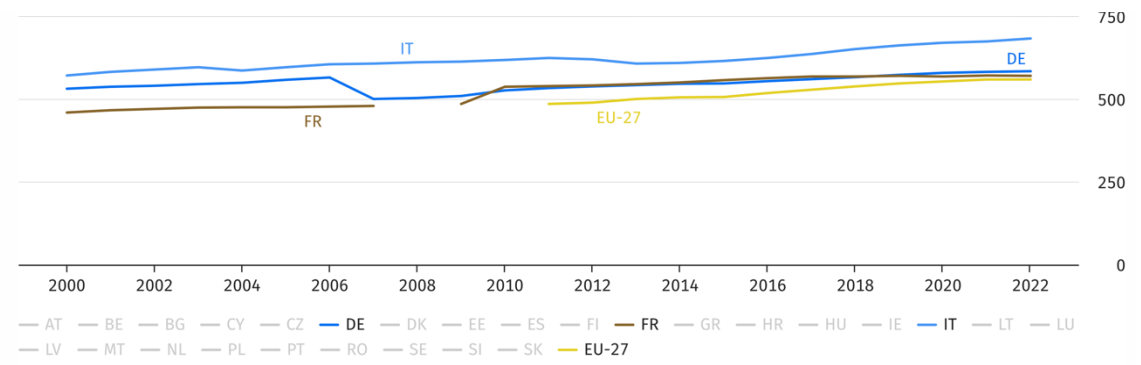

Figure 4: Vehicle density per 1,000 inhabitants

The registration of electric vehicles rose from under 2 % in 2019 to 18 % in 2022. By 2025, about 30 million new electric vehicles are anticipated to be registered annually, with this figure expected to increase to around 54 million by 2030 (Statistisches Bundesamt, 2023).

Society

While many studies suggest that electric vehicles are becoming a product for the masses, the German society is still sceptical. According to DAT (Deutsche Automobil Treuhand Research centre, 39 % of people would be open to purchase an electric vehicle. Approximately one in twenty of these individuals is expected to buy a vehicle within the next year, while about one in twenty would consider making a purchase within the next five years.

Notably, 34 % of respondents indicated they would not buy an electric vehicle at this time.

According to DAT, 55 % of respondents cited that subsidies are the main factor influencing their decision to purchase an electric car, ranking it significantly higher in importance than environmental concerns (38 %) or the interest in trying new technology (35 %) (Kędzierski, 2024).

Political situation

The German government announced significant changes to its environmental bonus. According to publications, the purchase incentives for electric vehicles were expected to be reduced in 2024 and intended to remain in effect until the end of 2025. On 16 December 2023, German government published an announcement resulting in the end of the program. This was based upon a ruling of the Federal Constitutional Court, which prohibited Germany from accessing further climate transformation funds to subsidize electro mobility. The funds accounted for approximately 60 billion €.

Between 2016 and 2023, approximately 90 % of all electric vehicles in Germany were subsidized, amounting to a total of around 10 billion €. During these seven years, 2.2 million vehicles were purchased, providing a significant boost to the electric mobility market in Germany.

However, the discontinuation of the subsidy program is expected to jeopardize the target of achieving 15 million electric vehicles by the end of the decade. It is questioned, how the missing incentives for consumers will influence the purchase behaviour. (Kędzierski, 2024).

Lastly, Germany enhanced its emission regulations, like the Euro 6 standard, to cut down pollutants from internal combustion engines. By imposing stricter limits on nitrogen oxides and particulate emissions, the Germany is pushing automotive manufacturers to innovate and implement cleaner, more advanced technologies (Tuev-nord, 2024).

Charging Stations

In general, a distinction is made between charging points, charging facilities, and charging locations.

A charging location is a place where a person can charge an electric vehicle. At each charging station, there are individual cables and sockets, known as charging points. Each charging point can only serve one electric vehicle at a time, a charging station can have multiple charging points.

A charging station is essentially the electric vehicle equivalent of a traditional gas station. Instead of fuel pumps, it typically features multiple fixed charging cables, to which where electric vehicles can be connected (Elektromobilität: Öffentliche Ladeinfrastruktur, 2024).

According to the Bundesnetzagentur, as of November 2023, Germany had a total of 61,915 public charging stations. This marks an increase of approximately 42 % from November 2022, when there were 43,567 public charging stations.

In 2023, the number of standard charging points reached 93,261, reflecting a nearly 36 % rise compared to 2022. Fast-charging stations experienced a 61 % increase, totaling 22,047 in 2023.

Charging stations are managed by around 7,900 providers, with 30 % being operated by the top five companies.

As mentioned before, these leading companies are: EnBW Mobility + AG und Co. KG, E.ON Drive GmbH, Tesla Germany GmbH, Mercedes-Benz AG, and EWE Go GmbH (Elektromobilität: Öffentliche Ladeinfrastruktur, 2024).

In Germany, the Federal Association of Energy and Water Management estimates that 70,000 charging stations will be necessary by 2020 to provide adequate infrastructure if the goal of one million electric vehicles is achieved.

Given that many people are expected to prefer charging their electric vehicles at home overnight, expanding private charging stations, commonly referred to as "Wallboxes," will be a crucial element (Now-Annual Report 2020, 2020).

5. STAKEHOLDERS PERSPECTIVES ON E-MOBILITY

In order to evaluate the obstacles, which arise in the acceptance of electric vehicles throughout Germany, multiple interviews have been conducted.

