



CHALMERS

# Market- and customer analysis regarding wireless charging on EV's

Bachelor's thesis in Science in Engineering

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## Preface

This thesis work was carried out during the spring of 2023 as a part of the education program Industrial Management and Production Engineering at Chalmers University of Technology. It was written by two students and the course consisted of 15 credits, meaning the thesis is worth 30 credits in total. This study treats wireless charging on EVs and was conducted at Polestar Sweden on a mutual agreement where the subject and the scope of the work were created together by the supervisor at Polestar, Chalmers, and the students.

A massive thanks to our supervisor at Polestar for enabling this work, helping us find the right contacts for the different subjects, and for all support. Also a big thanks to all colleagues at Polestar for a warm welcome and their help and input. A special thanks to every participant in our workshops, interviews, and survey for contributing valuable information. Both private persons and the fleet companies. We hope this thesis will contribute with guidance and valuable information for users as well as companies.

We also want to thank our Supervisor and examiner at Chalmers at the institution, Technology Management and Economics, Kaj Suneson for all guidance, provided feedback, and help regarding the writing of this report.

Key words: EV charging, V2G, Customer needs, Market analysis, Fleet operations, Market segments



# Abstract

EVs have existed for many years but have not become popular until a few years ago due to the environmental benefits they offer. This has caused the EV market to recently explode in terms of sales and it is expected to have great potential since the EU decided to ban the selling of new ICE cars from 2035. A fast growing EV market demands good ways of charging since this is one of the biggest obstacles when compared to traditional ICE cars. Wireless charging is a new way of charging EVs with multiple benefits which could be the standard way of doing it in the future. Some companies have started to develop this way of charging and pilot projects have been conducted to try it out.

The broad aim of this study was to examine customer needs regarding wireless charging for private customers and fleet operations, identify their readiness to understand where the biggest potential is and what customer segment to focus on, and get a deeper understanding of the market regarding wireless charging. All this was done on electric vehicles in the form of passenger cars only, meaning two-wheelers and commercial vehicles were excluded. This was done by conducting workshops, interviews, a survey, and through internet research.

In conclusion, private users were identified as having the biggest use of wireless charging since it is key in making V2G useful and reaching its full potential. Fleet operations would also have great benefits of wireless charging but the amount of kW that was required was on the edge of too big and therefore the infrastructure would need to be expanded a lot to lower this demand and enable a technical solution that is realistic. Therefore, it is believed that fleets will have to wait longer until they will start using EVs which will be charged wirelessly.

## List of Abbreviations

EV = Electric Vehicle  
PLM = Product Lifecycle Management  
CSF = Critical Success factors  
V2G = Vehicle to grid  
V2X = Vehicle to everything  
ICE = internal combustion engine

Kilowatt (kW): is a power unit, which measures the energy rate which is being transferred or used. Watt (W) is the derived SI unit for the physical quantity power which means energy or work per unit of time where a kilowatt is equal to 1000 watts. A kilowatt-hour (kWh) is an energy unit that measures the work that has been done over a specific time period by a specific amount of power. Where a kilowatt-hour is equal to the energy amount that has been used by a 1000-watt instrument in one hour. In other words, kilowatt is measured at a certain point in time and measures power while a kilowatt-hour is measured over a time period and measures energy.

V2G: The definition of Vehicle To Grid is to use the vehicle's electricity to supply the power grid with electricity (Noel et al., 2019). V2G enables cars to not only charge EVs but also return power when the car isn't used. By doing this for example peak hours can be reduced and more environmentally friendly electricity can be used.

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# 1. Introduction

This chapter introduces a background to electrical vehicles, their charging, and the market. It gives an insight into the current problem regarding limited knowledge about the earlier mentioned areas which the report aims to solve. Further, it presents different questions that will be dealt with throughout the report and delimitations that have been done.

## 1.1 Background

EVs have existed since 1828 when Jedlik Anyos created and operated what is said to be the first EV but they first started to be useful around 1880 (Morimoto, 2015). In recent years there has been full-scale growth due to the small environmental impacts EVs contribute to but also with the higher price of gas. The EV market has in recent years been growing exponentially and is expected to continue. When referring to the EV market both fully electric vehicles (battery EV) and hybrids are accounted for regarding passenger cars, commercial vehicles, and two-wheelers (Akshay & Sonia, 2022). According to Akshay & Sonia (2022), the EV market was 2020 worth 163.01 Billion US dollars and is expected to increase with a compound annual growth rate of 18.2% during the years 2021-2030. This means that it is expected to be worth around 823.75 billion USD in 2030. On top of this, the European Parliament has introduced a law that states to ban all sales of new ICE cars from 2035, which means that the demand for EVs will increase drastically (European Parliament, 2022). This indicates that the EV market has a great future with much potential.

Today, most EVs are charged by plugging them into a charging station or a regular power outlet with a cable. Charging times vary depending on the type of charger and the battery size of the EV but can take anywhere from a few minutes to several hours. With the use of a cable, some problems can occur such as forgetting to plug in the charger, limited access for the elderly or disabled, and wear and tear of cables and charging ports. A technology that can help solve these problems, but also make it more convenient to charge is wireless charging.

The technical solution for the different parts of the product that enables wireless charging for EVs already exists. However, the market situation is largely unknown and EV manufacturers have limited knowledge about who the customers are since it is a new market and know where the biggest potential is. Customers' needs are also currently very diffuse and not defined. Therefore, it is hard to shape the product to make it fit the customer's demands. Different market segments might require very different solutions accounting for power supply and flexibility. The information regarding price, service, and investment costs needed to extend the infrastructure or if buying, hiring respective subscribing is the most cost-efficient model is unknown.

In this report, two different customer segments were identified, the private sector and fleet operations. Fleet operations are more focused on the taxi business and car rentals whereas the private sector is mainly for home use. These customer segments have different needs that must be accounted for and satisfied if possible. Therefore, they are through this report separated into their respective segment.

Today there is a moderate rivalry among existing competitors. However, all of the competitors are third-party suppliers meaning the customers cannot buy an original wireless charger for their car. Some of the leading companies in this sector are HEVO, WiTricity,

Qualcomm, and InductEV. Also, these third-party companies are more focused on fleet operations and not on the private sector. So far, very few EV companies have tested wireless charging officially which means only a few pilot projects are being tested and therefore it is very early in the PLM.

## 1.2 Purpose

The study aims to deepen the understanding of the electrical vehicle (EV) market accounting for the possibility of wireless charging. The focus is on examining customer needs and the potential of EV companies to meet them. Furthermore, the study aims to provide a broad view of the current market scenario. The outcome of the study will bring EV manufacturers beneficial information to choose their market positioning and product development wisely, with the ultimate goal of creating mutually beneficial solutions for both customers and the companies themselves.

## 1.3 Research Questions

- *What readiness do identified customer segments have for adopting wireless charging on EVs and where do we see the biggest potential?*
- *What customer needs, requirements, and buying habits do the customer segments have and what features should the product be equipped with?*
  - *What is the customer value?*
- *What does the current market situation for EV charging look like with a focus on wireless charging and what future possibilities are there?*

## 1.4 Delimitations

Two customer segments were identified together with both the supervisor from Chalmers and the case company. These segments were private sector and fleet operations. Both segments were limited to passenger cars because the scope of the thesis work would have been too wide if also two-wheelers and commercial vehicles would have been included. The assignment description that the case company presented was perceived to be angled toward passenger cars since they work in that industry. Further reasons are that more studies and experiments have been done on commercial vehicles such as buses and trucks. Because of this the passenger cars segment was more interesting to us. Passenger cars also account for 60.6 per cent of the CO2 emission that was released due to transportation within EU countries during 2019 (European, Parliament, 2019). Meanwhile, two-wheelers and commercial vehicles only stand for 39.4 per cent combined, of which commercial vehicles stood for an absolute majority of those.

## 1.5 Problem Definition

The world is under constant development and people are becoming more comfortable and demand new technical developments which contribute to a high degree of convenience. Products are being created to facilitate everyday life, and cars are one of those creations that now is seen as a standard for most people. Dioha et al. (2022) state that 24% of the total carbon emission created globally in 2020 arose from transportation with ICE cars, which are running on fossil fuel. Today only 1 in 250 passenger vehicles in the world are expected to be

EVs, meaning only 2.2% of all market shares are EVs (Kilgore, 2023). Further, the air pollution and greenhouse gases ICE cars contribute to also affects people's health. Diseases such as asthma, diabetes, Alzheimer's, high blood pressure, lung cancer, and dementia can arise and get worse (W.J. Requia et al, 2018). All those problems can be reduced by adopting and implementing more EVs since they are much more environmentally friendly when looking at the product's lifecycle (Moseman, 2022). When this implementation should be carried out an effective and sustainable way of charging is going to be required. This since charging today can take a long time and be complicated which is a big obstacle when people are choosing new cars today.

Wireless charging on EVs is a relatively new technique that started to be tested a few years ago. Developers of the charging device and car producers are not the same company which increases the complexity. Cars do not have spare areas where new products can be applied, meaning this space needs to be planned beforehand. This has led to a collaboration between car producers and third-party companies (developers of wireless charging) to find a good solution. Since it is a new product, developers do not know what the customer's needs are which leads to them developing a product that is not wanted by customers. Although in this case, it is hard to identify customers' needs since it is a complex problem that requires knowledge regarding both cars but also electricity and the different segments might have different needs. Due to the lack of knowledge about the upsides this technique offers, many people tend to be reserved for this new way of charging. Today there are already other solutions to the problem regarding how to charge EVs which are well adapted by consumers. However, those ways also imply problems that wireless charging could solve together as well as the bigger environmental problem.

The first question was chosen to see how the product needs to be communicated to the different segments and also identify what segment to mainly focus on to receive greater revenue and help the environment as much as possible. In other words the segment with the greatest impact. The second question was chosen to identify how the product needs to be designed/equipped, packaged (what should be included in it), service, pricing, and how the buying/selling process would look to fulfill customers' needs and be able to sell well. Also to identify what customers value to know what to point at when marketing the product. The third question is important to answer because companies need to know what competition there is and what they offer to focus on the right customer segment and know how to form their products to match the strategy they chose depending on the competitors.

## 2. Theoretical Framework

This chapter explains theories that will be used throughout the report with the goal of solving the research questions presented earlier. Those theories will be useful when reading the report to fully understand its meaning and reasonings. It presents theories regarding the market and the customer.

### 2.1 Market

The following part explains the theories used regarding the market which includes industry, competitors, and product lifecycle. It presents different important aspects of the market and explains why and what is important to consider.

#### 2.1.1 Market Analysis

A market analysis is based on both competitor and customer analysis to be able to make judgments strategically about the market and its dynamics (Aaker, 2008). The first objective of a market analysis is to decide whether a market is attractive or not to potential and current buying/selling actors. Market attractiveness is measured by the potential market profit and long-term returns on investments, and is a factor considered when a “product-market” investment is made.

The second objective is to understand the dynamics of the market. This includes identifying key success factors, threats, opportunities, trends, and developing appropriate questions that can be used to ease the analysis and information gathering. Being relevant in the market requires a specific asset or skill, referred to as a key success factor. If a company’s key success factor has a strategic weakness that is not compensated by a good strategy, then there will be some limitations for the company to compete in the market. Factors are often general for the market and are the same for all companies within the industry. However, a well-known strategy can be to differentiate the product from its competition (Nolega et al., 2015). This means that only some factors which are not prioritised by the competition should be focused on instead of the key success factors of the industry.

To understand the dynamics of the market, Aaker (2008) claims that usually, seven different dimensions are present. It includes actual and potential market size, market profitability, market growth, distribution systems, cost structure, key success factors, and trends and developments. With this information, enough data is available to understand the different potentials in the market.

#### 2.1.2 Industry Analysis

Industry analysis is done to understand the competitive environment a company is in and determine the potential profitability in that industry (Grundy, 2006). By doing this a greater understanding of the rules and structure of the industry will be gained. To determine potential profitability and rivalry in the industry Porter’s five forces are used. The mix of the forces can be used as an explanation for why certain industries are more profitable than others and what key strategies are needed to be successful (Mullins & Walker, 2013). The following forces affect the attractiveness of a market:

**Threat of new entrants:** By having a high threat of new entrants the attractiveness of the market is lower, due to the possibility of increased rivalry. However, some restrictions make entry more difficult, for example economic barriers, and government policies.

**Bargaining power of buyers:** If there is a saturated market the bargaining power of buyers is high due to the several different options existing. The buyers can then set demand on for example higher quality and reduced pricing.

**Threat of substitute products:** Substitutes are alternative products that can substitute the existing product by being able to perform similar functions.

**Bargaining power of suppliers:** The bargaining power of suppliers in an industry is determined by the number of suppliers in the industry. If there is a limited number of suppliers their bargaining power will be higher and if there are a lot of suppliers, the bargaining power will be lower.

**Rivalry among existing competitors:** Rivalry among competitors occurs when the industry is saturated with products that perform similar functions or are direct substitutes to each other. Usually, profitability in the industry decreases if there is a higher level of rivalry.

