BACHELOR THESIS

Consumer adoption of electric vehicles

Do users differ in their change of perception of comfortable range after gaining knowledge?

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13-06-2016

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Abstract

Even though electric vehicles are regarded as a future solution to create a more environmental friendly transportation system, the adoption process of this new technology is slow and market penetration remains low. This study explored one possibility to enhance the adoption process and dispose one of the main barriers regarding the adoption of electric vehicles, by increasing user's knowledge and accounting for differences between users. To do so two parted interviews with a short information intervention in between the two parts were conducted. The results suggest two different Personas, which substantially differ in characteristics, needs and possibility to dispose barriers through enhancing of knowledge. For one Persona range of electric vehicles can be considered a rather psychological barrier and therefore enhancing knowledge helped reducing the range barrier. For the second Persona on the other hand, range seems to be a rather factual barrier and increasing knowledge had no influence. This shows that one of the main barriers for the adoption, the range of electric vehicles, could for a portion of the users possibly be tackled by relatively low cost interventions and opens the door for further investigation of other barriers.

Sammenvatting

Hoewel elektrische voertuigen als een mogelijke oplossing voor een milieuvriendelijke transport systeem worden beschouwd, gaat het adoptie proces traag en marktpenetratie blijft laag. Deze studie onderzocht een mogelijkheid om het adoptie proces te verbeteren en een van de hoofdbarrieres voor het adoptie proces te verwerpen,door het vergroten van kennis van de gebruikers onder inachtneming van verschillen tussen de gebruikers. Daarvoor zijn in twee gedeelte interviews met een korte informatie interventie tussen de twee delen uitgevoerd. De resultaten suggereren twee verschillende persona's, die significant verschillen in kenmerken, behoeften en de mogelijkheid om barrieres door het verbeteren van kennis te verwerpen. Voor een persona kan range van elektrische voertuigen als psychologische barriere worden beschouwd en daarom lijkt dus ook een verhoging van kennis bij deze persona tot het verwerpen van range als barriere te voeren. Voor de tweede persona lijkt range nogal een feitelijke barriere te zijn en het verhogen van kennis had geen invloed. Hieruit blijkt dat een van de belangrijkste barrieres voor de adoptie van elektrische voertuigen, namelijk range, eventueel kan aangepakt worden door relatief goedkope interventies vorr een deel van de gebruikers, en opent de deur voor verder onderzoek van andere barrières.

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Introduction

In the past decade ambitious goals to reduce CO_2 emissions worldwide have been set by supranational and national institutions (European Commission, 2012), including critical CO_2 reduction in the transportation sector, as it is estimated that the share of greenhouse gas emission from this sector is set to increase by 50 % trough 2030 (IEA, 2007). The implication of these findings is, that the current transportation system is not feasible anymore and a transformation towards a more sustainable and future oriented system is urgently needed. The International Transportation Forum (2010) concluded that emission targets as set by the supranational institutions will mainly have to be met by new technological developments, as electrical vehicles, in the long term. Electric vehicles are introduced as a transportation possibility that can end the dependency on fossil fuels and reduce CO_2 emissions to protect the environment (Rezvani, Jansson, & Bodin, 2015), which is amplified by other studies, as for example King (2007, 2008) states that in regard of a long term solution only technologies with zero- emission should be prevalent and the use of pure electric vehicles might provide that in the future (Egbue & Long, 2012). But the adoption process of electric vehicles is slow and research conducted to assess the willingness of potential consumer's adoption of EVs reach generally the same conclusion: EVs are not entirely competitive and market demand for electric vehicles is rather weak (e.g. Dagsvik, Wennemo, Wetterwald, &Aaberge, 2002; Achtnicht, Bühler, & Hermeling, 2012). Therefore, research is needed to enhance the adoption process and overcome barriers towards the adoption of electric vehicles. In line with that this study explores whether range, one of the main barriers in the adoption of electric vehicles, can be overcome be enhancing users coping skills, especially enhancing user's knowledge, through a short knowledge intervention.

For further investigation a distinction has to be made between different types of electric vehicles. Electric vehicles are vehicles that are either partial or entirely powered by electricity. They can be categorized in three different categories: Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs) (Egbue & Long, 2012). BEVs are powered solely by batteries, normally lager than those of PHEVs that are rechargeable and are restricted in the range by the capacity of the battery. The main advantage of BEVs is that those vehicles do not emit any greenhouse gases directly and - if the electricity to recharge the vehicle is produced by renewable energies - none at all. As mentioned beforehand in the long-term only zero emission technologies, as BEVs are, should prevail (King, 2007) and are a possible alternative to significantly cut down Europe's

greenhouse gas emissions. Therefore this study only considers BEVs.

On further review of the literature a number of reasons for the weak current market position of BEVs can be found. Barriers towards the adoption of EVs mentioned in the literature are the high purchase cost of BEVs in comparison to an equal CV (Egbue & Long, 2012) and an expected disutility (10.000-16.250$) in owning an EV in comparison to a CV (Sovacool &Hirsh, 2008). Moreover it was found that potential customer's underestimate future savings of the new technology that would pay off in the future (Sovacool &Hirsh, 2008). In addition concerns in regard of usability and practicality of BEVs in daily life situations as well as the charging process and charging infrastructure can be found in most studies (e.g. Lane & Potter, 2007). However one other barrier is consistently found to be the most important barrier for the adoption of electrical vehicles: Range limitation (e.g. Graham-Rowe, Gardner, Abraham, Skippon, Dittmar, Hutchins & Stannard, 2012) and the so called 'range anxiety' (e.g. Rauh Franke & Krems, 2014). Range limitation in EVs regards the power of the battery and the associated limit of kilometers the vehicle can travel without being recharged. This limit of EVs is as of now generally lower than the limit of CVs and a physical attribution of the EVs that could only be enhanced by new battery developments. However research suggests that the main problem in regard of EVs range is the users subjective experienced anxiety about possibly being stranded somewhere and thus do not necessarily need to be solved by new battery developments but could as well be solved by enhancing users subjective experience (e.g. Franke, Neumann, Bühler, Cocron & Krems, 2012). As mentioned earlier this phenomenon is called 'range anxiety' and can be seen as a rather psychological barrier (Rauh, Franke & Krems, 2014), but still decrease customers intention to purchase an EV.

To better understand this psychological barrier several studies (e.g. Franke et al., 2012) introduced scientific frameworks (Figure 1) of range anxiety including different factors that lead to the user's subjective experience of range. Key to those frameworks is the notion of 'comfortable range', describing in how far users are prepared and willing to use the maximum range provided by the EV before feeling anxiety and getting stressed (Rauh, Franke & Krems, 2014). This 'comfortable range' experienced by users is influenced by individual factors of each user. On one hand trait variables, as for example control beliefs or general tendencies, influence comfortable range. For instance an individual with high internal control believes is more likely to experience less stress in terms of comfortable range and can easier gain high levels of range utilization (Franke et al., 2012). On the other hand individual coping skills, as for example practice, experience and knowledge, influence comfortable range as

well. According to this users with high experience with electric vehicles and good knowledge about them should as well lead to a higher comfortable range and less experienced stress of the users (Franke et al., 2012). Therefor enhancing user's trait variables and coping skills should lead to an enhanced comfortable range and by that could in the future help overcome the range barrier for the adoption of EVs.

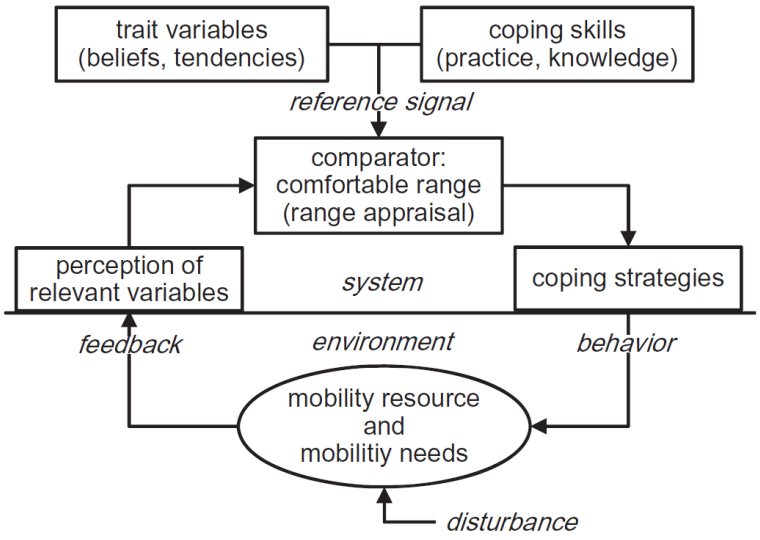

Figure 1. Conceptual framework of experiencing range [Franke et al., 2012]

First explorative studies in regard of the role of experience and practice with EVs have shown coping skills have a positive influence on range utilization, the general experience of range and comfortable range (Bühler, Cocron, Neumann, Franke & Krems, 2014; Franke et al. 2012). For example Franke et al. (2012) conducted a field trial with 40 customers leasing an EV for a 6-month period. Data was collected at three different points in time: at the beginning, after three months and after 6 months. A major finding of the study was that users, after experiencing EVs for a longer period, rather appraise range as a resource instead of seeing it as a barrier and have a higher comfortable range. Therefore enhancing the user's copings skills due to direct experience with an EV helped to overcome the barrier of range in the adoption process of EVs for some consumers. As those findings and the theoretical framework by Franke et al. (2012) suggests, enhancing coping skills of users might help overcome the barrier of range in the adoption of EVs. Therefore, knowledge could as well influence the user's experience of range, comfortable range and thereby also reduce the barrier of range in consumers. So it can be assumed that users with higher knowledge about EVs and range related factors should experience less stress in regard of range and might not see range of electric vehicles as a barrier anymore. As other studies (e.g. Potter & Lane 2007;

Caperello & Kurani, 2011) show that user's knowledge about electric vehicles is generally rather low; enhancing the knowledge of users through interventions might be a promising method to overcome the barrier of range. In addition other studies suggest (e.g. Attewell, 1996) that knowledge plays an important role in the adoption process of new and complex technologies, as innovations are unlikely to be adopted without sufficient knowledge of possible consumers.

Moreover it is expected that users differ in their perception of barriers such as range and intentions of adapting to electric vehicles, as literature shows (e.g. Hackbarth & Madlener, 2013; Skippon & Garwood, 2011) that socio-demographic variables, believes and personality traits influence the perception and therefore the perception should differ between different types of users. Because of that, the possibility of users to change their perception of barriers through such interventions might as well differ between users. As a field study by Jansen et al. (2013) suggests, the range barrier might for some users be a rather factual barrier, arising from an actual mismatch between users' mobility needs and the range of an EV, as they did not change their perception of range after experiencing EVs. This can as well be considered in line with findings of other studies, as for example Skippon & Garwood (2011) found that personality traits, such as conscientiousness, and believes, such as high personal concern for the environment, play an important role in user's perception of EVs. Moreover a generally complex range-user interaction was found (Rauh, Franke & Krems, 2014) leading to differences between individual users perception of range. So it is important to understand differences between users and the implications of those differences for the adoption process of electric vehicles. Those differences and characteristics of users can be accurately and clearly describe through the creation of personas on the basis of potential consumers (Wickens, Gordon & Liu, 2004), as Personas are fictional persons that embody users' typical characteristics, believes, activities, goals, environment, capabilities and limitations in a clear and conceptualized manner (Wickens et al., 2004). Therefore Personas are useful user orientated means that can help exploring differences between users and general characteristics of the target group.

The current study aims to explore whether enhancing users knowledge about range of EVs might influence the users perception of range and comfortable range and mainly in how far users differ in their change of perception. To do so open two parted interviews were conducted with a knowledge intervention in between the two parts. This made it possible for the researcher to explore in how far a change in the perception of range, an especially comfortable range, happened after new information was presented and the knowledge of

respondents was increased. So the current study will explore whether knowledge interventions can possibly change different user's perception of the range of EVs and thereby help to dispose range as a barrier of EV adoption. Therefore the research question is:

Do users differ in their change of perception of comfortable range after gaining knowledge?

To explore the question whether users differ in their change of perception of comfortable range, the general influence of an information intervention on user's perception of comfortable range has to be explored first. Therefore this study also explores whether users perception of comfortable range changes after gaining knowledge.

Methods

Participants

In order to answer the research question, qualitative semi-structured interviews were conducted with 8 respondents from Enschede in April of 2016. Of those 8 participants 4 were of Dutch and 4 were of German nationality, with 3 female and 5 male participants. The majority of participants were current students with an average age of 22,13 years (SD= 1,88) and a background in higher education. All respondents were selected based on availability sampling at the University of Twente in Enschede with the inclusion criteria of (1) being in possession of a valid EU-driver's license and (2) being the owner of a personal vehicle. These inclusion criteria were chosen to ensure that the participants had experience with acquiring costs, as well as the running costs of a car. These include maintenance and repair costs, insurance, as well as tax and gasoline consumption. Moreover, participants that are owners of a personal vehicle are more aware of their current driving habits and mobility needs, which are important factors to consider for the construction of user personas.

Furthermore, it was chosen to include mostly students and young adults, as they can be seen as the future target group for new technologies, such as electric vehicles. These respondents will more likely face the decision to purchase either a conventional vehicle or an electric vehicle in the foreseeable future, than a comparably older sample. The everyday habits of young car users are, to some extent, still developing (Efthymiou, Antoniou & Waddell, 2013) and they are therefore more flexible when it comes to evaluating the usability of electric vehicles.

Materials

The data for the current research were collected in form of a semi-structured interview (Appendix D), consisting of several main subjects with open questions and related sub questions or topics that needed to be covered. Moreover, the individual topics were

formulated rather broadly with example questions to give the interviewer the freedom to adjust formulation and order of questions to the progress of the interview, as well as the answers of the interviewee. The interview questions and topics were based on the researcher's theoretical overview of the topic.