Since this thesis is taking on a holistic approach, the following interviewees have been chosen from different departments. These departments included a vehicle manufacturer, service-centre, consumer, disposal company and the German government.

During the interview no other participants were present. Every participant was asked the same set of questions, the outcome of the topic are categorized and depicted in the following:

1. Key Opportunities of electric vehicles
2. Goals and Milestones of electro mobility in Germany
3. Driving factors of electro mobility
4. Barriers of electro mobility
5. Approach to manage change

Multiple interviewees asked their names to be disclosed.

Interviewee one, Polestar sales, 13.06.2024, Germany

Key Opportunities of electric vehicles
Interviewee one highlights several opportunities for electric vehicles. One major advantage is the significantly lower refuelling and operational cost. The COVID-19 crisis and political conflicts worldwide have led to an increase in oil prices. Gas prices increased by almost 50 %, impacting consumers which are driving traditional combustion engine vehicles. Gas prices are supposed to increase even further in the upcoming years.

Electric vehicles are built with fewer moving parts and reduced complexity, which means they require fewer spare parts. As a result, electric cars break down much less frequently, leading to lower operational costs.

Additionally, vehicles with an electro motor offer environmental benefits, such as a decrease in reliance of fossil fuels. This can result in political stability, since Germany is less dependent on other countries.

Goals and Milestones of electro mobility in Germany

The interviewee states that the ultimate goal of electro mobility can be defined as the electrification of all vehicles in Germany, resulting in a zero-emission mobility. However, technology and infrastructure does not provide the possibility for this change yet.

He states a strong political position towards electro mobility as an essential milestone. If politicians put in place enough financial incentives and policies, consumers will be open for change and companies increase their investment in this market segment.

Lastly, the interviewee identified 30 million electric vehicles on German roads as an essential turning point.

Driving factors of electro mobility

According to the interviewee, the main driving factor of electro mobility is climate change and it's possible future impact.

The interviewee states that international competition creates a strong drive for the development and imporvement of technology in the e-mobility sector. To accelerate developments in the electric mobility market, the Federal Government adopted a package of measures in 2016, which included nearly a billion € in investment.

Furthermore, electric vehicles provide a wide variety of refueling options. The numerous and diverse ecosystems for recharging offer a service tailored to the need of the individual consumer.

Investments for uniform charging standards and privileges for electric car owners, such as special parking arrangements, create another driving factor for electro mobility.

Barriers of electro mobility
The interviewee identifies the range of electric vehicles as a significant barrier. Even though many consumers do not plan to drive long distances with their electric vehicles, the potential limitations imposed by battery capacity present a major obstacle. Additionally, waiting times at charging stations and a confusing charging infrastructure contribute to considerable uncertainty for individual consumers. The German society can be described as rather conservative regarding change, leaving less opportunities to implement new processes and technologies in the market. Moreover, consumers are faced with an uncertain retail market and endurance of the batteries. While traditional combustion engines feature a generalized standard, batteries are only at the beginning of their development/innovation process. Consumers question, if their cars will be outdated in a number of years. The interviewee mentioned the high upfront cost. Most of the consumers are interested in an electric car in combination with a wall box. Missing subsidies, such as the environmental bonus, result in high investments. Lastly, the interviwee mentioned politics is leaving core responsibilities up to the market. The expansion of the charging infrastructure should be directed increasingly through policies and incentives. EVs offer a broader range of refueling options, creating a more competitive and diverse pricing ecosystem for recharging. This also makes the consumer experience more complex.
Approach to manage change
According to the interviewee, change can only be created through politics. Costs of electric vehilces need to be reduced and incentives to purchase a zero-emission vehilces need to be given. The interviewee states the importance of collaborations and communication in the market as an essential factor. If a greater number of vehicle manufacturers and policymakers work closely together, it can create more opportunities and significantly expand the market.

Interview two, HansaRepair GmbH, 1.06.2024, Germany

Key Opportunities of electric vehicles
The interviewee perceives the low operational costs of electric vehicles as a major opportunity for consumers and companies. This includes the low recharging and maintenance costs. According to the interviewee, gas prices are at an all-time-high and the increasing expense of maintaining traditional combustion engine vehicles creates a strong purchase incentive for consumers. Moreover the convenience of charging electric vehicles at home, was identified as another key opportunity for the e-mobility market. The interviewee notes that many vehicles are primarily used within city environments, where their range far exceeds the daily distance typically driven. In result, many consumers do not have to worry about finding charging stations in the city or deal with waiting times, which some view as a downside. Finally, the interviewee highlights the environmental benefit. Since electric cars emit only a fraction of CO2 throughout their life cycle, when compared to vehicles with a traditional combustion engine, cities are becoming greener, quieter and more sustainable. Resulting in several advantages for consumer and the environment. While consumers must consider multiple factors when choosing a station to charge their vehicle, which can be perceived as a potential downside, it also offers the possiblity for the user to find an offering perfectly tailored to their needs.
Goals and Milestones of electro mobility in Germany
The interviewee asserts zero-emission mobility across Germany as the goal of electro mobility. The initial step towards a fully electric ecosystem might be the electrification of society. However, under current conditions, achieving this goal is still far off, and substantial infrastructural development is needed. Additionally, the interviewee states that having an adequate number of charging stations is a critical milestone and recommends one public charging station for approximately every 100 electric vehicle users.

Lastly, the range of electric vehicles is perceived as a critical obstacle. A key milestone for electromobility is for manufacturers to offer vehicles that can travel at least 400 km on a single charge.