Using the data collected in Porter's five forces, it supplies sufficient information to act as an aid in finding the critical success factors of the industry (Leidecker & Bruno, 1984). CSF are key factors that are identified, which make a company successful in its industry. If managed well, a company can strengthen its competitive position in the industry. According to Jobber and Ellis-Chadwick (2020), the number of key success factors should be limited to 6-8. This is to avoid the analysis becoming too diffuse. By studying the competition including other solutions to the same problem and the power of buyers and suppliers, an understanding of what is important and how to succeed can easily be gained. When researching competition and other solutions a conclusion to why certain products do better than others can be made. If many companies have the same reasons as to why they succeed, it is then fair to suppose that those factors are decisive. By understanding the bargaining power of actors in the supply chain it is easier to adjust to the market and thereby do the best of the situation.

### 2.1.3 Competitor Analysis

Competitor analysis is often referred to as the process of identifying and researching all competitors within the same industry with the goal of understanding their market strategies to best position their own company. The information from a competitor analysis can be used to compare the own company with the competition to identify internal strengths and weaknesses and to decide on a competitive strategy such as differentiation or cost leadership. It is seeking to answer five key questions in the following order if the analysis is followed correctly (Jobber & Ellis-Chadwick, 2020, 632).

- Who are our competitors?
- What are their strengths and weaknesses?
- What are their strategic objectives and thrusts?
- What are their strategies?
- What are their response patterns?

When identifying competitors, a wide view needs to be taken not to exclude competition that produces substitute products (products that solve the same problem in a different way). It also includes potential competitors which might enter the same market through technically similar products or substitute products. Understanding the competitive landscape is very important for all competing companies since the risk of losing market shares or being irrelevant increases if it doesn't (Jobber & Ellis-Chadwick, 2020, 633).

It is essential to understand the strengths and weaknesses of competing companies to understand the competitor's vulnerabilities to form an internal competitor strategy. Examples of required data are profit margins, sales levels, investment levels, market shares, distribution channels used, company image, product, and service quality, etc (Jobber & Ellis-Chadwick, 2020). This information is also required to compare companies within the industry based on the key success factors identified for the industry in question. The key factors are suggested to be between six to eight factors (McDonald & Wilson, 2011). Lastly, a consideration of possible implications should be done to decide the competitive strategy.

Competitors often base their strategies and response patterns on their objectives, which makes it important to understand their strategic objectives and thrusts. The different objectives that a company can follow can be divided into five categories. These are to build, hold, harvest, divest, or niche (Jobber & Ellis-Chadwick, 2020, 635). Build stands for trying to take market shares from competitors and expanding the business. Are often used when a growth trend can be seen in the market, when it is possible to exploit competitors' weaknesses, or when the in-house strengths, resources, and capabilities are strong. Hold means that the company is trying to keep its market shares. Often used when firms are market leaders in both mature and declining markets or when the costs are greater than the benefits of trying to take new market shares. Harvest refers to tightening the product portfolio and only saving the best-selling products and projects. This strategy is well used in markets that are declining, where loyal customers exit, or when new products or projects steal the budget and priority. To divest meanest that a company exits the market. Often used when markets are declining or it is too expensive to compete. Niche refers to having a clear picture of customer needs and only focusing on specific market segments that are unfulfilled using small thinking. This can come in good use when only a small budget is available and a company can create a competitive advantage.

When talking about a company's strategies it is referred to as how the company will attempt to position itself which involves determining its target market and the differential advantage. Strategic decisions are often based on the earlier discussed strategic objectives and thrusts. Different strategies are cost leadership, differentiation, or cost- differentiation focus (Tanwar, 2013).

To compete with competitors a decisive factor is to predict their responses to competitive and market changes. Where their past behavior might work as a good guide to future possible responses. Retaliatory actions can be used to control other competitors. These competitors are referred to as retaliatory, as they are known to react fiercely to any competitive threats (Jobber & Ellis-Chadwick, 2020, 636). Although this can differ depending on the market, some markets are more stable than others which will affect the strategy that is most effective to use.

#### 2.1.4 Product Lifecycle

Product lifecycle management (PLM) is used to oversee a company's product throughout its entire lifecycle, from its launch to its retirement (Stark, 2011). PLM's objective is to increase the revenue of existing products, decrease product-related costs, and optimise the value for both customers and shareholders of current and future products. PLM will help understand the implementation of a new technical solution and the different parts of its lifecycle.

Products go through what is described in the literature created by Jobber and Ellis-Chadwick (2020) as four phases in their lifecycle where each phase represents a unique stage for the product. Different products have unique curves but the four stages are representative of every product. The first phase is the introduction phase, where the product is introduced to the market. New products often experience lower sales and lower profits due to the resistance of consumers. Financial losses are also common due to high development and promotional costs. The second phase is called the growth phase. In this stage, sales are usually higher and the profit becomes higher, this is due to the acceptance of the product on the market. The third phase is called the maturity phase. Due to saturation in the market, the sales often peak and flatten. The competitors that are left in the market compete for market shares by introducing improved products, lower prices, advertising, etc. The urgency for creating a strong brand is particularly acknowledged during the maturity stage, as market leaders have the advantage of being able to withstand the impact on profit margins. The final stage is the decline phase, where profits and sales decrease due to factors such as the emergence of alternative products or shifts in consumer demands.

Product management can be eased by using the PLC in several ways. PLC highlights that a product can't last forever and needs to be terminated or replaced in the long run (Jobber & Ellis-Chadwick, 2020). The PLC emphasises the need to discontinue products and introduce new ones to take their place. Neglecting this sequence may result in a company having multiple products in the declining stage of its PLC. According to Jobber and Ellis-Chadwick, the second application is to caution against assuming that growth will continue. The PLC reminds decision-makers in a company to be cautious when planning new investments due to the possibility of growth stagnating or even declining.

### 2.1.5 Diffusion of Innovation

Diffusion of innovation is used to choose the correct target market and explains how a newly introduced product is spread over time (Rogers, 2003). Important to understand is that not everyone will be ready to receive new technology/products at the same time, and different actors' innovativeness will vary as also the willingness to adopt new products. The diffusion of innovation curve classifies individuals or entities based on their willingness to adopt the innovation. Consumers who are willing to embrace new products and be among the first to try them out are referred to as innovators and early adopters. As shown in Figure 1, innovators make up a negligible portion of the overall sales. When the product has been tested and verified by the innovators and early adopters it becomes less risky for the early- and late majority who form the majority of the sales. The final group consists of the laggards, who are the last to embrace the new product.

To gain valuable marketing insights it is important to understand the characteristics of each stage. Innovators and early adopters are the first ones to buy during the product's growth phase (Jobber & Ellis-Chadwick, 2020). When the early majority and late majority enter the market the sales are accelerated as the product reaches the maturity phase. During the late maturity phase or even the decline, laggards may enter the market.

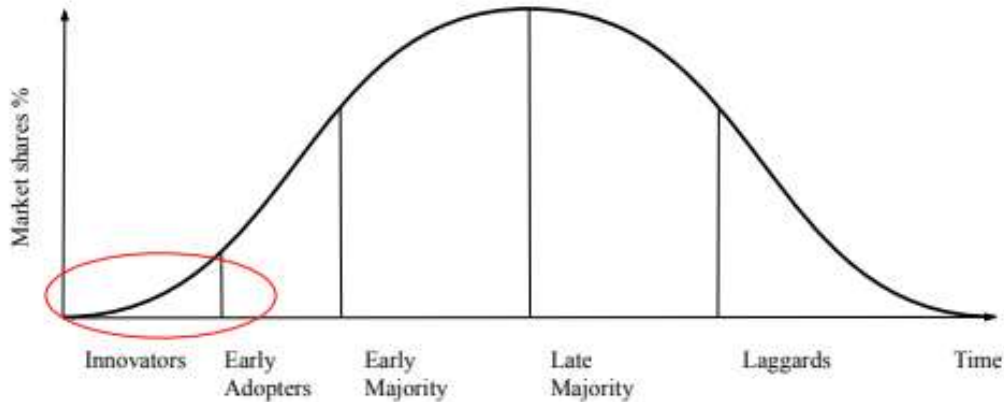


Figure 1 shows a representation of the diffusion of innovation curve and it highlights the innovators on which the report aims to focus on. The original picture (Fryer, 2009).

## 2.2 Customer

This chapter will present the theories that were used regarding customers. It will present different ways how of to study customers to create the best possible product for them.

### 2.2.1 Customer Analysis

Consumer markets change continuously and actors in the market need to understand those to be able to adapt their marketing activities (Jobber & Ellis-Chadwick, 2020). Cultural values are shaped by the global consumer culture which also involves the cultural norms that affect individuals and how they react. It is important to understand both the global and local nuances that take place in the market and identify different aspects that can influence the behavior of consumers. The aspects that need to be considered are how customers collect knowledge, behavior, and skills that shape the culture. In other words, it is important to understand consumer knowledge, consumer behaviors, and consumer skills. This is different depending on if it is a Business to Business (B2B) or Business to Consumer (B2C) market. The main reason for gathering this knowledge is to be able to understand customer needs.

The first part of a customer analysis is understanding the needs that the customer has. By understanding the needs and knowing how to satisfy these, companies can increase market shares, enter new markets or create and dominate new markets (Jobber & Ellis-Chadwick, 2020). To better understand the needs they are divided into three different categories which are physical, social, and psychological needs. Physical needs are often the basic physical needs a human requires such as food and sleep whereas social needs involve more emotions such as group affiliation. Lastly, psychological needs for example refer to the needs that bring self-fulfilment and psychological satisfaction.

Finding the customer needs can be done through market research or business intelligence. Market research can be done through surveys, interviews, focus groups, or observations. Business intelligence means collecting and analysing relevant data to help businesses make decisions and gain insights into their business operations (Loshin, 2012). To understand and identify customers and their behavior there are several key questions to answer that could be helpful.

- Is it business-to-business or business-to-consumer?
- Where do the consumers buy?

- How do the consumers buy?
- Who is important?
- What are their choice criteria?
- When do they buy?

#### 2.2.1.1 Who is Important

Regarding who buys and who is important the goal is to find out the different roles and how they affect the buyer (Jobber & Ellis-Chadwick, 2020, 76). Did the buyer make an impulsive move or was the buying action planned in forehand? In many cases, people around the buyer affect the decision the buyer makes. There are five different roles that might affect the buyer. The first is the *initiator* who is the person that starts the buying process by considering a solution to solve a problem by making a purchase. The second role that affects the buyers' decision is the *influencer*. An influencer is someone who tries to convince others in a group about the outcome of a decision. This person gathers a great amount of information and might sort the information that is being present to affect the buyers' decision. The third role is a *decider* which is a person with financial authority or other power over what to buy. The *buyer* is the fourth role and is the person who actually performs the transaction in the physical or online store. The fifth role regarding the buying process is the *user*. This person is the consumer of the products that were bought. One person can take on either one or multiple roles in a buying process. All those roles are important to understand for actors that want to succeed since the person that buys the product might not have the biggest influence. Therefore companies need to understand which person or group of persons has the biggest influence and therefore target them as well as the buyer.

#### 2.2.1.2 How customers buy

The question about “how customers buy” can also be divided into different stages where the first is to recognise a problem while the final goal being to find the best solution. This can be referred to as the consumer decision-making process where each step needs to be completed before the next starts (Jobber & Ellis-Chadwick, 2020, 79). To fully grasp how emerging contexts affect consumer behavior, it's essential to comprehend each stage of the process. Firstly is the need for recognition which means that a problem needs to be identified and awareness to be gained. Next up is the information search. This contains gathering information about alternative ways of solving the problem. This is done both internally and externally. The internal search means that “a review of relevant information from memory” should be gathered such as finding potential solutions, comparing different options, and using earlier experiences (Jobber & Ellis-Chadwick, 2020). The external search searches for the same information with the only difference being that it is now to be gathered from external sources such as friends or family, commercial sources, or websites. This will only be needed if a good solution is not already found.

The third stage is the evaluation of alternatives. The aim of this step is to narrow down the number of brands for more serious consideration. It can be seen as a shortlist of brands to evaluate more in-depth. The fourth stage is the purchasing stage. Depending on if the customer is highly involved with the brand in question or not implies different processes regarding evaluation. The level of involvement is depending on personal importance and perceived relevance tied to the brand. Lastly, the fifth stage is called post-purchase evaluation of the decision. All companies try to create satisfaction for their customers in both situations accounting for low and high involvement. Although customers might be concerned after their purchase which is called cognitive dissonance which increases with the purchasing price, the

degree of difficulty, with irrevocable purchases, and in cases where anxiety might occur (Jobber & Ellis-Chadwick, 2020). The goal of companies is to reduce cognitive dissonance which can be made through staying in touch with customers to calm and convince them that the right decision was made.