The first part of the interview (Questions 2.1-2.4) contains questions to inquire about the participant's general associations, knowledge, opinions and future buying intentions about electric vehicles. This was based on the review of scientific articles that showed that users differ in knowledge and opinion about EVs, and that those factors have an influence on perception of EVs as well as buying intention. This part was include because it is important to this research to know how participants viewed this topics beforehand, as literature suggested they have a clear impact on the adoption process of electric vehicles (e.g. Rezvani et al., 2015). Moreover this part also gave a good indication about the thought process of individual participants in regard of their answers to open questions without clear lead, as those showed which information is already present, how sure participants are about this and how relevant different topics are to them.

The second and third part of the interview contains questions about two specific aspects of electric vehicles, namely range and charging. Those were specified due to the researchers finding of the literature review, as articles about barriers for the adoption of electric vehicles most frequently mentioned range and charging, or a combination of both as main barriers (e.g. Lane & Potter, 2007;). So in this part the interview is designed to yield as detailed as possible information about the participant's knowledge of those two topics and moreover connecting them with their usual and significant mobility needs.

After the conclusion of that part the interviewer presented a short summarizing information paper about the two main topics, range and charging, to the participant (Appendix E). It was decided to do so in two different steps for a better distinction of the two topics and to be able to evaluate possible changes in opinion of the participants separately. However the topic charging will not be included in the analyses of this study, as a separate second study will explore the topic charging in depth. So first information about range were presented, followed by a few open questions projecting the main interview topics of the second part and connecting those to the new information obtained, to monitor a possible change of opinion and attitude. The same was repeated for charging afterwards. The information paper about range included a short overview of ranges from average modern EVs and current 'state of the art' technology with a visualization of reachable destinations on a map. It was chosen to only include basic information, to avoid overwhelming participants and make it easy to understand

and remember. After those two steps were taken separately at the very end of the interview a last part focused on a change in buying intention of electric vehicles in regard of the present and future. This was included to yield information about a possible actual change in adoption behavior through the information provided and not only a change in opinion or attitudes towards the technology. To conclude the interview the participant received the possibility to ask remaining questions, add information and give feedback to the interviewer.

Procedure

The participants were recruited through personal contacts of the researchers, as well as through the social media network Facebook. They were subsequently approached by standardized email to participate in the current research (Appendix A). No financial or material incentives were offered, other than gaining insight into the research subject. Beforehand the researchers conducted a pilot interview to test the interview scheme and procedure, detect possible shortcomings or mistakes and allow the interviewer to identify possible pitfalls. Due to this pilot interview, several minor changes were made to the interview scheme in regard of the formulation of questions and sub questions to facilitate the interviewees understanding of those.

Afterwards, individual appointments for the interview were arranged with all interested participants. The semi-structured interviews were conducted at the participant's home in a quiet room in all cases, and recorded with a smart phone. The interviews consisted of six different phases; after a brief introduction, the respondents were given a short questionnaire about their driving habits and mobility needs. After filling in the questionnaire (Appendix C) and informed consent (Appendix B), the first general part of the interview was conducted in order to assess the interviewees knowledge and experience with EVs, as well as their current opinion thereof, and their willingness to purchase. In the following phase, more specific knowledge about the main subjects of this research, namely range and charging, were inquired. As the conduction of the interview (Appendix D) was started, each new topic was briefly introduced to clarify the context and have a smooth transition between topics.

After the first part of the interview was concluded the participants were given a short information flyer (Appendix E) about the range of electric vehicles and again questioned about their opinions, possible change due to the new information and buying intentions. Then the second information moment followed with a short information flyer (Appendix E) about the charging of electric vehicles and the participants were questioned about their opinions, possible change of those due to new information and buying intentions. Following the interview a brief conclusion was given; the researcher answered remaining questions,

repeated that the data will be analyzed anonymously, answered any possible questions and gave the participant the room for comments and feedback. All interviews were conducted personally and held in Dutch or German (native language of the interviewee). The interview had an average length of 49:07 minutes (SD=4:51)

Data analysis

To be able to process and analyze the data yielded from the semi-structured interviews the activities 1 - 7 of the enhanced Persona Technique from Acuna, Castro and Juristo (2012) was applied. The remaining activities are beyond the scope of this research and were therefore not carried out. 'Activity 1: State Hypotheses' has the objective to state hypotheses about eventual personas (Table 1) that will be created and investigate possible consumers motivations and behaviors based on those through interviews that were transcribed.

Table 1

Persona Hypotheses

Hypotheses 1:	There are different Personas representing different knowledge and attitudes towards electric vehicles
Hypotheses 2:	Personas differ in how they handle modern technology
Hypotheses 3:	Personas differ in their use and perceived importance of range in EVs
Hypotheses 4:	Personas differ in their willingness to change perception of range after new information is presented
Hypotheses 5:	Differences in the barriers to adopt electric vehicles are related to differences in knowledge

The second activity 'Identify behavioral variables' consisted of the synthesizing of the responses to the interviews by coding the transcribed interviews with the program AtlasTi. A coding scheme (Appendix F) was constructed based on the topics found in the interview to label the quotes. Moreover a list of behavioral variables of the respondents was created through this and checked with the formally stated hypotheses to identify their validity. The third activity 'Map interview subjects to behavioral variables' consists of the identification of the range for each of the behavioral variables found beforehand and assigning each individual subjects grouping to all the significant behavioral variables. So in this part each subject was individually rated on all behavioral variables identified in the second activity, which helps to map each subject on those dimensions. The fourth activity 'Identify significant behavioral patterns' builds on the individual rating of activity three and aims to find bigger behavioral

patterns to identify significant behaviors of the target group. To do so a grouping table with percentages for each of the different range categories for the behavioral variables were created and individual participants were clustered around multiple ranges of variable values. The clustering of the individuals in this process is supported by the grouping table, giving a good indication on how to sort the different subjects.

Activity five ‘Synthesize characteristics and relevant goals’ aims to lay the foundation for future personas. During this step significant characteristics and goals of the target group were incorporated and summarized together with the creation of the personas personality trades. On basis of that a Persona foundation document is created, outlining detailed and important characteristics of the persona and giving a solid foundation for a detailed description. Afterwards the sixth activity ‘Check for redundancy and completeness’ was carried out. During this activity, the researcher checked the characteristics and objectives of the persona for gaps that may need to be filled and whether all important aspects were thoroughly defined. For an unbiased check of those points this was checked a second time through a second researcher to make sure no important information was missing.

Activity seven ‘Expand the description and of attributes and behaviors’ aims to enrich the features listed in the ‘Person foundation document’ with additional information derived from the interviews, to give a clearer and more distinct description of the Persona. To do so a third person narrative for each persona is written, containing the needs, attitudes, expectations and problems of the persona.

Results

Distinguishing variables

This section show the result of activity two ‘Identify behavioral patterns’, activity three ‘Map interview subjects to behavioral variables’ and activity four ’Identify significant behavioral patterns’. During the coding of the interview twelve independent variables emerged on which respondents and therefore users differ. In regard to Castro et al. (2012) each of those variables should range along one dimension between two extremes and every respondent can be assigned to a certain position on those ranges. In this case however, no variable seems to meet the criteria of ranging between to extremes, but the majority of the variables come close as they range over vast opposites, even though they can’t exactly be considered as extremes. Those variables are ‘Concern with environment’, ‘Knowledge about EV’s’, ‘Perceived disutility of EV’s’, ‘Buying intention regarding EV’s’ and ‘Range importance’. Moreover the two variables ‘Attitude about EV’s’ and ‘Expected comfortable range’ only have little range and rather represent small noticeable differences. The last for variables do ‘Change of attitude’, ‘Change of perceived disutility’, ‘Change of buying intentions’ and ‘Change of comfortable range’ meet the above mentioned criteria but still can be seen apart as they measure changes in variables, regarding the same constructs as mentioned earlier, occurring after the information intervention has taken place.

Table 2

Distinguishing variables and their ranges

Variable	**Range**
1. Concern with technology	worried – interested – affiliated
2. Concern with environment	moderate – decent – high
3. Knowledge about EVs	low – moderate – decent
4. Attitude about EVs	generally negative – rather negative
5. Perceived disutility of EVs	moderate – decent – high
6. Buying intentions regarding EVs	interested in the future – maybe in the future – not likely
7. Expected comfortable range	low – moderate
8. Range importance	moderate – decent – high

9. Change of attitude	negative – none – positive
10. Change of perceived disutility	negative – none – positive
11. Change of buying intentions	negative – none – positive
12. Change of comfortable range	negative – none – positive

Variable 1: Concern with technology

This variable gives an indication whether respondents are rather concerned and worried or affiliated with new technologies in regard of electric vehicles and other new developments. The variable has three major categories; worried, interested and affiliated.

Persona Kim can be placed in in the category *worried*, as she is worried about the new technologies and uncertain about the implications they might have for her. Persona Thijs can be categorized as affiliated with technology, as he generally embraces new technologies, is interested in its functioning and generally familiar with them.

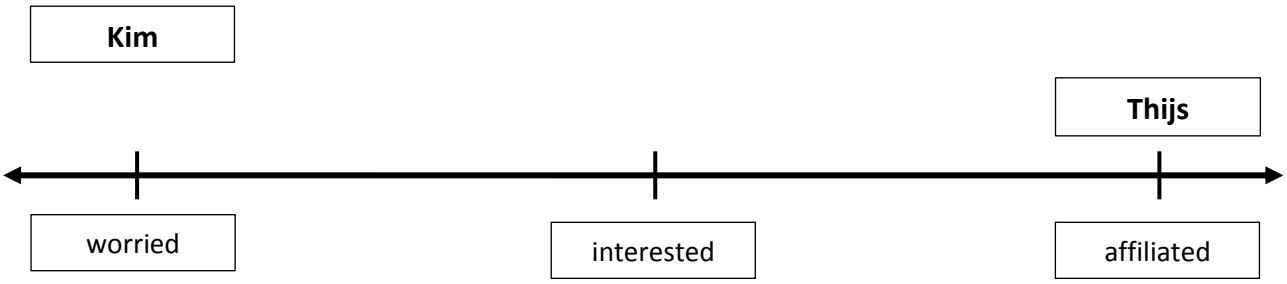

Figure 2.1. Concern with technology

Variable 2: Concern with environment

This variable indicates how strongly the respondents are concerned with the environment protection and how important that factor is to them in comparison to other factors that influence their decision making in regard to buying a vehicle as for example the utility of the car. The respondents differ in their concern with the environment, as persona Kim assigns environment a much higher value than persona Thijs.

Persona Kim is *highly* concerned with the environment and tries to incorporate the environmental impact in her decisions as much as possible. She would also consider setting aside her own needs in regard of range and utility for environmental advantages of her new purchased car. Persona Thijs is concerned with the environment to some degree as well, as his concern with the environment can be categorized as *moderate*. He also sees positive

implications for the environment in the development of electric vehicles, but is generally more skeptical and sees his needs as more important than those environmental implications.

"Well, I would surely be ready for compromise. I would still see it as a whole package, […] but including the environmental factor, I think I would do it [buy an electric vehicle]. Then I would rather put my needs aside and say: instead I can do something for the environment."(Persona Kim, Respondent 7)

"I think it is a good concept, also somewhat environment friendly, but I think at this moment it is not sufficient for everything I want to do with my car. That is more important to me."(Persona Thijs, Respondent 2)

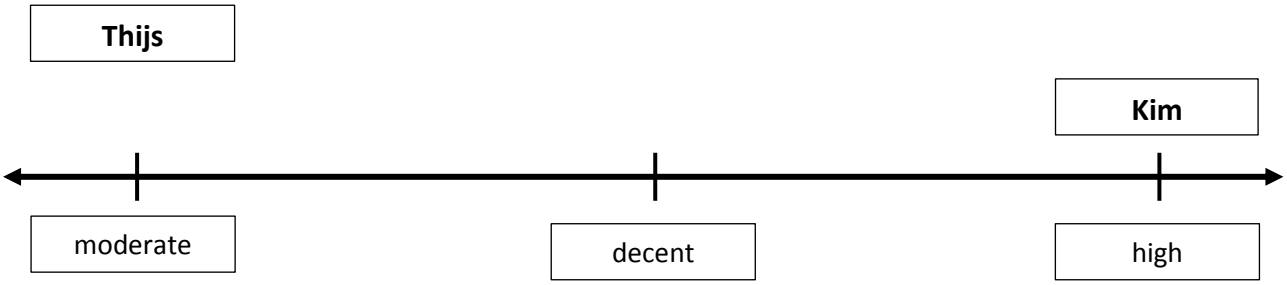

Figure 2.2. Concern with environment

Variable 3: Knowledge about EVs

This variable indicates how much knowledge the respondents possess about electric vehicles in general. The respondents differ in their knowledge about electric vehicles ranging from low to decent. However, knowledge regarded decent in this case is relatively seen in comparison to other respondents and still marks a rather low overall threshold of knowledge in the pool of participants in this study. Persona Kim has the least knowledge, categorized as low, and is very unsure about the topic. She can only give little vague estimation about electric vehicles without being able to point out where they come from. Persona Thijs on the other hand has decent knowledge about electric vehicles and can recall some points he has heard about in regard of electric vehicles. Moreover he knows basic principles and is able to make educated guesses in areas he isn't totally certain about.

"Well, that is a good question, I would estimate that they can't go any longer than 100km, […], but I don't really know anything about that. That's rather an estimation of mine." (Respondent 4, Persona Kim)

"[…] with the breaks of the car you can also recharge some energy, […]" (Respondent 2, Persona Thijs)

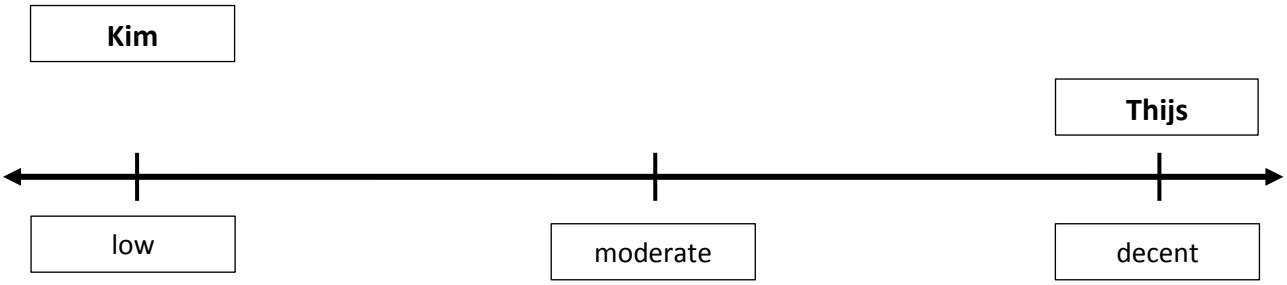

Figure 2.3. Knowledge about EVs

Variable 4: Attitude about EVs

This variable describes the respondent's attitudes towards electric vehicles. It was found that the attitude towards electric vehicles was commonly negative with little variances. The variable ranges from *negative* to *rather negative,* indicating that the overall perception of electric vehicles is negative and only few exemptions on topics as environmental friendliness are made.

