APPENDIX

The appendix provides background information for the analysis and ideation phase. For the analysis phase, the appendices extend the knowledge on electric cars (Appendix A1 to A4) and give additional information about the market (Appendix A5) and trends (Appendix A6). Also, the appendix describes the materials used for the interviews (Appendix A7 to A11) and the detailed train of thought in the analysis of the results (Appendix A12 and A13). For the ideation phase, the appendices describe the process from barriers to opportunity areas to concepts (Appendix A14 to B16). The quantitative research is described, analysed and a concept choice is made (Appendix B17 to B19). Though the report and appendix complement each other, all the information that was determinant for the process can be found in the report.

A1: ELECTRIC VEHICLES IN HOLLAND

Electric vehicles can be divided in four categories: hybrid (HEV), plug-in hybrids (PHEV), Range Extenders (E-REV) and battery electric (BEV) (see Figure 1). The hybrids use a combination of an internal combustion engine (ICE) and an electromotor. The electromotor generates energy using regenerative breaking, which can save 20-45% fuel (Berman, B., 2006). The ICE is the main power source for the hybrid, while this is the electromotor for the plug-in hybrid (Eachern, A., 2012). Since the hybrid cannot be charged, they are out of the scope of the project. The Range Extender uses only the electromotor to drive, the ICE is used to recharge the battery when needed. The full-electric vehicle only uses an electromotor and is dependent on the grid for power. In the Netherlands, most electric cars are plug-in hybrids (see Figure 2) (CBS, 2016a).

In the Netherlands, out of two people owns a car (CBS, 2015), what comes down to approximately 7.8 million owned cars. In 2015, 44.150 of these cars were electric, which has increased to 86.200 in 2016 as displayed in figure (CBS, 2016b). In 2015, 449.000 new cars were sold in the Netherlands (CBS, 2016e), of which 60.000 were electric (13,3%) (2016a).

The environmental advantages caused the electric cars to be heavily privileged through taxes. Because of this, most electric cars are business-owned. For all cars, only 10% is company-owned (CBS, 2012); for electric cars, this is 85% (CBS, 2016c). However, since the infrastructure for electric vehicles has improved significantly, the offer has increased and the advantages become more evident, a shift in buyers is anticipated.

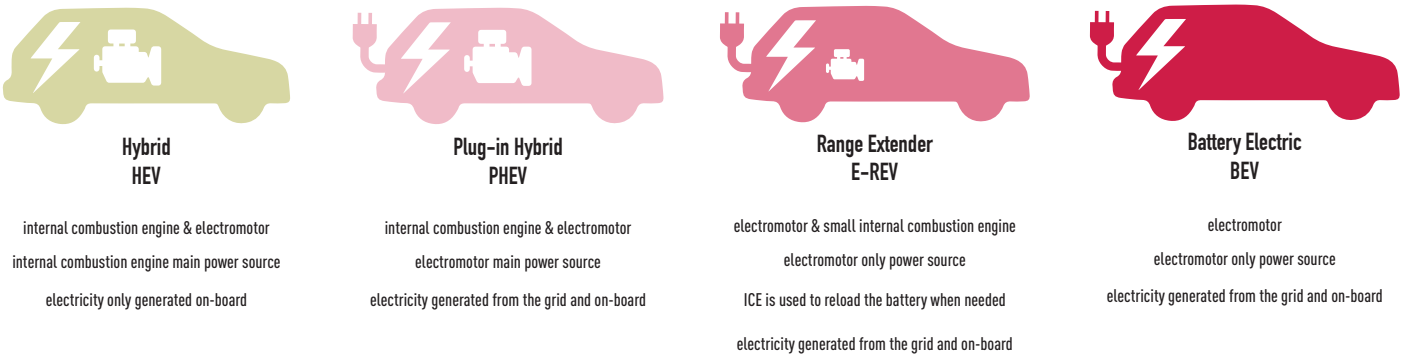


Figure 1: *different types of electric vehicles*

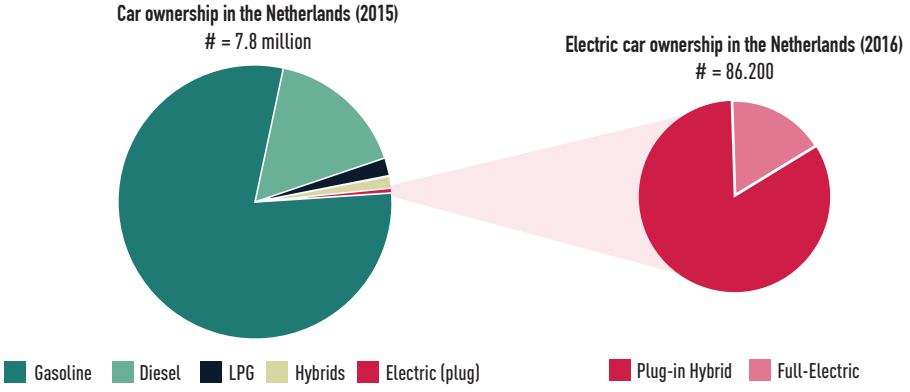


Figure 2: *car ownership in the Netherlands*

A2: COMPARISON OF ICE & EV

Verbeek et al, 2015

20%	engine efficiency	60%
250 g/km	emission (WTW)	70 g/km
600 - 1.000 km	driving range	70 - 300 km
10 minutes	refuel/recharge time	0,5-15 hrs
74 dB	noise	10 dB
€28.000	purchase price	€36.000
€8 - 12	costs per 100km	€3 - 7

A3: HISTORY OF ELECTRIC VEHICLES

In Figure 4, the timeline of electric vehicles since their invention is visualised. Through the years, the popularity of the electromotor has fluctuated significantly. At the beginning of the 20th century, the roads were a chaotic combination of carriages, gasoline cars, steam powered cars and electric cars. At that time, electric cars were most reliable, straightforward and easy to use. There was no infrastructure for long travels, so the driving range did not provide a problem. Steam powered cars had the disadvantage of a start-up time of 45 minutes. Gasoline cars had to be ignited, which could be dangerous. Gasoline cars were smelly and the engine backfired often. Thus, the electric car was sold most often, reaching a top in 1910 when 1/3rd of all cars was electric.

However, in that same period, three developments came together and led to the rise of the gasoline car. First, Henry Ford introduced the Model T Ford: an affordable, mass-produced gasoline car, which made cars accessible for the greater mass. Second, Charles Kettering invented the motor ignition system, eliminating one of the biggest drawbacks of the gasoline car. Third, since America was one of the largest oil producers in the world oil was cheap and widely available. It was distributed as water. Because the breakthrough innovations in batteries did not come, gasoline cars took a flight. The electric car went from the map.

When the energy crisis hit America in the 70's, the electric car got a small rebound. The energy crisis led to sky high fuel prices, queues for gas stations and rationing of the oil. It was then that Citicar was introduced, a small commuter car (see Figure 3). The car was quite popular for a while, but the limited range and original looks prevented it from being serious competition.

A new development came in the 90s, when smog pestered California. In order to reduce the smog issues, the state introduced a law that required automakers to sell electric vehicles as a percentage of their sales. In 2018, 4.5 percent of their sales should be "zero emission vehicles", rising to 22 percent in 2025 (UCS, 2016). This law forced manufacturers to invest in clean technology and led to a revival of the electric vehicles. GM Motors introduces the EV1, which was only available through a lease service. 800 models were leased through this construction (autofans.be, 2010). The Zero Emission Vehicle Programme endured enormous pressure. Car manufacturers and oil producers were lobbying for the law to be repelled since it was holding back their business. Eventually, they got their way. GM retrieved all their leased EV1 vehicles. Funnily enough, the EV1 owners did not want to lose their vehicle, but GM took them anyway.

In 1998, Toyota presented the Toyota Prius, the first hybrid car with similar capabilities to an ordinary car. The car was a great success. This proved a customer interest for an electric vehicle, as long as it had the same capabilities as a conventional car. This changed the overall opinion on electric cars and introduced a shift in the focus of innovation for many manufacturers. Hybrids became more commonly accepted.

Though the Prius was capable of most things a conventional car could do, it did compromise on performance, which most electric cars did. However, in 2008, Tesla proved this did not have to be this way. With the introduction of the Tesla Roadster, they proved that electric cars could be fast and powerful. This eliminated another important drawback of the electric car, paving the road towards an all-electric transport sector.

Figure 3*: the electric Citicar*

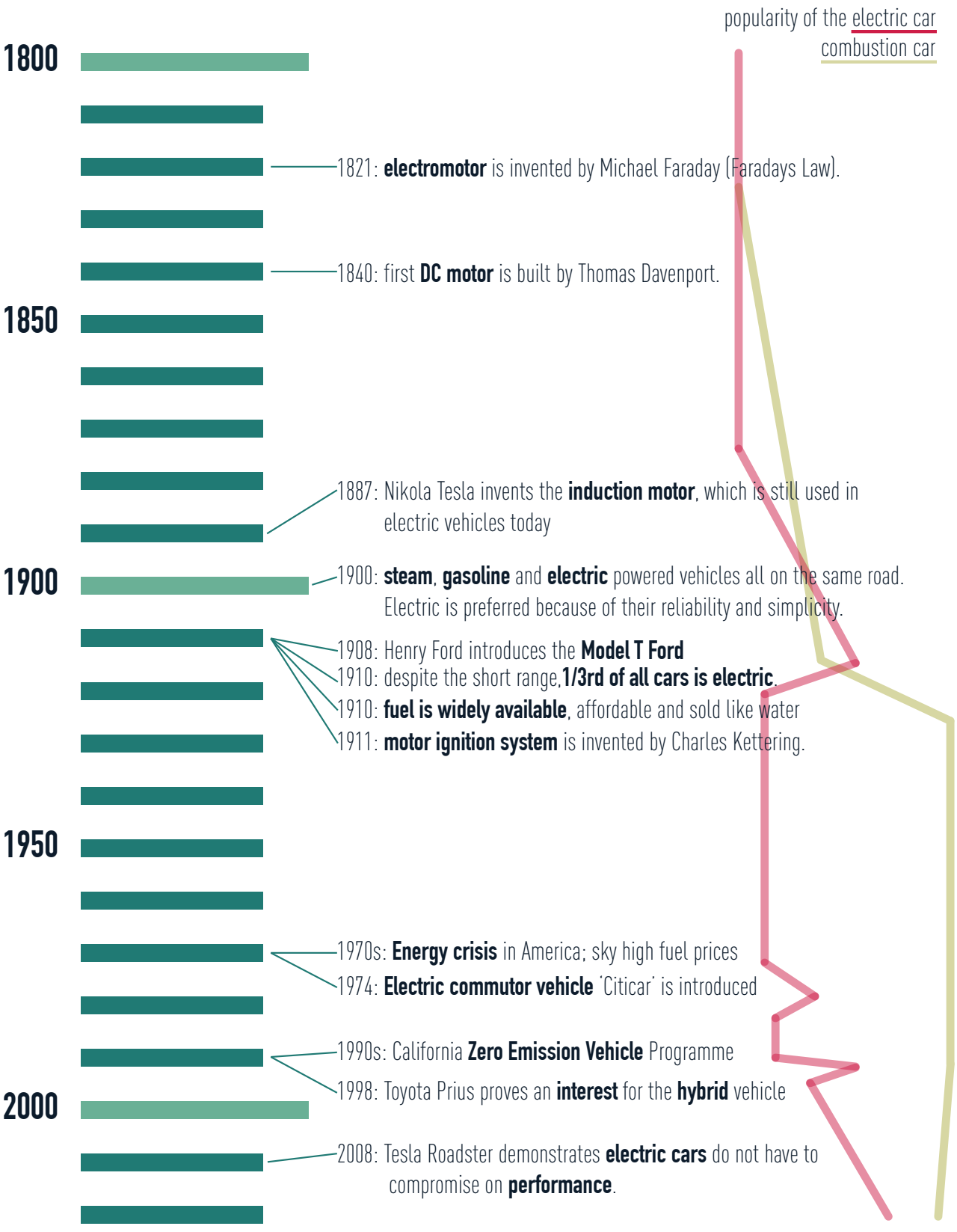


Figure 4: *history of the electric car*

A4: TECHNICAL DETAILS OF CHARGING

The time to charge is dependent on multiple factors, including the remaining energy in the battery, the power the source can deliver and the capacity of the battery. The power sources range from 2,3 kW to 42 kW, though not all cars are capable of charging at 42 kW. With the formula: E (power of the source in kWh) = P (battery capacity in kW) * t (time in hour), one can determine the theoretic time it will take for a car to be charged. In practice, this can deviate from theory because of temperature or losses. Also, the first 80% of the battery is known to charge relatively fast, while the last 20% goes slow. For example, the Tesla Supercharger needs 40 minutes to charge the first 80%, and another 35 minutes for the last 20% (Tesla, n.d.). This phenomena is known as ¨tapering¨.

The charging services offer more and more power, charging faster and faster. This leads to the question: what limits the charging time of a car? The answer is: the grid capacity and the car itself.

By placing multiple chargers parallel, chargers can reach extremely high power rates. However, the electricity grid present at that location can only deliver a certain amount of power per unit of time. The grid can be aggravated, but that is a costly investment that does not always pay off.

Another restriction is the car itself. Car batteries require direct current (DC), while the Dutch grid delivers alternating current (AC). To charge, a converter is necessary to convert the DC to AC. This converter has a power limit, which limits the charging speed. The higher the power limit, the heavier and bigger the converter becomes. Car manufacturers do not want to spend much space and weight on this converter. Thus, the power limit of most converters is 7,3 kW. This makes it impossible to charge AC current faster than 7,3 kW. A way to get around this, is to place the converter at the charging station, delivering DC directly to the battery. This allows for almost unlimited fast charging, a race in which most charging companies are now competing. However, this fast charging causes high temperatures in the wiring and is therefore destructive for the battery. Fast charging is seen as an exception to the regular charging and is therefore facilitated, though some car manufacturers put a power limit on the batteries charging speed to spare the cars' lifetime.

A5: COMPETITOR OVERVIEW

The main characteristics of the competitors are listed below. When the 'green/grey energy' column states N/A, this means that the provider connects the charging equipment to the energy supply already available. The energy contract of the consumer then determines the energy source.

Provider	Business	Market	#Chargers NL	Public/private	Charge speed	Green/grey energy
Eneco Elektrisch Laden	Energy	NL, GB, DE, FR, BE	3.000	Private & semi-pu	7,4 - 22 kW	Green
Mister Green	Lease bedrijf met snelladers	Netherlands	42	Public	42 kW	Green
EVnetNL	Electric car charging (general)	Netherlands	3.000	Public		
Allego	Electric car charging (general)	NL, BE, DE	3.000	Public & Private	11 - 42 kW	Green
Nuon	Energy	Netherlands	3.000	Public & Private	3,7 - 22 kW	Grey
EV Box / ENGIE	Energy	Worldwide	9.000	Public & Private	22 kW	N/A
NewMotion	Electric car charging (general)	Europe	2.500	Public & Private	22 kW	N/A
Alfen (ICU)	Energy operator for the physical network	Europe	850	Public & Private	3,7-22 kW	N/A
Ecotap	Electric vehicle charging (general)	NL, BE	600	Public & Private	3,7-50 kW	N/A
BlueCorner	Service provider e-mobility (advies, aanslui	NL, BE, DE	20	Public & Private	7,5-22 kW	N/A
Fastned	Electric car charging (fast)	Europe	150	Semi-Public	43 kW	Green
Tesla	Electric car manufacturer	Worldwide	42	Semi-Public	120 kW	Grey
			25204			

A6: DESCRIPTION OF DEVELOPMENTS

The aim of this project is to develop a product service system to implement the coming years. Because the world is currently changing, an overview of trends is necessary to get a picture of the future context. Today's developments shape consumers choices, behaviour and needs. This section therefore highlights the most important developments. In order to get a broad overview, technological, social, economic, political, demographic and environmental trends are considered. However, since politics (Egbue & Long, 2012; Sierzchula et al, 2014) and technology (Graham-Rowe et al, 2011; Lane & Potter, 2007; Ewing et al, 2016) have a significant influence on the adoption of the electric car, these areas received special attention.

Technology

Within the domain of technology, four innovation areas can be distinguished. Electric car innovation is mostly done by improving the battery and range. Furthermore, developments in charging structure are moving fast. The last large development is autonomous driving.

Battery

The interest for high-performance batteries is high and development is going fast. Next to the performance improvements, attention is payed to the end-of-life of the battery.

Performance
Batteries will become more energy-efficient. The energy-density is expected to double in the coming 10 years (Ernst&Young, 2012). Overall, the performance of batteries will grow with 4-6% per year (Ernst&Young, 2012).

Size and weight
Litium-ion accu's will get more light and more compact. Higher voltages will be possible through new, thinner materials for electrodes (Verbeek et al, 2015).

Magnesium-ion and metal-air batteries
While the lithium-ion battery will be the most used in the coming ten years, other techniques are expected to follow. Breakthroughs are expected in magnesium-ion or metal-air batteries (Verbeek et al, 2015).

Recycling
According to European guidelines, the batteries have to be recycled at their end-of-life. 50% of the lithium-ion battery has to be recycled. Four recycling companies are capable of recycling the batteries in Europe (Verbeek et al, 2015).

Repurpose
Even though recycling is recommended, this a cumbersome process. Lithium is too cheap to enable profitable recycling. Because of this, suggestions are done for the repurpose of the batteries. In this second life, the batteries can for example be used to store energy for houses (Verbeek et al, 2015).

Charging

Within charging, two developments are ongoing: innovation of the charging services and, simultaneously, the implementation of the charging network.

Wireless charging
In order to charge more conveniently without the use of a plug, multiple services for wireless charging exist (Plugless, n.d.). In order to charge, the vehicle has to be parked on top of a parking pad, while an adapter in the car leads the power to the battery. The technology is watched closely. Suggested opportunities are wireless charging at taxi-stands (Ernst & Young, 2012) and en-route charging for electric cars (Ernst & Young, 2012; Morris, 2017-a).

Switch battery
In 2013, BetterPlace and Tesla both experimented with a switch battery system. Instead of recharging, the empty battery was switched for a full one by an automated battery swapping station. This service came with a battery lease contract. Also in 2013, both withdrew their innovation. BetterPlace struggled to get car manufacturers to develop their cars complementary with the system (Chafkin, 2014). Tesla invited their consumers to try the new technology, but concluded there was not enough interest: the SuperChargers were sufficient (Korosec, 2015). Consequently, the technology is expected to be one of yesterday.

Lantern Pole charging
Since lantern poles are public and come with a grid connection,

many parties suggested them as interesting as a base for the charging infrastructure (Infineon, 2017). Already, companies provide equipment for lantern pole charging. However, since the grid connection of lantern poles provides low power, the promise of the technology is uncertain (Sietse Vis, personal communication, 15 March 2017).

Smart communication
Some parties anticipate on the combination of smart technology and charging infrastructure. Among the prophecies: automatic identification of the car and wireless payment (Ernst & Young, 2012).

Fast charging
Recharging times are an important consumer pain in the use of the electric car (Egbue & Long, 2012; Graham-Rowe et al, 2011; Sierzchula et al, 2014). Especially en-route, consumers do not want to spend time waiting for their car to be recharged. Therefore, fast-charging is an important area of innovation. Fast chargers are defined as chargers with a power of over 42 kW. Currently, chargers are developed with a power of 350 kW with a recharge time of ten minutes (Fastned, n.d.; Tesla, n.d.)). For the technical details of fast charging, see page 6.

Charging routes
Next to the innovation of the technique, the charging infrastructure is being implemented. Umbrella parties lobby for a widespread network of moderate chargers in combination with carefully placed fast-chargers (Ernst & Young, 2013). The fast chargers are expected to be mainly used for en route charging. The fast charging providers collaborate to create 'charging routes', which can be used for long-distance travel (Tesla, n.d.; Morris, 2017-b).

Rewarding off-peak charging
A new programme of the energy company Con Edison in America introduces rewards for off-peak charging. All EV owners that charge in the Con Edison service territory can join the programme. With off peak charging, they save for gift cards. The test is meant to measure the impact on the grid (Morris, 2017-c).

Range
Since range remains a bottleneck for the electric car, car manufacturers come up with clever ideas to extend the range with a couple of kilometres.