#### 2.2.1.3 What are the choice Criteria

There are four different groups of choice criteria that represent all the different attributes and benefits customers might value when buying a product or service. The brand that fulfills those the best or manages to market the product or service towards the aspects that customers find important wins the customer's loyalty. Therefore it is very important to figure out customers' choice criteria that are going to affect the design, production, and marketing of the product or service. People might use different choice criteria both compared to each other but also over time. As the conditions change new criteria become higher prioritised instead of the old ones. The four different types of choice criteria are technical, economic, social, and personal (Jobber & Ellis-Chadwick, 2020).

The *technical* criteria consider mainly the performance provided by the service or products. It takes several different aspects into account which is the reliability, comfort, durability, style, delivery, convenience (how easy it is to use), and taste (Jobber & Ellis-Chadwick, 2020, 84). As mentioned earlier, all aspects do not necessarily need to be considered as important for everyone. It depends on what product it is, who the user is, and the buyer's life situation. The *economic* criteria focus on all costs regarding a purchase such as price, value for money, running costs, lifecycle cost, and residual value which in other words means the estimated worth of an asset at the end of its useful life. The *social* criteria refer to how a purchase affects the perceived relationship with others and how social norms influence someone's decision. It concerns the status that a product brings, the fashion the product expresses, convention, and social belonging. Certain purchases can bring the buyer into different social groups. For example, some products are very expensive and a buyer of those kinds of products might be seen to belong to certain social groups with a great amount of money. *Personal* criteria pertain to the psychological relationship between an individual and a product or service. This includes self-image, risk reduction, emotions, and ethical considerations. For example, some people choose products to reflect their self-perception or to reduce the risk of being made fun of because the product is from an unknown brand, while others reject brands due to ethical concerns. People tend to buy more from brands that give back to society and do things in an ethical way (Jobber & Ellis-Chadwick, 2020). As mentioned earlier, aspects can change with time and the ethical aspect is a great example since it has become more important for a great number of people in the last few years.

#### 2.2.1.4 Where and when they buy

Where and when customers buy can vary widely depending on who the consumer is and what is going to be purchased. Where they buy can be at a physical store or on a digital website. When is referring to the time of the day, what year, month, and week but also if the purchase is spontaneous or planned. Lately, the two factors where and when have changed due to the possibility of e-commerce and digital markets (Jobber & Ellis-Chadwick, 2020). It is important for all selling companies to understand their customers and according to Jobber and Ellis-Chadwick (2020), it is especially important to know if customers are what is called compulsive shoppers. Compulsive buying can cause the buyers both financial and emotional difficulties which will affect the company in question. Compulsive consumption occurs when a person fails to control their desire to perform exaggerated and addictive purchases which

can be caused by promotional events. This is because they often are well-informed and updated about prices and events. This leads to them having higher abuse of their credit cards in a wider range than other shoppers. There is a big difference between compulsive shoppers and impulsive buyers. The last mentioned refers to unplanned and spontaneous purchases where the buyer still has control over their desire.

### 2.2.2 4C In Marketing

When developing a business the risk of only seeing things from the company's perspective is big. However, it is important not to do this since it is the customers' needs that should be fulfilled. Therefore it's important to mainly focus on the development from the customer's perspective. The 4C theory is for that reason often seen as more suitable for today's market. The theory is based on the 4 principles that are referring to customer demands (Tan & He, 2019). These are customer, cost, convenience, and communication. The 4C theory can be seen as a reworked of the 4P theory and it aims to switch the focus from only the company's profit to customer needs being equally prioritised to the profit (Yang et al., 2012). Both 4P and 4C have their strengths and weaknesses. 4P strives to communicate through a one-to-many strategy, meaning the enterprise reaches out to many customers at once. This leads to difficulties in containing long-lived relationships (Liao, 2015). Meanwhile, 4C emphasizes one-to-one communication between the company and its customer. This means companies have a better chance to hear customers' requirements and thereby fulfill them and contain a long-term relationship. However, 4C is more difficult to operate due to the prior reason.

#### 2.2.2.1 Customer

Since the report already provides a whole section about customer analysis only a short part will be presented here. The customer part of the 4C:s is about finding the different consumer groups' wants and needs (Lauterbron, 1990). To be able to compete in the market companies need to be able to specialise the products and services so that it fulfills their customer's needs. Companies are therefore required to have a wide range of customisation.

#### 2.2.2.2 Cost

Instead of thinking about what price to select for a product, think about what it costs. Cost is more than the price, it is also the driving cost of the building, the cost of conscience, and also the cost of guilt for doing the right thing. It is a much more complex equation that considers different aspects that have plenty of different solutions (Lauterbron, 1990). The main question to answer is how much are the customers willing to pay? After receiving this information the company can set the price of their product or service. If the price needs to be lower than the costs to be able to sell the company needs to lower some of their costs (Yang et al., 2012).

#### 2.2.2.3 Convenience

A crucial factor when selling a product or service is to facilitate the process of buying for the customers and to prevent problems and hinder obstacles to occur. If that's not the case some potential customers will turn elsewhere. The convenience aspect is about both the physical location and the online website. It also covers the degrees of difficulty in getting in contact with the selling firm. According to Lauterbron (1990), it is important to identify the different subsegments of the related market and know how each of them prefers to buy to match their expectations.

#### 2.2.2.4 Communication

Communication is an important tool to convince potential customers. A good communication and marketing strategy can gain attention from more customers. In general, good communication involves three aspects.

- Having a clearly defined message
- For a specific targeted audience
- With a defined set time and frequency

## 3. Method

To answer the RQs and fulfill the purpose of the thesis work, different methods were used to gather information and to analyse it. To answer RQ1 and RQ2 both qualitative and quantitative methods were used. To answer RQ3 an internet research method was used to collect valuable information. Lastly, the ethics and credibility of the different methods were discussed.

### 3.1 Data Collection

In this study, there are four different data collection methods that are used. These are focus group workshops, interviews, surveys, and internet research.

#### 3.1.1 Focus group workshops

Early in the project, two separate focus group workshops were held with the two identified segments. With this way of gathering information a lot of knowledge about the customer can be gained (Jobber & Ellis-Chadwick, 2020). It also gives a deeper insight into customer needs and what is important to the customer. Focus group workshops also encourage discussion among the participants and also allow them to build on each other's thoughts.

When selecting the participants for focus groups several criteria should be considered (Bryman & Bell, 2015). Aspects such as gender, age, and profession can in some cases be considered. Additionally, it is debatable whether the participants should be unknown to each other or not, so-called natural groups. In the selection, it was chosen to have people unknown to each other to get diversity in professions and lifestyles. However, all of the participants had a genuine interest in new technology and electric cars.

The first focus group workshop was held with the fleet operation sector where one representative from a large taxi company and one representative from a large car rental company were present. When selecting participants for the focus group workshop regarding fleet operations, e-mails were sent out to multiple people with the right qualifications asking whether they would be interested in participating. Two themes that were supposed to be discussed were prepared beforehand by the researchers. These themes were design and service which the participants were informed of beforehand. Design consisted of several different subelements and these were looks, user habits, and customer needs. Similar to the design theme, service consisted of different subelements which included what should the service around the product consist of, what type of customer support is necessary, possible application or system, and V2G. During the workshops, the participants were the ones leading the discussion while the researchers were making sure they stayed within the theme. Representatives from the case company were also present to answer possible questions that could occur regarding technical aspects. The workshop was audio recorded while notes were taken simultaneously to, later on, be able to analyse the answers.

The second focus group workshop was held with the private customers consisting of both people that had purchased their car and those who had private/company leasing. The selection of participants was done by posting an interest check in an EV charging facebook group where the members could sign up if they were interested to participate. This particular facebook group was chosen due to the high activity and passion regarding charging for EVs. The demand was that the participants had a genuine interest in charging solutions of EVs and

basic knowledge of it. The selection consisted of 5 people with different backgrounds and professions to get a wide spectrum of opinions and needs. Three themes were set to be discussed: Design, Service, and Price. Design and service consisted of similar topics as in the workshop with the fleet operations. Price consisted of how the charging pad could be funded (Subscription plan or one-time purchase), what it might cost, and what price packages could attract different customers. Same as in the previous workshop, representatives from Polestar were present to answer possible questions. This workshop was also led by the participants and the leaders were taking notes and making sure the correct theme was discussed.

### 3.1.2 Interviews

Personal one-on-one interviews were also conducted during the project. The interviews were structured with the same questions asked to every participant. The main goal of structured interviews is to give all the interviewees the same context of questioning (Bryman & Bell, 2015). When conducting this kind of interview the main goal is to get answers that can be accumulated and later on analysed. The only way to accomplish this is if the questions asked are done in the same way for every interviewee to give them the same possibilities to answer. Questions that are given should also be very specific about topics or areas that would like to be answered.

Similar to the focus group workshops the two identified customer segments were interviewed separately. The selection of participants from the private sector was made through a facebook group dedicated to EV charging where members could express their interest in participating. The participants from the fleet operations sector were contacted through e-mail. Requirements to participate were to have basic knowledge of EV charging and an interest in it.

In this project, the goal of the structured interviews was to get answers from potential customers regarding purchasing behaviors, user habits, and the purchasing process. The two different segments had different questions but the same topics were covered. Therefore the questions asked had a closed character where the range of answers was low. The interviews were conducted via teams due to not having the availability to meet in person. Interviewees were informed about the topics beforehand but were not given the questions that were going to be asked. During the interviews, the answers were recorded but also written down to give the writers as much information as possible. The goal was to keep the interviews short but effective and therefore they lasted approximately 30 minutes per person. Three interviews were conducted where one of them was with the private sector, one with a taxi company, and one with a car rental company.

### 3.1.3 Survey

Quantitative research is often conducted using questionnaires and surveys. It also often involves a greater amount of people than qualitative research does (Jobber & Ellis-Chadwick, 2020). Qualitative research was used to get a broader perspective on the subject area and collect more customer needs. The survey was made to enable the collection of numerical data that later on was presented in the result chapter. In this thesis, quantitative research data was used as a complement to qualitative research data.

The survey that was used during the project was made based on the topics and questions that arose during the focus group workshops but also topics that were not discussed but still in the scope of this thesis work. The questionnaire consisted of 14 questions regarding customer behavior, purchasing habits, pricing, customer readiness, and customer needs. When the

questionnaire was made it was posted in a facebook group with members interested in EV charging. This facebook group was chosen due to the high interest in EV charging by the participants. There the members were able to answer the questionnaire anonymously and give their feedback on the topics. Data that was collected was later on analysed and presented in the result chapter.

### 3.1.4 Market-, Industry- and Competitor Analysis

Market analysis was conducted mainly through internet research. The internet is considered to be a powerful way to get information about companies in a short period of time (Kuada, 2008). Firstly, general information about the market was gathered to get an overview of the current market situation. The way that the market analysis was structured was based on the theory presented under 2.1.1. The industry analysis was also conducted through internet research where both primary and secondary sources were used to gather information regarding Porter's five forces. Lastly, the competitor analysis was also conducted through internet research and based on the theory described under 2.1.3. All of the information that was collected through the internet was both primary and secondary sources to get a variety of information. The relevancy of the sources was also validated to ensure the correct information was gathered.

## 3.2 Credibility

To make the information gathered from the focus group workshops and interviews more credible it was chosen to voice record and take notes at the same time. With this method, the most interesting results could be taken note of directly and later validated by listening to the voice recording of the interview/workshop. Also to avoid getting one-sided and biased opinions in the focus group workshops people with different backgrounds and different professions were chosen to participate. They were also unknown to each other which according to Bryman & Bell (2015) can be beneficial in some cases. According to Lantz (2007), interviews can be problematic in credibility due to that the participant is the only one controlling the answers and can lead the answers in whatever direction they want. Therefore the interviews were not used as a base for the research and more as a control to validate what was said in the focus group workshops.

The problem with quantitative analysis is that it, in this case, is hard to know who has answered the question and therefore hard to validate whether the respondent is a valid source or not. Therefore the survey that was conducted was used as a compliment to the other research forms and the answers on the RQs are not solely based on the quantitative research.

## 3.3 Ethics

According to Bryman and Bell (2015) there are four main areas regarding ethics that should be considered when it comes to business research. These four main areas are if there is harm to participants, lack of informed consent, invasion of privacy, and if deception is involved.

Harm to participants can be seen from different perspectives which are physical harm, stress, harm to self-esteem, and harm to future career possibilities (Bryman & Bell, 2015). When conducting focus group workshops and interviews stress was avoided by giving the respondents time to answer without pushing for an answer and informing them about the areas

in which questions would be asked. The respondents could also refuse to answer questions that could harm their future career possibilities and be perceived as stressful.

Lack of informed consent means that the participants haven't gotten enough information about the project/thesis to make a rational decision about whether to participate or not (Bryman & Bell, 2015). In this thesis, this was avoided to give potential participants informative written information about the thesis and what their participation would contribute. Also before the interviews/focus group workshops started the participants were informed of the information needed to make rational decisions. The same was stated in the questionnaire that was published for people to answer.

