EDUARDO ALLISON OJEDA
C A R A S P O W E R P L A N T
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ASSESSING VEHICLE TECHNOLOGY ACCEPTANCE AND ITS IMPLICATIONS FOR
THE BUSINESS MODEL DESIGN

MASTER THESIS FOR M.SC. MANAGEMENT OF TECHNOLOGY

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Eduardo Allison Ojeda: Car as Power Plant, Assessing Vehicle Technology Acceptance and its implications for the Business Model design, © August 2013

* Cover image: Hyundai’s Blue2 Fuel Cell concept [Ricciuti, 2011]
Energy is a vital and pervasive element embedded in our civilization. Forecasts indicate the global energy requirements in 2030 will be 53% higher than in 2004 with the implications this have for the natural resources depletion and climate change. This situation puts in perspective the challenges lying ahead. Renewable energies have been proposed as the solution to meet the requirements of a growing population in a sustainable way. Unfortunately, the intermittent nature of these sources translates into the need of back-up plants with significant costs increase for these technologies. During the last century, two massive but disconnected conversion energy systems have been developed: the electric and transportation systems. On the one hand the electric installed capacity in Europe reached 870 GW in 2010. On the other hand there were 239 million cars in 2010 in Europe. Vehicle to Grid (V2G) has been proposed as an alternative way to cope with the electricity demands of the future by integrating the electric and transportation system infrastructures. In this way, the vehicle fleet will be used as a mobile storage system, enabling a higher penetration level for renewable energy sources. As an example, with the current personal transportation fleet of Europe, 2,390 GW of electric capacity could be fed into the grid.

Currently, V2G is in the Research and Development stage and several institutions around the world are testing its capabilities in pilot projects. The Car as Power Plant (CaPP) concept emerged as one of the projects from The Green Village, which is an initiative of Delft University of Technology. Similar to the V2G technology, the Car as Power Plant’s main aim is to deliver electricity to the grid. However, there are significant differences among them. In the case of the CaPP it uses Fuel Cell Vehicles to generate not only electricity but also water and heat. Therefore, the CaPP concept can be considered as a small multi-product power plant. There are additional elements that make the CaPP concept not only a way to deliver electricity to the grid, but a whole paradigm shift by using our cars to replace the electric system. The focus of this report is precisely in this technological concept.

In the past, the studies about the CaPP concept have concentrated mainly on the technical feasibility and economic estimations of the project. One of the studies examined the technological gaps and opportunities for the CaPP, while the other assessed the ancillary services delivered to the grid by the Fuel Cell vehicles. Nevertheless, the technology evolves and emerges into society as a technological system.
due to the alignment of several socio-technical factors. Some of these include user practices, market conditions, consumer perceptions or a merely functional basis. For this reason, it is relevant to go one step further and not only understand the technical conditions of the system, but also the perceived benefits and concerns by the potential users. On this way it would be possible to incorporate into the Research and Development stage some elements that could be of interest for society, to ease the adoption of the technology in the future.

The objective of this study is to bridge the gap between the technology development and the society’s perception by assessing the vehicle technology acceptance and its implications for the business model design in the Netherlands. This is done by addressing the following research questions:

A. What is the technology acceptance level regarding the CaPP and the main factors for its adoption in the Netherlands?

B. What are the main benefits / concerns perceived by the potential users of the CaPP in the Netherlands?

C. Based on the current technological development and the customer perception: what business model(s) would be more suitable for the implementation of the CaPP technology?

D. Which policies should be in place to stimulate the emergence of the CaPP from its current state? CaPP

A model extended from the Car Technology Acceptance Model is proposed to conduct the study. This model is formed by eight independent, three moderating and one dependant variables. To have a better impression about the user’s context, mixed research methods are employed. The application is done by individual in-depth structured interviews as the preferred data collection method with a reduced amount of participants. The sample comprises 20 participants, classified in 3 groups: 1) Students that do not own a car, 2) Professionals who own an internal combustion based car, and 3) Persons who own electric based cars. From the total participants, 7 are students, 8 are gasoline car owners, and 5 are electric car drivers. Considering two different measurements instruments are used, the data analysis follows the same structure. The quantitative instrument uses descriptive statistics and then a correlation analysis using the Statistical Package for the Social Sciences (SPSS) software. The qualitative data is analyzed using content analysis by grouping information together into category clusters and then comparing it with the group of participants.

The results show the technology acceptance levels about the CaPP concept are in general above average, this is true in both the quanti-
tative and qualitative sections. The most relevant factors to foster the technology adoption are grouped in 6 categories: price, incentives, information access, infrastructure, technology and values. The perceived benefits are classified in two categories: for the user and for society. The benefits for the user include: monetary incentives, guilt reduction, and increase in consumer power. The benefits for society are: environmental benefits, integration of services, and reducing the variation from renewable sources. The concerns are classified in two: car technology and the system. The concerns identified about car technology are: dangers of using hydrogen, degradation of the Fuel Cell, and lack of flexibility when the car is plugged-in. On the system side the concerns are: the lack of infrastructure, long distances from CaPP facilities to the final destination, and the risks involved in decentralizing the power generation. The semi-lease is determined to be the best business model structure to adopt the CaPP as it transfers the associated risks from the users to the provider and keeps the customer as the proprietary of the vehicle. Some of the policy recommendations to develop the niche include: continue funding the Fuel Cells R&D related activities, define an annual amount of energy that should be delivered to the grid with the CaPP technology, incentivize an open innovation scheme where different industry, governmental and academia actors come together under a joint venture to develop the technology, unify the development of the communication standards being used in the V2G projects around the world as they may influence the ones to be adopted in the future for the CaPP.

Different discussions and learning points are derived from this thesis project. Regarding the CaPPTAM proposed model, from the 11 variables studied, 7 had significant results: 5 of these variables showed strong levels of correlation and the other 2 had a moderate positive level of correlation with the dependant variable. However, further studies with greater samples would be required to validate the model. In the lessons learned from the study, there are three recommendations: 1) contact the users as early as possible, 2) the use of mixed research method would be modified to be used in a sequential fashion starting with a qualitative validation of the model to then continue to a quantitative section, 3) focus more sharply to go deeper on one single topic from the beginning. The present study can serve The Green Village as a starting point when thinking about the user perception regarding the CaPP concept. Some of the recommendations include: to refine the CaPP concept version for future studies, continue with the creation of the rhetorical space, and take the input from this report about the user concerns when considering on defining some of the technical consideration for the CaPP concept.
Further studies could concentrate on testing the Car as Power Plant Technology Acceptance Model (CaPTAM) model with a higher number of participants, conducting a vehicle technology acceptance study across different nationalities or countries, study the application of the CaPP concept for developing countries, conducting a research focused on design for interaction with the Industrial Design faculty, and assessing the perception of the CaPP concept for fleet management purposes.
I would like to express my gratitude to Dap Hartmann for having induced in me the interest for entrepreneurship and business innovation during the course “Turning Technology into Business.” The discussions held at his office provided me with useful insight that helped me to look at the broader picture.

Special thanks to Leendert Verhoef and Ad van Wijk who always provided valuable feedback that allowed me to keep focused on the most relevant issues. Additionally I thank Professor Bert van Wee from the Transport and Logistic section of TBM who helped me to validate my research model and questionnaires. I would also like to thank all the participants that kindly took some time from their daily activities to be interviewed for this study.

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I owe my gratitude to my family, as they have encouraged my professional and personal ambitions. Even though there was a big physical distance between us they were always close to me. Thanks to my mother Oty, my father Enrique, my sister Monica and Peluchin for their constant love and support. Moreover, I would like to thank “mi padrino” Luis for stepping in during a critical moment of the process that allowed me to secure the scholarship.

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Eduardo Allison Ojeda
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<td>Vehicle to Grid</td>
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<td>FCV</td>
<td>Fuel Cell Vehicle</td>
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<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
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<td>BEV</td>
<td>Battery Electric Vehicle</td>
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<td>CaPP</td>
<td>Car as Power Plant</td>
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<td>MLP</td>
<td>Multi Level Perspective</td>
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<td>SNM</td>
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INTRODUCTION

Energy is one of the pillars of our civilization and is pervasive for all our daily life activities. Communication systems, transportation networks and complex supply chains rely on different energy carriers to work properly. Any disruption to this system would create unimaginable consequences. It is therefore of the utmost importance to foresee the challenges that lay ahead. The main concern include the projected growth of the world population from 7 billion in 2012 to 9 billion in 2050 [IEA and UNEP, 2007], which is estimated to lead to the intensification of energy usage (53% higher in 2030 than 2004 [IEA and UNEP, 2007]), the potential depletion of fossil fuels, and to climate change.

Renewable energy sources have been considered for a long time as one of the best alternatives to fulfill the requirements of the growing population while diversifying into cleaner, non green house emitting sources. Unfortunately, some of the foreseen changes are still not happening. For instance, the Emission Trading System implemented a few years ago to curb the effect of CO\textsubscript{2} emissions is still not having a significant impact in the reduction of global emissions. In addition, the implementation of Renewable Energy Sources is not as easy as expected and challenges are arising due to the volatility the implementation of this technology creates in the electric transmission and distribution systems. For instance, as renewable sources are not constant, conventional back-up plants are required to off-set the intermittency, making the investment in these technologies to be higher against their fossil based counterparts. Additionally, it is well known the energy system is entrenched due to vested interests from the incumbent sector including oil, electric utilities, and transportation companies among others.

During the last century, the world has developed two massive but disconnected energy conversion systems: the electric and the transportation system. In Europe, the current electric installed capacity reached 870 GW in 2010, with a Renewable Energy proportion of 13% [EURELECTRIC, 2011]. Due to the growth in population and electricity demand the European electric sector is expected to double by 2050, reaching a total installed capacity of 1,600 GW [IEA and UNEP, 2007]. On the other hand, during the last decades the private transportation sector in the European Union has steadily adopted the vehicle for personal mobility purposes with a proportion of 477 cars per 1000
inhabitants, summing up to a total vehicle fleet of 239 million cars in 2010 [EU, 2012]. This figure is expected to grow 20% to 560 cars per 1000 inhabitants by 2050 [Per Sandberg and Nijma Khan, 2010].

Coping with the intermittent nature of renewable sources translates into the creation of new infrastructure with huge capital and operational costs. For this reason, experts believe a more economic alternative would be to develop a systematic integration of the transportation and electric infrastructures. This argument is based on the fact that a regular car spends in average 96% of its lifetime in an idle state, which means the private transportation fleet might be integrated to absorb or produce power when not in use for transportation purposes [Kempton and Letendre, 1996]. All of this under the assumption electric or fuel cells based vehicles become pervasive in the upcoming future. Lund and Kempton [2008] suggest each electric vehicle has the potential to absorb or deliver 10 kW to the grid when in an idle state. Therefore, the theoretical capacity of an electrically based vehicle fleet nowadays in Europe would be equal to 2,390 GW (10kW of electric capacity per vehicle times 239 million cars in Europe in 2010 = 2,390 GW) which is more than three times the current installed capacity [Lund and Kempton, 2008][EU, 2012]. The previously described concept is better known in the literature as Vehicle to Grid, which is seen as a promising solution to ensure the energy supply of the future.

1.1 PROBLEM STATEMENT

The V2G concept is considered to be the highest level of integration between electric vehicles and the electricity grid. This technology is based on the assumption that both electric vehicles and smart grids will be widely adopted in the future. Basically, the function of V2G is to enable a car to be a load to the grid, but also to serve as a source of power during certain moments of the day. On this way, the cars in the future will serve as mobile energy storage that may allow balancing the grid on a dynamic manner which has twofold implications. On one side this will allow to increase the penetration of renewable energy sources, while on the other it will allow to migrate towards a more decentralized energy generation system. Depending on the car technology it is possible to provide different services to the grid. These services can vary from wholesale production, to providing ancillary services or becoming a local electricity producer. There is a wide range of EV trains that might be used for V2G purposes: Fuel Cell Vehicle (FCV), Plug-in Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) [Kempton and Tomic, 2005]. First, in the case of the FCV, it generates on-board electricity from a fuel such as hydrogen, thanks to an electrochemical reaction. The PHEV is a car that has
both combustion and an electric motor; this vehicle generates electricity by feeding the charge stored in the battery or by using the fuel engine. The BEV stores the power from the electric grid in an electrochemical cell and therefore can feed the electricity back into the grid. Figure 1 illustrates the VaG concept. One of the advantages of FCV in comparison to the BEV is that the former can provide electric power to the grid as long as it is continuously fed with fuel. For this and other reasons that will be explored in the next sections, the scope of this study focuses on the use of FCV drive technology.

Figure 1: VaG concept with different EV technologies UDEL [2011]

The idea of integrating cars, buildings, and the electric grid emerged at the beginning of the 1990s. It is believed Willet Kempton, together with his research team at Delaware University, were the first group to envision the future of electric vehicles not only as a load to the grid but also as a source of power [Kempton and Letendre, 1996]. Since then, the scientific community and the industry developed interest and as a result an ever-increasing number of studies have been published year after year. However, after more than 20 years, the technology has not been commercially implemented and it seems is not even close to that stage. The reasons for this situation are challenging and diverse with some of them having a market, a social or a purely technical nature. Next, the three main identified problems are described:

1. Technology maturity and high costs. It is a reality the costs of BEV are higher in comparison to conventional combustion technologies. Moreover, the battery storage capacity available nowadays limits the distance the electric vehicles can reach. In the
case of the FCV the technology is taking longer time than expected to develop even though there is interest from the industry. Also, a big problem with FCV technology is the short life time of the Fuel Cells. All these technical factors add up to create barriers for the adoption of electric vehicle technologies for transportation purposes, not to mention the possibility to use them for V2G applications.

2. System entrenchment. The transportation manufacturers, fuel producers, and the existing infrastructure are highly entrenched with the incumbent technologies. The current system is composed of a complex networks where each actor have a stake on maintaining the status quo. This has lead to the so called chicken an egg problem where an overall paralysis remains, holding the actors back and hampering any possibility for change.

3. Prevailing way of thinking. In the social context there are cultural and behavior factors associated with the current use of the prevailing technologies. This includes business as usual models, socio-cultural meaning of technology, consumer anxiety, misinformation and reluctance to change.

1.2 BACKGROUND

Throughout the last years there have been localized efforts from different institutions around the world to develop the required V2G technology and infrastructure. Mainly these actions are found in the technological niche level, where the functional characteristics are being tested. For instance in 2011 the University of Delaware, a widely recognized pioneering institution in this field, together with NRG Energy created a joint venture to commercialize grid integrated vehicles [University of Delaware, 2011]. Further examples are the EDISON project in Denmark or the e-mobility project in Germany among other parties. These initiatives aim to research the benefits and further opportunities of the vehicle and grid integration in “real life” settings [Bach Andersen et al., 2012]. Therefore it is certain the deployment of demonstration projects is of the upmost importance. As a result, it can be argued a technological niche based on V2G technology is emerging and these projects serve as a protected incubation environment that will allow the technology and the necessary regulatory framework to mature.

It is important to note these interventions, in some cases funded by the national institutions or in other by private companies, have led to advances in the field. In fact, we are approaching a point in time where technological innovation, together with strong support from different actors is creating the desired conditions to enable the
technology and society to move forward. Some of these developments include:

1. Technology improvements and mass production. Even though the technology still needs further development, there have been significant advances in battery storage capacity. In the case of fuel cell technology there have been interesting improvements. For instance, at the moment of writing Hyundai is introducing the first commercial FCV with the aim of demonstrating the benefits of hydrogen at several demonstration projects around the world. This vehicle is still far from being useful for V2G applications, but is a necessary first step towards the mass production of FCV which in turn may allow bringing the prices down.

2. System redesign. Small new companies like Tesla are driving at the forefront of the industry, forcing the big players to recognize the importance to catch up with the emerging technologies if they want to profit from them. Besides, there are increasing pressures for the companies to refocus on alternative vehicles as the governments start to think about implementing more stringent environmental policies in an effort to curb the emission levels at densely populated areas.

3. Emerging way of thinking. The emergence and pervasive nature of mobile technologies is enabling the younger generations to challenge the pre-established paradigms. This is evident in a wide array of trends were conventional business models are being challenged by initiatives such as crowd sourcing and product-service systems. These kinds of initiatives carry implications for different actors. This is why big players like Daimler are also launching experiments to assess the consumer acceptance and foresee future opportunities. Additionally care sharing and product-service schemes may convey deeper consequences for the ownership structures that need further investigation.

1.2.1 The Car as a Power Plant

The CaPP emerged as one of the projects from The Green Village, which is an initiative of Delft University of Technology. The Green Village is envisioned as a multidisciplinary sustainable enterprise focusing not only on researching but also on implementing innovative energy, waste, water and air projects. “The Green Village will be a lively, green and visible area where scientists and students meet entrepreneurs, innovators, companies, artists, teachers and you. An area with amazing possibilities, technologies, products and systems that will contribute to a green environment” [Wijk, 2013]. Apart from the core activities mentioned before, there are other components of this initiative as the Future labs, the GreeTech store, the Showcase and the Community which
will be composed by a set of stakeholders that will be involved in these projects [Wijk, 2013].

Similar to the V2G technology, the CaPP’s main aim is to deliver electricity to the grid. Nevertheless, the difference lies on the fact that the V2G concept considers different kinds of EV technologies (FCV, PHEV and BEV) regardless if the electricity delivered by the vehicle is depleted after some time. This would happen in the case of BEV, or a less sustainable alternative like generating electricity with the gasoline engine of a PHEV. That is precisely the reason why the CaPP concept is based solely on FCV. In this way, the electricity generated by the car can be delivered constantly (as long as there is a hydrogen supply) and in a more sustainable way. Moreover, an additional feature that further differentiates the CaPP concept versus the V2G is that the former also considers the generation of heat and water, in addition to the electricity. Thus, the CaPP enabled vehicles can actually be considered to work as a small multi-product power plant, with the advantages that the Fuel Cell have a higher efficiency range from 50% to 70% [Palazzi, 2013]. In addition, the use of FCV means that the electricity capacity per car is higher (around 100kW for Fuel cell cars) than in the case of BEV, with 10kW [Lund and Kempton, 2008]. Estimates indicate a car park with approximately 500 cars, each with 100 kW of electric power generation would be equivalent to a power plant of 50 MW [Wijk, 2012].

For all the aforementioned reasons, the CaPP concept proposes not only a way to deliver electricity to the grid, but a whole paradigm shift by using our cars to replace the electric system. This vision also includes eliminating the fuelling stations (since now it is possible to refill the tank before leaving the CaPP facilities) and having cars that allow better efficiencies for both transportation purposes (34%) and electric power (44%) than with the existing transport (17%) and electricity (36%) systems. There are still many financial, technical and social challenges ahead, but they have to be tackled each at a time. Figure 2 shows the main components of a Fuel Cell based vehicle.

There are a series of sustainability implications when thinking about the CaPP concept. Some of these include the reduction of CO2 emissions released into the atmosphere, the decrease in noise levels in urban areas, and the reduction in fossil fuel consumption. To get an impression about the impacts of such a change a calculation is presented next. If 25% of the cars in Europe were under the CaPP concept and assuming the hydrogen to power them for transportation and for electricity production comes from renewable sources, the potential reductions in CO2 emission for transportation would be around 13.98 Gigatonnes. This information is calculated considering there were 239
million cars in 2010 [EU, 2012], each car travelled in average 13,000 Km per year in Europe and generated 180 gr. of CO2 emitted by Km. This amount is significant, since the CO2 emissions in Europe generated by passenger cars are estimated to contribute in 10% to the total emissions of the region [World Energy Council, 2009].

1.2.2 Relevance

In the past, The Green Village has conducted evaluations of the CaPP initiative which had concentrated mainly on the technical feasibility and economic estimations of the project. Some of these studies include the Report: “Exploring the Carpark Power Plant (P3) - Technological gaps and opportunities for the TU Delft” performed in 2012 by a group of Industrial Ecology students [Bloemendaal et al., 2012], or the master thesis by Palazzi [2013] where the potential ancillary services provided by FCV were simulated. As a conclusion of this study it was determined the exact values depends on many factors like the price of hydrogen, the signal for value over time, historic imbalances in the market, etc.

Apart from economic and technological considerations, it is important to note the technology appears, evolves and eventually emerges into society as a technological system due to the alignment of several socio-technical factors [Geels, 2002]. Some of these include user practices, market conditions, consumer perceptions or a merely functional basis, apart from the previously addressed by the existing technology centered studies. For instance, in the paper “The market for electric vehicles” by Christensen et al. [2010] explored some of the so-
cial factors that influence the mass introduction of EVs in the Danish market. However, the aforementioned article and other similar studies focussed mainly in the willingness to buy EVs by the user, which is just a precondition for the existence of VaG or the CaPP concept. For this reason, it is relevant to go one step further and not only understand the drivers behind the electric vehicle adoption, but also the perceived benefits and concerns of potential customers of the CaPP concept. On this way, it would be possible to incorporate into the Research and Development stage some elements that could be of interest for society, to ease the adoption of the technology in the future.

1.3 RESEARCH OBJECTIVE

1.3.1 Purpose Statement

The purpose of this study is to assess the CaPP concept’s technology acceptance in the Netherlands and its implications for the business models design. In addition, this thesis will provide knowledge concerning the assigned importance and categorization of the perceived benefits/concerns provided by the users. Ideally, the results presented in this work will help future initiatives to focus the research not only on the technological side but also from the socio-technical context of the users to develop the appropriate mechanisms to maximize the technology adoption.

1.3.2 Rationale of the study

The reason of this study originated from the fact that most of the previous CaPP related studies focus on a “technology-push” perspective, where the technical and economic conditions are analyzed. On the other hand, few studies focus on a “technology-pull” approach, neglecting the importance the consumer perception will have in the evolution of the technology, in addition to its eventual adoption and diffusion. This is the main reason why the focus of this thesis is about exploring what the users think about the CaPP concept and the implications for the related business model structures.

1.3.3 Description of the study

Due to the exploratory nature of the CaPP project, each section of the study builds on existing literature applicable to the field but also proposes the extension of some models. To start, the literature review covers the main theories to be used through this document. The main topics include the socio-technical systems, the consumer behavior and business model innovation. Then, the methodology section proposes the use of mixed research methods to collect and analyze data.
Afterwards, the results of the interviews are presented. Next, by collecting information mainly from secondary sources, a socio-technical assessment of the electric mobility niche in the Netherlands is provided. Moreover, the next section elaborates on the implications the user perception of the CaPP concept may have on the business model design. To conclude, a summary of the main findings is provided in the last Chapter.

1.3.4 Expected outcomes

As a starter a model to assess the perception of the CaPP concept, the main factors for adoption in the country, plus a set of recommendations regarding the most convenient business model configurations and some policies to foster the emergence of the technology.

1.4 RESEARCH QUESTIONS

The four questions this study intends to answer are:

A. What is the technology acceptance level regarding the CaPP and the main factors for its adoption in the Netherlands?

B. What are the main benefits / concerns perceived by the potential users of the CaPP in the Netherlands?

C. Based on the current technological development and the customer perception: what business model(s) would be more suitable for the implementation of the CaPP technology?

D. Which policies should be in place to stimulate the emergence of the CaPP from its current state?

1.5 DOCUMENT STRUCTURE

To achieve the objective of assessing vehicle technology acceptance of the CaPP concept, this thesis project is divided into 6 main phases described below:

• Chapter 2: Scientific background. The review of the literature describes the description of the main theories used through the project. This includes the Multi-level perspective, the Strategic Niche Management, the Diffusion of Innovation, the Theory of Planned Behavior, Technology Acceptance, the Product-Service System, among others. In addition, the proposed framework is presented.

• Chapter 3: Research Methodology. This chapter describes the characteristics of the research design (nature of the study, unit
of analysis, sample, materials, and measurement instruments),
the data collection and analysis methods to be followed.

• Chapter 4: Results. In this chapter the insight revealed from
the interviews conducted during the study are presented. The
results from the analysis are described in a quantitative and a
qualitative section according to the measurement instruments.

• Chapter 5: Emergence of the niche. Taking into account the
stage of development of the electric mobility niche in the Nether-
lands a brief analysis is presented. In the end the implications
for the CaPP concept are introduced.

• Chapter 6: Business model design. Considering the previous
two chapters as an input, this chapter explores different alterna-
tives on the business model structures applicable for the CaPP
concept.

• Chapter 7: Conclusions. An overall summary of the study is
presented by answering the research questions. Besides, there is
a discussion about the main findings and recommendations to
conclude with the exploration of further research opportunities.

1.6 LIMITATIONS OF THE STUDY

Two limitations have been found regarding the research design. First,
it was not possible to identify a pre-defined model to analyze user
perception of future car technologies. Thus, the closest model that
was found in a recent study had to be extended for the CaPP context.
Second, as the study had an exploratory nature in a small purposeful
sample, the results cannot be extended to the rest of the population.
Consequently, the outcome will rather serve as an input for further
studies.

Since this thesis is focused on analysing the CaPP concept for per-
sonal mobility, other options were not considered. One of these al-
ternatives includes the evaluation of the CaPP technology in a fleet
configuration, among others where the concept can prove to be use-
ful.

To answer the research question, the business model analyzed in-
cluded five main business structures based on the options that are
available nowadays. This approach may have created a bias towards
other types of business models that were not evaluated and may
emerge in the future.
2.1 INTRODUCTION

This Chapter address three areas related to the path that technologies follow to form complex systems and the way the technology perception is formed. The first section will address the research related to Socio-technical systems with special focus in the Multi Level Perspective and Strategic Niche Management theories. In the second section, there will be a discussion regarding the theory behind the Customer perception and the adoption of technological innovation. Finally, the last section will discuss the business model innovation as a way to stimulate the interaction between the different actors for the adoption of new vehicle technologies. To conclude the findings of the literature review are presented, followed by the proposed framework. The methodology and detail used for the literature review is explained in the Appendix A.