Temperature regulation for battery
The range of electric car is known to fluctuate significantly with temperatures. Cold weather can double the energy consumption of the car, thereby reducing the range with 50% (Verbeek et al, 2015). Therefore, among others, Tesla uses temperature regulation for the battery. The battery is kept at the ideal temperature to maximize the range (Tesla Motors Club, 2015).

Set car climate before trip
Another method to solve the fluctuation due to outside temperatures, is developed by Nissan and REVA (Boxwell, 2011). They allow their car owners to choose the car climate before their trip, while the car is still connected to the grid. The energy from the grid can be used to pre-heat (or pre-cool) the car, without affecting the state of the battery.

Autonomous driving
The last technology trends concerning cars are developments in autonomous driving.

Autonomous driving expected between 2020 and 2025
With lane control, park assist and cruise control, consumers were eased into the idea of self-driving cars. Currently, multiple car manufacturers claim that the technology is ready for the streets (Mercedez-Benz, n.d.; Fehrenbach, 2016). What is holding the technology back now, is regulation and policy. The first self-driving cars are expected on the roads between 2020 and 2025 (Cuijpers et al, 2016).

Autonomous driving reduces needed amount of charging stations
With autonomous driving, the use of cars is expected to become more efficient (Cuijpers et al, 2016). The expectation is that in the long run and in combination with car sharing, half the amount of cars is necessary. Therefore, the needed amount of charging stations is also predicted to stagnate (Cuijpers et al, 2016).

Social

The social trends are developments in human behaviour, for example an increasing popularity of a specific product or activity. The social trends now concern multiple new technologies and preferences for electric cars.

Car use, not ownership
The last couple of years, an increasing amount of people make a shift from car ownership to car use (Rabobank, 2016-a). Services like GreenWheels, Amber Mobility and Car2Go make car use very accessible, decreasing the need for car ownership. A (negative?) side effect of the same trend is the use of those services by

consumers who used to go by public transport.

Total-package EV sales
When solar panels became available for the wider public and it was stimulated with funding from the government, this resulted in a rise of the collaboration business models. The consumer wanted the solar panels in the full package of hardware, measuring devices and installation. The industry collaborated to provide those packages. The same shift is expected for charging equipment for electric vehicles: the consumer will want a complete package, preferably offered at the car sale (Ernst&Young, 2012).

EV as service vehicle
In the years before the expected adoption of electric vehicles by consumers, most electric vehicles could be found in niche markets. For example, delivering services for food or packages used electric scooters or vans; city guards or police vehicles too, often make use of electric vehicles (Cuijpers et al, 2016).

E-Bike
The electric bike is increasingly popular. Elderly buy the bike to be able to cycle longer independently, while other buyers use the bike to cycle longer distances. With the ordinary bike, distances up to 15 kilometres were acceptable for commuting (Nu.nl, 2014). The electric bike extends this range up to 25 kilometres.

Connected living
'Smart' products are increasingly popular. These products are connected to the internet and can be used to communicate wireless amongst each other. This way, your phone could be used to switch lights on and off, or as a remote control for the TV. These smart products are found more and more in the house, leading to 'connected living' (Singh, 2014).

Digital experience through VR
Virtual reality is a technology of which the possibilities become more evident, and meanwhile, the popularity increases (TrendWatching, 2016). VR can support multi-dimensional experiences, creating realistic mock-ups of buildings yet to be built or a time travel to the past. The technology is now used for an increasing amount of applications, including museums, gaming and education.

Innovating to zero
This trend is a combination of the increasingly complex world and sustainability. Innovating to Zero refers to both aiming for carbon neutral, and to simplifying lives. On one hand, innovating to zero means reaching a carbon neutral, self-sustaining world: driving cars with zero emission and running a hotel which is carbon neutral. On the other hand, innovating to zero refers to simplification. Organisations have introduced strategies with "zero email", while Marie Kondo introduced a strategy to get rid of all the stuff that "does not spark joy" (Singh, 2014).

Economic

Economic developments have a great impact on the purchase of products. Economic numbers also give an indication of the attractiveness of markets. The economic trends below give an overview of attractive markets, market movements and purchasing power.

Increasing electric car sales
Since 2010, the electric car sales are growing. Cuijpers et al (2016) predict that in 2020, 133.000 to 327.000 EVs will have reached the market. This includes BEVs and PHEVs. Other predictions are even more optimistic, but the direction of the market is clear: up.

Private lease growth
The Dutch market is one of the only markets worldwide with a great interest for lease cars. The lease contract allows consumers to use the car for multiple years for a fixed rate per month. At the end of the contract, the car is returned and handed over to the second hand market. This is attractive for companies, but the 'private lease' category is becoming increasingly popular too (Rabobank, 2016-b).

Battery price
The battery price is an important factor in the price of the electric vehicle. Now the batteries have gained the interest of multiple car companies and the world is waiting for an innovation breakthrough, the prices are dropping rapidly. In 2012, Ernst & Young predicted a price drop from 600 dollar per kW in 2012 to 200 dollar in 2020 and 160 dollar in 2025. However, this prediction was even too modest: the price has dropped to 200 dollar in 2016 already (Cuijpers et al, 2016).

EV price
The dropping battery price has positive consequences for the overall EV price. Now, the purchase price of EV's is about 1/3rd higher than the price of a conventional car. Though, with the battery price falling at this rate, the price of an EV is expected to reach the level of a conventional car in 2025 (Verbeek et al, 2015).

Purchasing power
After the economic crises since 2008, the economy has now

carefully recovered. The average wage of the Dutch citizen will grow with 1,7% on average (Nibud, 2017).

Car sales
Even though the sales of electric cars are rising, the overall new car sales show a declining trend (Rabobank, 2016-a).

Consumer looks at price per km
The consumer is increasingly price-conscious when it comes to mobility. Instead of only looking at the total costs of ownership, the consumer pays attention to the price per kilometre too (Rabobank, 2016-a).

Politics

Sustainable initiatives that require an investment are highly dependent on government incentives to increase consumer adoption. Therefore, it is important to understand the opinion of the technology in the politics.

Free charging (Norway)
Countries are looking at each other when it comes to electric vehicles. Who does what to stimulate the use, and what is the effect? Norway, for example, has nationwide free charging for electric vehicles. This does lower the threshold, though the infrastructure is not very reliable (Jolly, 2015).

Standardised charging infrastructure (EU)
In an advisory piece for the implementation of the charging network, the European Union pledges for standardised charging equipment all over Europe (Europa Nu, 2010).

Funds for collaboration (EU)
To support the implementation of electric vehicles and the infrastructure, the European Commission will make €24.2 million available for collaboration initiatives (European Commission, n.d.).

Focus on additional research (EU)
The same European Commission indicates that the electrification of transport is a priority in the research programme (European Commission, n.d.).

Motion for EV-only market from 2025 (Netherlands)
In March 2016, D66, GroenLinks, PvdA, ChristenUnie, Klein and PvdD proposed a motion to only sell cars without emission in the Netherlands from 2025 onwards. The motion was declined, but it does indicate a substantial interest (and partly support) from the government for electric vehicles (Overheid.nl, 2016).

Tax advantages till 2020 (Netherlands)
In the new regulation for car taxes between 2017 and 2020, the advantages for electric vehicles remain until 2020. Battery electric vehicles are free of BPM and MRB taxes and have a reduced tax liability. The advantages for plug-in hybrids are reduced; the tax liability is the same as conventional cars, but the MRB is halved (Rijksoverheid, 2015).

Subsidies for collaborate innovation (Netherlands)
In official documents informing the government about the policy concerning electric vehicles (Greendeals), measures to stimulate collaborate innovation are presented. The Nederlands Kennisplatform Laadinfrastructuur is initiated by the government to stimulate knowledge sharing and collaboration for different parties. Subsidies are available for collaborate innovation (Kamp, 2016-a; Kamp, 2016-b).

City centre bans for polluting vehicles
An increasing amount of cities ban polluting vehicles from their city centres. Following Utrecht, that banned dieselcars older than 8 years (Nu.nl, 2012), Rotterdam considered doing the same (Autoblog.nl, 2015). Again, these trends confirm the reducing popularity of polluting cars.

Demographic

Shifts in population numbers and migration movements shape the future in the long run. These shift might also have consequences for electric cars.

Aging population
Until 2040, the aging population will remain an important topic in the Netherlands. The amount of people aged above 65 is growing and the working population declines. This trend means retirement is under pressure; the age as well as the income of the retired. It also requires extra investments in healthcare (CBS, n.d.).

Urbanisation
In the last couple of years, the urbanisation trend is revived. Cities and their suburbs are increasingly popular, while the interest in rural areas declines (CBS, 2016).

Sustainability in product purchase
An increasing amount of consumers considers the environmental impact when purchasing products. Previously, this consideration

was only made by 30% of the consumers, which has increased to 42% in 2014. However, consumers are sceptic about the claims on packaging like 'sustainable' or 'societal responsible' (MVO Nederland, 2014).

Consumer is ignorant about sustainability
Even though the consumer wants to behave increasingly sustainable, they are often in the dark on what is truly sustainable (Hensley et al, 2011; Lane & Potter, 2007; MVO Nederland, 2014).

Amount of single households is increasing
The amount of single households is rising rapidly. This growth is predicted to last until 2040 and is mainly caused by a higher amount of elderly living alone (CBS, 2015).

Environmental

Sustainability has been a hot topic in the last decades. Electric cars themselves are a good example. In relation to electric cars, the following trends are considered relevant.

Car as a battery for the house
Vehicle to grid is a frequently discussed topic in literature and media (Economic Board Utrecht, 2014; Sortomme & El-Sharkawi, 2011; van Vliet et al, 2010). This refers to the technology that enables communication between car and charging infrastructure, as well as back feeding to the grid. This way, the car can be used to store superfluous energy from renewable sources during the day, while back feeding this to the grid at a demand peak. This can help to balance peak hours, and, further along the line, as mass storage for renewable energy.

Energy transition
The vehicle to grid discussion is part of a larger revolution, the energy transition. Overall, there is an agreement on the fact that a transition to renewable energy is needed. This is a gradual, slow process which will result in renewable energy being produced more locally and at a less stable (reliable) rate. The discussion on this topic should give answers to the who, what and how of this new distribution network. For example, it requires investments in energy storage innovation. It is probable that the conventional energy organisation will be unsustainable (ECN, 2016; PBL, 2015).

Electric busses on solar energy
The Dutch island 'Ameland' has a very innovative mode of transport. Their busses drive on solar energy, charged by fast chargers. The aim is to equip the chargers and busses with smart technology, to allow back feeding when the sun has set (De Kennis Van Nu, 2017).

Increasing amount of solar panels
ECN (2016) reports an increasing amount of solar panels on rooftops. The growth remains focussed on households with control over their own roof, but there is an increasing interest for solar panels on rental houses as well (ECN, 2016)

42% green energy delivered
Since 2006, the green energy segment has grown steadily. In 2015, 42% of the energy was green from renewable sources. This energy is mostly imported from countries with waterpower resources (ECN, 2016).

Car is the second largest energy consumer
When it comes to energy, the boiler (taking care of the heating and water; 44,5 GJ) and car (34,9 GJ) consume 75% of the total use in a household. The gap with number three is large: household lighting consumers 3,5 GJ (ECN, 2016).

Less energy and gas consumption
As a result of better insulation and more efficient appliances, the overall gas consumption and energy use declines (ECN, 2016).

Heat pumps increasingly popular
Sustainability often starts with electrification. An example of this is the growing amount of heat pumps (a growth of 30% per year) (ECN, 2016). This makes sense, because electricity can be produced from renewable sources, whereas petrol and gas are per definition fossil fuels. However, to make these appliances truly sustainable, a growing amount of renewable energy is required.

5,6% of renewable energy generated
According to the Energieakkoord, 14% of the energy should be renewable in 2020. Currently, 5,6% of the generated energy is from renewable sources, especially from wind turbines. Currently, the Netherlands have 3 turbine parks at sea, with more parks planned (ECN, 2016).

Conclusion

Current developments shape the future context and are thus important to consider. However, not all trends have significant influence on Eneco's business. Some provide opportunities, others threats; some should be acted upon, whereas others can be happily ignored. This paragraph strives to make sense out of the developments.

Eneco Elektrisch Laden wants a product-service system to implement in the coming one or two years. Because of this, a lot of the developments mentioned above will not be fully evolved yet. For Eneco Elektrisch Laden, the product-service system should be developed for the present context, while prepared for the developments to come.

The developments in batteries and range are of minor importance for Eneco Elektrisch Laden, since it is out of their business. The main factor to take into account is the growing battery capacity, which will lead to longer charging times if it is not compensated by higher power outlets.

The charging developments however, are important to consider. Fast chargers are now mainly placed along motorways (Tesla, n.d.; Morris, 2017-b), but as it gets familiar to consumers, it might be something they desire for home use as well. Furthermore, the wireless communication between car and charging station may impact heavily on the product portfolio. It is a serious opportunity to provide additional services to the consumer, while it changes the requirements for the hardware. Eneco Elektrisch Laden can explore the possibilities with this technology. Wireless charging, too, provides an opportunity to make the lives of car owners easier.

Wireless communication and smart technologies occur in multiple trends (Singh, 2014; Ernst & Young, 2012), which emphasizes the opportunity. It is raised as a promising innovation to make car identification and payment easier (Ernst & Young, 2012). It is also an obvious innovation in combination with autonomous driving (Mercedez-Benz, n.d.; Fehrenbach, 2016). Especially in the long run, cars will do an increasing amount of tasks themselves; the management of their charging schedule, in combination with wireless charging, might as well be among the first. This is also confirmed by the trends 'connected living' (Singh, 2014) and the energy transition (ECN, 2016). Lastly, the interest in two-way vehicle-grid communication is evident (Economic Board Utrecht, 2014; Sortomme & El-Sharkawi, 2011; van Vliet et al, 2010).

Autonomous driving will impact on the use of the car in general. In the long run, this will change the way consumers see transport. Cars might be viewed as a taxi-service which you can call upon whenever you wish: available to anyone yet owned by no-one. Since the cars do most of the work themselves, consumers will expect them to be completely self-regulatory. It would be a misfit if the car can drive up to my house by itself, bring me to wherever I want to be and be off for a new consumer, while still being dependent on someone plugging it in. This future horizon is still far away, but probable. It is an example of something that might not directly influence the product-service system, but it has to be ready for it nevertheless.

The introduction of solar panels led to an increasing amount of collaborations that offered 'package deals' (Ernst&Young, 2012). Consumers like to have all necessary maintenance, services and equipment that is required for an electric car in one package deal. Consumers are served well by a full EV-package, complete with charging equipment, charging card, installation and additional services. As Eneco Elektrisch Laden already does, it is sensible to search for collaboration with complementary services, to offer the consumer a seamless experience. Also, connected living is an important trend, with a future perspective of a 'smart house' that can be programmed to different setting with everything that requires energy. This, too, requires the charging equipment to be installed 'smart' and allow for communication. The social trends also offer multiple markets to keep an eye on. The service vehicles, e-bikes and car sharing services are opportunities for Eneco to extend their consumer database.

The economy shows positive developments for the electric car. The dropping EV and battery price are beneficial for the EV market, confirmed by the increase in sales. This validates that the EV market is a promising one and Eneco Elektrisch Laden is clever to be part of it. Furthermore, the trends show where the next EV driver can be found: the private lease and second hand market indicate a new group of consumers with a car to be charged.

The political climate, too, shows the widespread interest for the EV. The amount of research requests to explore the impact of the technology shows that EV's are considered promising. On top of this, both the Dutch and the EU government have funding to stimulate collaboration and innovation in this field, and regulation is introduced to limit pollution from vehicles. EV sales are stimulated with multiple tax advantages, that will remain until at least 2020.

The demographic trends show a growing interest for sustainability.

Furthermore, the urbanisation might increase the desire for clean cars in the city centre and reduce the need for long-distance travel; both positively impacting the electric car. The ignorance about sustainability underlines the importance to educate and inform the consumer about sustainability and the environmental impact of electric cars.

The energy transition provides opportunities for vehicle to grid technology and emphasises the need to explore communication between car and charging equipment. The developments show that sustainability often starts with electrification: lawn mowers, cars and boilers are all exchanged for electric ones. This makes sense, since electricity can be generated in a renewable way, but it also shows a need for more renewable energy in order to be completely sustainable.

In summary, Eneco seems to have chosen well by investing in electric mobility. The economic and political climate both show positive developments that will support the adoption of the electric car. Overall, the developments will mostly impact the charging services by requiring faster charging and smart communication. Eneco Elektrisch Laden may search for other collaboration partners to provide package sales to consumers. Lastly, since environmental impact is one of the main benefits of the electric car, Eneco does well by investing in renewable energy to reduce this impact even more.

A7: PARTICIPANT DETAILS

Participant overview

Eleven participants were recruited for the research. The details of the participants are given in the table below.

#	Gender	Age	Household situation	Driving/Interested	Car Type	Charging station
1	male	30	DINKY	Interested (5)		
2	male	31	DINKY	Driving	BEV - BMW i3	Public
3	male	31	Family	Interested (4)		
4	male	34	DINKY	Interested (7)	BEV - Tesla model S	
5	male	34	Family	Driving	PHEV - BMW 225XE	Public
6	male	42	Family	Interested (5)		
7	male	42	Family	Interested (6)		
8	female	46	Single	Driving	BEV - Renault Kangoo	Public& Private
9	male	53	Empty nester	Interested (7)	BEV - Opel Ampera	
10	male	59	Empty nester	Driving	BEV - Mercedes Benz	Private
11	male	59	Empty nester	Interested (4)		

Definition of household

The research distinguishes three household categories: Dinky's, Families and Empty nesters. Here, a definition of the categories is given.

Dinky's

The term 'D.I.N.K.-y' refers to 'Double Income No Kids'. Households with this composition are young (often between 25-35) couples that both have a full-time job. Because of this status, DINKY's are often expected to have a lot of money to spend.

Families

In this research, 'Family' refers to households with one or more kids aged three or older.

Empty nester

The term 'empty nest' refers to the household where children have just moved out. After years of being a family, parents have the room to take decisions without strong consideration of their children. 'Empty nesters' are often 50-plus and still make an income. In this research, empty nesters had the maximum age of 65.

A8: TOPIC GUIDES (ENGLISH)

Interview guide EV drivers

Introduction 5 minutes

- Introduction of interviewer: name, background, main mode of transport
- Introduction of interviewee: name, background, main mode of transport
- Introduction of interview: graduation, background, purpose
- Explain how results will be used; ask recording permission

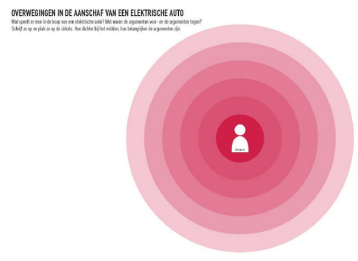
Modes of transport 5 minutes

1. Could you tell a little more about how you get around?
2. Which mode of transport do you prefer?
3. Is the car important in your transportation?

Pro's and cons of electric driving 10 minutes

4. What is the most important reason for you to own a car?
5. Where do you get a car? (second hand, new, lease)
6. What were your considerations in the purchase of an electric car?

Importance circles



7. What do you think of these considerations in retrospect?
8. How is your electric car experience different than a combustion car? (driving, parking, long distance travel, maintenance) What is better, what is a drawback?

Use of the car 5 minutes

9. What do you use your car for?
10. What characterises these trips? Long/far, spontaneous/ planned, who goes with
11. Where do you park/leave your car at that moment?

Experiences with charging 15 minutes

12. How do you charge your car most often?
13. What is your opinion about the ways of charging?
14. Could you tell me about your charge provider?
15. What services do you expect from a charge provider?
16. Are there charging apps you use?
17. What do you think of the current charging infrastructure?

Future of charging 15 minutes

18. In five years, the charging infrastructure has developed and been designed all around your needs.
19. How would you expect to charge your car by then?
20. How would the timeline change? (post its)
21. What do you have to do as a user?
22. What do you have when you drive away?
23. Do you have anything else you would like to mention on electric cars or charging?

Closing off 5 minutes

- Thank you for your participation
- Questions?
- Next steps
- Contact details for further questions

Interview potential EV drivers

Introduction 5 minutes

- Introduction of interviewer: name, background, main mode of transport
- Introduction of interviewee: name, background, main mode of transport
- Introduction of interview: graduation, background, purpose
- Explain how results will be used; ask recording permission

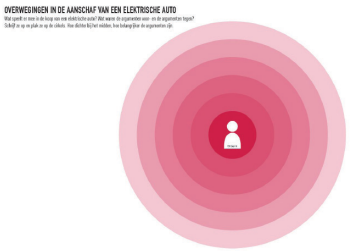
Modes of transport 5 minutes

1. Could you tell a little more about how you get around?
2. Which mode of transport do you prefer?
3. Is the car important in your transportation?