Invasion of privacy refers to the violation of an individual's right to keep their personal information or the feeling that the participant is treated as an object of measurement, not respecting the sense of privacy and individual values (Bryman & Bell, 2015). To avoid violating the privacy of the participants they have been offered the possibility to stay anonymous through the whole process. Also when the recording of interviews/focus group workshops was done the participants were able to decide whether they were comfortable to be recorded or not. This gives the participants full control of their privacy and time to make rational decisions.

Deception in research occurs when the research presents itself to be something that it is not (Bryman & Bell, 2015). This will be avoided by the thesis work being published publicly and accessible to everyone.

## 4. Market Research

This chapter will present the result of the market research that was done on the industry, market, and competitors to answer research question number three. The market analysis will present the answers to the following terms: *actual and potential market size, market profitability, market growth, distribution systems, cost structure, key success factors, and trends and developments* and give a picture of how the market situation looks. This information was collected solely from the internet.

### 4.1 Market Analysis

**Market size, profitability, and growth:** The wireless charging market for electrical vehicles is today relatively small because it is in the early stages of development. There are some pilot projects ongoing with the goal of trying to identify how wireless charging could best be used in different market segments and situations. Akshay and Sonia (2022) claim the EV market was worth 163.01 Billion US dollars in 2020 and is expected to increase with a compound annual growth rate of 18.2% during the years 2021-2030. Which means that it could be worth around 823.75 billion USD in 2030. Since the wireless charging market is a growing part of the EV market this shows the potential it can gain. Although today as earlier mentioned the EV wireless charging market is rather small and was 2020 projected to be worth 16.5 million USD and is expected to reach 221 million USD in 2028 (FortuneBusinessInsights, 2022). This might feel like a very little percentage of the EV market but the important thing is to realise the potential the wireless charging can reach if the infrastructure develops as required. According to HEVO, which is one of the biggest companies working with wireless charging for cars, there will be over 225 000 cars with wireless charging as an option in 2028 (Hevo, 2022).

The growth of wireless charging on EVs is mainly based on factors such as the rising demand for EVs overall and the following demand for fast charging which brings requirements for a wider expansion of the infrastructure (Meticulous research, 2023). This increased demand mainly originates from governmental policies. According to An (2020) fast charging in terms of high efficiency and high power seems to be highly requested by customers which will help drive the process of wireless charging forward in this direction. However, there are not only upsides regarding the market potential. The expansion of wireless charging infrastructure entails high costs which someone needs to pay and there are not many players in the market that can afford this without the help of the state.

**Distribution, profitability, and trends:** The European Parliament made it illegal to produce and sell ICE (internal combustion engine) vehicles with the start year 2035 (Huitema. J, 2023). This means that all car-producing companies in Europe are only allowed to produce and sell cars that can partly be fueled by electric power. In other words, there will be a great need for effective charging for EVs since the options that are on the market today require the car to charge for quite a time compared to cars that use for example diesel as fuel. Since wireless charging is one of the three ways an EV can be charged this indicates that the market for wireless charging on cars has a huge potential to increase.

Since the new law refers to European countries these countries will most likely stand for the biggest market share. Europe also stood for 41% of the revenue in 2020 (FortuneBusinessInsights, 2022). Asia Pacific is also expected to stand for a big part of the market shares in the future due to government initiatives accounting for charging

infrastructure and the overall level of technical development happening. North America is also expected to follow this direction since many big wireless charging companies are located here.

Further arguments that point towards Europa being the leader in the general EV market is that the Norwegian government has stated to be world leader regarding electrified road transportation (Zampoukos et al., 2015). To fulfill this statement many subsidies and incentives have been carried out regarding everything that has to do with EVs. Such as much economic support for EV owners since EVs have been more expensive than regular ICE cars but also in terms of comfort aspects such as access to bus lanes and ferry connections. Sweden has also been moving in the same direction and stated that in 2030 they should have a vehicle fleet that is independent of fossil fuel (Zampoukos et al., 2015). To manage this Sweden has also carried out incentives and subsidies to financially support EV owners. Although later statements by the Norwegian government point fingers towards more narrow financial subsidies. Larsson (2022) claims that multiple subsidies will reduce due to the great expansion of EVs, but they will still remain high to meet the statements. Other countries that are at the forefront are Great Britain and Portugal.

According to Hevo (2022) fleets are predicted to be the leading segment regarding the development of wireless charging. Meaning they will force the automakers to react to the demand regarding wireless charging and in that way accelerate the development. This can also be strengthened by looking at the few pilot projects that have been launched where every one of them is operating together with fleets.

**Cost structure, key success factors:** The cost drivers for wireless charging on cars are mainly research and development since it is a very new product. When looking at the different parts required to complete the product it is the power pad, power station, and pole mount that stands for the majority of the costs. The more power that is to be transferred (kW) the more the expenses will rise (Hevo, 2022). Key success factors that have been identified during interviews, workshops, and the survey are to enable V2G. To make this possible due to the high investments needed the infrastructure needs to expand. Other key factors are to have a well developed product regarding the technical aspects. Everything regarding the usage of the product needs to work fine and be easy to understand. To conclude, wireless charging needs to be convenient for the user to succeed and well technically developed.

## 4.2 Competitor Analysis

This chapter will answer the five questions regarding competitors on the four biggest competitors.

- Who are our competitors?

The top competitors that were identified in the wireless EV charging market were Hevo, WiTricity, Qualcomm, and InductEV. It is possible that there are a few more leading companies but these were chosen due to staying within the scope of the thesis. Below they will be compared by the following questions:

- What are their strengths and weaknesses?
- What are their strategic objectives and thrusts?
- What are their strategies?
- What are their response patterns?

### 4.2.1 Hevo

2011 Hevo was founded with the main goal to speed up the adoption of electric vehicles and to eliminate the reliance on fossil fuel vehicles. Since then they claim spending almost a decade on developing technology that would be highly competitive on the market (Hevo, n.d.). Internal strengths that Hevo has is that they have 14 patents regarding wireless charging where all 14 covers different parts of the product. Additionally, they comply with the globally recognized SAE J2954 wireless electric vehicle charging standard and hold the UL 2750 safety certification for the commercialisation of SAE J2954 technology (Wefunder, n.d.). The downsides are their economic situation where they have a recorded net loss of \$3,062,223 during the Jan 1 – Dec 31, 2021 period. However, they have raised \$4,452,847 in 2021 and have projected revenue to exceed \$500 million by 2027. The business strategy they have to reach this goal is by offering leasing deals with no upfront costs to the customer (Wefunder, n.d.). Due to the immaturity of the market, the company's strategic objective is to build. This means that they want to acquire as many market shares as possible and expand the business now in the early stages of the market. Hevo's response pattern can be considered retaliatory due to its aggressive strategy to acquire market shares and its willingness to adapt to new standards.

### 4.2.2 WiTricity

In 2007, WiTricity Corporation was founded with the goal to commercialise technology regarding wireless electricity (WiTricity Corporation, n.d.). Regarding internal strengths, WiTricity holds over 1300 patents worldwide and has exclusive energy transfer technology. They also have several big investors such as Siemens, Toyota, and Mitsubishi Corporation and have been funded \$176 million (Crunchbase, n.d.). A potential weakness is that WiTricity does not sell their products directly to consumers, rather they sell it to OEMs and ODMs who then sell it to the consumer (WiTricity Corporation, n.d.). This means that they potentially miss out on sales that would go directly to consumers. Their business strategy is as mentioned to develop leading technology that OEMs and ODMs can use on their products and sell to consumers.

WiTricity's strategic objective is to build, this means that they want to expand their business in the coming years and acquire market shares. This also complies with the acquisition of Qualcomm Halo which will be presented below. They have declared a lawsuit against their competitor InductEV two times which shows that their response pattern is to try and slow down the competition.

In 2019 WiTricity acquired the Qualcomm Halo technology which included platform technology and IP assets (WiTricity Corporation, 2019). By doing this WiTricity's response pattern is retaliatory because of the aggressive approach to acquiring different technology to become market-leading in this area. This also shows that they have certain financial power compared to other competitors in this business area.

### 4.2.3 Qualcomm

Qualcomm is a large company creating wireless technology and owns mainly patents regarding OFDMA and CDMA which are key parts of 3G and 4G, they also lead the development of 5G. Wireless charging of EVs is still in its development phase so no products are being sold. Although Qualcomm had a revenue of 44'200 million USD in 2022 (Qualcomm, 2022). The firm also has a market cap of 133'911 million dollars as of the time

of writing (Mackintosh, 2023). Being such a large firm entails both pros and cons regarding Qualcomm's wireless charging development. A disadvantage might be that they have several focus areas which might indicate that wireless charging of EVs does not receive enough resources due to it being a very small section of the company's portfolio. Meanwhile, the benefit is that due to their large size, they have a lot of resources to make available if wireless charging of EVs would go in line with their market strategy. Further benefits are that they can have a cost-leadership strategy which means they can compete through having low prices which often is attractive to customers.

Qualcomm can arguably be seen as a leader in the industry due to early pilot projects together with Formula E and they have also been assigned a project which is partly financed by the European Commission (Qualcomm, 2017). Although their products might be seen as a substitute compared to the other competitors. This is because they focus on the cars being charged wirelessly while driving instead of while standing still. They have developed both techniques but focus more on the first mentioned.

Regarding Qualcomm's strategic thrust, a build strategy is most likely to be applied since the market is growing. Their financial strengths are pointings towards an aggressive response pattern with the goal of closing out other competitors.

#### 4.2.4 InductEV

InductEV was founded in 2009 under the name of Momentum Dynamics Corporation but has recently changed to InductEV. The strengths that InductEV have are that they have several investors such as Oshkosh, Volvo Group, and RCHEnergy (InductEV, n.d.). They also have some pilot projects with fleet operations, one of them being with Volvo Cars in Gothenburg (Volvo Car Corporation, 2022). The downsides are that they do not possess as many patents as some of their competitors which has led to them being sued by WiTricity (WiTricity, 2020). They also do not sell directly to consumers which leaves out a large part of the market. Another downside is that they finance their business by investors which leaves them vulnerable if those decide to walk different parts.

InductEV is aiming to expand its market shares by moving to a new headquarters facility that offers better development and research spaces with open areas enabling collaboration (InductEV, 2023). It also offers larger engineering labs which is important when testing products. Further, it is described that the InductEVs team are expanding which indicates that the company sees great potential and is trying to build or niche to specify their products to a certain segment.

Regarding their response patterns, we believe that they will try to fight back as much as possible. Since they have won earlier lawsuits this sets a good example of their willingness to succeed in this market. Their market strategy is probably going to be differentiation since they are a smaller company with a thin financial situation. They have to be better in some areas to win customers or only focus on certain segments to specify their products.

### 4.3 Industry Analysis (Porters Five Forces)

#### ***Threat of new entrants:***

There is a big threat of new entrants since it is a market with great potential, where companies can make a great amount of money. As already mentioned governmental policies are laying a

solid ground for these companies to explore the possibility of charging electrical batteries in different ways. According to Charged Future, 31 countries around the world are planning to ban gas cars as well. Those 31 countries are to be found across Europe, Asia, North America, and South America. This shows the great potential for EV charging. Although it is a very technical market that requires a high level of competence, meaning not every company can meet this requirement. This together with today's big players with a build strategy that strives to close out competition creates entry barriers.

***Threat of substitute products:***

Wireless charging is still in its early stages of development, although there are several projects where it is already being tested in real-life situations. Because it is still in the early stages there are several possible substitutes for it. One of the substitutes is traditional plug-in charging. This way of charging an EV is by far the most established and is expected to grow even more in the coming years in line with the growth of EV sales (*Electric Vehicle Charging Cables Market Report 2022 To 2030, 2022*).

Another substitute for wireless charging is battery swapping which also is in the early stages of development. The idea is to replace the existing battery in the car with a fully charged one. By doing this recharge time is heavily reduced and lessens the load on the power grid (Yang et al., 2021). Although this is a possible substitute many companies find it hard to scale up due to there not being any standardisation on battery packs. This means that every car company would have to make their own battery-swapping stations which wouldn't be a beneficial business model.

Dynamic wireless charging is a method that builds upon static wireless charging. Dynamic wireless charging means that charging pads are built into the roads to enable charging while the car is driving (Kanesaki, 2021). This eliminates the uncertainty of running out of battery due to it being charged while on the go. Like the other substitutes, this one is also in the very early stages and is being tested to explore the possibilities with it.

Robot EV charging is similar to traditional plug-in charging but the difference is that it is fully automated. When the driver parks the car in the parking spot, a robot plugs in the charger in the car automatically without the driver needing to step out (Ford, 2022). This shares some similarities with wireless charging in the sense of the driver not needing to do much apart from parking the car and pressing a button. This substitute is also in the early stages but is being tested by a couple of car companies already.

Overall there are a few substitute products to wireless charging but most of the substitutes are just in the development phase and are being tested on a small scale.

