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Study on Consumer Demand on Electric Cars

The challenges related to battery electric vehicle adoption in Europe and expectations set by the customer base of Škoda Finland

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Thesis abstract

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The electric car is one of the most important and most discussed topics in today's automotive industry and in the media in general. The topic also arouses interest outside the industry, and nearly all European consumers are aware of these vehicles that run on an alternative fuel. However, only a few manufacturers have started the production of fully electric cars, and the models launched so far fail to meet the needs of most consumers.

The share of electric cars of the market remains at a very marginal level, and the growth rate has been slower than expected by manufacturers and governments. Manufacturing challenges, new technologies, without even mentioning business models and related customer behavior, are very tough and challenging topics for manufacturers, and provoke a lot of thoughts and questions among consumers.

The theoretical section of this thesis was written to highlight the main challenges of the adoption of electric cars and their causes in Europe. Furthermore, a survey was implemented among the customer base of Škoda in Finland to study customer behavior, including customer demands and expectations of electric cars and their properties. The results were approached from the whole sample perspective, but also differences between age groups, living areas, genders, and even income and educational levels were further sought and found. The sample consisted of 465 customers, aged between 25 and 64 years, from different regions of Finland.

The study was designed and implemented in co-operation with Helkama-Auto Oy, the Finnish importer of Škoda cars. The sample and related data was collected in co-operation with Bisnode Analytics and with the assistance of Traficom, the Finnish Traffic and Communication Agency.

Keywords: automotive, electric car, electric mobility, customer demands, customer behavior, customer needs

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Opinnäytetyön tiivistelmä

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Sähköauto on aiheena yksi keskeisimpiä ja ajankohtaisimpia tämän päivän autoteollisuudessa ja mediassa. Aihe herättää kiinnostusta myös laajalti alan ulkopuolella, ja lähestulkoon kaikki eurooppalaiset kuluttajat ovat tietoisia tästä vaihtoehtoisella käyttövoimalla toimivasta kulkuneuvosta. Tästä huolimatta vasta harva valmistaja on alkanut valmistaa täyssähköautoja eivätkä tähän mennessä markkinoille tulleet mallit täytä läheskään kaikkien asiakkaiden odotuksia tai vaatimuksia.

Sähköautojen osuus kokonaismarkkinasta on edelleen todella marginaalinen, ja markkinakasvu on hitaampaa, kuin mitä valmistajat tai hallitukset odottavat. Valmistukseen liittyvät haasteet, uudet teknologiat, puhumattakaan liiketoimintamalleista, saati asiakaskäyttäytymisestä, luovat paljon haasteita valmistajille ja herättävät asiakkaissa paljon ajatuksia ja kysymyksiä.

Tämän opinnäytetyön teoriaosuuden tarkoituksena on tuoda esiin suurimpia täyssähköautojen yleistymiseen liittyviä haasteita ja haasteiden takana olevia syitä Euroopassa. Opinnäytetyön empiirinen tutkimus toteutettiin Škodan suomalaiselle asiakaskunnalle kyselynä, jonka tavoitteena oli selvittää täyssähköautoihin kohdistuvaa asiakaskäyttäytymistä, mukaan lukien asetettuja vaatimuksia ja odotuksia täyssähköautoihin ja niiden ominaisuuksiin liittyen. Kaikki tulokset käsiteltiin koko otoksen näkökulmasta, mutta myös eroja ikäryhmien, asuinalueiden, sukupuolien ja jopa tulo- ja koulutusluokkien välillä analysoitiin ja löydettiin. Otos koostui 465 asiakkaasta eri puolilta Suomea, iältään 25–64 vuotta.

Tutkimus suunniteltiin ja toteutettiin yhteistyössä suomalaisen Škodaa maahantuovan yrityksen, Helkama-Auto Oy:n kanssa. Otos ja siihen liittyvä data kerättiin yhteistyössä Bisnode Analyticsin kanssa sekä Suomen liikenne- ja viestintävirasto Traficomin avustuksella.

Asiasanat: auto, sähköauto, sähköinen liikenne, asiakkaiden vaatimukset, asiakaskäyttäytyminen, asiakkaiden tarpeet

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Terms and Abbreviations

BEV	Battery Electric Vehicle
CO2	Carbon Dioxide
EV	Electric Vehicle
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
IEA	International Energy Agency
JRC	Joint Research Centre
KM	Kilometre
KW	Kilowatt
KWH	Kilowatt hour
MEB	Modular Electric Platform
OECD	The Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PET	Polyethylene terephthalate
PHEV	Plug-in Hybrid Electric Vehicle
SUV	Sports Utility Vehicle
TCO	Total Cost of Ownership

1 INTRODUCTION

1.1 Škoda Auto A.s.

Škoda Auto is a car manufacturing company that was established in 1905 in the Czech city of Mladá Boleslav and has a history of over 120 years. The development department and registered office remain there, but production of cars has spread to cities such as Kvasiny and Vrchlabi (Škoda Auto 2016). Manufacturing of components and car parts has been expanded to the markets of China, India, Russia, Ukraine, Kazakhstan and Algeria, and the smallest model of the range, known as Citigo, is made in Bratislava of Slovakia (Škoda Auto 2018). The current and constantly growing demand for higher production capacity could mean that manufacturing of some other models, current or future ones will be moved to the neighbour countries of the Czech Republic.

Škoda plays an important role in Western European market (including Finland), as it delivered 486 400 vehicles in 2018 to its customers while making an increase of 1,8% in comparison to 2017. Additionally, 212 900 vehicles were delivered to Central Europe with a growth of 2,8% in comparison to 2017. The Eastern Europe remains less represented in deliveries with 46 100 vehicles in 2018, but there was an increase of 11,5% compared to 2017, which makes it relatively faster developing than Western or Central Europe (Volkswagen AG 2019). The further internationalization and model campaigns enabled Škoda to deliver more than a million vehicles to its customers worldwide already in 2014. In 2018, the millionth vehicle had been delivered already in October. From this, approximately third was delivered to the biggest market, which is China. The total number of globally delivered vehicles in 2018 was 1 253 700 (Volkswagen AG 2019).

Considering the future of the company, Maier (2017), the Chairman of the Board, publically announced that Škoda Auto is guided by an initiative called Strategy 2025, which is designed to offer customers the finest mobility solutions in terms of digitalisation and e-mobility, while investing billions to make individual transport safer, more comfortable and environmentally friendly.

1.2 Helkama-Auto Oy

Helkama-Auto is the Finnish importer of Škoda cars, spare parts and accessories. It is a privately owned family company, which is a part of Helkama group that has a history of over 100 years. Helkama-Auto has functioned as a Škoda importer since 1947 and it is currently the longest-term importer partner of Škoda Auto in the world.

The Finnish market enjoys all the European models of the Škoda range, which serve the customers with taste toward quality, space, economic efficiency, and a high price/quality ratio. The newest member of the model family is Scala, which replaces Rapid in the current range and settles between Rapid and Octavia in size. The latest SUV, Karoq, got its first 20 units registered in Finland in the end of 2017.

The importer and a widespread network of dealerships and service partners are giving equal efforts to keep Škoda as one of the most sold passenger cars in the market of Finland (Helkama 2018).

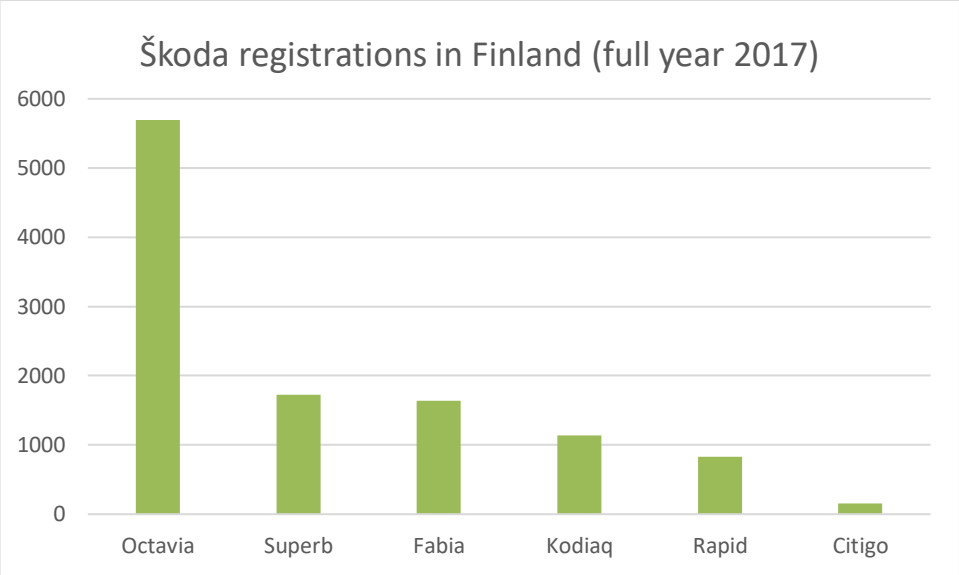

Figure 1. Škoda registrations in Finland by model (Traficom 2019).

Škoda is one of the most sold and registered cars on the Finnish market, and for example, in 2017, the most famous model of the brand, Octavia, was the most sold new car on the market, while the brand overall placed on third position, with only Volkswagen and Toyota being sold more. Octavia holds a share of approximately

50% from the brand sales in Finland, and therefore being a vital product in terms of overall success and image.

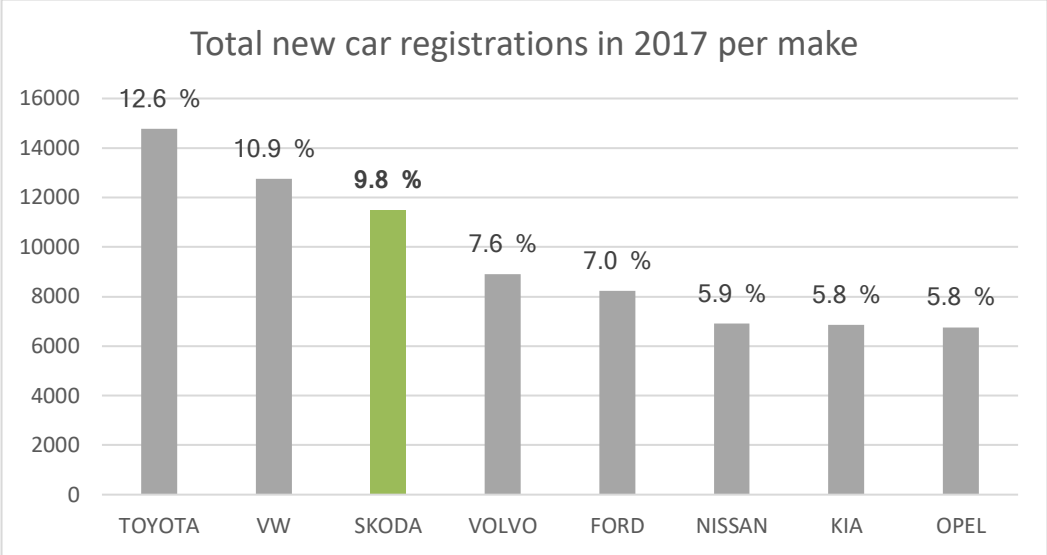

Figure 2. Top 10 Finnish new car registrations in 2017 per make including market shares (Traficom 2018).

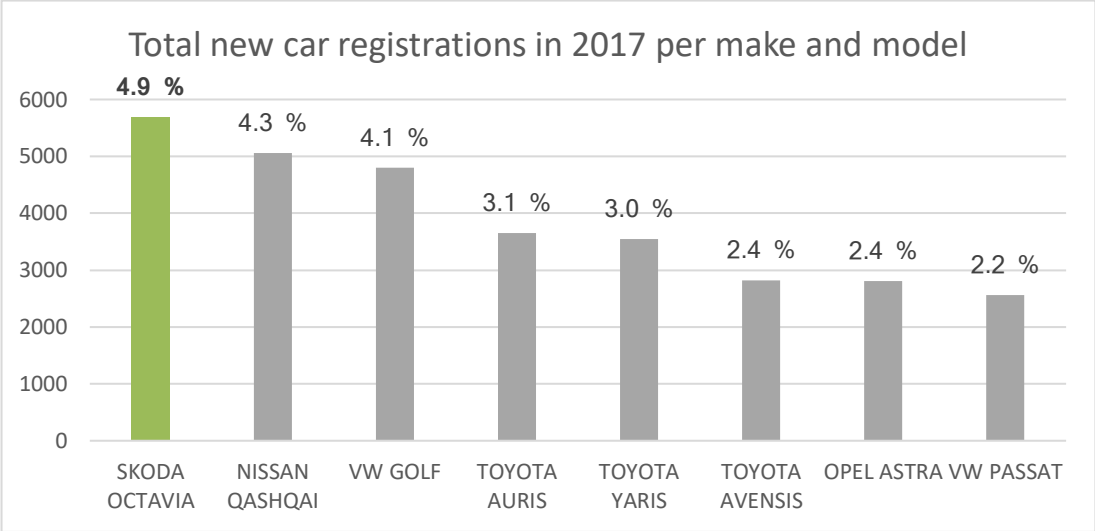

Figure 3. Top 10 Finnish new car registrations in 2017 per make and model including market shares (Traficom 2018).

1.3 Škoda entering the era of eMobility

At the moment, Škoda has only ICEVs in their range. However, they are planning to start producing their first plug-in electric vehicle, Superb iV, during the fall of 2019. The plug-in Superb will be followed by a small fully electric city car called Citigo^{e} iV in the beginning of 2020. In the same year, another BEV, the completely new, yet unnamed model based on a concept study called Vision iV will be launched before the end of the year. This will represent the current top-end electric car technology of the brand with range up to 500 kilometres, including inductive charging possibilities on top of the cable charging. Additionally, the manufacturer will be offering wall charging stations, known as wallboxes for the customers who are buying electric cars of the brand, so they can charge their electric Škodas at the comfort of their own home. On top of home chargers, the brand will be offering new connectivity services that can e.g. help its customers in the search of public charging stations and to control the charging of the car via a mobile app.

The new lettering iV stands for an ecosystem that is designed to deliver mobility solutions and make it easier for customers to access know-how regarding electric mobility. The letter i represents the features of the electric models, such as innovativeness, intelligence, inspiration, individuality and intuitiveness. The letter V stands simply for vehicle. These electric models that come with the lettering iV are claimed to hold the same traditional advantages as other cars of the brand, such as generous interior space and surprising Simply Clever solutions that make the life of customers easier, but also new advantages in terms of electric mobility such as short charging time and long range combined with an affordable purchase price.

Škoda has set ambitious targets already for 2022, as they are planning to offer ten electric models, both plug-in hybrids and even six BEVs during that time. To achieve this, the brand will work in a close co-operation with Volkswagen by using existing group synergies and by building cars on the common technology platform (MEB) designed by the Volkswagen Group. Škoda projects that the electric models will account for even 40% of the group sales by 2030. It is told that especially SUVs will play an important role also in the EV portfolio of the brand (Škoda Auto 2019).

1.4 Battery Electric Vehicle (BEV)

The main difference between an ordinary car with an internal combustion engine and battery electric vehicle (BEV), is that in BEV, the internal combustion engine is replaced by an electric motor and the fuel tank is replaced by a battery that trains the power to the motor, which makes the drive purely electric (Bessenbach & Wallrapp 2013, 8; Andwari et al. 2017; Hildermeier 2016, 6). There can be one or several high-energy batteries onboard depending on model, and the electricity is supplied from an external source such as the electric grid (Bessenbach & Wallrapp 2013, 8; Malloy & Lachapelle 2018, 19). This means that the combustion engine and its sound are not existent in BEVs, which could be either a pleasant feature for silence appreciating consumers, or considered as a barrier for some who perceive the engine sound as an essential product feature (Bessenbach & Wallrapp 2013, 33).

The current BEV batteries are based on lithium-ion technology, which gives them properties to go mostly from approx. 200-500 km ranges today with one charge (Andwari et al. 2017) in real driving conditions, which is superior compared to other available battery technologies on the market and therefore a choice of manufacturers (Ellingson & Hung 2018, 23).

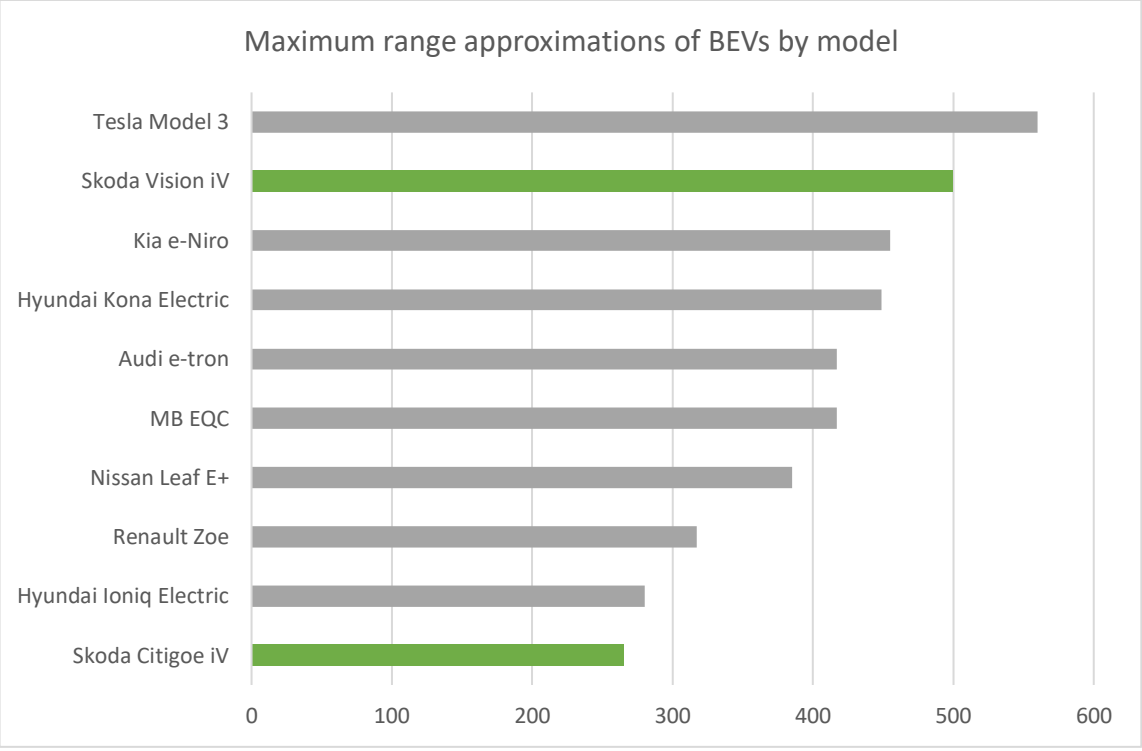

Figure 4. An example of maximum range of BEV models by Škoda and its potential competitors (Audi Finland 2019; BMW Finland 2019; Hyundai Finland 2018; Kia Finland 2019; Mercedes-Benz Finland 2019; Nissan Finland 2019; Renault Finland 2019; Škoda Auto 2019, Tesla Finland 2019; VW Finland 2019).

When BEV is being compared to an ICEV, the BEV has many benefits. The BEVs are highly efficient and significantly better for the local air quality than ICEVs with a lower impact on climate change, since they do not produce any tailpipe emissions at the point of use (Andwari et al. 2017; Hildermeier 2016, 6; Messagie, 11). What comes to performance, they have better acceleration, immediate torque and response to throttle, and the charging can be done overnight on low-cost electricity (Andwari et al. 2017). The Amsterdam Roundtable Foundation adds that there is a possibility for both home and workplace charging (2014, 22), where an ICEV needs to be refueled at a gas station. A report by Tekes (Antikainen 2016, 6) claims that some studies have found that the energy efficiency of EV is three times as good as of ICEVs from well to wheel. Additionally, the electric drivetrains have a straightforward structure and moderate amount of drivetrain components in comparison to ICEVs (Gnörich & Eckstein 2016, 5). Therefore, repair and replacement costs are low thanks to the absence of conventional transmissions and fuel-injection systems that would need maintenance. For example, in BEVs, there is no need for oil, coolant or filter changes, which leads to comparably lower maintenance costs for BEVs versus ICEVs (Bessenbach & Wallrapp 2013, 33).

1.4.1 The current market situation

A key political priority for the European Commission is the transition to a low-carbon economy, which means that low- and zero-emission vehicles need to become a widespread reality in Europe (Lombardi et al. 2018, 6). The European emission reduction target levels have been set for traffic already for 2020 and beyond, and these targets cannot be met without a significant reduction on fossil fuel usage (Antikainen 2016, 6). In this process, EVs play an important role to reduce greenhouse gases and reduce oil dependence by offering potential alternatives for traditional ICEVs (Avci, Girotra & Netessine 2012, 1; Thiel et al. 2012, 4; Li et al.

2016, 352; Ellingsen & Hung 2018, 23; Särkijärvi, Jääskeläinen & Lohko-Soner 2018, 11). To achieve these goals that are set to stabilize the climate change, large shift from petroleum fuel based ICEVs to EVs will be necessary (Lutsey 2015, 2). For example, the Finnish government has set its target to get 250 000 EVs and 50 000 natural gas powered cars on the roads of Finland until 2030 (Paakkinen et al. 2018, 5) which represent a share of 30% from all the liquid fuel powered cars (Särkijärvi, Jääskeläinen & Lohko-Soner 2018, 11). Additionally, the Finnish government has planned to eliminate all greenhouse gas emissions and liquid fuel powered cars by 2045. Furthermore, Norway aims for 100% new car sales share in BEVs by 2025 and UK have proclaimed to end ICEV sales by 2040 (Hertzke et al. 2018).

On a global OEM level, nearly all major manufacturers have expressed their ambitions to EV development, indicating a strong industry commitment to invest in e-mobility and to scale up efforts to develop EV technology in the near future (Amsterdam Roundtable Foundation 2014). For example, BMW plans to mass produce EVs by 2020 and aims to offer 12 electrified models by 2025. Renault plans to produce eight purely electric models by 2022 and Volkswagen will invest nearly 90 billion euros in EV technology to electrify the whole model range by 2030 (Lombardi et al. 2018, 7). Additionally, Volvo has committed to fit all the produced cars with hybrid or electric engines by 2019. Škoda plans that fourth of their sales will electrified in 2025 and therefore it will represent a significant part of their business in the future (Škoda Auto 2017). During this strategy, ten electric models will be launched, from which six will be fully electric. In total, global automakers will launch approximately 340 BEV and PHEV models during between 2019 and 2022, which will reduce supply barrier to further market uptake (Hertzke et al. 2018). Furthermore, a number of automakers have communicated their intentions to scale down or halt diesel model production in Europe, which means that electrified powertrains are likely to become more relevant alternatives to achieve regulatory CO2 compliance (Amsterdam Roundtable Foundation 2014). The ongoing headwinds for diesel technology and increasing customer interest in EVs have helped to grow the EV market of Europe by nearly 40% from 2016 to 2017, and in Germany, the sales have more than doubled (Hertzke et al. 2018).

EVs have already made significant progress globally as the milestone of one million sales passed in 2017 (Hertzke et al. 2018), and in the beginning of the same year, there were more than two million electric cars in total in the world (Jin & Slowik 2017, 1). From those, 780 000 were new registered cars, and BEVs represented a share of 62% (Thomas 2018, 7). In the Nordic countries, Norway is leading the way with a wide and fast growing EV fleet (Haakana et al. 2013, 5), and other major EV countries in Europe include Germany, UK, France and Netherlands. Outside Europe, China and USA have the most EV sales on a global scale (Lutsey 2015, 3). The growth of global EV sales is projected to reach over four million units already in 2023 if the annual growth rate remains approximately around 30% (Slowik, Pavlenko & Lutsey 2016, 4).

Growth in sales volumes together with increasing competition in technology development are likely to contribute to continuous reductions in battery manufacturing costs, which is one of the prior obstacles in EV adoption (Slowik, Pavlenko & Lutsey 2016, 3). According to Ellingsen and Hung (2018, 23) BEVs have just recently gained more acceptance and raised wider interest in consumers due to progress in battery technology. Cost reductions in related technologies strengthen EV competitiveness in comparison to ICEVs, which reinforces the case for market share expansion of EVs, and possibly a leading role across all models in the evolution of transportation (OECD/IEA 2018).

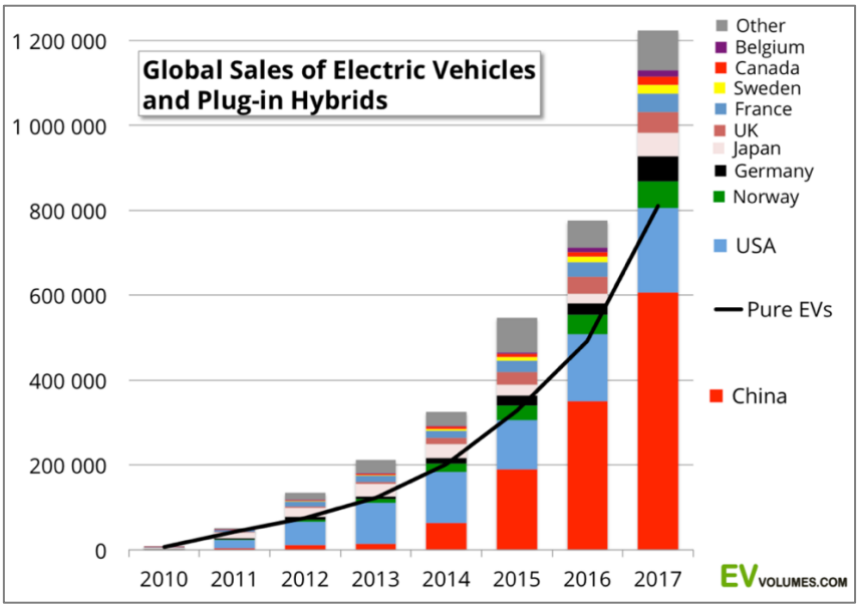

Figure 5. Global EV sales 2010-2017 (EV Volumes).

The gradual increase of momentum behind EV adoption suggests that electrified powertrains will play an important role in the forward going mobility of Europe. The next few years will be a phase of further maturation of the EV industry, and in the longer run, mainly due to a strong, gradual tightening of CO2 regulations, powertrains are likely to further diversify, resulting in a powertrain portfolio with many electrified alternatives to the traditional combustion engine. When regulations are further tightened between 2020 and 2025, remarkable rebalancing of powertrain portfolios toward EVs might take place by 2030 (Amsterdam Roundtable Foundation 2014, 26), and later in the future, the ICE alternatives could be completely replaced by electric powertrains.

1.4.2 Implemented surveys on EV market adoption

A Finnish leading renewable energy company Fortum (2017), concentrated in offering global solutions concerning electricity, heat, cooling and resource management, implemented a survey concerning consumer attitudes toward electric cars. It was found that 4% of Finnish consumers believe to own an electric car after the next two years, 10% after the next five years, and 18% after the next ten years.