Pro's and cons of electric driving 10 minutes

4. What is the most important reason for you to own a car?
5. Where do you get a car? (second hand, new, lease)
6. What are your considerations in the purchase of an electric car?

Importance circles



7. What should change to make you buy an electric car?

Use of the car 5 minutes

8. What do you use your car for?
9. What characterises these trips? Long/far, spontaneous/ planned, who goes with
10. Where do you park/leave your car at that moment?
11. Do you think your use of the car would change with an electric car?

Experiences with car charging 15 minutes

12. How do you expect to charge a car?
13. How do you feel about that?
14. What would you think is important for you in car charging?
15. How would you choose a charging provider, if you had a car now?
16. What services should the charging provider offer?
17. What do you think of the current charging infrastructure?

Future of charging 15 minutes

18. In five years, the charging infrastructure has developed and been designed all around your needs.
19. How would you like to charge your car by then?
20. What do you have to do as a user?
21. What do you have when you drive away?
22. Do you have anything else you would like to mention on electric cars or charging?

Closing off 5 minutes

- Thank you for your participation
- Questions?
- Next steps
- Contact details for further questions

A9: TOPIC GUIDES (DUTCH)

Interview elektrische rijders

Mee:
- Topic guide
- Stimuli cirkels
- Post-its / rondjes
- Stimuli tijdlijn
- Klok
- Recorder (opgeladen)
- Bedankje

Doen
- Telefoon internet uit
- Spraakrecorder klaarzetten

Introductie 5 minuten

- Introductie van het interview: afstudeeropdracht, doel
- Uitleggen hoe de resultaten gebruikt worden; toestemming om op te nemen
- Introductie van interviewer: naam, achtergrond, belangrijkste transportmiddel
- Introductie van geïnterviewde: naam, achtergrond, belangrijkste transportmiddel

Transport algemeen 5 minuten

1. Hoe komt u meestal van A naar B?
2. Is de auto een belangrijk vervoersmiddel voor u?
3. Waarom heeft u een auto?

Autogebruik 5 minuten

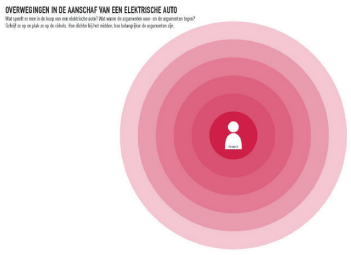
4. Waar gebruikt u de auto voor?
5. Wat karakteriseert deze ritten? (afstand, spontaan of gepland, wie gaat er mee)

Overwegingen elektrisch rijden 10 minuten

6. Wat waren uw overwegingen in de aanschaf van een elektrische auto?

Indien ze het niet zelf noemen:
financieel (kostenoverwegingen), milieu (impact op het klimaat), sociaal (overwegingen voor wat andere mensen denken), gebruiksgemak (zodat hij past in jouw manier van leven), technisch (eigenschappen m.b.t. de technische eigenschappen van de auto)

Importance circles
7. Hoe denkt u nu over deze overwegingen?



8. Is uw autogebruik veranderd met een elektrische auto?
9. Hoe bevalt de elektrische auto in vergelijking met de benzineauto? (rijden, parkeren, lange afstanden, onderhoud)

Ervaringen met laden 15 minuten

10. Hoe laadt u de auto meestal op?
11. Is uw parkeergedrag veranderd met een elektrische auto?
12. Welke service verwacht u rondom laden?
13. *Indien ze hulp nodig hebben:*
14. U kunt denken aan financiele services, milieu services, sociale services, gebruiksgemak vergroten, technische services, informatie
15. Zijn er apps die u gebruikt voor het laden van de auto?
16. Hoe denkt u over de laadinfrastructuur op dit moment?

Toekomst van het laden 15 minuten

17. Over vijf jaar, de laadinfrastructuur is verder ontwikkeld naar

uw behoeften.
18. Hoe zou u verwachten uw auto te laden op dat moment?
19. Hoe zou de tijdlijn veranderen? (post its)
20. Wat moet je doen als gebruiker?
21. Wat heb je als je wegrijdt?
22. Is er nog iets anders dat u kwijt wilt?

Persoonlijke gegevens

23. Hoe/waar koopt u meestal een auto?
24. Wat is de samenstelling van uw huishouden?
25. Wat is uw leeftijd?
26. Welk type auto rijdt u?
27. Heeft u een eigen laadpaal of laadt u publiek?

Afsluiting 5 minuten

- Bedankt voor uw deelneming
- Vervolgstappen
- Weet u nog iemand die ook overweegt over te stappen?
- Vragen?
- Contactgegevens voor vragen

Interview potentiele elektrische rijders

Mee:
- Topic guide
- Stimuli cirkels
- Post-its / rondjes
- Klok
- Recorder (opgeladen)
- Bedankje

Doen
- Telefoon internet uit
- Spraakrecorder klaarzetten

Introductie 5 minuten

- Introductie van het interview: afstudeeropdracht, doel
- Uitleggen hoe de resultaten gebruikt worden; toestemming om op te nemen
- Introductie van interviewer: naam, achtergrond, belangrijkste transportmiddel
- Introductie van geïnterviewde: naam, achtergrond, belangrijkste transportmiddel

Transport algemeen 5 minuten

1. Hoe komt u meestal van A naar B?
2. Is de auto een belangrijk vervoersmiddel voor u?
3. Waarom heeft u een auto?

Autogebruik 5 minuten

4. Waar gebruikt u de auto voor?
5. Wat karakteriseert deze ritten? (afstand, spontaan of gepland, wie gaat er mee)
6. Denkt u dat u de auto anders gaat gebruiken als u elektrisch rijdt?

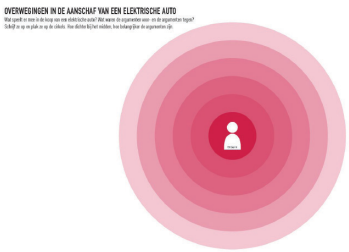
Overwegingen elektrisch rijden 10 minuten

7. Wat zijn uw overwegingen in de aanschaf van een elektrische auto?

Indien ze het niet zelf noemen:
financieel (kostenoverwegingen), milieu (impact op het klimaat),

sociaal (overwegingen voor wat andere mensen denken), gebruiksgemak (zodat hij past in jouw manier van leven), technisch (eigenschappen m.b.t. de technische eigenschappen van de auto)

Importance circles



8. Wat moet er veranderen voor u om een elektrische auto te gaan rijden?

Verwachtingen van laden 15 minuten

9. Hoe verwacht u de auto op te laden?
10. Wat vindt u belangrijk in het opladen van de auto?
11. Welke service verwacht u rondom het laden?
12. *Indien ze hulp nodig hebben:*
13. U kunt denken aan financiele services, milieu services, sociale services, gebruiksgemak vergroten, technische services, informatie
14. Hoe zou u een laaddienstverlener kiezen?
15. Hoe denkt u over de laadinfrastructuur op dit moment?

Toekomst van het laden 15 minuten

16. Over vijf jaar, de laadinfrastructuur is verder ontwikkeld naar uw behoeften.
17. Hoe zou u verwachten uw auto te laden op dat moment?
18. Wat moet je doen als gebruiker?
19. Wat heb je als je wegrijdt?
20. Is er nog iets anders dat u kwijt wilt?

Persoonlijke gegevens

21. Hoe groot is uw interesse in een elektrische auto?
    1: het is een mogelijkheid ergens in de toekomst
    7: ik ga er één kopen / heb er al één gekocht
22. Hoe/waar koopt u meestal een auto?
23. Wat is de samenstelling van uw huishouden?
24. Wat is uw leeftijd?

Afsluiting 5 minuten

- Bedankt voor uw deelneming
- Vervolgstappen
- Weet u nog iemand die ook overweegt over te stappen?
- Vragen?
- Contactgegevens voor vragen

A10: CONSENT FORM

Toestemmingsverklaring

Onderzoek: Onderzoek naar ervaringen met laadinfrastructuur van elektrische rijders

Onderzoeker: Student TU Delft Faculteit Industrieel Ontwerpen, Master Strategic Product Design:
Maaike Boot

Project: Afstudeerproject 'Facilitating the next market for electric vehicles: increase adoption with user centered charge services' voor Eneco

Begeleiding: Sietse Vis (Eneco), Pascalle Govers en Lise Magnier (TU Delft)

Contact: +316 34 98 35 38
M.A.Boot@student.tudelft.nl

Om met nieuwe services de klanten van dienst te kunnen blijven, wil Eneco graag inzicht krijgen in de behoeften van consumenten. Dit onderzoek heeft als doel kansen voor product- en serviceontwikkeling boven te halen die voortkomen uit de huidige verwachtingen van en ervaringen met de laadinfrastructuur.

Omdat Eneco graag inzicht wil krijgen in de wensen van specifieke gebruikersgroepen, zullen uw leeftijd, geslacht en gezinssituatie worden vastgelegd. Deze informatie zal anoniem worden verwerkt en nooit in verbinding met uw naam worden vrijgegeven. Al uw persoonlijke informatie zal na de onderzoeksperiode worden verwijderd en zal in geen geval worden doorgestuurd naar derden. Wel zullen de anonieme inzichten uit het onderzoek worden gepresenteerd tijdens project presentaties aan de TU Delft of bij Eneco, onderwerp gerelateerde conferenties of in publicaties.

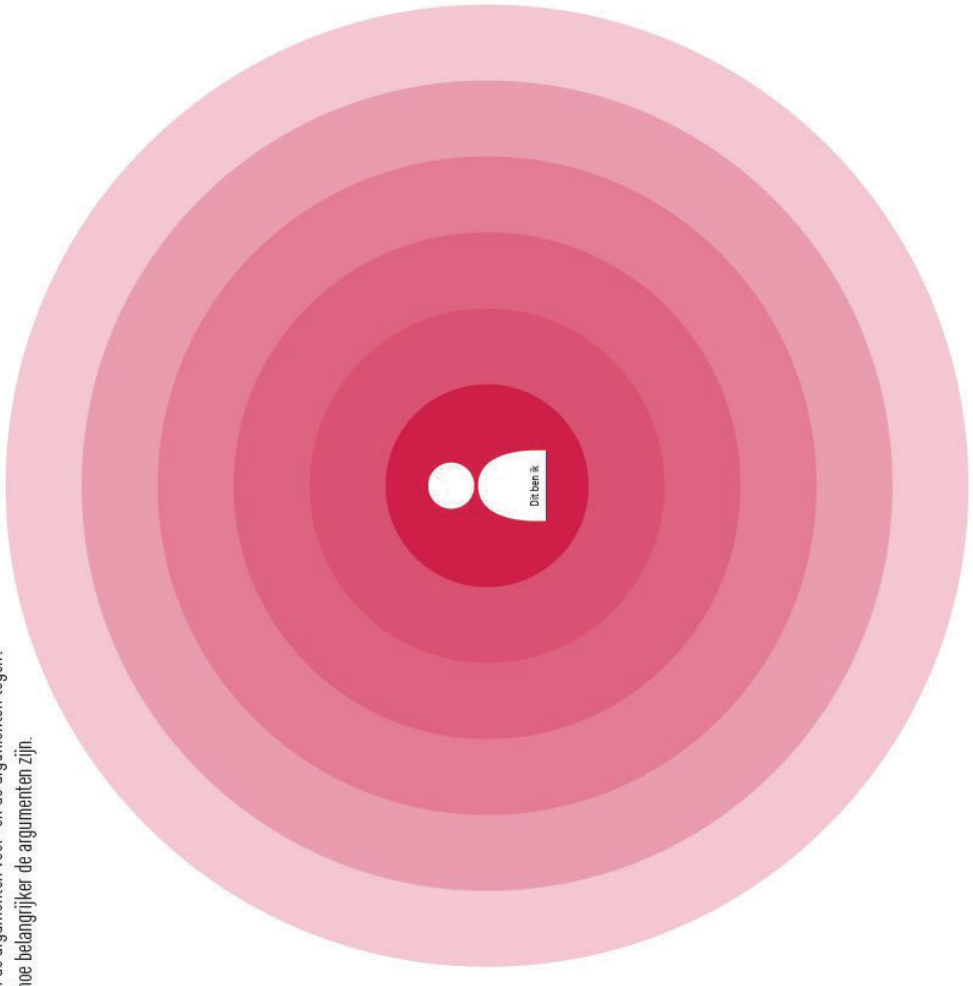
De deelname aan het onderzoek duurt naar verwachting 60 minuten. Er worden geen risico's of ongemakken als resultaat van het onderzoek verwacht. Deelname is vrijwillig en kan op elk ogenblik, voor, tijdens of na het interview, ingetrokken worden. Met uw toestemming zou de onderzoeker het interview op willen nemen als naslagwerk. U heeft de mogelijkheid om op elk moment vragen te stellen of het onderzoek stil te zetten, zonder dat dit enige gevolgen voor u zal hebben.

Als u vragen heeft over het onderzoek en uw rechten of als u als gevolg van het onderzoek schade hebt opgelopen, dan kunt u contact opnemen met Maaike Boot (zie bovenstaande contactgegevens).

Graag hieronder ondertekenen als de informatie begrijpelijk is en u toestemming geeft:

Naam Datum Handtekening

A11: STIMULUS



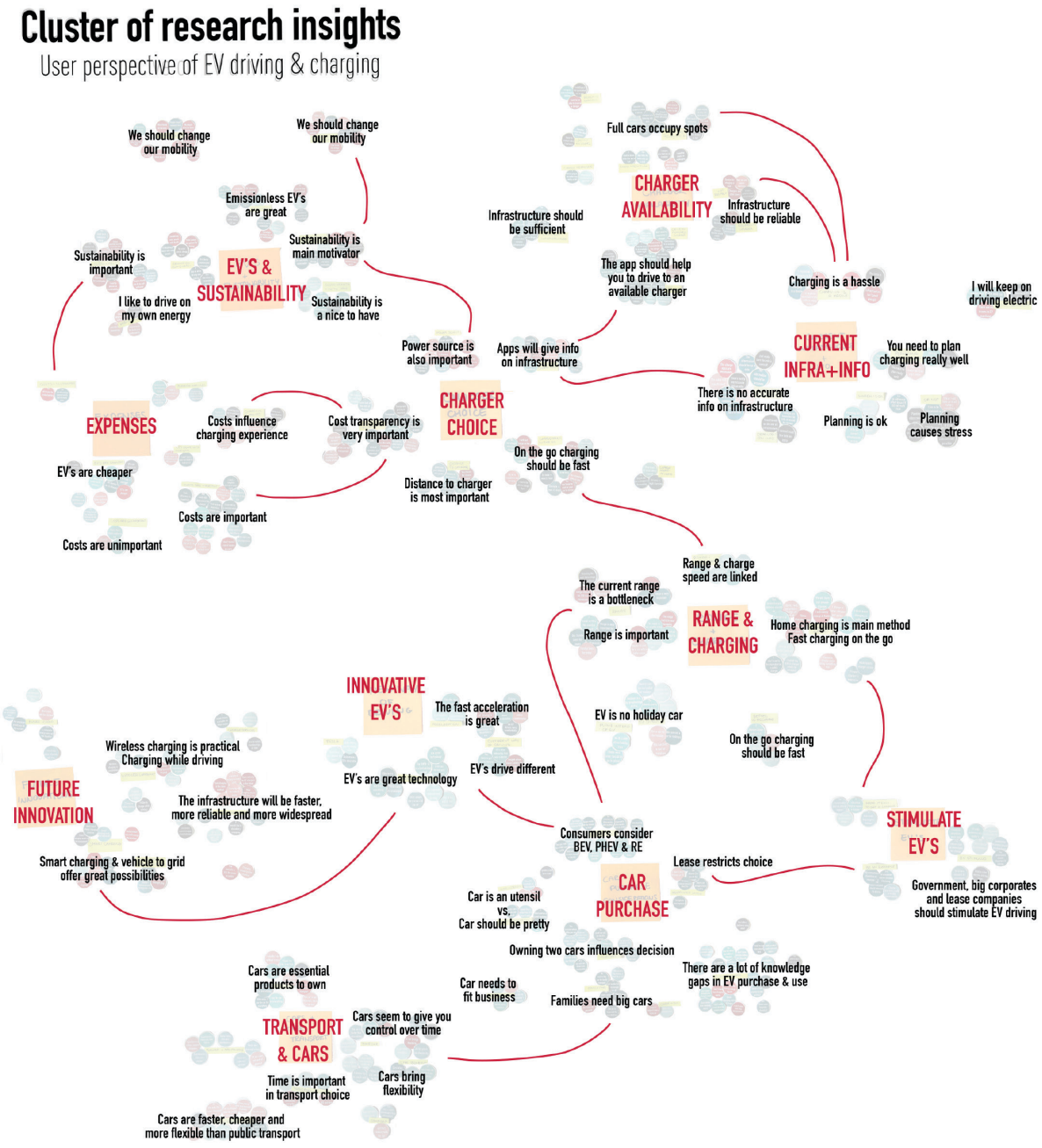
OVERWEGINGEN IN DE AANSCHAF VAN EEN ELEKTRISCHE AUTO

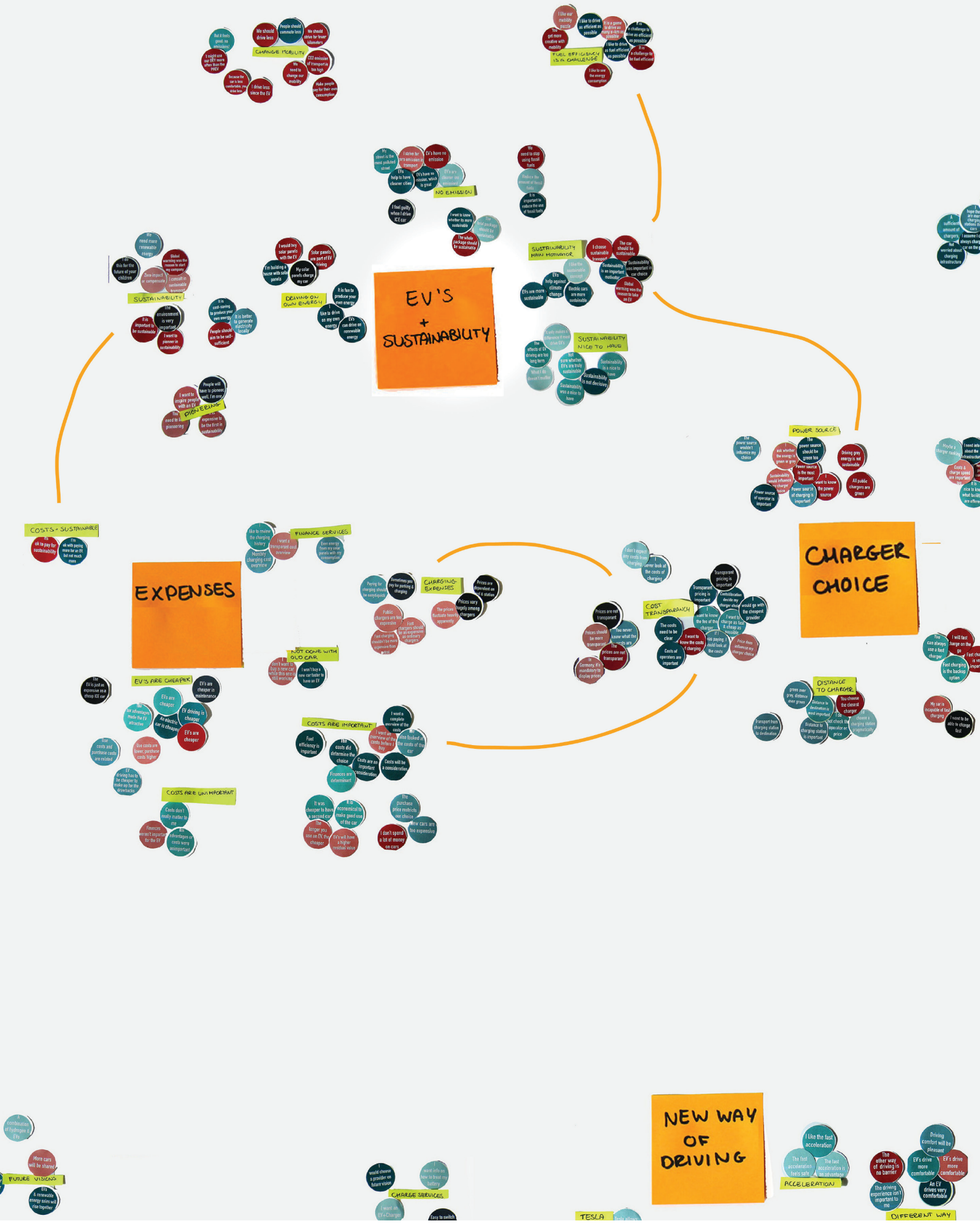
Wat speelt er mee in de koop van een elektrische auto? Wat waren de argumenten voor- en de argumenten tegen?
Schrijf ze op en plak ze op de cirkels. Hoe dichter bij het midden, hoe belangrijker de argumenten zijn.