Persona Kim can be categorized as *rather negative,* as her overall attitude towards electric vehicles is still negative with exceptions on some topics. Persona Thijs on is categorized as negative, as his overall attitude towards electric vehicles is negative without exemptions.

[…] and of course also as an alternative for cars with combustion engines. But more negative I would say, because I have heard a lot negative about it [electric vehicles]" (Participant 4, Persona Kim)

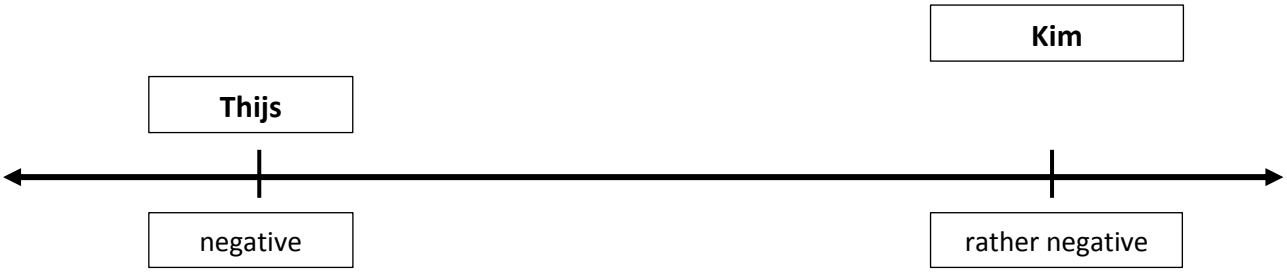

Figure 2.4. Attitude about EVs

Variable 5: Perceived disutility of EVs

This variable indicates to which extent respondents perceive disutility in possibly owning an electric vehicle in comparison to cars with combustion engine. Perceived disutility ranges from *moderate* to *high.*

Persona Kim perceived disutility of EV's is categorized as *decent*; as she sees some disutility's in owning an electric vehicle with rather small negative implications for her daily

use and needs. Persona Thijs perceived disutility of EV's on the other hand is *high*, as he sees several significant differences in utility that would affect him negatively in his daily use and needs.

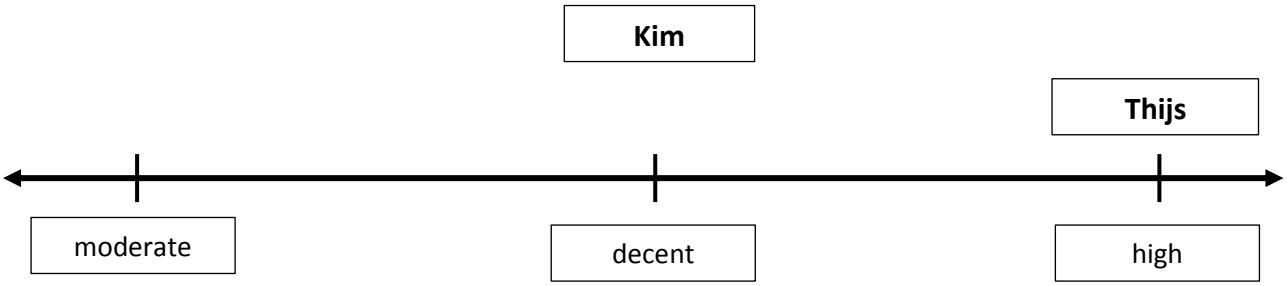

Figure 2.5. Perceived disutility of EVs

Variable 6: Buying intentions regarding EVs

Respondents differ in their buying intentions in regard of electric vehicles. From the data three different categories emerged: *interested in the future*, *maybe in the future* and *not likely*. This variable indicates the willingness of different respondents to purchase an electric vehicle.

Persona Kim can be placed in the category *interested in the futur*e, as she would definitely consider an electric vehicle during her next purchase decision in is quiet certain that she would chose for an electric vehicle in the future. Persona Thijs can be placed in the category *not likely*, as he won't consider an electric vehicle during his next purchase decision and doesn't intend to purchase and electric vehicle in the next 10 years.

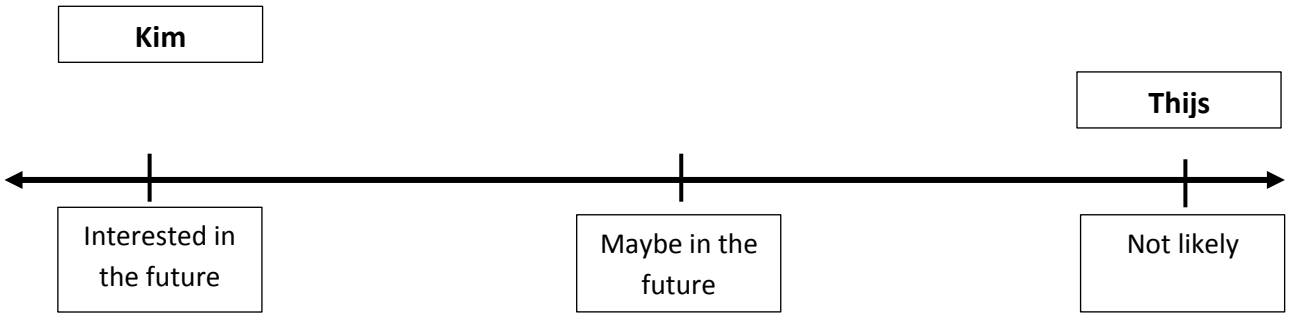

Figure 2.6. Buying intentions regarding EVs

Variable 7: Expected comfortable range

This variable describes the participants expected comfortable range and the related feeling of anxiety or getting stressed due to the range limitations special to electric vehicles and the possibility of getting stranded. Overall all respondents anticipated a low comfortable range and high levels of stress if they would own an electric vehicle, making this variable range from *low* to *decent*.

Personas Kim is categorized as *moderate* as she anticipates experiencing high levels of

stress and anxiety, but would try to take as much counter measures as possible, try to avoid such situations through good planning and still use the electric vehicle. Persona Thijs on the other hand is categorized *low*, as he anticipates experiencing even higher levels of stress and anxiety, which would be sufficient enough for him to not use the electric vehicle and rather opt for alternatives.

"Well that [long trip] would be something that would be too risky for me, because the danger of being stranded is certainly present" (Participant 1, Persona Thijs)

"If I would ride one [electric vehicle] myself I would be anxious, because I wouldn't feel as flexible anymore, be able to just fill up the tank if necessary" (Participant 7, Persona Kim)

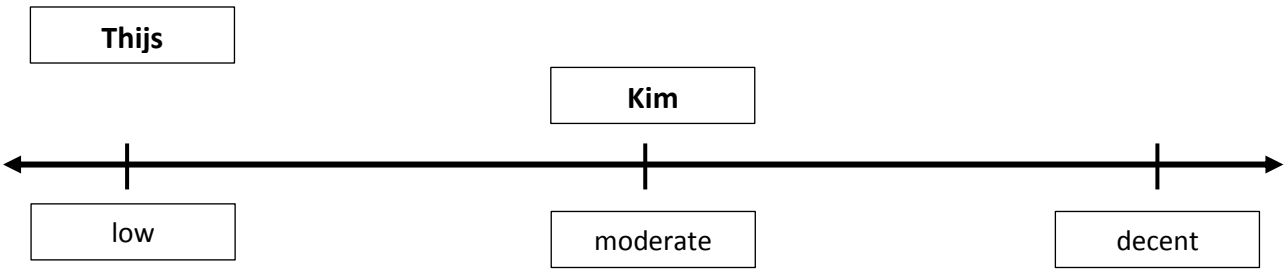

Figure 2.7. Expected comfortable range

Variable 8: Range importance of EVs

Respondents differ in how important the topic range in electric vehicles generally is to them and how much range they need. The variable range importance is thus defined by the participant's estimation of their mobility needs, regarding how far they need to go and how much range would be needed for their daily use. Moreover this variable examines the degree of importance the respondents attach to the range of electric vehicles; indicating whether the range of electric vehicles can be sufficient for respondents easily or it needs to meet higher demands. The variable ranges from *moderate* to *high*.

Persona Kim can be categorized as moderate, as she doesn't value range in electric vehicles that much, other topics are more important to her and lower ranges of electric vehicles that are sufficient for her basic needs would be regarded as satisfactory. Persona Thijs on the other hand has *high* range importance, as range of electric vehicles would only be sufficient for him under the assumption that range of electric vehicles is equal to capability of cars with combustion engines and long trips of about 1000 km are possible.

"Well usually I don't travel long distances with my car anyway, but I don't really go that far very often. So as long as it that, going far enough is it okay for me." (Persona Kim, Respondent 5)

"In that case it would need to be able to drive very far, because sometimes I don't have that much time in between to recharge and I thinks in that case it would need to be able to drive between 1000 and 1200 km. So the range is very important to me and I Would need a big range. And I would anyhow like to be able to travel longer distances, it is important to me that the possibility is there." (Persona Thijs, Respondent 3)

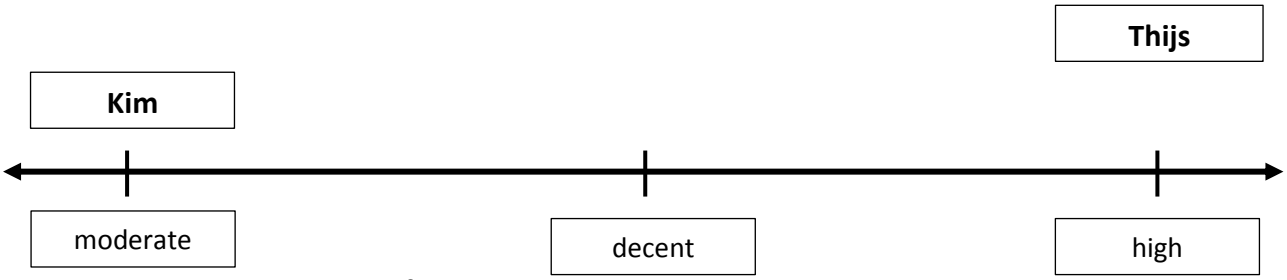

Figure 2.8. Range importance of EVs

Variable 9: Change of attitude

This variable indicates in how far the respondents changed their 'Attitudes about EV's' after the information was presented. The respondents differ in their 'Change of attitude' with this variable ranging from *none* to *positive*. A respondents is regarded in the range of *none* if the they can be sorted to the same range after the information as they were beforehand and as *positive* if they can be sorted to a higher (more positive) range after the intervention.

Persona Kim is regarded as *positive*, as she views electric vehicles in general much more positive after the information was presented. Persona Thijs is categorized as *none*, as he doesn't see electric vehicles any different after the information is presented and still remains skeptical.

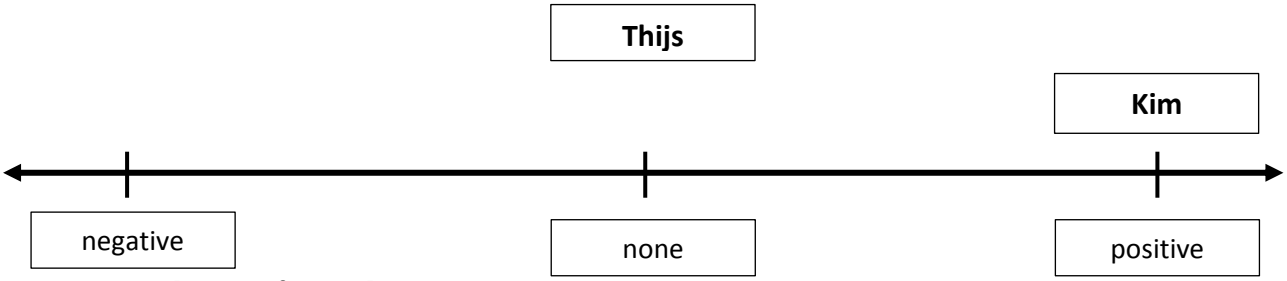

Figure 2.9. Change of attitude

Variable 10: Change of perceived disutility

This variable describes in how far the respondents 'perceived disutility' changed after the information was presented. The respondents differ in their 'Change of perceived disutility' as this variable ranges from *none* to *positive*.

Persona Kim is seen as *positive*, as she sees much less disutility after the information is presented and has therefore a more positive view in regard of disutility. Persona Thijs on the other hand is sorted as *none*, as he sees some small improvements, but still perceives significant negative consequences for his everyday use.