According to Era (Fortum 2017), the owning of a car operated with biofuel (e.g. compressed natural gas) is not being believed in such a growing scale in Finland as an electric car. He stated that the development of Finnish electric car base is behind when compared to other Nordic countries, but a growing number of Finns believe to own an electric car in the future. The late development was also agreed in a study by Antikainen (2016, 11), which explains that it might be related to the lack of national government policies and incentives. Currently, the only incentives are aimed at charging infrastructure development, condominium charging and purchase subsidies (Paakkinen et al. 2018, 15). Therefore, there is no direct benefit for the consumers, outside the purchase subsidy which amounts for 2000 euros on an EV costing less than 50 000 euros. However, the same VTT study (Paakkinen, et al. 2018, 5) emphasizes that the EV adoption strongly depends on customer decisions, rather than just on the government decisions or legislations regarding electromobility. The Governmental project group estimates in their report (Särkijärvi,

Jääskeläinen & Lohko-Soner 2018, 14) that the most effective actions to increase EV adoption could be both raises in fuel taxation and EV purchase subsidies in the near future. The VTT study (Paakkinen et al. 2018, 41) found that around 43% of the participants would consider a subsidy worth 4000-5000 euros to have an effect on the purchase decisions, but fourth of the conventional car drivers felt that the subsidy should be nearly 10 000 euros.

A study by Fortum (2017) shows that 62% of Finnish participants would buy an electric car because they think that an electric car is eco-friendlier than gasoline or diesel powered car, and a total of 69% of the participants agree that there should be more electric cars in Finland to lower the high traffic emission levels. A study by RAND Europe (Tsang et al. 2012, 6) confirms that EVs are more fuel efficient than conventional cars, but there is a problem which is that consumers do not value fuel efficiency as much as other properties that they find useful, especially consumers who put a lower value on future savings in general. The results also indicate that even consumers who see themselves as eco-friendly do not necessarily back up this attitude by purchasing an EV. This might be a sign of rising environmental concerns toward the production and life-cycle aspects.

A study by JRC (Thiel et al. 2012, 4) concludes that European drivers see opportunities that EVs are offering, but several pre-requisites need to be fulfilled to ensure the consideration of EVs as a credible choice in comparison to ICEVs. A project by RAND Europe indicates that the found problems can be categorized as technological, social, perceptual and institutional (Tsang et al. 2012, 6). As an example, technological problems can be related to battery capacity and charging time, where social problems refer to the overall image and transparency of electric mobility toward consumers. Perceptual problems are usually the ones that consumers face when they are experimenting with new technology. This could be e.g. in a situation where a consumer tries an electric car for a day and faces technological problems such as the time he or she needs to spend at a gas station to have the car charged, or that the consumer finds the louder tire noise caused by the lack of engine sound irritating. The institutional problems can be e.g. the low coverage of charging network or the number and form of implemented incentives by the government.

There are barriers such as technology costs, inconvenience concerning range and charging times, and the absence of consumer understanding about the availability and viability of related technology (Jin & Slowik 2017, 1). A survey by VTT (Zulkarnain et al. 2014, 272) indicates similar results as it addresses that the most important issues regarding the EV market penetration are associated with infrastructural questions, technological maturity and consumer aspirations. These and related problematic topics are handled further in this work in their own respective chapters.

In general, consumer awareness is crucial, since the development of EV markets is fundamentally tied to it together with understanding of EV benefits (Jin & Slowik 2017, 1). According to Andwardi et al. (2017), one of the major issues holding down the market penetration outside battery and charging is the social acceptance of electric vehicles. Additionally, the high capital cost is a barrier for most of consumers and the low running costs have a niche visibility. High upfront costs are also mentioned to be an obstacle in a research by Kassakian et al. (2015, 12), where additionally the niche model availability and range by manufacturers is brought up as a concern that is slowing down the EV adoption. The vehicle design is essential, including both performance and style aspects, which play an important role to meet the requirements of consumers (Tsang et al. 2012, 8; Zulkarnain et al. 2014, 264). A study by VTT (Paakkinen et al. 2018, 38) indicates that the major need for increase in electric powertrain selection is aimed at the station wagon body type with the support of 74% of participants. Even though SUVs have experienced a high peak during the past few years, only 32% of participants show desire for additional selection in the respective body type. However, it is the second most desired body type after wagons. The niche model selection is one of the five major EV adoption obstacles together with range, price and infrastructure related issues, according to nearly half of the survey participants. However, according to Bessenbach & Wallrapp (2013, 25), EVs are not necessarily disruptive as long as the objective remains in developing EV specifications to match the range, speed and pricing of conventional vehicles.

1.5 Battery and range

Battery is the enabling technology and key to the revolutionary change when it comes to EVs, and it has been verified already in their early history (Young, Wang & Strunz 2013, 15). The EV batteries are required to handle high power and high energy capacity within a limited weight and space at an affordable price, which has taken a lot of extensive research efforts and investments to make them suitable for EVs all over the world (Young, Wang & Strunz 2013, 16). The early battery development for consumer electronics provided invaluable experience in the Li-ion cell production, underpinning the cumulative production capacity attainment of 100 GWh by 2010, enabling the achievement of remarkable performance improvements and cost reductions over the past decade. These very improvements made the Li-ion battery pack development increasingly viable and the storage technology prices decreased as manufacturing volumes increased (OECD/IEA 2018, 61).

The development and adoption of Li-ion batteries is expected to grow in EVs during upcoming years, particularly in BEVs and PHEVs due to the potential of obtaining higher specific energy and energy density in comparison to other available battery types, such as NiMH (Nickel Metal Hybride) or lead acid, which are either too low on energy or efficiency, or cannot obtain the energy as well as Li-ion (Mok 2017; Young, Wang & Strunz 2013, 16). By now, lithium-ion battery technology has reached a level that enables the EV design to begin to match the performance of ICEVs. One important parameter is the battery lifetime, and a good proxy is the expected mileage associated with a lifetime of a battery and its ability to retain a good share of its initial capacity, which is around 80% (OECD/IEA 2018, 61). If we assume that the battery capacity is 35 kWh as in the most EVs today, and the consumption is 0.2 kWh/km, the EV cycle life threshold would not be attained during the first 175 000 kilometres of driving, indicating that the battery lifetime is compatible with the expected car lifetime of an ICEV (OECD/IEA 2018, 61-62).

The battery is the component that is still going through the most development, having a heavy effect on the price of the car, approx. 30-40% depending on the car and battery size (Giffi et al. 2011, 10). This high cost is driven by limitations in technology, which make electric cars approximately 10 000 - 15 000 euros more expensive than their combustion-powered variants (Tsang et al. 2012, 6). The

battery itself can cost even nearly 14 000 euros (Giffi et al. 2011, 10) depending on the size and capacity, which significantly slows down consumer adoption (Avci, Girotra & Netessine 2012, 1). Additionally, battery size is a decisive factor in terms of range that can be covered by one charge, and it can be projected also to the resale value. There is a forecast that EVs could become more affordable than ICEVs in the future, when the battery costs will decline enough to reach such levels.

The long charging time is indicated as a serious limitation around battery technology by Tsang et al. (2012, 6), Andwari et al. (2017) and Haakana, Laurikko, Granström & Hagman (2013, 2). The charging time can be around 20 to 30 minutes at the quickest in a public fast charging station, but only with models that allow this type of charging. The more common type takes around 2-4 hours with a regular charger at public station or home, and if the charging is done from a home socket, it can take even between 11 and 15 hours, or even more (Pod Point 2019). The charging times always depend on the power output of the charger, compatibility of the car and capacity of the battery. The power output of chargers can vary from just a couple of kilowatts to even hundreds of kilowatts.

A survey by Deloitte (Giffi et al. 2011, 1) found that consumers generally feel that EVs should be able to be recharged faster and have longer range and for a cheaper price that OEMs are currently able to offer. Most of surveyed consumers expect EVs to recharge batteries in less than two hours independent of location and only a small minority view eight hours as acceptable, which is unfortunately even closer to the actual and most common charging time e.g. at home and workplace. This highlights the inconsistency of consumer expectations with current technological capabilities and further pushes the demand toward infrastructure of public fast chargers and faster home charging options.

According to the Amsterdam Roundtable Foundation, the charging of an electric car takes at least 20 to 30 minutes even with fast charging at its best (2014, 22), which is possible only on selected public stations and actually ten times more expensive than with slower and battery-friendlier charging options (Giffi et al. 2011, 9). The better availability for fast charging options could eliminate the complications of long charging times, but there are further, serious problems such as faster degradation of battery life, high voltage related safety concerns and increased stress on used

power grid. Additionally, the energy use of battery is highly dependent on factors such as driving conditions like outside temperature and terrain, traffic situation and level of cabin heating or air conditioning (Haakana, Laurikko, Granström & Hagman 2013, 2). For example, Irvine (2015, 26) stated that the higher the speed is, the more energy a BEV requires, which means that highway range is usually approximately 20% less than city range, being therefore an opposite of ICEVs. The same report claimed that driving in the city could improve range by even up to 25%.

According to Andwari et al. (2017), the fact that charging can be done only from the grid when the car is stationary is also a significant challenge. For example, mobile charging could enhance the comfortability and reduce range anxiety of EV drivers in the case when there is an insufficient charging infrastructure. There could be e.g. a truck loaded with chargers that could move between different locations, or even more futuristically, there could be inductive charging applied beneath the road surface or on the roadside to charge EVs equipped with inductive charging on the move.

Additionally, the limited drive range of BEVs on top of long charging times remains as a major obstacle in terms of consumer adoption (Avci, Girotra & Netessine 2012, 1; Irvine 2015, 26), which is also due to the slow advancement in battery technology (Bessenbach & Wallrapp 2013, 32). The range is usually only around 250-350 km at its best in real driving e.g. in the mid-class affordable (around 30 000 – 40 000 euros), well sold EV models such as VW eGolf, Nissan Leaf and Renault Zoe. The feeling of low range is also known as “range anxiety”, which is a concern that a car loses power before reaching the destination or charging point (Raab et al. 2014, 10). It can also be related to a feeling about low range and the constant need for charging, e.g. on a daily basis that is not required with an ICEV. For Nordic countries, this is even more challenging due to the severe climate that has a strong effect on EV energy consumption (Haakana, Laurikko, Granström & Hagman 2013, 5). Irvine (2015, 26) referred a finding by American Automobile Association in his report, which found that batteries produce weaker current in cold conditions, especially in winter, where the range capability can drop by 60% or even more. He additionally highlighted that especially heating, but also audio, navigation and nearly all accessories have a reducing effect on range. This effect can be even multiplied

when used several accessories at once. It is also more battery-friendly and ecological to drive on flat or smooth surfaces instead of steep or more difficult terrain.

Furthermore, a survey by Deloitte (Giffi et al. 2011, 6) shows that range is something that European consumers are not willing to compromise with, as 80% of the participant drivers were doing journeys less than 80 kilometres per day, but for example, French individuals seem to be highly sensitive toward this property as only 67% of the participants were satisfied with a range of at least 480 kilometres. In Germany, the share was 71%, but still a bigger sample of 85% would prefer a range of 640 kilometres. The majority of drivers expect way longer ranges than their normal daily driving distances, which correlates much closer to ranges of ICEVs.

A survey by VTT (Paakkinen et al. 2018, 39) found that the insufficient range was placed second on the major adoption obstacle ranking by the participants, right after the purchase price with a share of around 52%. As a note from this, the insufficient range was brought up more on the side of the participants who did not own an electric car than on the side of electric car owners; approx. 62% versus approx. 35%. EV owners experienced a range of 200-300 km to be enough, where the ones driving conventional cars felt that EVs should be able to do approximately 100 km more per charge (300-400 km) to be more attractive.

Also the project by RAND Europe (Tsang et al. 2012, 8) brings up the topic of range anxiety, adding that EV drivers tend to be overcautious on their journey plans. For example, a trial in England found that the longest EV journey was only fourth of the average range capability of the vehicle. Additionally, in Denmark, in-depth interviews with EV owners revealed how unfamiliarity with the car led owners feeling that their cars were underperforming in relation to conventional car. This indicates that programs aimed at increasing EV familiarity would be supplementary to maximize the current technological capabilities. It would help early adopters to appreciate and take advantage of the vehicle capabilities to the fullest, and in the longer term, opinions of early adopters could affect the willingness of conventional car drivers to consider EVs (Tsang et al. 2012, 8).

The first EV of Škoda, the electric Citigo^{e} iV in 2019 will have a range of 265 kilometers and the following next EV generation in 2020 will have it around 500 kilometers. Haak states that this should be more than enough to manage e.g. commutes, and associated with range, the charging times and stations, these are important key factors for EVs to succeed in the future (Škoda Auto 2018). However, in Finland, the distances are longer in comparison to other European countries, and there are a lot of journeys outside commutes, e.g. business trips, different hobbies, daycare of children and cottages that demand a long range capability by the vehicle. At the moment, EVs would have at least a functional role as a primary car of the family to do shorter trips such as grocery shopping and commutes. Then ICEVs or even CNG cars could be used as secondary cars to handle the longer journeys such as business trips or routes to cottages with less charging infrastructure.

The RAND project brings up consumer concerns that are related to electrical safety of batteries, which can be higher since the battery is large and high in voltage, and the underlying chemistry is sensitive and flammable. This also raises related concerns toward collision and charging safety. The safety point-of-view is also mentioned in studies by Kassakian et al. (2015, 12), Bessenbach & Wallrapp (2013, 25) and VTT (Zulkarnain et al. 2014, 264). Additionally, the VTT report named further battery challenges that need solving, such as ones related to weight reduction. For example, the weight of a battery remains around 150 kg, but due to the increased demand toward higher energy density (Zulkarnain et al. 2014, 264; Messagie, 11) it is tough to compromise with. Instead, the weight reduction could be done by combining high-strength and lightweight material compositions (Giffi et al. 2011, 6). According to Messagie (11), especially the steel chassis should be substituted with lower weight materials. However, there are also other parts of the car that could be substituted. For example, a future study model by Škoda called Vision RS has interior parts such as seats that are partially made of 100% recycled polyester thread and floor mats that are made of Pinatex textile in a carbon weave (Škoda Auto, 2018). Also competitors such as Nissan Leaf, BMW i3, Toyota Prius and Kia Soul are known to be constructed by taking advantage of recycled materials (Hall 2018); for example, Leaf has nearly fourth of its weight covered with recyclables, such as PET bottles and plastics (seats, dash, doors), fabrics (insulator pads) and parts from used electric appliances (centre console). The i3 has leather

seats that are tanned with olive leaves and door panels are made from open-pore eucalyptus, and Prius uses bio-plastics in e.g. seat cushion design, where Soul uses bio-plastics also in carpets in addition to door panels and seat trims. These kind of lightweight and also vegan materials can be expected to become more common in electric cars already in the near future.

1.6 Charging infrastructure

A key factor for a successful EV market is a wide and functional charging infrastructure, and according to a report by Accenture (Raab et al. 2014, 8), there are two primary charging locations; home and workplace. For example, a recent OECD/IEA survey shows that in the Nordic region of Europe, current EV owners clearly prefer to charge their car daily or weekly at home (90%) and 20-40% of owners charge their vehicle at work (2018, 45). Despite the rather low share of public charging stations compared to the car stock, Norway achieved its top role as an EV market, which indicates a strong preference for home charging.

A survey implemented by energy company Fortum (2017) found that 36% of Finnish consumers would buy an electric car if there would be a possibility to charge it in their garage or at their parking lot, and a VTT study found that a clear majority (93%) of electric car owners charge their cars at home (Paakkinen et al. 2018, 30). These charging places were also mentioned as the most pleasant options for charging by 66% of participants in the Fortum survey. The next pleasant option was charging near home, which was agreed by 16% of the sample. Additionally, 45% of the participants would purchase a new home that includes a charging station instead of a similarly priced alternative without one. These results highlight the importance of developing and providing both efficient and affordable charging solutions for both private homes and condominiums.

1.6.1 Charging in condominiums

The barometer results of the Finnish Real Estate Union (2018) indicate that every fifth Finnish condominium (incl. row and apartment houses) is planning to implement

charging stations between 2018-2022, even though the current situation according to the VTT study is that only around 3% of condominiums are equipped with at least one charger (Paakkinen et al. 2018, 19). From these, 59% are apartment houses and 41% row houses. From apartment house condominiums, 65% are equipped with a maximum of three charging points, where 70% of row house condominiums had a maximum of two charging points. The same study found that around 2% of condominiums are working on charging point construction, but the projects are still in progress. Even if a total of 5% of condominiums would have charging stations ready and implemented in 2019, it would still mean that about 20% more should be done in just three years, which accentuates the importance of the condominium charging infrastructure support. The most desired support toward home charging device would be around 25-50% of the purchase price for 69% of the participants, but still 25% would not see the need for support. At the moment, the VTT study (Paakkinen et al. 2018, 36) names the two major obstacles in condominium implementation as costs (19%) and the fact that there is currently no actual need for charging points (68%), which partially explains the answers that consider the support needless. Additionally, the related attitudes of shareholders and boards remain sceptical (71%) and the lack of information regarding charging solutions (58%) is highly present.

1.6.2 Public charging

From Finnish consumers, 30% would be willing to buy an electric car if the number of public charging stations would increase in Finland, and 22% of consumers are not willing to buy an electric car because they do not know where to charge it (Fortum 2017). From electric car owners, a share of 64% charge their cars at public charging points and 37% at their workplace (Paakkinen et al. 2018, 30). However, from these participants, 70% would like to be able to charge at their workplace and 77% meanwhile shopping, which means that the share of parking hall and parking lot chargers near shopping malls, grocery shops and workplaces should be significantly increased. Additionally, a share of 21% would be willing to have roadside chargers near their apartments.

A project by RAND Europe (Tsang et al. 2012, 6) found that the center of the charging problem is the insufficient infrastructure, and lack of related elements such as overnight parking dedicated for EVs with respective chargers and equipment. Also the Amsterdam Roundtable Foundation highlights the stumble with relatively low range and the demand for charging infrastructure, which currently has a limited availability. A report by World Economic Forum recommends the infrastructure to cover business districts (Lombardi et al. 2018, 9), which would increase the convenience of employees, customers and other visitors. Also highways, destination points such as parking lots, shopping centres and hotels, and surroundings of public transport hubs need to be seriously considered as an option for consumers according to Giffi et al. (2011, 8) and Lombardi et al. (2018, 5).

In Finland, major retail chains such as Kesko and Lidl are already planning to implement charging stations across their parking lots during the next two years. This project by Kesko will include 2000 chargers to be installed by 2020 and therefore increase the overall number of public fast charging points by 50 % nationwide (Kesko 2018), meanwhile giving a big boost for public EV awareness. Lidl has already implemented ABB fast chargers to shopping centers in seven Finnish cities, getting the eighth done in 2018 (ABB 2018). ABB claims that these Terra chargers might even reach charging times of only 15 minutes, which would have a positive impact on the range anxiety and charging related concerns that have been raised by consumers.

According to a report by World Economic Forum (Lombardi et al. 2018, 9), the highest charging demand will be toward public transport hubs and city outskirts that offer a variety of services such as EV maintenance, car sharing and shopping centres. A report by World Economic Forum (Lombardi et al. 2018, 9) emphasizes that even some automotive manufacturers have deployed fast charging networks that focus on highways and destination points. The profitability of these fast and ultra-fast charging stations rely on the customer willingness to pay premium for faster charging times.

1.6.3 Enhancements on charging network user experience

In addition to charging, battery swapping stations could be implemented, where EV drivers or service personnel could change a nearly or already depleted battery for a charged and functional one in just a couple of minutes (Giffi et al. 2011, 8). This could reduce battery costs and concerns toward charging times, and further decrease range anxiety (Avci, Girotra & Netessine 2012, 1). The changeable battery could be purchased or leased, depending on preferences of the customer and the payment could be based on driving distance, for example. Later in the future, even wireless inductive charging could become part of the infrastructure development in the Nordic countries. There are already models with inductive charging possibilities under development by e.g. Audi and BMW, and it is also a feature that could be part of the model that will be based on the Vision iV project.

For further increasing of efficiency and flexibility on top of a functional charging network, a digital end-to-end customer experience regarding charging service access should be constructed (Lombardi et al. 2018, 5). The future need for these user experience related technologies is also mentioned to be increasingly important in the survey results of VTT study (Zulkarnain et al. 2014, 264). Currently, low level of system digitalization and limited interoperability are complicating customer experience, which put customer engagement at risk. When an optimal level of digitalization and interoperability is reached, it provides more useful data efficiently, while making customer access easier and therefore enhances the overall experience (Lombardi et al. 2018, 9).

According to a report by Deloitte (Giffi et al. 2011, 9), several companies are developing these kind of charging information related telematics for smart devices. By using e.g., a smartphone that is connected to the vehicle, customers can receive real-time information regarding charging state of the car battery and energy use forecasts to optimize their driving and charging plans accordingly. Additionally, customers can access real-time map of charging stations and monitor the state of battery to know when it is time to replace a depleting unit. A report by Accenture (Raab et al. 2014, 9) adds that there could be a possibility for customers to reserve a charger through a mobile app. This could be also done through the infotainment system of the car, even with voice commands without the need to browse the screen

with fingers or gestures if preferred. Furthermore, the co-operation with energy providers could make it possible to follow electricity payments and cost information through the app, and the battery could be even pre-heated or charged by just a touch of a screen or by giving a voice command. These kind of functions could be used by taking advantage of technologies such as remote control, system automation, smart sensors and smart devices such as smartphones, tablets and computers (Lombardi et al. 2018, 9).

1.7 Purchase price and costs

Currently one of the most significant factors limiting the EV uptake of consumers is costs (Amsterdam Roundtable Foundation 2014, 25; Irvine 2015, 26) and the purchase price as itself continues to represent a major obstacle toward adoption of electric powertrains. A study by VTT (Zulkarnain et al. 2014, 260) states that the high initial purchase price is one of the major inhibitors, which is mainly due to the relatively high battery cost, which is agreed by Giffi et al. (2011, 10), Bessenbach & Wallrapp (2013, 33) and Amsterdam Roundtable Foundation (2014, 13). The battery prices are decreasing, but not low enough to make EVs cost competitive and it is still a major reason why the TCOs of EVs are remarkably higher than for ICEVs. However, maintenance and operating costs are lower in comparison to ICEVs (Bessenbach & Wallrapp 2013, 33), but the average purchase price is way higher and in most cases, this difference is enough big to outweigh the lower maintenance and operating costs (OECD/IEA 2018).

For example, Wietschel et al. (2013, 14-15) summarized that gasoline cars continue to dominate at low mileages because EVs are not able to compensate for their higher purchasing costs via cheaper running costs per kilometre. An annual mileage of over 15 000 kilometres is an essential prerequisite for EVs to be economical, but at very high mileages, the most cost-efficient option is a diesel engine, because BEVs will be eliminated due to insufficient range, and PHEVs need to use the combustion engine too often.

A survey implemented by JRC (Thiel et al. 2012, 9) shows that 75% of the participants think that the electric cars are quite expensive and where an average

of 60% show no interest on purchasing an EV instead of an ICEV (2012, 11). Also a study by Deloitte (Giffi et al. 2011, 10) indicates that the majority of respondents would not be willing to pay premium for EVs over an ICEV. For example, in both Belgium and UK, 71% of consumers were expecting to pay as much or even less for EV than an ICEV. The results of the same study additionally show that globally, the overwhelming majority of the respondents would not pay more than around 26 000 euros for an EV. When projected to the Finnish Driver Barometer study by Kantar (2018), this price is similar to the one that Finnish car owners would be willing to pay for a new car in general despite the powertrain. Additionally, a study by Amsterdam Roundtable Foundation (2014, 3) found that the primary reason to buy an EV in Norway was “to save money” for 41% of EV buyers, and survey results by Paakkinen et al. (2018, 39) reveal that 67% of Finnish participants see the purchase price as the prior obstacle in electric car adoption. Moreover, a publication based on a poll implemented by Bosch by Kilcarr (2017) states that everyday motorists harbour reservations about EV practicality especially when it comes to higher level of pricing. Despite this, the report states that simultaneously, consumers feel a certain kind of inevitability developing around them; that they will be owning an electric car at some point in the upcoming years.

However, the share of price-conscious EV buyers is likely to be higher in the general population in comparison to early EV adopters. Furthermore, the estimated differences between EV and ICE vehicle TCOs vary largely, from around 5 000 euros even up to 20 000 euros per vehicle. The difference depends on factors such as powertrain type, model, fuel price and a number of other variables. Especially lower battery prices will be an important driver for longer term mass market adoption.

1.8 EV prospect customer profiles and related challenges

The heart of successful large scale diffusion of EVs is the consumer perception and willingness to purchase these vehicles with new technologies (Thiel et al. 2012, 4). Consumer acceptance is one of the most critical aspects that needs to be paid attention in this early stage of EV development (Zulkarnain et al. 2014, 260). They are looking for less expensive and greener transportation alternatives with at least

all the same performance qualities of traditional cars, which makes a successful EV adoption very intriguing and complicated (Giffi et al. 2011, 1).

Many consumers might perceive electric cars as disadvantageous and therefore have a negative opinion about them (Bessenbach & Wallrapp 2013, 31), which could be caused by a long-term use of fossil-fuelled cars, as it is likely that the long usage term creates a natural scepticism towards a substituting technology. However, several consumer surveys show a promising EV market when viewed from an early adopter perspective, but outside that, some challenges coming from the side of consumers are still present. There is existent uncertainty that calls for better acknowledgement before consumers are ready to adopt EVs, which relate to e.g. price, performance and infrastructure (Zulkarnain et al. 2014, 260). Giffi et al. (2011, 19) found in their survey that there is a common set of consumer expectations and they are very similar throughout all involved segments, which differ in an extreme way from what manufacturers are currently able to offer.

A survey by JRC (Thiel et al. 2012, 9) found that many consumers are unaware or lacking knowledge on certain parts of EV technology. For example, every third participant could not provide an answer on the question concerning battery fast charging time (if it can be less than half an hour), and 28% did not know if electric cars can run for a maximum of 150 km between charges. Also the cost aspect concerning range and maintenance were less known, for example, 43% did not know if it is possible to drive 100 km for under two euros, and 33% did not know if the maintenance costs are high in comparison to an ICEV. Additionally, the same study shows that consumer familiarity is worrying, as even 50-58% of the participants are not familiar with EVs at all in France and UK. Furthermore, a study by VTT (Paakkinen et al. 2018, 20) found that 45% of participants living in apartment houses with charging stations did not know the type of the implemented charger in their condominium.

These highlight the need to increase public awareness of e-mobility by distributing reliable information and demonstrating these activities together with all the strengths of EVs in order to make them more attractive (Tsang et al. 2012, 3). A research by Kassakian et al. (2015, 12) found that the familiarity with EV capabilities within consumers cannot be called typical. Especially uncertainty concerning costs and

benefits were highlighted, as well as the diverse consumer needs that are tough to be met in terms of EVs. This emphasizes the criticality of identification and evaluation of EV adoption barriers. As consumers get more experience and knowledge regarding e.g. range, charging and costs, they will create new considerations toward EVs (Giffi et al. 2011, 19).