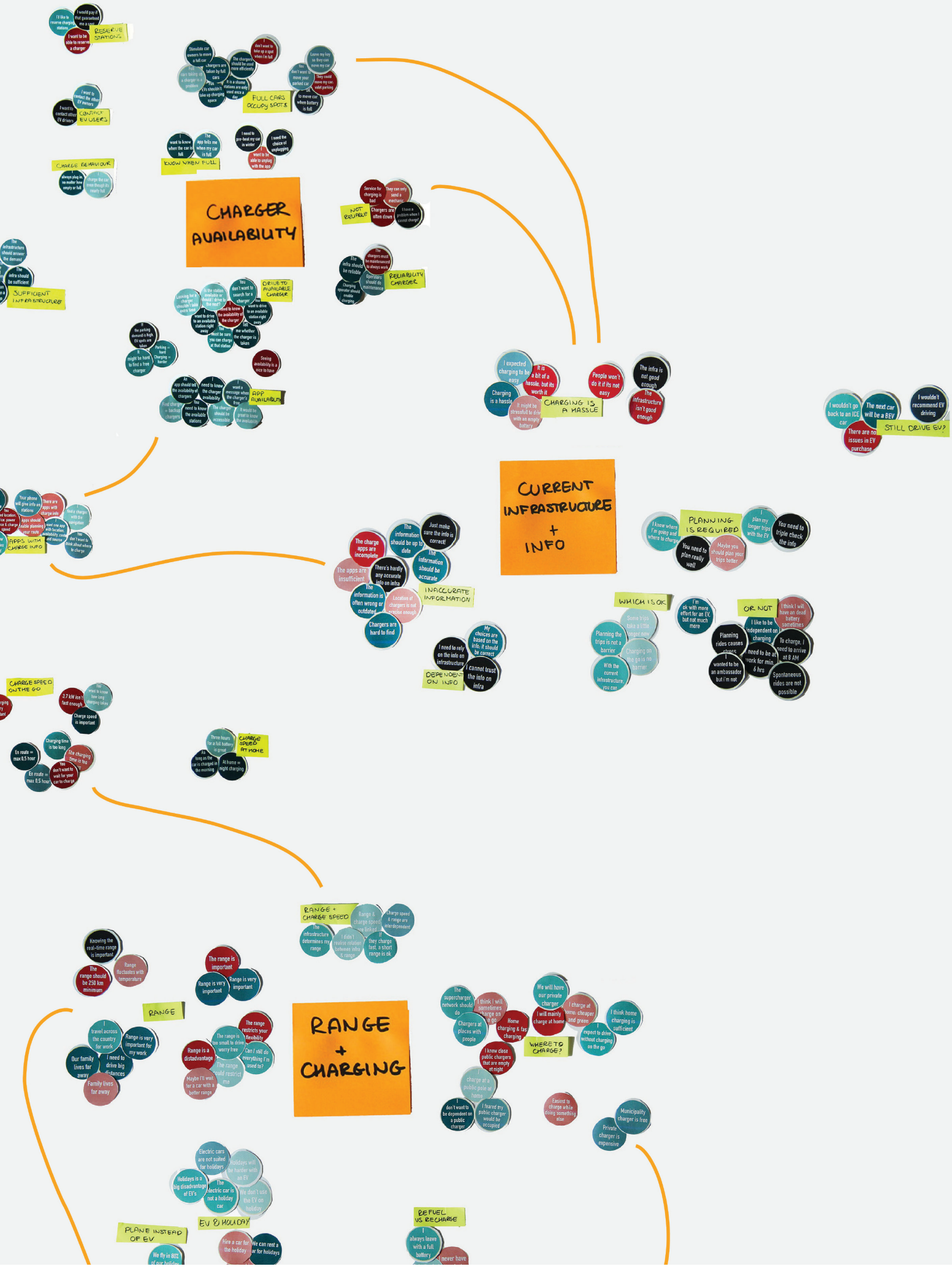
A12: RESULT CLUSTER

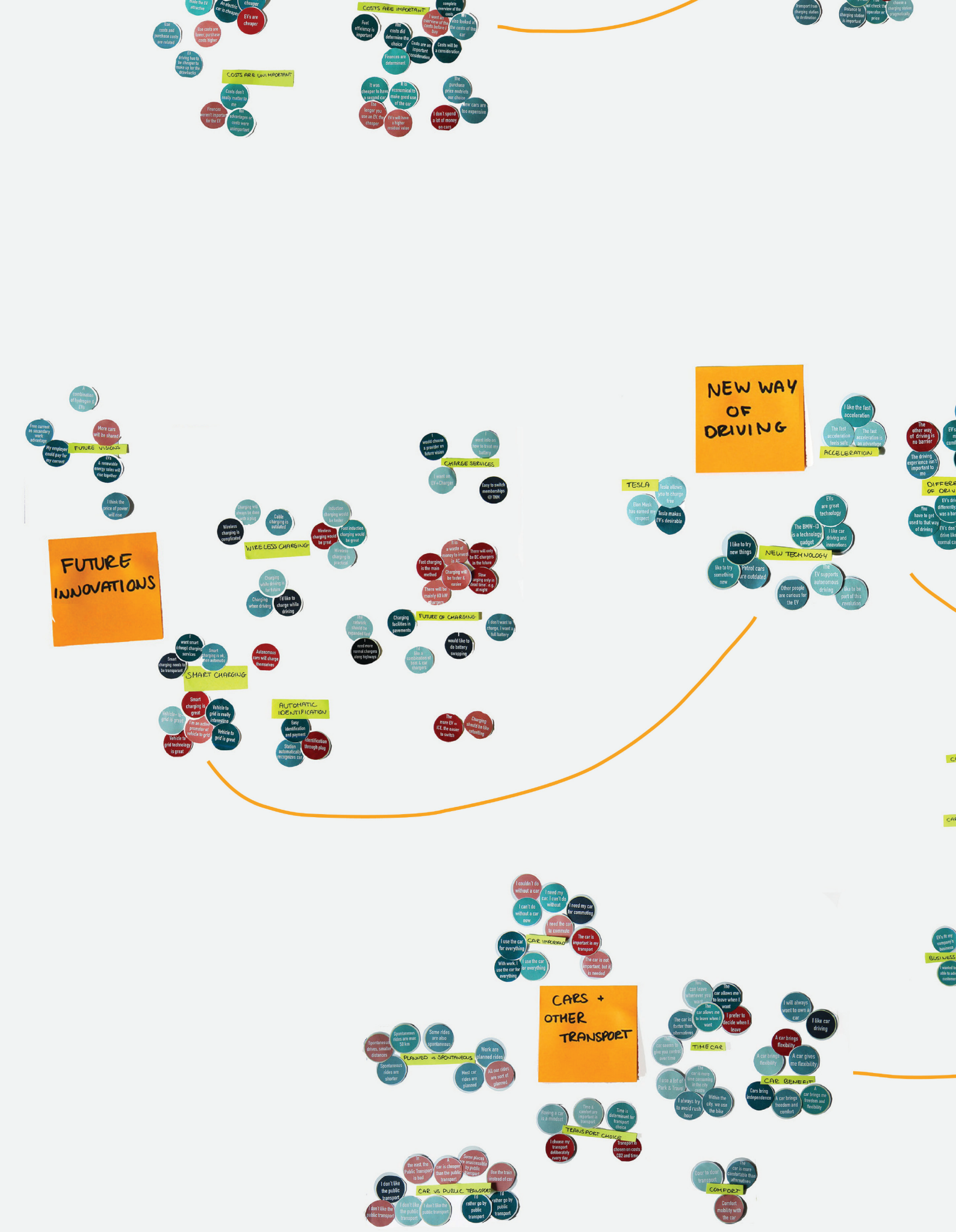
The most important findings of the interviews were translated to statements. The statements were put on colour-coded circles and clustered. The final cluster of the user research is shown in the figure below. The orange notes name the clusters and the yellow notes the subclusters. Figure is meant to aid the reader to find the topics of his/her interest.

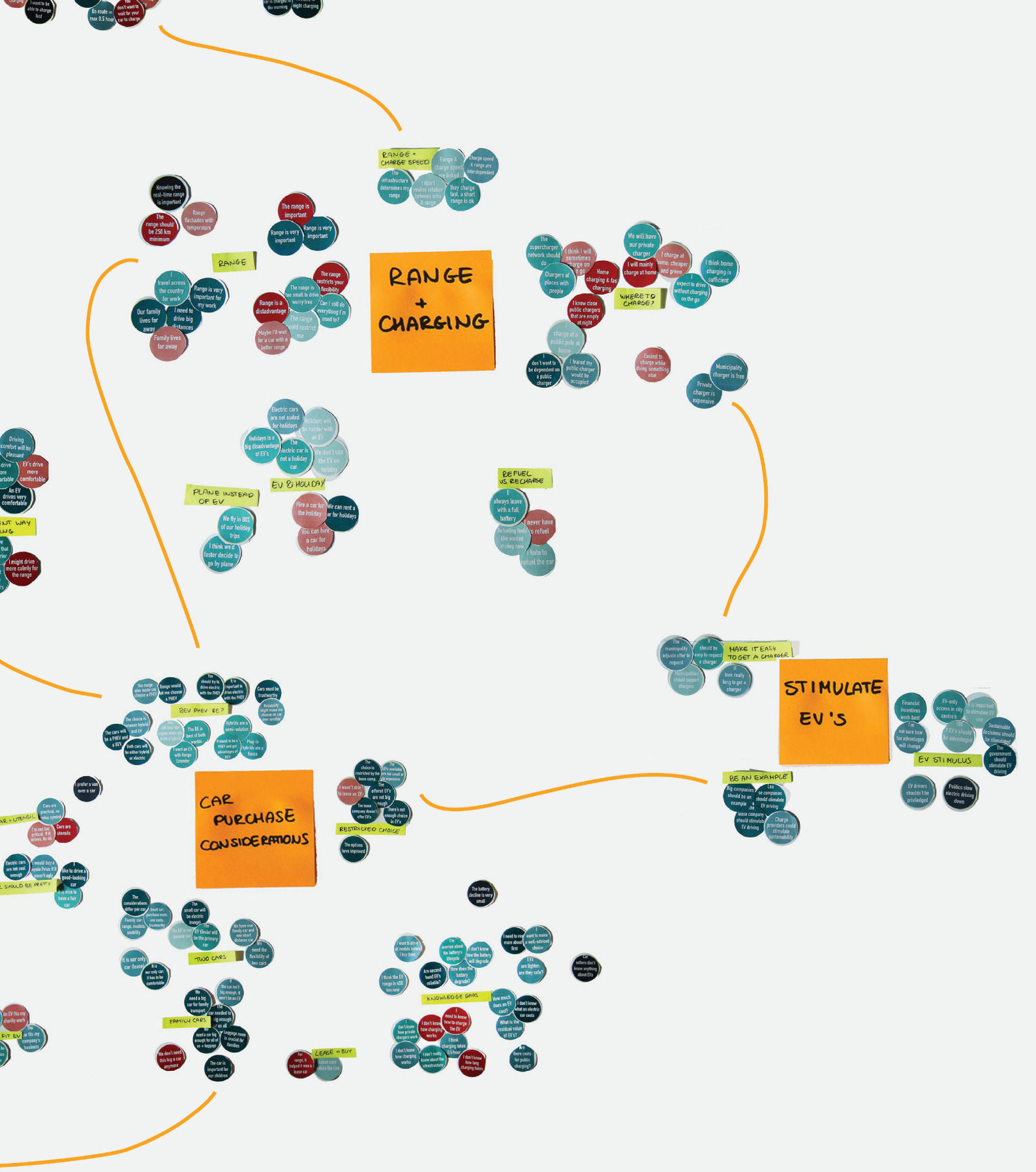
In the text, the clusters are explained: the topics discussed in the interviews are described. Differences between user groups are clarified.




EV'S + SUSTAINABILITY
CHANGE MOBILITY
FUEL EFFICIENCY IS A CHALLENGE
NO EMISSION
SUSTAINABILITY MAIN MOTIVATOR
SUSTAINABILITY
DRIVING ON OWN ENERGY
SUSTAINABILITY NICE TO HAVE
PIONEERING
POWER SOURCE
COSTS + SUSTAINABLE
EXPENSES
FINANCE SERVICES
CHARGING EXPENSES
NOT DONE WITH OLD CAR
EV'S ARE CHEAPER
COSTS ARE IMPORTANT
COSTS ARE UNIMPORTANT
COST TRANSPARENCY
CHARGER CHOICE
DISTANCE TO CHARGER
FUTURE VISIONS
CHARGE SERVICES
NEW WAY OF DRIVING
ACCELERATION
TESLA
DIFFERENT WAY


RESERVE STATIONS
I'd like to reserve charging stations
I would pay a fee for that guaranteed me a spot
I want to be able to reserve a charger
FULL CARS OCCUPY SPOTS
Stimulate car owners to move a full car
Full cars taking up a charger is a problem
chargers are taken by full cars
The chargers should be used more efficiently
It is a shame stations are only used once a day
It's shouldn't take up charging space
I don't want to take up a spot when I'm full
Leave my key so they can move my car
You don't want to move your parked car
They could move my car, valet parking
to move car when battery is full
CONTACT EV USERS
I want to contact other EV drivers
I want to contact other EV drivers
KNOW WHEN FULL
I want to know when the car is full
The app tells me when my car is full
I need to pre-heat my car in winter
I need the choice of unplugging
I want to be able to unplug with the app
CHARGE BEHAVIOUR
always plug in no matter how empty or full
charge the car even though it's nearly full
CHARGER AVAILABILITY
NOT RELIABLE
Service for charging is bad
They can only send a mechanic
Chargers are often down
I have a problem when I cannot charge!
RELIABILITY CHARGER
The infra should be reliable
The chargers must be maintenanced to always work
Charging operator should enable chargers
Operators should do maintenance
SUFFICIENT INFRASTRUCTURE
The infrastructure should answer the demand
The infra should be sufficient
DRIVE TO AVAILABLE CHARGER
You don't want to search for a charger
Is the station available or should I drive to the next?
Looking for a charger shouldn't take extra time
Need to know the availability of the charger
You want to drive to an available station right away
You want to drive to an available station right away
You want to be sure you can charge at that station
Tell me whether the charger is taken
If the parking demand is high EV spots are taken
Parking = hard Charging = harder
It might be hard to find a free charger
Seeing availability is a nice to have
APP AVAILABILITY
An app should tell the availability of chargers
I need to know the charger availability
Find charger = backup chargers
You need to know the available stations
The charger should be accessible
Would a message when the charger's free
It would be great to know the availability
CHARGING IS A HASSLE
I expected charging to be easy
It is a bit of a hassle, but its worth it
Charging is a hassle
It might be stressful to drive with an empty battery
CHARGING IS A HASSLE
People won't do it if its not easy
The infra is not good enough
The infrastructure isn't good enough
I wouldn't go back to an ICE car
The next car will be a BEV
I wouldn't recommend EV driving
There are no issues in EV purchase
STILL DRIVE EV?
CURRENT INFRASTRUCTURE + INFO
APPS WITH CHARGE INFO
Your phone will give info on stations
There are apps with charge info
Find a charger with the navigation
Apps should enable planning your route
I want one app with location, availability, costs and menus
You don't want to think about where to charge
INACCURATE INFORMATION
The charge apps are incomplete
The information should be up to date
Just make sure the info is correct!
The apps are insufficient
There's hardly any accurate info on infra
The information should be accurate
The information is often wrong or outdated
Location of chargers is not precise enough
Chargers are hard to find
DEPENDENT ON INFO
I need to rely on the info on infrastructure
My choices are based on the info, it should be correct
I cannot trust the info on infra
PLANNING IS REQUIRED
I know where I'm going and where to charge
You need to plan really well
Maybe you should plan your trips better
I plan my longer trips with the EV
You need to triple check the info
WHICH IS OK
Some trips take a little longer now
Planning the trips is not a barrier
Charging on the go is no barrier
With the current infrastructure, you can
OR NOT
I'm ok with more effort for an EV, but not much more
I think I will have an dead battery sometimes
I like to be independent on charging
Planning rides causes stress
To charge, I need to arrive at 8 AM
I wanted to be an ambassador but I'm not
I need to be at work for min 8 hrs
Spontaneous rides are not possible
CHARGE SPEED ON THE GO
3.7 kW isn't fast enough
The want to know how long charging takes
Charge speed is important
Charging time is too long
The charging time is too
En route = max 0.5 hour
You don't want to wait for your car to charge
En route = max 0.5 hour
CHARGE SPEED AT HOME
Three hours for a full battery is great
As long as the car is charged in the morning
At home in night charging
RANGE + CHARGE SPEED
The infrastructure determines my range
Range & charge speed are linked
Charge speed & range are interdependent
I didn't realise relation between infra & range
If they charge fast, a short range is ok
RANGE + CHARGING
RANGE
Knowing the real-time range is important
The range should be 250 km minimum
Range fluctuates with temperature
The range is important
Range is very important
Range is very important
I travel across the country for work
Range is very important for my work
Our family lives far away
I need to drive big distances
Family lives far away
The range restricts your flexibility
The range is too small to drive worry free
Range is a disadvantage
Can I still do everything I'm used to?
The range could restrict me
Maybe I'll wait for a car with a better range
WHERE TO CHARGE?
The supercharger network should go
I think I will sometimes charge on it go
We will have our private charger
I charge at home, cheaper and green
I think home charging is sufficient
Chargers at places with people
Home charging & fast charging
I will mainly charge at home
I expect to drive without charging on the go
I knew close public chargers that are empty at night
I'll charge at a public pole at home
I don't want to be dependent on a public charger
I feared my public charger would be occupied
Easiest to charge while doing something else
Municipality charger is free
Private charger is expensive
EV & HOLIDAY
Electric cars are not suited for holidays
Holidays will be harder with an EV
Holidays is a big disadvantage of EV's
The electric car is not a holiday car
We don't use the EV on holiday
PLANE INSTEAD OF EV
We fly in 80% of our holidays
hire a car for the holiday
We can rent a car for holidays
REFUEL VS RECHARGE
I always leave with a full battery
I never have


COSTS ARE UNIMPORTANT
COSTS ARE IMPORTANT
FUTURE VISIONS
FUTURE INNOVATIONS
WIRELESS CHARGING
CHARGE SERVICES
FUTURE OF CHARGING
SMART CHARGING
AUTOMATIC IDENTIFICATION
NEW WAY OF DRIVING
ACCELERATION
TESLA
NEW TECHNOLOGY
CARS + OTHER TRANSPORT
CAR IMPERSONAL
TIMECAR
CAR BENEFIT
PLANNED vs SPONTANEOUS
TRANSPORT CHOICE
CAR VS PUBLIC TRANSPORT
COMFORT


RANGE + CHARGE SPEED
RANGE
RANGE + CHARGING
WHERE TO CHARGE?
PLANE INSTEAD OF EV
EV & HOLIDAY
REFUEL VS RECHARGE
MAKE IT EASY TO GET A CHARGER
STIMULATE EV'S
EV STIMULUS
BE AN EXAMPLE
REV PHEV RE?
CAR PURCHASE CONSIDERATIONS
RESTRICTED CHOICE
TWO CARS
FAMILY CARS
KNOWLEDGE GAPS
LEASE + BUY

Cars among other modes of transport

While choosing between modes of transport, most users weigh time, costs and comfort. The more sustainable oriented participants also considered CO2 emission to some extent. Time appeared to be the most determinant factor. The public transport is viewed as a less comfortable, less time-efficient and more expensive way to get around. Cars, on the other hand, are chosen because of their flexibility, time efficiency and comfort. Most participants prefer to choose their departure time independent of other schedules. One participant mentioned that a car (seems to) give control over time.