Driving factors of electro mobility

Three actors in the development of change have been presented throughout the interview:

- Consumers
- State/Politics
- Economy/Companies

According to the interviewee, a significant boost for electromobility is driven by the interaction between individual companies and consumers purchasing their products. Regional politics has only a small effect in the development of electric mobility throughout Germany. However, their role cannot be entirely overlooked, as government policies and incentives can still impact the adoption rate. The interviewee emphasizes that a significant progress in the market requires stronger collaboration between multiple actors, with more proactive support and regulation from state and local government.

Finally, the interviewee mentions that electric vehicles help reduce noise pollution and points out that around 100 million people worldwide are exposed to dangerous noise levels. In an increasingly hectic and noisy world, reduced noise pollution can be recognized as another key driving factor.

Barriers of electro mobility

The interviewee identifies the limited range of electric vehicles as a major barrier, compounded by a confusing charging infrastructure and consumer fears about the availability of charging stations when needed. The interviewed person also believes that most barriers exist on the consumer side and describes German society as skeptical toward new innovations.

Germany is already well positioned and offers many more opportunites for an electric change. Nonetheless, many consumers are not willing to deal with the topic of electric

mobility, perceive cars with a combustion engine as an easier alternative and doubt whether a change is truly necessary.

Furthermore, the switch to electric vehicles is often associated with fears regarding the safety of the new battery technology, according to the interviewee.

Lastly, companies offer only a limited selection of electric vehicles to consumers. Since many buyers prefer to purchase vehicles based on their prior experiences, they tend to remain loyal to one brand or one type of vehicle. However, the current market offers a narrow range of options with little variation.

Approach to manage change

The interviewee states politics as the driving factor of electro mobility. Government need to put incentives in place to reduce the upfront costs, to make electric vehilces more appealing for consumers. Additionally, only politics is able to push the development of technology. Companies need to be convinced to invest in infrastructural development and research. The German government should allow for incentives for vehcile manufacturers to compromise the risk taken by investing in this development.

During the interview, higher barriers for traditional cars with combustion engines are presented as a solution to push towards sustainable change. This can include a rise in CO2 tax or higher gasoline prices.

Lastly, the interviewee states that the German government should increasingly establish cooperations and partnerships to push the electric development. The interviewed person also stated that communication and cooperation is an essential building block to manage change.

Interview three, Philip Gebhardt, EV Customer, 30.07.2024, Germany

Key Opportunities of electric vehicles
Philip Gebhardt has already leased multiple electric vehicles throughout the last couple of years. He is convinced that e-mobility is the future and that a replacement of the traditional combustion engines is necessary to create a sustainable ecosystem. The interviewee identifies the manufacturing quality of electric vehicles as a key opportunity. He perceives that even the lower cost models are already of higher quality, than vehicles in the same price range with a combustion engine. Modern and aesthetical outer design and interior create a more harmonious and prestigious feeling. Philip highlights the lower operational costs, such as the absence of oil changes, minimal wear, reduced brake replacements, and exemption from certain taxes, as a significant advantage. Another upside for the interviewee was the environmental aspect. By driving an electric vehicle, Philip has the opportunity to reduce his environmental footprint and doing something good for the environment.
Goals and Milestones of electro mobility in Germany
The interviewee asserts faster charging times as essential and closely tied to a widespread adoption of electro mobility throughout Germany. According to him, acceptance throughout Germany will increase, if the use of electric vehilces can be perceived, also during long distant-travel, as a convinience factor. Additionally, he perceives a higher average range of electric vehicles as essential and an improvement in the battery technology a major stumbling block to the success of electric vehicles. Philip also emphasizes the importance of improving the sustainable performance of electric vehicles. Although electric cars are already more environmentally friendly in their operation, he perceives the improvement of recycling batteries and parts thereof as a major milestone.

The interviewee is also criticising how companies and the government are greenwashing consumers by selling a green alternative, though cobalt and other depletable resources are gathered from third world countries in inhumane conditions. According to him, a milestone in the process of electro mobility should be educating todays's society about the damaging consequences of electric vehilces, and then finding better alternatives.

Driving factors of electro mobility

Philip Gebhardt identifies three driving factors of electro mobility in Germany:

- Environmental crisis
- Company profit
- Societal Pressure

The interviewee states that a major push of electro mobility is created through the environmental crisis and politics.

Companies as well as govermental policies create a push and drive the vehicle market to sustainable solutions. Both pressure the German consumers in taking part in the sustainability journey.

Barriers of electro mobility

The interviewee highlights the restricted range of electric vehicles and the unsustainable extraction of finite resources for batteries as key challenges to the progress of electromobility.

Philip also points out that range anxiety heavily impacts car purchasing decisions. He believes that comfort is a vital factor when choosing a car, and a limited range detracts from the convenience and pleasure of using these vehicles.

Lastly, the interviewee states that the high price point of electric vehicles are a major barrier. Philip is leasing his vehicles through a company, however not everyone can be this fortunate. According to him, the high price point lowers the opportunity for the e-mobility market.

Lastly, the interviewee mentions that older vehilces are oftentimes cheaper. Even with a decreased price point of incentives by the government, individuals with the need to buy a new car are not able to. As a result, cars with high CO2 output stay on the streets.

Approach to manage change

The interviewee states that an increasing amount of funding should be directed towards research of new technology. German politics play a crucial role in development, and institutions should receive additional support to gain an edge and advance battery technology.

Interview four, Disposal Company, 01.08.2024, Germany

Key Opportunities of electric vehicles

The interviewee states that electric vehicles need much less maintenance and are cheaper in operation, through the use of much less components.