The buying intentions of consumers are strongly dependent on the planned time of new car purchase. Basically, the later it will be, the higher chance there it is for it to be an EV on average. As an example, a study by JRC (Thiel et al. 2012, 11) indicates that individuals who are planning to purchase a new car in the next six months declare their preference for electric cars more than any other group, where those who are planning a purchase in a couple of years are above the average. A study by Deloitte (Giffi et al. 2011, 1) found in their survey that potential first movers of EVs (5-9% dependent on the country) were likely to purchase or lease a new vehicle within the next year. The same study found that Western European countries are more receptive toward EVs than Southern European countries.

A JRC survey (Thiel et al. 2012, 11) shows that everyday drivers are more cautious about purchasing an electric car, but those who think to have a good knowledge on EVs are more prepared to purchase one. These consumers with better knowledge are usually the first movers or early adopters who tend to see themselves politically active, environmentally conscious, tech savvy and trendsetting (Giffi et al. 2011, 4). They attribute positive characteristics to EVs, such as convenience, safety, value for money and attractiveness. Additionally, they can be sensitive to efficiency and charging costs. Also younger people seem to have a significant role on EV prospect portfolios, as a JRC survey (Thiel et al. 2012, 11-12) shows that 41% of participants are aged between 18 and 34 years. Furthermore, people living in large cities and metropolitan areas have a significant part in EV prospect portfolios. The study found that younger consumers make shorter trips in average, and those trips are made in large cities and metropolitan areas, which fits better with the use of an electric car.

A study by Wietschel et al. (2013, 4-5) found that especially consumers who work full-time and live in rural areas or small to medium-sized towns or suburbs of larger cities show high potential to switch to EVs. This makes up almost a third of private car owners. However, a survey by Deloitte (Giffi et al. 2011, 4) indicated that

European EV prospects tend to live in urban areas, and suburbanites are more common in the United States and Japan. These consumers are marginally more likely to be male than female and represent either middle or upper class. Also a survey by Deloitte (Giffi et al. 2011, 4) found that EV first movers are generally better educated, with a higher-than-average number of prospects holding post-secondary degrees.

2 EMPIRICAL RESEARCH

The research was intended for the customer base of Škoda Finland and implemented as a survey by using quantitative method, which is the most common approach for doing market research. The quantitative research aims to quantify problems and understand their size by searching projectable results to a larger population (SIS International 2018). This means that the participants were given pre-defined answers to choose from and in the end, the results were analysed by the help of statistical tools and methods to form cause-and-effect relationships between factors. As the distribution was made for 2000 Škoda owners, and the target was more than 400 participants, it was the approach of choice to enable efficient filtering and analysis of large amounts of data. In total, the survey gathered 465 participants, which was more than expected.

The distribution was made throughout Finland to include participants from different living areas and infrastructures. The regions were divided to five major groups such as Southern, Eastern, Southwestern, Western and Northern Finland, and the living areas were divided to three different categories such as rural, suburban and urban. All the prospects were picked from customer bases of Škoda Service partners of different regions with the help of data providers such as Traficom and Bisnode Automotive Analytics. The questionnaire form was distributed to a total of 2000 customers, divided in two different pickings, containing 1000 customers each.

The survey was made on Webropol platform, but the invitation was sent by mail as a form of letter, including a written link to the survey. The link was modified for a more efficient typing process; instead of the original and complex Webropol address, the questionnaire was hidden behind a link called www.skoda.fi/kysely, “kysely” meaning questionnaire in English. By using this approach, the survey would reach the desired customers directly and be noticed efficiently.

The questionnaire contained 25 questions divided in three different categories. The first set of questions was about the customer profile of the participant, the second one investigated purchasing readiness and behaviour, including evaluation of importance regarding different electric car properties, meanwhile the third one concentrated on range and charging related attitudes.

The requirements for participants were that they were private owners and in one of the four pre-defined age frames. Additionally, they should own a Škoda model that is at least model year 2014, so the research was aimed at new car owners. The age frames were divided in young adults from 25 to 34 years old, middle aged from 35 to 44 years old, and older adults in two different groups; from 45 to 54 years old and from 55 to 64 years old.

First sample picking (out of two)				
Age	**Total #**	**Gender #**		**Gender %**
25-34	146	Male	101	69 %
		Female	45	31 %
35-44	310	Male	225	73 %
		Female	85	27 %
45-54	271	Male	176	65 %
		Female	95	35 %
55-64	273	Male	188	69 %
		Female	85	31 %

Table 1. Customers selected by first picking.

Second sample picking (out of two)				
Age	**Total #**	**Gender #**		**Gender %**
25-34	149	Male	102	68 %
		Female	47	32 %
35-44	312	Male	225	72 %
		Female	87	28 %
45-54	270	Male	174	64 %
		Female	96	36 %
55-64	269	Male	188	70 %
		Female	81	30 %

Table 2. Customers selected by second picking.

The largest age group of the first sample was middle aged adults (35-44 years old) with 310 customers (31%), meanwhile older adults in two different groups (between 45 and 64 years old) had shares of 27% respectively. The smallest group was young adults (25-34 years old) with a share of approximately 15% from the whole sample. The sample customers were mostly men, with a differing share between 65% to

73% depending on the age group, whereas approximately every third or fourth of the customers in the sample were women (from 27% to 35%).

The actual participant shares from the first sample group had a slight difference in comparison to the targeted mix. The share of women fell slightly short (only approximately 19% of the participants) and the older adults showed to be more active than middle-aged.

The survey results were mainly analysed from the whole sample perspective, but additionally, differences between genders, living areas, age groups and even education and income levels were found. These were further investigated to highlight the differences in buying behaviour of the customers. Respective graphs were implemented in the beginning of each chapter for a quick overview of results, and the results were further analysed by writing underneath.

2.1 Customer profiles

2.1.1 Gender share

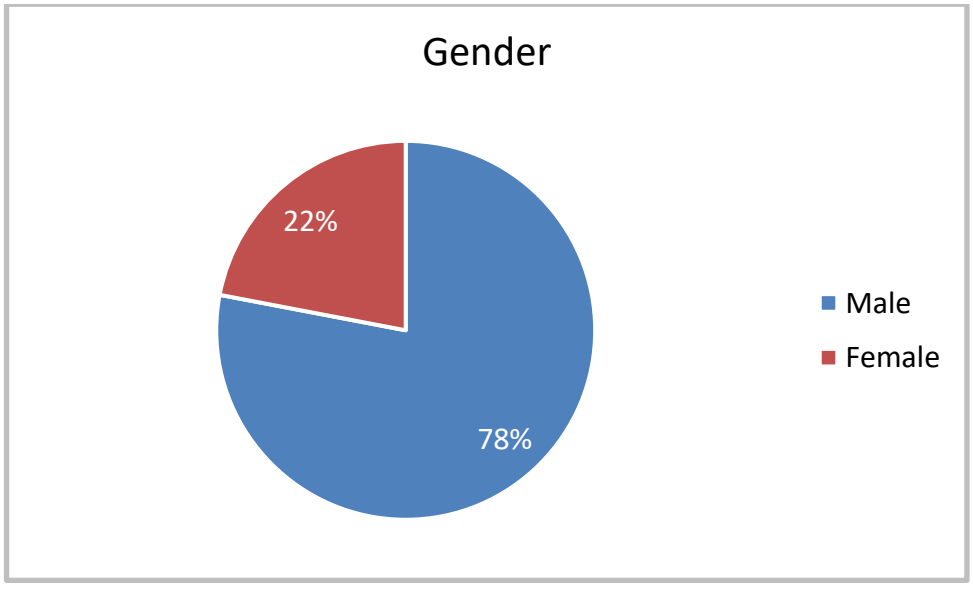

Figure 6. Gender share of participants.

In total, the majority of the survey participants were male (78%). This is mainly due to that a strong majority of the Finnish Škoda owners are representing this gender, whereas clear minority are female (22% of all the survey participants). The share of genders in the whole Škoda base between years 2014 and 2018 was 52% male and 20% female, while 28% of holders were not classified (Traficom, 2019). This also had an effect on the sample picking process which was made based on the content of customer base data.

The first sample was even more favourable for men, and the lack of female representatives in that stage drove for a decision of a weighted sample for the second round to achieve the final share of 22%. This decision increased the part of female participants by approximately 4%, as the share of female participants after the first picking was only around 18%. Furthermore, this highlights the worth of two different pickings, as the second picking made it possible to effectively increase the share of female participants.

Still, in terms of participants, it can be concluded that female recipients were less active than male. If the participation would have been equal between all recipients, the share of female should have been even more than 30%. After the first sample, the target was to reach approximately fourth of all the female recipients (25%) as the target number of all participants was 400, but the achieved share came out slightly lower even though the overall number of participants was 465.

2.1.2 Age groups

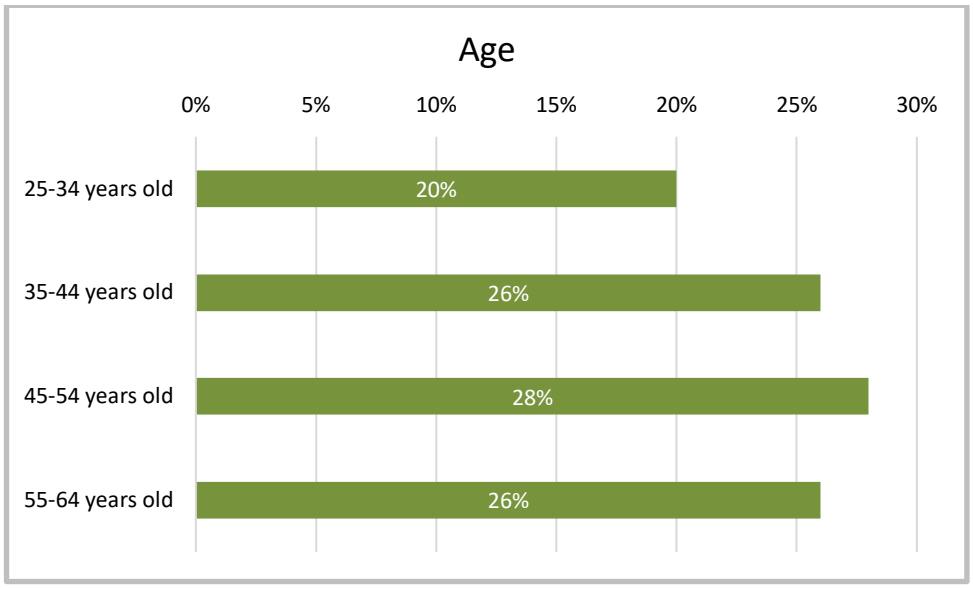

Figure 7. Age share of participants.

The share of participants was quite equal in three of the four age groups, but one of the groups remained clearly less presented than others. Participants aged from 35 to 64 years old were represented with a strong share of 26% on average, but unfortunately, the group of young adults between 25 and 34 years old barely reached a total of 20%, which remains under the set target of 22% by just 2%. However, this can be explained by that most of the new car buyers and owners are older adults, and it is still quite rare to own a new car as a younger adult. For example, the overall share of 25-34-year-old Škoda owners from owners aged between 25-64 years old is 18% (Traficom, 2019). Moreover, 20% share in participants is quite impressive, as the share from distribution was only 15%. As an opposite example, the age group of 35-44 years old had 26% share of participants, but the share of receivers was 31% of the whole targeted sample.

When looked from the gender perspective, female participants were the most active in the age groups of 25-34 and 45-54 years old with a share of 29% participating in both, where the 35-44-year-old females were the least active with only 15% share in their respective group. The oldest age group (55-64 years old) had a share of 27%. Males were the most active in the age groups of 35-44 and 45-54 years old with a representation of 29% in both, and the least active in the youngest group (25-

34 years old) with a share of 17%. Fourth of men (25%) belonged in the oldest age group, 55-64 years old.

The questionnaire also included an option for those who did not want to express their gender; this option was chosen by only less than 1%, positioned in the oldest age group (55-64 years old).

2.1.3 Living region

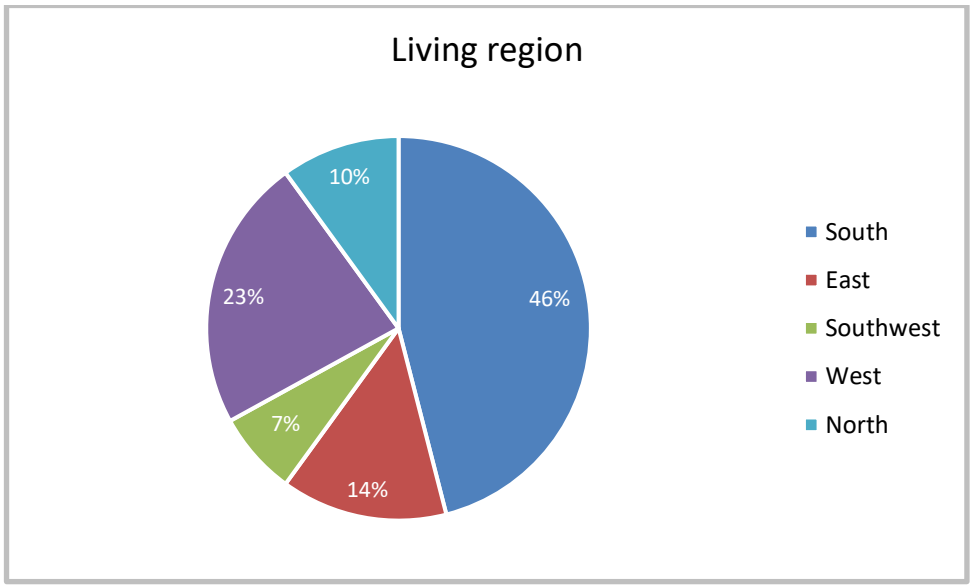

Figure 8. Living region share of participants.

Living regions were divided in a total of five different geographical areas of Finland. A significant majority (46%) from the participants came from the Southern Finland, as also the actual citizens of the country. This area is mostly urban and covers cities such as Helsinki, Espoo and Vantaa. The second largest participation (23%) came from the Western Finland, which includes cities such as Tampere, Jyväskylä and Vaasa, from which all include several suburban areas in addition to the urban areas. Both Southern and Western regions are especially known for their high level of university education and wide labour market for administrative jobs in comparison to other regions of the country.

As Southwest includes major cities such as Turku and Pori, it was decided to be placed into its own category. However, the Southwest remained as the least

represented with just 7% and around 32 participants, which can be considered low. Eastern Finland had a participation of 14% of the recipients, and includes cities such as Kuopio, Joensuu and Savonlinna, which cover several suburban areas. The least represented from the main regions was North, which consists of the rural areas of Lapland, Kainuu and Northern Ostrobothnia.

There were no significant differences found in participation of genders; from their respective samples, both male and female had very equal participation shares in each area in comparison to the total gender samples. However, from the age point of view, the Southern Finland was from 6-8% more represented by young adults than the other regions, meanwhile the Northern Finland was 5% more represented by 35-64-year-olds. Eastern Finland was the most equal among the age groups with 12-14% participation from each group, and the second equal was Western Finland with 21-25%.

2.1.4 Living area

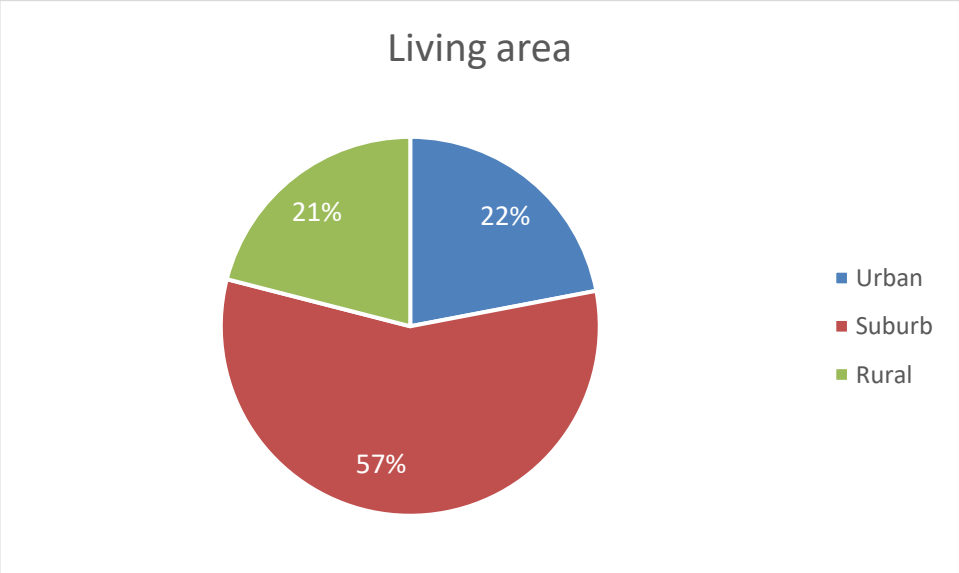

Figure 9. Living areas.

The living areas were divided into three main categories; urban such as city centres with apartment buildings and high population density, suburb with smaller buildings and lower population density, and rural as countryside with a very low density of population in comparison to other areas. The majority of participants were from

suburbs (57%) and both urban and rural areas shared very close participation shares of 21 and 22%.

The living areas were clearly more equally represented within female than male participants. The suburb was less in favour of female participants with 46%, as it was 20% more represented within male participants with a majority of 61%. Furthermore, within female participants, the rural area was the second most popular with 36%, meanwhile only 17% of the male sample came from rural areas. Even though the shares were very different between these areas, the urban area was only 1% more represented by female (22% vs. 23%).

When observed from the age perspective, the share of rural area participants increased on each group when moved from youngest to the oldest. From young adults, only 10% came from rural areas. When entered the group of middle-aged, the share increased already by 7% (17%), and the most significant increase (9%) can be seen when moved from middle-aged to 45-54-year-olds, from which already 26% came from rural areas. The oldest age group had a share of 28% in these areas. The suburb was the most popular living area within 35-44-year-olds with 66%, as the other age groups were placed between 51% and 57%, and the urban area was the most popular in terms of young adults as 33% of the younger participants lived there, where other groups were placed between 17% and 21%.

2.1.5 Education level

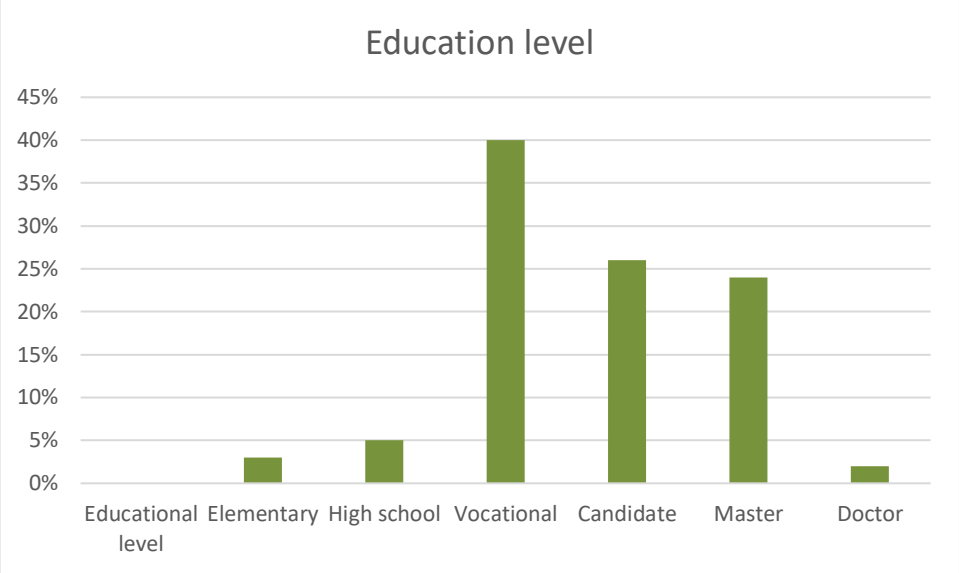

Figure 10. The highest education levels achieved by the participants.

A clear majority of the participants had a vocational education (40%) as their highest degree, where the other more often completed educational levels were bachelor and master, both including approximately fourth (25%) of the participants. Only 5% of all the participants had high school as their highest educational degree, and only a few were either doctors or elementary graduates at the highest. However, there were several differences in the education levels when viewed from the gender, age and living area perspectives.

In terms of gender, the most visible difference lied in vocational and bachelor degrees. From men, 42% of participants had a vocational as their highest education level, meanwhile the share of vocational women was 36%. At the same time, 30% of women were bachelors, where 24% of men had the same degree. This could mean that women are slightly more educated on average than men, which could be related to the differences in income levels, as the following income chapter shows.

From the age point of view, the most elementary degrees were in the oldest age groups, where the shares of participants were 4% (45-54 years old) and 6% (55-64 years old). From the two youngest age groups, only 1% had elementary as their highest achieved education degree, which indicates the enhancement in education offer and system over the years. The education level with the most participants,

vocational, had the biggest share from the oldest age group (50%) and the lowest share from the middle-aged (31%). Bachelor was the most presented by young adults and middle-aged (33-34%) and the least presented by the oldest age group (15%). From adults between 45 and 54 years old, 22% had a bachelor degree.

The youngest group was the least presented in doctors (1%), and the other three groups had 2-3% shares in the doctor category. The low share in the youngest age group can be basically explained by the young age, where e.g. the most are still in their master's degree. The master's degree was completed by 17% of the youngest participants, while both middle age groups, aged between 35 and 54 had 27% share of master graduates. This 10% difference could mean that many young adults do not proceed straight from bachelor to master, but rather gather e.g. working experience in between before moving on with their education. The oldest group had a share of 23% in masters.

2.1.6 Income level

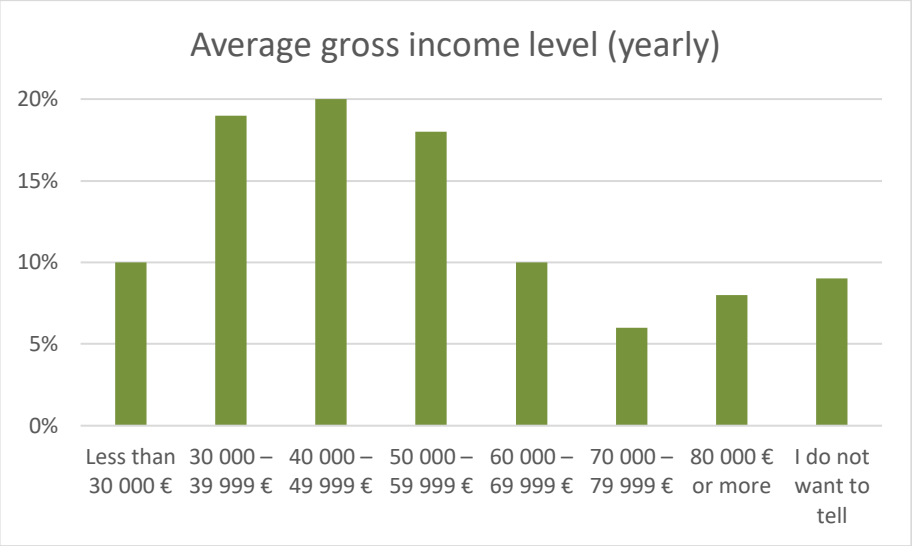

Figure 11. Gross income levels.

The yearly gross income levels differed remarkably between the participants and the differences became visible especially when looked from demographical and geographical perspectives. For example, women seemed to have a remarkably lower income level in average than men; from women, nearly half (46%) made less

than 40 000 euros in a year, where the share of men in the same income category was only fourth (25%).

However, the share of participants earning between 40 000 and 50 000 euros per year was the same; exactly fifth (20%). In higher categories, the share of men earning between 60 000 and 80 000 euros was 37%, where 23% of women earned the same yearly amount. From participants earning more than 80 000 euros per year, 9% were men and 2% women. From both genders, 9% of participants did not want to tell their income level. This sums up that men have a higher income level on average than women, which also partially explains why women tend to reach for higher education levels.

There were also clear differences in income levels between living areas. Participants coming from urban areas clearly had higher income on average than those coming from suburban or especially rural areas. From urban consumers, 30% had an income level placed between 30 000 and 50 000 euros, where 42% of suburban and 45% of rural consumers had the same income level. From urban participants, approximately third (33%) earned more than 60 000 euros in a year, where 22% of suburban and 17% of rural participants earned the same amount.

2.1.7 Household members

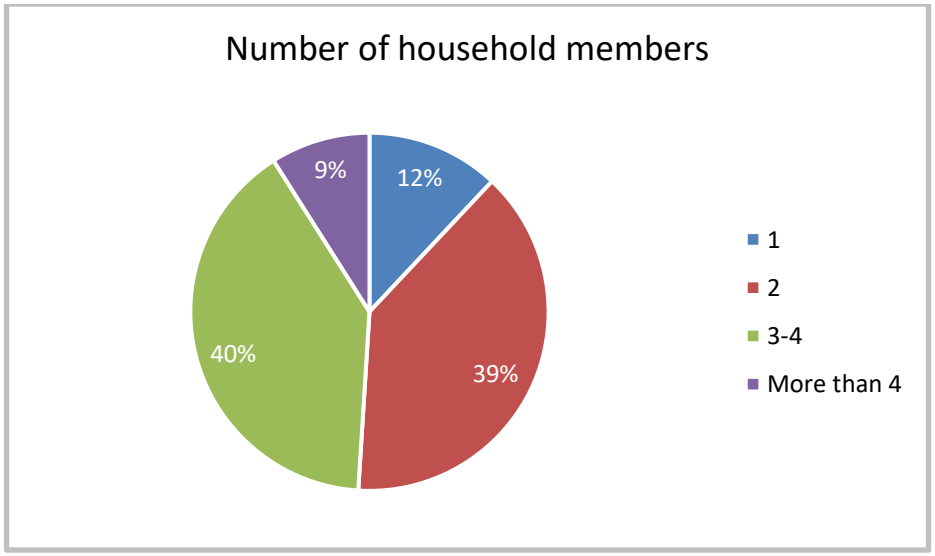

Figure 12. Number of household members.

From all the participants, 79% had at least two members in their household, from which 40% were small families with a total of 3 or 4 members, and 39% were couples. Only 12% were in a single household, and even 9% were big families with at least four members in their household altogether.

Suburb was clearly in high popularity between small families, as nearly half (47%) of suburban participants had household sized between 3 and 4 members. It could be explained by that families see this kind of environment more spacious and suitable for their children to grow in. However, the highest share of bigger families with more than 4 members was in the urban area (10%), which could be related to the shorter distance between e.g. day care, schools and hobbies. Additionally, most of the single person households came from urban areas (14%). The preference toward urban environment could be explained by social life and activities nearby. From rural areas, more than half were households with two members (51%), from which more than half were older adults.