Cars are most used for between-city travel; within cities, other modes of transport like biking and walking are preferred.

The car is seen as an essential product and is often the main mode of transport.

Quotes

- "Ik ben sneller met de trein in Amsterdam dan ik dat met de auto doe. Snelheid en gemak zijn dan bepalend."
- "Een auto brengt mij vrijheid omdat ik sneller, op een moment dat ik dat wil, ergens heen kan."
- "Het is fijn om te kunnen beslissen 'nu ga ik weg'. In plaats van moeten wachten tot de trein gaat."
- "We zijn niet zo'n enorme fan van het openbaar vervoer."
- "In het openbaar vervoer moet je je tijd organiseren en daar ben ik niet goed in."
- "Ik rijd van stad naar stad met de auto, en parkeer de auto buiten de stad."
- "Het is fijn om te weten dat je de auto kunt pakken wanneer je wilt."
- "De auto is mijn belangrijkste vervoersmiddel: ik doe alles met de auto."
- "Voor mijn werk is die auto gewoon nodig, ik kan niet zonder."
- "Voor een spoedgeval moet ik weg kunnen, dus de auto moet er wel zijn."

Car purchase considerations

Multiple aspects play a role in car purchase, depending on the household situation. Costs, car size, purchase method and available models are all important. Sustainability and social factors are also mentioned, though this varies a lot per participant. Sustainability is decisive for some, and non-influential for others (read more about this in 'EV's and Sustainability'). Similarly, some participants consider a car as a utensil, while others require the car to be fair-looking.

Leasing a car changes the considerations, as costs and residual waste are less of an issue. The lease users do not have to worry about degradation of the battery or better models that might be available later.

Participants that own a second car have other considerations than users with one car. Users with one car need to have a car fulfilling the needs of all purposes: family trips, holidays and work. Users with two cars often distinguish between a smaller 'shopping car' and a bigger 'family car'. Especially families need a big car for everyone plus luggage.

Participants were conscious about the fit between the car and their work. Sustainable entrepreneurs also wanted to have a sustainable car. An entrepreneur wanted to drive a pretty car, but found most expensive cars too pretentious. The Tesla was a good combination of fair-looking and modesty.

The choice in cars was often restricted by the lease company. Especially in electric cars, the choice was limited: having little room for employees to choose a sustainable car.

In the purchase of electric cars, a lot of knowledge gaps exist. Even if the participant is on the verge of purchasing an electric car, they lack knowledge on charging, costs, range or battery degradation. For some participants, this lack of knowledge was a barrier for purchase. Battery degradation, for example, was a serious worry. Others intended to fill the knowledge gaps on the fly.

Quotes

- "De auto is wel een overweging geweest. We hadden al een auto. Dit was een rekensom. Twee auto's was goedkoper."
- "Milieu en vervuiling waren de belangrijkste overwegingen."
- "Ik heb niet heel veel eisen aan een auto. Als het rijdt is het goed."
- "Belangrijk dat de auto er mooi uit ziet."
- "Voor de actieradius is het belangrijk dat de auto een lease-auto is dus dat je hem inruilt."
- "Het is belangrijk dat we één auto hebben waar het gezin in past met bagage."
- "Ik heb in zo'n duurzaamheidsding gezeten, dan moet ik daar zelf ook actief mee bezig zijn."
- "Omdat ik bij een bedrijf werkt in duurzame elektriciteit vind ik dat ik ook die kant op moet bewegen."
- "Onze leasemaatschappij bood geen elektrische auto's aan."

- "Het leuke aan benzine is dat je het overal kan krijgen, maar waar haal je elektriciteit vandaan."
- "De levensduur van een accu is wel een onzekere factor."
- "In de stad kun je waarschijnlijk ook je eigen laadpaal installeren, of een kabel door de brievenbus. Ik weet niet hoe dat werkt."
- "Daar kom ik met vallen en opstaan wel weer achter."

Stimulate EV purchase

Most participants mentioned that EV ownership should be stimulated by the government, international companies and lease companies. The last should offer a wide range of models with an electric car in each category. The international companies should provide stewardship: stimulating their employees to drive electric. The government should keep up the financial incentives and make it easy to get charging facilities. EV users also wanted to be advantaged by EV-only access in city centre's or free parking.

Most users had already decided their next car would be electric, but still had to choose between the different electric models. The PHEV was preferred because of the range, especially for the bigger family car. The shopping car could be replaced by a full-electric car. The RE was preferred because of the combination of the range and the driving comfort (sound of the engine). One participant considered the PHEV a failure, because they were sensitive to fraud and did not help the environment.

Quotes

- Grote bedrijven en leasemaatschappijen moeten hierin het voorbeeld geven.
- De leasebedrijven moeten een stimulerende rol aannemen; bijvoorbeeld door groot aanbod te hebben.
- De leasemaatschappij zou elektrisch rijden moeten stimuleren: ik zou nu al mijn auto moeten kunnen inwisselen, ook al is mijn contract nog niet af
- "Ik zou balen als de bijtelling zou stijgen naar 22%. Het is belangrijk om volledige elektrische auto's te stimuleren."
- "Het is heel belangrijk dat de gemeente flexibel omgaat met de vraag. Gemeenten moeten laadpalen stimuleren."
- "Plug in hybrids zijn een fiasco natuurlijk. Dat was leuk in het begin om de boel op gang te krijgen. Maar het heeft geen enkele bijdrage gehad aan het doel van het milieu."
- "Het is lastig te controleren of een auto een plug-in hybrid is of niet. Je kunt bij wijze van spreken je broodrooster in de achterbak gooien en het snoertje eruit laten hangen en je doet alsof je aan het bijladen bent."

Range & charging

By almost all participants, the range was mentioned as a disadvantage of electric cars. They thought the range would restrict them, limit their flexibility or influence their driving comfort. This was a major barrier in the purchase of electric cars and an important reason to consider a PHEV. Accordingly, it was evident to all participants that the EV was no holiday car. Some participants did not consider this as a disadvantage and intended to hire a car for holidays. Others intended to fly more often.

The participants linked the range of the car to the charging speed. If the car would be full fast, the limited range would be less of a problem.

Most participants were still in the dark about charging methods. When probed, they expected to mainly charge at home, and at public chargers on the go. Some knew public chargers near their home and intended to charge there at night. Those who were familiar with the fast charging network, expected to use those the most on the go. The participant intending to buy a Tesla said that the range would be sufficient for his driving habits. The choice in charging method was also influenced by the costs of chargers: private chargers had to be funded by the participant himself, while public chargers were free.

One of the EV users charged at a public charger. He was in the process of buying a new house, but required it to have a private drive. He did not want to be dependent on a public charger anymore.

Both EV-owners and potential EV-owners saw it as an advantage to get rid of refuelling. A participant who had already ordered an EV said that refuelling felt like wasted money, now he knew he would get an EV.

Quotes

- "Minder positief is gewoon de actieradius, dat moet je je blijven realiseren."
- "Voor elektrische auto's is de actieradius niet voldoende om een volwaardig alternatief te vormen voor een brandstofauto."
- "De actieradius is te beperkt om zorgeloos mee te rijden."
- Actieradius en laadtijd hangen samen: als laadtijd sneller is, is de actieradius ook minder belangrijk
- "Ik laad het meeste, 80% thuis. Ik laad het liefst thuis want dat is het goedkoopste."
- "Ik denk dat ik voldoende heb aan het zelf laden thuis."
- "Ik wil niet afhankelijk zijn van een publieke laadpaal die

mogelijk bezet is. Er komen steeds meer elektrische auto's."
- "Ik kom al een jaar niet bij een pompstation. Je hoeft nooit meer te tanken."
- "Voordeel om niet te hoeven tanken"

Charger choice

The (hypothetical) choice between chargers is made based on distance to destination, costs, power source and charging speed.

Distance to destination seems to be most important, saving time and keeping the advantage of door to door transport.

Furthermore, the charging speed on the go was considered important. Especially on the go, the charger should charge the battery in maximum half an hour. Participants did not want to wait for their car to charge. Therefore, fast charging was considered an important feature of the car. It was often seen as a safe back-up option, providing the participant with a feeling of security. Other public chargers were found too slow by the participants.

At home, however, the charging speed was of less importance. The participants wanted their car to be ready in the morning, but did not care about when and how it was charged overnight.

Next to distance and charging speed, price was important for the choice for a charger. The costs needed to be clear, though, according to EV drivers, this was currently not the case. These considerations differ between lease drivers and car owners, because lease drivers often do not pay for their expenses. Some participants did not consider the costs.

The last factor influencing charger choice was the power source. Especially the participants that aimed for sustainable behaviour, believed the total package should be sustainable and therefore weighed power source heavily in their charger choice. Some participants had asked after the power source, but this had not always been clear.

All participants expected to find the information on chargers in an app, in their navigation system or online. They wanted it to be intuitive: so that they did not have to think about where to charge. The app should plan their route. The app would have information about the location, costs, charge speed, power source and availability of the charger. Some participants would like to know what facilities were offered nearby.

Quotes

- "Dat is een afweging tussen gemak en prijs: net zoals tankstations."
- "Ik verwacht geen services rondom het laden, alleen zo snel mogelijk en zo goedkoop mogelijk."
- "Afstand is het meest belangrijk in de keus voor een laadpaal; omdat dat tijd kost."
- "Ik ga niet checken wat een kW kost bij welke laadpaal."
- Thuis maakt de laadtijd niet uit, als hij 's ochtends maar is opgeladen
- "3,7 is te weinig, vaak, voor deze auto, dan duurt het te lang. Daar let ik wel op: is ie 11 of 22."
- Een pauze van een half uur is geen probleem. Twee uur langs de kant staan kan niet.
- "Ik heb altijd nog de back-up mogelijkheid van een snellaadpaal."
- "Als ik ergens vaker kom vraag ik of het groene energie is."
- "In je navigatiesysteem zit al automatisch alle laadpalen en hoe lang je nog hebt, dus ja. Hoe makkelijk is het dan?!"
- "Of uit je smartphone, maar dan moet je op twee schermpjes kijken en dat mag weer niet als je in de auto zit."
- "Ik gebruik 9 van de 10 keer het navigatiesysteem van de auto om een laadpaal te vinden."

Current Infrastructure & info

The EV drivers were asked to share their experiences with the current infrastructure. An important pain was the lack of accurate information about the infrastructure. The information was often outdated, inaccurate or just wrong. Locations of chargers were off and chargers were hard to find.

The EV drivers emphasized they were dependent on the information. Especially the owners with cars that could not fast charge, needed to plan their journeys towards chargers. They shared painful stories about the times that they found chargers to be private while marked public, broken chargers or just no chargers at the places they intended to go. The car owners based their choices on the information about the infrastructure, which was often incorrect. Their most important message: if you offer information, make sure it is right.

The EV drivers stated that the infrastructure was not good enough at the moment. Charging their car was a hassle and cost time and frustration. If they wanted to take their car, they should plan their trip carefully and check the information in multiple ways. Some EV owners were ok with planning their trip, while others found it too

stressful.

Even though they were not happy with the infrastructure, the EV owners would not go back to a gasoline car. Also, the plug in hybrid owners would buy a full electric vehicle next time.

Quotes

- "De informatie voorziening over de beschikbaarheid van laadpalen is me enorm tegengevallen."
- "Vooral waar welke paal staat en of die beschikbaar is wil ik weten, maar dat is echt slecht."
- "Ik verwacht niet per sé ergens informatie te vinden, maar als je informatie biedt, zorg dan dat die accuraat is. Biedt m anders niet."
- "Het is relatief veel gedoe ten opzichte van een normale auto. Maar dat is het per saldo wel waard."
- "De laadinfrastructuur moet heel goed zijn, maar dat is hij nog niet."
- "Want je moet wel naar een laadpaal, je moet erop aankunnen dat die laadpaal vrij is voor jou. Je kunt 'm of niet vinden, dat heb ik ook wel eens gehad. Had ik nog vier kilometer. Dan moet je weg, anders sta je als dood ijzer langs de weg."
- "Ik heb door schade en schande ontdekt dat die informatie niet klopt. En dat ik er niet op kan vertrouwen en dat ik driedubbele checks moet doen en dat het dan nog mis kan gaan. En dat vind ik heel vervelend."
- "Als hij niet staat waar ze zeggen dat hij staat heb ik echt een probleem, dus ik heb tegenwoordig dat ik twee back-up locaties opzoek."
- "Dat heb ik ook wel eens, een laadpaal die ik opzoek en dan blijkt het op een privé terrein te zijn."
- "De infrastructuur valt heel erg tegen."
- "De infrastructuur is gewoon niet goed genoeg."
- "Ik moet autoritten beter plannen, maar dat is geen drempel om niet te gaan."
- "Ik hoef niet meer terug naar een andere auto."

Charger availability

Of all information an application can offer, the participants stressed the importance of 'availability'. In this context, the availability refers to the possibility to charge when needed. Participants predicted problems, like full cars occupying charge spots or broken chargers. They clearly stated that they did not want to search for an available charger, which would take extra time. Participants wanted to drive to an available station right away.

Extra services connected to the availability were that an app could send a message when a charger was free, or could allow to make reservations

Prospective users expected (and required) the infrastructure to be sufficient for the demand. It was also important that operators made sure the infrastructure was reliable by doing maintenance. However, they foresaw problems in this, caused by late maintenance, full cars occupying charge spots or parking pressure. EV users confirmed that chargers were often down, and full cars did occupy spots often. This inefficient use of the infrastructure frustrated some users. EV users were ok with moving their cars. They also wanted to give others permission to move or unplug their car, as long as the choice stayed with them.

Though, EV users also said they would always charge their car, no matter how full or empty. Plus, they did not always want to be unplugged. For example in the winter, when they needed to pre-heat their car while charging. They would like to be able to contact other EV owners to find solutions for their issues.

Quotes

- Je wilt meteen naar de goede laadpaal toe kunnen rijden, zonder zelf te hoeven kijken over de beschikbaarheid.
- "Ik verwacht dat de app aangeeft of hij beschikbaar is of niet."
- "Het zou helemaal fantastisch zijn als je kunt zien of hij beschikbaar is of niet."
- "Als je de hele tijd moet zoeken naar een plekje is dat wel vervelend."
- "Vooral waar welke paal staat en of die beschikbaar is wil ik weten, maar dat is echt slecht."
- "Parkeren in de stad is al best wel lastig, en parkeren bij een laadpaal in de stad is nog lastiger."
- "Ik verwacht genoeg plekken om te laden wanneer het nodig is."
- "Volle auto's die laadplekken bezet houden wordt een probleem."
- "Bovendien sta ik daar het hele weekend een laadplek bezet te houden. Ik wil de sleutel ergens droppen: verplaats hem maar als hij vol is."
- "dan kun je zeggen als hij vol is krijg je een appje, maar dan moet je van die bank afkomen, je auto verzetten. Dat kan lastig zijn maar.. dan moet je weer een ander parkeerplek gaan zoeken. Zou zo'n laadpaal zo'n proces niet kunnen faciliteren?"
- "Het is heel prettig om de auto voor te verwarmen terwijl hij aan de stekker staat."
- "Als bestuurder moet je actief een keus kunnen maken in wel

of niet loskoppelen als hij vol is."

Expenses

Expenses are an important consideration in car use. As mentioned before, costs are an important consideration in car purchase and are also a consideration in charger choice. Most participants want a complete picture of the costs (purchase costs, use costs, maintenance costs, charger costs and residual value) before purchase. The importance of costs differ per participant. For some, the costs are decisive: they would always choose the cheaper option. Others would not consider costs at all. The sustainable oriented participants were ok with paying a little more for this sustainable alternative.

EV's were often expected to be cheaper than conventional cars. Though, participants would not faster take a new car because it was electric. Their current car had to reach end of life first.

Payment for charging should be easy and quick. Most participants were aware of the fluctuating prices. They found a monthly overview of charging costs important.

Quotes

- "Maar als per saldo het misschien niet eens zo heel veel goedkoper is waarom zou je dan al die concessies gaat doen."
- "Inzicht in laadhistorie en kosten zijn belangrijk. Ik wil weten hoeveel laad ik nou en hoeveel kost het. Dan krijg je ook bevestiging van hoeveel goedkoper het is van fossiele brandstoffen."
- "Belastingvoordelen en kosten waren niet belangrijk."
- "Kosten kunnen een overweging zijn om één auto over een ander te kiezen."
- "Betrouwbaarheid en laag verbruik zijn voor mij heel belangrijk. Beheersbare kosten."
- "De restwaarde hangt sterk samen met de aanschafprijs."
- "Ik vind het ook zo stom om een nieuwe auto te kopen als deze het nog doet. Dat is ook niet echt duurzaam."
- "Daar zit dan wel een prijskaartje aan. Dat milieuaspect vind ik niet het belangrijkste, maar het prijs aspect vind ik het wel belangrijk."

New way of driving

Most participants were aware that the EV's drive different from conventional cars. They knew all EV's did not have gears, accelerated faster and the engine is more quiet. The opinion about this different way of driving differed. Most participants were neutral to positive towards this new way of driving. Some participants thought the EV would be more comfortable to drive and considered it as an argument pro-purchase. Some participants indicated that the new way of driving was a barrier. The other way of driving would be less sportive and non-car like.

All DINKY's were enthusiastic about the fast acceleration. The new technology of the electromotor was an argument pro-purchase for DINKY's. They liked to try something new and be part of the revolution. The new technology was considered attractive and the car felt gadget-like. The electric cars were believed to be future-proof by enhancing autonomous driving.

Quotes

- ¬"Ik hou wel van een auto met een sportieve rijstijl. Voelt wat minder als een auto."
- "Het is vrij comfortabel om de motor niet te horen, maar het is soms ook wel fijn om de motor wel te horen."
- "Je hoeft niet te schakelen, ze maken geen herrie."
- "Heel prettig dat de auto stil is."
- "Het is comfortabel dat de motor zo stil is."
- "Als je wel een brandstofmotor hebt rijdt het minder comfortabel: dan hoor je de motor nog steeds. Het rijcomfort is beter bij een echt elektrische auto tov een hybride."
- "Ik vind de auto's hele mooie techniek." "Ik vind de techniek gewoon heel mooi."
- "Leuk, iets nieuws, altijd uitproberen. Een Gadget-achtig gevoel."
- "Ik vind het leuk om nieuwe dingen uit te proberen."
- "Het is een opstapje die nodig is voor autonoom rijden. Mogelijkheid tot meer zelfrijdende functies"
- "Ik hou van auto rijden en van innovaties."

Future innovations

Participants were asked to predict the future of the charging infrastructure. They expected the network to be expanded fast. The recognition of the car by the charging station would be automatic, for example with the plug. Often mentioned technologies were wireless charging and smart charging. Both technologies were thought promising and convenient. Participants were enthusiastic about vehicle-to-grid technology, but mentioned that it should be transparent and automatic. Wireless charging was especially thought interesting in 'charging while driving'.

When asked what they wanted in the future, participants wanted the network to be extended as wide as possible, as fast as possible. Some expressed specific interests in technology like battery

swapping, charging facilities in pavements or a combination of boat and car chargers. One participant wanted the full battery as a service ("I don't want to charge, I want a full battery").

Charge services involved package deals in car purchase and info on battery treatment. Future visions were a combination of electric and hydrogen cars, shared cars, a rising power price, a combination of EV sales and renewable energy sales and current as a secondary work advantage.

Quotes

- "Je wilt de auto parkeren zonder draad. En dan laad hij op."
- "De laadpaal herkent de auto automatisch aan de stekker of draadloos."
- "Draadloos laden is wel praktisch."
- "Nog een stap verder, rijdend laden. Maar dat is wel toekomstmuziek. Dat zou wel fantastisch zijn."
- "Over het netwerk: hoe meer hoe beter hoe sneller hoe beter. Ik denk dat dat voor veel mensen een remmende factor is."
- "Er zitten grote pieken en dalen in het aanbod en de vraag van elektriciteit. Ik vind de vehicle-to-grid technologie onderbelicht, ik denk dat daar een heel mooie kans ligt. "
- "Vehicle to grid technologie is super. We zijn dit actief aan het uitrollen."
- "Leuk, vehicle to grid laden. Dat is economisch"
- "Ik zou een combinatie van elektrische laders en bootladers willen, vooral in de binnensteden"
- "Ik denk dat waterstof en een elektrische auto's goed samen gaan. Misschien de waterstofcel als range extender."