2.2 SOCIO-TECHNICAL SYSTEMS AND NICHES

The framework to analyze how technology emerges within a social context has built over different theories throughout the years. Its main foundation lies in the evolutionary economics field where an analogy between the development of biologic and productive systems was introduced. The approach to observe evolutionary characteristics in economic and technological change was proposed by the economist Schumpeter in 1932. This theory proposed technological change emerged as a result of the recombination of technical and social elements that unfolded within time [Schumpeter, 1943]. During the period of 1980 to the end of the 1990s several authors elaborated on other elements of economic and technological change. Two fundamental mechanisms of evolutionary economics theory are the variation and selection criteria that eventually shape the direction the development of technology takes. Additionally, during this period some other elements were included in the proposed theories as technological trajectories, path dependencies and innovation systems [Lente and Rip, 1992]. Eventually, the concept of Socio-technical system was proposed by Geels as an extension of the innovation system to incorporate not only the production but also the use of the technology in society. From this perspective, a socio-technical system contains the whole cycle of production, diffusion and use of technology, providing a holistic approach [Geels, 2004]. On this way, the system acquires a
functional orientation where the different elements work together to fulfil a specific need. In the case of the transportation system there will be sub-functions that work as resources which are not always physical. For instance some of them might be of capital, knowledge or cultural nature. These characteristics imply socio-technical systems have a human dimension and will only work thanks to the interaction of groups of actors. These social groups vary depending on the industry from academic institutions, social groups, public authorities, consumers, firms, etc. interacting in a coordinated way (see Fig. 3).

By the end of the 1990s, the Multi Level Perspective (MLP) emerged as a compilation of different theories with the objective of analysing the complex dynamics of socio-technical change. This framework consists of 3 nested levels: the socio-technical landscape, socio-technical regime and niches (see Fig. 4). The embedded structure helps to explain the existence of economic, technological, cognitive, social and cultural conditions for the diffusion of technologies. The landscape level refers to a wider context formed by external factors such as oil prices, political situation, cultural values and environmental problems. For this reason the landscape has a high amount of inertia, moves slowly with time and is difficult to change. The socio-technical regime consists of a set of rules followed by the interaction of different social groups. Socio-technical regimes are characterized by a dynamic stability where innovation consists mainly of incremental changes due to the high degree of alignment among the actors. Niches are considered protected space where radical innovations are tested and are useful for stimulating the formation of social networks and the learning processes. Additionally, niches are relevant because they offer milder selections criteria compared with the ones present in the
The Strategic Niche Management (SNM) term was proposed by Kemp et al in 1998. After analyzing a series of historical cases of shifts in the technological regime, the authors concluded the success of niche formation obeyed to a combination of internal and external structural problems inherent to the niche, plus shifts and changes in the incumbent regime [Kemp et al., 1998]. Moreover, they identified 3 ways institutions can manage the change process: the first is the so called economic approach where governments impose taxes to promote or penalize externalities, the second is the creation of a socio-technical regime and the last is to stimulate the dynamics of socio-technical change in the desired direction by the creation of temporary protected spaces. It is suggested in the article the last option to be the most effective. Thus, the proposed definition of SNM is the following:

"the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the regime. The main contribution of the MLP is that the evolution of a new technology into the regime is not only dependant on the developments of the niche where it is firstly introduced, but it is also influenced by the changes at the socio-technical regime and landscape [Geels, 2002]. V2G and the CaPP technologies are still in the niche stage of development. Therefore, the next paragraphs elaborate on the Strategic Niche Management theory.
Here, the experiments are considered beyond the traditional definition because of their orientation towards both the creation of a network of actors and learning processes. Five steps are proposed to be followed by government and institutions wishing to apply this framework. The steps suggested as part of a SNM oriented policy are: the choice of technology, the selection of an experiment, the set-up of the experiment, scaling up the experiment and the breakdown of protection [Kemp et al., 1998]. In the SNM theory, these steps are aimed to the formation of niches by contributing to three key processes: coupling of expectations, articulation processes and network formation. Coupling of expectations is relevant because it creates cooperation among group of actors by aligning the promise to solve a problem relevant to society if certain technology is developed. The articulation process has the objective to understand the barriers and perceptions by learning about the needs, process and possibilities. The idea behind network formation is that the development of a niche requires the interaction of groups formed by incumbent and external actors. However, as noted by Raven some of the concepts provided by the SNM theory are over simplistic and have a fundamental lack of detail regarding the evolution of technological niches into market niches, the dynamics in actors expectations and the niche-regime interaction [Raven, 2004]. It is for the aforementioned reasons; Raven proposes an extension of the SNM framework. The most relevant insight from his work related to this thesis is the one related to dynamics in actors expectations as a consequence to the niche experiments. Raven suggests a model to explore if the results of the experiments or the external circumstances are more influential to modify the actors’ expectations. In Fig. 5 is possible to see the relation of (1) external circumstances changing the expectations at the niche level, (2) the change in expectations at the niche level leading to different experimental designs, (3) the results of the experiments changing expectations at the niche levels and (4) the changes in expectations at the niche level changing as a consequence the external circumstances in the regime.
As indicated in Chapter 1, the purpose of this master thesis is to explore the user perception towards V2G technology in the Netherlands. Given the current stage of development the technology is still in the development phase and therefore the few experiments that are being performed around the world are still protected from the regime in what can be considered a technological niche. A technological niche is defined by Raven as:

“a loosely defined set of formal and informal rules for new technological practice, explored in societal experiments and protected by a relatively small network of industries, users, researchers, policy makers and other involved actors.”

This definition comes from the graphic representation of two variables relevant to the niche socio-technical literature: protection and stabilisation. The combination results in four different types of niches: technological niche, regular market niche, dedicated market niche and protected market niche Raven [2004]. The technological niche arises during the early phases of experimentation with the technology where limited interaction exists between the experiments. Regular market niches emerge when the technology is mature, no protection is needed anymore and there are users benefiting from the technology. The dedicated market niche occurs when the technology is still not stabilized but the degree of protection is relatively low due to the benefits the technology provides to specific group of users. Protected market niches exist when the technology is already stabilised but due to high costs it still needs a certain degree of protection (See Fig. 6).

The MLP and the SNM are tools that help to understand and locate the current stage of development of technology niches from a broad system perspective. The next section reviews the relevant literature to
consumer behavior and technology adoption. The reason to continue in this direction is motivated (as described in the SNM description) by the articulations process, as it is the factor that will contribute towards the niche formation by understanding the barriers and perceptions of the potential users.

2.3 CONSUMER BEHAVIOR AND TECHNOLOGY ADOPTION

For some decades, consumer behavior has been used in marketing science “to understand the processes involved when individuals or groups of individuals select, purchase, use or dispose of products, services ideas or experiences to satisfy needs and desires” [Salomon et al., 1999]. Being able to assess the motivations of the customers is of vital importance for any business wishing to stay competitive in the market. On the same way, it is relevant for the companies to anticipate or even influence the reactions new products will have once they are introduced. Nowadays organizations of all kinds invest heavily in market research to anticipate the consumer trends for all kinds of products and services. In this sense, during 2011 the whole industry spent in market research an estimated amount of $33.5 billion USD, with a 42% of the total generated in Europe [ESOMAR, 2012].

Most of the concepts currently applied in the consumer behavior area evolved from the psychology discipline. Some theories started exploring the impacts detonated by certain attitudes, emotions, personality type or even values in consumer behaviors. For instance, the Social Cognitive Theory (SCT) has been widely used in psychology, communication and education to explain human behavior. This theory suggests human beings learn by observing others in a societal context and later on by means of cognition maintain the self-regulation of their own actions. The three principal sub functions of the self-regulating mechanism include: self-monitoring one’s behavior, judgement of one’s behavior and affective-self reaction [Bandura, 1991]. On the contrary Vinson et al. conducted a study where they compared the influence of values in consumer behavior measured by the identification of specific product attributes in two socio-economic groups in the United Stated. The results concluded that global values, consumption-related values and the evaluation of product attributes were consistent with the consumer intention for each of the groups [Vinson et al., 1977]. In a more integrative approach, the Elaboration Likelihood Method (ELM) proposes a dual model that considers both the cognitive and affective input in a continuum that serves as the basis to process external messages [Cacioppo et al., 1986]. In short, the ELM explores the way involvement of emotions can have on shaping the decision making process.
From the market perspective, another relevant aspect is to understand how ideas and technology spread through society. One of the most influential theories is the Diffusion of Innovation (DoI) proposed by Rogers in the 60's. Rogers conducted a study among individuals and organizations in the agricultural sector. The author suggested the diffusion is "the process by which innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication in that the messages are concerned with new ideas". Four key elements were identified in the diffusion research: innovation, communication channels, time and the social system. The innovation refers to an idea, a practice, or object that is perceived as new by an individual or other unit of adoption. The communication channel is the mean by which the message gets from one individual to the other. The time is the length of time required for the innovation communication and decision process to happen between the actors. The social system is the set of interrelated units engaged in solving problems for a common goal [Rogers, 1962]. The diffusion of innovation occurs in five steps in what can be considered a decision making process: knowledge, persuasion, decision, implementation and confirmation. The rate of adoption is defined as the relative speed in which members of a social system adopt an innovation. Where the social system is divided into 5 main categories depending on its level of innovativeness: innovators, early adopters, early majority, late majority and laggards (See Fig. 7). The innovators are depicted as the first group to adopt innovation which are young, very social and have financial liquidity. The early adopters form the second group that may adopt innovation; they have advanced education, are socially forward and have a high degree of opinion leadership. The early majority is the group that will follow adopting innovation after a varying degree of time due to its above average social status but a lack of opinion leadership. The late majority group adopt innovation after the average member of society due to its scepticism and below average social status. The last group is the laggards whom usually show an aversion to change and are older in average than the previous groups [Rogers, 1962].

The DoI theory has been criticized for being primarily descriptive, indicating why adoption occurs but not telling how to facilitate it as for instance at the technological niches this thesis project is concerned about. Additionally, as indicated by Straub, Rogers' theory cannot be applied to all situations and for this reason the academia developed other theories that could cope with these issues [Straub, 2009]. The main development in the field stemming from the social psychology field is the Theory of Reasoned Action (TRA). This theory proposed a model to predict attitudes and behavior. Its main three constructs are: behavioral intention, attitude and subjective norm. TRA implies
that a person’s behavior intention depends on the attitude about the behavior plus the subjective norms associated with it. Therefore if a person intends to do a behavior it is very plausible it will do it [Ajzen and Fishbein, 1980]. Later on, in 1985, TRA was revised and extended by Ajzem into the Theory of Planned Behavior (TPB). The idea behind the TPB was to improve the predictive power of the TRA by including a perceived behavioral control [Ajzen, 1991]. The key variables of TPB are: attitude toward the behavior, subjective norm and perceived behavioral control (See Fig. 8). The attitude toward behavior relates to the positive or negative evaluation given by the individual to the performance of the behavior. The subjective norm refers to the individual’s perception of the behavior taking into account the judgement of other persons. The perceived behavioral control assess the individual’s perceived ease or difficulty for performing a determined behavior. In combination the three variables lead to the formation of behavioral intention. Thus, the stronger the three variables are, the higher the person’s intention to perform the behavior [Ajzen, 1991].

TPB has been extended to different domains, especially within the field of consumer behavior. One of the most influential extensions is the Technology Acceptance Model (TAM). This model tries to explain the process in which the users are inclined or not to accept and use a technology. The theory developed a framework and validated new measurement scales for the adoption of new Information Technologies. The model proposed by Davis found two main variables: perceived usefulness and perceived ease of use have a strong correlation with the technology acceptance, which in turn precedes the system
use [Davis, 1989]. The perceived usefulness was defined as “the degree to which a person believes that using a particular system would enhance his / her job performance”. The perceived ease of use refers to “the degree to which a person believes that using a particular system would be free of effort” [Davis, 1989]. Some critics against the TAM include different aspects, like the fact it does not consider important control factors as age, gender, and other parameters that may influence the intentions towards adopting a technology [Straub, 2009]. For the aforementioned reasons, in 2003, Venkatesh et al. revised the TAM incorporating eight recognized theoretical methods used to understand the individual adoption and use of information technology systems. Therefore, the most important characteristics of each model were incorporated into the so called Unified Theory of Acceptance and Use of Technology (UTAUT) [Venkatesh et al., 2003]. Four main constructs appear to be direct determinants of Behavior intention: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions [Venkatesh et al., 2003]. Performance expectancy is defined as the degree an individual expects that using the system will help him to improve performance. Effort expectancy refers to the degree of ease associated with the usage of the system. Social influence measures the individual’s perception towards the importance of using the system given by other people. Facilitating conditions refers to the degree an individual believes the technical infrastructure to support the system is available. The Behavioral Intention is defined as the readiness from an individual to use the system and it is considered an immediate predictor of Behavior (system usage)[Venkatesh et al.,

![Diagram of Theory of Planned Behavior](https://example.com/diagram.png)

Figure 8: Theory of Planned Behavior. [Ajzen, 1991]
2003]. Additionally there are some moderating variables as: gender, age, experience and voluntariness of use (See Fig. 9).

In the context of the car technology adoption there are two relevant studies that incorporate different elements from the previously described methods. The first one focuses on extending the UTAUT into the so called Car Technology Acceptance Model (CTAM) by including elements from other theories. The four additional constructs to the ones existing in the UTAUT are: Attitude towards using technology, Perceived safety, Anxiety in the car context and Self-efficacy [Osswald et al., 2012]. The Attitude towards using the technology refers to the individual’s affective reaction towards the use of the system. The aim of the perceived safety indicator is to measure the degree to which the individual believes using the system will affect his or her well-being. The anxiety construct is defined as the degree to which a person responds to a situation with apprehension, uneasiness or feelings of arousal. Self-efficacy definition refers to the individual’s belief in his ability and competence to use the technology in order to accomplish a task (See Fig. 10) [Osswald et al., 2012]. The second study, proposes to introduce and assess the impact of emotions in the electric car usage intention, a situation that the authors argue has been ignored in most of the existing research. The proposal in this case is to extend the TPB by introducing the analysis of some emotions, a group of moderators and a set of standard socio-demographic indicators as control. In the context of this master thesis only the moderators are relevant and therefore discussed. The authors define four moderators relevant to the electric car usage intention: environmental concern, environmental behavior, opinion leadership respect to cars and personal values [Moons and De Pelsmacker, 2012]. The environmental concern is the
2.4 BUSINESS MODEL INNOVATION

In the past, the idea that companies had to focus on the development of innovation relying solely on funding R&D activities to push the boundaries of technology prevailed in many industries. Although, ever increasing costs, inherent complexity and shorter product to market cycles has led to rethink this conception. Nowadays, several authors point out that even outstanding high-tech products are not enough to survive in the market. Instead they propose a more integral approach where the product or service together with an appropriate business model can truly deliver value to the customer [Chesbrough,
As a starter, a business model has been defined as the way an organization creates, delivers, and captures value [Osterwalder, 2010]. Some of the core components of a business model vary according to the field and authors, typically including some of the following: value proposition, customer segments, distribution channels, core capabilities, key activities, revenue model and cost structure among others [Osterwalder, 2010].

During the last 20 years, disruptive technologies like the personal computer, the internet and the proliferation of mobile devices have created a business landscape that changes at the rhythm of the latest innovation available in the market. This situation has created volatility in the business environment for companies across all sectors, forcing them to either evolve by taking advantage of new technologies or to hold by maintaining the old proven practices. Most problems faced by the companies belonging to the later group emerged as a consequence of the managers focusing on doing business as-usual, while ignoring the context beyond their own industry [Moore, 1996]. The business ecosystem concept proposed by Moore during the 1990s helps to exemplify this situation, suggesting a comparison with a biological ecosystem where the firm is embedded in the business environment [Moore, 1996]. A business ecosystem was defined as “a network of organizations (including suppliers, distributors, customers, competitors, government agencies, etc) involved in the delivery of a specific product or service through both competition and cooperation. Over time, they coevolved their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move towards shared visions to align their investments, and to find mutually supportive roles” [Moore, 1996].

The companies willing to adapt better to their changing environment have done it through the Business Model Innovation approach. The term Business Model Innovation (BMI) refers to the way in which organizations create or reinvent their business model. This topic has followed several paths lead by different academic groups. Due to its relevance, one of this will be covered in this review given the fact it aims at improving sustainability in comparison to regular business models. The Product-Service System (PSS) originated in the late 1990s with its main contributors coming from the environmental and social sciences [Baines et al., 2007]. A Product-Service System (PSS) “consist of a mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling a final customer need” [Osterwalder, 2010]. There are three main types: product-oriented PSS (sells product while extending after sales service, ownership by cus-
customer), use oriented PSS (sells usage of product on a leasing or sharing scheme, ownership by the producer) and result-oriented PSS (selling a capability to the customer paying on a usage basis, ownership remains on the producer) [Osterwalder, 2010]. The benefits of the PSS include higher differentiation possibilities for the producer, the potential of a higher asset use by serving an increased customers base with a smaller amount of products/resources, release of asset ownership and related implications for the customers [Baines et al., 2007]. Nevertheless, the concept has been mainly explored in the academic setting and there is still lack of practical tools and implementation efforts [Baines et al., 2007].

Despite some of the PSS drawbacks, there have been already a series of attempts to adapt different schemes into different environments, including the car industry. There are plenty of papers exploring the possibility of implementing PSS inspired business models for car sharing services. In a study conducted in 2012, a series of characteristics for a PSS were evaluated including: political-legal, technological, economic, socio-cultural, and the competitive environment. The study’s objective was to bridge the gap by proposing a framework and modelling how a PSS structure would behave for a car sharing scheme [Yoon et al., 2012]. The conclusions of the study showed a mixed set of results. The main benefits of the adoption of the PSS approach point out that a considerable amount of fuel and CO2 emissions would be reduced; the economic, technological and political environment also scored high in degree of acceptance [Yoon et al., 2012]. On the other hand, the customers didn’t seem to have a very positive perspective towards the intention of adopting this sharing car system as they didn’t want to give up the privilege of vehicle ownership [Yoon et al., 2012]. Additionally, customers indicated they preferred to use the scheme in one way trips having service availability in places like parking lots located less than 10 minutes away by walk.

In a different study conducted in 2010, the authors proposed a structured way to develop electric mobility based business models due to the high complexity this entails. The global electric mobility system is decomposed in three units of analysis which are used as a base for this framework: vehicle system, infrastructure system and associated service system [Kley et al., 2011]. The results of this proposal are three morphological boxes with different characteristics proposed for each component in a gradual scale from traditional (left side) to more innovative (right side) (See Fig. 11). One of the main advantages is that with a single glimpse it can provide a broad perspective on the way the different system characteristics are intertwined, showing also the implications it has for a potential business model [Kley et al.,
Nevertheless, a big drawback is this approach does not provide a clear understanding on what elements account as the drivers for the system configuration which makes it difficult to use.

### 2.5 FINDINGS FROM THE LITERATURE REVIEW

As a starting point, the literature review of socio-technical systems shed light on the fact that technology cannot thrive in the market without an understanding of the enabling support provided by different social groups. The introduction of the Multi Level Perspective served to break down three distinctive levels necessary to analyze the emergence of technology into a societal context, with the niche as the center of attention for this study. It was possible to ratify the Strategic Niche Management theory can be used both to perform a descriptive analysis and as a policy instrument. Four different types of niches were found according to the degree of protection and stabilisation: technological niche, regular market niche, dedicated market niche and protected market niche. Special interest was paid to the technological niche as its definition fits very well the current development of the technology subject of this study. The SNM indicates there are three mechanisms relevant for the formation of niches: coupling of expectations, articulation processes and network formation. Among these, the articulation process was the most relevant as it intends to understand the barriers and perceptions by learning about the customer needs in an attempt to influence the technology development in an early phase. As mentioned before, both the MLP and SNM theories were found to be more descriptive than prescriptive. This has a twofold implication for this master thesis. On the one hand, the MLP and SNM will serve as the preferred framework to analyze the evolution of the electric mobility niche in the Netherlands and its relation to the CaPP concept. On the other hand the importance of understanding the technology consumer perception, at the core of the
2.5 FINDINGS FROM THE LITERATURE REVIEW

articulation process, was the basis to explore consumer behavior and the factors concerning technology adoption.

Most of the consumer behavior theories and models emerged from psychology and migrated throughout the years to the marketing field. A stepping stone in this direction was the Social Cognitive Theory which states human beings learn by observation and have self-regulating mechanisms that assess one’s behavior at every given moment. From there a series of theories were developed taking elements from each other to serve different purposes. One of them was the Diffusion of Innovation proposed by Rogers during the 60’s, which aimed to explain how technology spread through society. In fact the diffusion of innovation was defined as a type of communication process about new products. Later on during the 80’s the Theory of Reasoned Action and the following Theory of Planned Behavior were proposed in an attempt to understand the factors that lead to behavior intention and the subsequent behavior of persons. Due to the emergence of Information Technologies and its implications among society, the need to understand the user perception became the basis of the Technology Acceptance Model. The TAM’s objective is to understand the process behind the technology adoption process by measuring perceived usefulness and ease of use. This model was extended at the beginning of the 2000’s by Venkatesh et al. into the Unified Theory of Acceptance and Use of Technology were characteristics of the eight most recognized theoretical methods were incorporated. It is important to note, one problem found during the literature review, was the difficulty to find a predefined framework to analyze consumer perception of emerging car technologies, some authors argued the reason behind this situation was not surprising given the fact future car technologies are of strategic importance for the industry and therefore will not be available for public examination. The only model found to assess future car technology was an extension of the UTAUT, called Car Technology Acceptance Model. This model was created to assess the user perception about future onboard voice-activated navigation systems. The main constructs added to the UTAUT standard version were: Attitude towards using technology, Perceived safety, Anxiety in the car context and Self-efficacy. For the aforementioned reason, the need to develop a tailor made framework to analyze future car technology was identified to bridge this gap found in the literature. The proposed framework will use the CTAM as a starting point, but will require being adapted as it will serve as the backbone of this study.

Business models are nowadays starting to be considered an alternative approach to innovation as they have been enabling the process of technology adoption. A business model was defined as the way an organization creates, delivers, and captures value. In the current volatile
business environment a company has no longer the option of concentrating solely on its industry competitors, but rather on the whole business ecosystem in which it is immerse. Some organizations have taken steps to update their operations by performing a revision of the old model through Business Model Innovation. One of the proposed options to design more sustainable business models is the Product-Service System were companies instead of selling products offer their services to the customer. This has a number of advantages including the shift from product sales to service differentiation, transfer the ownership from the customer to the producer and the potential reduction of resources since the number of products is shared by several customers during its lifetime. There are drawbacks indicating the PSS has been mainly adopted in the academic literature and not in more practical applications. In fact, some studies have applied this scheme for car sharing schemes in several occasions. The existing literature point out there is still resistance from the users on adopting this kind of system due to ownership concerns. It would be therefore relevant to study the perception of the users towards alternative ownerships schemes that may facilitate the adoption of the CaPP concept. Both a PSS and a traditional business model schemes seem to be interesting and therefore deserve attention to be explored in this master thesis project. The business canvas model combined with a morphological analysis could shed light on the most appropriate model to deliver value according to the users.

2.6 THEORY AND PROPOSED FRAMEWORK

Throughout the literature review it was possible to confirm the existence of state of the art literature on electric mobility. This was evident in the number of perspectives from which this topic has been covered. It was demonstrated the interest for using electric cars in future mobility has been active for a long time and therefore has been widely researched. The electric mobility technology development and the existence of related academic literature are relevant as they are considered a stepping stone for the development and eventual roll-out of CaPP technology. Moreover, the later has not been researched so extensively in the social sciences due to the current efforts concentrated in the technology development and enhancement. For the aforementioned reasons, this section deals with an extended elaboration of the most critical theories and the way this study aims to bridge the gaps founded.

The current state of V2G technology is found in a technological niche where high levels of protection and low stabilization exist according to the extended version of the SNM theory. The importance of the niche lies on the observation that these protected spaces funda-
mental in the take-off and further development of a technology into the socio-technical regime [Kemp et al., 1998]. It is important to remember the aims of the Strategic Niche Management is not about the mere introduction of new products into the market but deals with a more strategic transition management into new regimes by learning about the needs, actor networks and alignment of expectations [Kemp et al., 1998]. From the three mechanisms involved in the niche formation, the articulation process is the one that concerns this thesis project as it is involved in learning about the articulations of needs, perceptions and possibilities. Going a step further from the SNM elaboration of the provided before, the articulation process involves: 1) articulation of technical aspects and design specifications, 2) articulation of government policy, 3) articulation of cultural and psychological meaning, 4) articulation of the market, 5) articulation of the production network, 6) articulation of the infrastructure and maintenance network and 7) articulation of societal and environmental effects [Kemp et al., 1998]. Therefore, this study will focus on covering a combination of 3), 4) and 7) through a more proactive approach by developing a framework and assessing consumer perception towards the CaPP concept.

The Multi-level perspective framework indicates general consumers are immerse in the socio-technical regime, which in turn is predetermined by the rules established in the landscape level. One problem of this approach is that most of these consumers will not be aware of the specific developments being carried out at the niche level, mainly due to a lack of communication between both levels. Thus, for the development of this conceptual model, and as it has been happening already when new technologies are researched, the assumption is that there will be a set of consumers brought from the regular environment into the technology experimentation field. On the contrary, it can also work the other way around, with the experimental technology being taken out from the lab into the consumer’s daily environment to test in regular conditions. As we can see in the conceptual model, the customer that are brought for the first time into the experimentation level will have pre-existent knowledge based on the usage of regular technology in the regime level (See Fig. 12). This pre-existing knowledge and experiences brought by the user creates a firsthand perception of the technology to be employed. Additionally, there is a degree of indirect perception which could have been infused by social interaction or by other stimuli like reading newspapers, etc. Then, the assessment of consumer perception is carried out in order to understand the motivations or barriers perceived by the users about the technology. Next, the results of the assessment help to define the socio-technical articulation for the technology, which includes different dimensions such as technological performance, ecologic norms or
security characteristics among others. The socio-technical articulation is used to update the generation of the upcoming niche experiments, which in turn foster the niche formation and as secondary stream provides new impressions for the participants of the experiment. In the present master thesis, the starting point for assessing consumer perception about CaPP technology would take into account documented perceptions found in the electric mobility literature for the design of the perception assessment.