Furthermore, electric motors are highly energy-efficient, with efficiency rates exceeding 90 percent. In contrast, traditional internal combustion engines achieve a maximum efficiency of only 40 percent and operate within a narrow torque-speed range. The high efficient rates positive envrionmal impact of electric vehicles can be seen as a key opportunity for the market.

Goals and Milestones of electro mobility in Germany

The interviewee asserts that zero-emission mobility is the ultimate objective of electromobility. However, under current conditions, achieving this goal is still far off, and significant infrastructural development is necessary. Given that the infrastructure and technology aren't fully in place yet, the interviewee suggests that reaching 80 percent adoption of electric vehicles among German consumers would be a significant milestone.

Most electric vehicles utilize lithium-ion batteries due to their high energy density. While these types of batteries are very effective, recycling is very costly. According to the interviewee, Germany needs to increase their research technology in the area of battery

technology, to recycle these types of batteries in a cost-efficient way. The interviewed individual perceived this as an essential milestone to increase the acceptance of electro mobility throughout Germany.

Driving factors of electro mobility

According to the interviewee, a driving factor of electro mobility are political policies and incentives set by the European Union. Both influence the consumer behavior and direct the purchasing decisions towards electric vehilces.

Another facor mentioned during the interview was the environment. The interviewee noted that German consumers are highly aware of climate change, and many are willing to alter their consumption habits. Sustainable practices, like using electric vehicles, create momentum and can be seen as a driving force.

Barriers of electro mobility

According to the interviewee, many parts used in electric vehicles cannot be recycled. Moreover, the "re-use" of vehilce parts is heavily reduced compared to cars with a traditional combustion engine, since much technology of modern cars is integrated and glued to the body of the vehicle.

Some vehicle parts of old timers were very robust and according to the interviewee almost indestructable. Today, componends are not build to last anymore. Instead cheap production allows for a low price point and low-cost replacements. a

A key issue highlighted by the interviewee is the battery recycling process. Although a significant portion of a battery pack can be recycled, the process is costly. While major manufacturers claim up to 90 % recyclability, it's important to note that this is oftentimes not profitable for companies.

Approach to manage change

The interviewee suggests that more research is needed to enhance the durability and longevity of vehicle parts. This includes technology integrated in the vehicle, such as screens or switches, but also the battery-pack.

Two options were presented during the interview.

Developing a sustainable battery that is largely recyclable or investing more in the recycling process and research is essential. According to the interviewee, technology is advancing, and methods to recycle significant portions of batteries already exist. However, the innovation process is too slow, particularly given the current number of vehicles on German roads.

Interview five, Bundesamt for Ecomomics, 25.05.2024, Germany

Key Opportunities of electric vehicles

The interviewe highlights the low carbon emission as a major opportunity of electric vehicles, allowing for greener cities. Electric vehicles are quieter than regular cars with a combustion engine, resulting in less noise pollution. The release of new vehicles on the market generates incentives for consumers to buy, thereby boosting the economy. The interviewed individual mentioned financial incentives such as rebates, leasing options, and trade-in programs for those transitioning from internal combustion engine vehicles to electric ones. These efforts, coupled with greater investments in technology and infrastructure, bring additional funds into the economy. A push in the economy results in new job opportunities and a possible attraction of further investments from abroad.

The interviewee also identifies significantly lower refuelling cost and an independence of oil prices as a major change for the consumer and economy. While upfront costs are high, low operational costs pay off in the long term. Environmental benefits of the government allow for additional savings.

Lastly, electric vehicles reduce dependence on fossil fuels, which can lead to greater political stability and increase Germany's energy independence.

Goals and Milestones of electro mobility in Germany

The interviewee mentions that the ultimate goal is to electrify all vehicles in Germany, aiming for a zero-emission mobility solution. To achieve this, several milestones must be

reached, including the expansion of charging stations, particularly in non-urban areas. Consumers should have the ability to charge their vehicles whenever needed, without worrying about the availability of charging stations.

Another milestone identified throughout the interview are the 30 million electric vehicles, planned until 2030 across Germany.

Other milestones mentioned in the interview include:

- Increased number of production capacities for battery cells
- Improved recylcing facilities for battery cells
- Urban traffic without fossil fuels until 2050
- Decrease Political dependance

Driving factors of electro mobility

The interviewee asserts that a key driver of this development is the German government and its incentives, which guide the implementation and investment in electric mobility across Germany. This effort is closely linked to climate change and its potential future impacts. Additionally, since German society is aware of the future effects of climate change, it is seen as a secondary stakeholder pushing for nationwide electrification.

Barriers of electro mobility

The interviewee identifies the higher purchase price of electric vehicles as a significant barrier. This elevated cost is largely due to the high price of the battery. Many consumers are not familiar with the available government incentives, which further exacerbates the issue.

Additionally, the limited range of electric vehicles, due to ongoing improvements in battery technology, poses another challenge. While this may not affect consumers with garages or private parking spaces, it is a notable issue in urban environments where overnight charging is not possible.

Improving the charging infrastructure, in urban and sub.-urban environment comes with a high investments. This concers companies, but also individuals trying to install a home-box at their own home.

The interviewee also mentiones the residual value of electric cars. Rapid advancements in battery technology create uncertainty among consumers about whether it's the right time to invest in electric vehicles. Although many are already inclined to buy their first electric car, they hesitate to make the purchase due to concerns about potential risks.