***Bargaining power of buyers:***

As of right now, there are very few buyers since the wireless charging products for cars are still in a development phase. Buyers are referred to as car manufacturing companies because they as it looks today need to add this feature as an option before their customers which are private people and fleets can be the ones buying the wireless charging. There are some collaborations between producers of wireless charging gear and car manufacturing companies but very few. The number of suppliers is few as well due to the early stage in the life cycle of this kind of product. The technical solution for the product is already existing but there needs to be more collaborations with the car manufacturing companies to enable the growth of this market. As for the switching costs from a buyer's perspective, the price will be great. In

theory, the products of different brands for wireless charging on cars should work on all cars that have enabled this function since a copper wire is a reason for the transferring of electrons. Although developing and marketing such new innovative and technical products requires lots of money which makes the switching costs high. The new law invented by the European Parliament which states that car manufacturing companies are forbidden to sell ICE vehicles from 2035 makes electric charging important. There are only three ways of doing so which are mentioned earlier. This makes it more difficult to substitute the product since there are so few options. Although as the market looks today traditional cable charging is used on a much larger scale which makes it easier to use since it is more explored and developed. The threat of backward integration is low since it is such a new market with few sales companies that might be afraid to take over too much of the supply chain since this puts them deeper in and makes it harder to get out or change direction if the result is negative.

Overall the bargaining power of customers is low due to a lack of suppliers. Car manufacturing firms need to collaborate with producers of wireless charging where most of the big companies already are “taken”. This might change if wireless charging is made possible for an aftermarket but this is not the case as of today. This makes it a bit complicated since car manufacturing companies can not only buy wireless charging stations and apply them to their existing models. They need to integrate wireless charging in the manufacturing process of the cars which costs much more.

***Bargaining power of suppliers:***

The bargaining power of suppliers can be considered moderate to high. The reason for it being high is that there is as of right now a limited number of suppliers due to it being a new type of technology. This gives the suppliers a high bargaining power because they can set prices according to that. Companies that are suppliers have also invested heavily in the research and development of the technology. The suppliers also might have key patents that are required for the technology to work which also reflects in higher bargaining power.

However, this could change in the coming years due to the expected growth in the EV market which could result in a higher demand for wireless charging (Akshay & Sonia, 2022). With growing demand, more companies could try to enter the market which may result in a slight decrease in the bargaining power of suppliers. Also as the technology becomes more adopted it could see a decrease in the price of the products. This could increase competition among suppliers and potentially reduce their bargaining power.

Overall the bargaining power of suppliers can be considered to be high due to few suppliers however with the expected growth of the market, this could come to change.

***Rivalry among existing competitors:***

Today there is a moderate rivalry among existing competitors. However, all of the competitors are third-party suppliers meaning the customers can not buy an original wireless charger for their car. Some of the leading companies in this sector are HEVO, WiTricity, Qualcomm, and InductEV. Also, these third-party companies are more focused on fleet operations and not on the private sector. Therefore there is an opportunity in the market for companies willing to focus more on private customers. So far, very few EV companies have tested wireless charging officially meaning that the rivalry among these companies is low.

## 5. Result of customer analysis

In this chapter, the result of the study will be presented. The result is based on two workshops, three interviews, and one survey. One of the workshops was together with two different fleet companies where one was a holding company that operates in the taxi industry and the other one was a car rental company. The second workshop was together with private persons who drive electric vehicles, both cars they have bought or leased.

### 5.1 Fleet Workshop

This part presents a summary of the discussions and answers given by the respondent from the taxi company and the rental company during the first workshop.

#### 5.1.1 Taxi Company

As mentioned earlier the workshop was divided into two sections where the first discussed aspect was the design of the wireless charging which includes user habits, customer needs, problems with cable charging, potential problems with wireless charging, and appearance. The other section handled every aspect that has to do with service.

##### 5.1.1.1 Design

Charging/User habits: The representative taxi company claims that their cars are on average being used 80 per cent of the day since often two drivers share the same car. The charging of EVs as it works today is through cable charging where their cars are charged when they have reached or are close to the geographical location they are supposed to be at. It depends on where the charging stations are located. The representative of the taxi company expresses that it would be preferable if the charging could be done while standing at the “taxi pocket” instead of needing to charge at a parking lot or gas station close by. However, a problem that occurs with traditional cable charging is that the car looks *inactive* when having a cable connected to it which scares the customers from approaching that cab. This problem would be even clearer if the charging would be done in the “taxi pocket”. On average an electric taxi vehicle stands still and charges for about 15 minutes to one hour before receiving a new drive. This way of charging stands for most of the charging done in a day. The charging stations that are used by many taxi drivers are often located a few minutes away from the location customers want to be picked up. Although close enough for it to be seen as a relevant waiting time for the customer who makes the request, which means the driver will be able to receive the drive instead of a competitor.

Another important aspect regarding the possibility of wireless charging on cars is the effect. The amount of electricity that can be transferred in a short timespan is important for all electric taxi cars. The respondent claims that the efficiency needs to be greater than 50 kW but 100 kW would be preferred. This is because it is very difficult to predict how the day will turn in forehand. Therefore the cars need to be able to charge quickly to manage to accept all requests of the day. One key factor to convince the industry to adapt and increase the number of EVs and therefore also increase the possibility of charging wireless is that the charging need to always work. This is because taxis need to be able to serve the next customer when demanded. If the charging does not work it is important that the technical parts work so it is easy to identify where the error occurs, such as the pad on the ground or on the car, or if the driver does not line up correctly. If this works, self-driving in terms of parking is not seen as

necessary for taxis. According to the respondent, taxi drivers that have tried parking on a wireless charging pad through pilot projects think it is easy. The pad located on the car is approximately half the size of the one located on the ground which offers margins.

Furthermore, it is not a requirement that the charging pads are portable but is preferred. If it is possible to charge at many locations the pad that is located in the parking space probably never needs to be moved. A problem that would occur if constructing a charging pad that is placed on the ground so it should be portable is that the required effect makes the volume of the pad very large. If the effect needs to be a minimum of 50 kW the size of the pad will be large which makes it hard to handle and move around. To be able to endure the possibility of being run over by cars or stolen the pad also needs to be buried under the ground which also makes it even hard to move. This might only be the case for taxis since those pads are located in public, pads for other segments might have different requirements.

The size of the infrastructure does also affect the requirement of having a minimum of 50 kW. If there could be at least ten different areas near Gothenburg involving multiple charging “spots” where taxis could charge wireless, that is predicted to be enough to cover the Gothenburg region with charging pads that allow 11-22 kW. Important for this statement to be true is that the charging spaces are owned by the taxi company to make sure there is always space and free chargers to use when needed. Furthermore, the representative claims that those ten areas do not need to be located in the city center since the taxi cars often collect people from the city center and drop them off further out, or the other way around. Another alternative that could work to enable the statement or at least would be preferred is if one or more charging spots could be reserved for taxi cars. This would also enable the charging pads to have less effect such as 11 or 22 kW since the charging access would be larger. Most of the drivers chose not to charge at fast charging stations that offer 150 kW plus as of today since they are expensive. To conclude the optimal situation would be to have less effect and more charging spots which also is better for the battery’s lifespan. All cars are used for all types of distances so there is no option to have some cars that can use fast charging and some that can not.

In general, to make wireless charging work a lot of the pressure is on the electricity companies to be able to provide enough electricity to a small area where the demand today is low. Furthermore, a standard regarding how the charging will work and how the pads will look needs to be conducted. If not the different car models will not be able to collaborate with the different wireless charging brands and it would require a great number of extra charging stations which will affect the distribution of electricity. If the demand for 100 kW pads would be fulfilled by the charging companies and electricity companies can provide and distribute enough electricity to make this possible the infrastructure will, according to the respondent take a huge step in the right direction.

#### 5.1.1.2 Service

Regarding the service of wireless charging for EVs there is one aspect that covers the everyday usage and one covers errors. With reference to everyday business, our respondent argues that there is no need for an app or system which shows all available taxi cars, and proposes a driving route instead. However, it would be interesting to have if there was a function helping prioritise which car would have access to the charging first respective last. Would also benefit if payments could be done through the app if there was one, instead of needing to step out of the car and pay with a special card. Further, the respondent claims that a taxi driver on average drives 300 kilometers, and customers would not tolerate stopping in

the middle of the journey to charge for 15 minutes before continuing. Therefore a system or app that could prioritise taxi cars on charging stations would be preferable.

Regarding service that handles errors, taxi companies do not see a problem with one or two charging pads breaking down. Due to the fact that if wireless charging should be implemented the volumes need to be large and then there will be another charging pad that works in the same area. Therefore, there is no need to spend a large amount of resources on fixing broken charging stations quickly. The time that would be acceptable to reach out and fix it if there would be no other stations free is not realistic. This means that taxi companies do not want to own charging stations.

Service aspects also cover warranties. According to the respondent taxi drivers do not take price into much consideration when buying a car if there are warranties that cover the range and years that a battery should provide. As long as the warranty covers the range and life span of the battery, buying prices for EVs could be high because of the depreciation.

When discussing how the installation of wireless charging should look, the most logical alternative is that it works the same way it does today with cable charging. Connect the wireless pad with the already existing energy box. This enables an electrician to do the installation. Today the owner of the land decides whether electrical charging boxes should be installed or not. The respondent thinks this is the smartest way to do it with wireless charging as well. This might be done to attract customers, for example, their shopping mall. Even private investors could collaborate with the land owners to earn money on the charging. Taxi companies themselves will probably never buy and install their own charging stations due to the low financial profit they see in them. If a charging station would need to be moved this would most likely be done by a third party such as electricians.

## 5.1.2 Car Rental

This part will present the result from the workshop from the perspective of the car rental that was present. The topics that will be covered are as earlier mentioned design aspects and service aspects.

### 5.1.2.1 Design

The representative from the car rental begins the workshop by stating that their main goal is to have as many cars on the roads as possible. The respondent says that about 80% of their cars are out with the customers every day. Because of this, he expresses that there is a need to have enough time to charge the car before the next customer takes over. The company experiences a great variety of how long the car stays parked in their garage and has time to charge. Sometimes it stays overnight and sometimes it only has 30 minutes to charge. This means that the cars need to be equipped with the option to fast charge if such a situation occurs. The representative claims that in cases where the car has a reasonable amount of time to charge before the next customer collects it, 11 kW charging would be sufficient. However, the times that the turnaround of the car is very fast charging is required but even 150 kW would not meet the needs in some cases. To solve the need for a fast-charging wireless pad the representative claims that the narrative to rent out a fully charged/fueled car needs to be changed. Instead, the optimal way would be that the customer charges the car and leaves it with for example at least 50% left. This would mean that even if the turnaround of the car is fast, there is no need for a fast charger due to the car already being charged. Until there is a change in society from cable charging to wireless charging the car would need to be equipped

with both wireless charging and cable charging. The person interviewed claimed that wireless charging with the combination of autonomous driving would be very beneficial for them. This means that the customer leaves the car in a parking lot close to the car rental and then the car itself drives to the car rental, parks, and then charges automatically. The representative believes that many customers would find wireless charging beneficial. However, it needs to be designed so that the car's wireless pad connects with the wireless pad on the parking lot without the driver having to do much. The ideal would be that the car parks itself, starts charging automatically, and the cost of charging would later be charged when the customer pays for the car rental.

V2G is also a topic that arose during the workshop. The car rental company did not see a direct connection to how they would be able to benefit from being able to sell electricity. This is due to the fact that their cars need to be rented out for them to make money, and when it's not rented out it needs to charge to be ready for the next customer. However, when a customer rents their car they are often parked somewhere charging overnight. The representative says that a possible solution for all parties to earn money could be found so that for example the person renting gets a better deal. But this sort of deal would be very hard to make due to the number of involved actors.

The representative also says that the car rental does not own their parking spots, they hire it from the property owner. Therefore, it is the property owner that decides if new charging stations will be built or not. The interviewee says that the optimal way of designing the charging pad would be to make it portable, meaning it could connect to an already existing charging station or to a 3-phase charging socket. This would enable them to move from different locations easily and not have to hire for example an electrician to install it.

A problem that the representative has noticed is that sometimes the car is returned without a charging cable. This is because the customers forget the chargers at the charging station. The interviewee believes that this problem could be solved with the help of wireless charging where the customer does not need to think about any cable.

#### 5.1.2.2 Service

The representative expresses that he would want a system that can control which car is going to get charged first and which car needs the most electricity. They would want this so they don't have to move the car between different parking spots to charge them. In their business, they want to avoid moving their cars as much as possible due to the fact that it takes up personnel and time to move them. According to the interviewee this kind of system is being used at some of their pickup locations but not all of them.

Another important aspect that was mentioned earlier is that the company would not like to own the charging pads if they were fixed to the parking spot. The reason for this is that they often don't own their parking spots. Therefore, they would not like to own something that would have to be left in case of moving to a different spot.

The major benefit the representative sees with wireless charging is the combination of the car being self-driven and being able to park without anyone having to interact with it. One example that was mentioned is for example at airport drop-offs. There the idea would be to leave the car at a dropoff and when the customer has left, the car itself drives to the rental office parking spot, parks and charges by itself.