2.1.8 Number of cars in household

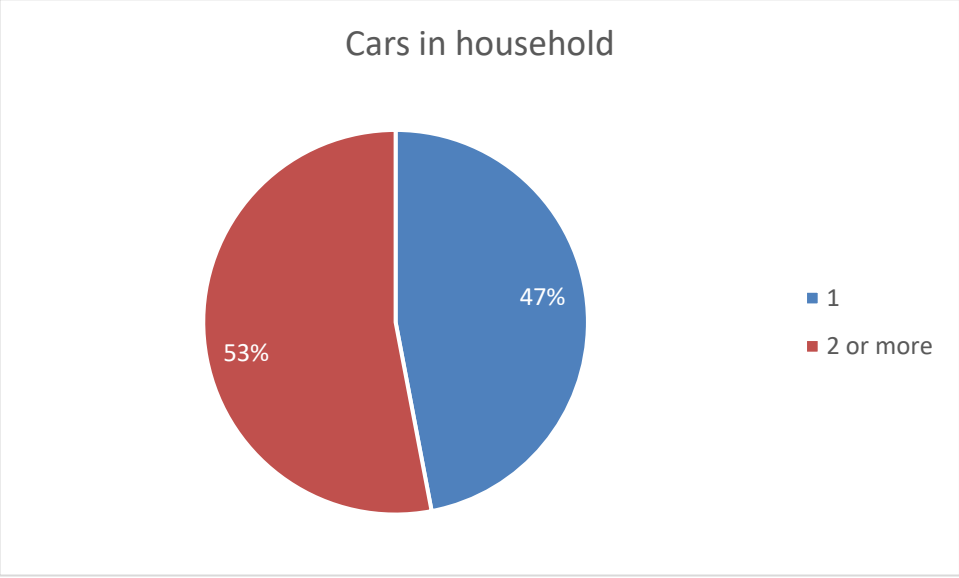

Figure 13. Number of cars in households.

A slight majority had at least two cars in their household (53%). In living areas like suburban and urban, the share of one car households was more than half; in suburban 53% and in urban 59%. In rural areas, even 83% of households had at

least two cars. This can be related to high participant share in rural areas with families and long distances to reach different services.

Even in single households, the share of at least two cars was 9%. From households with two members, already more than half (55%) had at least two cars at their disposal, where from small and big families, 62-65% had at least two cars, which means that in families, even more than third cope with one car (35-38%).

There were also differences in number of cars between participants earning different amounts of income. From participants earning between 30 000 and 40 000 euros per year, 43% had two cars in their household, meanwhile from income category 40 000 to 50 000 euros, already 55% had at least two cars at their disposal. In the category 50 000 to 60 000 euros, the share of participants having at least two cars in their household was 61%.

2.1.9 Type of parking spot at home

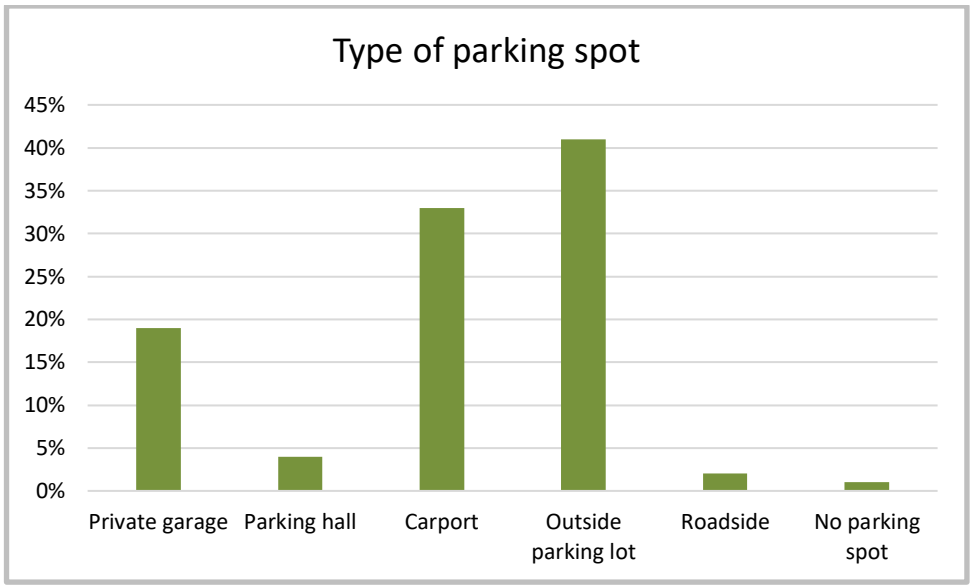

Figure 14. Type of parking spot at home.

The three most common parking places within participants were outside parking lots, carports and private garages. Outside parking lot was the most usual with over 40% share, meanwhile 33% of the participants kept their cars in carports. The private garage was clearly the least common from the top three with 18%, but still

significantly more represented than e.g. parking halls or roadsides, which remained under 5%.

Private garage was especially popular in rural areas with a share of 31%. In suburban areas, the share of private garages was nearly half less (17%), and in urban areas, only 13% of participants used private garages as their primary parking spot. Nearly the same share of urban participants had their parking spots in a parking hall (12%), where in suburbs, only 3% had their car parked in a hall. From rural areas, no one had a parking hall spot. Additionally, no roadside parking was used in rural areas, and everyone in such areas had an own parking spot, as well as in suburban areas. The share of participants with no parking space in urban areas was 4%, meanwhile roadside parking was a bit more common with a share of 5%.

The great share of almost third of participants in rural areas parking in private garages indicates quite promising future and a good target market for wall chargers, which would also remarkably ease the range anxiety and dependence on public charging stations. A wall charger could be also a reasonable choice for those parking in carports, which is a common parking form especially in suburban areas (36%). However, especially in urban areas, consumers use outside parking lots to park their cars, as even 39% have stated in the survey. This could mean a great opportunity for heating post conversions for those who have a heating post at their disposal. For this, a new service could be implemented in co-operation with a service provider of such services, or otherwise by e.g. training suitable, mobile personnel for these tasks to configure and install the needed equipment, and to prepare a ready-to-use service package for customers at a suitable price.

2.1.10 Estimation on personal EV knowledge level

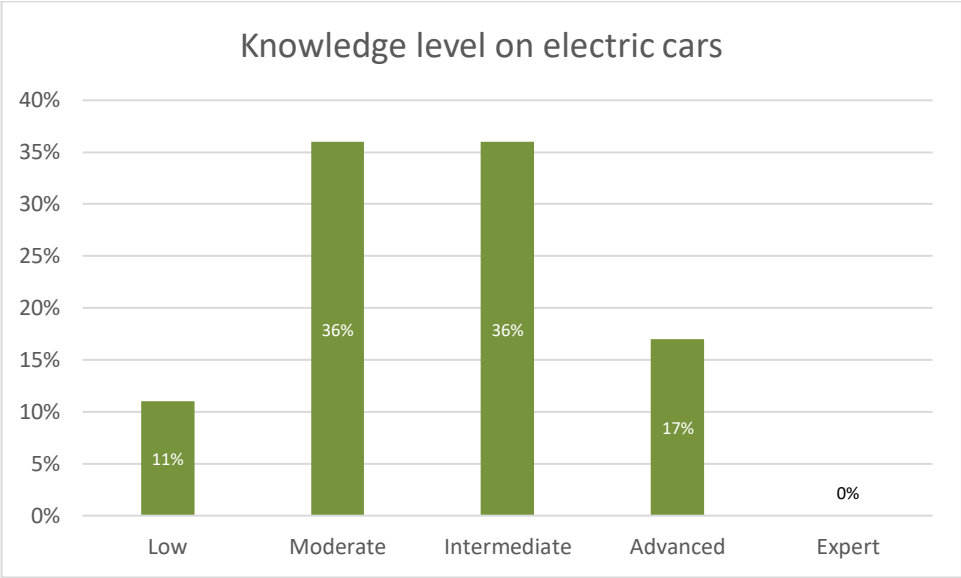

Figure 15. Knowledge level on electric cars.

The majority of participants evaluated their knowledge on electric cars to be on moderate or intermediate level. The positive side is that in general, there were more participants that evaluated themselves as advanced in terms of knowledge, than those who thought they have a low level of knowledge. There was also an option for expert level, but it was chosen only by a couple of participants, which can be considered realistic as the survey was aimed at regular and random customers rather than those who were e.g. working in the field.

However, there were significant differences in evaluation of knowledge levels between genders and participants from different living areas. For example, even 36% of all women considered having low level of knowledge on electric cars, where in case of men, the share of participants going for same answer was only 3%. From women, a remarkable share of 82% claimed to have low or moderate level of knowledge in the field of electric cars, where from men, only 35% estimated their knowledge to be lower than intermediate. Therefore, a share of 65% of men claimed to have at least intermediate level, from which 21% stated to have an advanced level of knowledge. As a summary, men have a remarkably better knowledge level on electric cars on average than women, which means that women could be brought up more often in communication concerning electric cars. It could be done by e.g.

creating an image by using more women in advertising or by organizing EV-related events aimed for them.

From rural areas, more than fifth of participants (21%) evaluated their knowledge to be on a low level, where only 8% of participants from both urban and suburban areas evaluated similarly. The most equal knowledge level was intermediate, with 33-38% share of participants in each living area. A share of 18-19% participants from urban and suburban areas answered advanced, where 13% from rural areas went for the same answer. This concludes that the average knowledge level on electric cars is significantly lower in rural areas than e.g. suburban and urban areas, which highlights the importance of outreach programmes and actions for rural customers, and additionally, more visibility for electric mobility in rural areas in general.

Additionally, there were clear differences found in the knowledge levels between participants with different educational backgrounds, from which vocational, bachelor and master were further analysed. From customers with vocational as their highest education level, 16% stated to have a low knowledge level on electric cars, where only 9% of bachelors and 5% of masters answered similarly. Even 21% of masters and 20% of bachelors claimed to have an advanced knowledge level, where the share of similar level within participants with vocational education was only 13%. Moderate and intermediate levels were the most common within all participants with different education levels with shares between 31 and 39 % in each background.

2.2 Customer behaviour

2.2.1 Attitudes toward fuel types

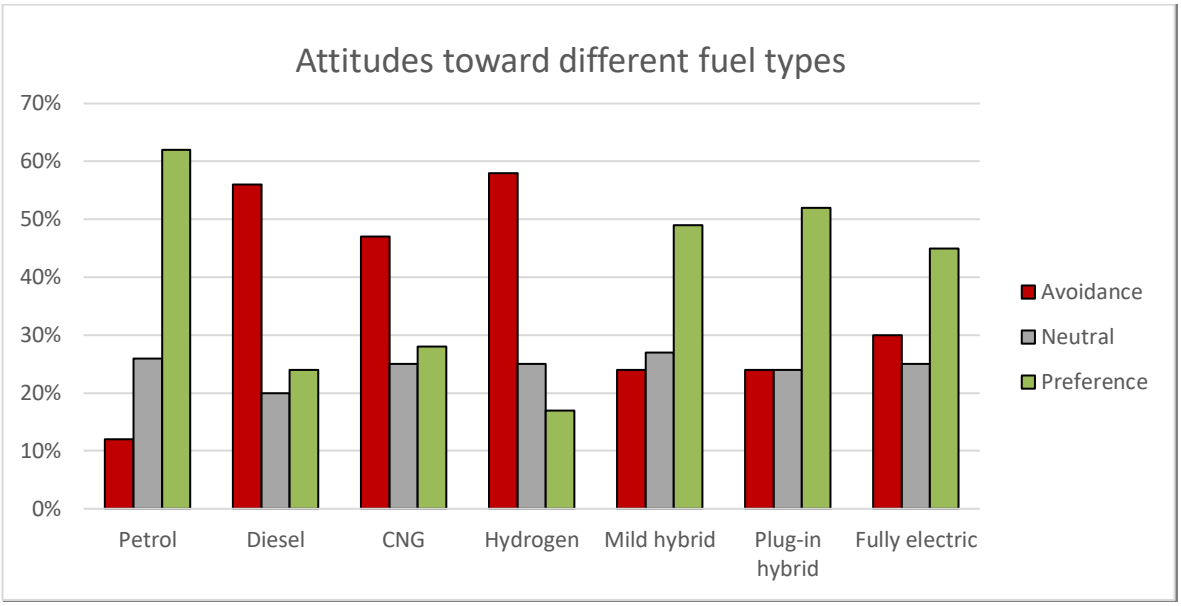

Figure 16. Attitudes toward different fuel types.

The attitudes toward different fuels were evaluated between seven different types to estimate the position of fully electric in comparison to others. Four of these fuels gained strong interest and preference within participants, including also fully electric, but three were clearly more avoided than preferred.

The most preferred fuel was petrol, with still over 60% of participants showing their interest and trust toward this traditional fossil variant. The second most preferred fuel type was plug-in hybrid, which was approximately only 10% less desired than petrol. However, it still had the support by over half of the participants, which shows the strong potential and interest in alternative fuels. Moreover, the position of alternative fuels is further strengthened with third and fourth most preferred fuel types; mild hybrid (approx. 48% of the participants) and fully electric (approx. 45% of the participants). All three of the electric fuel types were quite close to each other, placed between 45 and 52 % preference shares.

The most avoided fuel type was hydrogen (approx. 58% avoidance), which could be explained by e.g. rarity of the fuel type and unavailability of models on the market.

Additionally, there is no distribution network for hydrogen in Finland, and the fuel itself is physically unpredictable and the technology is quite unknown. Furthermore, the lack of information and knowledge regarding hydrogen might have a strong effect on the overall consumer desire and behaviour.

The second most avoided was diesel, which has shown worrying signs in terms of market shares in the past years, and the implemented heavy taxation measures on the fuel price itself and also on the yearly fuel tax further drive the demand toward other alternatives in the Finnish market. Additionally, the uncertainty caused by e.g. diesel bans in central and western Europe, and the overall unstable political atmosphere around diesel do the favour for e.g. petrol and electrified cars.

The third clearly more avoided fuel type was natural gas (CNG), which was avoided by nearly half of the participants. The reasons can be similar to hydrogen and even fully electric, as the model offer of CNG cars is really niche on the market, including only a few brands. Furthermore, the gas distribution network is still under a major development stage and in need for further spreading, especially to the northern and even middle parts of the country. The CNG sales could be boosted by e.g. offering free CNG fills for a year or even two or three years for a new car buyer.

From the gender perspective, clear differences in fuel preferences were found from types such as CNG, hydrogen, plug-in hybrid and fully electric. All of these types had a higher preference share within men than women. For example, hydrogen had three times bigger share within men than women; 21% versus 7%. CNG was preferred by over third of men (32%), where only 18% of women were interested in it. Plug-in hybrid got 56% of men participants interested, where the share of women interested was 35%. The fully electric was preferred nearly by half of men (48%) and 38% of women. This clearly indicates a more open attitude and behaviour toward alternative fuels by men than women, which might be connected to e.g. higher level of interest or knowledge in biofuels and electric powertrains.

When looked from the living area point of view, petrol was clearly more preferred by urban and suburban participants (63-66%) than by rural participants (54%). In contrast, rural participants had significantly higher preference share in diesel (33%), where urban and suburban participants had lower interest in it (20-21%).

Additionally, alternative fuels were more in favour of participants coming from suburbs and urban areas than ones from rural areas. For example, the fully electric was nearly half less preferred in rural areas than in urban and suburban (27% vs. 50-52%), which could be connected to e.g. range anxiety, lack of network coverage or overall information or knowledge on electric mobility. Also plug-in hybrid had higher share in urban and suburban areas (53-56%) than in rural (42%). Alternative types such as CNG and mild hybrid were more preferred by urban than both suburban or rural participants; CNG had a share of 35% from urban, and 26-28% from suburban and rural, where mild hybrid had a more impressive share of 55% by urban and 44-48% by suburban and rural.

2.2.2 BEV Purchasing readiness

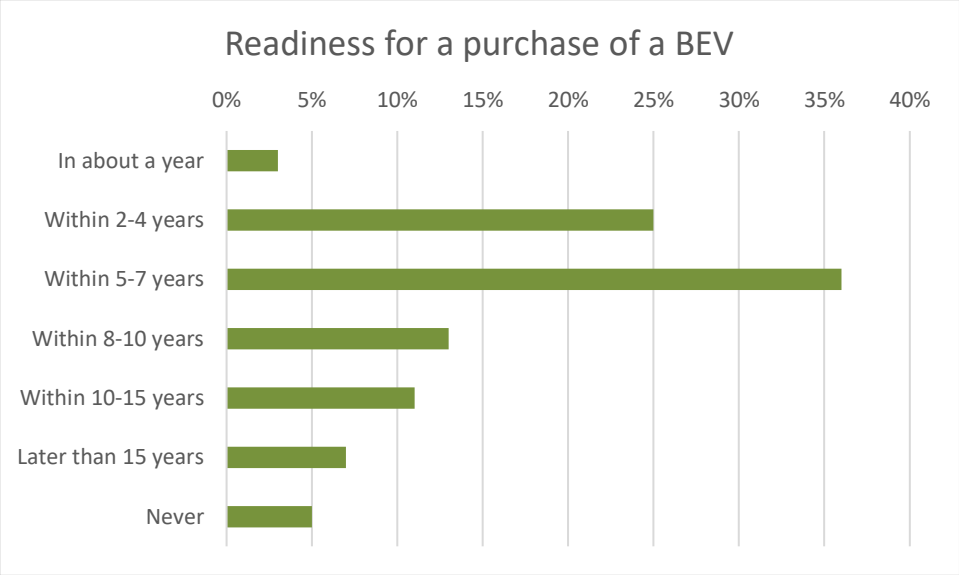

Figure 17. Purchasing readiness.

The readiness levels concerning battery electric vehicle purchase were quite positive and closely related to the actual adoption goals that have been set by governments and manufacturers. Over a third of all participants claimed to be ready for a BEV purchase within 5 to 7 years, and fourth already within 2 to 4 years. Therefore, more than 60% of all the participants believed to be prepared to buy a fully electric car within the next seven years. From the less enthusiastic third, 5% claimed to never be willing to buy a BEV, and approximately 7% would buy it after

2034, which is positioned quite close to the planned banning of ICEVs from different countries.

It appears that men are generally prepared to purchase a BEV sooner than women, as 80% of men would be ready to buy in 10 years, where still 23% of women would rather purchase a BEV after 10 years, and even 9% would not want to purchase it at all. From men, only 4% stated that they would not be willing to ever buy a BEV.

There were also clear differences depending on the living area, as only 19% of the participants who were coming from countryside would be prepared to buy a BEV in less than five years, where in the same time frame, the share of participants from suburbs and city centres were around 30%. Furthermore, 31% of countryside participants would buy a BEV after 10 years, where approximately 21% of the ones coming from suburbs or city centres had the same level of readiness regarding time of purchase. These results indicate that participants coming from both suburbs and city centres are more prepared to buy a BEV in shorter time than the ones coming from countryside. The reasons might be similar as previously mentioned in the chapter concerning fuel types; range anxiety, insufficient network coverage or the lack of information or knowledge.

Moreover, the purchasing readiness was closely related to income levels of the participants. Three of the income levels between 30 000 and 60 000 euros were further analysed. Basically, the higher the income, the sooner the purchase would take place. However, only 2-4% participants from each level would be ready to buy an electric car already in a year. This could be also related to that there is currently no need for a new car in the household in general, despite the powertrain. More than fourth (26-28%) of participants with income level between 40 000 and 60 000 euros would be ready to buy a BEV between 2 and 4 years, where only 15% of participants with lower income than 40 000 euros would be ready to purchase in the same time frame.

Despite the differences, the readiness for BEV purchase in between 5 and 7 years was the most common in all income groups. In the income level of 50 000 – 60 000 euros, even 74% of participants believe to buy a BEV within eight years, where 62% in level 40 000 to 50 000 euros and 47% in level 30 000 to 40 000 euros would be

ready to purchase in the same time period. However, nearly fourth (23%) of participants in the income category of 30 000 to 40 000 euros would be ready for a purchase after 10 years, where 18% of the participants from the income category of 40 000 to 50 000 euros would buy a BEV in the same time frame. It was also found out, that the higher the income, the less participants were stating not to be ever willing to buy a BEV. Within income levels between 40 000 and 60 000 euros, only 4-5% of participants did not want to buy a BEV, where from those who earned between 30 000 and 40 000 euros, 8% stated that they are not willing to buy a BEV.

2.2.3 BEV Brand preferences

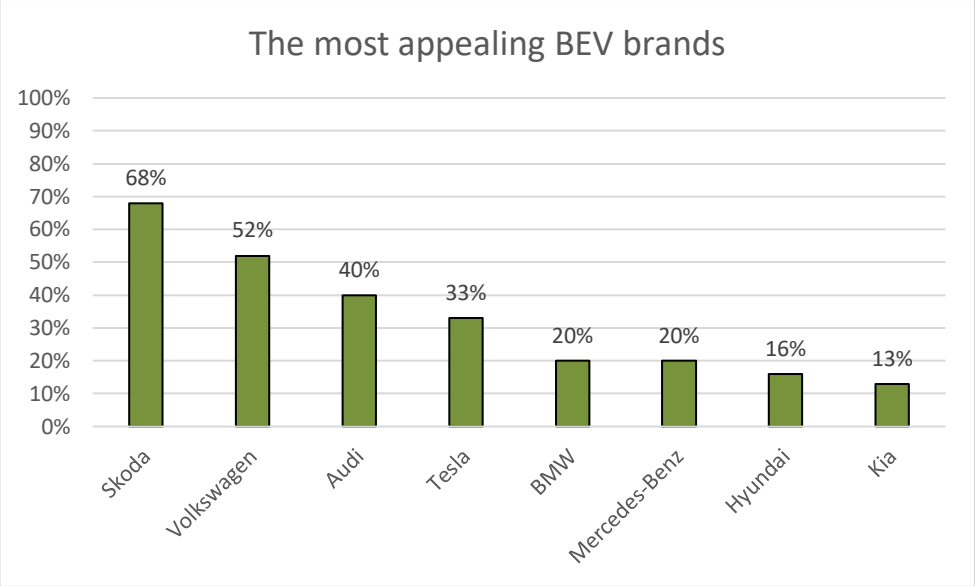

Figure 18. The most appealing brands in terms of current or upcoming BEV model offer.

The participants were given a series of brands to choose from, and they could choose as many as they like. The brands were chosen by their BEV offer, current and/or upcoming. Additionally, model examples were concluded to the options as possible and close competitors for the upcoming BEV model of Škoda.

The most appealing brands for participants in terms of current or upcoming BEV models were Škoda, Volkswagen and Audi. As the participants were Škoda customers, it is quite clear that the brand was in favour when choosing the brand of

choice. As seen from the results, second and third place were also claimed by VW Group brands. Right after VW AG brands, Tesla was enjoying a remarkable popularity, being chosen by approximately third of the participants with 33%. Fifth and sixth place were claimed by premium brands BMW and Mercedes-Benz, both getting votes by fifth of participants, where Koreans, Hyundai and Kia claimed seventh and ninth place with 13% and 16% shares.

There were a few differences found between participants with different levels of income. Especially premium brands were significantly more in favour of participants with higher income levels. For example, BMW, Mercedes and Polestar had a relatively high popularity in the income group of 50 000 – 60 000 euros, where Hyundai, Nissan and Opel were more preferred in lower income categories, such as 30 000 to 40 000 euros. The premium brands enjoyed approximately 8% more preference in the higher income category on average, where the more affordable brands had approximately 5% more preference in the lower income categories on average than in the higher income categories.

2.2.4 BEV holding type preferences

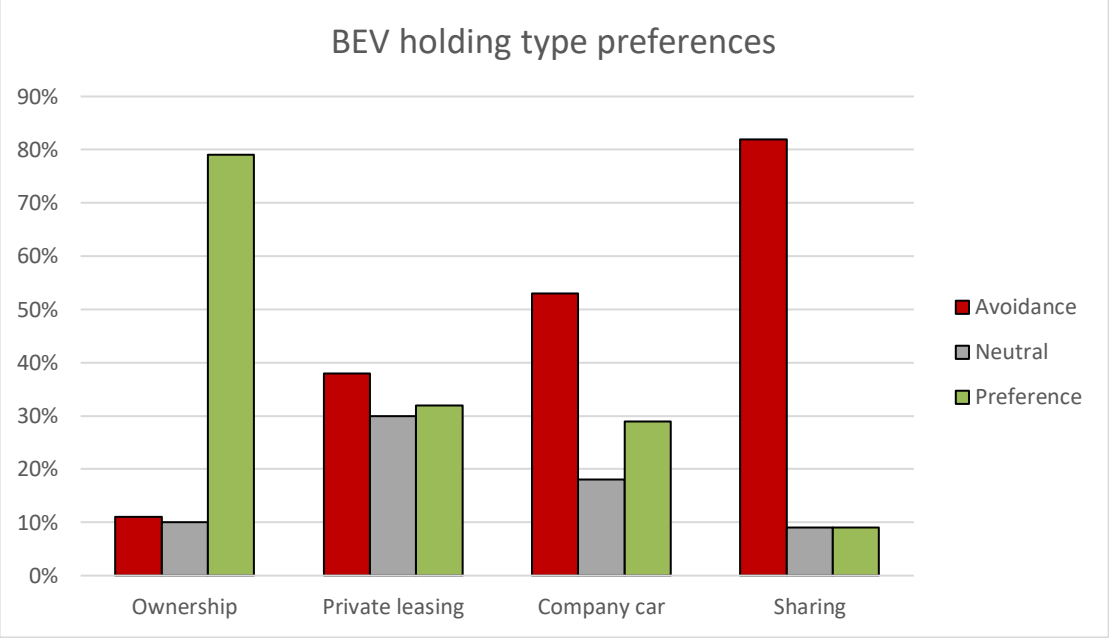

Figure 19. Holding type preferences concerning BEVs.

The traditional ownership of cars seems to be still going strong, also in terms of Finnish Škoda drivers. Almost 80% of participants showed preference toward this holding type for a BEV. All other types were more avoided than preferred, especially sharing with over 80% avoidance. This result could be caused by the fact that sharing is still very niche and unknown as a holding type, while seen only in the capital area and a few urban areas with high population densities. Furthermore, the driving possibilities with a shared car heavily depend on other users and there might be lack of clarity in terms of cost coverage and maintenance of the car, which drive consumers to avoid this holding type.

Private leasing shared the most opinions between participants, as the preference, avoidance and neutral answers were nearly equal between 32 and 38 %. This holding type has just recently been launched within the brand and it is also quite new on the private car market in general. The strong preference could indicate aiming for a more carefree holding, when in the best case, the customer needs to cover only the fuel or insurance costs if anything, and maintenance and spare parts come free of charge. This would also relieve the stress concerning uncertainty of BEV resale value, as the customer could just return the car when the contract ends without worrying about the remaining value or reselling process. In terms of BEVs, the private leasing could also cover costs related to battery, if not fully, at least partially.

The most significant difference between men and women in holding type category was found in sharing; only 7% of men consider this holding type pleasant, where 16% of women could consider sharing as their type of holding a BEV. Ownership, leasing and company car were each approx. 5% more preferred by men than women respectively. Sharing also divided opinions between participants from different living areas. From rural participants, only 6% found sharing interesting, where within suburban customers, the share of interested participants was 12%. From urban category, 10% of participants found sharing important as a holding type.