In order to assess the consumer perception of future car technologies, the most appropriate model found was the CTAM. This model was originally based on the UTAUT. The objective of the CTAM is to explore the technology adoption intentions among the users in the car related context. The main eight constructs CTAM intends to measure are: Performance Expectancy, Effort Expectancy, Facilitating Conditions, Social Influence, Attitude towards using Technology, Perceived Safety, Anxiety in the car context and Self-Efficacy [Osswald et al., 2012]. Performance Expectancy is the degree which the customer believes the technology will help him to reach his goal. Effort Expectancy is associated with the degree of ease perceived when using the system. Facilitating Conditions are defined as the degree an individual believes technical infrastructure exist to support the use of the system. Social Influence is the degree in which a person believes the opinion of people around them is relevant for the use of the system. The Attitude towards using the Technology refers to the individual’s affective reaction towards the use of the system. The aim of the Perceived Safety indicator is to measure the degree to which the individual believes using the system will affect his or her well-being. The Anxiety construct is defined as the degree to which a person responds to a situation with apprehension, uneasiness or feelings of arousal. Self-Efficacy definition refers to the individual’s belief in his ability and competence to use the technology in order to accomplish a task [Osswald et al., 2012]. It is noteworthy; the CTAM will be used as a general guideline because its background is rooted in the Information Technology field. Therefore, the eight constructs will be maintained, but will be adapted in order to fit the technology and specific requirements of this study. The proposed model will be de-
fined from now on as the CaPPTAM (See Fig 13). Further detail on the specific methodology will be provided in Chapter 3. An additional set of moderating variables like Environmental Concern, Environmental Behavior, and Opinion Leadership will be incorporated as they seem to have a strong relation with the Behavioral Intention to adopt more sustainable technologies. The Environmental Concern is the evaluative response towards environmental issues. In the case of Environmental Behavior, it refers to the degree in which the individual takes action towards improving the environment in their daily activities. The Opinion Leadership refers to the inclination of individuals to be knowledgeable and at the forefront of technology adoption in the car context. The Behavioral Intention is defined as the readiness from an individual to adopt the technology and it is considered an immediate predictor of Behavior (technology usage). In addition, a set of control parameters as: gender, age, occupation, will be included for statistical purposes.
3.1 INTRODUCTION

To answer the research question presented in Chapter 1, special care has been taken to select the most appropriate research design. As the primary focus of this study is applied research where consumer perceptions are assessed, in depth information is needed from the participants of the study. For this reason the study will follow individual in-depth structured interviews as the preferred data collection method with a reduced amount of participants. The unit of analysis are individuals who are residents of the Netherlands and speak English. The sampling follows the purposeful sampling design with specific criteria to have input from three different user groups. Both quantitative and qualitative information will be collected from each interview in a way to complement the information obtained. There won’t be experimental control as the purpose is to assess consumer perception of future car technologies which are still not available in the market. Nevertheless, a brief standardized textual and visual explanation of the technology will be provided at the beginning of the interview to each participant. Due to time constrains, the study will consist of a cross-sectional sample with exploratory purposes to validate the proposed CaPPTAM.

3.2 NATURE OF THE STUDY

It was clearly stated the purpose of this study is to assess consumer perception towards the concept of CaPP in the Netherlands. This implies the aim of the study is exploratory with the idea to generate applied research that has specific implications in this field in a medium term. Moreover, in order to understand consumer motivations priority will be given to in-depth information from a reduced number of participants rather than little information from a big sample. This means the results are intended to get an impression of the market since it is the first time this technological concept will be validated with potential users. As in any other naturalistic inquiry study there was no need for a control group [Patton, 1990].

3.3 UNIT OF ANALYSIS AND SETTING

The unit of analysis are individuals who are residents of the Netherlands and speak English. As the data collection is done through in-
depth interviews the preferred setting to get the information is a quiet place where there are no disturbances for the users and is possible to record the conversations. To ensure the interaction with the participants a flexible approach is necessary to conduct the interviews at the most accessible spaces for them. Thus, the interview setting varies from the academic environment, to offices and quiet public spaces.

3.4 SAMPLE / PARTICIPANTS

A purposeful sampling method was followed with specific selection criteria. The criteria was based on the degree of experience the user had with traditional internal combustion and emerging car technologies. For instance, some users lack experience because they have never owned a car but may want one in the future. Next to this group, other users might have experience using a car because they owned one at the moment of the interview. Lastly, owners who had experience with traditional combustion technologies in the past and currently own / use an electric based car. Consequently, three main groups were defined as the target of this study given its level of experience with cars: 1) Young bachelor and master students that do not own a car at the moment of the study, 2) Professionals and other users (non students) who own an internal combustion based car, and 3) User / owners (non students) of electric based cars. The reason behind the previous purposeful sampling criteria is the possibility to identify patterns inside each group according to the experience of the participants and to determine if there are significant differences towards the perception of the CaPP concept. At least five participants were invited for each of the groups to get a minimum sample size of fifteen participants.

In the end, the study included 20 participants. From the total, 7 were students, 8 were gasoline car owners and 5 were electric car drivers. The age range went from 23 to 64 years old, with an age average of 33.5. Across the study 13 participants were male, while 7 were female. From the 13 participants driving a car, 8 had a regular car and 5 an electric vehicle. The electric car technologies studied included 2 full electric vehicles, 2 plug-in hybrids and 1 hybrid. Most of the interviews were held in Delft (12), 5 were done in Rijswijk, 1 in Rotterdam, 1 in Eindhoven and 1 in Utrecht. At the moment of the study 1 participant studied up to High school, 11 participants had a Bachelor degree, 7 had Master studies and 1 a Post Doc. Table 2 shows the participants’ summary.

3.5 MATERIALS

Two main types of explanatory materials were used to conduct the study in an attempt to standardize the technology description across
<table>
<thead>
<tr>
<th>#</th>
<th>GENDER</th>
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<th>OCCUPATION</th>
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<td>33</td>
<td>professional</td>
<td>master</td>
<td>hplug-in</td>
</tr>
</tbody>
</table>

Table 2: Participants’ summary
all the participants. The first one consisted of a brief textual explanation of fuel cell cars and the proposed CaPP technology. The second was a pair of videos where the concept of CaPP and a V2G project were displayed in operation to ease the understanding of the technology and the implications it might bring for the driving behavior of the user. See Section II of the interview questionnaire in the Appendix B for samples of the materials provided.

3.6 Measurement Instruments

Due to its complementary characteristics both qualitative and quantitative measurement instruments were necessary during this study. First, it was required to develop a model to assess the degree of technology acceptance from the users, the so called CaPPTAM, as defined in the Chapter 2 (See Fig. 13). For this reason a quantitative questionnaire was the most appropriate instrument, considering it is easier to compare the results across the users on this way. Second, an in-depth talk with the user was necessary in an attempt to understand the underlying personal motivations to use this technology. In this case the instrument of choice was an interview through qualitative open ended questions. Next a description of these measurement instruments:

The quantitative questionnaire was applied after introducing the participant to the technology through the explanatory materials. This questionnaire was based on the constructs included in the Car Technology Acceptance Model. However, as this was not specific enough to evaluate the proposed concept, the model was extended to fit more appropriately with the context of this study and was defined as the Car as Power Plant Technology Acceptance Model. The objective of this model was to explore the CaPP technology adoption intentions among the users in the car related context. This measurement instrument included a set of 33 questions where the participants were asked to answer in a five category likert scale (where 1 represents strongly disagree and 5 equals to strongly agree). From the 33 questions, 25 were related to the CTAM, while the other 8 were external to this model. A total of eight independent variables (Performance Expectancy, Effort Expectancy, Attitude Towards Technology, Social Influence, Facilitating Conditions, Self Efficacy, Anxiety, Perceived Safety) were tested against one dependant variable (Behavioral Intention to use the technology). Next to that, three additional moderating variables were assessed (Environmental Concern, Environmental Behavior, and Opinion Leadership). Table 3 shows a summary of the variable definitions covered in Chapter 2.
### Variable Definition Summary

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>Belief the technology will help the user to reach its goal</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>Perceived ease about using the system</td>
</tr>
<tr>
<td>Attitude Towards Technology</td>
<td>Individual’s attitude towards using the system</td>
</tr>
<tr>
<td>Social Influence</td>
<td>Degree of importance given to the social group opinion</td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>Importance given to existence of technical infrastructure</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>Individual’s belief in its competence to use the technology</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Degree to which a person responds with apprehension</td>
</tr>
<tr>
<td>Perceived Safety</td>
<td>Individual’s belief about system impact on its well-being</td>
</tr>
<tr>
<td>Environmental Concern</td>
<td>Evaluative response towards environmental issues</td>
</tr>
<tr>
<td>Environmental Behavior</td>
<td>Degree of environmental actions taken by the individual</td>
</tr>
<tr>
<td>Opinion Leadership</td>
<td>User awareness about being knowledgeable in a topic</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>Readiness to adopt the technology (behavior predictor)</td>
</tr>
</tbody>
</table>

Table 3: CaPPTAM Variable definition summary

The qualitative interview was the last section of the interview and was applied just after the quantitative section. Through this instrument, the real perceptions of the participants towards the technology adoption are explored. This instrument consists of only 9 open-ended questions, with one of them only applicable when the user had previous experience with electric cars. These questions assess the impression of the user about electric cars, about the technology, their experience with electric cars (when applicable), the perceived benefits and concerns, the willingness to adopt, the situations where the participants perceive more benefit by using the technology, the factors that would contribute towards adopting the technology and the preferred ownership structure. In some cases, additional questions were asked to the participants to get a more detailed answer. A sample of this questionnaire can be found in Appendix B.

### Data Collection

The data were collected through individual in-depth interviews following a standardized questionnaire that captured both qualitative and quantitative data from each person. Prior to the application of the interview to the participants, the questionnaires were evaluated by the thesis supervisors and a professor of the transportation sec-
tion of TBM. The feedback received was integrated into the questionnaires. The data collection process was performed during a 3 week time period. The interviews were conducted at the most convenient place for each interviewee to avoid disruption from its daily activities. Therefore the settings included TU Delft facilities, some offices and a few public spaces in the cases where the two former locations were not available. Each interview was digitally recorded for accuracy and lasted between 30 to 60 minutes, depending on the time availability of the interviewee.

The measurement instruments were administered to participants following the same sequence. Before starting with the interview, the participants were briefly introduced to the study and the sections to be covered; making clear confidentiality would be kept at any given moment. Then, the participants were asked to answer the first section which includes the general socio-demographic information, followed by their transportation preferences. As this section was the easiest, the participants became more confident and there was some time to create a comfortable atmosphere. Later on, the researcher introduced the fuel cell car technology and the CaPP concept with a textual description, to continue with two videos where the participant could visualize the way in which the technology would be used. Once the text and the videos were covered, the researcher clarified the concept by answering the participant’s questions; in addition notes of the main comments expressed at this moment were taken. After this section, the participants were introduced to the quantitative section to assess the technology acceptance. At that moment, the participants were instructed to read each statement, think about it and then select the answer they felt more related with. The participants were instructed to take as much time as required. This section was handed and answered directly by the participants (without the participation of the researcher), so they could feel free to express their real opinion about the CaPP concept. Once the quantitative section was finished, the researcher proceed to ask the set of qualitative questions and in some specific cases a few extra questions or specific clarifications based on particular answers provided before. At the completion of the administration, a booklet of The Green Village was given to the participants to thank them for their participation in the study. Finally, the questionnaires were collected and stored for analysis by the researcher.

3.8 Data Analysis

Considering two different measurements instruments were used during the study, the data analysis was done following the same structure. On one side, the quantitative instrument initially followed descriptive statistics and then a correlation analysis using the SPSS soft-
ware. While on the other, the qualitative data was analyzed conducting content analysis by grouping information together into category clusters and then comparing it with the group of participants. Next an elaboration for each of them:

3.8.1 Quantitative analysis

As indicated in section 3.6 the quantitative sections used a 5 point likert scale which was used as an interval scale, which is important to take into account for the development of the subsequent analysis. The sequence for the quantitative analysis included the following: coding, data transformation, grouping by concept, descriptive statistics, reliability analysis and correlation analysis.

The first step was to code and capture each of the constructs into SPSS (coding details can be found in Appendix D). The second step consisted in reversing some of the quantitative data collected to match the concepts they were intended to measure. For instance the results obtained from Self Efficacy (Q17), Perceived Safety (Q21) and Perceived Safety (Q22) constructs were reversed. Then, the results from the constructs measuring the 8 independent variables, the 3 moderating variables, and the dependent variable were grouped by variable. This was done with the objective to work directly with the average result of the variables and to reduce the amount of data to be processed in SPSS. To do this, the average of each variable was calculated in Excel by adding its construct values and then dividing it by the total number of constructs. The third step consisted in validating the information. This included descriptive statistics, a normality test, and the calculation of the Cronbach’s alpha to ensure the internal reliability of the data. The fourth step comprised a correlation analysis to check strength and direction of the independent variables proposed in the CaPPTAM model. Nevertheless, when a correlation exists this does not mean there is a causal relationship among the independent and dependent variables.

3.8.2 Qualitative analysis

For the qualitative section the techniques defined as conceptual and relational analysis were used. The conceptual analysis looks for the frequency specific topics are addressed in the material by the participants. Then the relational analysis builds over the conceptual information by examining relationships among the concepts.
First, all the material captured from the interviews was reviewed. After the material was read, it was reduced by selecting the most significant elements, which were then coded using key words and a color coding. After that, using deductive and inductive reasoning the emergence of patterns in the data was analyzed. When patterns were recognized and considered to be relevant they were grouped into topics and when detailed enough, represented as classifications on a general way and by user category, etc. Then, inter group comparisons were done to see if there were significant similarities or differences among the participants. Also, taking into account the participant’s context, the potential causes and relationships were assessed. Finally, the patterns among users, the group comparisons and the motivations were reported, trying to maintain a balance between the description and interpretation of the information.
RESULTS

4.1 INTRODUCTION

In this chapter the results from the analysis are presented in a quantitative and a qualitative section according to the measurement instruments. The quantitative section includes a Data validation subsection and the Correlation analysis, while the qualitative section is divided in General findings and the CaPP findings. At the end of this chapter, there is a conclusion where the main findings are presented, followed by a discussion about the usage of mixed research methods.

4.2 QUANTITATIVE RESULTS

4.2.1 Data validation

4.2.1.1 Descriptive statistics

The participants of the study were 20 in total with the youngest having 23 years old and the eldest 64, giving a total average of 33.5 years for the sample. Figure 14 shows from the total sample 25% were electric car drivers, 40% were regular car drivers, and 35% were students without a car. In the case of the gender 35% were female, while 65% were male. From the 13 participants driving a car, 8 had a regular car and 5 an electric vehicle.

Figure 14: Graphical representations by group and gender

In Table 4 the descriptive statistics are presented for all the variables in the study including the minimum, maximum, mean, and standard deviation. Across the variables it is possible to observe the minimum scores were in the range of 1.0 for Anxiety to 2.5 for Self Efficacy, while the maximum scores went from 3.7 for Anxiety to 5.0.
The mean scores were in the range of 2.6 for Anxiety to 4.1 for Facilitating conditions. The highest variability was present in Environmental Concern with a standard deviation of 1.1; the lowest was for Opinion Leadership with .6.

When the mean values are visualized on descending order the representation in Fig. 15 is obtained. From this figure the highest mean values correspond to Facilitating Conditions, Environmental Concern, and Environmental Behavior. The lowest mean values are for Self Efficacy, Opinion Leadership and Anxiety respectively.

Figure 16 shows the education level by group. For the group of students there are 6 participants with Bachelor studies and 1 with a PhD degree at the moment of the study. The regular car drivers include 1 person with High school, 4 with a Bachelor degree, and 3 with Master studies. In the electric car drivers group there is 1 person with a Bachelor degree, 3 with a Master degree, and 1 with a PhD.

Figure 17 shows a Box plot for Behavior Intention by group. This sort of graph represents the dispersion of the results for the desired
variable in quartiles. The lower part of the box represents 25% of the data, while the highest part of the box is equivalent to 75%. The whiskers extending from the box indicate the variability beyond the lower and higher quartiles. One variable is represented at a time for each of the groups to ease the comparison among them. In the case of Behavior Intention the students had the highest levels with a relatively small variation going from 3 to 4.3, the regular car drivers showed a higher variation from 2.3 to 4.8, and the electric car drivers had the highest variation level among the three groups ranging from 1.8 to 4 (See Fig. 17). For the Facilitating Conditions variable the student group responses varied between 4 to 5, for the regular car drivers it was between 2.9 to 5, and for the electric car drivers it went from 3 to 4.3 (See Fig. 32 in Appendix E). In the case of Opinion Leadership the students had the lower results going from 2 to 3, the regular car drivers were on a more neutral tone ranging from 2.4 to 3.5, and the electric car drivers showed higher levels but also variability going from 2.8 to 4.2 (See Fig. 38 in Appendix E). The rest of the graphs can be found at the Appendix E.
4.2.1.2 Reliability analysis

When a set of variables are measured, it is important to ensure the internal reliability of the data. In order to do this a coefficient defined as Cronbach’s alpha is computed. This coefficient measures the intercorrelations among the items selected. Therefore, the closer the result is to 1 the better. The Cronbach’s alpha analysis was tested with the 11 measured variables (Performance expectancy, Attitude towards technology, Social influence, Facilitating conditions, Effort expectancy, Self efficacy, Anxiety, Perceived Safety, Environmental concern, Environmental behavior and Opinion Leadership) obtaining a coefficient of .74. The acceptable range for this coefficient is between .7 and .8 [Sekaran and Bougie, 2010]). The result of the test can be seen in Appendix E, Fig 40.

4.2.1.3 Normality test

A normality test is used to verify if the data collected belongs to a normal distribution or to a random sample. The normality test applied to the variables was the Shapiro-Wilkinson. For most of the variables the ρ value is higher than .05 meaning the data is normally distributed. Some exceptions are Behaviour intention and Self Efficacy. It is important to note the sample size is reduced and no complex methods will be used, so the normality test is only included for demonstration purposes. Figure 18 shows the SPSS results. An additional set of graphs showing the variables distribution is presented in the Appendix E.

<table>
<thead>
<tr>
<th>Tests of Normality</th>
<th>Kolomogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
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<td>Effort_exp</td>
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<tr>
<td>Opinion_lead</td>
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<td>.20</td>
</tr>
</tbody>
</table>

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 18: Normality test of the variables
4.2.2 Correlation analysis

Correlations are used to indicate the direction, strength and significance of the relationship among two or more variables. In the present situation a correlation analysis is relevant to understand the relation and strength between the independent and dependant variables. Both Pearson and Spearman’s correlations were calculated for all the variables. The results can be observed in Table 5. From this table, it is possible to identify strong positive correlation levels between Performance expectancy, Attitude towards technology, Social influence, Facilitating conditions and Perceived Safety with the dependant variable (>0.6). There are moderate positive levels of correlation among Self efficacy, Effort expectancy, and Environmental Concern in relation to Behavioral intention (>0.3). Moderate negative correlations can be observed between Anxiety and Opinion Leadership towards the dependant variables. Nevertheless, none of the last two variables seems to be significant as their $\rho > 0.05$.

<table>
<thead>
<tr>
<th></th>
<th>Pearson</th>
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<th>Spearman’s</th>
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<td>Sig.</td>
<td>Level</td>
<td>Sig.</td>
</tr>
<tr>
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<tr>
<td>Group</td>
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<td>Performance Exp.</td>
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<td>Effort Exp</td>
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<td>Attitude T</td>
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<td>0.73**</td>
<td>.00</td>
</tr>
<tr>
<td>Social Influence</td>
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<td>.00</td>
<td>0.63***</td>
<td>.00</td>
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<td>0.83***</td>
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<td>0.56*</td>
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<td>Env. Behaviour</td>
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<td>.23</td>
</tr>
<tr>
<td>Opinion Lead.</td>
<td>-0.42</td>
<td>.07</td>
<td>-0.29</td>
<td>.22</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 5: Correlations with the dependent variable

In the case of the moderating variables, it can be noted in Fig. 19, the correlation levels among Environmental Behavior and Environmental Concern do not show the same levels of correlation with the dependant variable and among them. A possible explanation is that in general people express to be concerned about the environment, but the actions taken do not correspond to the same level. A similar situation was also found in a study about electric vehicle adoption in Belgium conducted in 2012 [Moons and De Pelsmacker, 2012].

There are some studies based on the UTAUT model that use more advanced statistic tools to analyze the data. Some of these methods...
include factor analysis or multiple linear regressions. These tools are used to investigate the statistical prediction power of the independent variables over the dependent variable. The majority of these studies have hundreds of participants, a condition that is necessary when performing analysis with these methods. Taking into account the present number of participants is reduced (20), using this sort of method is not relevant for this study.

![Inter-Item Correlation Matrix](image)

Figure 19: Moderating variables correlation

From the 11 variables studied, 7 had significant results; 5 of these variables showed strong levels of correlation and the other 2 had a moderate positive level of correlation with the dependant variable. Figure 20 shows the proposed CaPTAM correlation levels for both independent and moderating variables (darker colors meaning stronger correlations). It is worth mentioning; the correlation levels are associated to the sample of this study and therefore cannot be generalized to the

4.2.2.1 Correlations and the proposed model

From the 11 variables studied, 7 had significant results; 5 of these variables showed strong levels of correlation and the other 2 had a moderate positive level of correlation with the dependant variable. Figure 20 shows the proposed CaPTAM correlation levels for both independent and moderating variables (darker colors meaning stronger correlations). It is worth mentioning; the correlation levels are associated to the sample of this study and therefore cannot be generalized to the
rest of the population. For the moment it is possible to conclude there were several variables showing positive levels of correlation with the dependant variable.

4.3 QUALITATIVE RESULTS

4.3.1 General findings

This subsection deals the general findings about Electric Vehicles. Specifically it explores the current and future vehicle preferences, the perceptions of Electric Vehicles, the way electric car users have dealt with the range anxiety and some of the motivations behind the electric car adoption in the Netherlands.

4.3.1.1 Current and future vehicle preferences

Future car preference was dominated by German and Japanese brands by half of the participants (regardless of their occupation, gender and age). Both preferences are associated with proven technology, higher efficiency, better performance and reliability. The rest of the participants either bought their last car very recently or doesn’t know at the moment due to uncertain factors in the long term. Interviewee 15 about his brand preferences: “In the case of the brand I prefer Japanese cars as they give me more value for each euro invested”.

In the case of future technology preferences the participants with electric driving experience (5) were willing to buy another electric car in the future. On the contrary, the gasoline car drivers and non drivers without electric experience expressed an attitude of wait and see. Interviewee 8 about her preference for a gasoline car: “I wouldn’t choose fully electric vehicles now since I don’t think the system is completely developed. To adopt a full electric I would prefer to wait and see. For instance, may be in 10 years the technology is improved with better ranges, but also the infrastructure and efficiency of these vehicles”. In the case of the gasoline car users, 5 from the 8 indicated they would like to continue using gasoline cars in the future. From those 8 participants, 1 expressed interest on considering a battery car alongside to a gasoline option, another one expressed interest for a hybrid car and 1 for a fully electric if the infrastructure continues to evolve favourably. On a similar way, from the 7 students without a car, 6 were interested on buying a car in the future. In this case 2 students would be interested on buying a hybrid, 1 would consider electric with the other 3 preferring a gasoline car. Therefore, from 15 persons currently not using an EV, 6 users or 40% would consider adopting one in the future depending on the evolution of the technology.
4.3.1.2 Perceptions of Electric Vehicles in line with other studies

In general and in line with other studies on the field, EVs were perceived in general as eco-friendly, generating less CO\textsubscript{2} emissions and lower noise levels. Also, similar to other studies performed in the past [Egbue and Long, 2012] EVs were associated with some negative connotations. Some of these comments included a relation with expensive technology, low speeds, limited range, range variability due to weather conditions, lack of infrastructure, long charging times, reduced flexibility and the danger EVs could represent due to the lack of sound for pedestrians. Interviewee 16 about his impression of EV: “I think electric vehicles could be good for the environment as they emit less CO\textsubscript{2} and are silent. On the other hand they can be dangerous as people cannot listen to them when they are approaching. In fact I was hit once by an Electric Vehicle when crossing a street”. Some positive remarks from drivers of electric and non-electric vehicles included lower operation and maintenance cost, that EVs are necessary for the energy transition, they have very attractive incentives from tax exemptions, there is development of infrastructure in the Randstad area and the awareness of a increasing rate adoption by the population of the Netherlands. The most favourable comments came from current EV users, while the gasoline car drivers and students reviews were more negative towards electric mobility.

4.3.1.3 Dealing with range anxiety

An interesting finding from the full electric vehicle users is the way they dealt with the range anxiety. Three factors seemed to contribute to reduce the range anxiety: 1) routine trips, 2) minimal infrastructure available and 3) experience. The first one is the regularity of the schedule that allows the user to anticipate the distances he/she will have to travel every day. The second refers to the knowledge there is enough infrastructure (South Holland) at the moment of adoption, plus the additional stations that would be implemented due to the commitment shown by the government. The third is the experience with the vehicle in different conditions which seems to decrease the uncertainty as the user is more familiar with the vehicle capabilities. Interviewee 9 about dealing with range anxiety: “Regarding the range anxiety, at the beginning I used to have a lot, but once you get used to the distances and usage you can give to the car it decreases a lot. A good option to encourage people on adopting the technology is to give them the opportunity to try it by themselves to reduce this fear”.

4.3.1.4 Impacts of internal motivation, tax incentives and resources in electric mobility adoption

From the interviews with the electric vehicle users it was evident the main reason to adopt this technology was not only based on the price
but it also had an internal motivation component.

From the 5 electric vehicle drivers, 3 participants mentioned their main motivation was due to environmental reasons, while the other two mentioned it was mainly due to monetary incentives. Interviewee 18 about his motivation for buying a plug-in hybrid: “Mainly because of the convenient incentives as tax, insurance exemptions and also for having it as a leasing, fuel costs are also less and I really feel it when compared to my previous car”. For the participants that demonstrated an internal motivation, in 1 of the cases this obeyed only to a personal interest to contribute towards the greater good, while for the other 2 users it was a combination between a personal motivation but it also had a professional component as they are promoters of renewable energy and electric driving. Interviewee 10 on his motivation about electric cars: “I choose the Tesla because I consider is a game changer and I want to show people this is a beautiful car. Actually this is the first time I buy a brand new car. Also as a person that promotes electrical driving I need to have an electrical car”.

Apart from the internal motivation and beneficial fiscal conditions perceived by the electric car users it is important to note these users had enough resources (knowledge and economic) that allowed them to better deal with the uncertainties associated to using new technologies. Additional information to consider is that all electric car users had a stable work and were in an age range between 31 to 53 years old. Specifically the hybrid users had 30, 31, and 33 years old; the fully electric drivers had 46 and 53 years.