Another aspect that was discussed was that the installation process of the charging pad needs to be easy to do. The interviewee expresses that they don't want to be forced to call a technician or similar to install it, they want to be able to do it by themselves.

## 5.2 Private user workshop

This part will present a summary of the discussions held and answers given by the respondents during the workshop with private persons.

### 5.2.1 Design

All of the respondents see wireless charging as mostly a comfortable way of charging EVs and argue that this might be the main driving force together with the technical parts being well-developed. V2G is also a strong driving force since it offers the possibility to earn money. V2G and wireless charging work hand in hand since wireless charging allows the car to always be connected to the electricity network. A high level of scepticism was felt regarding the efficiency loss being larger than it is using cable charging. Although the discussions ended up with a common understanding that those losses are negligible and wireless charging works just as fine as cable charging does in this aspect which allows the driving forces discussed earlier to be large.

When discussing the effect and size of the charging pads the respondents claim that different kW solutions might be preferred depending on the purpose of the charging. Fast charging (over 20 kW) is not required when talking about home charging most people have their car parked at home for 8-12 hours a day, which indicates that 3,7 kW is enough. Although from an economic perspective instead of only comfort, 11 kW might be preferable to be able to fully charge the car within the cheap electricity hours. (The electricity is cheaper when fewer people require it which often occurs at a few hours each night). This is a key factor if V2G should meet its full potential and generate economic benefits. The amount of kW that seems to be optimal mainly depends on costs but also on payback time. A lower effect means a smaller charging pad, which makes the implementation into the car easier which in turn means a lower buying price. So if the purpose is to charge the car comfortably, 3,7kW is enough, but if customers want to save money in the long term, 11 kW is preferred.

Later in the workshop, problems regarding cable charging were discussed. One important problem to solve is that the cable should know which car is being charged to handle payment and prioritise electricity distribution. This must work on the wireless charging as well. Plug and charge which is what has just been described plus that the payment should be automatically added to your house electrical bill without you having to do anything is soon to be demanded by many customers according to the respondents. Another problem is that the charging hatch is hard to open when the car is parked outside in cold weather conditions. Also when charging in public stations many EVs have a very short cable which makes parking hard since cars are standing higgledy-piggledy to be able to reach the charging socket. This often leads to cars blocking charging stations that are not being used.

Another important aspect to consider is that the charging pad connected to the ground should be able to be buried under the ground but also just laying on top of the ground. This should be an option for each customer to decide. It is also important that cable charging is still an option since people would probably not be willing to switch to wireless after having invested in cable charging. Further, the material of the wireless charging pads needs to be tolerable to

handle abuse since it can be driven over. Regarding if the charging pad needs to be portable the respondents do not think it is necessary but might be good to have as an option. They believe the charging pad will be bought and sold with the house. However, the most important thing is that a standard is being developed so that different car brands can work with different charging companies.

Regarding choice criterias the design aspect is not believed to be as important as the technical. The importance is that the product works well and as it should. Further, the respondents do not want solutions that require moving parts when charging, such as charging arms.

### 5.2.2 Service

When discussing public charging a topic that arose was if it was possible to have a system that prioritised which cars should receive the most electricity depending on when they needed to leave. The optimal solution would be if all drivers would report when they were planning on leaving and a third party could evaluate which car needed the electricity first and then prioritise so all cars would be fully charged in time. This would also allow people who do not need their car to be charged quickly to receive a cheaper price since they got prioritised lower. Although this idea brings complicity such as it forces the drivers to know exactly when they need to leave and how long they need to drive to match the required fuel. The common agreement was that if things get too complicated customers do not want it, simplicity is key. The payment method will be complicated which indicates that a third party is needed. This could be in terms of an application where the driver puts in how much fuel is required and where the app could communicate with the charger. This app should always include a safety margin that will cover unpredicted happenings.

When charging EVs today there are a lot of different parts that cooperate which makes it hard for customers to understand what part of the chain actually decides when the car should charge. This needs to be easy to understand, for example through the app mentioned above. When many parties are involved it is also hard to know who is in charge of different errors that occur. A solution as the app mentioned earlier would be preferable since it lowers the number of parties involved. The respondents claim that using wireless charging should be easy, smooth, and as comfortable as possible. If things work as they should and customers know who to call if they do not, they are happy.

Regarding the installation of wireless charging pads, it doesn't matter who installs it as long as it works. This puts requirements on the charging pads that they are simple to understand and install. The respondents also believe that the aftermarket is important. There should be an option to “rebuild” the charging poles customers have today into allowing both cable and wireless charging. The respondents do not believe customers would buy wireless charging if it were to exclude the traditional cable charging, it should complete the cable option.

Furthermore, none of the respondents would see self-parking as an important part of wireless charging. It is rather seen as a big risk that the car would park itself in the wrong spot or hit an object. Having the option would be interesting since all of the respondents are interested in technical solutions but it is not necessary. They believe the cost is much greater than the revenue together with the fact that it already works fine today with the assistance some cars offer when parking. Although it is a must that there is an indicator that tells if the car is parked correctly to start the charging.

### 5.2.3 Pricing

What price customers are willing to pay for wireless charging depends on what features and advantages it brings. It also depends on the depreciation time that is enabled with V2G. If wireless charging is only seen from a comfort point of view none of the respondents would be willing to pay extra, but if it offers a way to earn money and help the environment they would. How much depends on the payback time. As long as it is a guarantee that it will generate money along with being environmentally friendly the price is not an important factor. The way this solution allows people to earn money is through V2G where wireless charging is a key aspect of enabling V2G since it allows the user to always be connected to the electricity network as long as the car is parked on a charger. If wireless charging is not available the respondents claim that people might forget to plug the charger into the car at times when they do not need to charge it. Since it is a large battery in all EVs it might only be needed to charge it once every second day which means that the car won't be connected to the electricity network most of the time. Being connected is a demand for V2G to work. If V2G is enabled all respondents would be willing to pay for wireless charging. If it is 30 000 SEK or 60 000 SEK does not matter as long as they believe they will earn it back.

People that were identified as having the biggest use for wireless charging are people who have an EV and also solar cells since they can connect the car battery to their own electricity production and save the electricity or sell it. A question that arose is if people would get paid by every available hour they can sell electricity or by kWh. Today it is possible to get paid as a private person for being able to sell battery capacity. For example, energy companies could want to pause the electricity flow to your house with very short foresight to prioritise it elsewhere. This is only possible if the household can receive electricity from somewhere else which is the case for EV owners. The car battery also offers better efficiency rates, meaning that you can use less energy during peak hours and save money. To conclude if you can earn or save money from it, many think it is interesting and worth paying for.

When discussing if there should be an option to hire or subscribe to wireless charging pads instead of buying them the respondents did not find that important as long as they are owning the car. But if customers are leasing a car it would be smart to offer a leasing option for the charging pads as well. If there would be a possibility to hire a charging "kit" for a certain time and try it out and then buy it, it would be an option but it is not seen as necessary. To lower the total price for customers it is believed that the charging pad would be a portable rubber pad that does not have to be integrated into the ground.

## 5.3 Interview private sector

This chapter will present the result in the form of a summary of the interview done with a private person regarding purchasing behaviors, the process of purchasing, and user habits.

### 5.3.1 Private sector respondent

The respondent has worked a few years as a consultant within the taxi industry and works now for a company that creates charging boxes/poles, both software, and hardware. His charging habits have varied widely throughout the last years which means he has been charging at home, work, and public stations. The home charging goes through an 11 kW owned wall box with 25-ampere as main fuse and charging is scheduled to be done when the prices of electricity are low. During summertime when the solar panels produce electricity at maximum effect, he is able to charge with only electricity produced by those which prevents

him from charging when the grid prices are high. This enables cheap charging during all hours. He also charges on public stations from time to time when needed. He travels much with his EV and also charges much both at work and at his temporary residence. The charging at work is done during the day at a fixed cost and during the night at the temporary residences, also at a fixed cost. Despite all the travelling the car's battery is nearly never empty. The respondent claims that during winter time when the temperature is cold, it is beneficial to charge the last one per cent during the morning before leaving. This is done to raise the temperature inside the car and minimises wear on the battery. A warm battery does not consume as much electricity as a cold one does.

The charging box at home is bought from the company where the respondent has worked at. Regarding important choice criteria, the social (environmental) aspect was most important. Since he is from Sweden he chose a Swedish brand that focused much on sustainability to ensure a long life span. The technical aspect is also claimed to be important. The product needs to have good quality and always work as it is supposed to. Furthermore, the charging cable was long which was a big bonus. The respondent explains that he made the decision of what box to buy by himself since he worked with the product. Further, he expresses that 30 per cent of people are buying charging poles based on the recommendation of electricians who in turn choose the brand they believe is easiest to install and will generate the most revenue for them and their company. While the rest base their decision on either the cheapest box and brand or the one recommended by their car brand when they bought their first EV. He claims that people buy either online or from their electrician.

## 5.4 Interviews Commercial Sector

This chapter will present the result in the form of a summary of the interviews done with the commercial sector regarding purchasing behaviors, the process of purchasing, and user habits.

### 5.4.1 Leasing Firm

Regarding user habits, all cars are fully charged when leaving the company's depot, after that it is the customers who are responsible for the charging. Each of the 160 rental offices has its own charging stations but not every car has its own spot, which means that plenty of cars need to use the same charger. There is an occupancy of about 74 per cent, which in turn means that there is a great need for fast chargers such as 150 kW which is the maximal efficiency the cars today can manage. Today most of the stations use 11 kW which is described to be working fine, but more fast charging is desirable. Although the main problem is electricity access. Many stations can not receive enough electricity to be able to upgrade the chargers with larger efficiency. Although it works well in most cases since customers are usually never returning the cars empty. According to the respondent, cars are 60-70 per cent charged when returned the majority of times. The company counts 80 per cent or more as fully charged, which saves the lifespan of the batteries.

Cars are often dropped off in the evening and directly put to charge and then a new customer collects it in the morning the next day. Otherwise, other solutions must be applied such as using public charging stations when not enough own chargers are enabled. The time span cars are charging varies widely. Portable charging stations which can offer fast charging are being used and are much appreciated since they can be used where it is needed. In places where those are not available for the company cars tend to leave the rental office without being fully charged.

A problem that has been identified is that the charging cable can freeze during winter if it is not being used in a garage. Self-parking is another interesting aspect that would have been appreciated but the respondent questions who should pay for it. He further claims that their customers would not want to pay more for such a function but it is helpful. He continues claiming that wireless charging would be great and much useful but their main goal is to increase efficiency.

Further buying habits of chargers were discussed. The company owns all their cars but regarding the charging boxes depends on the office. Some places use wall boxes that have been put up by the property owners and others use wall boxes owned by themselves. Examples of locations where they use their own wall boxes are Arlanda and Landvetter Airport. Also, all portable charging stations are their own. When deciding what brand of charging boxes to select, the technical aspects are most important. "Smart charging" is preferable which means that the system itself can distribute electricity to the car with the greatest need. The economic aspect is not as important since they value their customers' needs of having a fully charged car on time more.

Charging poles are being bought when there is a demand and are only being replaced when breaking down or there is a demand for poles offering faster charging instead. There is no decided time in forehand nor policy on how long they are allowed to stay in the company. Since plenty of cars share the same charger there are no buying patterns connected to new cars being bought. Regarding decision-making, customers have some demands on what car

brands they want, often electrical. This creates some barriers to what charging poles to buy. Demand for EVs can indicate a care for the environment which also applies to the charging poles. The company is also in collaboration with a car brand which limits the number of options but the electrician has the final word. This buying process only applies in situations where the company buys the poles themselves, otherwise, the landlord possesses all decision power. Since the company in question has a contract with a car brand the poles which are being bought are done so through this company.

#### 5.4.2 Taxi Firm

The interviewed taxi firm sees itself as a private driver company and is driven by three words which are safety, luxury, and sustainability. 70 per cent of their travels are booked at least one day before and the rest are registered a few hours in advance. This enables good planning on when and where it is possible to charge. Most of the charging is being done during the night since very few customers travel then. The majority of the time charging is done from the home of the drivers where they are using their private charging poles. If this is not the case they charge at different premises that are being hired. Public charging stations are only being used when required, which nearly never happens. During the night 11 kW is enough to usually fully charge the cars but when charging is needed during the day a higher efficiency is preferred. In those cases, at least 50 kW is demanded but 150 and 300 kW are happily being used if possible. A guideline for when they decide to charge the cars is when the battery goes beyond 30 per cent which barely happens during the drives that occur on a day. Although charging is not a big problem since their cars are on average active for 6 hours per day where much time for charging is available.