2.2.5 Price preference for a new car (BEV vs. ICEV)

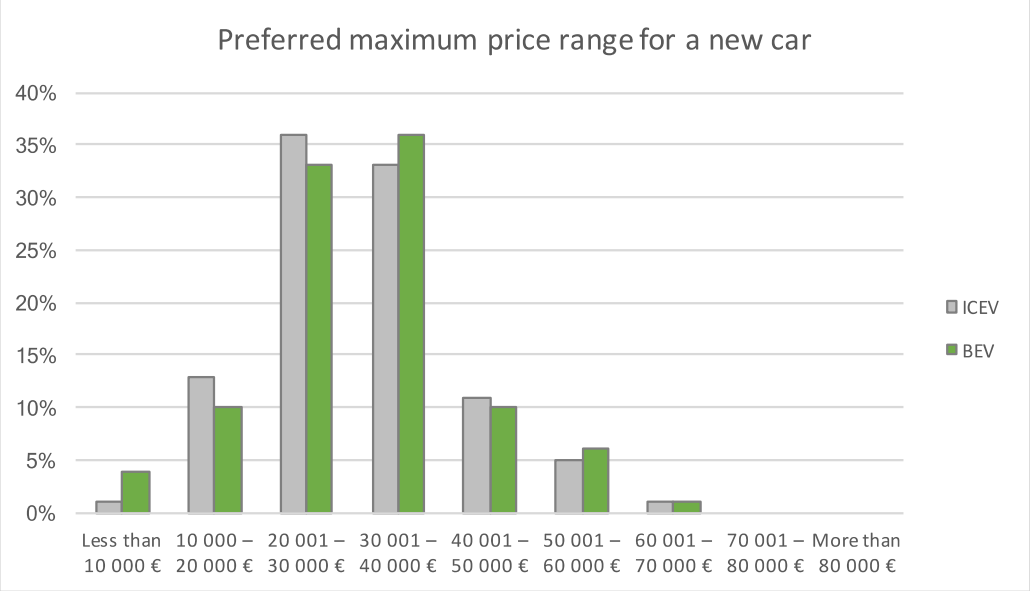

Figure 20. Maximum tolerable purchase price range, ICEV vs. BEV.

The preferred price range is very similar whether the car is an ICEV or a BEV, which indicates that in most of the cases, consumers are not willing to pay extra for the electrified powertrain. This further strengthens the argument of high purchase price as a purchasing barrier. Most of the price expectations fell in between 20 000 and 40 000 euros, which is a range that takes most of the BEVs out of the question, leaving only the options with the least range and equipment left to choose from. Only under 20% would be prepared to pay more than 40 000 euros for a battery electric car.

When viewed from gender perspective, women are clearly willing to pay less for their car, as even 37% of women would be willing to pay a maximum of 20 000 euros for a new car, where only 8% men would prefer a new car of the same value. From men, a majority of 76% are looking for a new car that is valued between 20 000 and 40 000 euros, when 72% of women prefer a car that is valued between 10 000 and 30 000 euros. In conclusion and on average, a majority of men are prepared to pay approximately 10 000 euros more for their car than women. This could be related to e.g. the lower average income of women in comparison to men.

From the men point of view, there are very minimal differences (maximum 1-3%) between ICEVs and BEVs when compared with equal price ranges, which indicates that men have the same price expectation in both ICEV and BEV on average, and therefore, in general, the price expectation is powertrain neutral. However, 17% of women are prepared to pay approximately 30 000 to 40 000 euros for their new ICEV, but even 10% more of women (27%) would pay the similar amount for BEV, which means that 10% of women would clearly pay more for a BEV than for an ICEV. The share of women willing to pay more than 40 000 euros for their car despite the powertrain was 6-7%.

Within living areas, the price expectations were quite similar toward both powertrains and the differences were marginal despite the area. However, significant differences were found between participants with different income levels. Even though, again the gaps between price preferences toward ICEV and BEV were minor, it gave a good view on price expectations by participants who earn different amounts of income. For example, approximately fourth (24-25%) of participants earning between 30 000 and 40 000 euros per year preferred the purchase price to be less than 20 000 euros in both powertrains. From income level between 40 000 and 50 000 euros, only approximately 12-13% had the demand for similar price.

Only the participants with income level between 30 000 and 40 000 euros showed to be ready to pay more for a BEV, as 10% would be ready to pay more than 40 000 euros for a BEV, where only 4% would pay the same price for an ICEV. Within participants in the income level between 40 000 and 50 000 euros, already 13-14% could pay more than 40 000 euros for their new car independent of the powertrain. In the income category of 50 000 to 60 000 euros, the share of participants being ready to pay the same amount was even 20%.

2.2.6 Importance of different properties in a BEV

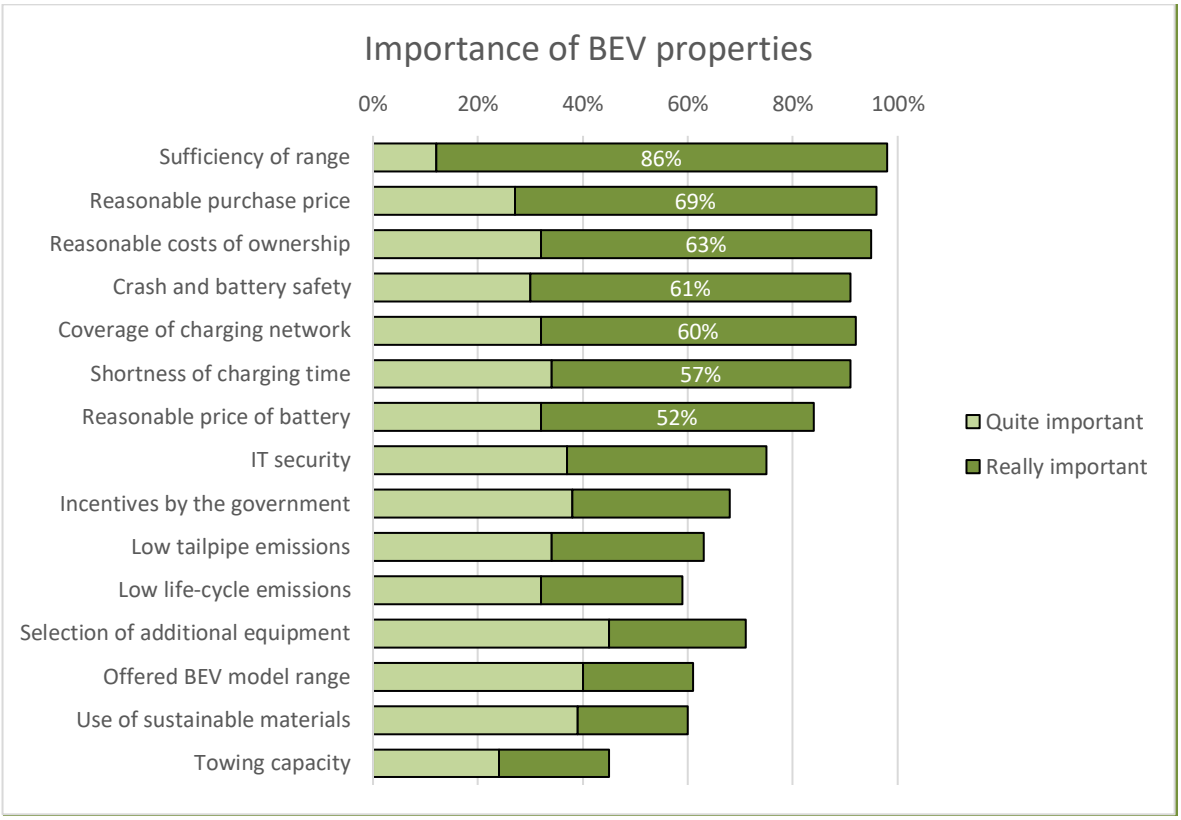

Figure 21. Importance of BEV properties.

The participants were given a total of 17 different properties to evaluate on a scale of 1 to 5, from which 4 stood for “quite important” and 5 for “really important”. The combination of 4 and 5 can be described as importance, which is presented in the graph above as full bars, shared in two parts that are based on options 4 and 5.

Seven of the most important properties had a vote of “really important” by more than half of the participants and were therefore highlighted with white digits on the graph to present the strong share. One property is above all of them by 17%, which is the sufficiency of range. The range had 86% of the participants voting for “really important”, meanwhile only 12% voted for “quite important”. The overall importance is therefore a significant 98%. The insufficiency of range was mentioned several times in the background of the work as a remarkable barrier in BEV adoption in Europe, and this result proves it also in terms of the Finnish market. Furthermore, the range anxiety caused by insufficient range has even more considerable effect in Finland where the distances are long and the charging network fractural.

The second most important property was the purchase price. A total of 69% considered it as a very important factor what comes to BEVs, meanwhile 27% saw it as quite important, which counts for 96% in importance. Also the property that was considered as third important comes to price and costs, as the total costs of ownership had a share of 63% from the “really important” votes, where 32% keep it as “quite important”, totalling a 95% share of participants.

For women, especially emissions in terms of both tailpipe and life-cycle categories were clearly more important factor than for men. From women, a total of 79% considered low tailpipe emissions to be important, meanwhile 58% of men stated the same. Concerning life-cycle emissions, 75% of women stated it to be an important factor, meanwhile 55% of men considered it important as well. This shows that both genders care more about tailpipe emissions in general than those coming from the life-cycle of the vehicle, and especially for women, emissions play a big role in terms of purchase decision. Furthermore, in terms of environmental friendliness, women cared more about the use of sustainable materials in the vehicle; 72% saw it as important, meanwhile 56% of men supported the same thought.

From the side of men, properties like performance and towing capacity were more important for them than for women. A share of 61% from men consider performance important, where a slightly over half of women, 51%, thought the same. Nearly half of men (48%) kept towing capacity as an important factor, where only under a third (31%) of women felt the need for it. Additionally, a strong majority (91%) of women felt the reasonable price of the battery as an accessory important, where 82% men supported the importance of this factor.

When looked from the living area point of view, properties like charging time, vehicle design, government incentives and towing capacity shared lots of opinions. From urban participants, even 96% see the charging time as an important factor, where 85% of rural participants see the importance in it. Design was clearly the most important for urban participants (72%), where 57% of rural participants kept design as an important factor. The participants coming from rural areas felt especially government incentives and towing capacity important; 76% of them stated the government incentives to be important, meanwhile e.g. from suburban participants,

65% thought the same. Towing capacity was considered important by nearly half (46%) of rural participants, meanwhile only slightly over third (37%) of urban participants felt it important.

The sufficiency of range was considered strongly important by participants from all living areas, especially from rural, where exactly 100% stated the range to be important, which makes it the most important from their area. The second most important factors for rural participants were purchase price and costs of ownership, both with a share of 96% in importance. For suburban, the most important were range (97%), purchase price (96%) and costs of ownership (94%), and for urban participants the top three were range (98%), charging time (96%) and coverage of charging network (95%).

2.2.7 Limiting factors in BEV consideration

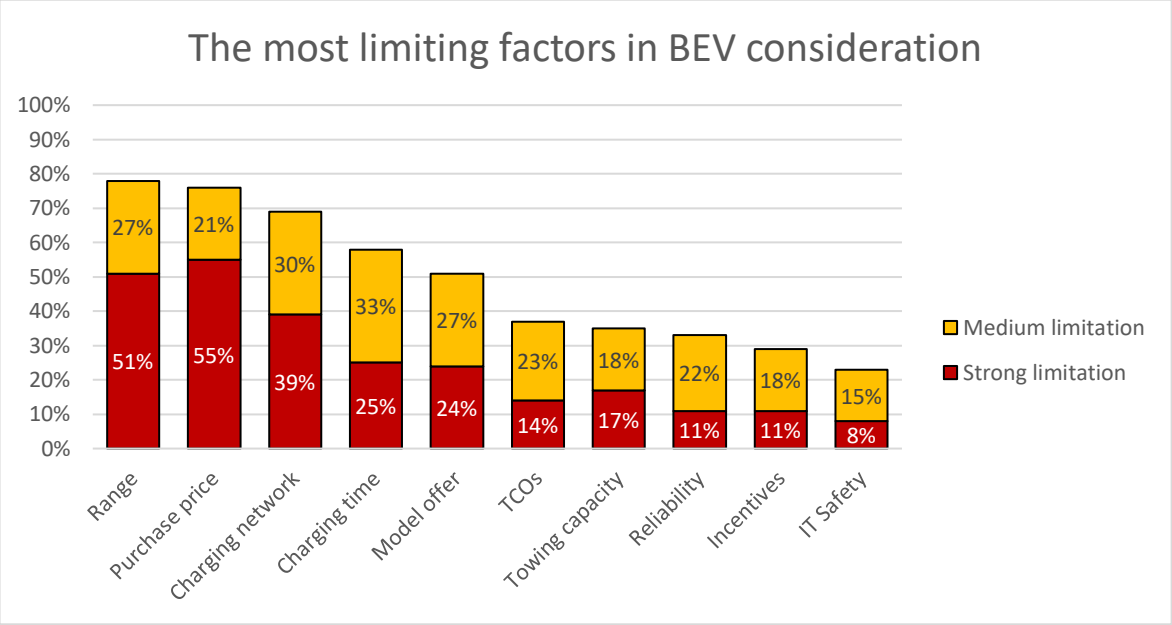

Figure 22. The most limiting factors concerning BEV purchase decision.

The most limiting factors for the participants at the moment are low range, high purchase price and the low coverage of charging network. Especially range and purchase price are critical obstacles as more than half of the participants experienced them as strong limitations when considering a BEV, and overall, nearly 76-78% of participants saw them as limitations in general. Additionally, charging

time and model offer by manufacturers were considered as limitations by more than half of the participants, where approximately fourth stated them to be strong limitations in their decision-making. TCOs were stated as a limitation by 37% of the participants, which could mean that they are uncertain of the costs that would be included in the holding of a BEV, which means that more promoting actions and transparency are needed. It should be communicated more clearly and efficiently to consumers that TCOs are one of the major benefits of BEVs, as the taxation and insurance are lighter, as well as there are less parts that need maintenance, which can save several thousands of euros over the holding time in comparison to an ICEV. This would need clear examples and evidence for consumers, where ICEV and BEV are compared against each other to highlight these differences.

Other limiting factors were towing capacity and reliability, both considered as limitations by approximately 33-35% of the participants. Moreover, the lack of incentives by government was seen as a limitation by 29% of the participants. From these three, the trickiest one could be the towing capacity, mainly for technical and safety reasons, since there is currently no towing capacity for most of the fully electric cars. This still needs working in terms of product development. Reliability concerns might be related especially to winter conditions and the uncertainty of new technology. It is a proven fact that the battery drains during colder conditions when going below zero, and that it might have a dramatic effect on the functionality and battery if the temperature drops near -30 degrees. However, despite the effect of freezing conditions on the battery, instead, battery heating systems should be implemented or at least offered, and actively promoted toward consumers to acknowledge that these dramatic effects can be prevented with right kind of equipment and ways of use. What comes to incentives, it is up to the government to find the right ways to enhance and fasten the adaptation of electric cars. In comparison to e.g. Norway, which is known for its high share and growth rate of electric cars, the incentives are still on a low level. Especially funding for charging network development and purchase subsidies should be further raised. Additionally, government could find the right kind of benefits for electric car owners in co-operation with different cities, e.g. parking benefits and rights to use lanes and roads that ICEV drivers are not allowed to. Furthermore, tax and VAT exemptions could have a dramatic effect on BEV sales increase.

From gender perspective, factors like range, charging network, model offer and towing capacity were seen clearly more limiting by men than women. In range, the difference was in terms of strong limitation, where the share from men was 53% and from women, 43%. However, in charging network, the difference lied mostly in medium limitation, where the share within men was 33% and women 20%. Within both genders, 39-41% kept the lack of charging network as a strong limitation. In model offer and towing capacity, the differences were quite equal between medium and strong limitations. The model offer was seen as a strong limitation by fourth of men (25%) and 15% of women. More than half of men stated it to be a limitation in general (54%), where 37% of women agreed, and towing capacity was seen as a limitation by 38% of men and fourth (25%) of women.

2.2.8 Appealing factors in BEV consideration

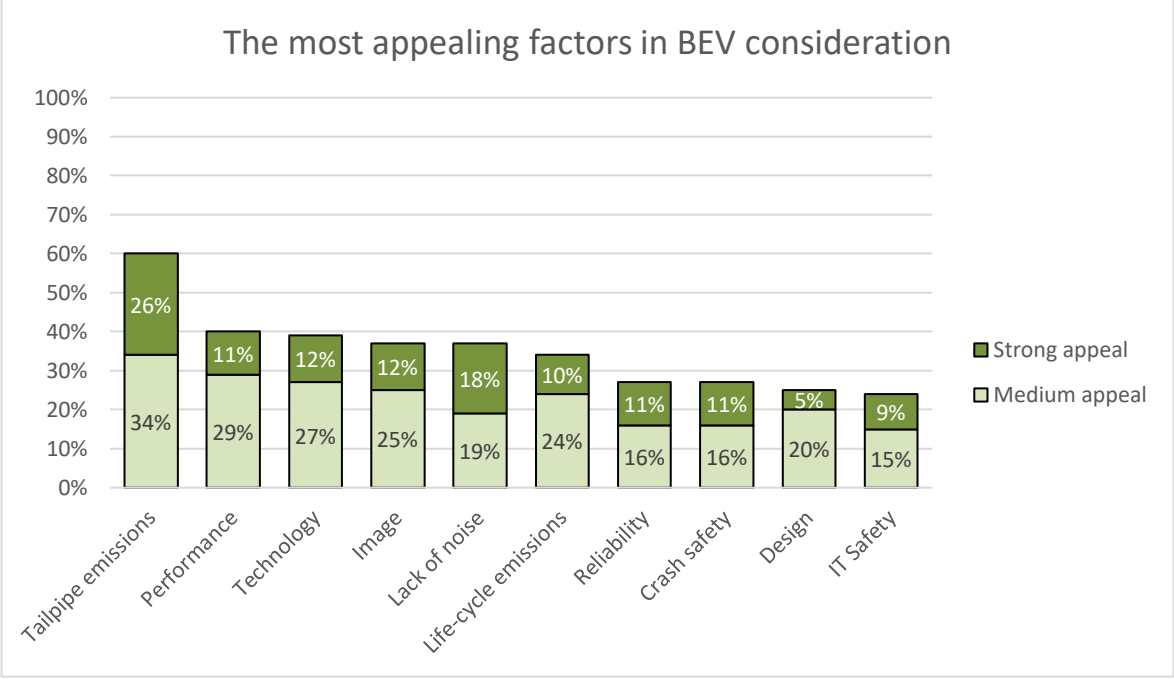

Figure 23. The most appealing factors concerning BEV purchase decision.

The most appealing factor in a BEV for the participants is tailpipe emission level with a clear majority of 60% of positive answers. Additionally, performance, technology, image and low level of noise were experienced appealing by 37-41% of participants respectively. Low noise level had the second most answers for strong appeal (18%),

where tailpipe emission level was stated as strongly appealing by over fourth of the participants (26%). Furthermore, safety and design were claimed as appealing by approximately fourth of all the participants. Design was seen as appealing by 28% of men, where only 18% of women stated the same, and also technology was remarkably more appealing for men (42%) than for women (27%). Additionally, men cared more about the tailpipe emission levels, as 63% considered it as an appealing factor of BEVs, where the share of women was 48%. From the side of women, factors such as life-cycle emissions (38% vs. 33%) and low noise level (39% vs. 36%) were slightly more appealing than for men.

From the living area perspective, several factors shared a lot of opinions. Especially participants from rural areas had remarkably different preferences when compared to suburban or urban participants. For example, factors like design, technology, tailpipe emissions and image were approached differently in different areas. Design was seen as appealing by 24% of urban and 29% of suburban participants, where only 15% of rural participants kept the design as an appealing factor. The new technology was considered appealing by 40-42% by urban and suburban participants, but only by 26% of rural participants. Tailpipe emissions were seen as appealing by 62-63% of suburban and urban participants, and 49% of rural participants.

Reliability and incentives were seen more as appealing in urban areas, but more as a limitation in suburban and rural areas. From urban participants, 35% considered reliability as appealing, while 34% of suburban and 38% of rural participants considered it as a limitation. Only 25% from suburban and 23% of rural participants found reliability appealing. Incentives were seen as appealing by 30% of urban participants, where 30% of suburban and 34% of rural participants considered it as a limitation, and only 18% of suburban and 22% of rural participants saw it as appealing.

Unfortunately, the share of appealing factors in comparison to limiting factors is significantly lower. For example, three of the most limiting factors have higher share of inputs by participants than the most appealing factor. Basically, the lack of range, high purchase price and low coverage of charging network outdo the appeal of

environmental friendliness, in addition to other pros like high level of performance, new interesting technology and image.

2.2.9 Importance of different connectivity features in a BEV

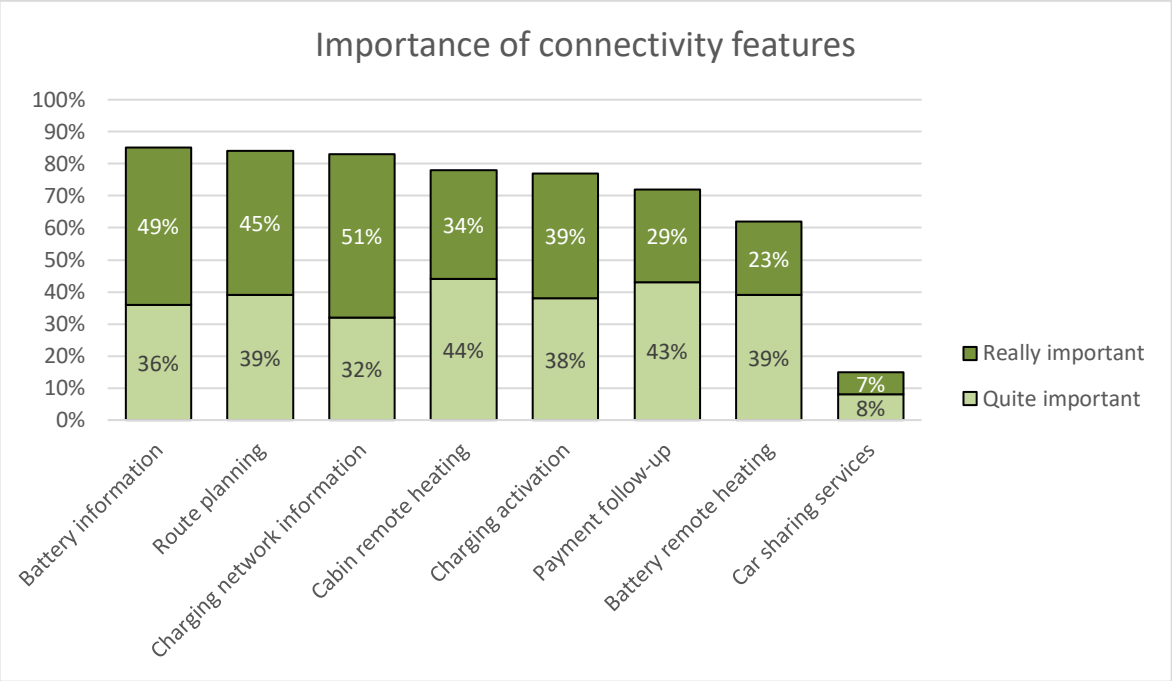

Figure 24. Importance of connectivity features.

The three of the most important connectivity features included information regarding both battery and charging network, and car information (including routes) with over 80% importance voted by the participants. Especially battery and charging network information were considered to be really important by approximately half of all the participants. Similar features are already implemented in the petrol and diesel cars with connectivity services, so the change in the platform itself would be minor. Basically, battery information would be a BEV variant for the original driving information that would include e.g. range, battery temperature and energy consumption instead of remaining fuel level and consumption. The charging network information would be based on the fuel stations application, but instead of petrol and fuel it would show the charging stations, charger types and charging prices.

There are also two completely new BEV-related connectivity features that were considered important by most of the participants; charging activation and payment

follow-up, both placed between 70 and 80 % in importance. Additionally, the two more traditional types of heating for both cabin and the battery were considered as important features by the majority. Only one given feature was considered unimportant, which was car sharing with only 15% share of participants keeping it as important.

The connectivity services were considered important especially by younger and middle-aged adults. On average, older adults seemed to give them slightly less importance in general, but in terms of car sharing services, adults over 55 years old showed clearly more interest than others; fifth of them (20%) considered car sharing services important, meanwhile in other age groups the interest rate was only between 12 and 14 %. The most important connectivity features by older adults between 45 and 64 years old were battery information (84%) and driving information (84%). Also charging network information was considered important by both of the older age groups, but from adults between 45 and 54 years old, 85% considered it important, where from adults between 55 and 64 years a bit less, 80% agreed.

Younger and middle-aged adults seemed to have a high preference for remote cabin heating (83%), where from both of the older age groups, 75% kept it as an important feature. Additionally, younger adults kept payment follow-up (81%) and mobile charging activation (82%) more important than the older age groups. Charging activation was considered important by 73-77% of participants from older age groups, meanwhile payment follow-up raised interest in 77% of middle-aged and 75% in adults over 55 years old. The participants aged between 45 and 54 years old had only 65% interested in the payment follow-up service. Especially the high share of younger participants showing interest toward payment follow-up could be related to higher knowledge level and firmer approach on new digital services, whereas this kind of service could be experienced slightly more difficult and even somehow unpleasant by the older participants. Therefore, a straightforward introduction or tutorial should be implemented for the service, and the user interface should be simple and easy to navigate to increase user friendliness and enhance related experience.

The battery remote heating shared lots of opinions, as 65% of participants aged between 45 and 54 years old kept it important, meanwhile from the age groups of

35-44 years old and 55-64 years old, 72 and 74% agreed. Charging activation was seen slightly more important also by older participants, as each of the age groups between middle-aged and old adults had a share of 73-77 % stating it to be an important feature.

2.2.10 Body type preference

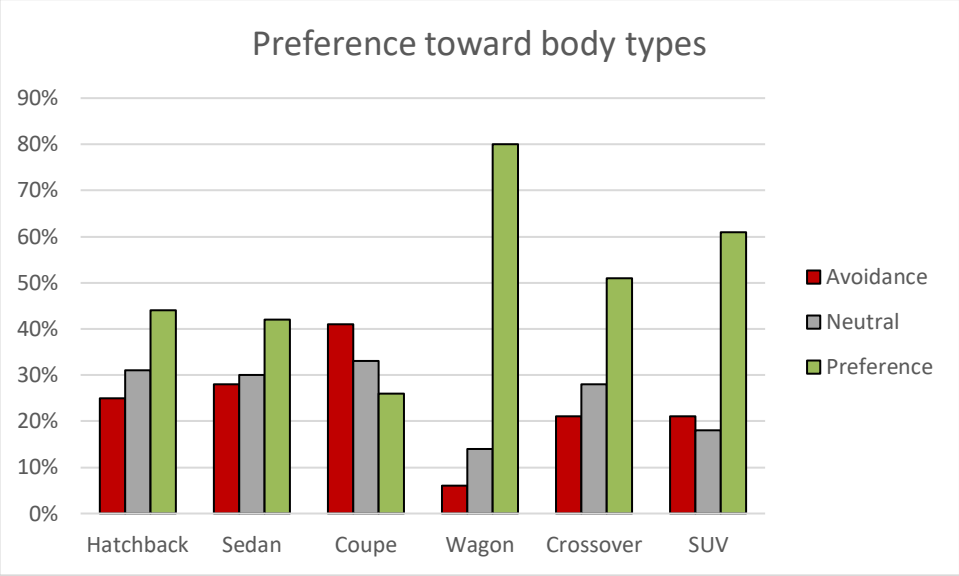

Figure 25. Preference toward body types.