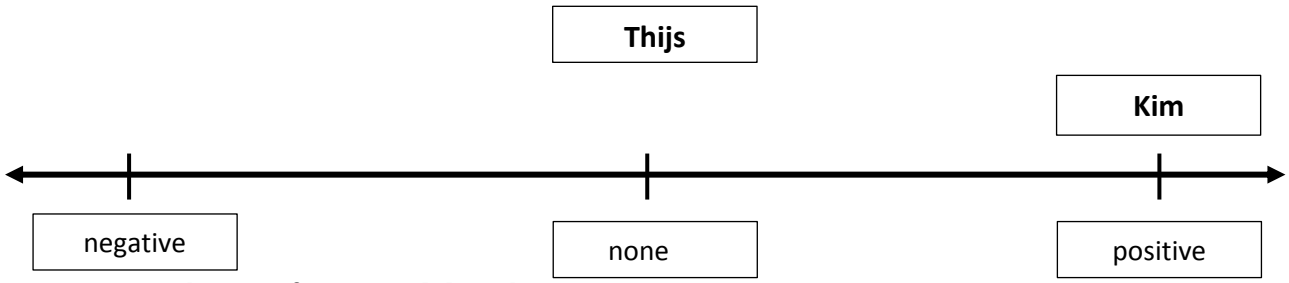

Figure 2.10. Change of perceived disutility

Variable 11: Change of buying intentions

This variable indicates in how far the respondents 'Buying intentions regarding EV's' changed after the information was presented. The respondents differ in their change of 'buying intentions regarding EV's' as the variable ranges from *none* to *positive*

Persona Kim is regarded *positive*, as her buying intentions are now even more positive as she thinks her next car will be an electric vehicle. Thijs on the other hand is regarded as *none*, as no change in his buying intentions has occurred and he still isn't likely to purchase an electric vehicle.

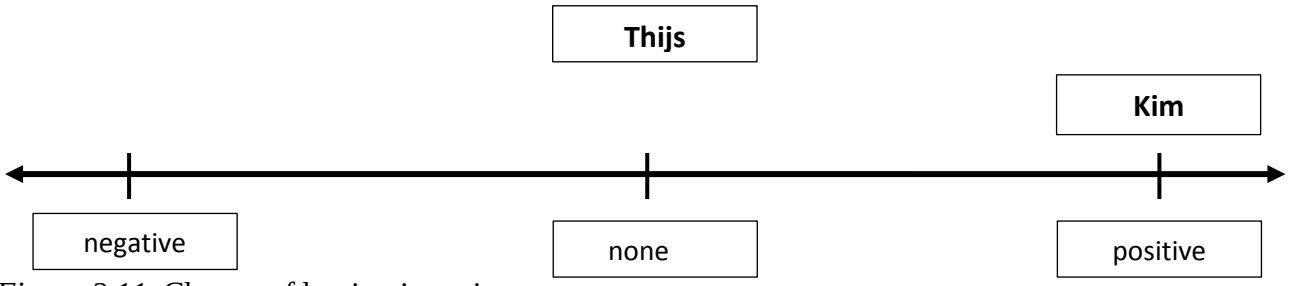

Figure 2.11. Change of buying intentions

Variable 12: Change of comfortable range

This variable gives an indication in how far the respondent 'comfortable range' has changed after they were presented with new information. The respondents differ in their change of

their ‘Comfortable range’ as the variable ranges from *none* to *positive*.

Persona Kim can be assigned to positive, as her ‘comfortable range’ is higher and she expects to be less stressed due to the range limitation of electric vehicles after the information was presented. She now thinks that stress can easily avoided by good planning and she won’t run into situations where she might get stranded with and electric vehicle. Persona Thijs on the other hand can be sorted to *none* as his ‘comfortable range’ still remains the same and he would expect to get stressed and anxious about possibly being stranded with an electric vehicle. His ‘comfortable range’ has not changed after the information was presented and he would still rather opt for an alternative way of transportation.

“But there are for sure, at least as I see it, enough possibilities that one won’t get into problems or distress, that one could get stranded. So apparently you don’t have to plan as much beforehand as I expected first, but you are also able to drive somewhere spontaneously.” (Participant 4, Persona Kim)

“I still think that is a huge disadvantage, so my opinion hasn’t really changed.” (Participant 3, Persona Thijs)

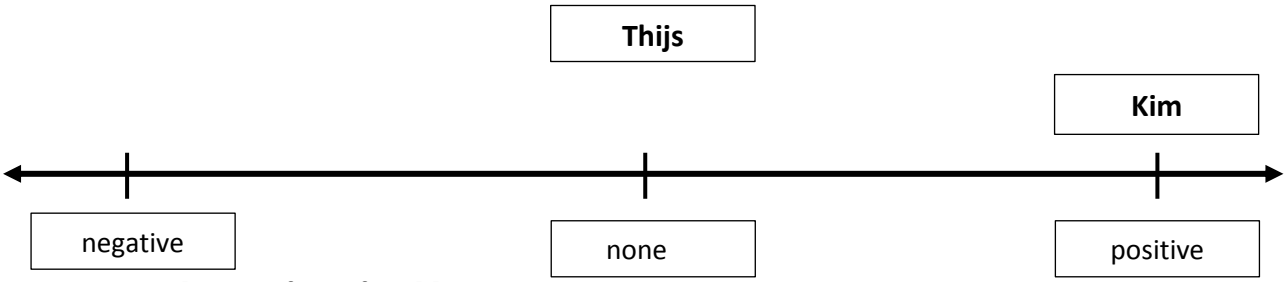

Figure 2.12. Change of comfortable range

Persona synthesis

This section shows the results of Activity five ‘Synthesize characteristics and relevant goals’, Activity six ‘Check for redundancy and completeness’ and activity seven ‘Expand the description and of attributes and behaviors’, which yielded a detailed description of each personas relevant goals, behavioral characteristics and personality. Moreover Appendix H presents the Persona foundation document, including all important characteristics of each Persona.

Kim is based on 5 respondents. Their age ranges from 20 to 22 years (M=21; SD=1,73). Three of them are female and two are male.

Kim

Kim is 21 years old and has just finished her Bachelor’s degree in Psychology. She owns her own car for about three years now and mostly uses it for shorter distances during the week. The car isn’t the most important thing in her live, but practical for her as it gives her flexibility and the possibility to visit friends and family back home as often as she needs to. Kim doesn’t know much about electric vehicles in general and has only heard some vague things in the media, making her overall attitude towards EVs rather negative. She isn’t sure about what electric vehicles have to offer, how they work and what most of the possible advantages and disadvantages are.

She feels like the limited range of an EV would limit her flexibility and she also is anxious about possibly being stranded and experiencing more stress due to the constant search for a charger, which would be impractical for daily use. Due to the feeling of anxiety she will try to plan as much as possible beforehand to avoid stressful situations, but would sometimes also opt for more risk free alternatives if available. But the possible outlook of being stranded somewhere gives her a strong reason to not consider electric vehicles at the moment. Even though a long range is not the most important factor to her, she still wants the electric vehicle to meet her basic daily needs in regard of range and give her the opportunity and flexibility to make a few longer trips to visit friends and family. As long as the range is sufficient for those demands she would be satisfied, but in her current estimation those demands are not met by electric vehicles at the moment.

On the other hand she also sees a possible advantage of electric vehicles as they would be much better for the environment, which goes hand in hand with her general concern for the environment. She would even consider experiencing disutility to some degree, to do something for the environment.

After getting some information in regard of the range and charging of electric vehicles, Kim has a more positive attitude towards electric vehicles sees far less disadvantages. One of the points that improved after the information was provided is that she does expect a higher level of comfortable range and much less anxiety about running into risky situations of the verge of the range anymore, as she did beforehand. The range level provided by electric vehicles at the moment would be sufficient for her needs, as she doesn't need to leave those ranges frequently. Therefore she doesn't expect to be stranded somewhere without any possibilities of avoiding this and has the feeling that she could handle all her daily mobility needs with the resources provided by an electric vehicle. Another aspect that reduced her expected anxiety and expanded her comfortable range as well is the provided overview of the charging infrastructure and different ways to charge electric vehicles that exceeded her expectations by far. Because of this she expects much lower risks in using an electric vehicle daily and doesn't view range as a barrier anymore, as she has the feeling of being able to spontaneously use the new technology in comparable way to usual cars with a combustion engine.

Figure 3.1. Photograph depicting student. [Primary source]

Thijs is based on 3 respondents. Their age ranges from 23 to 26 years (M=24; SD=1,73) and all of them are male.

Thijs

Thijs is 24 years old and a master student in International business administration. He has bought his second car 3 months ago and pays carefully attention to his car and maintenance. The car is generally important to him, he uses it frequently in his daily live and also makes longer trips from time to time. His knowledge about electric vehicles isn't extensive, but decent, as he is generally aware of the automobile market and has encounter electrical vehicles several times. He also already had the chance to drive inside an electric vehicle once, but generally he perceives electric vehicles negative.

In his perception the range of electric vehicles isn't sufficient for his everyday life demands and would limit his flexibility significantly. Especially the time consuming charging in connection with a short range is viewed as a waste of time by him. He expects to be stressed and anxious about the possibility of being stranded to those limitations and thinks that he would experience the constant time consuming search for a charging stations as stressful. He is very certain that an electric vehicle would be impractical for his daily use, as he would constantly run into situations that won't be covered by the range of electric vehicles. Because of that he expects that he would frequently choose for other alternatives to avoid any problems and therefore use electric vehicles only for short distances. This is a strong reason for him to not consider an electric vehicle in the next decade. Moreover a long range is very important to him as he needs the electric vehicle to meet his high mobility demands, which would only be met if it would be equal to a normal car with combustion engine. So he would only be satisfied if the new technology would reach capabilities comparable to a common car with combustion engine and he wouldn't need to change his habits.

He is more concerned with the usability of his car than with environmental topics and has a clear emphasize on practicality in his everyday life. He is skeptical about the current technology and its usefulness to him, as he thinks his demands can't be met by the technology available at the moment.

After being presented with new information about the range and charging of electric vehicles, the attitude and perception of him barely changes. The most important thing that didn't change is his comfortable range, as he still thinks driving an electric vehicle would be too risky for him. Even though the range of electric vehicles and the charging possibilities are

a little better than he expected, he still thinks electric vehicles at the moment are incapable of satisfying his demands, as he still very often would operate on the border of the range, which he sees as to risky. Therefore he would still expect to be in stressful situation rather often with electric vehicles and would be anxious to test out the maximum range of the vehicle. He thinks that he couldn't handle his daily mobility needs with the resources given to him by electric vehicles and would therefor opt for other options that won't expose him to the risk of being stranded. So to him range of electric vehicles is still a major barrier for the adoption process of electric vehicles, as he does not see a way in which electric vehicles would provide sufficiently and risk free for his mobility needs.

Figure 3.2. Photograph depicting student. [Primary source]

Discussion

The current study aimed to explore whether users differ in their change of perception of comfortable range after enhancing their knowledge. For this purpose open two parted interviews were conducted with a knowledge intervention in between the two parts to answer the research question: *Do users differ in their change of perception of comfortable range after gaining knowledge?*

This study identified two types of users, which differ in their change of perception of comfortable range after gaining knowledge. Users represented by Persona Kim changed their perception positively in regard of comfortable range after they gained knowledge. Other users, represented by Persona Thijs, on the other hand did not change their perception at all. These findings point out that enhancing users' knowledge could help dispose range as a barrier to the adoption of electric vehicles for a portion of the users, comparable to Persona Kim, as further discussed later on.

Knowledge intervention to decrease psychological barrier of range

The model by Franke et al. (2012) discussed in the introduction shows that several factors influence the comfortable range of users. One of the factors that emerged from the framework was knowledge, as the framework indicates that higher levels of knowledge might enhance coping skills of the individual and therefore enhance comfortable range and decrease stress, without changing the actual range of electric vehicles determined by technical features of the battery. As research till now hasn't investigated whether enhancing knowledge actually can increase comfortable range, this current study was designed to explore this effect. If this were found to be true, participants should expect a higher comfortable range after they

received information during the short intervention within the interview, as their level of knowledge increased.

The findings show that this is, at least for a considerable portion of the participants, true. Persona Kim clearly changes her perception of comfortable range after she received the new information. She expects much less stress afterwards and does not see range as a barrier for the adoption of electric vehicles anymore. This is in line with the findings Franke et al. (2012), which showed that enhancing coping skills, specifically experience, of users in turn enhances users comfortable range, suggesting that range is a rather psychological barrier for users that can be disposed through intervention aimed to enhance coping skills of users. For another portion of the participants on the other hand, this is not true. Persona Thijs does not change his comfortable range after he received the same information and therefore knowledge does not lead to higher levels of comfortable range and less stress for some users, range of electric vehicles still remains a barrier to him. This was earlier shown by Jensen et al. (2013) as the findings of this study suggested that range is a rather factual than psychological barrier to some users, which cannot be disposed by enhancing users coping skills, but rather has to be tackled through technological developments, as current technology is not sufficient for their needs. Therefore those users will not adopt electric vehicles, as there is a true mismatch between their demands and the resources given by an electric vehicle. The question that remains to be answered is; why users differ in their view op range after the presentation of information and connected increase of knowledge.

One possible explanation could be that other factors, as for example also mentioned in the model by Franke et al. (2012), influence whether a change through increased knowledge can take place. Franke et al. (2012) indicate that trait variables such as believes and tendencies might influence comfortable range as well. Connecting this to the findings of the current study it becomes apparent that the Personas do have different beliefs and tendencies, as Kim is rather concerned with the environment and worried about new technologies and Thijs on the other hand views his own needs as most important and is rather interested and affiliated with new technologies. As Skippon & Garwood (2011) point out, such differences in believes and characteristics influence users perception of range, which might therefore explain the differences in change of perception of range between Persona Kim and Thijs. Moreover the model of Franke et al. (2012) also states that mobility needs of the users' influence comfortable range of users as well. The mobility needs of the Personas differ substantially, as Kim has relatively low mobility needs and is using her car rather infrequently; Thijs on the other hand has relative high mobility needs and uses his car frequently. Those differences

between the Personas on two factors, which should according to Franke et al. (2012) as well influence comfortable range, could explain the differences in the reaction to the presented information. This could indicate that only certain users, comparable to Persona Kim with low mobility needs and comparable trait variables, can be positively influenced to enhance their comfortable range by an increase of knowledge.