Charging boxes at driver's homes are being chosen by the drivers themselves and most likely follow a decision process of a private person with some limits, such as it needs to fit their specific car. Regarding the boxes at the different premises, the company is responsible for both the buying and installation. 11 kW is enough efficiency-wise and also has a reasonable cost. Their cars are of well-known and expensive brands but since their customers do not see their charging stations there is no social status in what brand to choose. They rather prioritise the technical aspects, which makes the price less important. Since one of their keywords is safety this applies to the charging poles as well. New charging stations are only bought when there is demand for expansion of the company or when old ones break down. The electrician is important in decision-making and has a big saying. The company initiates the buy and has the last saying but the electrician and driver (for private charging at home) have much influence. Since the company uses the word sustainable in marketing they care more about where the electricity comes from rather than what charging pole that distributes it.

When discussing wireless charging the respondent sees it as a comfort upgrade since a lot of different charging cards are needed today. V2G also sounds interesting since it offers a way to help the environment and so being sustainable.

## 5.5 Survey/ Customer Analysis

The survey got 36 answers where all respondents were current users/owners of EVs, of which seven had never owned a charger and 11 had owned one or more for less than a year. The remaining 18 respondents (50%) had owned a charger for a longer time. When asked about when in time wireless charging would be implemented 66 per cent believed it would be more than 5 years away. 20 per cent believed it to be between 3-5 years away and only 1 person thought less than a year.

**Where do you most often charge your electric vehicle? At what part of the day do you usually charge your electric vehicle?**

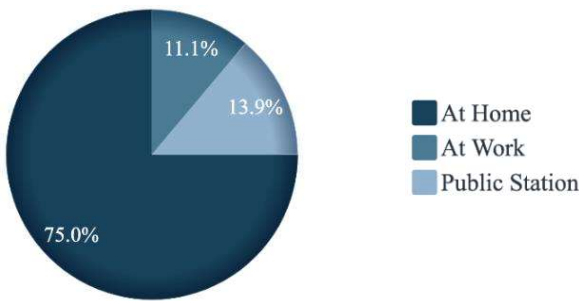


Figure 2 shows where EVs are being charged the most By private consumers from our survey.

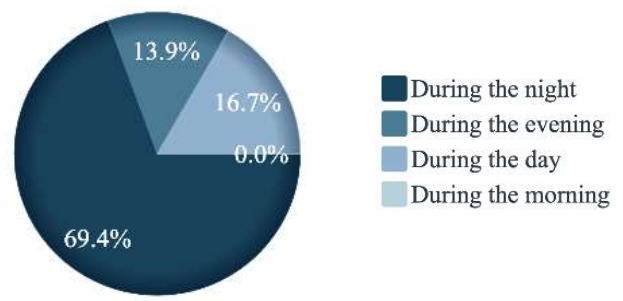


Figure 3 shows at what time EVs are being charged the Most by private consumers from our survey.

Regarding charging time where 64 per cent of the respondents claimed to charge between 2-6 h per charging occasion. 19.4 per cent charged for under 2 hours and 16.7 per cent charged for over 6 hours. Those numbers are associated with the amount of kW which is being used and battery size.

**How many kW do you charge with at home?**

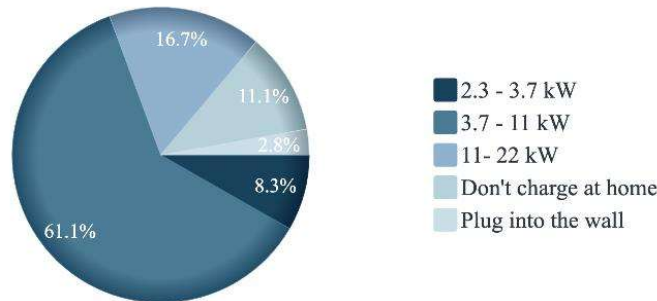


Figure 4 is a visual representation of how many kW of private consumers of EVs are used when charging at home, from our survey.

Most of the respondents are using between 3.7-11 kW which is equivalent to around 8 hours of charging time to fully charge a “normal”(60kWh battery) EV from empty to full. This, of course, depends on the size of the car battery and the exact amount of kW used (7kW in the case above), but this indicates that most of them are trying to have a safety margin regarding their battery level to never go under a certain percentage. This in turn is associated with the

amount of Ampere the main fuses are set to trigger at. This since it is not possible to use a high kW charger if the amount of Ampere is set to be low. As shown in Figure 5, the most popular alternative is 16 Amperes and then 25. 16 Ampere is equivalent to 3.68 kW and 25 Ampere is 5.75 kW per fuse.

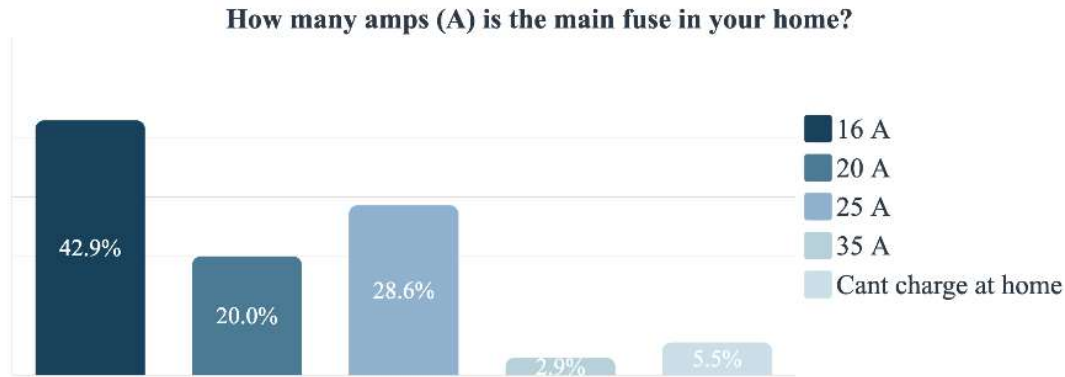


Figure 5 shows how many amps EV users have at home. Data collected from our survey

The next part of the survey covered problems with traditional cable charging where 75 per cent have encountered or heard of people who have problems and 25 per cent have not. Those problems were loose contact, the charging being slower than programmed due to heating and risk of fire, app problems, cable locking to the car (stuck in the car), and too many applications needed to charge causing confusion.

**Where do you buy your charger or would buy if you don't own one?**

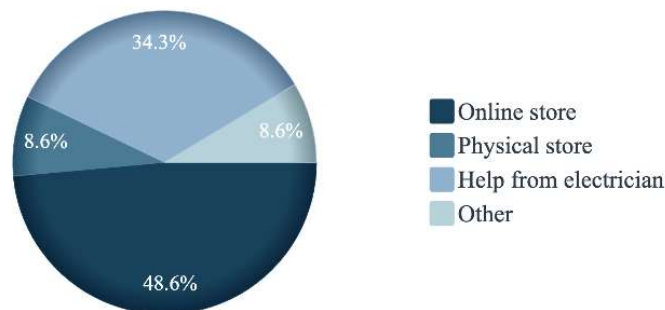


Figure 6 shows where EV users buy their chargers to indicate where wireless chargers will be bought. Collected from the survey.

When asked if they would be willing to pay more for a car equipped with wireless charging than one without, 44.4 per cent answered no. 16.7 per cent said that it depends on the payback time wireless charging helps to offer and 25 per cent claim to be willing to pay between 5'000 - 20' 000 extra. 13.9 per cent would be willing to pay over 20'000. Before answering the survey the respondents got to read a short text which explained wireless charging and V2G which is the factor that allows users to earn money from it. After this, those people whose answers were no got to express why they would not be willing to pay extra. The summary of those answers can be divided into three categories. First, people do not find it troublesome to

connect their cars with wired charging. Second, a fear of it being slower and involving higher efficiency losses with great risks. Third, there is too little knowledge about it.

Lastly, a question where different important choice criteria would be ranked from most important to least would be addressed. The different criteria were convenience, cool features, costs, personal aspects (ethical, emotional, self-image), making V2G and V2X easier (economical and environmental benefits), and making owning an EV easier. Nearly all aspects got places in every possible ranking position meaning some valued it to be very important and some did not find the same aspect important at all. Overall convenience got placed the highest which means that technical aspects were most important. Cost, V2G, and easier ownage were seen as equally important. Cool features were seen as the fifth most important and personal aspects finished last. To summarise the entire survey some people expressed their gratitude and showed they want the product while others are more sceptical and do not believe wireless charging will be of any use in the future.

## 6. Analysis of the result and recommendations

This chapter contains an analysis regarding the identified customer's readiness for wireless charging which builds on both customer's knowledge and will to adapt in the product development phase. It will present an analysis of different essential aspects regarding the design of the product and analyse how the market situation is shaped and might develop in the future.

### 6.1 Customer Readiness

*RQ 1: What readiness do identified customer segments have for adopting wireless charging on EVs and where do we see the biggest potential?*

The readiness varies between different segments but mostly between different people within the segments. This can be because different respondents have different attitudes towards new technologies. This is what earlier in the reports theory section (2.1.5) is called *Diffusion of innovation*. Overall the people from the workshops were more positive toward wireless charging than people from the interviews and surveys. If not from the beginning they became more convinced after the discussions. This is probably because they were what are called innovators or early adopters but can also be because it is easier to convince someone through a discussion than from an online survey. The invitation to the workshops was posted in a Facebook group aimed towards EV-interested people and in an open form, meaning that the participants had to sign up themselves which increases the odds of them being innovators and therefore more positive. If the respondents would have been people from the group's late majority or laggards they would, according to the theory, be more reserved and would want to see the products in action to observe that it works well before deciding whether to purchase or not. Thereby also receiving a positive attitude towards it as the innovators already had.

People that had a more negative attitude towards wireless charging regarding all involved segments could have different reasons for it. We believe it has to do with a lack of knowledge and that they do not see a problem with the cable charging used today and switching systems always entails costs. Wireless charging is in its introduction phase described in Chapter 2.1.4 about PLC, meaning that the price customers have to pay is higher than many might find it to be worth. Only innovators and early adaptors might believe it is worth that cost. During both workshops, some people were a bit reserved at first but when they heard other's thoughts and points of view they began to see other aspects and values which they had not thought of earlier.

Regarding what segment constitutes the biggest potential, private users are reasonable to argue for. This is mainly because, from the first workshop with fleets, it could be seen that large investments in infrastructure are needed and especially for taxi companies. The respondent from a taxi company also claimed that they were not willing to finance this, meaning a third party must do so. This indicates that fleets might have lower readiness than the private sector. Leasing companies were willing to pay for it on a wider scale but might not have as much use of it as taxi companies but it is still highly usable. In the private sector, finance will not be a problem and the innovators believed in the concept of charging wirelessly. However, fleets are the segment that has reached the farthest in the development with different pilot projects, which points towards them being the leaders of the development. Despite this, the private sector might be seen as more profitable due to lower complexity. Although it is not crystal clear. Private users are today limited to nearly only houses since

apartments do not offer the possibility to charge. People with EVs that live in apartments often have to charge at work or public stations which also adds complexity and limits the market segment. However, this problem seems to be easier to encounter than the expansion of infrastructure required by fleets. If the landlord of the apartment can be convinced EVs need to be able to charge at the premises the problem is solved, and with the EU 2035 ICE ban, this will probably be the occasion that happens either way.

Our recommendation would be that the companies work with innovators and make them ambassadors for the product. Innovators are usually people that like to show their newly acquired technology which will market the product for the companies. By doing this an effective marketing strategy can be established. Also a larger focus on the private sector as customers should be established due to the potential they contribute and the fact that this segment is behind in the development.

Overall it is hard to say what readiness customers have but what can be said is that innovators and early adaptors seem to be ready and willing to try it out, but mostly as a pilot project to see if it is worth continuing investing in.

## 6.2 Product Requirements

*RQ 2: What customer needs, requirements and buying habits do the customer segments have and how should wireless charging be packaged? What is the customer value?*

When it comes to user habits they were presented in the result chapter in this report. In the private sector, most of the respondents were EV owners that had the possibility to charge at home. For them the average charging time was between 4-6 hours depending on the battery size but also the effect on the charger. Most of the participants expressed that their longest charging often occurred during the night and the reason for this being to avoid expensive peak hours for electricity. The conclusion that can be drawn from this is that the charging times depend heavily on the price of the electricity since you do not want to charge when it is expensive but also the availability of the car. Often the car stands still in the parking spot during the night and therefore is the most convenient to charge at that time as well which will also imply wireless charging.

When it comes to fleets their user habits partly differ from the private sector but also between itself. Not in terms of the timespan when the cars were charged since fleets also try to charge much during nighttime when the prices are cheaper, but in other aspects, they differ. All fleets are striving to use their cars as much as possible, meaning that there are few hours when the cars stand still. This is to maximise the usage and economic benefits. As it is today no money can be earned from a car that is not being used. However, this can change with the possibility of V2G since it allows the company to sell electricity back to the grid when the cars are not being used. However, it is probably going to be more worth using the car for its original purpose instead, such as driving customers. Despite that, it gives the option to generate income when the demand is low. Due to this fact, V2G prospects to have a much larger use in the private sector than for fleets. The time a car is not being used is most likely going to be needed to fully charge it regarding fleets. The respondents regarding fleets were however positive about trying V2G since they are innovators but did not necessarily see great value in it.