Approach to manage change

The interviewee asserts that electric vehicles need to become even more affordable and uncertainties for the individual consumer needs to be reduced. This involves establishing guarantees, such as for the battery, ensuring transparency, and providing a clear development plan.

Consumers will only be willing to invest if clear political goals and milestones are set and communicated. Increased cooperation between policymakers and companies is essential to align development efforts and drive progress in the same direction.

The interviewee also notes that a key factor in determining whether electromobility will be the future solution is not just finding solutions for barriers but developing strategies to mitigate their impact. Many of these barriers are a result of the market's stage and will be resolved over time. It is crucial for policymakers and companies to find solutions now to lessen these barriers for consumers.

Main conclusions of expert interviews

The following section outlines the main results from the interviews conducted. It provides insights into the role of government incentives in promoting electromobility and highlights significant barriers such as high vehicle costs and limited charging infrastructure. This section aims to present a comprehensive overview of these factors and their implications for the future of electric vehicle adoption.

Key Opportunities of electric vehicles
The five interviewed individuals conclude the following opportunities. A major advantage of electric vehicles is their low operational costs. With fewer moving parts, maintenance requirements are reduced. The use of electricity minimizes CO2 emissions, offering environmental benefits and reducing dependence on oil prices. High efficiency rates and regenerative braking optimize resource use, and the ability to charge vehicles at home adds significant convenience. Additionally, lower-cost electric models often surpass their combustion engine counterparts in quality, while their modern, aesthetic design enhances both their exterior appeal and interior comfort.
Goals and Milestones of electro mobility in Germany
The interviewees identified the following milestones A critical milestone is the adoption of only carbon-neutral vehicles in urban areas by 2050, with the goal of achieving a zero-emission environment thereafter. Establishing a robust political position is also essential. One interviewee proposed targets of 30 million electric vehicles by 2030 and a public charging station for roughly every 100 electric vehicle users.

Another important milestone would be for manufacturers to offer vehicles with a minimum range of 400 km per charge.

Additionally, a significant advance in electromobility would be achieving cost-effective, full recycling of batteries.

Driving factors of electro mobility

Climate change and its potential future effects are the main driving forces behind electromobility.

Additionally, international competition plays a significant role in advancing the field. In 2016, the Federal Government launched a package of measures that included an investment of nearly a billion euros.

Ongoing government policies and incentives remain pivotal in influencing the rate of electric vehicle adoption. The German government's strategies are vital in directing and supporting investment and implementation efforts in electric mobility across Germany.

Barriers of electro mobility

The interviewee highlights the range of electric vehicles as a significant barrier, also noting that range anxiety, long waiting times at charging stations, and a confusing charging infrastructure create considerable uncertainty for consumers. German society is described as relatively conservative about change, which limits opportunities for introducing new processes and technologies.

The interviewee also mentioned the high upfront cost of electric vehicles, with many consumers showing interest in pairing them with a wall box.

Additionally, politics is seen as leaving core responsibilities to the market, and companies currently offer a limited range of electric vehicles.

The "re-use" of vehicle parts is significantly reduced compared to traditional combustion engine cars, as much of the technology in modern vehicles is integrated and glued to the vehicle body. Although major manufacturers claim up to 90 % recyclability, this is often not economically viable for companies.

Approach to manage change
The interviewees emphasize the need to lower the costs and provide incentives for purchasing zero-emission vehicles. Moreover collaboration and communication in the market is essential, suggesting that the German government should foster more partnerships, including with other countries and through trade agreements. Developing a sustainable, largely recyclable battery-packs or investing further in the recycling process and research is deemed essential. Additionally, the interviewee considers reducing consumer uncertainties to be essential and the increase of a vehicle tax as a great incentive to push the market towards electric vehilces.

6. OBSTACLES TO THE ADOPTION OF E-MOBILITY

The following goal of electro mobility was assessed.

Interview Five states that the primary goal of electromobility is to reduce dependence on fossil fuels, improve air quality, and eliminate CO2 emissions by creating a sustainable transportation system. Achieving this goal involves the gradual replacement of traditional combustion engines with electric vehicles over time.

The previous chapters stated clearly that the obstacles have not been overcome yet. This chapter outlines the evaluated obstacles of electro mobility which hinder today`s market penetration. Multiple obstacles have been identified through interviews with different stakeholders (as presented in the previous sections), conducted using a qualitative model, and data of reliable sources.

In particular, six obstacles were identified, these include charging infrastructure, range, cost of purchase, uncertain residual value, scepticism of today's society and weak political engagement.

Charging infrastructure

The interviews indicate that a robust charging infrastructure is considered essential for the widespread adoption of electric cars. A resilient charging infrastructure must be available in both urban and suburban areas. Expanding the network of charging stations in the sub-urban area is even more decisive, since consumers cover more kilometres and are faced with an increased range anxiety. In both urban and suburban areas, the number of electric charging stations must exceed a specific threshold to prevent any usage limitations for consumers.

Interviewee two from HansaRepair GmbH, perceives one charging station for approximately every 100 electric vehicle users as a critical milestone.

While today's infrastructure is well-established, a bottleneck remains in the rapid expansion of public charging stations. As of November 2023, Germany had 61,915 public charging stations, according to the Bundesnetzagentur. This represents a 42 % increase from November 2022, when the number of public charging stations was 43,567. In 2023, the number of standard charging points reached 93,261, reflecting a nearly 36 % rise compared to 2022. Despite significant investments and improvements in charging networks, there are still areas, particularly in rural and suburban regions, where charging stations are rare or non-existent.