Furthermore the different levels of knowledge prior to the intervention might have played an important role as well. As Attwell (1996) showed that knowledge does play an important role in the adoption process of new technologies and adoption without sufficient knowledge about the new technology is not likely. He suggested that possible users with little knowledge are usually more skeptical and uncertain about new technologies and therefore will not adapt to those. Comparing this to the findings Persona Kim for instance had little knowledge beforehand and the main reasons for her not to consider an electric vehicle was amongst others that she was uncertain and worried about the new technology, which is in line with Egbue & Long (2012) as they found that a high levels of uncertainty are associated with EVs. So in her case the knowledge intervention might have filled an important gap and therefore changed her perception of range. Thijs on the other hand already had a relatively high level of knowledge beforehand and his main reason not to consider an electric vehicle at the moment was that he thinks electric vehicles simply cannot satisfy his demands, which would not be changed through new information. Even though those findings suggest that the most important factors - coping skills, trait variables and mobility needs - mentioned by Franke et al. (2012) influence comfortable range, more research is needed to confirm the proposed relations.

Strengths and restrictions

The current study provides new insights about possible psychological intervention that could enhance users' adoption process to electric vehicles and thereby help to decrease users' perceived barriers towards electric vehicles. The current study extends on first steps taken by other studies (e.g. Franke et al. 2014) as it investigates a more practical and cost effective way to decrease the range barrier for the adoption of EVs, using a short knowledge intervention to do so. Showing that such short and cost effective ways might be sufficient to enhance the adoption process in a large portion of the users might open the door for future research and new approaches, such as enhancing users' knowledge, to tackle the challenge of the weak market demand for electric vehicles and slow adoption process of potential users.

On the other hand certain restrictions of the current study have to be mentioned. One of those weaknesses can be found in the material provided during the knowledge intervention.

Even though this information was intended to give a good overview and not bias the respondents in one way or another, the possibility to choose from a variety of information seemed to be used by the respondents to reinforce what the already believed, or wanted to believe. For example respondents who thought that EVs would not be able to satisfy their demands, often only considered the lowest range information given in their answers. So less and clearer information, possibly only regarding one typical model or the state of the art technology, might be more appropriate and does not leave that much room for interpretation, as participants would not be able to choose information confirming their beforehand mentioned believes. Furthermore some respondents also felt the need for information on various more topics such as costs and reliability for example, so future research should include information about several more topics.

Another main concern with the current study is the number of respondents, as only eight respondents were used based on availability sampling at the same University with comparable educational backgrounds. Some findings of the study do indicate that there might as well be at least a third persona. Respondent 8 was originally sorted to Persona Kim, as the respondent fits here best, but especially her negative change after the intervention and her overall very skeptical attitude deviate considerably from Persona Kim and other respondents. A bigger dataset, with 16 participants as planned first, might have yielded findings with other respondents being comparable to respondent 8, leading to the creation of a third persona. But with just one respondent showing this pattern there is not sufficient enough data to consider the creation of a third Persona, a different category of users.

Recommendations

Until now there is little research exploring the possibility of decreasing barriers towards adoption of electric vehicles through psychological interventions. However this study suggest that the possibility to do so does exists, as this study takes a first step in exploring a change in comfortable range through an increase of knowledge. This shows that one of the main barriers for the adoption, the range of electric vehicles, could possibly be tackled by relatively low cost information interventions. This opens the door for the investigation of other barriers as those might also be overcome by psychological interventions because of their rather subjective nature. More research is needed to investigate those possibilities. Moreover the role of other variables, such as mobility needs and users believes, involved in the decision process to change the users perception are not clear yet. As this research gives a first explorative indication, future research might be able to show exactly for which users a change is possible and thereby identify a clear target group for future interventions.

Conclusion

The present study identifies two different types of potential users for electric vehicles with different believes and needs, and also a significant difference in their potential to change attitudes and perceptions by means of a knowledge intervention regarding electric vehicles. Those findings show that some barriers towards the adoption of electric vehicles such as the range barrier are rather of psychological nature, at least for a portion of users, and can be changed through means of an intervention. This implies that the adoption process of electric vehicles must not only be tackled from a technical point of view, but also trough means of information and enhancing the subjective experience of users. The new insights can be used to enhance marketing strategies and promote the adoption of electric vehicles.

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Appendix

Appendix A: First Mail

Studie Elektrische voertuigen

Beste student,

We willen uw graag uitnodigen om an onze studie over elektrische voertuigen deel te nemen. De studie word in vorm van een interview die ongeveer 45 minuten duurt doorgevoerd. Hierbij zijn wij vooral interesseert in uw mening en kennis over dit onderwerp. Voor een afsprak voor het interview of eventuele vragen kunt u een bericht sturen aan n.hanebaum@student.utwente.nl of c.w.oconnor@student .utwente.nl

Met vriendelijke groet

Nik Hanebaum & Chris O'Connor

Appendix B: Informed consent

Titel Onderzoek: Consumer adoption of electric vehicles

Verantwoordelijke onderzoeker: Christopher OConnor & Nik Hanebaum

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over aarde, methode, doel en belasting van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord.

Ik begrijpt dat opnames of bewerkingen daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaa van redenen mijn deelname aan dit onderzoek te beeindigen.

Naam deelnemer: .....

Datum: ..... Handtekening deelnemer: .....

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schrijftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beanwoorden. De deelnemer zal van een eventuele voortijdige beeindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam Onderzoeker: .....

Datum: ..... Handtekening onderzoeker: .....

Appendix C: Questionnaire

Vragenlijst rijgedrag:

Naam / Name: _____

Leeftijd / Alter: _____

1.

Hoe lang bent u al in bezit van een rijbewijs?

Wie lange sind Sie schon im Besitz eines Führerscheins?

_____

2.

Hoe lang heeft u al een eigen auto? (Hoeveel jaren)

Wie lange sind Sie schon im Besitz eines eigenen Fahrzeuges? (Anzahl Jahre)

_____

3.

Hoe belangrijk is uw auto voor uw alledaagse leven?

Wie wichtig ist Ihnen Ihr Auto im Alltag?

_____

4.

Waarvoor gebruikt u uw auto meestal? (Denk bijvoorbeeld aan: boodschappen doen, tot werk komen, etc.)

Wofür benutzen Sie Ihr Auto meistens? (z.B. Einkäufe, an die Arbeit kommen)

_____

5.

Hoeveel kilometer rijt u ongeveer per jaar?

Wie viele Kilometer fahren Sie ungefähr pro Jahr?

0 – 5.000	
5.000 – 15.000	
15.000 +	

6.

Hoeveel kilometer rijt u gemiddeld op een gewone werkdag? Geef a.u.b. een inschatting.

Wie viele Kilometer fahren Sie durchschnittlich an einem normalen Wochentag? Schätzen Sie bitte.

Appendix D: Interviewschema

Interviewschema: Consumer adoption of electric vehicles

Christopher O'Connor, s1474596
Nik Hanebaum, s1476688

1. Voorstelling en Kennismaking

Begroeting en verheldering:
Goedemiddag, bedankt dat u de tijd genomen heeft om dit interview te voeren. Mijn naam is (Chiris/Nik) en ik doe met mijn collega (C./N.) op de Universiteit Twente voor ons afstudeeropdracht onderzoek naar elektrische auto's. Wij zijn van plan dit interview ter eigen analyse en voor eigen gebruik op te nemen, bent u daarmee akkoord? Het interview zal ongeveer 45 minuten duren, en er zijn geen goede of foute antwoorden. Het gaat puur om uw mening. Voordat wij beginnen wil ik u graag vragen om een korte vragenlijst over uw rijgedrag in te vullen.
Is dat duidelijk of heeft u nog vragen?

Begrüßung und Erklärung:
Guten Tag, und danke, dass Sie sich die Zeit genommen haben um dieses Interview zu führen. Mein Name ist (Chris/Nik) und ich schreibe zusammen mit meinem Kollegen (C./N.) an der Universität Twente in den Niederlanden meine Bachelorthese über elektrische Autos. Wir wollen dieses Interview zur weiteren Analyse gerne aufnehmen. Sind Sie damit einverstanden? Das Interview sollte insgesamt etwa 45 Minuten dauern. Es gibt keine richtigen oder falschen Antworten, es geht uns ausschließlich um Ihre Meinung. Bevor wir beginnen möchte ich Sie aber noch bitten, diesen kurzen Fragebogen über Ihr Fahrverhalten auszufüllen.
Ist alles deutlich oder haben Sie noch fragen?

2. Bepalen algemene kennisstand en mening over EVs

Het gaat in dit interview om pure elektrische voertuigen, dus niet om Hybriden met nog een conventionele verbrandingsmotor. Voordat wij gaan focussen op bijzondere aspecten van EVs, willen wij graag iets algemener weten wat u over EVs denkt en weet.

Es geht in diesem Interview um reine elektrische Autos, also nicht um Hybriden mit sowohl konventionellem Verbrennungsmotor und Elektroantrieb. Bevor wir uns aber bestimmten Aspekten von elektrischen Autos widmen, möchte ich gern noch etwas allgemeiner erfahren, was Sie über E-Autos denken und wissen.

2.1 Vrije associatie
Waaraan denkt u het eerst als u over elektrische auto's nadenkt? ☐
Woran denken Sie als erstes, wenn Sie über elektrische Autos nachdenken?

2.2 Kennis en ervaring
Heb je al eigen ervaring met EVs gemaakt? ☐
Haben Sie schon eigene Erfahrungen mit EVs gemacht?

Wat weet u over EVs? ☐
Was wissen Sie überhaupt über EVs?
Heeft u een idee hoe EVs op dit moment verder worden ontwikkeld? ☐
Was denken Sie, wie E-Autos momentan weiterentwickelt werden?
→Heeft u een idee van hoe de batterij in een EV werkt? ☐
Was denken Sie, wie die Batterie in E-Autos funktionieren?
→Heeft u een idee van hoe ver men gemiddeld met een momentele EV zou kunnen rijden? ☐
Was denken Sie, wie weit man im Schnitt mit einem aktuellen E-Auto fahren kann?
→Heeft u een idee hoe het opladen van een EV werkt? ☐
Was wissen Sie darüber, wie das Aufladen von E-Autos funktioniert?

2.3 Mening
Wat is uw mening over EVs? ☐
Wie ist Ihre Meinung über E-Autos?
→ Als u denkt aan technische aspecten? (Denken Sie dabei an *technische Aspekte?*) ☐
→ Als u denkt aan milieuaspecten? (Denken Sie dabei an *Umweltaspekte?*) ☐
→ Als u denkt aan bruikbaarheid? (Denken Sie dabei an *Benutzerfreundlichkeit?*) ☐

2.4 Koopintentie
Zou u op basis van wat u nu over EVs weet ook een EV willen kopen? ☐
Würden Sie, basiert auf was Sie so weit über E-Autos wissen, eines kaufen wollen?
Zou u voor uw volgende aankoop van een auto daarover nadenken een EV te kopen? ☐
Würden Sie darüber nachdenken bei Ihrem nächsten Autokauf ein E-Auto zu kaufen?
Kunt u voorstellen binnen de volgende tien jaren een EV te kopen? ☐
Könnten Sie sich vorstellen innerhalb der nächsten zehn Jahre ein E-Auto zu kaufen?

3. Bepalen kennis over range

"Dank u wel. Dit was een iets algemeen deel, maar nu willen wij op enkele bijzondere aspecten van EVs komen te spreken. In het volgende stuk gaat het over de distantie, die men met een EV zou kunnen rijden – in het Engels "range" genoemd. Wij willen in dit stukje niet alleen weten wat u over het onderwerp denkt, maar ook graag uw redenering daarachter"

"Danke so weit. Das war nun ein allgemeinerer Teil, aber nun möchte ich gern auf einige spezielle Aspekte von E-Autos eingehen. Im folgenden Teil geht es um die Reichweite, die man mit einem E-Auto erreichen kann – auf englisch 'Range' genannt. Ich möchte in diesem Stück nicht nur wissen was Sie über dieses Thema denken, sondern auch gerne, sofern möglich, warum Sie so denken."

Is het huidige 'state of the art' technologie voldoende om aan uw eigen eisen te voldoen? ☐
Ist der aktuelle Stand der Technik für Sie ausreichend, um Ihre Anforderungen zu erfüllen?
→ Hoe belangrijk vindt u range? ☐
Wie wichtig finden Sie range/Reichweite?
→ In vergelijking met uw huidige auto? ☐
Im Vergleich mit Ihrem momentanen Auto?

Denkt u dat de chauffeur de mogelijkheid heeft de range te verbeteren? Zo ja, hoe? ☐

Denken Sie, dass der Fahrer die Möglichkeit hat die Reichweite zu verbessern? Falls ja, wie?

Hoe denkt u veranderd range met temperatuur? ☐
→Denkt u dat dit hier in Nederland/Duitsland een belangrijke rol zou kunnen spelen?
In wiefern, denken Sie, verändert sich die Reichweite bei unterschiedlichen Temperaturen?
→ Denken Sie, dass das hier in den Niederlanden/Deutschland eine Rolle spielen könnte?

Gezien hoeveel u rijt, hoe veel range heeft u (meestal) nodig? ☐
→ Comfortable range ☐
Gemessen an wie viel Sie fahren, wie groß müsste die Reichweite für Sie sein?
→ Komfortable Reichweite

Op basis van u nu weet, zou range van EVs een barrière voor u zijn om uiteindelijk een EV te willen kopen? ☐
Basiert auf was Sie momentan über E-Autos wissen, wäre die Reichweite von E-Autos eine Barriere um letztendlich ein solches Auto kaufen zu wollen?

4. Bepalen kennis over opladen

"Dank u wel. Nu dat wij over range hebben gesproken, willen wij nog iets daarover te weten komen wat u over bepaalde aspecten van het opladen van elektrische auto's weet. Ook in dit stukje zijn we heel erg geïnteresseerd aan uw mening, maar ook aan uw redenering daarachter"

"Dankeschön. Jetzt wo wir über die Reichweite gesprochen haben, möchte ich nochmal auf einige Aspekte des Aufladens von EV's eingehen. Ich möchte in diesem Stück nicht nur wissen was Sie über dieses Thema denken, sondern auch gerne, sofern möglich, warum Sie so denken."