4.3.2 CaPP findings

This section presents the results about the Car as Power Plant concept assessment among the participants. The topics are grouped on a similar way to the questions presented to the participants: CaPP concept perception, perceived benefits, main concerns, preferred location, remote control anxiety and preferred ownership scheme.

4.3.2.1 Concept perception

In the case of the perception of the CaPP concept, the opinions were mixed among the participants.

From the 20 participants, 4 were somehow sceptical about the concept throughout the interview, 9 had a mixed opinion, while the other 7 had a more optimistic outlook about the possibilities the technology could offer. As a common denominator the sceptical group argued it was possible only in a very big scale, it had many complexities in-
volved to make it work as intended, problems by working with hydrogen, idea that V2G with BEV could work better, and a preference for specialization than generalization. Interviewee 12 about his perception of the CaPP concept: “I think is a highly optimistic concept. I think a car is a car and a power plant is a power plant. I think specialization is better than generalizing, most of the time in engineering”.

In the case of the mixed group the participants expressed it was a good idea that could also bring more power to the consumer. At the same time they were concerned about the potential high costs of adoption, the idea that companies operating the system might receive more benefits than the users, reduced freedom due to the connection of the car in moments of need, and more realistic concept if the parking is not fully automated. Interviewee 11 about the CaPP: “I think is a nice idea, but I wonder whether or not it requires a lot of infrastructure, cost and development. I think you also need a separate building, unless is less automated where you can plug yourself; I think that will be more realistic”.

The optimistic group expressed it was an original idea; the integration could solve different problems at the same time like increasing the car usage, advantages of distributed generation, help to overcome fluctuations from renewable sources, and the concept offers added value to the customers as it is possible to concentrate other service like fuelling on the same place. Interviewee 6 about the CaPP: “My first impression was having a mind switch to consider an alternate way of thinking about cars. Now I can see different possibilities, is more like a smart phone that has been integrating a bunch of functions into a single device. An added value of this concept is that this parking places are also like a refuelling station on site and the customer doesn’t have to stop in the way”. After analyzing the different groups: the positive group was formed mainly by students, some conventional car drivers and 1 electric car user; the mixed group had few students, regular car drivers and an electric car driver; the sceptical group was composed by 2 electric car drivers, 1 regular driver and 1 student.

4.3.2.2 Perceived benefits

The perceived benefits can be classified in two ways: direct for the user and indirect for society.

The perceived benefits for the user included the potential monetary incentives, the potential to park for free, making driving fun once again as it allows the user to avoid feeling guilty while driving, the possibility to avoid electricity costs by producing own power, increase consumer power as it is less dependent on the grid, potential to make EVs more affordable. Interviewee 5 on benefits from CaPP: “I
think it would save me a lot of money, of course still hydrogen may cost you something, but I would feel less guilty and driving may be fun again. In terms of the technology I would like to get more control on where I get the energy from”.

For the indirect benefits for society the participants identified the environmental benefits like less CO2 emissions and pollution levels in urban areas, integration of services in one single place, reduced problems at the distribution level of the grid, reducing the variability coming from renewable sources and possibility to generate power in remote areas of developing countries or emergency situations in case of natural disasters. Interviewee 1 about the benefits of CaPP: “I see indirect benefits, like ensuring the supply of power at homes or hospitals in case there are problems with the distribution network”.

4.3.2.3 Main concerns

The concerns point in two directions mainly: one is related to the car technology, while the other to the system itself.

In the case of the vehicle technology the most common concern across all users was about safety because of the usage of hydrogen as the main fuel. The hydrogen issue has appeared in several studies related to FCV and this was no exception. During the study the participants expressed concern about the possibilities of a potential explosion while onboard of the car or also while plugged as a power plant. Interviewee 4 about her concerns: “My concerns with hydrogen would be general. This concept is different than only storing electric power in your car, because when used it as a power plant you car is still active doing something while you are away. My concern comes from the combination of the hydrogen being used in the car and the usage of the car without direct supervision on site”. Apart from this matter, in decreasing level of frequency other concerns involved the degradation of the Fuel Cell with the usage, the lack of flexibility on the car when it is plugged-in, and potential problems finding infrastructure when travelling to rural areas or other countries where the technology is still not implemented.

On the system side the concerns were the potential lack of infrastructure both for fuelling in the street and for parking the car to deliver power to the grid, the necessity to have the facilities in close proximity to final destinations, the risks involved in decentralizing power generation, and the experimental nature of the technology at this stage. Interviewee 1 expressed this concern: “If you distribute the generation of power like with this proposal, it means the level of security in parking areas should be increased. There could be safety issues because nowadays with the centralized generation you also have the risks concentrated in
one facility, whereas if you have small plants around the country your risks will spread over and may be having control over them would be more difficult”.

4.3.2.4 Preferred location

The preferred location to use the technology varied greatly among participants, and their perceptions were clearly based on their particular lifestyle and needs. For instance 4 persons driving gasoline cars mentioned the technology would deliver more value if parked at home as their cars were there most of the time. From these 4 participants, 2 were retired and the other 2 were young professionals that use public transportation to go to work. Interviewee 19 about technology usage: “It would be more convenient when having this system near home, especially for people retired like me because as I don’t really use the car I leave it at home most of the time”.

A group of 6 participants expressed more interest in the combination of work and home, since they considered a car spends a significant amount of time in both locations. Interviewee 5 about the technology use: “If it is my car at home definitely. Is difficult because for instance if the car is mine and then I go to work my boss would like me to plug the car, but I would do it only if I get compensated. It also depends where the ownership is. On the other hand, if my employer gives me a car and then I plug it at home may be I would receive some money but how much? Since in reality is property of the company. It is a difficult question due to the ownership”.

A group of 3 participants indicated any setting was useful for them. 2 other participants indicated the technology would be more useful in developing countries where access to the grid is difficult or isolated areas. Interviewee 17 about technology use: “I think it would also be interesting for generation in off-grid locations at developing countries or for remote projects”. Another 2 participants expressed their interest to use the technology at work mainly.

Another 2 participants thought they will benefit more from the system in case of emergency situations, like when there is a shortage on the electricity supply due to natural disasters. Interviewee 6 about the technology usage: “In Sweden sometimes we have big storms and the electricity goes down. Therefore, in this kind of situations it would be useful to have your car as a backup to provide energy in emergency situations. It would be like a life line”.

Last but not least, 1 participant indicated he perceived the greatest value not at the personal, but at the aggregate level. This finding is
relevant as the user relates to its closest experience and needs, in this sense there could be additional locations where the technology could be applied but might have to be explored in the future.

4.3.2.5 Remote Control anxiety

One of the problems associated to the production of electricity with an EV is the perceived loss of control by the user when its car is used to feed the grid. This study addressed this issue with the participants with surprising results.

From the 20 participants, 13 indicated they agreed with the idea their cars were accessed remotely by a third party with the following considerations: 1) setting parameters, 2) transparency and monitoring, 3) attractive incentives. First, in the case of setting parameters the participants indicated they wanted to be able to specify the conditions and time in which the car would be operating. Second, the users would be interested on having visibility of the vehicle’s situation at any given moment on a transparent way. Third, the participants are ok with the remote control as long as they receive attractive incentives that compensate for the usage of the fuel cell. Interviewee 10 about remote control: “It depends on how much money I can get from the system but as long as I am able to specify the parameters it would be ok. For the rest I think people in the future will be aware of the network function, we are already heading towards a network society. We are connected all the time; especially young people will feel natural their car might be connected and that the car is a local storage device for the grid”.

The other 7 participants also agreed if the operation was transparent but indicated some additional remarks, for instance some of them think there would be people that would try to abuse the system virtually or physically with safety implications, others were concerned about privacy issues (in case there are log files that can be downloaded from the car through the connection), other users said they would be disappointed if the car was not used as they expected. Interviewee 6 on remote control: “In the end someone has to be in charge and you need to trust this party. For me it would be ok as long as they respect what I want. For instance if I’m going to park for 3 hours and already made my car available, I would be disappointed if it was not used, because I already invested time to park there and walk some minutes to my final destination. If I buy a system like this I expect to make a contribution and would make the effort to take advantage of the technology as much as I can”. These findings are important considerations to have at the moment of designing the system operation details.
4.3.2.6 Relevant factors to adopt the technology

The relevant factors included in this section are fundamental for the users when considering the adoption of the CaPP concept. Similar factors that would influence the adoption of the CaPP technology were also expressed directly or indirectly by the participants when answering other questions of the interview. All the factors were grouped in 6 main categories: price, incentives, information access, infrastructure, technology and values. Next, an elaboration of each:

**Price** The most relevant economic aspect was of course the price of the technology, followed by the costs of driving and the cost of replacing the Fuel Cell of the vehicle. Interviewee 5 about relevant factors: “The cost of implementation is relevant, how much should I invest to use the technology. Would I get for example with electric cars a dedicated pole or socket installed for me?, the reliability would be a big thing specially with a technology like this”.

**Incentives** Monetary incentives like the money generated by the vehicle to the user were a strong point. However, government support ranked as second in level of importance. Government support is perceived in the shape of regulations or tax reductions, but also in a broader sense by showing commitment to the population when building the necessary infrastructure or when working together with other stakeholders. Additional remarks include the possibility to use point systems to incentivize the adoption of the technology and the advantage of having added values as different services integrated in the same place. Interviewee 10 about relevant factors: “I think it should always be transparent what the benefits are for the consumer. I think people in the future will be willing to participate as long as there are incentives which could be financial or you earn mobility points, energy points, CO2 points, etc. I expect people will be willing to, as long as they are confident the technology is ok”.

**Information access** The participants expressed having access to transparent information related to the operation of the system from third parties (non manufacturers), was important to understand the advantages and disadvantages of the system. The information provided preferably would be based on objective test results. In addition, having direct or indirect access to information through demonstration projects or by the social network of the participant was a strong reason to create confidence in the system. Interviewee 4 about relevant factors: “I like to have open information, which is possible to get from demonstration projects where I can ask the scientists and not the marketers or sales people, may be a sales engineers could be”.
INFRASTRUCTURE Most of the participants were concerned about the existence of the required infrastructure, but also on having access to it in order to make proper use of the technology. Additionally, the costs associated and the party paying for the development of the infrastructure were relevant. Interviewee 2 about relevant factors: “Mainly the infrastructure where I could plug-in my car into the grid, but also how easy is to have access to buying a vehicle with this characteristics and the system itself”.

TECHNOLOGY In the case of the technology, the participants expressed safety as one of the priorities not only for the vehicles but as a whole for the system. Next to that, other relevant factors are the possibility to monitor the operation of the system, that it is a proven technology, that the use of the vehicles does not affect the performance in a negative way, to ensure the flexibility when using the system, to have similar levels of comfort and driving ranges than with conventional cars. Interviewee 14 about relevant factors: “As for conventional cars, I am concerned about the safety and in this case it would even be more important. It would also be important the comfort of the vehicle provided if compared to regular cars”.

VALUES Some participants also expressed interest in factors related to environmental motivations like reducing the pollution (CO2) and noise levels; at the same time other participants mentioned their interest on contributing to the greater good and leading by example. Interviewee 9 about relevant factors: “Lead by example would be a reason for me. We can talk about using this technology, but we should do it, in order to start the momentum”.

4.3.2.7 Preferred ownership

The ownership scheme also varied according the participants’ context.

The possibility to get the vehicle as a service was preferred by students as they only require the vehicle on an occasional basis, with 5 of 7 preferring it as a service scheme. Interviewee 6 on ownership: “I like to think about the idea of a plane which is bought and shared by some pilots, on this way they can afford an airplane that can be used more frequently than if bought separately. For this reasons I think it is also possible to share a car, where the community spread the costs among them and use it together, because at this moment it wouldn’t make sense to buy a car for myself”.

From the schemes introduced the semi-lease was the one that captured the attention of most of the participants with 6 persons interested (2 of them drivers of electric cars) as a first option and 8 as a second. Interviewee 5 on ownership: “For circumstance like this, I would
be more interested in the semi-lease because the reliability issue is shifted to
a third party. May be I make less money, but the risk is transferred. Another
reason is that I want to be the owner of my car so it make sense to lease
the sensible parts because you can have a contract with a company, also to
arrange when I get my payments for the energy generated. Overall, I think
it simplifies the stuff”.

For the leasing scheme 3 persons were interested and 2 of them
were electric car drivers. Interviewee 18: “For me the leasing would be
the best option, because I see the technology mainly used in offices as in my
case. You can have the infrastructure at offices, with a lot of cars which are
from the same company. I think the car should be provided by the employer
as a benefit”.

The traditional scheme was the first option for 6 participants as
they prefer to own their own stuff in the regular way. As it can be
observed from the user impressions, there is a wide range of options
that appeal to different persons, so the existence of various ownership
models should be considered in the business model design. Another
alternative is the evolution of the ownership structure as a function
of the technology maturity.

4.4 RESULTS CONCLUSIONS

4.4.1 Findings summary

Through the quantitative analysis it was possible to find:

• The Attitude Towards the technology and the Behavior Inten-
tion to adopt varied according to the different groups: students
showed the higher levels, followed by the conventional car drivers
and then by the electric car users.

• From the moderating variables, Environmental Concern had the
strongest correlation with the Behavior Intention to adopt the
technology.

• The participants’ expressed levels of Environmental Concern is
not strongly correlated to their actual Environmental Behavior,
as the results differ among them.

• The perceived Opinion Leadership had a negative correlation
with intention to adopt the technology. Therefore, the higher
the levels of Opinion Leadership were, the lower the intention
to adopt the technology.

• Seven of the proposed eleven variables had significant positive
levels of correlation with the dependant variable with the cur-
rent sample size. However, further studies with higher number of participants will be necessary to verify the model through the use of advanced statistical methods.

The qualitative analysis shed light over some relevant issues regarding EVs and in the specific CaPP context.

For the general findings:

- The future car preferences were dominated by Japanese and German brands. Additionally, there is evidence previous experience influences the future technology selection, but it is not the only factor.

- The perception of EVs was in line with other studies related to electric mobility performed in the past.

- Three identified factors that helped electric car drivers to deal with the range anxiety were: routine trips, minimal infrastructure available and previous experience with the EVs.

- Inner motivation, attractive fiscal incentives and an adequate access to resources (knowledge and economic) as fundamental drivers for the users of electric mobility in the Netherlands.

On the specific CaPP context, the main findings were:

- The technology acceptance levels about the CaPP concept were in general above average. From the 20 participants, 7 were optimistic, 9 had a mixed opinion, and 4 were somehow sceptical. This means 16 participants from the 20 rated the concept above average in the qualitative section. This results were also coherent with the data captured by the quantitative instrument through the Attitude towards the technology and Behavior Intention variables; both presenting mean scores of 3.5 and with different compositions by group as demonstrated in the box plots.

- Perceived benefits for the user (monetary incentives, guilt reduction for driving, and increase in consumer power) and for society (environmental benefits, integration of services, reducing variation from renewable sources).

- Main concerns classified by car technology concerns: hydrogen as main fuel, degradation of the Fuel Cell, lack of flexibility when the car is plugged; and system concerns: lack of infrastructure for fuelling and for parking, facilities far from final destinations, risks involved in decentralizing power generation.

- Most valued location varies with user needs: retired and young professionals at home, employees at work, students plus some employees with a mix of both, and developing countries.
• No remote control anxiety under certain conditions: users set operation parameters, transparency in operation and monitoring, attractive incentives.

• Relevant factors for adoption classified in 6 categories: price, incentives, information access, infrastructure, technology and values.

• Preferred ownership structure according to the user needs and technology concerns: car drivers go for traditional and semi-lease, electric car drivers with leasing and semi-lease and students with a stronger preference for a service scheme.

4.4.2 Mixed Research methods discussion

Working with mixed research methods is challenging. This type of research has both advantages and disadvantages:

On the one hand, some of the advantages include a better understand of the participant’s context, the possibility to triangulate information by comparing the respondent’s answers to both measurement instruments, and when necessary the interview format allows to take the conversation into the desired direction. On the other hand, the disadvantages are the preparation of two sets of measurement instruments, longer amounts of time to conduct each interview, and the application of two analysis methods for each of the instruments.

After all the implications of mixed research methods, in my personal opinion the benefits outweigh the drawbacks as they allow having a broader perspective of the answers provided by the users. In general, the quantitative questionnaire captures the discrete answers of the participants, but the qualitative questions provide the context capturing the motivations behind the responses. Thus, a better understanding of the subject is gained through mixed research methods.
EMERGENCE OF THE NICHE

5.1 INTRODUCTION

In Chapter 2 a group of theories used to study Socio-technical systems were introduced. Special emphasis was given to the Multi Level Perspective and the Strategic Niche Management theories, which can be used either as a descriptive tool or as a policy instrument. The SNM purpose is to study the niche formation by analyzing three key processes: coupling of expectations, articulation processes and network formation. Moreover a classification of the niches was provided with the following categories: technological niche, regular market niche, dedicated market niche and protected market niche. The last two aforementioned components of the SNM are used in this section to structure the analysis of the electric mobility evolution in the Netherlands. At the end of the chapter a summary of the main findings is provided, followed by their implication for the CaPP project.

5.2 ELECTRIC MOBILITY NICHE

The vehicle market has seen an increasing rate of adoption among EVs during the last years. In a report released by the Electric Vehicle Initiative in April 2013, it was estimated that by the end of 2012 there were more than 180,000 EVs for personal transportation. This amount represents .02% of the world vehicle fleet [IEA, 2013]. It is noteworthy to point out these numbers include only passenger cars, mostly using battery (BEV) and hybrid (PHEV) technologies since FCV are very limited in numbers. By 2020, the amount of EVs on the road is estimated to make up to 2% of the worldwide passenger car fleet [IEA, 2013]. The countries with the highest share of EVs by the end of 2012 were: Norway, Japan, Ireland, the Netherlands and the United States (See Fig. 21). The drivers behind EVs adoption vary across countries to a certain extent including some or all of the following elements: deployment of infrastructure, fiscal incentives, decreasing costs with enhanced performance, favourable policy implementation and collaboration among private-public stakeholders.

In the case of the EVs niche, it can still be considered a protected market niche. The reason for this is the technology is already in a commercial stage reaching the end consumer with possibilities to improve substantially its future performance. Additionally, it also counts with moderate to high levels of protection since this kind of vehicles are
still more expensive than conventional ones and require monetary and non-monetary incentives (See Fig. 22). In the next section the development of the electric mobility niche in the Netherlands is explored with the SNM framework thanks to its accelerated evolution, geographical relevance, but also as a precursor of the CaPP concept.

Electric mobility has been taking up strongly in the Netherlands due to an aggressive plan implemented by the government together with private stakeholders. The aim of the Dutch government is to benefit from an early implementation of EVs in the country by providing the users with the adequate conditions. Some of the objectives set by the Dutch government include a progression of EVs driving around the country throughout the years, with an projection of 20,00
5.2 Electric Mobility Niche

for 2015, 200,000 for 2020 and 1 million for 2025 [Trip et al., 2012]. The latest estimates indicate by the end of June 2013 there were already more than 10,049 EVs registered in the Netherlands [Duurzaam Bedrijfsleven, 2013]. Thus, the objective set for 2015 seems more than attainable under these circumstances. Even though there have been good results in a relatively short period of time, electric mobility in the Netherlands it is still a Protected market niche with less than 1% of the personal car market share. Consequently, on the next lines, a brief analysis of the three main SNM processes is presented:

**Coupling of Expectations** In the case of electric mobility, the users are motivated on reducing the pollution levels, improving the environment conditions and contributing towards the greater good. All this expectations are advantages offered by an EV that conventional technologies cannot provide. Besides, there is a very important economic component where the users would be interested on reducing their driving costs and the amount of taxes they pay every year. Moreover, these expectations have been coupled with additional advantages like parking for free in busy areas of Amsterdam, work areas, preferential electric rates, etc. In the Netherlands, it has been done on a way that all these expectations were covered through different kinds of incentives. On a greater level, the governments want to decrease the dependency of the transportation sector in fossil fuels, foster the economic development by the creation of new service providers and improve the air conditions in urban areas, all of which are also attainable by the use of EVs [Anton Wolthuis, 2011][Trip et al., 2012].

**Articulation Process** The articulation process deals with learning about the needs, problems and possibilities to provide solutions in several dimensions. As a starter, the Netherlands seems a good environment for the deployment of EV due to the high population density in urban areas like the Randstad or Amsterdam. This translates into covering the demand for a high amount of users by setting up a delimited amount of infrastructure. Financial incentives have been articulated in the national, regional and local levels to make the technology adoption more interesting for the users. For instance in the national level there is a tax relief for purchasing commercial EVs and road exemptions among others, while in the regional level there are subsidies for innovative projects, and the local level offers additional incentives for either purchasing an EV or installing recharging stations (Amsterdam, Rotterdam or Leeuwarden) [Trip et al., 2012]. One dimension of the articulation process that is being addressed not only in the Netherlands, but globally, is the enhancement of battery technologies to extend the range and performance of the BEVs by investing in R&D programs. In the
case of the articulation of the production network, there are also stimulus for the formation of new companies providing services and products like E-Traction Europe or Innosys Delft [Anton Wolthuis, 2011].

**NETWORK_FORMATION** The Dutch government has also heavily supported the interaction among different group of actors and this has been fundamental for the take off of the EVs niche in the country. One of them was the “Action Plan for Electric Driving” implemented between 2009 and 2011 with the objective of running a full scale experiment for electric driving with 9 demonstration projects around the country [IEA, 2012]. In addition, the government fostered the creation of the “Formula E-team” which brings together all relevant members across the industry, the local government and research institutes to provide support for the market development and removal of potential obstacles that may arise during the process [IEA, 2012]. On the regional level, the so called “Metropolregio Amsterdam Elektrisch” consortium, active in the provinces of North-Holland, Flevoland, and the Metropolitan area of Amsterdam, collaborates together with the local government to deploy hundreds of new charging points through the “Green Deal” initiative [Trip et al., 2012]. Moreover, during the last week Tesla announced the opening of its first plant in the Netherlands to serve the expanding market in Europe [Zacks, 2013].

As we have seen, the developments of the electric mobility niche in the Netherlands have influenced various Socio-technical regimes. This has been evident in the development of infrastructure, introduction of new technology, change in user practices and sectorial policy targeted towards the adoption of EVs.

### 5.3 Emergence of the Niche Conclusions

#### 5.3.1 Findings summary

During the last years, the electric mobility niche has been emerging in different countries around the world. Due to the relevance to this study and its current status, the Netherlands was chosen to perform a brief, non exhaustive analysis using the SNM framework. After analyzing the available literature it is possible to see how the coupling of expectations, together with the articulation process and the network formation incentivized by the government has lead to the take off of a major adoption rate of EVs in the country. The results show how this theory is useful in structuring the analysis into three main categories, which if analyzed from a higher perspective it is possible to observe the formation of virtuous cycles between them and its interaction
with various Socio-technical regime (infrastructure, technology, user practices and sectorial policy).

5.3.2 Implications for the CaPP

From the analysis of the electric mobility niche in the Netherlands it is possible to derive relevant lessons that can be applied to the CaPP concept. Of special interest is the fact that the country is already a leader in the adoption of EVs with around 5.58% of the global stock (2%), an advantage when thinking about implementing the CaPP project. Previously, the three processes associated to the SNM theory were used as a descriptive tool: coupling of expectations, articulation processes, and network formation. In this case, the same processes can be applied as a policy tool.

- First, in the case of coupling of expectations for the CaPP concept to be reality, a pre-requisite is the existence of FCV. Consequently, the technology needs to be developed into a commercial stage, so policies targeted towards funding the Fuel Cells R&D related activities would be mandatory. Also setting adoption objectives by the government has proved to be relevant in the electric mobility process. On this sense, an option would be that the government defines an annual amount of energy that should be delivered to the grid with the CaPP technology.

- Second, the articulation process can explore the current and future needs. In this sense, due to the relation FCV will have with the electric mobility sector as the next generation of EVs, it is relevant to monitor the current development on this field since the experience accumulated by the users would influence a future diffusion or contraction of the market. Special care should be taken to inform the users about the real capabilities the current EVs fleet offers to align it with their expectations. For instance, an impartial institution can be in charge of monitoring that the advertised capabilities of the EVs in fact comply with the delivered performance.

- Third, in the case of the network formation process, the creation of a national or regional organism with the participation of highly active countries in EVs related topics like Germany, Denmark and the Netherlands would be beneficial. Working with advanced countries/industries in electric mobility would be an advantage as they will have a broad leading group that is required for the CaPP adoption. Some problems in the past with the R&D activities have been the high cost of development coupled with long timeframes to reach the market, so an option would be to incentivize an open innovation scheme where
different companies and research institutions come together under a joint venture to develop the technology together. Besides, there is a recent emergence of different V2G projects around the world where several communication standards are being implemented. Therefore, a policy to unify the development of these standards would be important as it would be a potential stepping stone for the standards to be adopted during the eventual implementation of the CaPP.
6.1 INTRODUCTION

Chapter 2 described some concepts related to Business Model Innovation and their relationship to emerging alternatives for V2G. At the end of the literature review an approach based on morphological analysis was presented and selected, as it allows reducing the complexity of the analysis. The advantage of this approach is that it allows to have a quick glimpse of the business model structure, the available combinations, and how the options relate to each other (See Fig. 11 in Chapter 2). In the following sections the main components to be considered for the potential CaPP business model are listed, followed by some proposed business model alternatives, then the conclusions with the main findings are presented, to finalize with the answers to the research questions.