Even if the different types of fleet operations have different user habits it is possible to identify a common habit for most of them. As can be seen in the result section of the report (*chapter 5*), cars are usually used 80% of the time when being a fleet car, where the charging time can vary from 30 minutes to overnight. This means fleet operations are in great need of “fast charging”, over 50 kW. However, this statement is only true if the infrastructure stays the same and does not expand much more than it has done today. Because if it would expand to a certain degree 11 kW is expected to be enough in most cases. Although a huge investment cost is needed if the infrastructure were to expand enough on a social level which most companies today are not willing to pay for and neither are their customers. So this requires a third party to do so which makes the situation more complex. Another big problem is the amount of electricity the electricity companies can transfer. If all of the fleet chargers would be 50 kW and larger they would not be able to receive enough electricity at a time. Meaning even larger investments are needed and property owners need to be convinced to upgrade their electricity power transportation which most likely will increase the prices of electricity.

When it comes to the choice criteria that were presented under 2.2.1.3 a variation between the different customer segments could be seen. In the private sector, all of the four different types of choice criteria were present however some were more important than others. The technical criteria were the one considered as the main choice criteria by many of the respondents. As shown in the result chapter the majority of the respondents used a 3,7-11 kW charger and for private use at home everyone was satisfied with that effect and came to the conclusion that from a technical point of view, there was no need for a higher effect. 3,7 kW can be sufficient for home use but the problem with such a low effect is that it takes a fairly long time to charge. This in itself is not the problem but the problem occurs when the charging time is so long that the customer is forced to charge during peak hours regarding price on the electricity grid and with that the charging becomes more expensive. Therefore 11 kW is preferred due to the fact that it on average takes about 6 hours to fully charge a battery and with this shorter charging time the customer is able to avoid peak hours. Another thing as to why 11 kW is the sweet spot is due to the fact that most homes in Sweden have at least a 16 A fuse which means that most people would not have to change the fuse which would also drive up the cost. However, we are aware that there are some exceptions that would want a higher effect and therefore it is beneficial to have cable charging as an option as well. From a technical point, the private segment was very clear that the possibility of V2G was crucial to make them interested. With this, an app to control the charging also was desired. This implies that to make the wireless charging option competitive towards the other substitutes these technical criteria need to be fulfilled. As the theory mentions convenience is also considered under technical criteria. In the survey, this was the choice criteria that most of the respondents put in first place when it comes to what would attract them to buy wireless charging. The conclusion that can be drawn from this is that a key success factor to get the customers interested and willing to buy the product are the technical aspects of it. Therefore there needs to be a lot of work done here to match the requirements presented in the result.

The second most important choice criteria that we identified was *economic*. This was also where we experienced the most resistance from consumers to purchase this product. The majority were not prepared to pay more to get this as an add-on feature on the car. However, some were prepared to pay an unspecified amount depending on the payback time of the product in combination with V2G. Therefore it is very challenging to put a number on how much the product can cost at most and what the customer is willing to pay (see 2.2.2.2). Why this price resistance exists is not clear but it may have to do with the fact that many already

have a charger and they don't see a need to change it. An option to avoid or at least lower the price resistance could be to offer a product that can be connected to the already existing power mount that the customers in these cases have. By doing this the costs could be lower and more people open to purchasing. Another option mentioned earlier is V2G which would enable selling electricity to the grid and by doing this having a payback time for the product. This would most likely reduce the price elasticity of demand for the product, meaning that the quantity of buyers does not necessarily reduce with a higher price of the product.

*Social* and *Personal* criterias, presented in 2.2.1.3, were ranked the lowest by the respondents and not considered as crucial to satisfy the customer needs. Regarding *personal* criteria, there isn't anything expressed by the respondents that it is important. However, it is reasonable to consider that there is some underlying ethical driving force to buy an EV and then later on buy a charger. This is due to the low environmental impact the cars have which then in some cases can boost the self-image of people buying them. This theory can reasonably also be applied to wireless charging pads.

*Social* criterias were also not explicitly expressed by the respondents however we believe that there is a social impact on the purchases people tend to make. People easily get influenced by their surroundings and therefore also get affected by their purchases. Therefore, we believe that word of mouth will be important in marketing and it is why it's important to have a quality product based on the expressed customer needs.

Regarding choice criteria for fleet operations, the technical criteria were once again clearly the most important one. The technical aspect includes convenience which is described as the main reason to buy wireless charging, "smart charging" which means that the system itself can distribute electricity to the car with the greatest need when multiple cars are being charged at the same time and there is a limit on how much electricity that can be distributed simultaneously, and low error percentage. Another technical aspect that is important is that it is portable. Although this only applies to some firms and was not seen as useful for private persons. The reason it would be useful for some firms is both because companies switch locations and also to move it for short periods when it is demanded somewhere else. As described in section 2.2.2.1 companies need to have a wide range of customization for their customers to be able to compete in today's modern market. Depending on the situation a portable pad can be both useful and not, and therefore it is only important for some of the firms. For the taxi companies portable pads entail more risk than benefit. This is because a portable pad is easier to steal and taxi companies often pick up passengers in the city center and also want to charge here. However, cities contain many people which increases the risk of it being stolen if it is portable. Another problematic aspect of the portable pad is that it needs to be level with the driveway, which is not possible, to enable for example snow shoveling in the winter. A non-portable charging pad can however be buried underground and is much safer, but this will increase the cost. This is one of many examples of customization customers need to have to enable the sale of wireless charging.

Further choice criteria regarding fleets are that companies are in greater need of an expanded infrastructure. In other words, many more charging boxes/pads are required. This means that the economic aspect will be heavily affected. However, during discussions, this criteria is not considered as super important for fleets. As long as the products work as they should and include all requirements customers have the price is not the deciding factor. Companies can also buy large scales which lowers the cost. Social criterias are not seen as important either. The personal might be more important since customers are evaluating environmentally

friendly cars when choosing an EV which indicates that the chargers need to be environmentally friendly too, just as for the private sector. Both the technical and personal aspects are the most important for charging developers to understand and fulfill to be able to successfully sell the product to fleets.

Another useful thing to understand is the different roles key persons within the buying process have which is presented in chapter 2.2.1.1. All fleet operations that participated in this thesis work were their own initiators. New chargers were bought when a need could be identified. Either this could happen when they expanded to new locations or when they enlarged their EV fleet. Another way a need to buy a new EV charger occurs is if the current one breaks down. However, this has not been a common problem according to the respondents. From this, it can be understood that the majority of purchases are planned in advance. However, even if the companies themselves initiate the purchases they are not always the ones choosing what brand to buy. Some are heavily influenced by other partners whereas some are more free to decide for themselves. The most common influencer regarding fleets is cooperation partners and electricians. However, in some cases, the fleet companies are just the user of the product and don't have the ability to decide what is going to be bought. This is due to the fact that in some cases the company does not own the parking spots and therefore does not have the right to decide what type of charger is going to be installed. One good way for wireless charger-producing companies to sell their products is therefore by collaborating with electricians and in some cases, parking spot owners to reach the fleets. However, since producers of wireless charging pads are third-party companies they also need to collaborate with EV manufacturing companies. This is to make sure their product fits on the car since there is limited space on the car for aftermarket mounting as of today. Those car manufacturing companies often collaborate with fleets which makes them obvious collaboration partners. When it comes to the private sector it is a bit more clear on the different key roles that exist. The buyer is in all cases the decider but as shown in the result, the decisions are heavily influenced by other actors. In this case, the biggest influencers are electricians and social groups that have a big impact on the decider. These key actors can be assumed to be the same for the wireless charging market.

Regarding the decider, it depends on the cases above. If chargers are bought by the property owners those are the decider, if they are bought by fleet companies those are the decider as long as they do not collaborate with other car manufacturing companies such as the company in 5.4.1. The buyer is the same as the decider in these cases. The users are the fleet operations drivers alone or together with the public depending on where the chargers are put up (public chargers or privately owned by the fleets).

As mentioned earlier fleets buy when a need is identified often associated with an expansion, so the purchase is planned and not compulsive which is important according to Chapter 2.2.1.4. The same can be said for the private sector. No connection to season or time can be seen. Regarding where they buy, if it is from a physical store or online and from what brand is mostly chosen by the electrician which is another topic to study that lies outside our thesis work. The buying habits presented in the result are from purchases of cable changing, meaning there is no data on how the buying of wireless charging pads would actually look like. It can be assumed that purchases of wireless charging will look the same but this can not be guaranteed. For wireless charging, much depends on if the charger can be installed in the after-market or if it needs to be pre-installed with the car from the beginning. If third-party companies which create those pads can make them easy to assemble in an aftermarket, buying habits will look very different from what they would have done if not able to sell to an

aftermarket. Although this depends on the thickness of the charging pad since cars today do not have a space created that fits the charging pads. Especially on cars that are lower, such as sports cars. With this information, it is too uncertain to say if the buying patterns for wireless charging will be the same as for traditional cable charging.

Regarding how customers buy 2.2.1.2 fleets have expressed that the first step called *need for recognition* is what they all do, but from here the steps described in the model do not apply to all. The second step is *information gathering* where both internal and external gathering according to the earlier mentioned chapter should be done. However, most companies only use external gathering which is done by asking their electrician. In some cases, there is no need for this since the parking spot owners decide what is installed. Why the external gathering is a big factor can depend on the EV charging market being fairly new and therefore limited knowledge about the subject exists within the company. The third *evaluation* step is often skipped since many brands apply the recommendation received from the electrician. The fourth stage, the *buying* is often done quickly with not much involvement since this is not the main product for the fleets. It is their EVs that take up the time instead. Lastly, a post-purchase is done where companies evaluate if the purchase was good or not which can be used for further purchases. The process of buying in the private sector is in some cases similar to fleet operations. A consultation with an electrician is in many cases done where the customer gets a recommendation on what to buy. This implies that steps two and three are in many cases skipped due to there not being a need to do research and evaluate different alternatives. This may be because today the EV charging market is overwhelming and complicated to understand and it takes a lot of time to do research. However, there was also a great amount that purchased their chargers from online stores. In these cases, it is reasonable to consider that some research was conducted and some evaluation of different alternatives was done implying that steps two and three were present (see 2.2.1.2). In all cases step four is conducted with the final purchase of the product. An assumption can also be made that there will be a similar purchasing pattern for wireless chargers.

However, both private and fleet customers do not buy products if they do not live up to the requirements. One requirement that stretches outside the product's characteristics is convenience described in 2.2.2.3. This aims to make the buying process as smooth as possible, preventing obstacles. One way of doing this is to use the electricians as distribution channels since most of the fleets relied heavily on the electrician's word and work. The fleets are already in contact with their electricians and do not need to build new relationships with the manufacturing firm of wireless charging gear. This also applies to the private sector, although it might not get the same effect since those customers also use other methods when deciding what charger to buy as described earlier. A collaboration with the electricians also makes the communication described in 2.2.2.4 easier. This is because the producing company of wireless charging does not have to do as much marketing directly toward customers. They can thereby deliver a clearer message to the electricians which also have easier to understand the function and the language used that regular people might not understand. It is also easier to focus on a smaller segment of the market when marketing since more time can be put towards that work.

## 7. Conclusion

This chapter presents our conclusions for each research question and the subjects they cover. It touches on customers' readiness and which segment offers the biggest potential for wireless charging manufacturers. Requirements and customer needs the different segments have, what parts contribute to customer value, and key criteria to focus on when developing and marketing wireless charging and selling channels. Finally, it answers the question regarding the current and future market situation.

### **Readiness and potential**

The readiness is believed to be greater in the private sector mostly because it is considered easier to meet their requirements. Fleet operations require an expanded infrastructure due to their demand for fast charging which is challenging to create due to the lack of space under the car which would make aftermarket impossible and therefore less potential is seen. Further on, they are unwilling to pay for this expansion themselves, which involves a third-party investor. Private customers respondents used in this study also had a more positive attitude toward wireless charging. However, fleet operations have reached further with the implementation of various pilot projects and could gain greater benefits from it.

### **Requirements, customer value, key criterias, and influences.**

The key requirements to meet the customer needs are at least 11kW of power for private consumers since this allows the customer to avoid peak hours. For fleet operations, there was a desire for more efficiency or to expand the infrastructure. For private consumers, V2G was also vital to be included in the package since wireless charging makes the use of V2G more convenient. V2G was not vital for fleet operations but it would not hurt to include it. For private users, the portability of the charging pad was not necessary but an easy installation was required. For car rentals, easy installation and portability were crucial while taxi companies did not have a strong opinion since they do not want to own anything. Technical aspects were crucial for both customer segments and there was a desire for an app to be able to control the charging remotely. Effective selling channels could be electricians and partnering up with for example car rentals.

### **Market situation and future possibilities**

The wireless charging market is in a very early stage with only a few large competitors. It is expected to have great potential where the biggest competitor seems to be cable charging which is much further developed and solves the same problem. However wireless charging contributes much convenience which attracts customers.

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