Waar denkt u dat men een EV kan opladen? ☐
Wo denken Sie kann man ein E-Auto aufladen?
Heeft u al eens opladers voor EVs gezien? Indien ja, waar? ☐
Haben Sie vorher schon einmal eine Ladestation gesehen? Wenn ja, wo?
Hoe denkt u dat het opladen werkt? ☐
Wie funktioniert Ihrer Meinung nach das Aufladen?
Waar zou u uw EV in de toekomst willen kunnen opladen? ☐
Wo würden Sie in der Zukunft gerne ihr E-Auto aufladen können?
→ Denkt u dat er binnenkort meer opladers zullen zijn? ☐
→Denken Sie, dass es in nächster Zeit mehr Ladestationen geben wird?
→Zou het opladernetwerk van vandaag, op basis van wat u nu denkt hoe het eruit ziet, voor uw behoefte voldoende zijn? ☐
→Würde Ihnen das Ladenetzwerk, so wie Sie es sich nun wahrnehmen, ihren Bedürfnissen entsprechen?
Vergeleken met een gewone moderne auto, wat denkt u hoe duur het zal zijn om een EV op te laden? → Goedkoper of duurder? In hoeverre? ☐

Wie viel würde es Sie ihrer Meinung nach, im Vergleich mit einem normalen modernen Auto, kosten ein E-Auto aufzuladen? -> Günstiger oder teurer? In wiefern?

Heeft u al eens een eigen vergelijking van de kosten tussen een EV en een CEV gemaakt? ☐
Haben Sie schon einmal einen solchen Kostenvergleich zwischen E-Auto und herkömmlichem Auto angestellt?
→ EV opladen vs. momentele CEV tanken (CEV = combustion engine vehicle) ☐
→*E-Auto aufladen gg. momentanes normales Auto tanken*

Wat denkt u hoe lang het zou duren om een EV maximaal op te laden? ☐
Wie lange denken Sie dauert es ein E-Auto komplett aufzuladen?

Heeft u al eens van andere manieren om EV's op te laden gehoord? ☐
Haben Sie schon einmal von anderen Möglichkeiten E-Autos zu laden gehört?
→ Indien ja, leg alstublieft uit. ☐
→*Falls ja, könnten Sie diese erklären/beschreiben?*

> Heeft u al eens van een snellaadpaal, in het Engels 'supercharger station', gehoord? ☐
> *Haben sie schon einmal von einer sogenannten Schnellladestation (Supercharger) gehört?*
> → Indien ja, leg alstublieft uit. ☐
> → *Falls ja, könnten Sie diese erklären/beschreiben*

Stel dat u een reis naar Amsterdam wilt ondernemen:
Heeft u een idee hoe u het opladen zou moeten inplannen? (time-management) ☐
→ *Zo ja, hoe? Zo nee, waarom niet?*
Stellen Sie sich vor Sie wollen nach Amsterdam reisen:
Haben Sie eine Idee wie Sie das Aufladen auf einer solchen Reise einplanen müssten?
→ *Wenn ja, wieso? Ebenso: wenn nein, wieso nicht?*

Stel dat u op vakantie naar Spanje wilt rijden:
Heeft u een idee hoe u het opladen op zo'n reis zou moeten inplannen? ☐
→ Zo ja, hoe? Zo nee, waarom niet?
Stellen Sie sich vor Sie wollen nach Spanien reisen:
Haben Sie eine Vorstellung von wie Sie das Aufladen auf einer solchen Reise einplanen müssten?
→ Wenn ja, wieso? Wenn nein, wieso nicht?

Stel dat u vanaf nu voor enkele weken een EV in het alledaagse leven mag gebruiken:
Hoe zou u het opladen inplannen? (habits) ☐
Stellen Sie sich vor Sie würden ab jetzt für einige Wochen ein E-Auto im Alltag benutzen:
Wie würden Sie das Aufladen einplanen?

6. Verandering in perceptie van EVs

Dank u wel. Wij hebben nu zowel over range als ook het opladen gesproken, en ik heb de voor u belangrijkste punten genoteerd. In het volgende stuk wil ik u graag over de net besprokene onderwerpen de nieuwste informatie presenteren. Ik geef u daarvoor nu eerst een informatieblad over de recente ontwikkelingen en het momentele 'state of the art' wat betreft

de range. Neemt al de tijd die u nodig heeft om alles door te lezen. Als u vragen heeft, stelt hem alstublieft.
Vielen Dank soweit. Wir haben bis jetzt sowohl über die Reichweite als auch das Aufladen gesprochen und Ich habe mir die wichtigsten Punkte notiert. In dem nächsten Abschnitt möchte Ich Ihnen gerne ein paar neue Informationen präsentieren. Ich werde Ihnen dazu nun erst ein Informationsblatt über aktuellen und neusten Entwicklungen im Bezug zur Reichweite von E-Autos geben. Nehmen Sie sich so viel Zeit wie Sie benötigen um alles gut durchzulesen. Sollten Sie Fragen haben können Sie diese gerne stellen.

→ INTERVENTIE: INFORMATIEBLAD RANGE GEVEN ☐

6.1 Range

Wat is nu uw mening over de range van EVs? ☐
Wie ist nun ihre Meinung über die Reichweite von E-Autos?

Heeft deze informatie uw perceptie over EVs veranderd? ☐
Haben diese Informationen ihre Wahrnehmung von Elektroautos verändert?
→ In hoeverre m.b.t range ☐
→In wiefern mit bezug auf Reichweite

Denkt u dat het huidige state of the art in technologie voor u behoefden voldoende zou zijn? ☐
Denken Sie, dass die derzeitige modernste Technologie ihren Bedürfnissen gerecht werden würde?

Dank u wel. Nu dat we het over range hebben gehad, wil ik u ook nog een informatieblad over het opladen geven. Neemt weer al de tijd die u nodig heeft om alles door te lezen. Als u vragen heeft, stel hem alstublieft.

Vielen Dank soweit. Nachdem wir uns erst über die Reichweite unterhalten haben möchte Ich ihnen jetzt gerne ein Informationsblatt über das Thema Aufladen geben. Nehmen Sie sich so viel Zeit wie Sie benötigen um alles gut durchzulesen. Sollten Sie Fragen haben können Sie diese gerne stellen.

→ INTERVENTIE: INFORMATIEBLAD OPLADEN GEVEN ☐

6.2 Opladen

Wat vindt u daar nu van? Wat denkt u nu over het opladen van EVs? ☐
Was denken Sie nun über das Aufladen von E-Autos?

Heeft deze informatie uw mening misschien veranderd? ☐
Haben diese Informationen Ihre Meinung eventuell verändert?

Denkt u dat het huidige opladernetwerk voor u behoefden voldoende zou zijn? ☐
Denken Sie, dass das heutige Ladenetzwerk ihren Bedürfnissen gerecht werden würde?

Dank u wel. Afsluitend willen wij u nog enkele vragen daarover stellen, in hoeverre u een EV zou willen kopen.

Vielen Dank. Abschließend würde Ich Ihnen gerne noch ein paar Fragen über Ihre Kaufintentionen in Bezug auf E-Autos stellen.

6.3 Koopintenties in de toekomst

Zou u voor uw volgende aankoop van een auto daarover nadenken een EV te kopen? ☐
Würden Sie bei ihrem folgenden Autokauf ein E-Auto in Erwägung ziehen?

Kunt u voorstellen binnen de volgende tien jaren een EV te kopen? ☐
Können Sie sich vorstellen in den kommenden 10 Jahren ein E-Auto zu kaufen?

7. Afsluiting

Bedankt dat u de tijd heeft genomen voor dit interview.
Hoe vond u het?
Heeft u misschien nog iets toe te voegen, of heb je misschien vragen aan mij/ons?
Vielen Dank, dass Sie sich die Zeit für diese interview genommen haben.
Wie fanden Sie das Interview?
Haben sie unter Umständen noch etwas hinzuzufügen oder Fragen an mich?

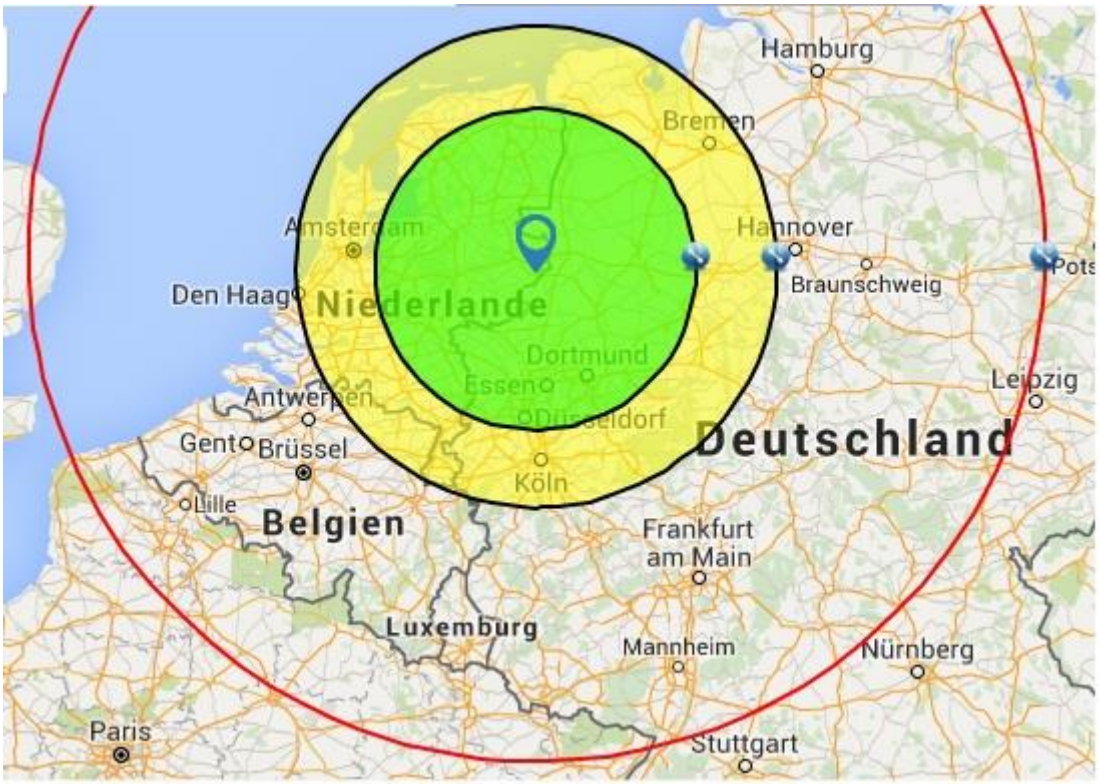
Appendix E: Information

Informatie Range

Gemiddelde Range van huidige EV's: 150-210 km (bij voorbeeld E-Golf: 190 km)
State of the Art Range: 450-550 km (bij voorbeeld Tesla Model S 90D: 550 km)
Range loss door gebruik van verwarming: 10-20%
Range loss bij lage temperatuur (-5°C): 15-25%

Het groene bereik op de onderstaande kaart geeft een indicatie van bestemmingen die met een huidige EV, zonder tussendoor op te laden, bereikbaar zijn. Het gele bereik op de kaart geeft een indicatie van de maximale range van gemiddelde moderne elektrische voertuigen. Bestemmingen binnen deze bereik kunnen gehaald worden, maar soms is er een korte pauze om op te laden nodig. Het roode en grootste bereik geeft een indicatie voor de range van 'State of the Art' technologie elektrische voertuigen, zoals de Tesla Model S. Bestemmingen binnen deze bereik zijn met deze Autos zonder tussendoor op te laden bereikbaar, gemiddelde elektrische voertuigen moeten om deze bestemmingen te bereiken een keer helemaal nieuw opgeladen worden.

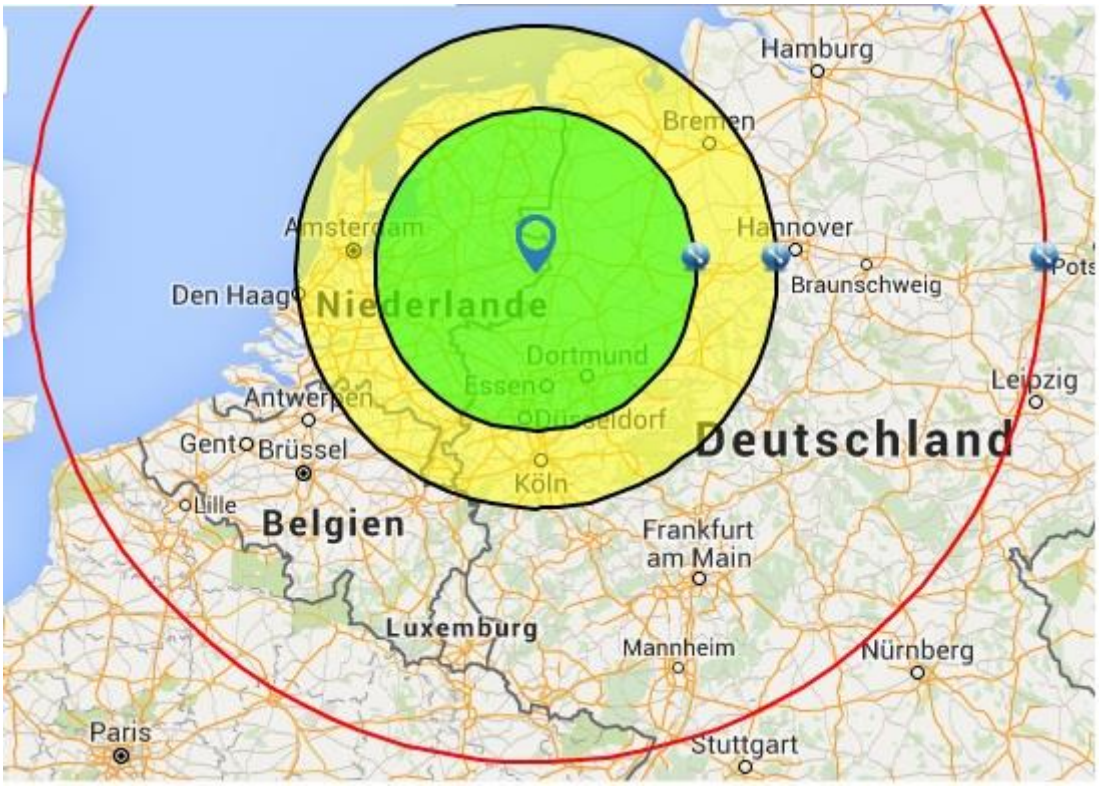
Voorbeeld afstanden: Enschede - Nijmegen 113km
Enschede - Münster 68 km
Enschede - Amsterdam 159 km
Enschede - Hamburg 316 km