6.2 BUSINESS MODEL COMPONENTS

<table>
<thead>
<tr>
<th>Base Model</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer segment</td>
<td>Student</td>
</tr>
<tr>
<td>Ownership Struct.</td>
<td>Traditional</td>
</tr>
<tr>
<td>Proprietary</td>
<td>User</td>
</tr>
<tr>
<td>Billing</td>
<td>Pay for eq.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Private</td>
</tr>
<tr>
<td>Aggregator</td>
<td>Local party</td>
</tr>
<tr>
<td>Location</td>
<td>Home</td>
</tr>
<tr>
<td>Grid integration</td>
<td>Stand alone</td>
</tr>
<tr>
<td>Rev. User (U)</td>
<td>E. Services (A)</td>
</tr>
<tr>
<td>Rev. Aggregator (A)</td>
<td>E. Services (GO</td>
</tr>
<tr>
<td>Rev. V. Provider (P)</td>
<td>Selling car (U)</td>
</tr>
</tbody>
</table>

Figure 23: Base model

Some studies address the potential business models for V2G technologies, which are the closest in the literature to the CaPP. In one of them, the authors list three possible strategies to follow: 1) fleet management, 2) power generation from dispersed vehicles and 3) aggregator of individual services [Kempton and Tomic, 2005]. To start with, fleet management is out of scope since the focus of this study is on personal transportation. Second, having dispersed facilities for individual vehicles will not be ideal, since the investment could be very high due to the implication of building a full hydrogen distribution network which seems unfeasible at this moment. Therefore, the most appropriate strategy to follow in the case of the CaPP concept is the concentration of services through an Aggregator.
concentration of services through an Aggregator.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer segment</td>
<td>Potential market segments using the system</td>
</tr>
<tr>
<td>Ownership structure</td>
<td>Indicates the way the vehicle was acquired and used</td>
</tr>
<tr>
<td>Proprietary</td>
<td>Refers to the entity that actually owns the car</td>
</tr>
<tr>
<td>Billing</td>
<td>Way in which the customer is charged for the car</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Indicates who has access to the vehicle</td>
</tr>
<tr>
<td>Aggregator</td>
<td>Provides infrastructure and interacts with Grid Operator</td>
</tr>
<tr>
<td>Location</td>
<td>Location where the vehicle would be used as a Power plant</td>
</tr>
<tr>
<td>Grid integration</td>
<td>Level of integration between the CaPP and the grid</td>
</tr>
<tr>
<td>Revenue stream</td>
<td>Source of income for the corresponding stakeholders</td>
</tr>
</tbody>
</table>

Table 6: CaPP business model components

Taking into account the existing morphological analysis in the literature, the findings of this study and the proposed business model strategies; the most relevant components for the CaPP would be defined as: customer segment, ownership structure, proprietary, billing, accessibility, aggregator, location, grid integration and revenue stream (See Fig. 23). The **Customer segment** refers to the potential market segments using the system which are defined as student, professionals, families, and retired people. The **Ownership structure** indicates the way in which the vehicle is acquired and used; this can be traditional, leasing, semi-leasing (the car is bought as a whole by the customer and at the same time the fuel cell or any other sensible component is leased), and service. The **Proprietary** refers to the entity that actually owns the car; this can be the user, an independent provider, the energy utility company, the company where the user works and a vehicle manufacturer. The **Billing** refers to the way in which the customer is charged for the car; this can be done by paying for the entire equipment, a fixed rate or per usage. The **Accessibility** means who has access to the vehicle and this can be private, semi-public and public. The **Aggregator** is the entity in charge of providing the parking infrastructure to concentrate the services and interacting with the Grid Operator (Grid Operator (GO)); this can be a local party (non-institutional), an independent provider or the energy utility company. The **Location** is the primary location where the vehicle would be used as a Power plant and this can be at home, at the office, in a commercial area, for emergencies, or in a remote location. The **Grid integration** refers to the level
of integration between the CaPP and the grid and can be stand alone (for home), local (using a group of cars for a building) or regional for the distribution network. The Revenue stream is defined as the source of income for the corresponding stakeholders. It is divided in three: revenues received by the users (U), revenues received by the aggregator (A), and revenues received by the vehicle provider (V). Figure 6 shows a summary of the aforementioned definitions.

6.3 BUSINESS MODELS OPTIONS

From the possible combinations among the selected components, 4 business model combinations were found to be the most relevant for the CaPP concept. They are based on the customer segment and ownership structures. The business structures follow a progression that could be implemented as a function of the technology maturity: 1) Service, 2) Semi-leasing, 3) Leasing, and 4) Traditional. Appendix F contains each business structure on a full page in case the images in this section are small for the reader. Next a description of each of them:

<table>
<thead>
<tr>
<th>1</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer segment</td>
<td>Student</td>
</tr>
<tr>
<td>Ownership Struct.</td>
<td>Traditional</td>
</tr>
<tr>
<td>Proprietary</td>
<td>User</td>
</tr>
<tr>
<td>Billing</td>
<td>Pay for eq.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Private</td>
</tr>
<tr>
<td>Aggregator</td>
<td>Local party</td>
</tr>
<tr>
<td>Location</td>
<td>Home</td>
</tr>
<tr>
<td>Grid integration</td>
<td>Stand alone</td>
</tr>
<tr>
<td>Rev. User (U)</td>
<td>L. Services (A)</td>
</tr>
<tr>
<td>Rev. Aggregator (A)</td>
<td>E. Services (GO)</td>
</tr>
<tr>
<td>Rev. V. Provider (P)</td>
<td>A. subscription (U)</td>
</tr>
</tbody>
</table>

Figure 24: Service model

**Service.-** This business model assumes the student doesn’t have a car but may require using one occasionally (See Fig. 55 in Appendix F). The proprietary of the vehicle will be the independent provider or the energy utility company. The billing method will be on demand based on the vehicle usage. The access will be semi-public as some restrictions may apply like having a valid driving license, etc. The most convenient aggregator seems to be the same independent provider or the energy utility since they are the owners of the car. The main location for these vehicles will be at the or Universities in commercial areas where the students can pick them up; this could be at the city center, the central stations or commercial parking spots where the cars will be generating power if not used for transportation purposes. The grid integration will be regional. The revenue stream for the user is zero, since it is not his/her car. Consequently, the revenues generated from feeding electricity into the grid will be received by the
Aggregator from the GO. The user will pay the vehicle supplier an annual subscription plus the usage fee.

**Semi-lease.** The semi-leasing also assumes the professionals, families and retired people would be interested as all of them want to feel safe in case of technology failure (See Fig. 56 in Appendix F). With the semi-lease model the user is the main owner but the critical parts as the fuel cell may belong either to the independent provider, the energy utility or even the vehicle manufacturer. The billing method would include both the payment for the entire vehicle and an amount for the leased component. The accessibility would be private as in the traditional and leasing schemes. The aggregator would be the same independent provider that offers the leasing of the battery or a different one, or it could also be the energy utility company. As with the previous models home and office would be the preferred locations to use the technology. The grid integration can vary from stand alone applications, to local integration for buildings or the regional network. The revenues for the user in this case are coming from the energy services provided to the grid and also from a potential scheme with an “energy points” reward system. The revenues for the aggregator would be covered by the GO; they would include the hours generated by all the cars in their facilities during a given period of time and the annual fees from the users. The revenues for the vehicle provider will also come from selling the car itself but also from leasing the critical components to the user.

<table>
<thead>
<tr>
<th>Customer segment</th>
<th>2</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership Struct.</td>
<td>Traditional</td>
<td>Leasing</td>
</tr>
<tr>
<td>Proprietary</td>
<td>User</td>
<td>Ind. Provider</td>
</tr>
<tr>
<td>Billing</td>
<td>Pay for eq.</td>
<td>Fixed rate</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Private</td>
<td>Local party</td>
</tr>
<tr>
<td>Aggregator</td>
<td>Local party</td>
<td>Semi-public</td>
</tr>
<tr>
<td>Location</td>
<td>Home</td>
<td>Office</td>
</tr>
<tr>
<td>Grid integration</td>
<td>Stand alone</td>
<td>Local</td>
</tr>
<tr>
<td>Rev. User (U)</td>
<td>E. Services (A)</td>
<td>Energy points (A)</td>
</tr>
<tr>
<td>Rev. Aggregator (A)</td>
<td>E. Services (GO)</td>
<td>A. subscription (U)</td>
</tr>
<tr>
<td>Rev. V. Provider (P)</td>
<td>Selling car (U)</td>
<td>Leasing car (U)</td>
</tr>
</tbody>
</table>

Figure 25: Semi-lease model

**Lease.** For the leasing model the customers are professionals (See Fig. 57 in Appendix F). In this case the car can be owned by the company where the customer works or by the user itself. The billing is based on a fixed monthly rate and the accessibility is private. The aggregator is also an independent provider with preferred locations in the office and the house as with the traditional model. The grid integration can vary from stand alone applications, to local integration for buildings (like The Green Village) or the regional network. The revenues for the user in this case are also coming from the energy services provided to the grid and from an “energy points” reward
scheme. The revenues for the aggregator would be covered by the GO; they would include the hours generated by all the cars in their facilities during a given period of time and the annual fees from the users. For the vehicle provider the revenues will come from leasing the car to the user.

### Figure 26: Leasing model

**Traditional.**- In the traditional business model the customers can range from professionals, to families or retired people (See Fig. 58 in Appendix F). Thanks to the traditional ownership scheme, the user is the sole proprietor of the vehicle. This means the customer also pays for the entire equipment and therefore the accessibility is private. In this case the most convenient aggregator seems to be an independent provider as this would allow the user to choose the most convenient option. The preferred location to use the system is the home and office depending on the particular needs for each customer. The grid integration is also flexible depending on the requirements and can vary from stand alone applications to power its own house, to local integration for buildings (like The Green Village) or the regional network. The revenues for the user in this case are coming from the energy services provided to the grid and also from a potential reward scheme with “energy points”. The revenues for the aggregator would be covered by the GO; they would include the hours generated by all the cars in their facilities during a period of time and the annual fees from the users. For the vehicle provider the revenues will come from selling the car to the user.

### Figure 27: Traditional model
6.4 CONCLUSIONS

The previously described structures might be in some ways similar to the business models we have nowadays, at least regarding the ownership structure and the customer segments. Nevertheless, there are substantial differences in the stakeholders implicated in the system, the revenue streams, the role of the aggregator, the levels of grid integration, the preferred location to use the car as a power plant, etc. Thanks to the proposed morphological analysis it is possible to have a standardized way to analyze the different components that are relevant for the CaPP concept; which in turn eases the comparisons among the different options and helps to identify relevant assumptions for each of them. As a final remark it might be of interest to consider the deployment of the different alternatives in relation to the technology maturity and the user perception. For instance, at the initial stages when there is still uncertainty about the system performance, the participants expressed to feel more comfortable adopting a semi-lease scheme. Later on, when the technology has evolved, the customers might be ready to move towards a leasing model and finally to the traditional one. Additionally, the participants expressed interest on demonstration projects where they can interact with the technology during short periods of time. For this option the service could be the most attractive alternative to the users, as they don’t have to compromise an initial investment and might be able to test different technologies.
CONCLUSIONS

7.1 INTRODUCTION

The purpose of this study was to assess the technology acceptance of the CaPP concept in the Netherlands and its implications in the business model design. This was done by extending a variant of the UTAUT model, the so called CaPPTAM, to cover the specific requirements of the CaPP concept. Consequently, quantitative and a qualitative measurement instruments were designed to be applied to a group of participants through personal interviews. This investigation also sought to determine the perceived benefits, concerns, potential business models, and policies to stimulate the development of this technology.

This chapter is divided in three sections. The first one deal with answering the research questions, the second discusses the major findings and provides some guidelines about the use of this research. The last section gives some indication of where the next research efforts can be focused.

7.2 ANSWERING THE RESEARCH QUESTIONS

A. What is the technology acceptance level regarding the CaPP and the main factors for its adoption in the Netherlands? The technology acceptance levels about the CaPP concept were in general above average. From the 20 participants, 7 were optimistic, 9 had a mixed opinion, and 4 were somehow skeptical. This means 16 participants from the 20 rated the concept above average in the qualitative section. These results were also coherent with the data captured by the quantitative instrument through the Attitude towards the technology and Behavior Intention variables; both presenting mean scores of 3.5 and with different compositions by group as demonstrated in the box plots. Relevant factors for adoption were classified in 6 categories: price, incentives, information access, infrastructure, technology and values. Further information about this factors can be found in Chapter 4.

B. What are the main benefits / concerns perceived by the potential users of the CaPP in the Netherlands? Benefits were perceived in two categories: for the user and for society. On the one hand the perceived benefits for the user were: monetary incentives, guilt reduction, and increase in consumer power.
On the other hand, the perceived benefits for society were: environmental benefits, integration of services, and reducing the variation from renewable sources.

The concerns were classified in two: car technology and the system. The concerns about car technology were: dangers of using hydrogen as main fuel, degradation of the Fuel Cell, and lack of flexibility when the car is plugged-in. On the system side the concerns were: the lack of infrastructure for fuelling and for parking, long distances from CaPP facilities to the final destination, and the risks involved in decentralizing the power generation. Section 4.3.2 in Chapter 4 elaborates on both topics.

C. Based on the current technological development and the customer perception: what business model(s) would be more suitable for the implementation of the CaPP technology? Considering the interviews and the analysis performed, the most appropriate business model to be used for the CaPP seems to be the Semi-lease. The main reasons are because this scheme transfers the associated risks from the users to the provider and keeps the customer as the proprietary of the vehicle, which was a fundamental factor that was raised constantly during the interviews (See Fig. 56 in Appendix F). Additional elements of this business model would include sharing the ownership of the Fuel Cell with the independent provider that could also play as the Aggregator, with whom the user would have a contract with. The role of the Aggregator would be central to deploy the infrastructure required for the CaPP and to deal with the GO. The interaction with the GO is relevant since this party would pay to the Aggregator for the services delivered to the grid. Another advantage is that the selected Aggregator could work together with other Aggregators to offer similar options like the roaming offered by cell phone operators when users travel out of their zones inside a country or abroad. Other options include the possibility for the User to connect the CaPP vehicle for standalone applications, at home, and at the office to feed the grid. In this scheme the User benefits when delivering services to the grid by receiving monetary incentives and/or energy points from the Aggregator which could be exchanged for products or preferential kWh rates.

D. Which policies should be in place to stimulate the emergence of the CaPP from its current state? The three processes associated to the SNM theory are now applied as a policy guidance tool: coupling of expectations, articulation processes, and network formation.

First, in the case of coupling of expectations for the CaPP concept to be reality, a pre-requisite is the existence of FCV. Conse-
Therefore, the technology needs to be developed into a commercial stage, so policies targeted towards funding the Fuel Cells R&D related activities would be mandatory. Also setting adoption objectives by the government has proved to be relevant in the electric mobility process. On this sense, an option would be that the government defines an annual amount of energy that should be delivered to the grid with the CaPP technology.

Second, the articulation process can explore the current and future needs. In this sense, due to the relation FCV will have with the electric mobility sector as the next generation of EVs, it is relevant to monitor the current development on this field since the experience accumulated by the users would influence a future diffusion or contraction of the market. Special care should be taken to inform the users about the real capabilities the current EVs fleet offers to align it with their expectations. For instance, an impartial institution can be in charge of monitoring that the advertised capabilities of the EVs in fact comply with the delivered performance.

Third, in the case of the network formation process, the creation of a national or regional organism with the participation of highly active countries in EVs related topics like Germany, Denmark and the Netherlands would be beneficial. Working with advanced countries/industries in electric mobility would be an advantage as they will have a broad leading group that is required for the CaPP adoption. Some problems in the past with the R&D activities have been the high cost of development coupled with long timeframes to reach the market, so an option would be to incentivize an open innovation scheme where different companies and research institutions come together under a joint venture to develop the CaPP technology together. Besides, there is a recent emergence of different V2G projects around the world where several communication standards are being implemented. Therefore, a policy to unify the development of these standards would be important as it would be a potential stepping stone for the standards to be adopted during the eventual implementation of the CaPP.

One of the most difficult aspects of this study was to familiarize the participants with the technology since they have never interacted with it. Because of time constrains and the material available for the study, it was very useful to present two shorts videos to the participants additional to the text explanation. This videos described the basic features of the CaPP concept and an additional V2G project in the USA. In general the participants responded favourably to the videos and
had a better impression of the system after watching them. If there is a study in the future, a recommendation will be to develop an extended version of the video (around 5 to 10 minutes) with animations and voice. On this way it will be possible to explain all the features and benefits of the system on a standardized way to all the participants. Another option is to use the concept known as “Information Acceleration”. This idea was found during the literature review and it has been applied for marketing research in the past. In this case, the customers are presented with a virtual environment (showrooms, supermarkets, stores, etc.) where the products exist as they are not available yet in the market. On a similar direction, other options available to do this include virtual tours, virtual reality, mock-up models, etc. In fact, The Green Village already has a portal where a user can have a virtual tour through the facilities. May be a further step would be to include a video for the CaPP project and even conduct an online survey about the user perception after watching it.

About working with mixed methods, it was interesting to experience the complementary capabilities of quantitative and qualitative research methods. In most of the cases it was evident the convergence between the participants’ answers to the open questions with their results for the quantitative questions. A drawback of using mixed research methods was that a full interview took around 60 minutes and the participants had limited amount of time, so it was very difficult to compress the material to fit shorter schedules. Moreover, this implied the use of two collection and analysis methods that were time consuming in later stages. Regarding the CaPPTAM proposed model, from the 11 variables studied, 7 had significant results; 5 of these variables showed strong levels of correlation and the other 2 had a moderate positive level of correlation with the dependant variable. However, further studies with greater samples would be required to validate the model.

If the study had to be conducted again, the first lesson learned would be to define the sample from the beginning in order to contact the users as early as possible. The reason is that it took long time to find persons willing to participate in the study and then organize the interviews was also time consuming. This situation was especially true with the EVs users, since they are not as common nowadays as regular vehicle users. In average the response rate from the contacted users by email was around 60%. As a second point, the way of using mixed research method would be modified. For instance, on a first stage I would conduct a field validation of the model through some in-depth interviews with open questions (to determine if the variables included in the model are the most relevant). Later on, after the model has been adapted, a quantitative questionnaire would
be applied to a greater number of users with the idea of performing statistic analysis. The third lesson learned would be to focus more sharply on one topic from the beginning. In this case the study assessed the technology acceptance levels for the CaPP concept, but also the niche developments of electric mobility in the Netherlands, and the implications for the business model design. Of course in some cases there are complementary points between them, but a drawback was that the developments of the EVs niche and the implications for the business model designs were not covered in-depth as the technology acceptance. Therefore an idea that may help with further studies would be to define a central topic and stick to it.

The present study can serve to The Green Village as a starting point when thinking about user perception regarding the CaPP concept. For further studies though, it would be useful to have a more defined version of the CaPP concept, by including some technical specifications that can serve to clear the doubts of the customers that are knowledgeable with the electric mobility topic. Therefore, further technical studies may be necessary in first place to advance these definitions that may serve as an input for the forthcoming social related studies. Besides, continue with the creation of the rhetorical space (a space in which the promises/expectations of technology are floated and directed to sponsors that have interest in promising ideas [van Lente and Rip, 1998]) seems fundamental at this stage by bringing the industry, academia and governmental actors together until the technology can be tested on a demonstration project. This has been already initiated by the first CaPP symposium held in June 2013 and needs to be an ongoing activity where the most relevant advances are presented to the involved stakeholders. Other point to take into account is that this report can provide input when considering on defining some of the technical consideration for the CaPP concept. Then, these new considerations can be tested once again with the users to see if their perception about the CaPP concept changed, like in a feedback cycle.

Finally and on a personal level, an additional skill developed during this project was the use of the LyX software to write this thesis report. The main advantage of this program is that it allows having a better control of the document formatting, without the steep learning curve that is required to learn Latex. This program follows the WYSIWYM (“What You See Is What You Mean”) approach and has been placed as a product in between the functional Microsoft Word and the code based Latex. Also there are different templates that could be followed for scientific publications, books, dissertations, among others. Some of its drawbacks include the lack of advanced change tracking control and spelling check tools. Nevertheless, I feel satisfied with the
Conclusions

7.4 Further Work

- It would be interesting to test the CaPPTAM model with a higher number of participants to verify it and to see how it responds to statistically advanced methods. Another possibility would be to reduce the variables included in the model by selecting the most relevant ones and then complementing it with more practical variables for the customer. On this way it would be possible to quantitatively assess for instance the influence from incentives or cost factors in the dependent variable.

- Other possibility is to conduct a vehicle technology acceptance study across different nationalities or countries. This would be useful to assess the understanding of the technology and to verify the degree of impact created by the exposure to the electric mobility context between the Dutch people who are used to the EVs, against other participants that are not familiar with this environment.

- In a couple of interviews the topic about applying the CaPP concept in developing countries was brought up. Unfortunately the main focus of this study was on personal transportation in the Netherlands, so it was not possible to consider all the implications that taking this system into developing countries may have. May be a future study could explore this idea.

- After the CaPP design parameters have evolved further, it could be interesting to conduct a research focused on design for interaction with the Industrial Design faculty. An option would be to create a mock-up facility with a smart phone application that works together with the vehicle’s control board, allowing the interaction of the users with the system.

- This study focused on the CaPP concept in the personal transportation domain. Nevertheless, there are other applications that can be investigated. One alternative is to assess the perception of the CaPP concept for fleet management purposes and the implications this may have in the business model design for this segment, as it would allow to maximize the fleet usage even in an idle state.
APPENDIX: LITERATURE REVIEW

A.1 METHODOLOGY

At the initial stages of this master thesis, several topics were explored to address the research questions on the most appropriate way. Once the three main topics were clearly defined, the first step was to conduct a search at the scientific databases. In the cases when the information was not available a second step was necessary. This consisted in doing a broader search in general databases in order to expand the results obtained.

The terms contained in Table 7 were used as the main search parameters for each of the segments of the literature review. In each case, a combination of the first and the second or even third term were used together with the AND operator. The search for these terms was applied to the title, keywords and the abstract of the documents contained in the databases. The last column represents the journals in which the terms were applied.

For the first topic block of Socio-technical systems and niches, the main scientific fields are the Socio-Technical systems, the Multi Level perspective and the Strategic Niche Management. For all of these fields the main database used to find the relevant literature was Sciverse. Furthermore, in order to get access to a document exploring additional elaborations of the niche theories the Eindhoven University thesis repository was used.

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<th>TITLE, KEYWORDS AND ABSTRACT</th>
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<td>Diffusion AND Innovation*</td>
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<td>Consumer AND perception*</td>
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<td>Perception AND assessment*</td>
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<td>Business AND model AND innovation</td>
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<tr>
<td>Product-service AND system*</td>
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</table>

Table 7: Search terms
In the case of the second block related to Customer service and technology adoption, the researched topics included the Diffusion of Innovation and the Consumer perception. To find relevant articles two main databases were used, on one hand the Sciverse portal was used for the Diffusion of Innovation while on the other the JSTOR repository was used to search for the Consumer perception and assessment topics.

The block about Business Model Innovation contains the fields related to Business Models, Business Model Innovation and the Product-service system. The databases used in this case were Sciverse and in some particular cases Google Scholar.
APPENDIX: CAPP INTERVIEW FORMAT

SECTION I

In this section general socio-demographic information and transportation preferences are captured.

General Information

Gender: Male Female Age: ___ Occupation:________________________
Communting -> from: ___________ to: ___________ Education level:_______________

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle __ Car __ Public __ Other_______
2. What distance do you travel every day in average? _________km
3. Do you have a car? __ Yes __ No
4. What type: _Gasoline/Diesel _Battery Electric _Hybrid
5. What is the model and brand?
6. How frequently do you use the car? _______ days per week (from 7 days)
7. In case you have a car, what is the most frequent destination?
8. Please, order the destination from most frequent to less frequent (1 most-5 least): __ Visit family / friend __ Shopping __ Work __ Education center __ Other: ______
9. Are there cases when you use public transportation? __ Yes __ No
10. How frequently does this happen? ______ times per month
11. In case Yes, please describe in which cases do you use public transportation:
12. Are there situations where you think having a car would be useful? __ Yes __ No
13. How frequently does this happen? ______ times per month
14. In case Yes, please describe in which cases you would prefer to use a car:

15. Do you consider buying a car in the future? __Yes __No

16. In case Yes, in what timeframe? __ <1 year __ 2-5 years __ > 5 years

17. Technology preference: _Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea

18. What would be your preferred brand / model?

19. What are the main factors behind your selection (technology and brand)?

SECTION II

In this section the CaPP context and concept proposal are introduced to the participant.

Car Technology context

Electric vehicles use electrical energy stored in batteries to move the motor. They can be classified in: Battery Electric Vehicles (BEV) and Fuel Cell Vehicles (FCV). The one to be covered in this study is the Fuel Cell Vehicle. This type of car uses hydrogen instead of gasoline. A FCV produce electricity when the fuel (hydrogen) passes through the fuel cell and combines with oxygen coming from the air. The electricity is then used to power the on-board electric motor. This means a FCV emits no harmful exhaust gases like CO2, but only water. Hydrogen is stored at an onboard storage tank and can be loaded in hydrogen stations, which are very similar to conventional fuel stations. An image of the first commercial fuel cell car (ix35 SUV) introduced by Hyundai in 2013 is showed next. Some characteristics include: top speed of 160 km/h, travel distance with single tank 594 km, acceleration from zero to 100km/hr in 12.5 seconds

Problem Description

In average, a car is only used 4% of the time for transportation purposes, while the rest of the time it rests in a parking spot at the office, at the house or any other given place . Most analysts estimate electric cars in the future will be as common as combustion vehicles today, which means there is a big potential for secondary applications for this kind of vehicles when not used for transportation.
Proposed Solution: Car as Power Plant

The Car as Power Plant concept proposes the use of Fuel Cell Vehicles to produce electricity, water and heat while they are parked at home, in an office or shopping center. These cars could be used for transportation purposes as any other car. The only difference is they would have additional components that allow them to work as a Power Plant. Some characteristics of this system may include 1) a communication system to allow the control of the fuel cell from a remote location to turn it on and off, 2) an input connection to allow the injection of hydrogen into the car and 3) an output connection to evacuate the electric power, water and heat from the car. Some potential benefits of this system include a payment to the owner for the services provided to the grid (preliminary estimations range from 250 Eur – 2,300 Eur per year ) and reductions of CO2 emission in urban areas and increasing renewable energy penetration since the cars act as a buffer. Some of the disadvantages may include a faster degradation of the fuel cell and high investment costs. Delft University of Technology is interested on running a pilot for this technology at the so called “Parked Power Plant” project located at the Green Village (http://green-tech-gateway.com/).

Please watch the following videos for further explanation:
- Car as Power Plant automated concept
- Example of ongoing V2G project in USA

SECTION III

In this section both the quantitative and qualitative questionnaires are applied to the participant.