Within Škoda owners, the wagon body type is considered appealing by 80% of the participants, meanwhile SUV is nearly 20% less popular. Even though the SUV has gained a lot of attention, admiration and the most remarkable growth in the modern market, the traditional wagon still manages to keep a reasonable gap in between. As the most sold model on the Finnish market is Octavia Combi, the strength of wagon as a body type is not as surprising from customer perspective of the brand. However, Škoda has already launched two SUV models in the past couple of years, and a crossover is on the way around the end of 2019. The results show the potential of these body types and it can be concluded that Škoda has well managed to meet the needs of a demanding market in terms of offered range. This also paves a way for the upcoming fully electric SUV model and further potential for launching more electrified models with similar body type.

The most avoided body type is coupe, which is not included on the model offer of the brand. At the same time, it is the most opinion sharing body type with hatchback and sedan. Both hatchback and sedan are in the current range. Coupe is the most popular within young adults, as 37% show preference toward this body type, meanwhile only 19% of old adults (55+) seem to like it. Also, sedan is quite popular among younger adults, as even 63% of such participants have shown interest toward it.

As in coupe, the most resistance comes from the side of old adults, where nearly less than half show their interest (32%) toward sedan. Hatchback remains solid in its popularity within participants aged between 35 and 64 years old, as in each included group, approximately 43% of participants are interested in this body type. Young adults seem to be standing out other age groups, as over half of the participants stated their preference (52%). The high popularity of hatchback type within younger participants could be related to the lower income level or household size in comparison to older age groups. Additionally, the high level of interest in coupe type by young adults could be also explained by the smaller household size, and moreover, more appealing, dynamic design and possibly stronger performance.

In conclusion, Škoda is making a good introduction in terms of electric mobility as it is launching an SUV as an introductory model. The customers are showing strong interest toward the body type and it is gaining increasing amount of admiration and popularity globally, as well as nationally. In terms of the Finnish market, the electric SUV can further strengthen the SUV offensive of the brand on a national level, meanwhile it has possibilities to shrink the popularity gap between SUV and wagon, while producing more profit and electrifying the model range. Additionally, crossover would be an ideal follower for the electric SUV to pave easier and more affordable way for drivers of e.g. hatchbacks or sedans to join the future of electric mobility. These two mentioned body types might not have such a remarkable admiration, unless they would be sold as more affordable, volume-based models.

2.3 Range and charging

2.3.1 Estimation of daily driving distance

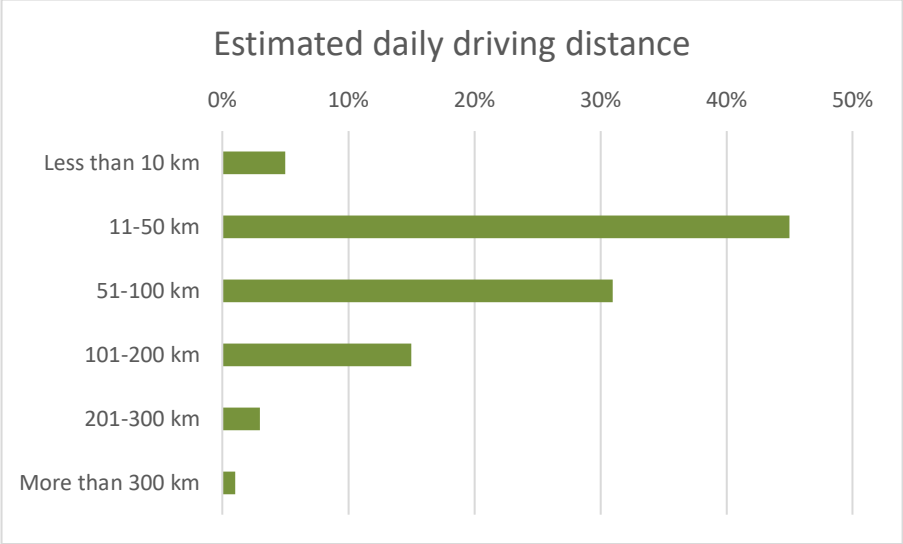

Figure 26. Average daily driving distances of participants.

The estimated daily driving distances remained mostly under 100 kilometres, as approximately 76% of all the participants have expressed, which would mean that the most weekly covered distances would be placed between 500 and 700 kilometres on average. This could be done with two charges per week with the market leaders in range, if e.g. the temperature would be optimal as in spring or summer.

However, 15% of the participants drive even between 100 and 200 kilometres every day, counting for even up to 1400 kilometres per week, and a few percent drive more than 200 kilometres per day. The drivers who cover around 200 km distances per day should be charging their cars at least every second day, or even every day in the case of tougher conditions or BEVs with less range capacity. This means that home chargers would play a vital role if they were willing to own a BEV.

On average, women are doing shorter trips than men, as 89% women drive less than 100 kilometres daily, where 79% of men have the same covered distance on a

daily basis. Additionally, this means that 21% of men drive more than 100 kilometres per day, where only 11% of women cover as much distance.

From the viewpoint of living areas, such visible differences were not found. However, based on the slight differences, consumers living in rural areas did longer trips which is quite logical, as shopping malls and workplaces can be further away from their home. For example, 22% of rural participants made daily trips with a distance over 100 km, as 15% of urban participants covered the same daily distances. The share of participants from suburbia covering more than 100 km was 18%.

2.3.2 Range expectations

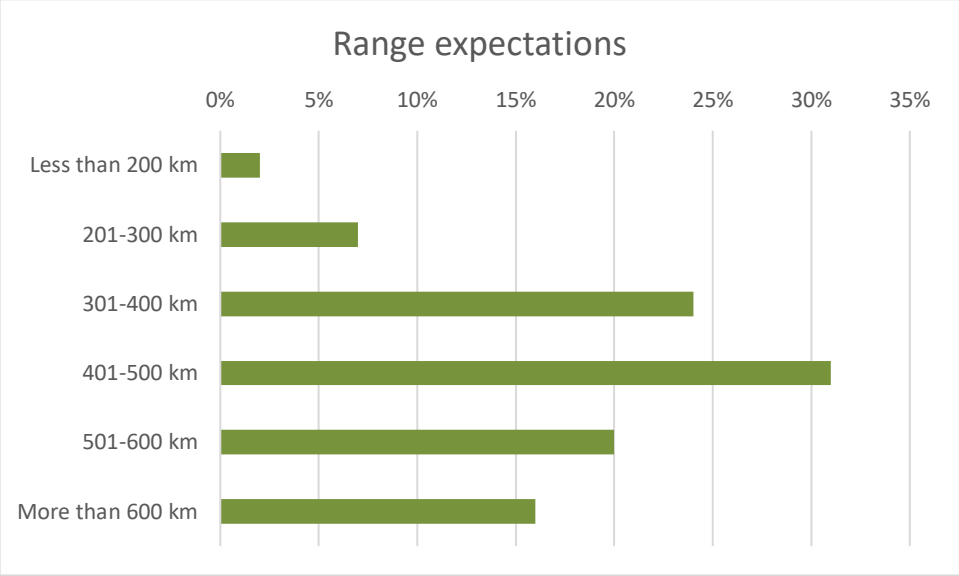

Figure 27. Range expectations.

The range expectations mainly vary from around 300 kilometres to more than 600 kilometres. Only around 10% are satisfied with a range of less than 300 kilometres, which is probably the most common in less expensive BEVs of today. Unfortunately, the high purchase price is a significant barrier, and therefore the options with higher range are not considered by the majority of consumers. This makes a contradiction between range and purchase price, which at least postpones the purchase decision, or in the worst case for BEV, the decision is aimed at different powertrain.

When moved from 300 to 400 kilometres, the number of satisfied consumers is already doubled. However, still over 30% expect a BEV to have a range of at least 400 to 500 kilometres, which is becoming more common already in 2019 and 2020.

The range between 400 and 500 kilometres corresponds to e.g. VW Group BEV models such as Audi e-tron and the upcoming model based on Škoda Vision iV, and also the Tesla Model 3. Additionally, the electrified Koreans such as Hyundai Kona Electric and Kia e-Niro come with this kind of range, which can be considered as a threat from the perspective of Škoda, as the new electric Škoda SUV could be more expensive by even a third in the case it will settle to the level of more expensive Kodiaq models. The relatively low purchase price in combination with high battery capacity and therefore longer range makes the Koreans very appealing from the technical and pricing perspective for customers.

Despite the high share of participants being satisfied in range between 300 and 500 kilometres, still more than third, approximately 36% of participants, expect a range of more than 500 kilometres, from which around 16% would expect it to cross the line of 600 kilometres. This long range is basically possible only with the most capable models of Tesla that go over 100 000 euros in purchase price with ease.

There are quite many visible differences between gender, age and living area categories in the topic of driving range expectations. It appears that women are more tolerant toward shorter ranges than men, as 21% of women are satisfied with a range less than 300 kilometres, meanwhile only 5% of men find it tolerable. This can be also further proved by the finding that 28% of women would like to have a range more than 500 kilometres, where 38% of men have the same expectation.

From the age perspective, the young adults were the most demanding toward range, as only approximately fourth (26%) of them were satisfied with a range less than 400 kilometres. The share of participants in other age groups concerning the satisfactory toward same range category of less than 400 kilometres was at least 10% more, 33-36%. This means that 74% of young adults demand a range over 400 kilometres before they would be ready to consider a BEV, where from the middle-aged and older adults, 64-67% demand the same range abilities.

When looked at living areas, it seems that urban consumers are more satisfied with less range than those who come from suburban or rural areas, which is quite explanatory by that most of services and even workplaces are nearer than in suburban or rural areas, and therefore the demand and use of range is also lower.

However, it appears that participants from suburban areas are even more demanding toward range than those who come from rural areas, as only 7% of suburban participants find the range of less than 300 kilometres satisfactory. From rural participants, 10% state that the same range would be enough, where 14% of urban participants are satisfied with the same range. From suburban participants, even 17% expect a range over 600 kilometres, where from rural and urban participants 12-13% expect similar range.

2.3.3 Charging time expectations

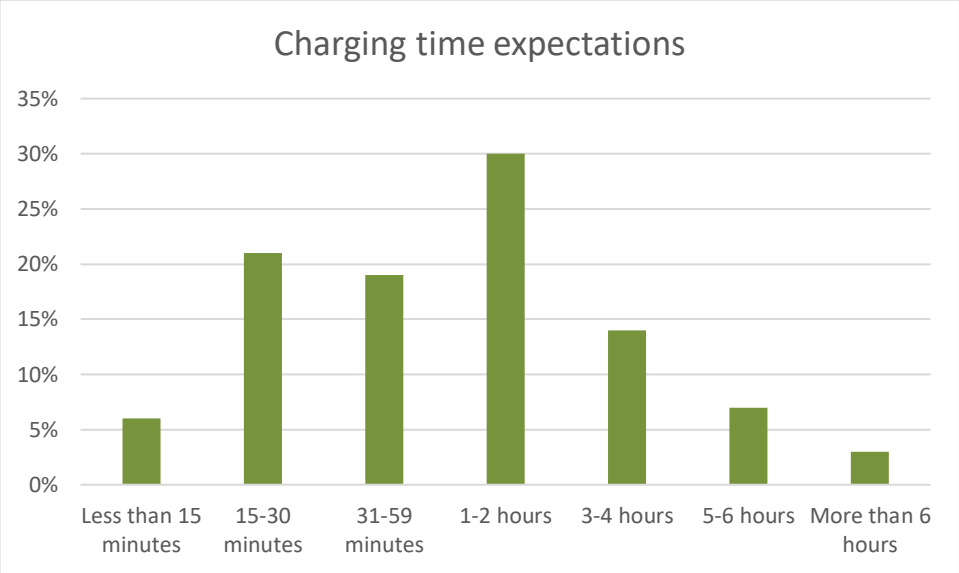

Figure 28. Charging time expectations.

As well as expectations toward range, also the expectations toward charging time vary considerably; all the way from as rapid as under half an hour to around four hours. However, more than 70% expect a charging time less than two hours, from which approximately half expect the charging to take less than an hour. This would mean a heavy dependence on fast charging and therefore public charging network.

The consumers with this kind of expectations should be made more familiar to the advantages of home charging and related possibilities such as overnight charging.

Even though the demand set by customers is quite tough in terms of current charging time and possibilities on offer, even 30% of participants stated that 1 to 2 hours would be enough. In two hours, home chargers would be able to charge the car to approximately half of the capacity at maximum, depending on the charger output and battery capacity. In public charging stations, this charging time could get the car already up to around 70-80%, which is optimal level for a BEV. Unfortunately, the charging network is still quite niche and therefore public charging is out of the question especially for consumers coming from rural areas. Still, nearly fourth (24%) of all the participants consider more than three hours as acceptable, which is already better also in terms of home chargers.

In general, women expect faster charging times than men. For example, 42% of men are setting the requirement for the charging time to be less than one hour, where a 56% majority of women expect the same time. Additionally, even 12% of men are still satisfied with a charging time more than five hours, where only half less, 6% of women could stand the same charging time. From the age perspective, the older the consumer is, the less time the charging should take; for example, 39% of young adults (25-34 years old) expected a charging time of less than two hours, where the same time was expected by even 55% of adults over 55 years old.

From the living area point of view, the expectations toward charging times were quite similar through all time frames. The most difference can be seen between time frames of 31-59 minutes and 1-2 hours. In both urban and suburban areas, 49% of participants found a charging time between half an hour and two hours to be acceptable. However, in suburbia 41% required the charging time to be less than an hour, where in urban areas, 54% consumers had similar expectations. Therefore, it can be concluded that urban participants are looking forward to more rapid charging than suburban participants. In rural areas, nearly half of the participants (48%) required a charging time of less than one hour. For urban participants, the need for faster charging is easier to be satisfied with the better coverage of charging

network than what comes to suburban and especially rural areas, where the benefits of home charging should be more brought up and promoted.

2.3.4 Importance of different charging types

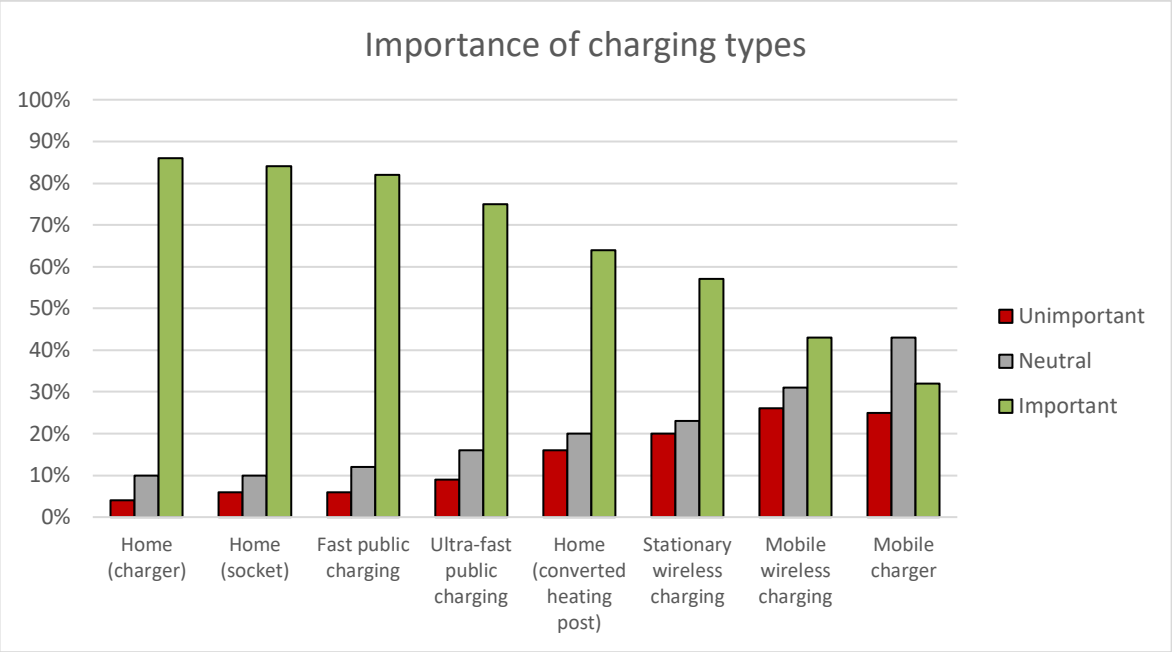

Figure 29. Importance of charging types.

As in the background of the work, the charging possibilities at home seem to be the most important for European consumers, which is confirmed by the survey results also from the side of the Finnish consumers. From charging types, a home charger was considered the most important, but also a home socket is nearly as important, even though the charging time is multiplied in comparison to a charger. However, both are preferred by around 85% of the participants. Additionally, fast public charging as a charging type reached over 80% importance in the survey. Ultra-fast charging was considered slightly less important (75%), which indicates that all the participants do not feel the necessity for the charging time to match a refuelling of an ICEV.

There was also a third option for home charging, which was a converted heating post. This is in high importance, especially for the drivers who park their cars on an outside parking lot instead of a private garage or parking hall. These drivers do not

have a warm place to keep their car in, or possibility for e.g. a wall charger or socket, which means that the heating pole conversion could be the solution for this problem. This can be also seen as a result indicating over 62% importance rate by the consumers.

The more futuristic charging options such as wired and wireless mobile charging shared a lot of opinions within participants. Despite this, both were found rather important or interesting instead of unimportant or undesirable. However, the stationary wireless charging was considered clearly more important and had more clarity between the answers, where the mobile charger and mobile wireless charging had more neutral answers indicating that most of participants did not know what to say or think about them. This could be due that they have not heard about the existence of these options before, or they do not have made themselves familiar. These futuristic options raised considerably higher share of interest within urban than suburban or rural participants. Especially the stationary wireless charging, which got 67% of urban participants interested, where the shares within suburban and rural were only 53-54%. The mobile wireless charging was considered important by nearly half of the urban participants (46%), where 42% of suburban and 38% of rural participants found it important, and the mobile charger was seen slightly less important, as 40% of urban, 33% of suburban and only 24% of rural participants showed their interest.

Nearly all the charging options raised more interest within urban and suburban participants than rural participants, except home charger and socket. The home socket was considered important by 89% of rural participants, and by 82-83% of urban and suburban participants. The home charger was the second most important within rural participants with a share of 87%, meanwhile urban participants considered it to be even more important (89%), and suburban participants slightly less important (84%). The high share of rural participants choosing home socket could be explained by the unwillingness to pay for an actual home charger and that most of the rural participants have the possibility to use the socket as most of them have a private garage at their use. The charger could be considered more important by urban participants due to higher purchase readiness and the unavailability of socket use, as many urban participants park their cars in halls or carports. The high

share of urban and suburban participants parking in lots, halls or ports can be also reflected to the importance in converted heating post option; 71% of urban and 68% of suburban participants consider it important, where only less than half, 45% of rural participants show their interest.

A finding that could be found quite surprising was that the public charging was seen significantly less important by rural than urban or suburban participants, which further strengthens the high preference toward home charging by rural participants. This could be also related to the slow development of the charging network in areas with lower population density. Fast charging had a share of 73% by the side of rural participants, where urban and suburban participants, 83-85% kept it in importance. The ultra-fast charging option was slightly less important within all areas, as 66% of rural participants found it useful, and 76-79% of urban and suburban participants stated the same.

2.3.5 Importance of different charging places

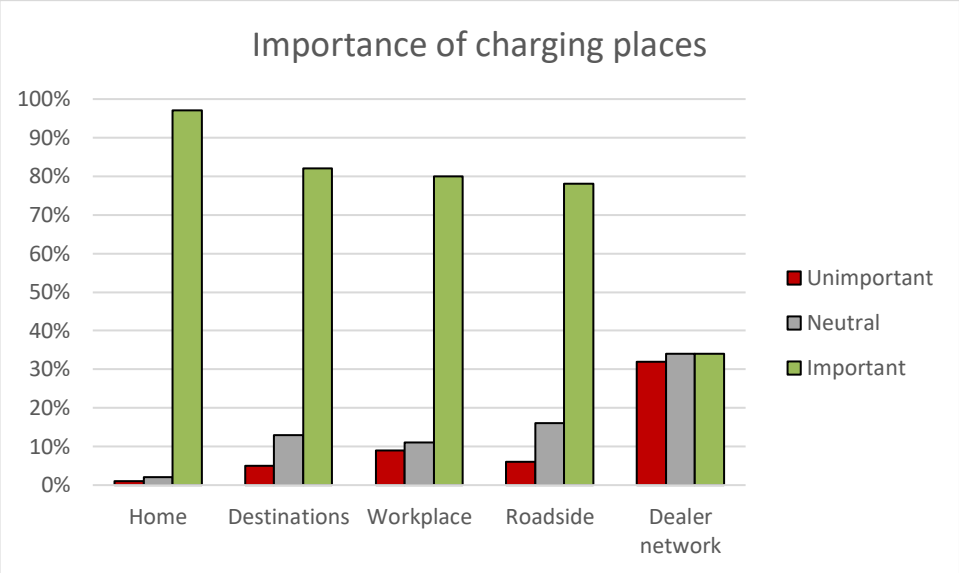

Figure 30. Importance of charging places.

As seen earlier in the background and also in the results concerning charging types, the home is the most desired also in terms of charging places. Nearly all of the survey participants consider it important. Even though the workplace was highlighted in the work background as the second important charging place, the

survey results show that its importance is equal with destinations and roadsides. However, from these, the workplace would be the most used together with home charging. The charging places were quite equally ranked despite of living area or age of participants. From the gender perspective, workplace was considered as important charging place by 82% of women, meanwhile 73% of men considered it important. Within women, workplace was tied as the second most important charging place with destinations, but within men, it was remarkably less popular than roadside (78%) and destinations (84%).

The new addition to charging places is the dealer network as a form of future vision, which is probably the most opinion sharing option in the whole work when looked at the results. Around 33% considered it as unimportant, neutral or important. By 1%, it was considered more important or neutral than unimportant. This raises the question if this option would be profitable enough to be worth establishing throughout the network. This charging option was more popular within women than men, as 44% of women considered it important, and only 31% of men agreed. From the living area perspective, especially urban consumers saw more importance in this charging place (39%), meanwhile 30% of those living in rural areas considered it important. However, the high share of participants answering neutral could be possibly won over by efficient communication or even with right kind of related campaigns and offers.

2.3.6 Preferred price for a home charging device

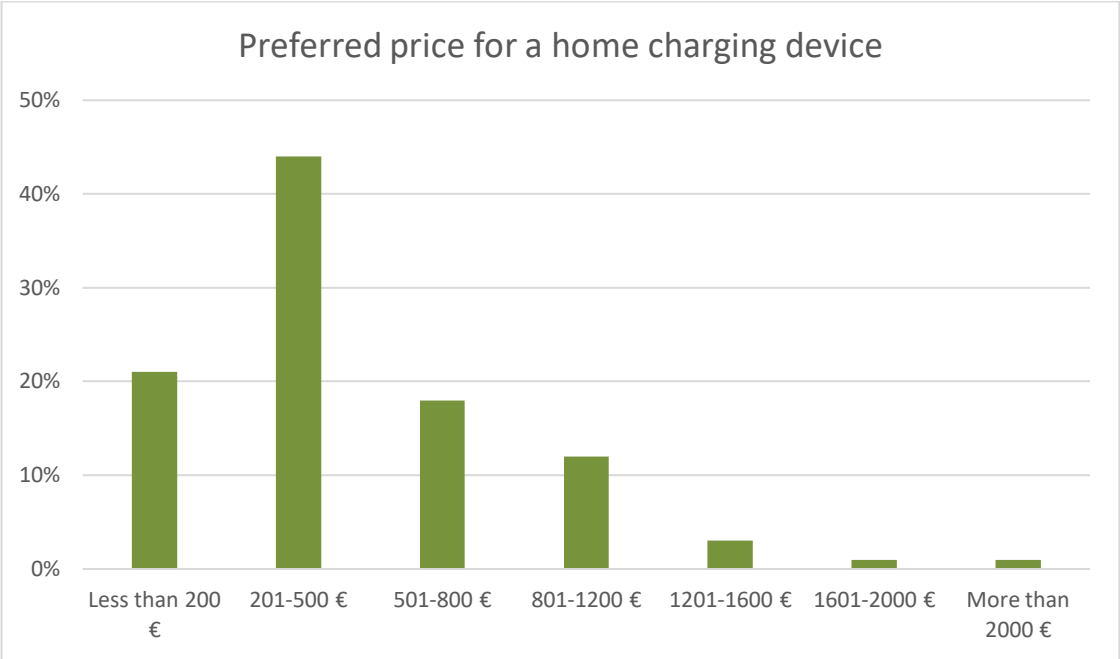

Figure 31. Preferred pricing for a home charging device.

The most desired price for a home charger within participants was placed between 200 and 500 euros, which was preferred by approximately 44% of the participants. The second most desired price was less than 200 euros with approximately 21% preference rate, which basically means that around 65% of the participants would not be prepared to pay more than 500 euros for a home charging device. Despite the majority going for less than half a thousand, around 30% could pay more, and approximately 12% could pay even between 800 and 1200 euros, which means that there could be a demand and readiness also for a more powerful range of home charging devices.

The home chargers would be vital for customers living in rural areas, especially variants with higher power output. However, when it comes to price, a significant majority of 69% would pay only less than 500 euros for the device, from which 30% a maximum of 200 euros. The price expectation is greatly lower than in other areas, as only 19-20% from suburban and urban participants would require a price less than 200 euros, meanwhile the need for the higher power output would be also lower, meaning that the expectation would be easier to be met from their side.

The most equal price category within living areas was between 500 and 800 euros with 18-20% of participants from each area. When scaling up the price levels, only a minority of 3-6% from each area would pay more than 1200 euros for their device. There was also a clear difference between living areas in the price category from 800 to 1200 euros; from rural participants, only tenth (10%) would be prepared to pay such amount, where 16% from urban participants could pay the same.

CONCLUSION

Battery electric vehicles raised a lot of interest within participants on the side of hybrid electric vehicles. When it came to fuel types, only petrol managed to be slightly more interesting than the electrified alternatives, meanwhile diesel was avoided by the most, but still being more preferred by participants from rural areas than petrol due to e.g. longer distances which makes it more beneficial. Additionally, participants from rural areas avoided plug-in hybrid and BEV more than others. Less known alternative fuels like hydrogen and CNG were mostly avoided, and on average, women were more sceptical toward alternative fuels than men.