The lack of a well-developed and reliable charging infrastructure intensifies range anxiety, with drivers worrying about whether they will find a charging station when needed. In urban areas, where charging stations are more available, fast-charging options are still often scarce, and the time required for a complete charge can be much longer than the time it takes to refuel a gasoline vehicle.

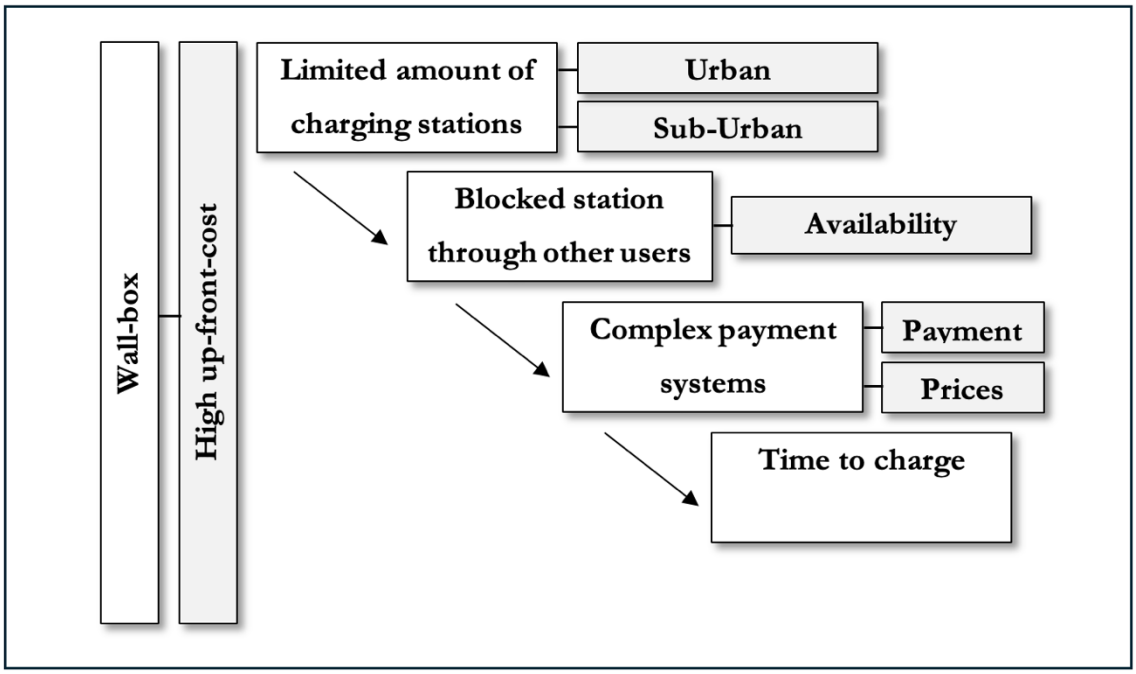

Figure 5: Barriers of Charging

Another crucial aspect of charging stations is their availability. The number of charging ports and their utilization directly affect the convenience of charging. Consumers may incur a fee if a charging station remains occupied after their vehicle has finished charging. Often, it is difficult to determine if a charging station is blocked, and users may face delays if they need to wait for another vehicle to finish charging.

A third factor affecting consumer convenience is the inconsistency in payment systems. While this may not be a major barrier to the electric mobility market, it can be perceived as an inconvenience. As discussed in previous chapters, payment methods and pricing for recharging can vary widely, leading to a more competitive and diverse pricing landscape. However, this also complicates the consumer experience and presents challenges, particularly for older customers.

Finally, the time required to charge electric vehicles can be viewed as a significant barrier to the e-mobility market. As discussed in previous chapters, charging a vehicle from 10 to 80 % typically takes about 30-40 min. Consumers planning longer trips may be reluctant to accept these extended waiting periods. Although fast-charging stations saw a 61 % increase, reaching a total of 22,047 in 2023, this remains a notable obstacle.

Range

The range of electric vehicles is a significant challenge, often referred to by interviewees as "range anxiety." Although there have been substantial advancements in driving range over the past decade, in 2022 only 34 % of electric vehicles could travel between 235 and 384 km on a single charge, and just 57 % had a range exceeding 385 km (European Commission, 2024). By comparison, the average German driver covered 39 km daily, totalling approximately 1170 km per month in 2017 (Bundesministerium für Verkehr und digitale Infrastruktur, 2018). Interviewee five highlighted that a crucial milestone would be for manufacturers to offer vehicles with a minimum range of 400 km per charge.

Currently, this limitation is particularly challenging for consumers in suburban areas, who often drive longer distances in a single trip, increasing the risk of running out of battery. Additionally, individuals accustomed to traditional combustion engines may view electric vehicles as inadequate for their needs and are reluctant to sacrifice their accustomed level of comfort.

Cost of Purchase

Interviewees identified the high upfront cost as a significant barrier. This elevated price is primarily due to the cost of battery cells and technology, which has not yet advanced to the same level as traditional combustion engines. Although interviewees anticipate that prices will decrease in the coming decades as battery technology improves, this cost remains a considerable barrier in the present.

The government has implemented several incentives, such as the environmental bonus, to lower the cost of electric vehicles. Despite these efforts, electric cars remain considerably more expensive. Additionally, Interviewee Five notes that many consumers are not well-informed about the available government incentives, which compounds the problem.