Informationen Reichweite

Durchschnittliche Reichweite aktueller E-Autos: 150-210 km (z.B. E-Golf: 190 km)
Modernste Technologie Reichweite: 450-550 km (z.B. Tesla ModelS 90D: 550 km)
Reichweite Verlust durch Heizung: 10-20%
Reichweite Verlust bei niedriger Temperatur (-5°C): 15-25%

Der grüne Bereich der Karte markiert mögliche Ziele, die mit durchschnittlichen modernen Elektroautos, ohne zwischendurch zu laden, von Enschede aus erreichbar sind. Der gelbe Bereich markiert die maximale Reichweite durchschnittlicher Elektroautos. Dieser ist allerdings nicht immer ohne Ladestopp zu erreichen. Mit einer kurzen Pause von maximal 30 Minuten sind allerdings auch diese Ziele ohne Probleme erreichbar. Der rote und größte Radius markiert die Reichweite der Elektroautos mit neuster Technologie von Tesla. Ziele die in diesem Bereich liegen, sind mit diesen Autos ohne Ladestoppp erreichbar. Durchschnittliche Elektroautos (z.B. E-Golf) müssen zwischendurch einmal komplett geladen werden.
Strecken Beispiele: Enschede - Münster 68 km
Enschede - Nijmegen 113km
Enschede - Amsterdam 159 km
Enschede - Hamburg 316 km



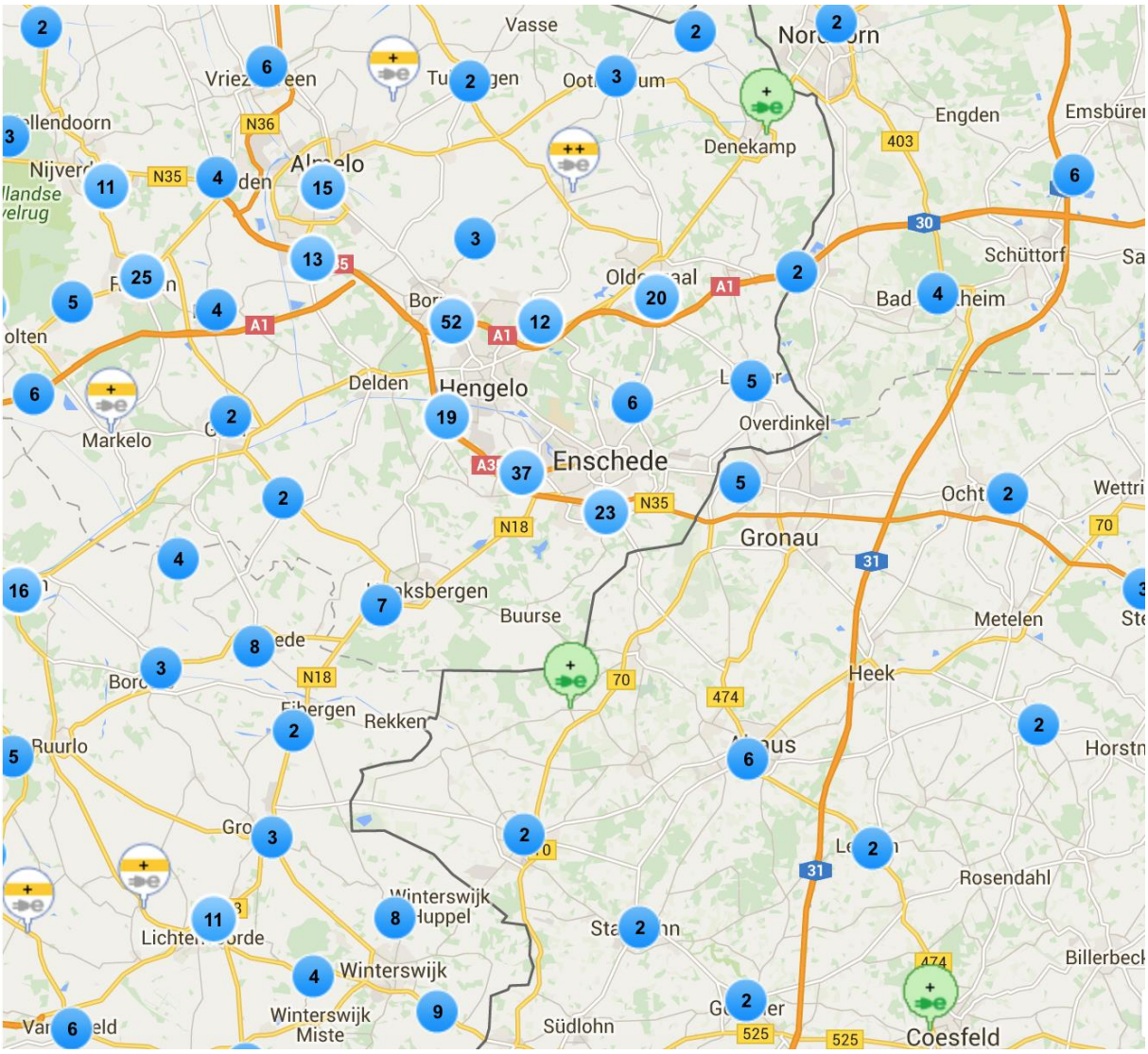
Information Charging:

Op de volgende pagina's vind u enige informatie over het oplader-netwerk in Nederland, Duitsland en heel Europa, alsook informatie over de oplaadkosten en –tijd.

Auf den folgenden Seiten finden Sie einige Informationen zum Auflade-Netzwerk in den Niederlanden, Deutschland und ganz Europa, sowie zu den Kosten und der benötigten Zeit zum Aufladen.

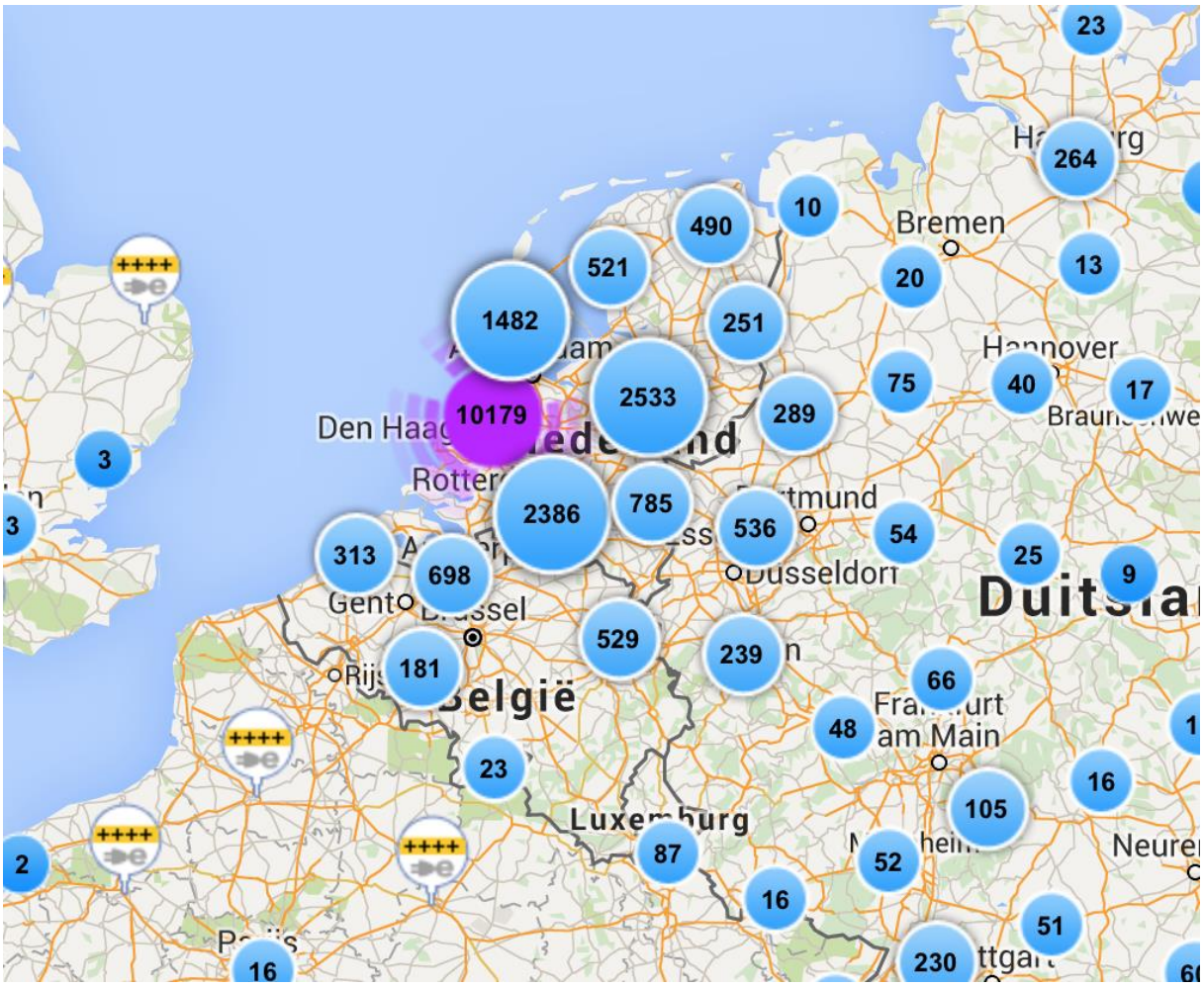
1. Hieronder vindt u een landkaart met opladers in het gebied om Enschede heen. Het cijfer binnen de blauwe stippen geeft het aantal opladers in deze buurt aan. (Bron: www.oplaadpalen.nl, een online zoekmachine voor opladers in uw omgeving)

   Hierunter finden Sie eine Karte mit Auflade-Stationen im Raum Enschede. Die Zahl innerhalb der blauen Punkte gibt an, wie viele Auflader sich im näheren Umkreis befinden. (Entnommen von www.oplaadpalen.nl, einer online Suchmaschine für Auflade-Stationen in Ihrer Nähe)



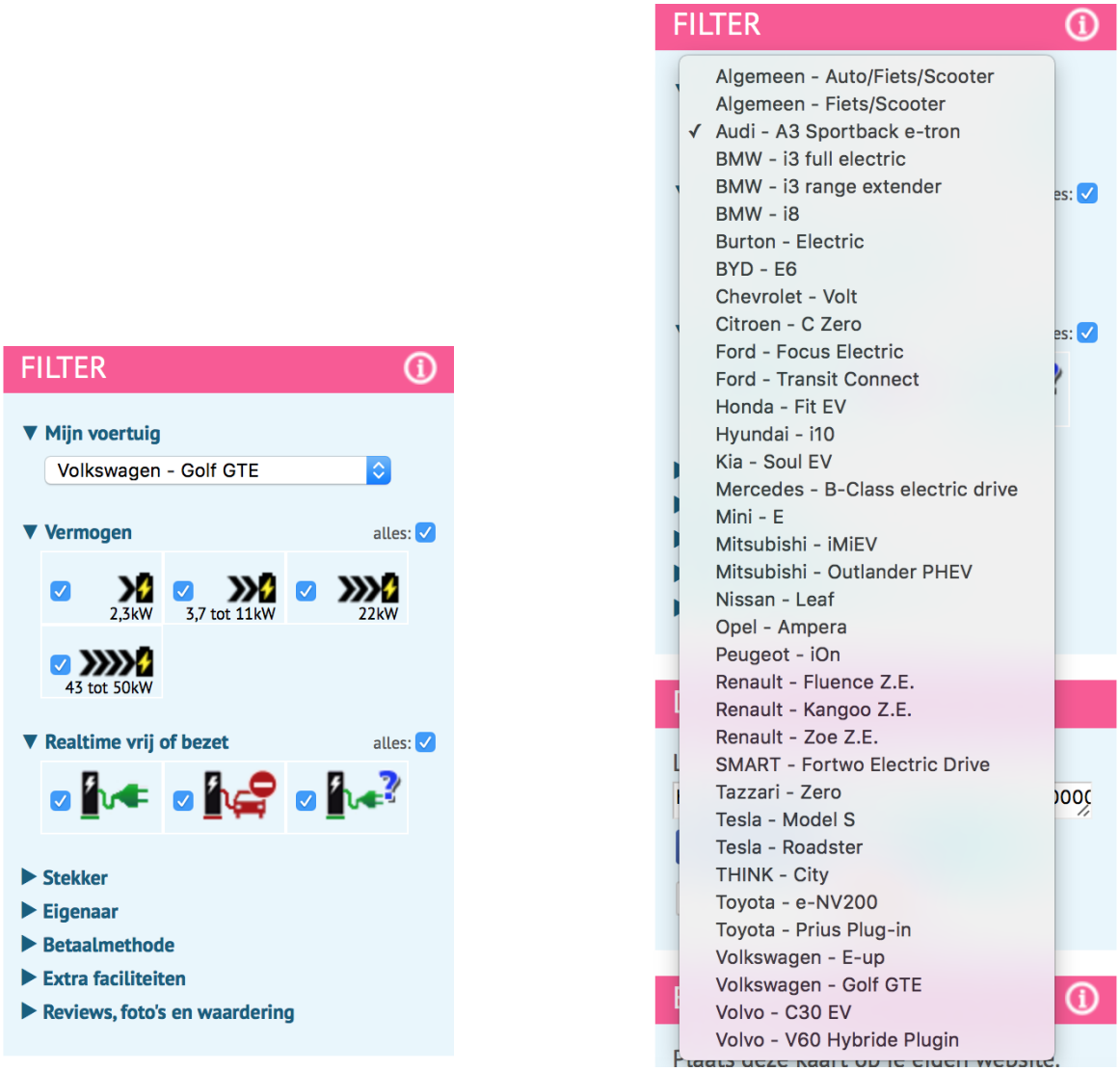
2. Hieronder vindt u een landkart met opladers in heel Nederland, alsook in België en delen van Duitsland. Het cijfer binnen de blauwe en parsen stippen geeft het aantal opladers binnen deze regio aan.