Most of the participants were considering purchasing a fully electric car already within five years, especially as an SUV or wagon model. Additionally, hatchback body type was in favour of younger participants and ones with lower income level. However, approximately fourth were not considering a BEV in the next ten years. On average, men and consumers from urban areas were prepared to buy a BEV sooner than others. The high level of readiness in urban areas could be also connected to the relatively higher income, knowledge level and interest in new technology.

As a brand, Škoda was seen clearly the most appealing, which can be mostly explained by the target group of the study, which consisted only of Škoda owners. Other highly interesting brands were Audi, Volkswagen and Tesla. Additionally, premium brands such as Mercedes-Benz and BMW enjoyed popularity within consumers with higher income, meanwhile Hyundai, Nissan and Opel were considered more appealing within consumers with less income.

The preferred new car purchase price by participants remained between 20 000 and 40 000 euros on average despite the powertrain, which falls quite short in terms of BEVs. On average, women would be willing to pay less than men, which could be connected to the relatively lower income level. Furthermore, the results indicate that the consumers with higher income are more prepared to buy more expensive cars also in terms of BEVs. However, women in lower income categories would be ready to pay more for a BEV than for an ICEV, where in higher income categories despite the gender, the purchase price expectations are similar between the powertrains.

The holding type of choice still seems to be ownership with a strong vote, meanwhile private leasing is raising its reasonability, as nearly third stated their interest toward this holding type. Private leasing could be a considerable holding type for those who want to avoid the high purchase price, sudden costs related to e.g. battery or the concerns toward resale value. Therefore, private leasing could be used together with the upcoming BEV models of Škoda to create new campaigns and offers to enhance the nationwide visibility and popularity of private leasing. Sharing was avoided by even 80% of the participants, but it was found that women and consumers coming from urban and suburban areas were more open toward it. It can be concluded that this holding type will take its time to be more widespread, but there is also a risk for it to not to become more common in Finland due to the long distances and low population densities in comparison to other European countries.

The average knowledge level evaluated by the study participants was placed between moderate and intermediate, and there were 6% more consumers with advanced than low knowledge level. This means that most of consumers have a hold of the principles concerning electric mobility, but more accurate data and facts concerning properties and factors that affect them should be provided. Furthermore, it was found that men and urban consumers had a higher level of knowledge than women and consumers from rural areas, which could be related to the lower level of interest toward electrified powertrains by women and consumers from rural areas. Furthermore, it appeared that participants with higher education were more familiar with electric cars than the ones with lower education level, which could indicate a keener approach on related research and literature for enhanced knowledge.

Especially factors like high purchase price and low driving range seem to keep the adoption of electric mobility to the Finnish market at slow pace. Additionally, low coverage of charging network, long charging time and niche model offer were considered as other top limitations. Most of the participants expected the range to be between 400 and 500 kilometres, which is nowadays possible only with the more expensive models especially in the Northern conditions, and therefore it will still take a couple of years for such battery technology to be implemented to more affordable models. Additionally, a great share of participants demanded a range more than 500 kilometres, and even 17% expected the range to cover at least 600 kilometres.

Men and younger adults seemed to be the strictest toward strong range capabilities. Surprisingly, suburban participants are even more demanding toward range than the ones coming from rural areas, meanwhile the urban consumers have the best tolerance for lower range. Nearly fourth of the participants would be satisfied with less than 400 kilometres, which is possible with more affordable BEV models already today. In terms of range, nearly half of the participants drove approximately between 11 and 50 kilometres daily, where approximately third drove between 51 and 100 kilometres, which both should be well handled with the average capabilities of current BEV models on the market, especially if the charging is done overnight at home. This would mean approximately 2-4 charges per week depending on model and covered distances. On average, men and participants from rural areas drove longer daily distances than women and participants from suburban or urban areas.

Properties such as range, purchase price, costs, safety, coverage of charging network and charging time were considered as the most important within all the participants on average. Charging time and network were in high importance especially within participants coming from urban areas. In addition to charging time, design was considered more important by urban participants than by e.g. ones coming from suburban or rural areas. Overall, emissions were not seen as important, but women kept both low tailpipe and life-cycle emission levels in higher importance than men. Additionally, women showed more preference toward use of sustainable materials, where men found performance and towing capabilities more important than women. This indicates that women are more supportive toward environmental friendly and sustainable ideology, where men are looking primarily for practicality instead.

The most appealing factor in terms of BEVs was tailpipe emission level with a 60% majority of votes. Moreover, high level of performance, new technology, image and low noise level were considered quite equally appealing within participants. Men were more appealed by exterior and interior design, new technology and lack of tailpipe emissions than women, where women saw life-cycle emissions and low noise level more appealing than men. For urban and suburban participants, design, technology and lack of tailpipe emissions were found fascinating. Additionally, urban consumers found also reliability and incentives more appealing than suburban and

rural participants. These results show that overall, suburban and urban consumers were more appealed by BEVs than those coming from rural areas, while having more open attitude and trust toward the technology and reliability.

The charging time was not experienced as affecting factor as e.g. range, but most participants would prefer it to be between 1 and 2 hours, meanwhile an hour and half an hour were both considered as maximum by approximately 20% of participants respectively. Especially women and older participants were more demanding toward charging time. Taking in consideration that home was found as the most important charging place on average, it will also take a couple of years for home charging devices to be improved on the level that enables them for more rapid charging, as the time is more than double or even triple than expected still in 2019, even with more capable chargers. The implementation of charging devices would be the most optimal to rural areas, as it has the highest share of private garages in comparison to other areas.

The highest purchase price for a home charger would be preferred to be placed between 200 and 500 euros, voted by nearly half of the participants. Additionally, approximately 20% would not pay more than 200 euros for it, but also a similar share of participants would pay between 500 and 800 euros. Rural consumers are willing to pay less for their device, meanwhile they have the possibility to use a home socket. Urban and suburban areas offer reasonable opportunities for heating pole conversions as the shares of outside parking lots is higher, and the conversion option was also considered interesting by the majority. Additionally, urban participants showed more interest toward wireless inductive charging and mobile charging than participants from other areas. Outside home, public charging was seen important 75-82% of the participants, from which fast charging raised more interest than ultra-fast charging, which indicates that most of the consumers are not expecting the charging time to match the refuelling of an ICEV. The public charging was considered more important by urban and suburban participants, which shows stronger preference toward home charging by participants from rural areas.

As a charging place, home was considered the most important by nearly all the participants, where both charger and socket were popular. Additionally, destinations e.g. shopping malls and hotels, and roadsides were standing out as important

charging places, being equal to workplace, which was considered more important by women than men. The new concept of charging at dealerships was sharing lots of opinions; nearly equal share was interested, neutral or indicated avoidance. It was found that women and urban consumers were the most open toward it.

Connectivity features were found as an important part of BEVs, especially by young and middle-aged adults. Information regarding battery, driving and charging network raised the most interest. The two completely new features, remote charging activation and mobile payment follow-up were considered important especially by young adults. Sharing was experienced significantly less interesting within all the participants than any other connectivity feature. However, older adults were clearly more interested in it than younger and middle-aged.

BIBLIOGRAPHY

ABB. 2018. Lidl adopts ABB fast charging technology across Finland. Helsinki: ABB. [Online article]. [ref. 18 September 2018]. Available at: https://new.abb.com/news/detail/7955/lidl-adopts-abb-fast-charging-technology-across-finland

Amsterdam Roundtable Foundation. 2014. Electric vehicles in Europe: Gearing up for a new phase? Amsterdam: Aris. [Online publication]. [ref. 10 September 2018]. Available at: http://kms.energyefficiencycentre.org/sites/default/files/McKinsey%20-%202014%20-%20Electric%20vehicles%20in%20Europe.pdf

Andwari A., Pesiridis A., Rajoo S., Martinez-Botas R. & Esfahanian V. 2017. A Review of Battery Electric Vehicle Technology and Readiness Levels. Amsterdam: Elsevier. [Online article]. [ref. 2 September 2018]. Available at: https://www.researchgate.net/profile/Amin_Mahmoudzadeh_Andwari/publication/316781702_A_review_of_Battery_Electric_Vehicle_technology_and_readiness_levels/links/5b9281664585153a53015270/A-review-of-Battery-Electric-Vehicle-technology-and-readiness-levels.pdf?origin=publication_detail

Antikainen M. 2016. EVE – Electric Vehicle Systems 2011-2015. Helsinki: Tekes. [Online publication]. [ref. 25 September 2018]. Available at: https://www.businessfinland.fi/globalassets/julkaisut/eve_final_report.pdf?_t_id=1B2M2Y8AsgTpgAmY7PhCfg%3D%3D&_t_q=eve&_t_tags=language%3Afi%2Csiteid%3A53b34a16-7ce7-4ab0-8c7e-f06c83547e28&_t_ip=193.65.255.1&_t_hit.id=Finpro_Web_Features_MediaData_GenericMediaData/_a390ee23-81f6-46f4-9b22-8bc70b8b5015&_t_hit.pos=1

Audi Finland. 2019. Audi e-tron. [Web page]. [ref. 14 July 2019]. Available at: https://www.audi.fi/fi/web/fi/models/tron/audi-e-tron.html

Avci B., Girotra K. & Netessine S. 2012. Electric Vehicles with a Battery Switching Station: Adoption and Environmental Impact. Fontaineblau Cedex: INSEAD. [Online publication]. [ref. 10 December 2018]. Available at: http://www.hbs.edu/faculty/lists/events/attachments/299/girotra_seminarpaper.pdf

Baker, S. Charge anxiety: Range anxiety is now being replaced by ‘charge anxiety’ for consumers buying electric cars. Motor Trader. [Online publication]. [ref. 14 April 2019]. Available at: EBSCO Publishing. Requires credentials.

Bessenbach N. & Wallrapp S. 2013. Why Do Consumers Resist Buying Electric Vehicles? An Empirical Study of Innovation Perception and the Effect of Consumer Characteristics, Innovation Exposure, and Buying Incentives. Copenhagen: Copenhagen Business School. [Online publication]. [ref. 11 December 2018]. Available at: http://studenttheses.cbs.dk/bitstream/handle/10417/4329/nadine_bessenbach_og_sebastian_wallrapp.pdf

BMW Finland. 2019. BMW Concept iX3. [Web page]. [ref. 27 November 2018]. Available at: https://www.bmw.fi/fi/mallisto/i-yhteenveto/iX3/2018/at-a-glance.html#/bookmark=aHR0cHM6Ly93ZWJmb3JtLmJtdy5maS9uZXdzbGV0dGVyP2NhbXBhaWduPWI4Mw==

Ellingsen L. & Hung C. 2018. Research for TRAN Committee – Battery-powered electric vehicles: market development and lifecycle emissions part 2. Policy Department for Structural and Cohesion Policies, European Parliament. [Online publication]. [ref. 10 December 2018]. Available at: http://www.europarl.europa.eu/RegData/etudes/STUD/2018/617457/IPOL_STU(2018)617457_EN.pdf

Era, T. 2017. Fortum explored the attitudes of Finnish people toward electric cars. Helsinki: Fortum. [Online article]. [ref. 21 October 2018]. Available at: https://www.fortum.fi/media/2017/11/fortum-tutki-suomalaisten-suhtautumista-sahkoautoihin-yli-kolmannes-olisi-valmis

EV Volumes. Global Plug-in Vehicle Sales for 2017 – Final Results. [Online article]. [ref. 2 December 2018]. Available at: http://www.ev-volumes.com/news/global-plug-in-vehicle-sales-for-2017-final-results/

Fortum. 2019. Toimimme puhtaamman maailman puolesta. [Online article]. [ref. 14 April 2019]. Available at: https://www.fortum.fi/tietoa-meista/yhtiomme/toimimme-puhtaamman-maailman-puolesta

Giffi C., Vitale J., Drew M., Kuboshima Y. & Sase M. 2011. Unplugged: Electric vehicle realities versus consumer expectations. Deloitte. [Online publication]. [ref. 3 November 2018]. Available at: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Manufacturing/gx_us_auto_DTTGlobalAutoSurvey_ElectricVehicles_100411.pdf

Gnörich B. & Eckstein L. 2016. Battery Electric Vehicles. Aachen: RWTH Aachen University. [Online publication]. [ref. 3 November 2018]. Available at: https://application.wiley-vch.de/books/sample/3527332405_c01.pdf

Hall L. 2018. Manufacturing Electric Vehicles With Recycled Materials. Ontario: FleetCarma. [Online article]. [ref. 18 December 2018]. Available at: https://www.fleetcarma.com/manufacturing-electric-vehicles-recycled-materials/

Helkama-Auto. 2018. Helkama- Auto Oy. Espoo: Helkama-Auto Oy. [Online article]. [ref. 1 September 2018]. Available at: http://www.helkama-auto.fi/index.php?p=HelkamaAuto

Hertzke P., Müller N., Schenk S. & Wu T. 2018. McKinsey & Company. The global electric vehicle market is amped up and on the rise. [Online article]. [ref. 1 December 2018]. Available at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-global-electric-vehicle-market-is-amped-up-and-on-the-rise

Hildermeier J. 2016. Electric Vehicles in Europe – 2016: Approaching adolescence. Brussels: Transport & Environment. [Online publication]. [ref. 1 December 2018]. Available at: https://www.transportenvironment.org/sites/te/files/publications/TE%20EV%20Report%202016%20FINAL.pdf

Hyundai Finland. 2019. IONIQ electric – sähköauto. [Web page]. [ref. 27 November 2018]. Available at: https://www.hyundai.fi/mallisto/ioniq-electric/

Hyundai Finland. 2019. Kona electric nyt Suomessa. [Web page]. [ref. 27 November 2018]. Available at: https://www.hyundai.fi/mallisto/kona-electric/

Irvine, M. 2015. Why You Shouldn't Fear the Electric Car. Popular Science. [Online publication]. [ref. 14 April 2019]. Available at: EBSCO Publishing. Requires credentials.

Jin L. & Slowik P. 2017. Literature review of electric vehicle consumer awareness and outreach activities. International Council on Clean Transportation. [Online publication]. [ref. 2 December 2018]. Available at: https://www.theicct.org/sites/default/files/publications/Consumer-EV-Awareness_ICCT_Working-Paper_23032017_vF.pdf

Kesko. 2018. K-Group Makes Way for New Forms of Mobility: Nationwide Network of Electric Car Charging Points and Car Sharing Pilot. Helsinki: Kesko. [Online publication]. [ref. 18 November 2018]. Available at: https://www.kesko.fi/en/media/news-and-releases/press-releases/2018/k-group-makes-way-for-new-forms-of-mobility-nationwide-network-of-electric-car-charging-points/

Kia Finland. 2019. Uusi Kia e-Niro. Sähköllä jopa 455 km. [Web page]. [ref. 14 July 2019]. Available at: https://www.kia.com/fi/mallisto/e-niro/tutustu/

Kiinteistöliitto. 2018. Korjausrakentamisbarometri / Syksy 2018. Helsinki: Suomen Kiinteistöliitto ry. [Online publication]. [ref. 8 December 2018]. Available at: https://www.kiinteistoliitto.fi/media/3426/korjausrakentamisbarometri_syksy_2018.pdf

Kilcarr, S. 2017. The disconnect between EV expectations and reality. Fleet Owner Exclusive Insight. [Online publication]. [ref. 14 December 2019]. Available at: EBSCO Publishing. Requires credentials.

Li, W., Stanula, P., Egede, P., Kara, S. & Herrmann C. Determining the main factors influencing the energy consumption of electric vehicles in the usage phase. [Online publication]. [ref. 4 December 2018]. Available at: https://core.ac.uk/download/pdf/82767966.pdf

Lombardi M., Panerali, K., Rousselet, S. & Scalise J. 2018. Electric Vehicles for Smarter Cities: The Future of Energy and Mobility. Geneva: World Economic Forum.

[Online publication]. [ref. 31 October 2018]. Available at: http://www3.weforum.org/docs/WEF_2018_%20Electric_For_Smarter_Cities.pdf

Lutsey, N. 2015. Global climate change mitigation potential from a transition to electric vehicles. The International Council on Clean Transportation. [Online publication]. [ref. 2 December 2018]. Available at: https://www.theicct.org/sites/default/files/publications/ICCT_ghg-reduction-potential-evs_201512.pdf

Malloy G. & Lachapelle M. 2018. Gas, Hybrid and Electric: What You Need to Know. Ottawa: Canadian Automobile Association. [Online publication]. [ref. 1 December 2018]. Available at: http://caa.ca/docs/eng/CAA_Engine_Technology_eBook_en.pdf

Mercedes-Benz Finland. 2019. Uusi EQC. Sähköllä on nyt Mercedes. [Web page]. [ref. 14 July 2019]. Available at: https://www.mercedes-benz.fi/passengercars/mercedes-benz-cars/models/eqc/explore/footnote.module.html

Messagie, M. Life Cycle Analysis of the Climate Impact of Electric Vehicles. Brussel: Vrije Universiteit. [Online publication]. [ref. 4 December 2018]. Available at: https://www.transportenvironment.org/sites/te/files/publications/TE%20-%20draft%20report%20v04.pdf

Mok, B. Types of Batteries Used for Electric Vehicles. California: Stanford University. [Online publication]. [ref. 16 May 2019]. Available at: http://large.stanford.edu/courses/2016/ph240/mok2/

Nissan Finland. 2019. Nissan Leaf. [Web page]. [ref. 27 November 2018]. Available at: https://www.nissan.fi/ajoneuvot/henkiloautot/leaf.html

OECD/IEA. 2018. Global EV Outlook 2018: Towards Cross-modal Electrification. France: International Energy Agency. [Online publication]. [ref. 7 September 2018]. Available at: https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/globalevoutlook2018.pdf

Paakkinen M., Pihlatie M., Peltola V. & Pylsy P. 2018. Sähköautojen lataaminen – GASELLI – Väliraportti 1. Espoo: VTT. [Online publication]. [ref. 12 December 2018]. Available at: https://cris.vtt.fi/ws/portalfiles/portal/21137015/VTT_R_02416_18.pdf

Pod Point. 2019. How Long Does It Take to Charge an Electric Car? London: Pod Point. [Online publication]. [ref. 16 May 2019]. Available at: https://pod-point.com/guides/driver/how-long-to-charge-an-electric-car

Raab C., Huber A., Trenka J. & Wahl J. 2014. The Electric Vehicle Challenge: Electric Vehicle Growth in an Evolving Market Dependent on Seven Success Factors. Accenture. [Online publication]. [ref. 12 November 2018]. Available at: https://www.accenture.com/in-en/~/media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Industries_15/Accenture-Electric-Vehicle-Challenge.pdf

Renault Finland. 2019. Renault ZOE -sähköauto on yksinkertaisesti vallankumouksellinen! [Web page]. [ref. 27 November 2018]. Available at: https://www.renault.fi/henkiloautot/zoe/

SIS International. 2018. What is Quantitative Research? New York: SIS International. [Web page]. [ref. 16 May 2018]. Available at: https://www.sisinternational.com/what-is-quantitative-research/

Škoda Auto. 2015. ŠKODA produces 17,000,000th vehicle. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 14 April 2019]. Available at: https://www.skoda-storyboard.com/en/press-releases/skoda-produces-17000000th-vehicle/

Škoda Auto. 2016. Factory holiday: ŠKODA Modernizing and Expanding Czech Production Sites. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 14 April 2019]. Available at: https://www.skoda-storyboard.com/en/press-releases/factory-holiday-skoda-modernizing-expanding-czech-production-sites/

Škoda Auto. 2018. How Will Customers Benefit from Electric Cars? Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 5 September 2018]. Available at: https://www.skoda-storyboard.com/en/innovation/mobility/how-will-customers-benefit-from-electric-cars/

Škoda Auto. 2018. Škoda Auto Company. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 3 September 2018]. Available at: http://www.skoda-auto.com/company/about

Škoda Auto. 2018. Škoda Vision RS: Creating a Sporty and Sustainable Future. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 18 September 2018]. Available at: https://www.skoda-storyboard.com/en/press-releases/skoda-vision-rs-creating-a-sporty-and-sustainable-future/

Škoda Auto. 2019. Alain Favey: The future lies in offering a wide range of electric vehicles. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 28 June 2019]. Available at: https://www.skoda-storyboard.com/en/lifestyle/people/alain-favey-the-future-lies-in-offering-a-wide-range-of-electric-vehicles/

Škoda Auto. 2019. ŠKODA VISION iV: the next step towards e-mobility. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 14 July 2019]. Available at: https://www.skoda-storyboard.com/en/press-kits/skoda-auto-at-auto-shanghai-2019-press-kit/skoda-vision-iv-the-next-step-towards-e-mobility/

Škoda Auto. 2019. The ŠKODA CITIGOe iV is here. What's hidden inside? Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 14 July 2019]. Available at: https://www.skoda-storyboard.com/en/models/citigo/the-skoda-citigoe-iv-is-here-whats-hidden-inside/

Särkijärvi J., Jääskeläinen S. & Lohko-Soner K. 2018. Toimenpideohjelma hiilettömään liikenteeseen 2045: Liikenteen ilmastopolitiikan työryhmän loppuraportti. Helsinki: Liikenne- ja viestintäministeriö. [Online publication]. [ref. 7 September 2018]. Available at: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161210/LVM_13_18_Toimenpideohjelma%20hiilettomaan%20liikenteeseen%202045%20Liikenteen%20ilmastopolitiikan%20tyoryhman%20loppuraportti.pdf?sequence=1&isAllowed=y

Tesla Finland. 2019. Tesla Model 3. [Web page]. [ref. 14 July 2019]. Available at: https://www.tesla.com/fi_FI/model3

The National Academies Press. 2015. Overcoming Barriers to Deployment of Plug-In Electric Vehicles. Washington D.C.: The National Academies Press. [Online publication]. [ref. 30 October 2018]. Available at: https://www.nap.edu/read/21725

Thiel C., Alemanno A., Scarcella G., Zubaryeva A. & Pasaoglu G. 2012. Attitude of European car drivers towards electric vehicles: a survey. Petten: Joint Research Centre. [Online publication]. [ref. 23 October 2018]. Available at: http://www.ehcar.net/library/rapport/rapport018.pdf

Thomas, M. 2018. Research for TRAN Committee – Battery-powered electric vehicles: market development and lifecycle emissions part 1. Policy Department for Structural and Cohesion Policies, European Parliament. [Online publication]. [ref. 10 December 2018]. Available at: http://www.europarl.europa.eu/RegData/etudes/STUD/2018/617457/IPOL_STU(2018)617457_EN.pdf

Tsang F., Pedersen J., Wooding S. & Potoglou D. 2012. Bringing the electric vehicle to the mass market: a review of barriers, facilitators and policy interventions. Cambridge: RAND Europe. [Online publication]. [ref. 25 October 2018]. Available at: https://www.rand.org/content/dam/rand/pubs/working_papers/2012/RAND_WR775.pdf

Volkswagen AG. Record year: ŠKODA delivers 1.25 million vehicles worldwide in 2018. Mladá Boleslav: Škoda Auto A.s. [Online article]. [ref. 18 April 2019]. Available at: https://www.volkswagenag.com/en/news/2019/01/SKODA_deliveries_Dec_18.html

Volkswagen Finland. 2018. Kansansähköauto e-Golf. [Web page]. [ref. 27 November 2018]. Available at: https://www.volkswagen.fi/fi/mallit/e-golf.html

Wietschel M., Plötz P., Kühn A. & Gnann T. 2013. Market Evolution Scenarios for Electric Vehicles. Karlsruhe: Fraunhofer ISI. [Online publication]. [ref. 2 November 2018]. Available at: https://www.isi.fraunhofer.de/content/dam/isi/dokumente/cce/2013/NPE_TCO_Bericht_en.pdf

Wolfram & Lutsey. 2016. Electric vehicles: Literature review of technology costs and carbon emissions. [Online publication]. [ref. 1 December 2018]. The International Council on Clean Transportation. Available at: https://www.theicct.org/sites/default/files/publications/ICCT_LitRvw_EV-tech-costs_201607.pdf

Young, Wang & Strunz. 2013. Electric Vehicle Battery Technologies. New York: Springer Science+Business Media. [Online publication]. [ref. 2 September 2018]. Available at: https://www.springer.com/cda/content/document/cda_downloaddocument/9781461401339-c1.pdf?SGWID=0-0-45-1364113-p174121858

Zulkarnain, Leviäkangas, P., Kinnunen T. & Kess P. The Electric Vehicle Ecosystem Model: Construct, Analysis and Identification of Key Challenges. Espoo: VTT. [Online publication]. [ref. 1 December 2018]. Available at: http://www.fm-kp.si/zalozba/ISSN/1581-6311/12_253-277.pdf

APPENDICES

APPENDIX 1. Summary of the survey results

Summary of the survey results and findings

Study on Consumer Behaviour on Electric Cars

Gender, age, region and area overview

- Gender share
  - **Male 78%**
  - Female 22%
- Age groups (years old)
  - 25-34 20%
  - 35-44 26%
  - **45-54 28%**
  - 55-64 26%
- Living region
  - **South 46%**
  - West 23%
  - East 14%
  - North 10%
  - Southwest 7%
- Living area
  - **Suburban 57%**
  - Urban 22%
  - Rural 21%

Gender, age, region and area detail

- **The strongest shares of women (29%) were in age groups of 25-34 and 45-54 years old**
  - 27% were 55-64 years old
  - Only 15% were 35-44 years old
- **The strongest shares of men (29%) were in age groups of 25-34 and 45-54 years old**
  - 25% were 55-64 years old
  - Only 17% were 25-34 years old
- Suburb was more popular among men than women (61% vs. 46%)
- Rural was more popular among women than men (36% vs. 17%)
- Urban was the most equal (22% and 23%)
- Southern Finland was 6-8% more represented by younger adults (25-34 years old) than other regions
- Northern Finland was 5% more represented by middle aged and older adults (35-64 years old) than other regions

Education and income level overview

- Highest achieved education level
  - Elementary 3%
  - High school 5%
  - **Vocational 40%**
  - Candidate 26%
  - Master 24%
  - Doctor 2%
- Income level per year (in thousands of euros)
  - < 30 10%
  - **30-39 19%**
  - **40-49 20%**
  - **50-59 18%**
  - 60-69 10%
  - 70-79 6%
  - > 80 8%
  - Classified 9%

Education level detail

- Elementary degree
  - Marginal, but most common within the oldest age groups including both genders equally
  - 45-54 years old 4%
  - **55-64 years old 6%**
- Vocational degree
  - The most common education level within participants
  - Mostly men from the oldest age group
  - **42% of men**
  - 36% of women
  - **50% aged 55-64 years old**
  - 31% aged 35-44 years old
- Bachelor's degree
  - The second most common education level within participants
  - Mostly younger and middle-aged women
  - **30% of women**
  - 24% of men
  - **67% aged between 25 and 44 years old**
  - 15% aged 55-64 years old
- Master's degree
  - Mostly middle-aged and older adults, no significant differences between genders
  - **54% aged 34-54 years old**
  - 17% aged 25-34 years old