EV's & Sustainability

Out of the eleven participants, eight indicated sustainability was the most important motivation to consider an electric car. The other three participants found this a nice to have. They were not sure whether EV's were truly more sustainable or thought their behaviour would not matter.

Electric cars were thought to be more sustainable, because they did not emit CO2 while driving. This was considered a great advantage to make the cities clean. Furthermore, their energy source was renewable: they would help to reduce the dependence on fossil fuels.

These participants often noted that the whole mobility should change. People should strive for fewer kilometres and commuting should be banned. This should be stimulated by making people pay for their kilometres.

The participants who found sustainability important wanted the whole package to be sustainable. They often considered to buy solar panels with the electric car. They liked to be independent on the grid and to drive on their own energy. Most of them followed this concept in other ways in their life too, for example in work choice or purchase behaviour.

Being fuel efficient or CO2 neutral had become a game for some participants. They liked keeping track of their consumption and saw it as a challenge to drive as efficient as possible.

Participants also explained their car use had changed since they had an EV. They were more aware of their energy consumption on the road. Some even drove less because the charging made car driving less comfortable.

Quotes

- "De gevolgen van elektrisch rijden zijn verre van direct merkbaar. Je moet er echt met het verstand naar kijken en de afweging maken." "Wat ik doe maakt niet uit. Mijn gedrag is een druppel op een gloeiende plaat."
- "Als ik op kolenstroom ga rijden draag ik niet bij aan het idee van duurzaamheid."
- "Wat voor kosten hebben zonnepanelen dan op het milieu? Dat moet ook duurzaam zijn."
- "Ik heb zonnepanelen laten leggen toen ik een elektrische auto kreeg."
- "Ik kijk uit naar dat je de auto hebt die je oplaad met je eigen zonnepanelen."
- "Als ik een elektrische auto koop zal ik mezelf verplichten om zonnepanelen op het dak te leggen."
- "Rijden voelt gewoon goed omdat hij geen uitstoot heeft."
- "Mijn principe is in wezen: verminder je uitstoot, en als dat niet kan moet je het compenseren."
- "Geen uitstoot belangrijk om klimaatverandering tegen te gaan en steden schoon te maken."
- "Ik wil voorop lopen met duurzaamheid."
- "Dit huis uit 1965 is nagenoeg energie neutraal. Met de volledige isolatie en zonneboiler."
- "Je moet anders nadenken over mobiliteit. WE moeten anders denken over mobiliteit."
- "Je wordt creatiever met hem omgaan van je eigen verplaatsing. Daar wordt je ook toe uitgedaagd."
- "Ik vind het leuk om er een sport van te maken zo min mogelijk te verbruiken."
- "Het is gewoon een sport om zo laag mogelijk uit te komen qua verbruik."

A13: BARRIERS IN EV PURCHASE

The aim of this project is to develop a product-service system that removes barriers in the purchase of the electric car. Even though the research provides inspiration for big leaps and strategy development, the small barriers found in the research were the starting point for product development. Solving a small problem for real was thought to be better than solving a big problem half. The obstacles were derived from the interview material: both the recordings and the stimuli material. They were made explicit to find potential product directions and will be described below.

Barriers

The following factors are reasons to not buy an electric car, ordered from the ones emphasised most to the less clearly stated barriers:

1. Range

As mentioned previously, cars are owned for their flexibility. Consumers are used to driving wherever they want to go, quickly refuelling when necessary. The range of the electric car forces them to think about the distance they are about to drive. Therefore, users are wondering: can I still do all I want to do? Won't the car restrict me in my transportation?

Holidays are also a factor in that consideration: EV's are considered unsuited for holidays.

2. Available models

Since the electric car is relatively new, the available models on the market is limited. Considerations like luggage room are therefore restricting the options. On top of this, lease companies arrange a number of options with the employer, limiting the choice even more.

3. Current car not finished yet

Consumers have a certain cycle in car purchase: some consumers buy a new car every five years, while others always keep their car until it breaks down. Out of the consumers that had not bought an electric car yet, some indicated that they wanted to finish this cycle before purchasing a new car. Buying a new car sooner was considered unsustainable and a waste of money.

4. Missing information

Of the seven participants that had not bought an electric car yet, some were still planning to search additional information. They wanted a complete overview of the costs, environmental impact or the charging network as input for the purchase decision. This was not caused by a lack of information, the participants had just not got around to doing the research yet.

5. Recharging times

The recharge time barrier was linked to the range barrier: the range would not be such an issue, as long as recharging would go fast. Being used to refuelling the car, participants said the recharge time was too long to be comfortable.

6. Unproven

Especially the consumers that intended to buy an electric car were worried about the residual value and battery degradation. Because the technology was so new, they considered the electric car unproven and therefore feared the high investment.

7. It might be hard to find a charger

Some participants were worried that the network was not developed enough. They were afraid to search for a charger. Some had heard rumours about wrong or outdated information. This sometimes caused them to wait for the infrastructure to develop further.

8. Electric cars are ugly

Apart from the Tesla cars, electric cars were considered dull and unattractive. Participants disliked the design and could not imagine their higher management in a Renault Zoë. For some, especially the ones that liked to drive a pretty car, this was a serious barrier.

9. Hard to get a charger

Participants mentioned issues requesting a charger. Especially for public or semi-public chargers, the process was long and complicated. Residence committees lacked knowledge and municipalities took a long time to take their decision.

10. Purchase price

The electric car purchase price is known to be relatively high (about one third higher than an combustion car). Even though this investment pays off after use, it does create a barrier for purchase.

11. Other way of driving

Since electric cars don't have gears and are powered by an electromotor, they drive different than a combustion car. One participant mentioned this was a barrier for him. He liked to hear the motor and considered the electric way of driving less sportive.

Future disappointments

Apart from the reasons holding consumers back from EV purchase, other factors will be a future disappointment. Consumers expect these factors to be sufficient or well-organised, while, according to current EV drivers, they are not.

1. The charging infrastructure

The participants expected the search for a charger to be seamlessly organised. They expected the information to be accurate and up to date. However, according to the current EV drivers, this was not the case. This will therefore be a disappointment when they start using an electric car. The experiences of current electric drivers will not be an advocate.

2. Requesting a (public) charger

Participants that planned to buy an electric car did not expect problems for charger requests. They expected the municipality to be proactive in the placement of chargers, to always be sufficient for the demand. This is, however, not how the current electric drivers experienced it and will therefore be a let-down.

A14: OPPORTUNITY AREAS

The previous section elaborated on the specific barriers in electric car purchase. Since removing the barriers is the focus of this project, they formed the input for seven 'opportunity areas'. These areas represent interesting directions for product-service systems. The opportunity areas are presented below with a description and an image of a cluster. The cluster image visualises link with the user research (red), market research (beige), trends (green) and company strategy (black).

EV-match assessment

The range of the electric car is an important and often mentioned drawback of the electric car. Being used to the worry-free range of the combustion car, users do not want to compromise on their flexibility. They are afraid the car will restrict them. Apart from the range, users are worried about the infrastructure. They do not know how charging works or how the infrastructure has developed in their area.

A potential solution to this is a device or application that tracks car use. For a certain period, for example, two months, the app tracks all trips with the car: their distance, route, timing. At the end of the period, the app has a proper overview of the car use, which can be used to advice the consumer. Based on the actual data, the app can give a reliable, personal review to the consumer whether or not to buy an electric car and where to charge it.

Figure 5: *EV match assessment cluster*

On-the-go charging with user-feedback

The range of the electric car is an important drawback from user perspective. This is concluded in the literature review and recurred in the user research. Also, developments in electric cars show that car manufacturers do anything to extend the range. Though, the user research also made clear that users care less about the short range if the infrastructure is widespread, fast and reliable. This solution, however, is not yet utilised. From the interviews with current EV owners, it was evident that the current infrastructure is not good enough and that charging is a hassle. The information available on the infrastructure is inaccurate.

This gives Eneco Elektrisch Laden the opportunity to provide accurate, reliable information on the infrastructure. User feedback could be an interesting feature to achieve this. It reduces an important clash between the benefit of a car (flexibility) and the use of the electric car (route planning). Currently, few competitors allow consumers to plan their journey incorporating charge stops.

Figure 6: *Charging on the go cluster*

VVE charger consult

According to the research, the process of arranging a charger is slow and complex. Especially residence committees and smaller municipalities lack knowledge on charging infrastructure.

This is a good opportunity for Eneco Elektrisch Laden to facilitate the charger process. Their expertise will help their stakeholders to make a well-advised decision. Their consultation will fasten the process and therefore create value for users.

Vehicle to grid/ smart charging

The most important, widely acknowledged benefit of electric cars is sustainability. Already, Eneco Elektrisch Laden guarantees green energy for consumers. The utilization of this sustainable advantage has potential for all stakeholders. Also, trends indicate the interest for renewable energy is growing. To reach the Paris Climate Accord, the Netherlands must produce more renewable energy (BRON). Users, too, wanted to power their electric car with their own energy. This is a part of the energy transition, which Eneco claimed a pilot position in. The generation of renewable energy in combination with electric car sale is a very effective way to utilize the sustainable advantage. Lastly, vehicle-to-grid technology is seen as a high potential solution to balance the offer and demand of electricity. This is even more important when a greater part of the energy is generated in the less predictable, renewable way. Eneco and consumers are both interested in the technology. Eneco is already experimenting with it.

Utilizing the sustainability of electric cars is best done in combination with renewable energy and vehicle-to-grid technologies. All three have caught the interest of Eneco, users and politics. This, plus the fact that users would like to buy a complete (sustainable) package at once, lead to the conclusion that a combination has high potential as a product-service.

Advisory platform

Both literature research and the user research showed that the potential electric car driver lacks knowledge. They are uninformed about sustainability, charging and costs. Even so, as the users themselves point out, the knowledge is important for their purchase decision. A cost overview, for example, was a must before purchase. Other users wanted to determine whether an EV was the most sustainable option.

Eneco Elektrisch Laden can develop a knowledge platform that informs the user about costs, sustainability and charging facilities. It could be an advisory platform that can be consulted when the user searches for ways to make his life more sustainable. Next to electric cars, the platform can be a stage for Toon, the Zonnehub and other Eneco products.

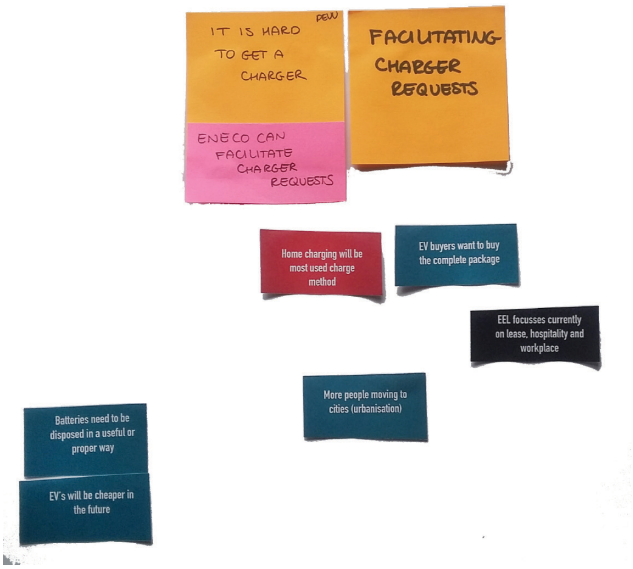


Figure 8: *VVE charger consult cluster*

Figure 7: *vehicle to grid cluster*

Easy car swap

The user research proved users consider the electric car unsuited for holidays because of the short range and long recharge time. The range, once again, proves itself a tough bottleneck. Also, the potential users consider the electric car as 'unproven': the residual value and battery degradation is an insecure factor.

The holiday issue can be resolved by making the car available for car swap. The EV owner can swap the car for a combustion car of a potential EV owner. In this period, the potential EV owner can experience the electric car, while the EV owner has a worry-free holiday. The swap can also be a starting point for a further conversation, which might ease worries of potential EV owners.

Finish your old car

The last important barrier for potential electric car buyers was the lifecycle of their current car. Of the seven potential buyers interviewed, four wanted to finish their current car before buying an electric car. Buying an electric car faster than normal was regarded as capital destruction or unsustainable. For another consumer, the lease company would not allow him to return his car before the contract had finished.

It is interesting for Eneco Elektrisch Laden to explore the possibility to meddle here. These users would buy an electric car – if not for their current car. A financially attractive or sustainable way to trade their car would remove this barrier.

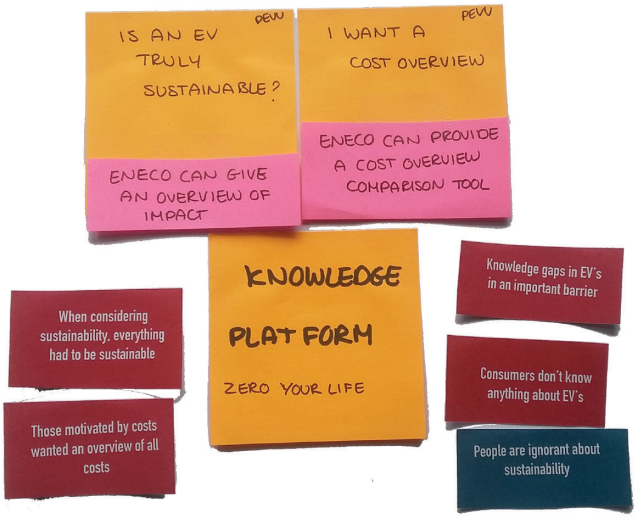


Figure 9: *advisory platform cluster*

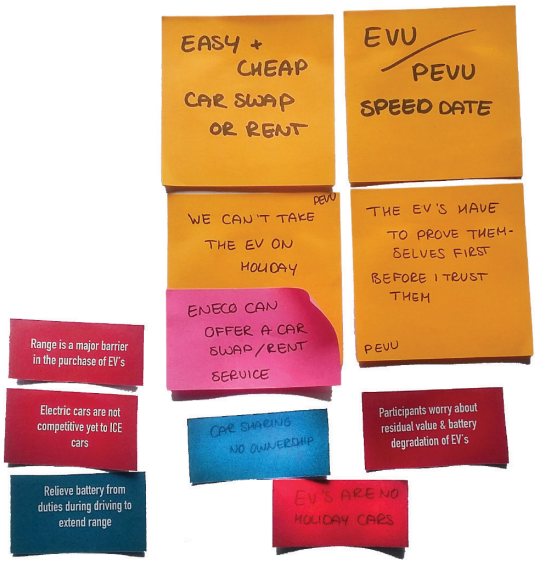


Figure 11: *Easy car swap cluster*

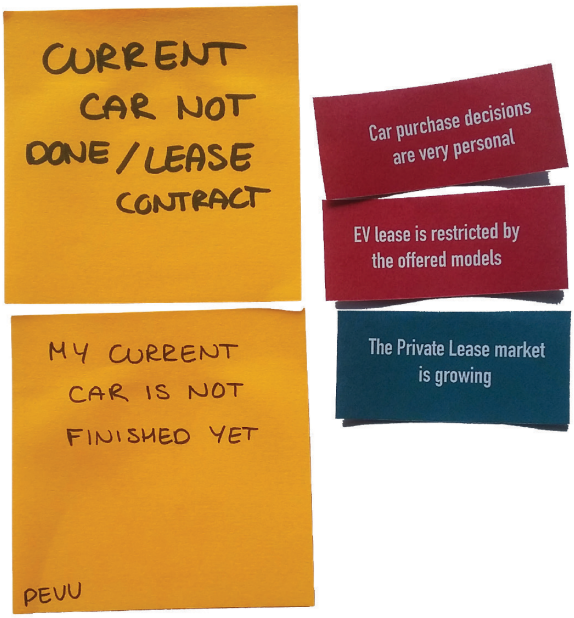


Figure 10: *finish your old car cluster*

B15: EVALUATION OPPORTUNITY AREAS

The seven areas mentioned before were explored further to evaluate their potential. Next, the areas could be evaluated and brought back to three to create focus. In order to do so, additional information was collected about the areas, before evaluating them on several factors.

Additional information

The additional information led to the following conclusions:

- The statistics on Dutch car use indicate that most distances driven can be done within the range of the electric car. For example, the average distance driven in one day is 37 kilometre (CBS, 2012). The average distance to family is 29,5 kilometre, which increases to 55 kilometre for academics (van Houten, M., 2016). The average commuting distance driven by car is 32 kilometre (CBS, 2016). Also, four users asked indicated an interest in the car use tracking device.

- Currently, 65% of the electric car owners charges the car at home, at a private charge station. In the future, however, this percentage is predicted to drop to 35% (Cuypers et al, 2016) due to the amount of people with a private car drive. All the other EV owners are dependent on public chargers to charge their car, which will have to be requested at the municipality. Other users might have to deliberate with their residence committee to install a charger at a semi-private car park.

- Vehicle to grid technology is an exploratory phase of development. Implementing the technology to such extend that it creates value for users is not possible before five years (Sietse Vis, personal communication, 9 May 2017). Also, the technology is found to have negative impact on the battery lifetime (Dubarry, M., Devie, A., McKenzie, K., 2017).

- A great amount of information platforms already exist online (ANWB, n.d.; Energieleveranciers.nl; n.d.; ElektrischeAuto.nl, n.d.). It is hard to stand out in the current offer. The fact that users are uninformed is often due to their lack of initiative.

- On proposing to four users, they did not seem interested in EV swap to experience the new car. Furthermore, only 0,5 to 1,5 percent of the Dutch citizens uses car sharing services (Emerce, 2015) and electric car sharing entrepreneurs struggle with user acceptance for both the electric and the sharing part of their service (Crowd Expedition, 2014).

These conclusions helped to evaluate the areas against the evaluation factors described below.

Evaluation factors

After the additional research, the opportunity areas were evaluated against criteria with the aim to reduce the possibilities from seven to three. These areas could then be used for additional diverging and exploration.

The criteria find their origin in the value they generate for the consumer and for Eneco Elektrisch laden. Futhermore, they are rated for their originality and the support they find in the research. Lastly, the success of innovations is proven to be dependent on five factors: the relative advantage, simplicity, compatibility, trialability and observability (Rogers, E.M., 2002) from the perspective of the consumer. For example: how easy is it for consumers to understand the benefits they receive from the electric car? The environmental advantages are only paper statements and the financial advantages become evident after the relative high purchase price. The electric car can especially improve on the relative advantage, compatibility, trialability and observability. Therefore, the opportunity areas are evaluated on the improvement they bring to the above factors.

The factors are weighted: since Eneco is consumer focussed and the consumer must use the service, it is

most important that they benefit from it (barrier solving and value for user). Second, it is important that the product fits Eneco Elektrisch Laden's product portfolio and generates profit (strategy match and commercial value). Thirdly, by distinguishing from the current offer, the relative advantage of the service becomes clear and competitors will struggle to copy the service. It is also important that the opportunity is substantiated by the research, but this is not decisive. The last four factors stimulate user adoption; it is great if this is improved, but not crucial.

The evaluation of the opportunity areas is shown in the tables below.

According to the ranking above, three areas are selected as most promising: 'EV-match assessment', 'VVE charger consult' and 'On-the-go charging with user-feedback'. These three areas are explored further in brainstorms and with users before a final concept is selected.

	Weight	EV-match assessment		VVE charger consult		Charging with user feedback	
Barrier solving	*5*	4	20	3	15	3	15
Value for user	*5*	3	35	4	35	4	35
Strategy match	*4*	4	51	5	55	2	43
Commercial value	*4*	3	63	4	71	4	59
Distinctiveness of service	*3*	4	75	3	80	2	65
Research support	*3*	4	87	2	86	5	80
Relative advantage of electric car	*1*	3	90	3	89	2	82
Compatibility	*1*	5	95	1	90	2	84
Trialability	*1*	1	96	1	91	1	85
Observability	*1*	1	97	2	93	3	88

	Weight	Vehicle to grid		Easy car swap		Advisory platform		Finish your old car	
Barrier solving	*5*	1	5	3	15	3	15	4	20
Value for user	*5*	3	20	3	30	2	25	1	25
Strategy match	*4*	5	40	2	38	4	41	1	29
Commercial value	*4*	2	48	4	54	3	53	3	41
Distinctiveness of service	*3*	3	57	2	60	1	56	3	50
Research support	*3*	5	72	3	69	3	65	1	53
Relative advantage of electric car	*1*	4	76	2	71	3	68	1	54
Compatibility	*1*	1	77	4	75	3	71	1	55
Trialability	*1*	1	78	5	80	1	72	1	56
Observability	*1*	1	79	4	84	1	73	1	57

B16: THE THREE CONCEPTS

In order to assess the potential of the three concepts, all three were explored further in ideation. In creative sessions, obvious and creative design directions were explored to find the most valuable direction for the consumer. Next, the concepts were described in three add-like overviews to be evaluated by potential consumers. This appendix describes the brainstorms towards the three concepts and then presents them as they were proposed to potential users.