CaPP Quantitative questionnaire

The system is defined as the set of components that enable the CaPP technology concept. Please read carefully each statement and select the answer that best describes your opinion for each of them:

Strongly disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly agree (5)

1. The system would be useful for me.
2. The system would enable me to make a more efficient use of the car.
3. CaPP enabled vehicles would outperform standard ones.
4. My interaction with the system seems to be clear.
5. The system seems ease to use.
6. Learning how to use the system seems easy for me.
7. Using the system makes sense.
8. Interacting with the system would be fun.
9. I would like interacting with the system.
10. I would be proud to show the system to people who are close to me.
11. People whose opinions are important to me would find the system to be useful.
12. In general, people who I like would encourage me to use the system.
13. I consider having the necessary knowledge to use the system.
14. Getting economic incentives for the services provided to the grid would motivate me to adopt the system.
15. Having the physical infrastructure close to my house or office (<5 min) is crucial to adopt it.
16. . . . if there was no one around to tell me what to do.
17. . . . if I had a lot of time.
18. I believe that using the system may decrease the car’s fuel cell performance.
19. The system is somewhat frightening to me.
20. I am afraid that I do not understand the system.
21. I believe that using the system is dangerous.
22. Using the system may have impact in my driving behavior.
23. Assuming I had access to the system, I intend to use it.
24. Given that I had access to the system, I predict that I would use.
25. If the system was available I would like to use it in the next years.
26. I am concerned about the environmental conditions our children will have to live in.
27. For the benefit of the environment, we should be ready to restrict our style of living.
28. I use energy-saving bulbs.

29. Whenever possible, I don’t use the car.

30. In general, in your discussions with neighbors are you approached as a source of information?

31. Are you the first in your circle of friends to buy new products when they appear in the market?

32. In general, can you tell about a person by seeing which car he/she drives?

33. Compared to your circle of friends, how likely are you approached as a source of information about cars?

U= perceived usefulness; RA= relative advantage; OE= outcome expectations; A= attitude; AF= affect towards use; Affect= affect; SN= subjective norm; SF=social factors; PBC= perceived behavioral control; FC= facilitating conditions; SE= self efficacy; ANX=anxiety; BA=behavioral anxiety; BI= behavioral intention to use technology; PS = perceived safety

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles

2. What can you say from your experience with Electric Vehicles?

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat?

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns?

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid?

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)?

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)?
8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this? I understand the price is fundamental, but what other (internal, external) factors would be the most important for you?

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least)

**Traditional** I am the only owner of the car physically and legally

**Service** I pay an annual subscription and pay for the use of the car, but I don’t own it

**Leasing** I pay a monthly fee for the car, have it all the time, in two years a new one

**Semi-Lease** I own the car legally, but lease parts like the battery / fuel cell

Can you tell me what motivates you to think like that?

That covers the things I wanted to ask. Anything you would like to add?
C.1 QUANTITATIVE DATA SUMMARY

Table 8 summarizes the answers provided by the participants for the quantitative section to minimize the pages required.

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Table 8: Quantitative data summary
C.2 INDIVIDUAL INTERVIEWS

This section presents the raw data captured from the interviews, excluding the quantitatative section, which is summarized in the previous section. Additionally, the questions that were not relevant for specific participants (due to their transportation preferences) were eliminated.

INTERVIEW 1

General Information

Gender: X Male Female Age: 23 Occupation: Aerospace Student
Communting -> from: Delft to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _X_ Bicycle __ Car __ Public __ Other: _
2. What distance do you travel every day in average? _2_ km
3. Do you have a car? __ Yes _X_ No
4. Are there situations where you think having a car would be useful? _X_ Yes __ No
5. How frequently does this happen? _1_ times per month
6. In case Yes, please describe in which cases you would prefer to use a car: For example if I have to transport something big that doesn’t fit my bicycle. Some weeks ago a friend of ours was injured and we couldn’t take him to the hospital, you have to go by public transportation and in this cases is very inconvenient. Also people going that want to go together as a group. The same applies if you are going to a remote location and you would like to transport a tent.
7. Do you consider buying a car in the future? _X_ Yes __No __May be
8. In case Yes, in what timeframe? _X_ <1 year __ 2-5 years __ > 5 years
9. Technology preference: _ Gasoline/Diesel _Battery _X_Hybrid _Fuel Cell _No idea
10. What would be your preferred brand / model? Still don’t know.
What are the main factors behind your selection (technology and brand)? With hybrid you can use the more convenient mode depending on the situation, but in any case you can still rely on the gasoline engine. It is more convenient to find the fuelling stations for gasoline and all the infrastructure. In Italy we use more GPL for any kind of cars. Hybrid for us also means Gas based cars.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: Eco-friendly vehicles, I also associate it with low speeds, limited range, lack of infrastructure and for specific applications. Due to this constrains I see Electric vehicles as a part of larger system, where they play a specific role, more like city cars.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? In the end, the energy is captured either in electricity or hydrogen, so it comes from other sources so I see this application more like walking batteries. From my side I see more use to have a car sharing like scheme where instead of using the cars to generate power, you increase the time each car spends in the road. I am a little bit skeptical that this may work one day.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I see indirect benefits, like ensuring the supply of power at homes or hospitals in case there are problems with the distribution network. If you distribute the generation of power like with this proposal, it means the level of security in parking areas should be increased. There could be safety issues because nowadays with the centralized generation you also have the risks concentrated in one facility, whereas if you have small plants around the country your risks will spread over and may be having control would be more difficult.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I don’t see this would be a problem if I know in advance the time and capacity my fuel cell would be operating at.
Also is important the I get the car in the same condition I originally left it.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I would consider this technology in comparison to others..

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I don’t really see a lot of use for personal purposes, but I see the benefits more in an aggregate level. Like for the entity operating the facility.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? For me as I don’t see a lot of personal reasons tu use it, I think monetary incentives from the government would be necessary to force people to adopt it.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (X)Traditional (1)Service (3)Leasing (2)Semi-lease (X)Company

Can you tell me what motivates you to think like that? As an aerospace student, in my opinion cars should be seen like airplanes and that approach seems to be more approapriate. As I mentioned before, for me it makes more sense to use them by increasing the time they are used by different people on their primary use which is transportation. Therefore the service option would be my first choice. Next to that, may be a semi-lease would be interesting for this technology as it would ease the access the company operating the parking lots, but also the responsibility in case of any problem.

That covers the things I wanted to ask. Anything you would like to add? I sill have many questions in my mind on how this could work. In general I think this scheme would need support from the government to be able to work. Additionally, I think there could be other options for using the cars which are not explored.
INTERVIEW 2

General Information

Gender: X Male Female Age: 28 Occupation: IT Consultant
Communting -> from: Zoetermeer to The Hague Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _2_ Car _1_ Public ___ Other: __
2. What distance do you travel every day in average? ___ 40_km
3. Do you have a car? _X_ Yes __ No
4. What type: _X_ Gasoline/Diesel __Battery Electric _Hybrid
5. What is the model and brand? Toyota Yaris
6. How frequently do you use the car? ___ 4_ days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? __ Work
8. Please, order the destination from most frequent to less frequent (1 most-5 least): 2__ Visit family / friend 3__ Shopping 4__ Work __ Education center 1__ Other: Going out
9. Are there cases when you use public transportation? _X_ Yes __ No
10. How frequently does this happen? ___ 20_ times per month
11. In case Yes, please describe in which cases do you use public transportation: For me it is more comfortable to go to work by public transportation, there are other times that I go to another city.
12. Do you consider buying a car in the future? _X_ Yes __ No __ Maybe
13. In case Yes, in what timeframe? ___ <1 year _X_ 2-5 years ___ > 5 years
14. Technology preference: _X_ Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea
15. What would be your preferred brand / model? I would like to have a car from Germany or Japan. Not a special brand or model, but a sedan would be nice.

16. What are the main factors behind your selection (technology and brand)? The looks and the performance of the car itself. But also how much the car costs when you don’t use it. So how high are the tax and insurance costs.

*CaPP Qualitative questionnaire*

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: What comes first to my mind is the reduced range you can drive to and also long charging time for the batteries.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? If the infrastructure can be built within a reasonable cost it would be a good idea to develop.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I see two main benefits: the first on is that it seems to be a clean technology that is benefitial to the environment and the second is that it creates a potential monely flow to the owner of the car. The concern I have is the infrastructure is still not there and eventually somebody would have to pay for it.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? In my case I would like to be sure this process will not have a negative effect in my car, but if it is proven this won’t happen I think I would be ok with it.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I would consider it, specially if it can be used to get some financial benefit back to me.
7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I think at home, because the car spends a lot of time there.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? Mainly the infrastructure where I could plug my car into the grid, but also how easy is to have access to buying a vehicle with this characteristics and the system itself.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (1)Traditional (X)Service (2)Leasing (X)Semi-lease (3)Company

Can you tell me what motivates you to think like that? I would go for the traditional scheme, because I like to have my own car, so I can do what I want at any time. The leasing would be easier instead of paying a bigger amount at the beginning, specially when you think about this technologies as they are more expensive than the conventional ones. A company car would also be nice, because it doesn’t generate a cost to me.

INTERVIEW 3

General Information

Gender: Male XFemale Age: 26 Occupation: Web editor
Commuting -> from: Zoetermeer to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _2_ Car _1_ Public ___ Other: _
2. What distance do you travel every day in average? _25_ km
3. Do you have a car? _X_ Yes ___ No
4. What type: _X_Gasoline/Diesel __Battery Electric _Hybrid
5. What is the model and brand? Honda
6. How frequently do you use the car? _3_ days per week (from 7 days)
7. In case you have a car, what is the most frequent destination?  
Delft

8. Please, order the destination from most frequent to less frequent (1 most-5 least): 2 __ Visit family / friend 3 __ Shopping 4 __ Work 1 __ Education center 1 __ Other: Going out

9. Are there cases when you use public transportation? X Yes No

10. How frequently does this happen? 25 times per month

11. In case Yes, please describe in which cases do you use public transportation: Mainly I go to work by public transportation, there are a few times that I go to another city and others that I also use it to go for shopping.

12. Do you consider buying a car in the future? X Yes No May be

13. In case Yes, in what timeframe? __ <1 year X 2-5 years __ > 5 years

14. Technology preference: X Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? I don’t know at this moment.

16. What are the main factors behind your selection (technology and brand)? The physical appearance is an important factor, low fuel usage and low CO2 emissions, not too expensive, no SUV, and 4 or 5 doors.

**CaPP Qualitative questionnaire**

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: I consider EV’s a very good initiative in different ways and hopefully in the future the obstacles will be overcome making this cars more popular.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I think it seems to be a good idea, but I am not sure exactly how it works. I hope it does one day.
4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? The main benefits is that is good for the environment, it provides money for the owner of the car. While the concerns include if this idea would be really feasible and if other people will adopt the technology.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I think if it is implemented through a closed system this potential anxiety could be diminished.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? If I had the money I would consider it, but if not I would have to consider more affordable options. Is sad but you have to make the choices based on the resources available.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? Mostly at home, because it is where the car is most of the time.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? Availability of the car, as well as the corresponding infrastructure would be fundamental. Apart from that the safety of the vehicle. Finally the amount of km that is possible to drive with one tank.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (1)Traditional (5)Service (4)Leasing (2)Semi-lease (3)Company

Can you tell me what motivates you to think like that? For me the best option is to own the car personally or that your own company owns the car. Probably I would rather use this car when it is a semi-lease because it would become less costly to fix it in case something happens.
Interview 4

General Information

Gender: Male XFemale Age: 26 Occupation: Applied Sciences PhD Student
Communting -> from: Delft to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle __ Car __ Public _X_ Other: Walking

2. What distance do you travel every day in average? _5_ km

3. Do you have a car? __ Yes _X_ No

4. Are there situations where you think having a car would be useful? _X_ Yes __ No

5. How frequently does this happen? _1_ times per month

6. In case Yes, please describe in which cases you would prefer to use a car: Mostly for my work to visit companies, because the companies are not well connected by public transportation. Sometimes also the public transportation is not there and it would take longer.

7. Do you consider buying a car in the future? __Yes __No _X_ May be

8. In case Yes, in what timeframe? __ <1 year _X_ 2-5 years __ > 5 years

9. Technology preference: _ Gasoline/Diesel _X_Battery _X_Hybrid _Fuel Cell _No idea

10. What would be your preferred brand / model? I like Audi, not because of the electric cars, but in general.

11. What are the main factors behind your selection (technology and brand)? I like the idea of electric cars due to environmental reasons, even though there is still room for a lot of improvements. I would adopt this technology if I’ve seen the technology is proven and people around me are using it, for instance now my uncle is driving an electric car and I get information about it. Social interaction. For the brand, mainly in the past I learned to drive in this kind of car and then when I drove my dad’s citroen I really didn’t like it.
CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: Right now, they still have a limited radius and is not possible to change batteries on the way so you have to find a place to charge and then continue towards the final destination, but improvements are still possible. I see a lot of development going on in this area. Still, you are getting the energy from somewhere, so there are some losses in the way, but that applies for any other thing. What I see now is that people are still not used to EV, people in bycicles do not realize there is a car behind them because they don’t hear it. I know this, because once I was driving with my uncle and people are crossing the street without even looking, so as a driver you have to be extra-careful until people get used to it. On the other hand this kind of cars are nice and quiet, which is also a good thing. It is so silent you can not even gossip about the people sitting in the back.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? Actually when I was seeing it, is that you get energy from somewhere and then you store it and use it later on. I was kind of thinking on a different way, because I saw a presentation the other day when they explained that after a certain point of implementing renewable energies it would be necessary to store the energy, so why not use the cars for this purpose to make it available later on when needed. Not to rely completely on the system but as a back up somehow. I think it would be more beneficial when connecting to the smart grid to overcome fluctuations, more than generation of the power itself. The water produced will be extra pure so not ready for drinking, it is interesting but needs further development.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I don’t see the benefits yet as a user, because the production capacity is limited, unless you are on a remote location and you need electricity. You can do stuff on the way in remote locations which are not connected to the grid, so you are not dependent on the grid and the same applies for the heat and water. I see more benefits for the grid operators than for the owner of the vehicle, because of the possibility of balancing the
grid. My concerns with hydrogen would be general, like are you driving on a bomb or having an active bomb while your car is parked at your home?. This is different than only storing the power in your car and leave it without doing nothing, because your car is still active doing something while you are away. My concern comes from the combination of the hydrogen being used in the car and the usage without direct supervision on site. In the past, they stopped using hydrogen because of it is explosive, like the famous example of the Zepelin accident. Additionally the water is not treated and you can not drink it.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? If the system is used as intended by designed and as indicated in the description I wouldn’t see any problem, but there is always people abusing the system. There could be a third party trying to benefit from it, any system that gives you money people try to abuse it (human nature). If you can set the system according to your preferences and that is working it would be ok.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? If I need a car I would prefer a technology to stabilize first, the bugs to be out and for this technology in 10 years they might be still working on it. In 10 years may be I would first buying the electric one, because it would be more proven technology. I am not much of a tryier, but more a user of proven technology, I prefer to wait and see if it is really benefitial. The price premium if you can have this technology in the future would depend on the size of the car but may be around a couple of thousand Euros, similar to the current difference between IC and EV.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? Mainly in emergency situations, if it is necessary. Also may be in the work environment, probably if I have one of this cars I would like to use it. If I need to use it at home I would build a bunker to minimize the risks in case of an explosion.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I un-
derstand the price is fundamental, but what other (internal, external) factors would be the most important for you? Proven technology, and also that someone in my network has experience with them. I like to have open information, which is possible to get from demonstration projects where I can ask the scientists and not the marketers or sales people, may be sales engineers could be. Advertisements are not good for me, so direct information is better. I like also to get the downsides and don’t feel pushed, actually the harder they push the less I want to buy something.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1)best - 3least) (X)Traditional (1)Service (X)Leasing (3)Semi-lease (2)Company

Can you tell me what motivates you to think like that? For now I would like to use it for work, so as a service would be very convenient, so I can use it when I need it (like greenwheels) as I don’t really need to own it. The second option would be if it is owned by my company also to be able to use it when I need it. The third option would be the semi-lease for this kind of technology, it would be very convenient to have the parts that are damaged replaced, of course considering all the restrictions that may apply.

That covers the things I wanted to ask. Anything you would like to add? I am curious about what happens next and how the technology develops in the future. I just think is interesting even when I don’t have to adopt it, but just to think about different possibilities is good. Thanks, I enjoyed the interview!

INTERVIEW 5

General Information

Gender: XMale Female Age: 27 Occupation: Designer
Communting -> from: The Hague to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _X_ Car __ Public __ Other_______
2. What distance do you travel every day in average? _25_ km
3. Do you have a car? _X_ Yes __ No
4. What type: X_Gasoline/Diesel __Battery Electric _Hybrid
5. What is the model and brand? **Sedan Renault Laguna**

6. How frequently do you use the car? _7_ days per week (from 7 days)

7. In case you have a car, what is the most frequent destination? **Commuting to work**

8. Please, order the destination from most frequent to less frequent (1 most-5 least): _2_ Visit family / friend _3_ Shopping _4_ Work _1_ Education center _5_ Other: ______

9. Are there cases when you use public transportation? _X_ Yes _No_

10. How frequently does this happen? **less than one** times per month

11. In case Yes, please describe in which cases do you use public transportation: **Sometimes if I need to travel somewhere and I want to avoid the traffic of the rush hour I’ll take the train.**

12. Do you consider buying a car in the future? _X_ Yes _No_

13. In case Yes, in what timeframe? _<1 year _2-5 years _X_ > 5 years

14. Technology preference: _X_ Gasoline/Diesel _X_ Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? **I don’t know yet.**

16. What are the main factors behind your selection (technology and brand)? **Electric is interesting, I would prefer a fully electric vehicle if the technology is more robust than now, but otherwise I would choose a regular gasoline car (if I have to choose now). I would never consider a hybrid, because I don’t really see the point in terms of sustainability you can better buy a cheap petrol car than a pretty expensive hybrid. If I want to buy electric car it would make more sense a fully electric.**

*CaPP Qualitative questionnaire*

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: **In general EV are quiet, the technology is interesting with a different way of driving. I’ve never driven one but apparently is very smooth and quite fast. I think many people would feel is very different driving**
experience, because for instance there is no sound. Of course is a more sustainable way of driving around, but I think currently there are a few some issues, but when they are eventually solved then it might be very interesting. Some of the issues are the battery depletion, the batteries can not be recycled. I still see a negative connotation, but when they are solved eventually it will be a positive thing.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? It is very interesting to have decentralized power generation, as it gives the consumer more power over their own energy necessities, which is a good thing. What I wonder is how that will turn into reality, what kind of business models would be developed, I could see the utility companies selling or leasing cars and that may be a risk. How it is commercially implemented would influence how interesting is for companies to lease or for individuals to own it personally. Is also relevant the way governments may promote or facilitate this, because in the Netherlands the government makes a lot of money from oil and cars, so if everything goes electric is fundamental how this adoption happens.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I think it would save me a lot of money, of course still hydrogen may cost you something, but I would feel less guilty for driving and driving may become more fun again. In terms of the technology I would like to get more control on where I get the energy from. Now you can buy “green” electricity, but you really don’t know. Of course in this case it depends where hydrogen is coming from. But those are the benefits I see. My biggest concern would be how hydrogen would be taxed, because making it is not difficult but if it is taxed similarly to petrol I guess how successful it can be and the impact can be limited. Hydrogen is of course explosive, but I assume there would be solutions for that. I think people in general would be concerned because it sounds dangerous, but not really for me. I don’t see real drawbacks on the daily use.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? If it would be my property as a consumer and somebody has
access to it on that way, then that wouldn’t be ideal, unless I rent it and it is not really my property. A possibility is that the battery or fuel cell is owned by the company that operates the facility and that would be fine I think. There should be a way to making sure that my car is not worn out because a company access it to charge and discharge without me knowing. As long as it is transparent, fair and there is a system to see how I get compensated appropriately it would be fine for me.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I would consider it with other alternatives available at that moment. The premium depends on the size of the cars, if I would replace the car I have know may be I would be willing to pay a couple of thousands as a consumer. May be leasing it could be a different story.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? If it is my car at home definitely. It is difficult because for instance if the car is mine and then I go to work my boss would like me to plug the car, but I would do it only if I get compensated. It also depends where is the ownership. On the other hand, if my employer gives me a car and then I plug it at home may be I would receive some money but how much? since in reality is property of the company. Difficult question due to the ownership.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? The cost of implementation is relevant, how much should I invest to use the technology. Would I get for example with electric cars a dedicated pole or socket installed for me?, the reliability would be a big thing specially with a technology like this. If mechanically everything is sound, it also depends how it is marketed from the brand perspective and how this is communicated. For me the brand would influence heavily my choice regarding the reliability the car has. Range would be a consideration, that I could charge it to go on holiday.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would
you be more interested in (1 to 3)? (1best -3least) (2)Traditional (3)Service (X)Leasing (1)Semi-lease (X)Company

Can you tell me what motivates you to think like that? I am hesitating between the semi-lease and traditional, because when I buy a car I would like to be able to fully pay for it when I buy it in the current situation. However for circumstance like this, I would be more interested in the semi-lease because the reliability issue is shifted to a third party. May be I make less money, but the risk is transfered. Another reason is that I want to be the owner of my car so it make sense to lease this parts because you can have a contract with a company to arrange when I get my payments for the energy generated, I think it simplifies the stuff. Second would be traditional and service the last one.

That covers the things I wanted to ask. Anything you would like to add? The interview was fine in my opinion, was very clear. In the case of the technology is difficult as I have to get in the future and is very conceptual. I think I understand the main idea on how this can work in the future. I am a bit afraid this can turn out differently form the ideal situation, but this happens to me with this kind of technologies where the potential is very big but the practical issues often limit the full development. I hope this can be overcome. It would be help to have a physical demostration project and it may change my perception on how it is to drive a car like this.

**INTERVIEW 6**

**General Information**

Gender: Male X Female Age: 26 Occupation: Industrial Design Student
Communting -> from: Delft to Delft Education level: Master

**Transportation preferences and use**

1. Which transportation mode do you use most of the time? (1most – 3 least) X Bicycle _ Car _ Public __ Other_______

2. What distance do you travel every day in average? _10_ km

3. Do you have a car? _ Yes X No

4. Are there situations where you think having a car would be useful? _ Yes X No

5. How frequently does this happen? _1_ times per month
6. In case Yes, please describe in which cases you would prefer to use a car: It would be very useful to have a car when I need to get to a certain place that is not easily accessible by public transportation or it takes too long time. For example, I have a friend that lives at another city, if we want to visit him by public transport it can take more than 1 hour and a half, but in car is less than 45 minutes. Also to visit places not covered by public transportation, which are more like rural areas. During the winter it can also be useful, because the public transportation is less reliable. The car is also very nice if you go on holiday, because on this way you can go around stopping where you want and without having to plan in advance, it gives you freedom.

7. Do you consider buying a car in the future? _X_ Yes __No

8. In case Yes, in what timeframe? __<1 year _X_ 2-5 years __> 5 years

9. Technology preference: _X_ Gasoline/Diesel _Battery X_Hybrid _Fuel Cell _No idea

10. What would be your preferred brand / model? I really like Mercedes, VW or BMW.

11. What are the main factors behind your selection (technology and brand)? Of course the technology would depend on different situations that may happen in the future, like family, living with a partner, travelling, etc. In general I think I would choose an economic and small car. If I have to choose for a more eco-friendly alternative, I would choose a hybrid, but the problem is that they look ugly, there is not much variety and don’t seem like a cool car I would like to drive. So the other option is a regular gasoline car where I have more options to choose from. The fully electric I see it further into the future, as the technology is still developing at this moment.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: First, I think the battery life should be improved to allow the user to drive longer distances. Second, as I mentioned before Electric Vehicles don’t look cool, is like if they are a generic car without a personal statement, which is very important for younger people that may be used to think big engines are good, but these cars don’t project that or much at all. In general
1. EV’s remind me they are good for the environment and there should be more out there.

2. What can you say from your experience with Electric Vehicles?
   Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? My first impression was having a mind switch to consider an alternate way of thinking about cars. Now I can see different possibilities, is more like a smartphone that has been integrating a bunch of functions into a single device. In general I think it can be a good initiative to provide solutions for the generation of energy. It is more like the old days when there were more distributed resources that were generated locally and communities were self-sufficient which is opposite to the current system with big generating plants provide energy to many communities. I like the concept of using Fuel Cell Vehicles, rather than with Battery Electric Vehicles, because with the former is possible to go home if you just fill with hydrogen whereas on the second if you don’t have battery you may not be able to go home. An added value of this concept is that this parking places are also like a refuelling station on site and the customer doesn’t have to stop in the way.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? My main motivation would be the environmental benefits as I think is a good way of contributing for a bigger cause. In fact I think I am already sacrificing money for this cause when I buy food and prefer to spend extra money on organic products. As well, it would be good to have the possibility to park for free while the car is producing energy. This could help to make the system on a more massive scale as it will be profitable. Some concerns include the parking areas are not far from my destination point so I can walk to them easily, because if it is necessary to take any sort of public transportation the car itself looses it purpose of being flexible. I would also be concerned of the amount of the lack of infrastructure to park and to fuel this kind of vehicles.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? For me it would be ok as long as the procedures are transparent and the agreements are clear, because in the end someone has to be in charge of all of the system. You need to trust
this party and for me it would be ok as long as they respect what I want. For instance if I’m going to park for 3 hours and already made my car available, I would be disappointed if it was not used as I expected, because I already invested time to park there and may be made an extra effort to walk some minutes to my final destination. If I buy a system like this I expect to make a contribution and would make the effort to take advantage of the technology as much as I can.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? If possible and in case I get a good job I would like to spend money in the most sustainable way to improve the environment conditions for the future generations. This technology would enable to do this, in this case by allowing me to drive around without feeling guilty about the emissions or using fossil fuels. Anyway I think this kind of cars should make a clear statement and express a more “cool” image, but it shouldn’t only concentrate on the external appearance but also in sound design as it is an electric car that doesn’t make a lot of noise while driving. It should communicate a feeling of power to drive the masses to adopt this technology. I would be willing to pay more than 1,000 Eur but less than 5,000 Eur. An important parameter would be the possibility to offset the initial investment with the money received from the usage of the CaPP.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? In my case I would like to use it as it is meant to be used, and would try to plug it as much as possible whenever possible. If the energy provided by the CaPP is cheaper than regular electricity price I would also be interested on plugging it at home, if not mainly when I am away. In Sweeden sometimes we have big storms and the electricity goes down. Therefore, in this kind of situations it would be useful to have your car as a backup to provide energy in emergency situations. It would be like a life line.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? The most important factors would be the costs for me as a consumer, the benefit I could make in the environment by using this technology, the added value this may provide for me (like
fuelling station integrated with parking spot). There could also be additional services like getting my car clean everytime I park there, etc.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1 best -3 least) (3)Traditional (X)Service (X)Leasing (2)Semi-lease (X)Company (1)Community car

Can you tell me what motivates you to think like that? I like to think about the idea of a plane which is bought and shared by some pilots which start how to fly, on this way they can afford an airplane that can be used more frequently than if bought separately, which could also be not possible due to the higher price each pilot should pay. Also there are some communities where different people come together, they buy a school and live together as a community. For this reasons I think it is also possible to buy a car on this way, where the community spread the costs among them and use it together, because it wouldn’t make sense only to buy a car for myself. The semi-lease would be interesting to replace some of the parts that can fail or be damaged after some use. The semi-lease can also cover service centers, because at the beginning few mechanics will be able to fix these vehicles.