Income level detail

- Less than 40 000 €/year
  - Up to approx. 3 300 €/month
  - **46% of women**
  - 25% of men
  - **33% from rural areas**
  - 24% from urban areas
- Women were earning clearly less income on average than men
- Participants from urban areas earned remarkably more income on average than ones from rural areas
- More than 60 000 €/year
  - More than 5 000 €/month
  - **46% of men**
  - 25% of women
  - **33% from urban areas**
  - 17% from rural areas

Household and parking overview

- Household members
  - 1 12%
  - **2 39%**
  - **3-4 40%**
  - > 4 9%
- Cars in household
  - 1 47%
  - 2 or more 53%
- Parking spot
  - **Outside lot 41%**
  - **Carport 33%**
  - Private garage 19%
  - Parking hall 4%
  - Roadside 2%
  - No spot 1%

Household and parking detail

- **Suburban area was in high popularity within small families, as it had the biggest share of households with 3-4 members (47%)**
  - Shares of small families in urban 33% and rural 32%
- Urban area had the most single households (14%)
  - Suburban 12% and rural 10%
- Urban area had the most households with at least 4 members (10%)
  - Suburban 8% and rural 7%
- **51% of participants from rural areas had a household of two, from which more than half consisted of older adults**
  - Urban 43% and suburban 33%
- **Up to 83% of rural households had at least two cars at their disposal**
  - Suburban 47%
  - Urban 41%
- **More members, more cars; 62% from households with 3-4 members had at least two cars at their disposal**
  - 55% from households with 2 members had at least two cars
  - 9% of single households had two cars

Household and parking detail

- **More income could mean more cars** (income in thousands of euros and share of households with more than two cars)
  - 30-40 43%
  - 40-50 55%
  - **50-60 61%**
- **Private garage was the parking place for more than third of the rural participants**
- Parking hall was quite uncommon in comparison to other places, but most common within urban participants (12%)
- Carports and parking lots were quite popular in all areas, especially in suburban and rural ones

- Private garage
  - **Rural 31%**
  - Suburban 17%
  - Urban 13%
- Parking hall
  - **Urban 12%**
  - Suburban 3%
- Carport
  - **Suburban 36%**
  - **Rural 33%**
  - Urban 27%
- Parking lot
  - **Suburban 43%**
  - Urban 39%
  - Rural 36%

Knowledge level overview and detail

- Estimated knowledge level
  - Low 11%
  - **Moderate 36%**
  - **Intermediate 36%**
  - Advanced 17%
  - Expert 0%
- **More than every third of women estimated their knowledge to be on a low level**
- **On average, men and urban participants estimated to have better knowledge on electric cars than others**
- **It was found that holders of higher education degrees had higher level of knowledge on electric cars in general than ones with lower degrees**

- Low level
  - **36% of women**
  - 3% of men
  - **21% from rural areas**
  - 8% from urban and suburban areas
  - **16% of vocational degree holders**
  - 5% of master's degree holders
- Advanced
  - **21% of men**
  - 4% of women
  - **19% from urban areas**
  - 13% from rural areas
  - **21% of master's degree holders**
  - 13% of vocational degree holders

Attitudes toward fuel types overview

- **Preference**
  - **Petrol** **62%**
  - Plug-in hybrid 52%
  - Mild hybrid 49%
  - Fully electric 45%
  - CNG 28%
  - Diesel 24%
  - Hydrogen 17%
- **Avoidance**
  - **Hydrogen** **58%**
  - **Diesel** **56%**
  - CNG 47%
  - Fully electric 30%
  - Mild hybrid 24%
  - Plug-in hybrid 24%
  - Petrol 12%

Attitudes toward fuel types detail

- **Overall, men were remarkably more open toward alternative fuels than women**
- **From living areas, urban and suburban participants showed clearly more interest toward alternatives than ones from rural areas**
- Hydrogen
  - **21% of men**
  - 7% of women
- CNG
  - **32% of men**
  - 18% of women
  - **35% from urban areas**
  - 26% from suburban areas
- Plug-in hybrid
  - **56% of men**
  - 35% of women
  - **56% from suburban areas**
  - 42% from rural areas
- Fully electric
  - **48% of men**
  - 38% of women
  - **52% from suburban areas**
  - 27% from rural areas
- Petrol
  - **66% from suburban areas**
  - 54% from rural areas
- Diesel
  - **33% from rural areas**
  - 20% from suburban areas

Purchase readiness and brand preference overview

- Readiness in years
  - Approx. 1 3%
  - **2-4 25%**
  - **5-7 36%**
  - 8-10 13%
  - 10-15 11%
  - > 15 7%
  - Never 5%
- Brand preference
  - **Skoda 68%**
  - **Volkswagen 52%**
  - Audi 40%
  - Tesla 33%
  - BMW 20%
  - Mercedes-Benz 20%
  - Hyundai 16%
  - Kia 13%

Purchase readiness and brand preference detail

- **Participants from urban and suburban areas were ready to switch to an electrified powertrain sooner than ones from rural areas on average**
- **Participants with more income were generally more prepared to buy a BEV in shorter time period than ones with lower income**
- Two points above could be connected to the finding that urban participants have more income on average and are more interested in new technologies
- **Premium brands were more popular in higher income categories**
  - Especially BMW, Mercedes-Benz and Polestar were popular within income level of 50-60 t€
  - Hyundai, Nissan and Opel were more preferred in the income category of 30-40 t€

- BEV purchasing readiness in under 5 years
  - **31% from suburban areas**
  - 19% from rural areas
  - **28% from income level 50-60 t€**
  - 15% from income level < 40 t€
- BEV purchasing readiness after 10 years
  - **31% from rural areas**
  - 21% from urban areas
  - **23% from income level 30-40 t€**
  - 18% from income level 40-50 t€

Holding type and price preference overview

- **Preference**
  - **Ownership** **79%**
  - Private leasing 32%
  - Company car 29%
  - Sharing 9%
- **Avoidance**
  - **Sharing** **82%**
  - Company car 53%
  - Private leasing 38%
  - Ownership 11%
- 78% of participants would keep their BEV as the primary car in household

- Preferred maximum price (in thousands)
  - < 10 1%
  - 10-20 13%
  - **20-30** **36%**
  - **30-40** **33%**
  - 40-50 11%
  - 50-60 5%
  - 60-70 1%
  - 70-80 0%
  - > 80 0%

Holding type and price preference detail

- **Car sharing was the only holding type that was more preferred by women on average**
  - 16% of women
  - 7% of men
- **12% of urban customers found sharing interesting, as half less (6%) of rural customers felt similarly**
- Ownership, leasing and company car were approximately 5% more preferred by men than women respectively

- BEV price preference less than 20 000 euros
  - **37% of women**
  - 8% of men
  - **Approximately 25% from income level 30-40 t€**
  - Approximately 12% from income level 40-50 t€
- 76% of men prefer a car despite the powertrain for a price of 20 000 – 40 000 €
- 72% of women prefer a car despite the powertrain for a price of 10 000 – 30 000 €
- **Men are not willing to pay more for a BEV on average, but approximately 10% of women would pay more for a BEV than an ICEV**

Importance of properties overview

- **Range** **98%**
- **Purchase price** **96%**
- **Costs of ownership** **95%**
- **Charging network** **92%**
- **Crash/battery safety** **91%**
- **Charging time** **91%**
- Battery price 84%
- IT security 75%
- Additional equipment 71%
- Government incentives 68%
- Tailpipe emissions 63%
- Model range 61%
- Sustainable materials 60%
- Life-cycle emissions 59%
- Towing capacity 45%

Importance of properties detail

- **Women were more conservative, as they kept both tailpipe and life-cycle emissions in higher importance than men, on the side of sustainable materials**
- **Men showed more importance toward dynamic and practical features than women, especially in terms of performance and towing capacity**

- Tailpipe emissions
  - **79% of women**
  - 58% of men
- Life-cycle emissions
  - **75% of women**
  - 55% of men
- Sustainable materials
  - **72% of women**
  - 56% of men
- Battery price
  - **91% of women**
  - 82% of men

- **Towing capacity and government incentives were clearly more important for rural participants, where urban and suburban ones kept battery charging time and vehicle design in higher importance than rural participants**

- Performance
  - **61% of men**
  - 51% of women
- Towing capacity
  - **48% of men**
  - 31% of women
  - **46% of rural participants**
  - 37% of urban participants
- Design
  - **72% of urban participants**
  - 57% of rural participants
- Charging time
  - **96% of urban participants**
  - 85% of rural participants
- Government incentives
  - **76% of rural participants**
  - 65% of suburban participants

Impressions of properties

- **Appealing**
  - **Tailpipe emissions** **60%**
  - Performance 40%
  - Technology 39%
  - Silence 37%
  - Image 37%
  - Life-cycle emissions 34%
  - Crash safety 27%
  - Reliability 27%
  - Design 25%
  - IT safety 24%
- **Limiting**
  - **Range** **78%**
  - **Purchase price** **76%**
  - Charging network 69%
  - Charging time 58%
  - Model offer 51%
  - Costs of ownership 37%
  - Towing capacity 35%
  - Reliability 33%
  - Government incentives 29%
  - IT safety 23%

Impressions of properties detail (appealing)

- Properties like design, technology and tailpipe emissions shared opinions within participants from different living areas
  - These properties were found more appealing by urban and suburban participants than by ones coming from rural areas
- **Design**
  - **28% of men**
  - 18% of women
  - **29% of suburban participants**
  - 15% of rural participants
- **Tailpipe emissions**
  - **63% of men**
  - 48% of women
  - **63% of urban participants**
  - 49% of rural participants
- **Technology**
  - **42% of men**
  - 27% of women
  - **42% of suburban participants**
  - 26% of rural participants

Impressions of properties detail (limiting)

- **Range**
  - **80% of men**
  - 70% of women
- **Charging network**
  - **72% of men**
  - 61% of women
- **Model offer**
  - **54% of men**
  - 37% of women
- **Towing capacity**
  - **38% of men**
  - 25% of women

- **In general, men expressed their impressions more strongly on different properties than women**
- **More than half (53%) of men found range as a strong limitation and charging network was found strongly limiting by 39%**
- **Model offer and towing capacity were found more as a medium than strong limitation**

Importance of connectivity features overview

- Importance of connectivity features
  - **Battery information** **85%**
  - **Driving information** **84%**
  - **Network information** **83%**
  - Cabin heating 78%
  - Charging activation 77%
  - Payment follow-up 72%
  - Battery heating 62%
  - Car sharing services 15%

- **On average, older adults gave less importance to connectivity features than others**
  - Despite this, participants over 55 years old considered car sharing services significantly more important than others (20% vs. 12-14%)
- **Especially mobile charging activation and payment follow-up were clearly more popular among young adults than others**
- **Battery and driving information were considered more important by older than younger adults**

Importance of connectivity features detail

- Battery information
  - 84% of 45-64 year olds
- Driving information
  - 84% of 45-64 year olds
- Charging network information
  - 85% of 45-54 year olds
- Remote battery heating
  - 66-67% of 25-44 year olds
  - 58-60% of 45-64 year olds
- Remote cabin heating
  - 83% of 25-44 year olds
  - 75% of 45-64 year olds
- Payment follow-up
  - **81% of 25-34 year olds**
  - 65% of 45-54 year olds
- Mobile charging activation
  - **82% of 25-34 year olds**
  - 73-77% of 35-64 year olds

Preference toward body types overview

- **Preference**
  - **Wagon** **80%**
  - SUV 61%
  - Crossover 51%
  - Hatchback 44%
  - Sedan 42%
  - Coupe 26%
- **Avoidance**
  - **Coupe** **41%**
  - Sedan 28%
  - Hatchback 25%
  - Crossover 21%
  - SUV 21%
  - Wagon 14%

Preference toward body types detail

- **Young adults indicated more preference toward various body types than other age groups, excluding crossover**
  - Especially coupe and sedan were significantly more preferred by younger than older adults
  - Crossover and wagon were the most preferred body types by older participants
- Sedan
  - **63% of 25-34 year olds**
  - 32% of 55-64 year olds
- Hatchback
  - **52% of 25-34 year olds**
  - 43% of 55-64 year olds
- Coupe
  - **37% of 25-34 year olds**
  - 19% of 55-64 year olds
- Wagon
  - **83-87% of 25-44 year olds**
  - 75-76% of 45-64 year olds
- SUV
  - **65-69% of 25-44 year olds**
  - 57% of 45-64 year olds
- Crossover
  - **50-55% of 35-64 year olds**
  - 47% of 25-34 year olds

Driving distances and range expectations (km) overview

- Estimated distance / day (week)
  - < 10 (50-70) 5%
  - **11-50 (55-350) 45%**
  - **51-100 (255-700) 31%**
  - 101-200 (505-1400) 15%
  - 201-300 (1005-2100) 3%
  - > 300 (>1500) 1%
- Range expectation
  - < 200 2%
  - 201-300 7%
  - 301-400 24%
  - **401-500 31%**
  - 501-600 20%
  - > 600 16%

Driving distances and range expectations (km) detail

- **It was found that men and participants from rural areas drive the longest distances on a daily basis**
- **Men and young adults seem to be the most demanding toward range capabilities**
- **Urban participants seem to be the most tolerant with lower range capabilities**
- Distance more than 100 km per day
  - **21% of men**
  - 11% of women
  - **22% of rural participants**
  - 18% of suburban participants
  - 15% of urban participants
- Range less than 300 km
  - **21% of women**
  - 5% of men
  - **14% of urban participants**
  - 7% of suburban participants
- Range more than 500 km
  - **38% of men**
  - 28% of women
  - **36-40% of 25-54 year olds**
  - 31% of 55-64 year olds

Charging time overview and detail

- Charging time expectations
  - < 15 min 6%
  - 15-30 min 21%
  - 31-59 min 19%
  - **1-2 h 30%**
  - 3-4 h 14%
  - 5-6 h 7%
  - > 6 h 3%
- **Women seemed to be a lot more impatient in terms of charging times than men**
- **More than half of older adults and urban participants expected charging of a BEV to take less than one hour**
- **Only 6% of women and 4% of younger adults could stand a charging time of over five hours**
- Less than 1 hour
  - **Women 56%**
  - Men 42%
  - **Urban 54%**
  - Suburban 41%
  - **55-64 year olds 55%**
  - 25-54 year olds 39-44%
- More than 5 hours
  - **Men 12%**
  - Women 6%
  - **35-64 year olds 12-13%**
  - 25-34 year olds 4%

Importance of charging types overview

- **Important**
  - **Home charger 86%**
  - **Home socket 84%**
  - **Fast charging 82%**
  - Ultra-fast charging 75%
  - Converted heating post 64%
  - Stationary wireless 57%
  - Mobile wireless 43%
  - Mobile charger 32%
- **Unimportant**
  - **Mobile wireless 26%**
  - **Mobile charger 25%**
  - **Stationary wireless 20%**
  - Converted heating post 16%
  - Ultra-fast charging 9%
  - Fast charging 6%
  - Home socket 6%
  - Home charger 4%

Importance of charging types detail

- **Urban participants were found to be more open-minded toward new and innovative charging types such as stationary and mobile wireless charging, as well as transportable mobile chargers**
- **Suburban participants were more interested in fast charging and heating pole conversion possibilities, while rural participants showed to be the readiest to stick to their home sockets**
- Stationary wireless
  - **67% of urban participants**
  - 53-54% of suburban and rural participants
- Mobile wireless
  - **46% of urban participants**
  - 38% of rural participants
- Mobile charger
  - **40% of urban participants**
  - 24% of rural participants
- Home socket
  - 89% of rural participants
  - 82-83% of urban and suburban participants
- Converted heating post
  - 68-71% suburban and urban participants
  - 45% of rural participants
- Fast charging
  - 83-85% of suburban and urban participants
  - 73% of rural participants
- Ultra-fast charging
  - 76-79% of urban and suburban participants
  - 66% of rural participants

Importance of charging places overview

- **Important**
  - **Home** **97%**
  - Destinations 82%
  - Workplace 80%
  - Roadside 78%
  - Dealer network 34%
- **Unimportant**
  - **Dealer network** **32%**
  - Workplace 9%
  - Roadside 6%
  - Destinations 5%
  - Home 1%

Importance of charging places detail

- **The two most opinion sharing charging places were workplace and dealer network**
- **Both were clearly more preferred by women, while dealer network raised interest especially in participants coming from urban areas**

- Workplace
  - **82% of women**
  - 73% of men
- Dealer network
  - **44% of women**
  - 31% of men
  - **39% of urban participants**
  - 30% of rural participants

Home charger price preference overview and detail

- Home charger price preference
  - < 200 € 21%
  - **201-500 €** **44%**
  - 501-800 € 18%
  - 801-1200 € 12%
  - 1201-1600 € 3%
  - 1601-2000 € 1%
  - > 2000 € 1%

- **Participants from urban areas were significantly more prepared to pay more for their home chargers than others**
  - Nearly every third of rural participants would not pay more than 200 euros for their device, while nearly fourth of urban participants could pay more than 800 euros

- Less than 200 €
  - **30% of rural participants**
  - 19-20% of suburban and urban participants

- More than 800 €
  - **22% of urban participants**
  - 13-15% of suburban and rural participants

APPENDIX 2. The questionnaire form in English.

A customer survey on expectations and demand toward fully electric cars

Customer profile

1. What is your gender? *

- Male
- Female
- I prefer not to tell

2. How old are you? *

- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old

3. In which region of Finland do you live in? *

- Southern Finland
- Eastern Finland
- Southwestern Finland
- Western Finland
- Northern Finland

4. In which kind of area do you live in? *

- Urban
- Suburban
- Rural

5. What is the highest education level you have achieved? *

- Elementary
- High School
- Vocational
- Candidate
- Master
- Doctor

6. How much is your average gross income per year? *

- Less than 30 000 €
- 30 000 – 39 999 €
- 40 000 – 49 999 €
- 50 000 – 59 999 €
- 60 000 – 69 999 €
- 70 000 – 79 999 €
- 80 000 € or more
- I prefer not to tell

7. How many members does your household have? *

- 1
- 2
- 3-4
- More than 4

8. How many cars does your household have? *

- 1
- 2 or more

9. What kind of parking space do you use at home? *

- Private garage
- Parking hall
- Carport
- Parking lot
- Roadside
- No separate parking space

10. What is your knowledge level regarding electric cars? *

- I barely know anything
- I know a little
- Intermediate
- I know quite a lot
- I am an expert

A customer survey on expectations and demand toward fully electric cars

Purchase intentions and related factors

11. How attractive do you find the following fuel types when considering your next car? 1 = not attractive at all, 3 = neutral/do not know, 5 = really attractive. *

	1	2	3	4	5
Petrol	○	○	○	○	○
Diesel	○	○	○	○	○
Natural gas	○	○	○	○	○
Hydrogen	○	○	○	○	○
Mild hybrid	○	○	○	○	○
Plug-in hybrid	○	○	○	○	○
Fully electric	○	○	○	○	○

12. How soon would you be prepared to purchase a fully electric car? *

- ○ In about a year
- ○ During 2-4 years
- ○ During 5-7 years
- ○ During 8-10 years
- ○ During 10-15 years
- ○ Later than 15 years
- ○ I would never buy a fully electric car

13. Which of the following manufacturers do you find attractive in terms of current or upcoming fully electric model offer? You can choose several options. Model examples in brackets. *

- ☐ Audi (e-tron)
- ☐ BMW (i3, iX3)
- ☐ Chevrolet (Bolt, Volt)
- ☐ Citroen (C-Zero)
- ☐ DS (DS 3)
- ☐ Honda (Insight, Urban EV)
- ☐ Hyundai (Ioniq, Kona)
- ☐ Kia (e-Niro, Soul EV)
- ☐ Mercedes-Benz (EQA, EQC)

- Mini (Mini E)
- Nissan (Leaf)
- Opel (Ampera, eCorsa)
- Peugeot (iOn)
- Polestar (Polestar 2)
- Renault (Twizy, Zoe)
- Skoda (eCitigo, Vision E)
- Smart (Forfour, Fortwo)
- Tesla (Model 3)
- Volkswagen (e-Golf, e-up!, I.D.)
- None of the above
- Other?

14. How reasonable would you consider the following holding types in the case of a battery electric car? 1 = not reasonable at all, 3 = neutral/do not know, 5 = really reasonable. *

	1	2	3	4	5
Ownership					
Private leasing					
Company car					
Shared car (e.g. common electric car of a condominium)					

15. If you kept some of the holding types reasonable, would the car be the primary or secondary car in your household? *

- Primary
- Secondary
- I did not consider any of the holding types reasonable

16. How much would you be prepared to pay for a new car with an internal combustion engine? *

- Less than 10 000 €
- 10 000 – 20 000 €
- 20 001 – 30 000 €
- 30 001 – 40 000 €
- 40 001 – 50 000 €
- 50 001 – 60 000 €
- 60 001 – 70 000 €
- 70 001 – 80 000 €
- More than 80 000 €

17. How much would you be willing to pay for a new fully electric vehicle? *

- Less than 10 000 €
- 10 000 – 20 000 €

- 20 001 – 30 000 €
- 30 001 – 40 000 €
- 40 001 – 50 000 €
- 50 001 – 60 000 €
- 60 001 – 70 000 €
- 70 001 – 80 000 €
- More than 80 000 €

18. How important do you consider the following properties and factors concerning a fully electric car? 1 = not important at all, 3 = neutral/do not know, 5 = really important.

	1	2	3	4	5
Sufficiency of range *					
Charging time of the battery *					
Coverage of the charging network *					
Model range offered by manufacturers *					
Aesthetically pleasing shape and design *					
Reasonable purchase price *					
Reasonable price of battery (e.g. as a spare part or an accessory) *					
Reasonable costs of ownership (incl. servicing, insurance, tax) *					
Comprehensive selection of additional equipment (e.g. chargers, cables and batteries) *					
Low tailpipe emissions *					
Low life-cycle emissions (e.g. ecological manufacturing process and handling of components) *					
Sufficient policies and incentives by the government (e.g. purchase subsidies, taxation benefits and parking privileges) *					
Impressive performance *					
Use of sustainable materials *					
Crash and battery safety *					
IT safety *					
Towing ability and capacity *					
Other property or factor that you consider important? important? Please describe shortly.					

19. How much do the following *current* properties and factors *limit (-) or attract (+)* you in terms of fully electric cars? -2 = limits significantly, 0 = neutral/do not know, +2 = attracts significantly.

	-2	-1	0	+1	+2
Range *					
Charging time of the battery *					
Coverage of the charging network *					

Model range offered by manufacturers *	○	○	○	○	○
Shape and design *	○	○	○	○	○
Purchase price *	○	○	○	○	○
Costs of ownership (incl. servicing, insurance, taxes) *	○	○	○	○	○
New technology *	○	○	○	○	○
Reliability and endurance *	○	○	○	○	○
Policies and incentives by the government (e.g. purchase subsidies, taxation benefits and parking privileges) *	○	○	○	○	○
Performance *	○	○	○	○	○
Tailpipe emissions *	○	○	○	○	○
Life-cycle emissions (e.g. manufacturing process and handling of components) *	○	○	○	○	○
Battery and crash safety *	○	○	○	○	○
IT safety *	○	○	○	○	○
Towing ability and capacity *	○	○	○	○	○
Image related to electric mobility *	○	○	○	○	○
Absence of engine noise *	○	○	○	○	○
Something else? Please evaluate the attractiveness and describe shortly.	○	○	○	○	○

20. Electric cars bring opportunities for new connected services that can be controlled via smart devices and the infotainment display of the car. How interesting would you find the following new services in a battery electric car? 1 = not interesting at all, 3 = neutral/do not know, 5 = really interesting.

	1	2	3	4	5
Information about the charging network (e.g. charger locations, charging prices, charger types and reservation status) *	○	○	○	○	○
Battery information (e.g. temperature and state of charging) *	○	○	○	○	○
Remote battery heating and cooling *	○	○	○	○	○
Remote cabin heating and cooling *	○	○	○	○	○
Driving information (route planning and remaining range) *	○	○	○	○	○
Remote charging activation and deactivation *	○	○	○	○	○
Follow-up of charging actions and payments *	○	○	○	○	○
Car sharing, leasing and related services *	○	○	○	○	○
Something else? Please evaluate the importance and describe shortly.	○	○	○	○	○

21. How attractive would you find the following body types in an electric car? 1 = not attractive at all, 3 = neutral/do not know, 5 = really attractive. *

	1	2	3	4	5
Hatchback	○	○	○	○	○
Sedan	○	○	○	○	○

Coupe	jn	jn	jn	jn	jn
Wagon	jn	jn	jn	jn	jn
Crossover	jn	jn	jn	jn	jn
SUV	jn	jn	jn	jn	jn

A customer survey on expectations and demand toward fully electric cars

Range and charging

22. What kind of distances do you drive on a daily basis? If you do not drive daily, please estimate the average mileage based on your weekly distance. *

- jn Less than 10 km
- jn 11-50 km
- jn 51-100 km
- jn 101-200 km
- jn 201-300 km
- jn More than 300 km

23. What kind of range per charge would be sufficient for you to consider a fully electric car? *

- jn Less than 200 km
- jn 201-300 km
- jn 301-400 km
- jn 401-500 km
- jn 501-600 km
- jn More than 600 km

24. What would be the longest bearable charging time for an electric car in your case? *

- jn Less than 15 minutes
- jn 15-30 minutes
- jn 31-59 minutes
- jn 1-2 hours
- jn 3-4 hours
- jn 5-6 hours
- jn More than 6 tuntia

25. How important do you consider the following charging types in your case? 1 = not important at all, 3 = neutral/do not know, 5 = really important. *

	1	2	3	4	5
Home socket	jn	jn	jn	jn	jn
Home charging device (e.g. wall charger)	jn	jn	jn	jn	jn

Home charging via conversed heating pole	○	○	○	○	○
Wireless charging at a parking spot	○	○	○	○	○
Wireless charging while on the move (e.g. via charging line under or next to the ground)	○	○	○	○	○
Mobile charger (movable charger e.g. on crowd events)	○	○	○	○	○
Fast public charging (approx. 30-45 min)	○	○	○	○	○
Ultra-fast public charging (approx. 10-20 min)	○	○	○	○	○

26. How important do you consider the following charging places in your case? 1 = not important at all, 3 = neutral/do not know, 5 = really important. *

	1	2	3	4	5
Home	○	○	○	○	○
Roadside (e.g. resting parks and fuel stations)	○	○	○	○	○
Destinations (e.g. hotels, sports centres and shopping malls)	○	○	○	○	○
Workplace	○	○	○	○	○
Dealer network (e.g. showroom parking lots)	○	○	○	○	○

27. How much would you be prepared to pay for a home charging device as an option, independent of the power output? *

- ○ Less than 200 euros
- ○ 201-500 euros
- ○ 501-800 euros
- ○ 801-1200 euros
- ○ 1201-1600 euros
- ○ 1601-2000 euros
- ○ More than 2000 euros