Brainstorm

A well-known method to generate ideas is a brainstorm (Osborn, 1953). To explore the three concepts, a brainstorm was setup with five participants (the ideal amount of participants (Buijs & van der Meer, 2014)) of all IDE master directions.

After an introduction into the project and the problem, everyone was warmed up with an ice breaker. Next, each concept was divided in five sub-problems that were formulated as 'how to' questions. Next, a timer was set for two minutes upon which each participant tried to generate as many ideas as possible for one question. After two minutes, the questions were rotated to allow association on each other's ideas. After five rounds, each participant had seen each question (Buijs & van der Meer, 2014). The questions were discussed with the whole group to associate even further. Eventually, around 25 ideas were generated per sub question (see figure). The aim of the brainstorm was to generate as many ideas as possible. Participants were encouraged to be as creative as possible. These guidelines are proven to give the best result (Buijs & van der Meer, 2014).

The input from the brainstorm was used to improve the concepts. For example, one aspect generated at the brainstorm that was implemented in the concepts was to translate time, money or environmental impact to something that related to the user. To a mother, one could say that 'the time spent in a car is the equivalent of 58 bedtime stories'. This was thought to make the message more relevant.

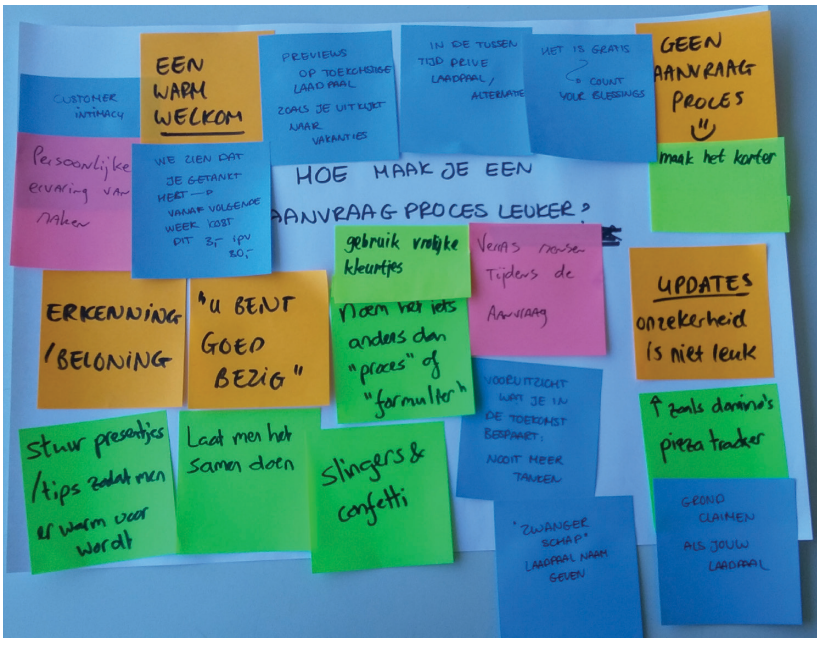


Figure 12: *one of the brainstorm questions*

Three concepts

With the input of the brainstorm, the concepts were developed to a level that could be assessed by a potential user. Later on, these descriptions could be used to evaluate the user value. The concepts are explained below.

EV-match assessment

One of the most important drawbacks of the electric car is the range. Instead of 500 km with an ordinary petrol car, the electric car reaches barely up to 200 kilometre. Users are afraid to be restricted in their mobility, while flexibility is seen as the most important advantage of a car.

Though, according to data of the CBS (2016) in the Netherlands, the average distance travelled on a day is 37 kilometre. Family, too, appears to live only 29,5 kilometre away (55 kilometre for academics, van Houten, 2016). This suggests that for the greater part of car travel, an electric car would suffice just fine. Plus, for the exceptional long-distance travel, fast chargers are available that get you up and running in a maximum of twenty minutes. Since people are in the dark about charge facilities and electric car ranges (as found in the user research), they might be helped by a personalised advisory app.

Maat (English translation: 'Mate') is a platform with app that helps you by tracking your car use. It records every trip for a longer period of time (for example two months). With GPS technology, it can exactly assess your location, the distance travelled and the parking time. If you prefer not to track this information, you can also add your mobility habits yourself, though this makes the advice less accurate.

With this information, Maat can give you tailored advice on electric cars. It can tell you what percentage of your travel you could do without charging on the go, which trips do need charging on the go and which chargers you can use. Maat can also tell what influence charging on the go has on your travel time. Furthermore, because Maat has such precise data on your car use, it can tell you your exact savings: either cost savings or environmental savings. Just like Toon, the smart thermostat, Maat will be branded to help you get insight in your car use, to start saving.

Maat helps users to find out whether an electric car would be interesting for them. By telling how much consumers can save, it provides awareness and stimulus towards electric cars. By being based on real data, the information is more trustworthy and probable to convince users. Most importantly, Maat helps to reduce the most important barrier in the adoption of electric cars: the range.

Figure 13: *advertisement EV match assessment*

VVE charger consult

In the Netherlands, 1.200.000 residents are part of a Vereniging van Eigenaren (VVE, Committee of Owners). This means that when they want to change something on the property, like the installation of a charger, they need to deliberate with the committee.

Because of the novelty of electric cars, the VVE is likely to have a lot of questions. For example: who pays for the installation? What influence does the electric car have on the network? For the electric car owner, this brings a lot of hassle in aligning the different stakeholders. This hassle is often foreseen by consumers and therefore holds them back from electric car purchase.

With its expertise, Eneco Elektrisch Laden can facilitate the charger request at the VVE. By getting themselves familiar with the organisation of the VVE and the most frequently asked questions, they can guide the EV owner in the purchase of a charger. They can provide a process the EV owner can follow, while being available for consultation by phone. This way, they provide the owner with a structured process that leads to a quick result. Simultaneously, Eneco Elektrisch Laden earns money with the sale of a charge point.

By facilitating the request for a charger, Eneco Elektrisch Laden relieves the consumer of a frustrating, time consuming task. The service fits their strategy perfectly. Their expertise will speed up the process and therefore creates value for the user. With this, it lowers the threshold to an electric car for the 1,2 million residents coordinated by a VVE.

Figure 14*: advertisement VVE charger consult*

On-the-go charging with user-feedback

Once consumers own an electric car, they will sometimes need to charge on the go. Once they search for chargers, they are likely to be disappointed by the accuracy of the information. As found in the user research, locations of chargers are often off, chargers are broken or appear to be private. Because this is the only information available, they have no choice but to trust the information, ending up frustrated and possibly even with an empty battery.

This problem can be solved by using 'user feedback' to improve the information in the application. When a user of the application discovers that a charger is private, he or she can adjust this information in the app. App users can improve the charger location, report broken chargers and add special information (for example: 'this is a private charger which can be used if the owner is home'). The app will require multiple users to confirm the adjustment before it is accepted, to prevent abuse. Giving feedback in the app could be rewarded by discount on charging or extra functionalities like charger reservations.

Next to this feature, users of the app will also be asked to add their expected departure time. This helps other users to estimate the availability of the charger. Once the hardware of the charging stations allow real-time availability tracking, this feature will also be added to the application.

The application also leaves room for Eneco Elektrisch Laden to include a 'consumer profile' to the application, in which the user can find his charging history, billing and average charge time. This application can be used to switch memberships. This also provides an opportunity to offer templates for 'costs', 'technology' or 'sustainability'. With the template, the user could see cost savings, CO2 savings or compare his driving style to others.

The application with user feedback makes use of the potential of its users. This will make sure the offered information is correct and therefore saves users time and frustration. The trustworthiness of the information makes sure Eneco Elektrisch Laden is ahead of competition. The app brings a seamless charging experience one step closer and thereby helps consumers to switch to electric driving.

Figure 15*: advertisement charging on the go*

B17: USER FEEDBACK ON CONCEPTS

The previous appendix presented the three concepts. For further development, the most promising concept will be chosen. In order to do so, the concepts will be evaluated against the same criteria that were mentioned in appendix B15, to see which concept fits best to the goal of the project. These criteria were 'barrier solving'; 'value for user'; 'strategy match', 'commercial value', 'distinctiveness of service', 'research support', and the theory of Rogers (2010): 'relative advantage', 'compatibility', 'trialability' and 'observability'.

Since the most important criteria are mentioned first, one can conclude that the 'barrier solving' and 'value for user' factors are very important. The three concepts, VVE charger consult, EV-match assessment and On-the-go charging with user-feedback all answer to a need or a frustration in electric car consumers. However, it is hard to assess the value of one concept over another. The topics were not explicitly covered in the interviews. Also, the interview participants were early adopters, close to the purchase of an electric car. They may have a different opinion than the early majority, that has hardly been explored yet. Therefore, additional user research is necessary to evaluate the 'barrier solving' and 'value for user' for the three concepts to enable concept choice.

Thus, another user research was set up. This appendix will cover the method, results, conclusion and discussion

Method

The goal of the research was to evaluate the importance of different barriers in electric car purchase and to assess the participants interest in the three service concepts that were developed.

Procedure

For the validity of the research, the amount of participants was considered important. Therefore, the research was setup as an internet survey that can easily be spread through email and social media. The online survey programme Google Forms was used to setup the questionnaire. Because the service is developed for the Dutch market, the survey was setup in Dutch.

The survey started with a few questions to assess the interest in – and experience with – the electric car, to understand where the consumer was in Rogers' adoption curve (Rogers, 2010). Next, participants were asked to what extend they experienced different assumed disadvantages of the electric as a problem ("Houdt uw kennis over de laadfaciliteiten u tegen om een elektrische auto aan te schaffen?"). Other questions were asked to define whether the service would be a solution for their problem ("In hoeverre bent u zich bewust van de faciliteiten om een elektrische auto op te laden in uw omgeving?"). Then, the participants received information about the three concept services (see stimuli), and were asked to express whether this would help them in EV purchase, their interest and willingness to pay. Also, the participants were asked for suggestions to improve the service. The survey was closed off with demographic questions about their gender and age. The complete survey can be found in Appendix B18.

Stimuli

In order to evaluate the concepts, the participants were given information about them first. The concepts were presented with an 'advertisement' accompanied by a clarification text:

"Als je een elektrische auto wilt kopen terwijl je een parkeerplaats deelt, kan het aanvragen van een laadpaal lastig zijn. Verenigingen van Eigenaren missen vaak kennis over de belasting van het netwerk, kosten en stroomverbruik. Omdat we precies weten wat er speelt kunnen wij helpen in het aanvraagproces, zodat u snel op weg kunt met de elektrische auto."

"De app 'Maat' helpt u te bepalen of een elektrische auto iets voor u is. Door uw autogebruik voor een langere periode (meer dan twee maanden) te analyseren kan hij persoonlijke informatie geven over dagelijks autogebruik en laadinfrastructuur in de buurt. Zo kan hij u helpen te besparen: voor uw portemonnee of voor het milieu."

"ChargeBuddy is een app met informatie over laadpalen: locatie, prijs, laadsnelheid en stroomsoort van de faciliteit worden gegeven. Wat deze app speciaal maakt, is dat de gebruiker de mogelijkheid heeft om de informatie te verbeteren. Zo wordt de informatie continu gecontroleerd en weet de gebruiker zeker dat het klopt."

Participants were asked to read the information carefully before answering the questions.

Participants

Participants were recruited through social media, flyers in apartment flats and through email. The requirements for the participants were that they should own a non-electric car and have (potential) interest in the electric car.

In total, 36 participants have filled in the questionnaire, of which 19 males and 17 females. The average age of the participants was 45,6 (see Figure 16).

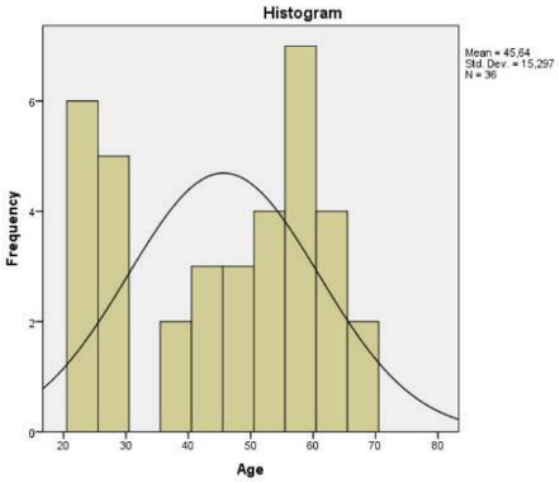


Figure 16: *age division of participants*

Analysis

The results were analysed in the IBM programme SPSS Statistics. The programme was mainly used to calculate the mean. No further analyses were done in the programme, because the result proved insignificant due to the limited amount of participants.

Results

The results of the survey can be split in four topics: interest in the electric car and feedback on the three concepts: EV-match assessment, VVE charger consult and On-the-go charging with user-feedback.

Interest in the electric car

On a seven point scale, the 36 participants averaged 5.1

on electric car interest. However, when asked after the probability of their next car being electric, the average was an 3.8. The participants had very little experience with the electric car: that question resulted in an average of 1.9.

Participants were also asked after their main reason to consider an electric car. Sustainability was mentioned by almost two thirds of the participants. Other reasons were costs and independence on fossil fuels. Participants also expected electric cars to be privileged. They liked that the electric car would result in a better air quality.

For reasons against electric car purchase, range, costs and charging were mentioned most often. For charging, participants mentioned hassle for charging, the density of the charging network and the charging time. Participants were also worried about charging abroad, the sound of the engine (for safety reasons) and the purchase price.

EV-match assessment

The barriers that would advocate for the 'EV-match assessment' app were the range and the awareness of the charging network. The question 'to what extend is the range a barrier' resulted in an average of 5.4 on a seven-point scale. On the other hand, participants were aware of the distances they drove: they indicated this with a 5.9 average. Their awareness with the electric car range was scored with an 4.6 on average. However, this was checked by asking what they expected as the range and most participants were too optimistic. Both the question 'to what extend are you aware of charging facilities in your surroundings' and 'is this knowledge a barrier in electric car purchase' resulted in an average of 3.3.

Next, the service was introduced. The question 'would this help in the consideration for an electric car' was answered with a 4.7 average. The question 'I would be interested in the service' scored a 4.8 average. 23 participants were not willing to pay for the service; 13 participants would pay for the service.

Suggestions for improvement included 'honest information on range per car type', privacy concerns, the option to include the mobility of others in the household, the assessment of exceptional trips like holidays and use outside of the Netherlands.

VVE charger consult

Of the participants, 18 used a shared parking space to park their car. The following questions were only answered by those 18 participants. Participants gave a 4.5 score on the question 'I expect to struggle with getting a charger'. When asked whether this hold them back in electric car purchase, they answered with a 3.9.

When the service was proposed, they scored the helpfulness in the consideration with an 4.2 and their interest in the service with an 3.8. Ten of the 18 participants were willing to pay for the service.

Suggestions for improvement covered a 'no cure no pay' business model, the advice to calculate the costs for the service in the price for the power or a connection to solar panels nearby.

On-the-go charging with user-feedback

Participants were asked after their expectation on the infrastructure and the awareness of chargers in the neighbourhood. The participants scored the 'I expect to have trouble to find available chargers' with an 4.6. The question 'I expect the information on the infrastructure is an issue' with an 3.2. The question whether this hold them back from electric car purchase was answered with a 3.8 average.

Here, the same questions as in EV-match assessment are relevant: the awareness of the chargers and whether that knowledge is a barrier: both scored with a 3.3.

The service proposal scored an 4.9 on 'this would help me in my electric car consideration'. Participants scored a 5.4 on their interest in the service. 21 participants would pay for the service.

Suggestions participants came up with were reserving chargers through the app, the availability of the chargers, the functionalities for the rest of Europe, the possibility to upload a picture and a push notification when the battery is charged. A few participants mention that this service is already offered by different websites and car navigation systems.

Remarks

In the remarks section, some participants justified their

considerations to not buy an electric car. Apart from what is already mentioned, some participants were worried about the possibility to pull a caravan. Other participants thought the amount of cars had to go down. One participant said old cars had to be rebuild to electric cars, to save the impact of manufacturing processes.

Conclusion

Based on the results, different conclusions can be drawn. Three topics will be covered in the conclusion: the interest in an electric car, the ability of the services to solve barriers and the value for the user.

Interest in an electric car
This survey shows that even though consumers do not consider to buy an electric car yet, the interest in the electric car is pretty high. Apparently, consumers do think the electric car is promising in the future, but need to develop trust in the infrastructure and user friendliness still. It also confirms that few people have experience with the electric car yet.

Once again, sustainability proves the main reason to consider the electric car. Range, costs and trust in the infrastructure are reasons to delay purchase.

EV-match assessment
Participants do consider the range as an important barrier: they are indeed afraid the range will restrict them. However, they claim to be aware of the distances they drive and the range of the electric car. This would suggest they do not need an app to inform them about the match between the electric car and their driving habits. Though, once asked after the range, participants are often too optimistic. This indicates that the range will even be a bigger barrier than they already think.

Thus, the participants think they are aware of their driving habits and the electric car range, but their guess proves they are less familiar with the range than they think. Furthermore, they are unfamiliar with the infrastructure. Though they think this is no barrier, it makes it hard for them to estimate what it means to own an electric car. Though they fear it might restrict them, they are unaware to what extent.

On proposal of the service, participants are mildly enthusiastic. They indicate a moderate interest in the service and say this might help them in their consideration. However, they prefer not to pay for the service, because it is considered as promotion material.

VVE charger consult
Then, for VVE charger consult, participants do expect issues in getting a charger. This might hold them back in electric car purchase, but they are clearly not so sure about this because the score is relatively low. This shows that getting a charger is not the first thing participants are concerned about.

When the service is proposed, they respond similarly. Their scores indicate the service might help them in their electric car considerations and they might be interested in the service. The answers about payment are mixed: a slight majority wants to pay for the service.

On-the-go charging with user-feedback
Concerning the on the go charging infrastructure, participants have some reservations. They do think they will struggle in finding available chargers. However, this will probably be not due to the inaccurate information. They think this might be a factor in electric car considerations. Up until now, they are unaware of chargers in their surroundings, but they do not consider this an important barrier.

Thus, the participants do think it is hard to find available chargers, but do not blame this on the information of the infrastructure. According to their comments, they expect this due to the undeveloped infrastructure and the amount of chargers. Therefore, it can be concluded that an app hardly lower the barrier: this is not what they think will solve the problem, even though electric drivers think differently.

After presentation of the service, they are interested in the service and think it might help them in their electric car consideration. Though, judging from the comments, the participants think this information is already available.

Discussion

Altogether, the three services were evaluated positive. All

services have at least a moderate interest of participants and a considerate amount of the participants wants to pay for the services. When the three services are compared on the factors 'barrier solving' and 'value for user', a few conclusions can be drawn.

Of all services, 'EV-match assessment' responds to the most important barrier. Potential electric car drivers do consider the range as an issue, but are unaware of the charging facilities and the impact the electric car might have on their mobility. Both the 'VVE charger consult' and 'On-the-go charging with user-feedback' respond to a smaller problem, less important to consumers.

Then, the 'On-the-go charging with user-feedback' has the highest user value. Participants score that service the highest of all three services. If the information is reliable and accurate, they would even pay for the service. Though, from the comments one can conclude that they think the service is already offered. Also, the participants do not expect big problems in the information on the charging infrastructure. Therefore, this user value might be significant, but since they expect it to be already there, it will be no stimulus towards the electric car. The 'EV-match assessment' app scores pretty positive and has therefore a sufficient user value. The 'VVE charger consult' service does not convince participants so well. Their scores are little over neutral and the user value is therefore relatively small.