That covers the things I wanted to ask. Anything you would like to add? I think is is a very interesting idea in general and the videos helped a lot to show how it may work. In the future it would be interesting to do some interaction design with some mock connections and like smartphone applications the user may be presented with. Some questions that arised after explaining the technology to the participant were: “What are the main benefits from the user?”, “Is it possible to get more hydrogen in the car at the end than at the beginning?”

INTERVIEW 7

General Information

Gender: XMale Female Age: 23 Occupation: TBM Student Communting -> from: Delft to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) X Bicycle _ Car X Public _ Other________
2. What distance do you travel every day in average? **25** km

3. Do you have a car? **X** Yes _ No

4. Are there situations where you think having a car would be useful? **X** Yes _ No

5. Do you consider buying a car in the future? **X** Yes _ No

6. In case Yes, in what timeframe? **X** <1 year _ 2-5 years _ > 5 years

7. Technology preference: **X** Gasoline/Diesel _ Battery _ Hybrid _ Fuel Cell _ No idea

8. What would be your preferred brand / model? Not really.

9. What are the main factors behind your selection (technology and brand)? The main factors for me would be a cheap price and availability of economic models but also of infrastructure.

**CaPP Qualitative questionnaire**

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: **As a technical student, what comes first to my mind is the possibility to use the breaking system to recharge the battery. I also think Electric Vehicles are still not ready for massive adoption and one of the main issues is the lack of infrastructure.**

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? **To be honest, at the beginning I really doubted if the CaPP actually made sense as it was not clear what was the main purpose of this?. Later, after further clarification of some concepts I reconsider it and I think it could be possible. However, an interesting thing is how does companies intend to manage this, as they can take advantage and receive more benefits than the users whose cars are being used. What comes to my mind is that this scheme could be similar to buying solar cells, you buy them but you don’t really know how much energy can it really generate, as there are many factors behind this. I also think the more adopted the technology is, the less need there will be, so you have diminishing returns with the higher number of CaPP vehicles and a reduction of the applicability, which**
in turn will reduce the prices that the users get and as a whole the system would be less useful.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? The main benefits would be for green minded people. A big benefit would be earning money when your car is parked of course, but in order to do this you would probably need to have enough money to buy this type of technology. My biggest concern is that the technology is still not mature and there are many complexities involved, as well it is not certain what is the lifespan of he technology.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I wouldn’t mind my car is being used to produce energy as far as I can specify the conditions in which the car will be used as I would like to avoid running out of hydrogen in the middle of the road. To achieve this there should be a clear set of rules predefined and known by all the parties involved.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I really don’t know at this moment as it seems to be so far in the future and considering my condition as a student is difficult to say. With the information I have at this moment, I think a price premium should be around 2,000 or 3,000 Eur. Nevertheless, I think the industry should be able to match the price of conventional technologies when they reach a massive level of production.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I think all setting make sense for this technology. For me the camping setting would be interesting as a way to get power for my own use.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? The most important for me would be the price of course but also the reduction of noise and emissions in an urban environment.
9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1) Traditional Service (X) Leasing (2) Semi-lease (3) Company

Can you tell me what motivates you to think like that? Personally, I like to own my stuff, so the first would be through a traditional scheme. As a second option I would choose the semi-lease because it seems to be convenient in case of damages or wear out of the critical parts which are more expensive.

That covers the things I wanted to ask. Anything you would like to add? mmm not really.

INTERVIEW 8

General Information

Gender: Male X Female Age: 24 Occupation: Design Student
Communting -> from: Delft to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) X Bicycle __ Car __ Public __ Other ________

2. What distance do you travel every day in average? _3_km

3. Do you have a car? __ Yes _X_ No

4. Are there situations where you think having a car would be useful? _X_ Yes __ No

5. How frequently does this happen? _1_ times per month

6. In case Yes, please describe in which cases you would prefer to use a car: I think the most useful would be when going on a holiday, as you can go at any time you want without depending on fixed schedules. A car gives you more flexibility and freedom. Also when I have to pick something up or buy something that is difficult to take on public transportation. For example, last week our dishwasher broke and we had to borrow a car from our housemate. Sometimes we also borrow cars from the neighbours, friends or family members, but always with the risk that something might happen. Other good reason to have a car is for those days when the rain doesn’t stop!

7. Do you consider buying a car in the future? _X_ Yes __ No
8. In case Yes, in what timeframe? __ <1 year _X_ 2-5 years __ > 5 years

9. Technology preference: _ Gasoline/Diesel _Battery _X_Hybrid _Fuel Cell _No idea

10. What would be your preferred brand / model? I like the Beattle from VW, although I’ve heard it can consume a lot of fuel. Sorry, but apart from that I don’t really know much about cars.

11. What are the main factors behind your selection (technology and brand)? The main factors behind choosing a hybrid car are that it may be more economic and environmentally friendly than regular car with the advantage that you can refuel it in any petrol station. I wouldn’t choose fully electric vehicles now since I don’t think the system is fully developed. To adopt a full electric I would prefer to wait and see. For instance, may be in 10 years the technology is improved with better ranges, but also the infrastructure and efficiency of these vehicles. If this happens I might consider it.

**CaPP Qualitative questionnaire**

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: First of all I think about trains and trams as they are powered by electricity as well, so if this modes of transportation can use electricity I think it makes sense to have electric vehicles as well. When I was in England it was very useful to plug your laptop and connect to the internet on the train. It also reminds me of the Prius car and the Smart electric version which can be charged with renewable energy. Although I think still the ranges of these kind of cars are reduced and therefore should be considered for small distances, like to run around the randstad area.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? In general I would like to know more details about this concept and how it works in detail. In a broad sense I think is a good idea and it reminds me of the Hilti power tools (actually I am looking to do an internship with that company) which are only used an average of 6 hours during their whole lifetime,
which is very short amount of time. The same applies for the car case, they are used very little time, so having the possibility to improve its usability is a very good option.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I think getting money back would be a big motivation and may trigger many people including myself to use this technology. This should have to be proven to really think about adopting the technology. The main concern would be that by plugging my car to generate power I would loose some of the freedom that using a car represents, which I think is one of the fundamental things. As well, I would be concerned about the safety issues, I don’t like the idea I am sitting on a car that can blow up at any moment.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I wouldn’t mind that somebody else operates the car when I am away as long as I am able to track on real time what is going on with it. On this way I can ensure the vehicle is in good condition whenever I want. For example if they want to do something unusual, they should notify me in advance or when an anomaly happens. In general transparency would be fundamental for me in this matter.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? As mentioned in the last question, I would be willing to buy this technology if the main mechanism is transparent enough and economically interesting for me. As well, it is important the technology is proven to be good for the environment. The price premium would depend on what amount I can earn back from the generation or regulation of power in a year. An estimation would be important and that it makes sense. For example if I can make 1,000 Eur in a year, I wouldn’t mind paying a price premium of around 2,000 Eur at the beginning.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I think it would be more common to use the technology in the home and work environments, since the car spends more time parked there than in any other place. Other uses as emergency or generation in remote locations would
be an option when really necessary and would accept as long as I don’t have to be obliged to stay for a certain amount of time, which implies giving away my freedom.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this? I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? As mentioned before transparency and the real environmental contribution from adopting the technology. Also that people around me can tell me the technology works well for them and has been proven, not only from the car manufacturers but from people close to me. In the future I would be an early adopter if I have enough money to afford it. For the regular users may be it would be necessary to implement additional regulation schemes where the users get money back or other type of incentives. Additionally, people like to be compared to each other. For example, now that I was living in England I heard the electricity company, enabled the comparison of electric consumption among neighbours and this motivated them to reduce their energy usage. Awareness proved to be a great motivation to change the user behavior.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best - 3least) (4)Traditional (1)Service (3)Leasing (2)Semi-lease (X)Company

Can you tell me what motivates you to think like that? So far I think that would be my preferences, but of course this may change in the future after I have a better indication of my salary when I get a job. 1.- The service has the advantage that people can benefit from it and also have the possibility to drive different kind of cars on the same segment by the same subscription. 2.- In the case of this technology it would be interesting to have the Semi-lease as I can keep the car with me all the time, while the responsibility of some critical parts which are very expensive are shared.

That covers the things I wanted to ask. Anything you would like to add? I think it would be important to guarantee parking spots are always available for the users of this cars at the office, so they can really take advantage of the technology, similar to what is being done nowadays with the reserved spots for electric cars. One doubt that I have when thinking on this concept is that in general the main objective of a car is to transport people around. There are already a lot of examples, where car sharing concepts attempt to increase the usage of the car even by bringing
more users that share the same car. On the contrary this idea goes on the other direction where the car is mainly used by one person but used for another purpose not related to transportation when not in use. I think at some point it is counter-intuitive for me. Another question that I have is what would happen if I have to leave unexpectedly?, would there be an emergency mechanism to stop the process so I can leave with my tank full?.

**INTERVIEW 9**

*General Information*

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*Transportation preferences and use*

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _X_ Car __ Public __ Other______
2. What distance do you travel every day in average? _80_ km
3. Do you have a car? _X_ Yes __ No
4. What type: _Gasoline/Diesel _X_Battery Electric _Hybrid
5. What is the model and brand? *Nissan Leaf*
6. How frequently do you use the car? 6 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? *Work*
8. Please, order the destination from most frequent to less frequent (1 most-5 least): _3_ Visit family / friend _2_ Shopping _1_ Work __ Education center __ Other: ________
9. Are there cases when you use public transportation? _X_ Yes __ No
10. How frequently does this happen? *Less than once* times per month
11. In case Yes, please describe in which cases do you use public transportation: *Mainly when doing work on the way could be important*
12. Do you consider buying a car in the future? __Yes __No *Not applicable*
13. In case Yes, in what timeframe? __ < 1 year _X_ 2-5 years __ > 5 years Just bought a car three months ago

14. Technology preference: _ Gasoline/Diesel _X_Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? _Nissan Leaf_

16. What are the main factors behind your selection (technology and brand)? _First of all, because we needed a second car since we moved from Amsterdam to a more rural area of the Netherlands were public transportation is not easily available. We selected this car, because since 4 years ago we have a prius and we are very happy with it so far. As well, I have a strong preference for electric vehicles since the emission levels are low and more beneficial for the environment. In this case there was a good opportunity available in Marketplaces, as this car was used before by a dealer and therefore a big discount was applied. He bought the car even without seeing it, all of good faith. If it was not due to the discount, may be I wouldn’t buy it with the full price. Some other important reasons additional to the reduced purchase price are that we get a discount from the annual VAT payment, the road tax and if bought as a leasing the user you also get an exemption that usually is charged. Not to mention the free parking spots available in some urban areas!_

_CaPP Qualitative questionnaire_

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: _We need to make the transition from fossil to renewable energy, obviously you need car that don’t run on fossil fuel. Electric cars can do that, so they are necessity for the future. Last year I went to a car show and I saw all brands with electric cars, an it was the first time with all manufacturers selling them. It was when I realized this was already happening. In this building we already have 2 cars. May be due to the fact the people in this building are attracted to hi-technology, but general public is also starting to accept it. Is like solar panels installing them in their houses, which is being adopted more and more due to all its benefits. Electric cars have many advantages less moving parts, less maintenance. Range anxiety is a drawback but can be fixed._

2. What can you say from your experience with Electric Vehicles? _Prius is a good car, normal car, you don’t notice any differences. When in fully electric mode, you can notice it behaves differently,_
less noise. Fuel economy is perfect, I managed 4.5 liters per 100km in average, which is very good. On the leaf I get .15 Kw/Hr per Km on average, which I think is pretty good. The infrastructure is not enough, there are occassion when I can not get to certain places. We need quick chargers spread through the country. If you go to the North of the country is impossible to use electric car so I take the Prius. In this building we don’t have dedicated chargers, we charge from the wall with the transformer that comes with the car. It takes a few hours (4) to be fully charged. Sometimes I don’t charge it outside because it still has charge enough to go back and forth, I can commute 1.5 times on one charge. 1 battery charge lasts 120 Km in average, but it really depends on the driving. From the Prius I became a lean driver, I was not like this, but since I get the feedback at every single moment is more like a challenge to get the best performance of the car. The main factor is speed to maximize the fuel economy, so I try to stay below the 120 Km/hr or even less.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I think is a good concept. It may be definitely feasible at some scale, it depens if it is home scale or utility scale, may be something in between. I don’t think you will be able to generate enough power for big industrial infrastructure, because if you do the math you need a huge amount of cars. I've seen reports where academics argue there is enough capacity but I don’t know. If you go for fuel cells I see two ways: with the battery you do peak shaving and you are more storage than a power plant, this system is already feasbile, specially if you connect to a domestic system. If you want to do it on a larger scale you need more infrastructure, technology, communication interface. On the other hand, fuell cells as power plants I don’t know how far is it. My gut feeling tells me is very far in the future, because you need the hydrogen infrastructure, which is still not there, you need efficient fuel cells which are still not there, so a lot of things are necessary for this concept before it works. Then you have where is the hydrogen coming?, is it from renewables. You also have a lot of conversion steps. I do see a future with wind power and then this energy is converted into hydrogen that is used off-peak in cars, but I think is going to take a lot of effort. I see the picture, the only question is how do we get there?
4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? Main motivation will be money, cost. The cost avoided by not having to buy energy from the grid. Battery life might be impacted, when you talk about hydrogen economy I am concerned about the infrastructure but is not as user. Not a lot of concerns apart from battery life as the more cycles you use it the more you shorten the life, so this should be compensated on the price of the Kw/hr that you receive.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I think mechanisms would be in place, where you can instruct if you want a 50% of the charge. This mechanisms would be there, because otherwise nobody will allow somebody to control their cars. I think this mechanisms would be enough to be acceptable, specially if the incentives are good enough. If the incentives are there, everybody will do this. Specially here in the Netherlands, everybody would donate their cars.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? As you can see I am kind of an early adopter, so probably yes. I think a 10% extra in comparison to a combustion car would be the maximum from a gut feeling.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? My typical use would be the home and work, because this is where the car is parked most of the time.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? Lead by example would be a reason for me. We can talk about using this technology, but we should do it, in order to start the momentum.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (X)Traditional (X)Service (1)Leasing (2)Semi-lease (X)Company

Can you tell me what motivates you to think like that? There is a general concern about the battery life and that is why some companies
like Betterplace offer leasing of some parts. The cars I have now are traditional with full-ownership. As a business user I would pick lease or may be semi-lease. In my case it was also influential to go for electric due to our involvement in the development of new technologies, it is more congruent. The car is owned by my personal company.

That covers the things I wanted to ask. Anything you would like to add? Have you seen the Nissan app?, in the Leaf link you can connect to the car and check the status, with the approximate range you can drive the car to, of course is exaggerated a bit than what is real. Charging in the building is for free, in the house I pay regular fee of the Netherlands 23c/Kw. In the house I plug to the regular power outlet. I would recommend an electric car as an additional car to the regular one, for cost reasons, emissions, etc. After the initial investment in the car, which in general can be higher than regular IC cars the O&M costs are much lower if compared with traditional cars. For instance the Prius best fuel performance of 4.5 lt by 100Km is completely nothing if compared to the equivalent price of 1 lt which give you 80 km. Regarding the range anxiety, at the beginning I used to have a lot, but once you get used to the distances and usage you can give to the car it decreases a lot. A good option to encourage people on adopting the technology is to give them the opportunity to try it by themselves to reduce this fear.

### Interview 10

#### General Information

Gender: X Male Female Age: 53 Occupation: Control Systems Professor Commuting -> from: Halmont to Eindhoven Education level: Postdoc

#### Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _X_ Car _X_ Public __ Other______
2. What distance do you travel every day in average? _20_ km
3. Do you have a car? _X_ Yes __ No
4. What type: _X_ Gasoline/Diesel __Battery Electric _Hybrid
5. What is the model and brand? Renault Kangoo
6. How frequently do you use the car? 7 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? 
   Work

8. Please, order the destination from most frequent to less frequent (1 most-5 least): _3_ Visit family / friend _2_ Shopping _1_ Work __ Education center __ Other: ________

9. Are there cases when you use public transportation? _X_ Yes __ No

10. How frequently does this happen? 4 times per month

11. In case Yes, please describe in which cases do you use public transportation: Long distance meetings for work in Utrecht for instance, because I can work in the train.

12. Do you consider buying a car in the future? _X_ Yes __ No

13. In case Yes, in what timeframe? _X_ <1 year __ 2-5 years __ > 5 years

14. Technology preference: _ Gasoline/Diesel _X_Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? Tesla model S

16. What are the main factors behind your selection (technology and brand)? The range (400km) and the performance where the main factors. Is paid by personal private car. The brand I choose because I consider is a game changer and I want to show people this is a beautiful car, actually this is the first time I buy a brand new car. Also as a person that promotes electrical driving I need to have an electrical car. If Tesla was not there I would have bought the electric version of the Renault Kangoo. Tesla is a game changer because is the only single car that is not more expensive than similar cars with similar performance, is it as good or better than cars on the same segment on conventional technology. In my house the Tesla will be the main car because it is so expensive we can not afford to have another one. For instance the Nissan Leaf is more expensive than the similar cars on its segment.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: EV’s are fun and clean.

2. What can you say from your experience with Electric Vehicles? I think we are one of the few countries that are very well aware about the necessity of the cars as well as the infrastructure.
I think also is very relevant to notice that fiscal climate should be kept as constant as possible and is really needed in this phase. I just came back from Viena yesterday and there electric driving hardly exists. In Germany is also very rare. Whereas in the northern countries, specially in Norway and also in the Netherlands, electric driving is much more spoken off and that is because of the fiscal climate, where there are a lot of stimulus for people, because at the moment electric driving is too expensive. Yes, in the fiscal climate I mean the VAT reduction, the fiscal road tax and also for private companies is interesting because when owning an electric car it is seen as an investment and they can deduct taxes.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I see many people around the world is working about this idea of using the car to make it part of a decentralized network of storing system. The key element is the development of the battery to see if the lifetime issues are relevant. As a consumer and also as a society we can earn money by shaving the peaks of electricity demand. However the loads and unload cycles of the battery also have a monetary implications, but we still don’t know yet what the state of the battery will be in the future. At least I am not willing yet to plug my Tesla and load and unload during the night, because I don’t know what would happen with the lifespan of my battery but 10 years from now, it may be more clear than now. As a consumer you might be able to make the trade off if you want the money now from providing grid services or later as life of the battery that last longer. That is one statement. The second one I think it will be relevant to notice in my opinion in a very long horizon on time, electricity will be really cheap because we will have a lot of solar and then we have a different problem which is storage. It could be expressed in euros but is a storage problem. Then I expect there would be a second market, an after market for batteries that were in an Electric car but dropped below 80% or 70% of their efficiency and there will be for stationary applications where you can store energy.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I personally doubt severely about hydrogen, inherently it is really unsafe, it is really expensive and inefficient. Anyway it could be that thanks to the breakthroughs in the next years that hydrogen
becomes feasible and solves the range problem as well. At the moment I wouldn’t heavily invest in hydrogen but it could be an option for the future. There are billions of euros being invested into battery development and the prices are dropping 8% per year approximately, so it is a factor of 2 in ten years so if indeed suppose the range has a factor 2 more in 10 years, then you have a factor 4 more value for money. For the same Tesla price I could say drive let’s say 800Km instead of 400Km, then you solve a lot of problems or you make the range 400Km and you sell it very cheap. I think there is so much investment into battery technology that it will have a very important development and may be it goes faster than we anticipate what we expect and it could be we don’t need hydrogen anymore. That is only my perspective. My main problem with the CaPP concept is that it takes a lot of efficiency out of the system, it takes a factor 3 more electricity by the production of the hydrogen that if you do it directly with battery storage. I belive that in the future when electricity from sustainable sources is for free, suppose you have to dump electrical energy like in this days if it is too hot for instance when you have a lot of PV electricity will be so cheap then you should make hydrogen and then use it to power your car later. But I doubt if it is then used to dump later on electricity into the energy grid. That is my impression.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? It depends on how much money I can get from the system but as long as I am able to specify the charge I would need for the next day it would be ok. For instance I can tell the system that I will use up to certain amount but the rest could be used for the grid. This could be done in an app where I could send the input.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? xx.

7. Can you describe how do you think would be an appropriate way to deal with the range anxiety? To deal with the range anxiety it is very important that as a user you can really rely on what your car dealer is telling you. The other thing is that I think batteries should become so cheap that everybody has enough batteries and there will be also very lightweight.
So if in 10 years from now you can drive twice as far it also means that half of the weight than you have now. I also think there is a tipping point below 150Km it is very small, specially if it is dependant on the weather conditions. So if you can only drive 80 Km with a Nissan Leaf in winter is too little, so I think it should stay above 150Km on all weather conditions in the Netherlands. Then people will not experience this range anxiety. Moreover if we have good infrastructure for fast charging it would be less an issue.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? I think it should always be transparent what the benefits are for the consumer. It should be made clear for the user the financial benefits and the drawbacks are not there, like the lifetime or health of the fuel cell system, because it is also probable they will also suffer from charging and uncharging. So for the user it should be very transparent how is it being used. For the rest I think people in the future will be very aware of the network function, we are already heading towards a network society. We are connected all the time, specially young people will feel natural their car might be connected and that the car is a local storage device for the grid. Everything as long as the consumer feels is benefiting from it. I mean the cars are felt less and less as an status symbol and I think people in the future will be willing to participate as long as there are incentives which could be financial or you earn mobility points, energy points, CO2 points, etc. I expect people will be willing to, as long as they are confident the technology is ok and that there are no damages to the battery or their fuel cell.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1)Traditional (2)Service (X)Leasing (X)Semi-lease (X)Company

Can you tell me what motivates you to think like that? I think this idea of Renault to lease the batteries is quite interesting, because it lowers the investment you have to do and you can imagine that the network companies pay for all the batteries in the Netherlands and that you can drive for the battery but they really pay for the battery and you pay a small amount as a function of how often they can use their battery. I think that is a very good business model, that will be the semi-lease. I also con imagine that when there is more confidence from the consumer in the battery technology
that I don’t mind paying a little bit more if I feel comfortable with the batteries and on the basis of a service contract I can earn some money from the network people so I can get back my initial investment, so both options. May be semi-lease would be the start but later on it will be service. So on the short term it might be semi-lease and later on it can be service, so timewise that is what you can expect.

That covers the things I wanted to ask. Anything you would like to add? You can look up in the internet for the Renault Kangoo, Florence or Zoe electric version. The problem is you have to pay like 70 Eur a month and you have to drive less than 10,000 Km, so if you drive that amount it takes you about 12 cents per Km, whereas my Tesla will cost me 4 cents per Km. So I drive much more cheap with my Tesla, however I have to pay the whole Tesla. On the other hand the Renault Kangoo electric is only 20,000 Eur is the same as my old regular Kangoo cost. The Nissan Leaf is 33,000 Eur, so the difference is basically the battery, but then you have to pay 70 Eur a month to Renault. The key thing to the consumer is that the uncertainty about the belief on the battery is taken from the consumer to Renault, cause as a consumer I don’t care anymore if the lifetime of the battery is only 3 years, because it would be replaced by Renault because I lease it. In comparison with the Tesla that has 8 years guarantee on the battery regardless of how much I drive, which is also a good deal. If I would have to pay so much for a car and then don’t get that guarantee I would feel uncertain. So the trust in the battery is one of the key elements in the equation that may drive the adoption in the market place.

INTERVIEW 11

General Information

Gender: X Male Female Age: 28 Occupation: Architecture Student Commuting -> from: Delft to Amsterdam Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _1_ Bicycle _2_ Car _3_ Public __ Other_______

2. What distance do you travel every day in average? can vary from 2km if stay in Delft to 120km if go to Amsterdam

3. Do you have a car? __ Yes _X_ No
4. Are there situations where you think having a car would be useful? _X_ Yes __ No

5. How frequently does this happen? Less than once times per month

6. In case Yes, please describe in which cases you would prefer to use a car: Moving stuff around or when I want to go to places where is difficult to reach by public transportaion that are not very well connected.

7. Do you consider buying a car in the future? _X_ Yes __ No

8. In case Yes, in what timeframe? __ <1 year _X_ 2-5 years __ > 5 years

9. Technology preference: _X_ Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea

10. What would be your preferred brand / model? Some cheap second hand car, but if money is not an issue a nice car. Of course a reliable car like a german or japanesse brands. Not italian or american.

11. What are the main factors behind your selection (technology and brand)? The distance that I have to travel is important, the cost of the fuel, anyway I would like to live as close as possible to my job so I don’t have to travel by car and then get stucked in the traffic jams, etc. Economic, cheap, small car that is reliable that I can use for years without very high costs of maintenance. Of course it has to look cool, not disgusting colour (even is not the most important issue).