   Hierunter finden Sie eine Karte mit Auflade-Stationen in den Niederlanden, sowie Belgien und Teilen von Deutschland. Die Zahl innerhalb der blauen und lilafarbenen Punkte gibt an, wie viele Auflader sich in der Region befinden. (www.oplaadpalen.nl)



3. De filterfunctie van oplaadpalen.nl: Zoek naar opladers in uw buurt, die voor uw auto en uw behoefde het best geschikt zijn. Alle tegenwoordige EV-modellen, alsook alle gangbare oplaadsystemen en spanningen staan voor uw zoek ter keuze. Bovendien kunt u alvast zien welke palen op dit moment al in gebruik zijn.

   Die Filterfunktion von oplaadpalen.nl: Suchen Sie Auflader in Ihrer Nähe, die für Ihr Auto und ihre Bedürfnisse am besten geeignet sind. Zur Auswahl stehen alle gängigen E-Auto Modelle des europäischen Marktes, alle gängigen Stecker Systeme und Spannungsstärken, sowie eine Echtzeitangabe ob die jeweilige Station frei oder besetzt ist.



4. Op deze landkaart vindt u alle Supercharger-stations van het automobielbedrijf Tesla. Supercharger zijn speciale opladers, die voor het extra snel opladen van Tesla auto's geconcipieerd zijn. Deze opladers kunnen Tesla auto's binnen 20 minuten (het gemiddelde pauzeertijd op een lange reis) voor de volgende 200km reis opladen. Het bedrijf heeft over heel Europa rond 550 eigen opladers opgesteld (einde 2015). Eigenaars van een Tesla mogen over de hele levensduur van het auto elke Supercharger station kosteloos gebruiken.

   Auf dieser Karte finden Sie alle Supercharger-Stationen der Firma Tesla. Supercharger sind spezielle Stromtankstellen des Automobilherstellers Tesla, die für besonders schnelles Aufladen der markeneigenen Autos errichtet wurden. Die Stationen erlauben es, Tesla-Fahrzeuge innerhalb von 20 Minuten (also der durchschnittlichen Pausenzeit auf Langstreckenreisen) das Auto für weitere 200km Strecke aufzuladen.
   Tesla betreibt europaweit ca. 550 Ladestationen (Stand Ende 2015).

Die Benutzung aller Supercharger Stationen ist für Nutzer von Tesla Fahrzeugen kostenlos. Das kostenlose Aufladen an allen verfügbaren Supercharger Stationen wird für die Lebensdauer des Fahrzeuges mitverkauft.

5. <u>Oplaadtijd, Infrastructuur en kosten:</u>
   Zowel de capaciteit van het oplaadstation als het technische opzet van elk auto hebben invloed op de oplaadtijd. Onder optimale condities kan een moderne accumulator binnen een half uur tot 80% van zijn capaciteit opgeladen worden (snel oplader), maar het helemaal opladen duurt duidelijk langer. Ook bij auto's die snel oplaadbaar zijn kan het langer duren om op te laden, als de spanning van het station laag is.

   Principieel wordt er onderscheid gemaakt tussen het opladen met gebruikelijke stopcontact spanning (230V; 2,5-3,6 kWh), het opladen met sterkstroom (400V, 20 kWh), en het opladen met gelijkstroom zoals gebruikelijk bij Superchargers (30 kWh).

   Veel van de Duitse EVs worden met een intern oplader met een capaciteit van 3,6 kWh gebouwd, die over 6 tot 8 uren opladen. Negentig procent van alle oplaad-processen worden thuis of op werk doorgevoerd, alleen tien procent via openbare opladers.
   Het installeren van een oplader in de eigen garage kost op dit moment tussen 500 en 2000€.

   <u>Aufladedauer, Infrastruktur und Kosten:</u>
   Sowohl die Leistungsfähigkeit der Ladestation als auch die technische Auslegung des jeweiligen Fahrzeuges haben Einfluss auf die Ladedauer. Unter optimalen Bedingungen können moderne Akkus innerhalb von etwa einer halben Stunde zu 80% aufgeladen werden (Schnelladung), wohingegen das hundertprozentige Aufladen deutlich mehr Zeit in Anspruch nehmen kann. Auch bei schnellladefähigen Autos kann

das Aufladen unter Umständen sehr lange dauern, wenn die Stromspannung der Ladestation gering ist.

Grundsätzlich wird unterschieden zwischen dem Aufladen aus gewöhnlicher Steckdosenspannung (230V; 2,5-3,6 kWh), dem Aufladen aus Hochspannungsladern mit Starkstrom (400V; 20 kWh), und Gleichstromladesystemen wie den Tesla Supercharger Stationen (30 kWh).

Viele deutsche Elektroautos werden noch mit einem internen Ladegerät (Bordlader) mit einer Kapazität von 3,6 kWh gebaut, was zu Ladedauern von 6 bis 8 Stunden führen kann. Neunzig Prozent dieser Ladevorgänge finden zurzeit zuhause oder am Arbeitsplatz statt. Nur etwa 10% der Aufladevorgänge entfallen daher auf öffentliche Stationen.
Das Installieren einer Ladestation in der eigenen Garage kostet momentan zwischen 500€ und 2000€.

Appendix F: Coding scheme

Coding scheme

The Interviews have been coded in the following way

Step 1: The researcher reads all interviews

Step 2: The researcher reads all interviews a second time and marks all passages in which the participants talks about the following topics:

1. Concern with technology
2. Concern with environment
3. Knowledge about EVs
4. Attitude about EVs
5. Perceived disutility about EVs
6. Buying intentions regarding EVs
7. Expected comfortable range
8. Range importance
9. Change of attitude
10. Change of perceived disutility
11. Change of buying intentions
12. Change of comfortable range

Step 3: The researcher uses the list of codes to code statements over the different main categories

Appendix G: Percentage grouping table

Table 3

Percentage grouping table

Observed behavioral variable	*Scale*	*Percentage(%)*
Concern with technology	worried	50
	interested	12,5
	affiliated	37,5
Concern with environment	moderate	25
	decent	25
	high	50
Knowledge about EVs	low	62,5
	moderate	12,5
	decent	25
Attitude about EVs	generally negative	50
	rather negative	50
Perceived disutility of EVs	moderate	12,5
	decent	50
	high	37,5
Buying intentions regarding EVs	interested in the future	50
	maybe in the future	25
	not likely	25
Expected comfortable range	low	37,5
	moderate	62,5
Range importance	moderate	37,5
	decent	25
	high	37,5
Change of attitude	negative	12,5
	none	37,5
	positive	50
Change of perceived disutility	negative	0
	none	37,5
	positive	62,5
Change of buying intentions	negative	12,5

	none	37,5
	positive	50
Change of comfortable range	negative	12,5
	none	37,5
	positive	50

Appendix H: Persona foundation documents

Persona Kim

1)

Full name: Kim Schmidt

Age: 23

2)

Kim is a Student at the University of Twente, has recently obtained her Bachelor in Psychology

Her routine activities include studying, sporting, going out with friends and working at her part time student job, which is easily accessible by bike

Occasional activities include visiting her friends and family (may. 150km) and go shopping

3)

Her short term goal is to finish her masters degree, in the long run she wants to become a therapist and settle down in the area

She uses her car very infrequent and tries to avoid it if possible, mostly visits friends and family

She motivated by being able to help other people and ‘doing the right’ thing

Kim values a healthy lifestyle and environmental friendliness

4)

Kim’s annual income is about 8000€, she lives in a student house in Enschede and is currently obtaining a degree in higher education

5)

Kim has very limited knowledge about cars and new technology, if she runs into problems with her car she lets her father take care of it

She has three years’ experience with her car

6)

Kim only needs her car for relative short trips from time to time, her car is not important to her

Car only fulfills some basic needs, as she sees it as means to get from A to B

She needs a reliable and easy usable car, complex technology isn't necessary for her

7)

Kim is skeptical and worried about new technologies, she prefers simple and well known, she values the environment and a green lifestyle, ease in use is important to her, she doesn't need any extras

Persona Thijs

1)

Full name: Thijs de Jong

Age: 27

2)

Thijs is a student at the University of Twente, pursuing a Master degree in International Business Administration

His routine activities include studying, going, working his part time job and traveling

Occasional activities include visiting his family and and maintaining/ taking care of his car

3)

His short term goal is to obtain his Master degree and be successful in his part time job. In the long term he wants to become a successful businessman that travels frequently

Thijs uses his car frequently and barely uses any other way of transportation

Thijs is motivated by financial incentives and personal advantages

He values high class style and comfort

4)

Thijs annual income is about 12000€, he lives in a student house in Enschede and currently obtains a degree in higher education

5)

Thijs is affiliated with new technologies and spends time to get acquainted with new developments

He has 6 years' experience with his car and maintains it cautiously

Thijs has decent knowledge about EVs, but thinks that the current technology isn't sufficient for him

6)

Thijs uses his car for nearly everything, ranging from getting groceries to traveling

His car is valuable for him and doesn't only fulfils his needs, but symbolic meaning to him

Thijs wants a car that supports his self-image and gives him everything he needs (The more the better)

7)

Thijs is affiliated with new technologies, image and comfort are important to him, he values the image of a businessman, needs to be flexible and able to travel long distances

Appendix I: Quote translation

Original Quote	Translation
„Also dann wäre ich da auf jeden Fall auch zum Kompromiss bereit. Also ich würde das schon als komplett packet ansehen […]aber mit dem Umweltfaktor, dann würde ich es glaube schon machen. Dann würde ich eher meine Bedürfnisse zurückstellen und dann sagen, aber dafür tu ich dann halt was für die Umwelt“	*“Well, I would surely be ready for compromise. I would still see it as a whole package, […] but including the environmental factor, I think I would do it [buy an electric vehicle]. Then I would rather put my needs aside and say: instead I can do something for the environment.”*
“Ik vind het op zich een mooi concept, ook een beetje milieu vriendelijk, maar ik denk nu op dit moment is het nog niet geschickt voor alles wat ik daarme zou willen doen. Dat vind ik wel belangrijker zeg maar.”(	*“I think it is a good concept, also somewhat environment friendly, but I think at this moment it is not sufficient for everything I want to do with my car. That is more important to me..”*
„Gute Frage also ich würde schätzen das es nichtweiter als 100 Kilometer,[…] aber da weiß ich jetzt auch nicht so viel drüber. Das ist eher eine Schätzung von mir.”	*“Well, that is a good question, I would estimate that they can’t go any longer than 100km,[…], but I don’t really know anything about that. That’s rather an estimation of mine.”*
“[...] met die remmen kan jij energei weer opladen, als jij dan meer op jij mototr afremmt laad die dan dus weer energie in je akkus en dan verhoogt de range.”	*“[…] with the breaks of the car you can also recharge some energy,[…]”*
„[…]natürlich als alternative dazu mit den Autos mit Verbrennungsmotoren. Aber auch schon etwas negatives, weil ich habe da auch schon vieles negative drüber gehört.“	*[…] and of course also as an alternative for cars with combustion engines. But more negative I would say, because I have heard a lot negative about it [electric vehicles]”*
„Also das [lange Reise] wäre schon etwas was mir zu riskant wäre, weil die Gefahr das man da wirklich auf der Strecke bleibt ist dann halt auch da.“	*“Well that [long trip] would be something that would be too risky for me, because the danger of being stranded is certainly present”*
„Also wenn ich das [Elektroauto] selbst fahren würde hätte ich da glaube schon Angst vor, also weil ich mich halt nicht so flexibel fühlen würde, man kann halt nicht einfach so runter fahren mal eben zur Tankstelle.“	*“If I would ride one [electric vehicle] myself I would be anxious, because I wouldn’t feel as flexible anymore, be able to just fill up the tank if necessary”*
“Ne ja ne normaal gesproken een hele lange afstand rijsen doe ik meestal toch niet met de auto, maar heel vaak gaa ik ook niet zo veer.	*“Well usually I don’t travel long distances with my car anyway, but I don’t really go that far very often. So as long as it that,*

Ik maak niet zo hele lange rijsen. Dus zou dat voor mij niet zo erg zijn. [...]Dus zodra die dat maar kan, veer genoeg rijden is het wel goed. “	*going far enough is it okay for me.”*
“Dan zou die heel verr moeten kunnen rijden, want soms heb je gewoon weinig tijd tussen de ritten door om op te laden en ik denk dan zp 1000 of 1200 km zou die mopeten kunnen. Dus de range op zich is voor mij wel belangrijk en ik zou wel een groot bereik nodig hebben. En ik denk dat ik in ieder gevall ook langere ritten zou kunnen ondernemen, ik vind het wel belangrijk dat er de mogelikheid is.”(	*“In that case it would need to be able to drive very far, because sometimes I don’t have that much time in between to recharge and I thinks in that case it would need to be able to drive between 1000 and 1200 km. So the range is very important to me and I Would need a big range. And I would anyhow like to be able to travel longer distances, it is important to me that the possibility is there.”*
„Aber es gibt auf jeden fall so wie ich das sehe wirklich genug Möglichkeiten auch das man nicht so leicht in Bedrängnis kommt oder Probleme bekommt, das man wirklich irgendwie liegen bleibt. Also man muss anscheinend nicht so viel im Voraus planen wie ich erst vermutet hatte, sondern man kann auch wirklich spontaner irgendwo hinfahren.“	*“But there are for sure, at least as I see it, enough possibilities that one won’t get into problems or distress, that one could get stranded. So apparently you don’t have to plan as much beforehand as I expected first, but you are also able to drive somewhere spontaneously.”*
“Dat vind ik nog steeds een groot nadeel, dus ne mijn mening is niet zo zeer verandert.”	*“I still think that is a huge disadvantage, so my opinion hasn’t really changed.”*