This user research gave insight in the consumer opinion on the three service proposals. It has improved the assumptions done before, which can now be used for concept evaluation. The research has thereby contributed to a reliable concept selection.

B18: SURVEY: FEEDBACK ON CONCEPTS

This appendix presents the survey used to gauge the service interest of potential electric car owners.

[start of the survey]

Hallo!
Mijn naam is Maaike en op dit moment ben ik aan het afstuderen aan de TU Delft. Als afstudeerproject ben ik een service aan het ontwikkelen met betrekking tot het opladen van een elektrische auto. De service moet de drempel tot de aanschaf van een elektrische auto verlagen.
Op dit moment heb ik een paar servicerichtingen bedacht waar ik de interesse voor wil peilen. Dat doe ik in deze enquête door eerst vragen te stellen over barrières in de aanschaf van de elektrische auto en daarna de servicerichtingen voor te stellen. Ik ben benieuwd naar uw mening!
Het invullen duurt vijf minuutjes en helpt mij om de service te verbeteren (en om af te studeren!).
Bedankt!

Maaike

[volgende pagina]

Screening

1. Bent u in het bezit van een brandstof auto?
Ja (next question) /nee (Helaas valt u niet binnen de doelgroep, bedankt voor het proberen!)

[volgende pagina]

2. Heeft u interesse in een elektrische auto?
Nee (helaas valt u niet binnen de doelgroep) / Ja, misschien in de toekomst (next question

[volgende pagina]

Algemeen

3. Hoe sterk is uw interesse in een elektrische auto?
1-7 milde interesse / sterke interesse

4. Hoe waarschijnlijk is het dat uw volgende auto elektrisch is?
1-7 zeer onwaarschijnlijk / zeer waarschijnlijk

5. Hoeveel ervaring heeft u met elektrische auto's?
1-7 geen ervaring / veel ervaring

6. Wat is voor u een belangrijke reden om een elektrische auto te overwegen?

7. Wat is voor u de belangrijkste drempel in de aanschaf van een elektrische auto?

[volgende pagina]

Actieradius

8. Ervaart u de actieradius als een drempel in de aanschaf van een elektrische auto?
1-7 Helemaal niet / heel erg

9. In hoeverre bent u zich bewust van de afstanden die u rijdt?
1-7 Ik weet niet welke afstanden ik rijd / ik weet precies welke afstanden ik rijd

10. In hoeverre bent u zich bewust van de actieradius van de elektrische auto?
1-7 ik weet niet wat de actieradius is / ik weet precies wat de actieradius is

11. Wat is de actieradius van de elektrische auto?

[volgende pagina]

Laadinfrastructuur

12. In hoeverre bent u zich bewust van de laadfaciliteiten in uw omgeving?
1-7 ik weet niet hoe de laadinfrastructuur is / ik weet precies hoe de laadinfrastructuur is

13. Houdt dit u tegen om een elektrische auto aan te schaffen?
1-7 Helemaal niet / heel erg

14. Verwacht u moeite te hebben met het vinden van beschikbare laadinfrastructuur onderweg?
1-7 Helemaal niet / heel erg

15. Verwacht u problemen in de informatievoorziening voor beschikbare laadinfrastructuur onderweg?
1-7 Helemaal niet / heel erg

16. Houdt dit u tegen om een elektrische auto aan te schaffen?
1-7 Helemaal niet / heel erg

17. Woont u in een appartementencomplex met gedeelde parkeerplaats?
Ja (volgende vraag)/nee (ga door naar vraag 24)

[volgende pagina]

18. In hoeverre verwacht u moeite te hebben met de aanvraag van een laadpaal voor de gedeelde parkeerplaats?
1-7 geen problemen / grote problemen

19. Houdt dit u tegen om een elektrische auto aan te schaffen?
1-7 Helemaal niet / heel erg

[volgende pagina]

Vanaf hier worden drie servicevoorstellen getoond die u kunnen helpen in uw overweging voor de aanschaf van een elektrische auto. De voorstellen hebben de vorm van een advertentie. Lees de advertentie en de begeleidende tekst goed en beantwoord daarna de vragen.

[volgende pagina]

Concepten

Als je een elektrische auto wilt kopen terwijl je een parkeerplaats deelt, kan het aanvragen van een laadpaal lastig zijn. Verenigingen van Eigenaren missen vaak kennis over de belasting van het netwerk, kosten en stroomverbruik. Omdat we precies weten wat er speelt kunnen wij helpen in het aanvraagproces, zodat u snel op weg kunt met de elektrische auto.

20. Denkt u dat dit product helpt in de overweging voor een elektrische auto?
1-7 helemaal niet – heel erg

21. Zou u interesse hebben in het product?
1-7 helemaal niet – heel erg

22. Zou u bereid zijn voor dit product te betalen?
Ja/nee

23. Heeft u nog suggesties ter verbetering van het product?

[volgende pagina]

De app 'Maat' helpt u te bepalen of een elektrische auto iets voor u is. Door uw autogebruik voor een langere periode (meer dan twee maanden) te analyseren kan hij persoonlijke informatie geven over dagelijks autogebruik en laadinfrastructuur in de buurt. Zo kan hij u helpen te besparen: voor uw portemonnee of voor het milieu.

24. Denkt u dat dit product helpt in de overweging voor een elektrische auto?
1-7 helemaal niet – heel erg

25. Zou u interesse hebben in het product?
1-7 helemaal niet – heel erg

26. Zou u bereid zijn voor dit product te betalen?
Ja/nee

27. Heeft u nog suggesties ter verbetering van het product?

[volgende pagina]

ChargeBuddy is een app met informatie over laadpalen: locatie, prijs, laadsnelheid en stroomsoort van de faciliteit worden gegeven. Wat deze app speciaal maakt, is dat de gebruiker de mogelijkheid heeft om de informatie te verbeteren. Zo wordt de informatie continu gecontroleerd en weet de gebruiker zeker dat het klopt.

28. Denkt u dat dit product helpt in de overweging voor een elektrische auto?
1-7 helemaal niet – heel erg

29. Zou u interesse hebben in het product?
1-7 helemaal niet – heel erg

30. Zou u bereid zijn voor dit product te betalen?
Ja/nee

31. Heeft u nog suggesties ter verbetering van het product?

[volgende pagina]

Demografisch

32. Wat is uw leeftijd?

33. Wat is uw geslacht?
Man/vrouw/zeg ik liever niet

34. Heeft u nog andere opmerkingen die voor het onderzoek van belang kunnen zijn?

B19: CONCEPT CHOICE

This appendix describes the evaluation of the concepts and motivates the concept choice.

Concept evaluation

With the input of the survey, the three concepts were re-evaluated against the same criteria as in appendix. The result is shown in table. In conclusion, the following can be said about the concepts.

EV-match assessment

The first concept scores relatively low on the strategy match, because it is different from what Eneco Elektrisch Laden already offers. On the other hand, it does have a strong link to the vision of Eneco Elektrisch Laden: lowering barriers for EV purchase. The commercial value is also low, because it is a pre-sale tool and therefore does not earn money in itself. Though, the concept is evaluated well for barrier solving, because it links to an important barrier in electric car purchase. Other good points are the distinctiveness, the support in the research for the project and the 'compatibility' in Rogers' theory (2010). It is different from the tools that are already there and helps consumers to understand how the electric car would fit in their life.

VVE charger consult

The second concept scores moderately on the barrier solving criterion. The survey has shown that consumers are not really hold back from electric car purchase because of the charger. The problem with VVE's is known and some support is already in place, which makes the service less distinctive. The service is also only moderately supported by the research within the project. Plus, the service hardly influences the factors of Rogers (2010). On the other hand, the concept scores very well on the strategy match and the commercial value. Consulting in charger installation is exactly what Eneco Elektrisch Laden already does for their business customers. By doing so, they sell chargers and therefore it has a good commercial value.

On-the-go charging with user-feedback

The last concept's weak points are the strategy match and the distinctiveness. Eneco Elektrisch Laden has consciously refrained from offering on the go charging services and the app therefore does not fit their vision. On top of this, a lot of apps with information on chargers are already offered. Though the information can definitely be improved, others are likely to copy which makes the competitive advantage short lived. Also, prospective EV drivers are not aware of the inaccurate information and therefore do not experience this as a barrier. The factors of Rogers (2010) are hardly improved. The positive points of the service are the value for the user: accurate information is very important to provide a seamless charging experience. The concept is also supported very well by the research.

	Weight	EV-match Assessment		VVE charger consult		Charging user-feedback	
Barrier solving	*5*	4	20	3	15	3	15
Value for user	*5*	3,5	38	3	30	4	35
Strategy match	*4*	3	50	5	50	1	39
Commercial value	*4*	2	58	5	70	3	51
Distinctiveness of service	*3*	4	70	3	79	2	57
Research support	*3*	5	85	3	88	4	69
Relative advantage of electric car	*1*	3	88	1	89	1	70
Compatibility	*1*	5	93	1	90	1	71
Trialability	*1*	1	94	1	91	1	72
Observability	*1*	2	96	2	93	2	74

Concept choice

Following the reasoning in the evaluation above, one of the concepts can quite easily be eliminated. The on-the-go charging with user-feedback does not fit the strategic goals of Eneco Elektrisch Laden and the competitive advantage is not strong enough, therefore, it is ruled out.

The choice between the other concept is more difficult. The VVE charging consult is realistic, attainable and profitable, which makes it interesting. The EV-match assessment, on the other hand, solves a real issue, fits the results of the research well and is an answer to the main goal of the assignment. Both are strong concepts for different reasons.

Though, in the light of this project, the EV-match assessment is thought to be a more interesting choice. The service is a better match with the main goal of the assignment and offers opportunities to incorporate the developed user profiles. It follows the research results naturally and has a significant effect on Rogers' adoption of innovation factors. It is a chance to inform consumers about the fit between the electric car and their mobility habits, while at the same time giving them personalised information about their environmental and cost savings. With this, it helps to solve the most infamous drawback of the electric car: the range.

A20: REFERENCES

- ANWB (n.d.) Elektrisch rijden – alles over Elektrische auto's – ANWB Electrische auto. Retrieved 15 May 2017, from https://www.anwb.nl/auto/elektrisch-rijden
- Autoblog (2015). ¨Diesel ouder dan acht jaar niet langer in Rotterdam¨. – Autoblog.nl. Retrieved 17 March 2017, from http://www.autoblog.nl/nieuws/diesel-ouder-dan-acht-jaar-niet-langer-in-rotterdam-75399
- Boxwell, M., (2011). What are electric cars like in bad weather? Retrieved 16 March 2017, from http://www.thechargingpoint.com/knowledge-hub/hot-topics/what-are-electric-cars-like-in-bad-weather.html
- Buijs, J., & van der Meer, H. (2014). Professioneel Wyberen. Het organiseren en leiden van creatieve sessies. Boom & Lemma, Amsterdam.
- CBS (2012). Personenauto's rijden gemiddeld 37 kilometer per dag. Retrieved 15 May 2017, from https://www.cbs.nl/nl-nl/nieuws/2012/10/personenauto-s-rijden-gemiddeld-37-kilometer-per-dag
- CBS (2016). Transport en mobiliteit 2016. Retrieved from www.cbs.nl https://www.cbs.nl/nl-nl/publicatie/2016/25/transport-en-mobiliteit-2016
- CBS (2015). Tot 2040 verdubbelt het aantal alleenwonende tachtigplussers. Retrieved 17 March 2017, from https://www.cbs.nl/nl-nl/nieuws/2015/51/tot-2040-verdubbelt-het-aantal-alleenwonende-tachtigplussers
- CBS (2016). Storymap Verstedelijking. Retrieved 17 March 2017, from https://www.cbs.nl/nl-nl/achtergrond/2016/23/storymap-verstedelijking
- CBS (n.d.). Dossier Vergrijzing. Retrieved 17 March 2017, from https://www.cbs.nl/nl-nl/dossier/dossier-vergrijzing
- Chafkin, M., (2014). A Broken Place: The spectacular failure of the startup that was going to change the world. | FastCompany. Retrieved 15 March 2017, from https://www.fastcompany.com/3028159/a-broken-place-better-place
- Crowd Expedition (2014). Rechters, scholen en bedrijven delen elektrische auto's – Crowd Expedition. Retrieved 15 May 2017, from http://www.collaborative-economy.com/nl/uncategorized/rechters-scholen-en-bedrijven-delen-elektrische-autos/
- De Kennis van Nu (2017, February 21). De Kracht van Zonne-energie [Television Episode]. Retrieved from http://www.dekennisvannu.nl/site/media/De-kracht-van-zonne-energie/6319
- Dubarry, M., Devie, A., & McKenzie, K. (2017). Durability and reliability of electric vehicle batteries under electric utility grid operations: Bidirectional charging impact analysis. Journal of Power Sources, 358, 39-49.
- Economic Board Utrecht (2014). Proeftuin voor slimme laadpalen in Lombok | Economic Board Utrecht. Retrieved 17 March 2017, from http://www.economicboardutrecht.nl/nieuws/proeftuin-voor-slimme-laadpalen-lombok
- ElektrischeAuto.nl (n.d.). Elektrische Auto, E-Auto, Elektro Auto Informatie, Nieuws en Blog. Retrieved 15 May from https://www.elektrischeauto.nl/
- Emerce (2015). Deeleconomie zit in de lift – Emerce. Retrieved 15 May 2017, from https://www.emerce.nl/nieuws/deeleconomie-zit-lift
- Energieleveranciers.nl (n.d.). Wat kost een elektrische auto? Energieleveranciers.nl. Retrieved 15 May 2017, from https://www.energieleveranciers.nl/elektrische-auto/kosten-elektrische-auto
- Europa Nu (2010). Europese Commissie heft plan voor elektrische auto's opgesteld (en) – Europa Nu. Retrieved 17 March 2017, from http://www.europa-nu.nl/id/vierc9yhj2yt/nieuws/
- European Commission (n.d.). Electric vehicles – European Commission. Retrieved 17 March 2017, from http://ec.europa.eu/transport/themes/urban/vehicles/road/electric_en
- Fastned (n.d.) How fast charging works | Fastned. Retrieved 15 March 2017, from https://fastned.nl/en/how-it-works
- Fehrenbacher, K., (2016). Tesla Says All New Cars Now Have Full Self-Driving Tech | Fortune.com. Retrieved 16 March 2017, from http://fortune.com/2016/10/19/tesla-self-driving-tech/
- Hensley, R., Knupfer, S. M., Krieger, A. (2011). The Fast Lane to the Adoption of Electric Cars. McKinsey Quarterly. February 2011.
- van Houten, M., (2016). Zo ver wonen kinderen niet van ouders. | TROUW. Retrieved 15 May 2017, from https://www.trouw.nl/home/zo-ver-wonen-kinderen-niet-van-ouders~a93e0f94/
- Infineon (2017). An Intelligent streetlight for the city of the future: Infineon teams up with eluminocity. – Infineon Technologies. Retrieved 15 March 2017, from http://

www.infineon.com/cms/en/about-infineon/press/market-news/2017/INFPMM201712-035.html
- Jolly, D., (2015). Norway Is A Model for Encouraging Electric Car Sales. – The New York Times. Retrieved 17 March 2017, from https://www.nytimes.com/2015/10/17/business/international/norway-is-global-model-for-encouraging-sales-of-electric-cars.html?_r=0
- Kamp, H.G.J. (2016-a). Uitvoering van de motie Groot. Ministerie van Economische Zaken. DGBI-GGBBE / 16081107.
- Kamp, H.G.J. (2016-b). Groene economische groei in Nederland (Green Deal). Mobiliteitsbeleid. 31 305 33 043; nr. 219.
- Korosec, K., (2015). Tesla's battery swap program is pretty much dead. |Fortune.com. Retrieved 15 March 2017, from http://fortune.com/2015/06/10/teslas-battery-swap-is-dead/
- Lane, B., & Potter, S. (2007). The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. Journal of cleaner production, 15(11), 1085-1092.
- Mercedes-Benz (n.d.). Autonomous Driving – Mercedez-Benz. Retrieved 16 March 2017, from https://www.mercedes-benz.com/en/mercedes-benz/innovation/autonomous-driving/
- Morris, C. (2017a). Charged EVs | WAVE demonstrates 250 kW wireless en route charging for e-buses. Retrieved 15 March 2017, from https://chargedevs.com/newswire/wave-demonstrates-250-kw-wireless-en-route-charging-for-e-buses/
- Morris, C. (2017b). Charged EVs | European fast charging networks work together to promote seamless electric travel. Retrieved 15 March 2017, from https://chargedevs.com/newswire/european-fast-charging-networks-work-together-to-promote-seamless-electric-travel/
- MVO Nederland (2014). Consument let meer op duurzaamheid bij aankopen. Retrieved 17 March 2017, from http://mvonederland.nl/nieuws/consument-let-meer-op-duurzaamheid-bij-aankopen-0
- Nibud (2017). Nibud koopkrachtberekeningen 2017: koopkracht meestal lager dan loonstrookje. – Nibud – Nationaal Instituut Budgetvoorlichting. Retrieved 17 March 2017, from https://www.nibud.nl/beroepsmatig/koopkrachtberekeningen-2017/
- Nu.nl (2012). Utrecht weert vervuilende auto's uit centrum | Nu – het laatste nieuws lees je als eerst op nu.nl. Retrieved 17 March 2017, from http://www.nu.nl/binnenland/2846202/utrecht-weert-vervuilende-autos-centrum.html
- Nu.nl (2014). Populariteit elektrische fiets verder gestegen. | NU - Het laatste nieuws lees je als eerst op nu.nl. Retrieved 17 March 2017, from https://zoek.officielebekendmakingen.nl/kst-30196-449.htmlhttp://www.nu.nl/economie/3714548/populariteit-elektrische-fiets-verder-gestegen.html
- Osborn, A. F. (1953). Applied imagination, principles and procedures of creative thinking.
- Overheid.nl (2016). Duurzame Ontwikkeling en Beleid; gewijzigde motie (nader); nader gewijzigde motie van het lid Jan-Vos c.s. (t.v.v. 20196, nr. 448) over de verkoop van emissieloze auto's in 2025. Retrieved 17 March 2017, from https://zoek.officielebekendmakingen.nl/kst-30196-449.html
- PBL, (2015). Energietransitie – PBL Planbureau voor de Leefomgeving. Retrieved 17 March 2017, from http://themasites.pbl.nl/energietransitie/
- Plugless (n.d.). Meet Plugless | The Wireless EV Charging Station. Retrieved 15 March 2017, from https://www.pluglesspower.com/
- Rabobank (2016-a). Mobiliteit, Rabobank Cijfers & Trends. Retrieved 17 March 2017, from https://www.rabobankcijfersentrends.nl/index.cfm?action=sector&sector=Mobiliteit
- Rabobank (2016-b). Universele Autobedrijven, Rabobank Cijfers & Trends. Retrieved 17 March 2017, from https://www.rabobankcijfersentrends.nl/index.cfm?action=branche&branche=Universele_autobedrijven
- Rijksoverheid (2015). Wijzigigen autobelastingen 2017-2020 | Belasintgen op auto en motor | rijksoverheid.nl. Retrieved 17 March 2017, from https://www.rijksoverheid.nl/onderwerpen/belastingen-op-auto-en-motor/inhoud/voorgenomen-wijzigingen-autobelastingen-2017-2020
- Rogers, E. M. (2002). Diffusion of preventive innovations. Addictive behaviors, 27(6), 989-993.
- Singh, S., (2014). The 10 Social and Tech Trends That Could Shape The Next Decade. Retrieved 17 March 2017, from https://www.forbes.com/sites/sarwantsingh/2014/05/12/the-top-10-mega-trends-of-the-decade/#31199482a62c
- Sortomme, E., & El-Sharkawi, M. A. (2011). Optimal charging strategies for unidirectional vehicle-to-grid. IEEE Transactions on Smart Grid, 2(1), 131-138.
- Tesla (n.d.). Supercharger | Tesla Nederland. Retrieved 15 March 2017, from https://www.tesla.com/nl_NL/supercharger?redirect=no
- Tesla Motors Club (2015). Optimal Battery Temperature | Tesla Motors Club. Retrieved 16 March 2017, from https://teslamotorsclub.com/tmc/threads/optimal-battery-temperature.51735/
- TrendWatching (2016). TrendWatching | 5 Consumer Trends for 2017. Retrieved 17 March 2017, from http://trendwatching.com/trends/5-trends-for-2017/