Interview Three indicates that older generations of cars are the least efficient in terms of CO2 emissions, yet they often come with the lowest price tags. Despite government incentives reducing the price of newer models, individuals who need to buy a new car may still be unable to afford them. As a result, high CO2-emission vehicles continue to remain in use.

Uncertain residual value

Uncertain residual value describes the value of a vehicle after a certain period of ownership or the end of a lease. This obstacle arises when consumers are planning to sell their electric vehicle. It is the result of the factors presented in the following paragraphs.

Battery cells installed in electric vehicles are creating the major expense. As the battery is one of the most expensive components of an electric vehicle, any potential degradation can significantly impact the vehicle's resale value. While many vehicle manufacturers offer warranties on cars battery cells up to ten years, many consumers are sceptical about the degradation over time. Continuous charging and regular use may result in a decreased efficiency of a battery cell, lowering the residual value.

Another factor considered by consumers is the swift advancement in battery technology, which has led to a noticeable increase in the range of electric vehicles, as discussed in previous chapters. As consumers seek to travel greater distances on a single charge and as investments in battery research grow, older models quickly become outdated. Since range is seen as an essential value of an electric car, it's value may decrease drastically, when new models with higher range come on to the market.

This is closely connected to the lack of historical data. It is to question how electric cars will establish in today's vehicle market and how they depreciate over time. Since electric vehicles only exist since a "short" period of time on German roads, dealerships as well as customers can only hardly evaluate the resell value. Additionally, Germany's mobility sector has long been heavily reliant on oil, particularly in the automotive industry. As one of the world's leading and most advanced automotive markets, the country's vehicle production and transportation systems have fostered a significant dependence on oil. This has led many consumers to question the effectiveness and timeline of Germany's efforts to reduce this reliance and transition away from oil dependency.

Scepticism

The acceptance of electric vehicles is being hindered by scepticism, particularly regarding their sustainability. A significant factor in this is the battery, which powers the electric motor. As discussed in previous chapters, lithium-ion batteries are preferably used due to their increased performance, long lifespan, energy density, and relatively low cost.

Key resources in battery production include lithium, silicon, and cobalt. Approximately half of the world's lithium extraction is dedicated to electric vehicle batteries, with 80 % of global lithium production concentrated in Chile and Australia (Essential Minerals Association, n.d.).

Cobalt is primarily sourced from Congo, which supplies nearly two-thirds of the global demand. The extraction of these raw materials in regions like South America and Africa frequently involves inhumane working conditions and causes substantial environmental degradation (Responsible Institute, n.d.). The extraction of these resources raises serious concerns about environmental sustainability and the alignment with the 17 Sustainable Development Goals (SDGs) that Germany has committed to, as discussed in previous chapters.

Nickel and cobalt can be recycled with a recovery rate exceeding 90 %, and the EU Battery Regulation mandates a minimum recycling rate of 95 % for nickel and cobalt, 80 % for lithium, and 70 % for lithium-ion and lithium batteries by 2031 (Deutsche Umwelthilfe e.V., 2023). However, Interviewee Four highlighted that the recycling process is both costly and energy-intensive. This raises questions about the sustainability of these practices if they prove unprofitable for companies.

Furthermore, the "re-use" of vehicle parts is significantly diminished in electric vehicles compared to traditional combustion engine cars, as much of the technology in modern vehicles is integrated and bonded directly to the vehicle's body.

The registration of electric vehicles surged from under two percent in 2019 to 18 % in 2022. By 2025, approximately 30 million new electric vehicles are projected to be registered annually, with this number expected to rise to around 54 million by 2030 (Statistisches Bundesamt, 2023). However, it raises concerns about the sustainability of this growth, given that effective recycling processes are still in the development phase.

Weak Political Engagement

This paper demonstrates that Germany is falling short in its development plan for electric vehicles. The ineffective Environmental Bonus and limited incentives, such as tax benefits, reflect a lack of government presence in driving this transition.

This is further highlighted by the fact that in 2021, the transport sector emitted approximately 148 million tons of CO2, surpassing the original target by three million tons. Many interviewees pointed out Germany's weak structural development strategy and called for increased collaboration, funding, and stronger policies to accelerate market progress. As to be seen in the chapter "innovation management", transforming an idea into a successful innovation includes several key stages, however these steps are not disclosed in detail from the German government. It is to question, if steps in this process have been skipped, which now hinder the market diffusion. These could stem from a poorly considered and unclear business plan, or from a rushed approach to bringing the product to market.

7. OBSTACLE MANAGEMENT

Involvement of Politics

Political incentives and policies play a vital role in influencing the electric vehicle market. The push towards sustainability in the automotive sector has been driven significantly by both the European Union and the German government.

The "Fit for 55" initiative set long-term objectives to steer Germany towards a sustainable development and the six goals of "The 8th Environment Action Programme", outlined in previous chapters, provide Germany with a strategic direction. However, the country needs to establish concrete incentives and a well-organized plan to effectively support this transition. The failure of the environmental bonus has been a significant setback, affecting both development progress and institutional trust. To recreate the professional interaction between consumer and institution, the involvement of politics can be seen as an essential factor.

Interviewees suggest that incentives lacking government backing are ineffective and require further development. Interviewee five emphasized that consumers will only commit to investments if there are clear political goals and milestones that are well communicated. Enhanced collaboration between policymakers and companies is crucial for aligning development efforts and driving progress cohesively.

The widespread adoption of electric vehicles largely hinges on the availability of charging infrastructure. Political decisions are crucial for financing and planning the extensive network of charging stations required nationwide. Additional measures could involve subsidies for purchases, tax incentives, and rebates. For instance, the government currently provides grants to support these efforts.

Tax increase (Push)

According to interviewee five, the German government could increase the barriers for vehicles with a traditional combustion engine, discouraging the use of these vehicles.

There could be multiple dimensions to this approach.

Since 2021, Germany has implemented a CO2 tax on emissions. This tax is set to rise progressively until 2026, with the final rate more than doubling. To further incentivize the adoption of electric vehicles, Germany could continue to increase this tax through 2030, making electric vehicles even more financially advantageous in the long run (ADAC, 2024).

Another method to enhance penalties for traditional combustion vehicles would be to raise fuel taxes or incorporate emission-related components into road tax (Kędzierski, 2024).

The European Union has tightened its emission regulations with standards like Euro 6, which restrict the levels of CO2 and particulate matter that vehicles can emit. As a result, vehicles powered by finite resources are facing higher operational costs, which diminishes their market value in Germany. This decline in demand pressures automakers to invest in and develop alternative fuel and drive technologies.

Subsidize (Pull)

To enhance the attractiveness of electric vehicles, it is suggested to lower electricity rates for charging, reduce registration fees or cut road taxes. These steps could make owning an electric vehicle more financially feasible for consumers and boost overall adoption rates. By addressing these economic barriers, the shift towards electric mobility could be accelerated. This is supported by research from an agency indicating that 55 percent of respondents cited high subsidies as the primary reason for purchasing an electric vehicle, surpassing environmental concerns, which were important to 38 percent of respondents.

Higher Transparency

Greater transparency from both companies and the government is essential to build trust with consumers, particularly concerning sustainability. The EU has already implemented measures like the Supply Chain Act and the EU Battery Regulation to enhance transparency, encourage sustainable practices, and hold companies accountable for human rights (Responsible Institute, n.d.).

Developing a robust innovation strategy and planning innovation activities, in combination with an innovation roadmap, is crucial. It is essential to define goals, visions, and strategic directions for innovation more clearly, as many stakeholders currently lack a clear perspective. Setting and tracking milestones is a key aspect of this process. This also entails implementing stronger incentives, investing significantly in infrastructure, and setting clear, long-term objectives for the car industry and the idea of traditional combustion engines. Furthermore, strengthening collaborations between public and private sectors could accelerate innovation, create openness and promote the development of crucial technologies. This could also foster the entry of new competitors in the market to create innovative approaches regarding electro mobility, since the market is currently heavily dominated by five companies.

By adopting these measures, Germany would be better equipped to achieve its environmental goals and promote the sustainable expansion of the electric vehicle market.

Lastly, implementing a unified and clearer charging infrastructure system could boost investments in electric mobility by companies and provide a streamlined approach to advancing development.

8. CONCLUSION

The paper opposed the question; which obstacles arise in the transition towards electro mobility, and can they be overcome? Despite numerous barriers, such as limited vehicle range, long charging times, societal scepticism towards the sustainable upside of electric vehicles, early-stage battery technology, a confusing charging infrastructure and a missing transparency, electric vehicles gained great acceptance throughout Germany in the last decades. The rapid expansion of the charging network reflects the determination of the automotive industry to restructure itself and seek more sustainable solutions.

By analysing multiple stakeholders, Government initiatives revealed to be an essential building block to push the development of e-mobility forward. Germany demonstrates a willingness to embrace and support new processes and innovations. Yet, current perceptions indicate that political efforts are insufficient, with previous successful initiatives like the Environment Bonus being discontinued and ambitious targets like 30 million electric vehicles by 2030 being scaled back.

To address the challenges effectively, a strong "push" from the political sphere is needed. Increased political involvement could include measures such as higher CO2 taxes on gasoline cars and sanctions on non-reusable vehicle parts.

To accelerate the transition, Germany must enhance political creativity and collaboration, potentially through international partnerships and increased transparency. By doing so the country would foster the entry of new competitors in the market to create innovative approaches as well as higher investments and commitment of companies in the field.

Although some barriers are likely to diminish over time, the current political approach appears to be shifting core responsibilities to the market. To effectively drive change and leverage the automotive sector's importance to the German economy, a more proactive and supportive political stance is crucial.

Limitations

This paper is faced with limitations that effect its findings and conclusion. A major limitation is the subjectivity of each interviewed stakeholder. While the information can be deemed as relevant, much of the provided information could be influenced through negative or positive experiences. Additionally, both the literature review and the case study were conducted without the four-eyes principle, allowing for a greater scope of interpretation. Future research could address this issue by involving multiple authors, allowing for a more objective analysis.

Moreover, to gain a better understanding and evaluate additional obstacles, more stakeholders should be involved in the paper. By conducting further interviews, such as in the department of research, one can gain a more comprehensive understanding. Another approach could include to interview multiple individuals throughout the different departments, to gain more data.

Much of the information was confined to reports dating back to 2010. Since the topic of elector mobility has emerged only recently, information is only limited. In this state of development, it may be difficult to assert the development of some key aspect, if the research will be conducted in a few years' time, it may come to more conclusive results.

Due to time constraint, it was not possible to conduct a quantitative survey and analyse it thereafter. It would have allowed to gain an in-depth understanding of the consumer perspective.

Further research could compare the development of electro mobility in other countries to the one in Germany and disclose their differences. It could be evaluated if the obstacles, which arise in Germany, are also found in other states and how those states addressed the issues. Lastly, future research could present additional solutions for each stakeholder, to actively push the trend towards electro mobility forward.

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