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: Right now I think they are sort of impractical, because there are a lot of issues with range. I have only driven a Prius car, which is not fully eletical and it was kind of sluggish and it can only run electric at slow speeds, so I think they are low performance still and not really developed up to the level you would like to buy one. On the other hand of course, the Tesla cars are really cool so they also have this technological edge. Anyway I think is more convenient to have a gasoline car at this moment. I think the infrastructure for daily commuting is fine around this area, you charge it according to your daily schedule but if you have to go on a trip to Spain for
instance it will be very difficult. In general I think it still needs development.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I think is a nice idea, but I wonder whether or not it requires a lot of infrastructure, cost and development and I wonder if is really efficient to have this small generators together instead of a big conventional power plant working on hydrogen as well. On the other hand the cars will be there anyway, so I am wondering if it is actually efficient. I think you also need a separate building, unless is less automated where you can plug yourself, I think that will be more realistic.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? If you could actually make some money that would be an advantage, if it doesn’t reduce your usability of the car. That would be a nice way to contribute towards the environment while making money. Then people will not have to reduce practicality for the environment, so it sounds good in general. In the end if would make it more affordable. I would be concerned about the degradation of the fuel cell, even though I am not sure how they work but this could be a problem. Apart from that may be it would make people lazy, as they are thinking they are helping the environment enough so they stop taking care in other aspects. It could aslo block some other technologies, because if a nation want to do this, then you have to do it big time becase in a smaller scale it might be not enough. So if you choose this option, you may have to stick to it and then you may hamper the development of other choices.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? If they can only control the car when is parked I guess it will be fine for me, it doesn’t sound like it is dangerous or anything. Right now a lot of other things work with computers interconnected as well and companies or persons can control your computer from remote locations if they want, so I don’t think that would be something that will stop people from using it in the future. Some important conditions will be the assurance that they can control your car only when it is parked and
your are not in it or not in the road. That it is safe against hacking or similar things, because if they can physically attach to it or control it, somebody else could be able to upload a virus or change the setting of the software or hardware and this could have implications for security or terrorism. I guess safety should have to be assured. May be people also would be concerned with the amount of fuel in the tank to drive back home, but I guess that could be also managed somehow with the system.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I think if it actually proves the benefits to me I could consider it. For me it would be a calculation, I would compare it against other cars available and see if it actually makes sense to use the system. Eventually with the mileage that I expect to drive if it will be more expensive and then I don’t think I would buy it, I wouldn’t buy it just for the technology or the coolness, I would buy it if it makes sense financially. For the price premium I would also evaluate the benefits, if it practically doesn’t add up to a regular car I wouldn’t pay an extra amount of course. Only in the case where I get something back I would calculate how much that amount might be and is positive, then I would compare it with the extra amount against other options. I do not think I am willing to pay only for the concept or the coolness of the technology.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? The emergency case is not really applicable in the Netherlands and the remote locations might be nice but it doesn’t happen too often, only during the holidays, so I am not going to buy a car only for that. On the case of home and work I think would make more sense and can attach it to the grid as a power generator.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? My prime concern would be the price, perhaps regulations and stuff like taxes that are applicable. Like if they force me to drive an electric car.
9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1 best - 3 least) (3) Traditional (X) Service (2) Leasing (1) Semi-lease (X) Company

Can you tell me what motivates you to think like that? Well, I don’t think the traditional would be attractive, because if there is a problem with the fuel cell then you have to replace it and might be very expensive. For that reason Semi-lease sounds very good, it would be more more interesting so that would have the highest score, as you own the vehicle and replace the components if needed. Then I would pick leasing, because I still prefer the idea of having my own car against having to share it with other people, also with the advantage of replacing the car after a couple of years which also means getting a new battery / fuel cell. After that would be the traditional.

That covers the things I wanted to ask. Anything you would like to add? I wasn’t exactly sure if hydrogen is safe, because what happens if you run into a tree?, does it explode or something?.

INTERVIEW 12

General Information

Gender: X Male Female Age: 31 Occupation: Director of own company
Communting -> from: Leiden to Delft Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _1_ Car _2_ Public __ Other ______
2. What distance do you travel every day in average? 50 km
3. Do you have a car? _X_ Yes __ No
4. What type: _Gasoline/Diesel __ Battery Electric X_Hybrid
5. What is the model and brand? Honda civic hybrid for about 4 years
6. How frequently do you use the car? 3 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? Work
8. Please, order the destination from most frequent to less frequent (1 most-5 least): __ Visit family / friend __ Shopping __ Work __ Education center __ Other: Holidays

9. Are there cases when you use public transportation? _X_ Yes __ No

10. How frequently does this happen? 5 times per month

11. In case Yes, please describe in which cases do you use public transportation: When I need to go to big cities and want to avoid parking

12. Do you consider buying a car in the future? _X_ Yes __ No

13. In case Yes, in what timeframe? __ <1 year __ 2-5 years __ X_ > 5 years

14. Technology preference: _ Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? Not idea yet.

16. What are the main factors behind your selection (technology and brand)? I would choose a battery for environmental reasons, is cleaner as well. The main motivation is related to personal interest.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: It comes to my mind the Tesla car, the future even though we already start seeing them around, probably my next car as I was telling you before.

2. What can you say from your experience with Electric Vehicles? The hybrid is completely the same as regular car. The differences when driving is that when I stop the engine stops completely and my car doesn’t make any noise when I stop, that is very nice. The driving behavior is not different. In the case of the range anxiety for my future car I don’t see a problem, because I live here in South Holland and many people lives around, so if this is implemented I am sure the infrastructure will be developed as well.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I think is a highly optimistic concept, because if you look at other power
plants. I think a car is a car and a power plant is a power plant. I think specialization is better than generalizing, most of the time in engineering.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? The main benefit for the user is awareness, because a lot of people doesn’t even understand what a liter of gasoline is, so in this way they might be able to understand better. I would be concerned about the parking places, the fact that many human beings should be motivated at some point, some good amount of money should be put down. People are lazy.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? In my opinion, it is not very different from what we have nowadays. Somebody can still use your car if they steal it, so I don’t really see a problem there.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)?

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? For remote locations and campsites it could be interesting, but how often does this happen in a year?, specially here in the Netherlands camp sites are very well prepared for that. I think the most value would be in developing countries with this kind of things.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? The fact that you are sort of helping the system, like the bigger picture is important. As well, taxes and regulations would be relevant.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best - 3least) (3)Traditional (2)Service (X)Leasing (1)Semi-lease (X)Company

Can you tell me what motivates you to think like that? For me it would depend whether the technology has proven itself or not,
if it hasn’t proven itself semi-lease on the risky parts. Then I would go for the service scheme, as you can use the same car by more users. If the technology has proven itself I would for the traditional scheme, cause it gives more freedom.

That covers the things I wanted to ask. Anything you would like to add? I hope it would evolve and that we also get energy from clean sources. If we feed electric cars with dirty energy, it is still dirty but taken far away.

**Interview 13**

**General Information**

Gender: Male  
Female Age: 25  
Occupation: Real State Student  
Communting -> from: Delft to Delft  
Education level: Master

**Transportation preferences and use**

1. Which transportation mode do you use most of the time? (1 most – 3 least)  
   _1_ Bicycle _2_ Car _3_ Public _Other__________

2. What distance do you travel every day in average? 5km

3. Do you have a car? __ Yes _X_ No

4. Are there situations where you think having a car would be useful? _X_ Yes __ No

5. How frequently does this happen? 2 times per month

6. In case Yes, please describe in which cases you would prefer to use a car:  
   *When doing big grocery shopping as I live on campus and the closest supermarkets are in the city center. Also when there are big things to carry around that do not fit on the bike or when the waiting time for the public transportation is too long.*

7. Do you consider buying a car in the future? _X_ Yes __ No

8. In case Yes, in what timeframe? __ <1 year _X_ 2-5 years __ > 5 years

9. Technology preference: _Gasoline/Diesel _Battery _Hybrid _Fuel Cell _X_ No idea

10. What would be your preferred brand / model? **Still far in the future to know.**
11. What are the main factors behind your selection (technology and brand)? *It would be important to take into account the brand, the technology, the price and the color.*

**CaPP Qualitative questionnaire**

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: *It seems to be a good thing for the environment in general and also for the future generations as the pollution levels would be less. However I don’t think is a good investment for car owners nowadays. Also it is not flexible enough to find a place to plug it on, specially if you are on the way.*

2. What can you say from your experience with Electric Vehicles? *Not applicable.*

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? *It could be a way to make the car profitable for the owner of the car and other people as well. I think the benefits may extend beyond the personal owner.*

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? *It is possible to share the energy produced by your car while also gaining some profit at the same time. My concern is that I see this kind of technology applicable far in the future.*

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? *It would be one way for the network operator to eliminate power distribution problems. On the other hand, for the power issue specific to your own car there is always the risk that the system breaks down, so you won’t really be able to control or monitor it 100%.*

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? *I might consider it later on.*

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? *I would use it anywhere I needed it, as long as the technology is mature enough and it is already fully commercialized.*
8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this? I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? For me the most relevant would be the safety issues, because I am still not sure how this may work and also the problems that may arise from working with hydrogen and specially if it is moving around a big installation.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1) best - (3) least. (1) Traditional (2) Service (3) Leasing (X) Semi-lease (2) Company

Can you tell me what motivates you to think like that? As I still don’t know all the details of the technology in a practical environment it would make sense first to use if as a service. Depending on the benefits and how the vehicle work in normal conditions may be I would think about another options.

INTERVIEW 14

General Information

Gender: Male X Female Age: 31 Occupation: Civil servant
Communting -> from: Rijswijk to Den Haag Education level: Bachelor

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most - 3 least) _2_ Bicycle _1_ Car _3_ Public _ Other_______
2. What distance do you travel every day in average? 7 km
3. Do you have a car? _X Yes __ No
4. What type: _X Gasoline/Diesel _Battery Electric _ Hybrid
5. What is the model and brand? Audi
6. How frequently do you use the car? 7 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? Work
8. Please, order the destination from most frequent to less frequent (1 most-5 least): _X Visit family / friend _2_ Shopping _ Work _1_ Education center _ Other: _______
9. Are there cases when you use public transportation? __Yes__
   No

10. Do you consider buying a car in the future? __Yes__ __No

11. In case Yes, in what timeframe? __<1 year__ __2-5 years__ __> 5 years

12. Technology preference: __Gasoline/Diesel__ __Battery__ __Hybrid__
    __Fuel Cell__ __No idea

13. What would be your preferred brand / model? __No preferred option yet, but middle class size.

14. What are the main factors behind your selection (technology and brand)? __The most important would be the comfort, safety as I have little kids, the price and the maintenance costs.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: __I think they are green in comparison with regular cars, they also have the advantage of lower costs and taxes, they are less noisy and need less power. Some of the disadvantages include the high production and sales costs, you loose flexibility as there are few charging locations, so you may become somehow dependant on this.

2. What can you say from your experience with Electric Vehicles? __Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? __First of all I think this idea is still far into the future, and might only work out on a large scale due to the reduced power every car can generate. It would take long time to introduce into the market and for people to get used to it. Also some time would be necessary for people to consider it as normal, rather than something special.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? __It might reduce the costs of adoption of electric vehicles and would contribute towards a greener world. My main concerns are that it still sounds very experimental, would it work in the end?, it also depends on the plug-in enabled locations.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you
are away in order to produce power or regulate the electric grid?

If more cars participate it shouldn’t be a problem, but if there are not so many around I would better keep the electric power generated to myself or for fellow users as well. Unless there is a payment for providing this kind of services I wouldn’t be interested on sharing the power of my car. I am also interested in the privacy aspect of the car. Would they have a log of your car everytime they connect?

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I would may be consider it, and for the price premium I think I maximum would pay around 10% of the price if compared to conventional gasoline cars.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? Most of the time I park my car in different locations for a period which is longer than an hour. This is more usual at home, at work and on shopping centers. Otherwise it wouldn’t make sense to be plugging and un-plugging all the time.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?. I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? As for conventional cars, I am concerned about the safety and in this case it would even be more important. It would also be important the comfort of the vehicle provided if compared to regular cars. Also it would be relevant to know objective test results after using this technology.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1)Traditional Service (2)Leasing (3)Semi-lease (X)Company

Can you tell me what motivates you to think like that? My first choice is a traditional scheme, because I prefer a car owned by myself, so I don’t have to wonder about the usage of the car I am driving. In that case I can also use the car whenever I like.
INTERVIEW 15

General Information

Gender: X Male Female Age: 64 Occupation: Retired
Communting -> from: Rijswijk to Rijswijk Education level: Master

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _3_ Bicycle _1_ Car _2_ Public __ Other________
2. What distance do you travel every day in average? 25 km
3. Do you have a car? _X_ Yes __ No
4. What type: _X_ Gasoline/Diesel _Battery Electric _Hybrid
5. What is the model and brand? Mitsubishi Outlander
6. How frequently do you use the car? 7 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? Shopping destinations
8. Please, order the destination from most frequent to less frequent (1 most-5 least): _2_ Visit family / friend _1_ Shopping __ Work _X_ Education center _Other: Recreational
9. Are there cases when you use public transportation? _X_ Yes __ No
10. How frequently does this happen? 3 times per month
11. In case Yes, please describe in which cases do you use public transportation: When I expect I can hardly find a parking space at my destination.
12. Do you consider buying a car in the future? _X_ Yes __ No
13. In case Yes, in what timeframe? _<1 year __ 2-5 years _X_ > 5 years
14. Technology preference: _ Gasoline/Diesel _Battery X_Hybrid __Fuel Cell _No idea
15. What would be your preferred brand / model? Honda or Mitsubishi hybrid.
16. What are the main factors behind your selection (technology and brand)? The technology because is partially electric and is better for the environment. In the case of the brand I prefer Japanese cars as they give me more value for each euro invested.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: Mostly positive, because they are good for the environment, they produce less noise. The problems I see is that they can restrict the distance I can travel (there is less distance I can travel with one “electric full tank”).

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? The idea is rather original and personally I have never thought about it. I wonder why we are not doing anything already about that, I mean why not using energy when the car are parked??? I think the outcome could be a win-win situation.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? The benefits I see are mainly concentrated on the environment as the cars will be used while they are idle. On the concern side I wonder how this system may affect the flexibility of the car user and how much one would have to sacrifice by using this system.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? If it is clear how should I use the system and the benefits as well I wouldn’t mind. Also it is important the user can control or monitor the outcome and the status of the energy transfer, in that case I wouldn’t have any objection.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? This is a matter of energy consumption in the future. In comparison with other alternatives this technology
should be the best option and than the reasons to make this choice are clear. May be around 5,000 to 10,000 as a price premium.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? As I am retired, most probably I would use this technology at home, as it is where my car is most of the time.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? The most important factor for me would be the environmental motivations of the user. Of course the costs for driving an electric car would also be important, like the taxes and the battery costs.

9. Let's assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (1)Traditional (X)Service (3)Leasing (2)Semi-lease (X)Company

Can you tell me what motivates you to think like that? In my case as I like to be the only owner and the only decider for the use of the vehicle I would choose the traditional way. Also depending on the conditions of the lease of the battery / fuel cell I would choose for the semi-lease.

That covers the things I wanted to ask. Anything you would like to add? I wonder how many houses would a parking facility like this could power???.

INTERVIEW 16

General Information

Gender: X Male Female Age: 32 Occupation: Real State Manager Communting -> from: Rijswijk to Hoofddorp Education level: Bachelor

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle _1_ Car _2_ Public __ Other_______

2. What distance do you travel every day in average? 200km
3. Do you have a car? Yes / No

4. What type: Gasoline/Diesel / Battery Electric / Hybrid

5. What is the model and brand? Audi A3

6. How frequently do you use the car? 7 days per week (from 7 days)

7. In case you have a car, what is the most frequent destination? Work

8. Please, order the destination from most frequent to least frequent (1 most-5 least): Visit family / friend Shopping Work Education center Other: _______

9. Are there cases when you use public transportation? Yes / No

10. Do you consider buying a car in the future? Yes / No

11. In case Yes, in what timeframe? <1 year 2-5 years > 5 years

12. Technology preference: Gasoline/Diesel / Battery / Hybrid / Fuel Cell / No idea

13. What would be your preferred brand / model? May be a german brand.

14. What are the main factors behind your selection (technology and brand)? For me performance is relevant when thinking on a car, like speed, range, price, maintenance cost and reliability. I would consider buying another german car as the current one I have has provided good service.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: I think electric vehicles could be good for the environment as they emit less CO2 and are also silent. While on the other hand they can be dangerous as people can not listen to them when they are approaching. In fact I was hit once by an Electric Vehicle when crossing a street.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but
also as source of electricity / water and heat? I think it could be a good idea, depending on how the system is built. However I am bit skeptical about this whole idea, because from my perspective there are many complexities involved.

4. What are the main benefits you perceive as a customer by using this technology? What are your biggest concerns? The main benefit I see is that this system may help to decrease the cost of driving electric cars as the user gets some money by generating power. The concern I have is that it could imply the maintenance costs are high.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? As long as they compensate on a proper way it would be ok.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles? What price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? It depends on many factors, but as a general estimation may be a 10% extra from a car on a similar segment.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I think it would be more suitable for work as I know in advance how long time am I going to be there.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this? I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? For me as for when I consider buying an electric car the main factors would be related to performance, so how does this system affect performance of my car and of the fuel cell.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1)best - (3)least (1)Company (X)Service (2)Leasing (X)Semi-lease (1)Company

Can you tell me what motivates you to think like that? The company would be the most interesting as I wouldn’t really like to experiment with it and also if I plug it at work it would make more sense if it is already property of the company. If this is not possible my next choice would be a leasing scheme and then the traditional way, because both ways allow me to keep the car with me all the
time.

That covers the things I wanted to ask. Anything you would like to add? Interesting idea, but not for me.

INTERVIEW 17

General Information

Gender: X Male Female Age: 32 Occupation: Cleaning services Contractor
Commuting -> from: Rotterdam to Wherever needed Education level: Bachelor

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _ Bicycle _1_ Car _2_ Public _3_ Other_______
2. What distance do you travel every day in average? can vary from 10 km to 80 km
3. Do you have a car? _X_ Yes _2_ No
4. What type: X_Gasoline/Diesel _Battery Electric _Hybrid
5. What is the model and brand? Jeep Cherokee
6. How frequently do you use the car? 7 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? Work (customer location)
8. Please, order the destination from most frequent to less frequent (1 most-5 least): _2_ Visit family / friend _3_ Shopping _1_ Work _2_ Education center _3_ Other: _______
9. Are there cases when you use public transportation? _X_ Yes _2_ No
10. How frequently does this happen? 1 times per month
11. In case Yes, please describe in which cases do you use public transportation: If I need to visit a customer office where is difficult to park or where traffic can be very intense
12. Do you consider buying a car in the future? _X Yes _2_ No
13. In case Yes, in what timeframe? _<1 year _X_ 2-5 years _> 5 years
14. Technology preference: X _ Gasoline/Diesel _Battery _Hybrid _Fuel Cell _No idea

15. What would be your preferred brand / model? Utilitarian vehicle like a pick-up, Toyota may be.

16. What are the main factors behind your selection (technology and brand)? Due to my work I prefer gasoline, because I need to go to both urban or rural locations in the country and need to be sure I can fuel my tank wherever I go. As well, gasoline is cheaper and an utilitarian car provides me with the power to couple it with equipment I need to take to deliver the services I provide. Japanese brand because that car has a good performance for the price and is fuel efficient for its segment, which is one of the problems I have now with the Jeep I have.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: I think they are still slow, expensive, non reliable as their range changes depending on the weather conditions, which not happens with gasoline cars. In theory they are supposed to be environmentally friendly but the energy is still coming from big plants nowadays, so I don’t know if this is true. Also I am concerned about the battery disposal when their lifetime is over.

2. What can you say from your experience with Electric Vehicles? Not applicable.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? Is a good initiative to hear about the integration of the electric and transport system, but I wonder if it could really work out as intended.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I see benefits in two levels: on the personal level the money potentially received by the user would be a big motivator, as well there are going to be less emissions at least on the urban areas or where the car is being used. On the social level it could be possible to use this system as a mobile storage, so it might allow to integrate more renewable sources. A concern I have is that as far as I know hydrogen can be explosive if not handled properly, so if you have people connecting lines with hydrogen flowing and there is a technical problem
it might blow out part of the building. As well, this system could be abused by people trying to make some money like with oil pipelines in some countries, where they extract oil illegally and sell it in the black market. But given the fact it is hydrogen the consequences can be very dangerous.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? At the beginning it is a little bit strange to think someone is using your car, but everything seems to be pointing in that direction. I think if the compensation is superior to the degradation of the cell and the scheme is clear as well as the money you can make it should be ok, is just about regulating it and getting used to it.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I would make a comparison by then and if it gives me more money back from what I am investing initially I would consider it. May be between 10% to 20% of the prices, but it depends of course on the specific numbers.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? Mainly useful for home as my work I am moving around where most probably there won’t be this kind of facilities. I see also use in the emergency situations, specially emergencies in remote locations. Also for generation in off-grid location in developing countries or for remote projects where there are night shifts.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? First of all to see there is long term commitment for this technology from different actors like governments, car manufacturers, etc. If that happens is possible there would be incentives, like tax reductions we are seeing now with the electric cars. As well infrastructure development and to know the technology has been proven to know is not going to blow up when being used like a power plant.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would
you be more interested in (1 to 3)? (1 best - 3 least) (3) Traditional (X) Service (2) Leasing (1) Semi-lease (X) Company

Can you tell me what motivates you to think like that? I think semi-lease would be my first option so I avoid getting worried about the fuel cells being worn out and all that stuff, because anyway it can be replaced if something happens. It would be like a guarantee from the manufacturer or whomever is selling the cars. The other two (leasing and traditional) because it is like my current car, which means flexibility, on that way I can ensure to use the car when I need.

INTERVIEW 18

General Information

Gender: X Male Female Age: 30 Occupation: Application Manager
Communting -> from: Nieuwegein to Houten Education level: Bachelor

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _2_ Bicycle _1_ Car _ Public __ Other_______

2. What distance do you travel every day in average? 20km

3. Do you have a car? _X_ Yes __ No


5. What is the model and brand? Toyota Prius

6. How frequently do you use the car? 6 days per week (from 7 days)

7. In case you have a car, what is the most frequent destination? _Work

8. Please, order the destination from most frequent to less frequent (1 most-5 least): _2_ Visit family / friend _3_ Shopping _1_ Work __ Education center __ Other: _______

9. Are there cases when you use public transportation? _X_ Yes __ No

10. How frequently does this happen? 1 times per month
11. In case Yes, please describe in which cases do you use public transportation: Shopping or to go for a performance or any other reason in the city center

12. Do you consider buying a car in the future? Yes ___No

13. In case Yes, in what timeframe? < 1 year ___ 2-5 years ___ > 5 years

14. Technology preference: Gasoline/Diesel ___Battery ___Hybrid ___Fuel Cell ___No idea

15. What would be your preferred brand / model? No preference yet, far in the future.

16. What are the main factors behind your selection (technology and brand)? I have with my car since January. Mainly because of the convenient incentives as tax, insurance exemptions and also for having it as a leasing from its company, fuel costs are less and I really feel it. Not really for environmental conditions. In average the range can vary from 15 to 25 km, depending on the weather. Idea than electric vehicles are booming due to incentives, but only when they are plug-ins, so that is why I choose the car I have. Another reason I choose hybrid is to use in case I decide to go on holidays to remote areas of the country or outside of the Netherlands.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: I think everything comes down to the loading mentality, so everything will work down if people plug their cars on the road and also on a daily basis, which is different from regular cars as you can leave it with gasoline loaded more time. There is also the charging point availability, around urban areas it is very good in the Netherlands, but if you go further away can get complicated. I think Holland is already the second country in the world that uses more the electric vehicles, the government support with the taxes exemptions have contributed greatly to this. Then you have the problem of range anxiety for fuel electric.

2. What can you say from your experience with Electric Vehicles? 
   If you drive electric is very quiet, I would even say relaxing. For instance if I change mode or to another gasoline car I found it is very noisy in comparison with the hybrid. The problem with charging stations for me is not the availability, but there are occasions where I would like to charge my car, I look for it and then after looking for it I find a normal
gasoline car parking in the electric charging spot. You can call the police to get it removed, because you don’t want to wait half an hour for that. Then if I think about a full electric car that would be a big problem due to the range restriction. There are already websites were you can even find electric charging etiquette. In another occasion, the loading station didn’t wanted to give my cable back and it took 45 min for that. Usually there is a phone were you can call but as it was new I couldn’t. Anyway that is not normal. I don’t really have the range anxiety problem as I have the gasoline car as a back-up. Whenever I can try to cover all the distance on electric mode, is like a challenge to get as more as I can but the more time you spend with the car the more you know the characteristics. At work we have 20-25 charging points at the moment. I can really feel the fuel savings, with my previous car (Opel Astra) I used to drive 100km with 6lt, whereas now I can drive 100km with 3.1lt, even that the manufacturers say you can drive up to 45km with 1lt. Most of the cars in the office are hybrid plug-ins. I have a 10 min rule, if the charging point is further away from this I don’t plug it there.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? It can work but only at the office. I think it also comes down to people willing to plug-it in and then if they want to leave they might feel they can not go, takes out freedom. For instance what would happen if you need to pick-up your kid if it is ill, and then you will have to unplug your car. People might hesitate to use the system due to this reason. A solution for this would be to have a car available for people to take when necessary and leave their cars but it may also not work because people like to drive their own car and is like an extension of their personal space. An idea is to transfer the electricity to the grid by induction, instead of a plug.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? The main benefit is to potentially take the electricity cost down for own consumption. One the concerns is that people need to be willing to plug-in every time, is not like normally you get out and get into your office. Safety is also important for me and hydrogen could be dangerous, not nice to feel you are driving on a time bomb. In the end, I think if you can get it down to safety regulations it should be ok.
5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? Personally I don’t think I would have a problem with that. I think people want to have the idea they have the control over their car and they want to use it when they need it. When you have an emergency you want to go home, which is not possible because it is being used as an electricity back-up, which might be a problem.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? Would be willing to consider as an option if it is safe enough. Is of course more complicated than only a car, because you are connecting it to a greater system, so it would depend on the electricity demand. In general is an interesting concept but is difficult to imagine, because electric cars are only taking off and this concept is still further away from that.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? I think it will not work if people is not working on the same location everyday. For instance if you have the system at the office and you go every day there I think it would work, but if you have to visit customers in different locations, then it gets complicated. I know there are some mail companies that use electric cars, but they move on a certain range of less than 100km and also don’t use it for private use. I think routines are very important for the system to work. However, in the future I see changes in work environment with all this flexi schemes the office may not be the main place to work anymore, but that is only my impression.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? I think is important that you can use the car beside your regular working at home and that the range is not limited. The flexibility of leaving the place as soon as I need to. Tax reductions would be important as we can see nowadays with the electric cars taking a high rate of adoption, specially when leasing the cars we can see more and more influence from the tax benefits. People is considering how much will it cost for
me to drive this car on a monthly or daily basis?. With the economic crisis people is more aware of the costs, it is good for the environment but what’s in it for me?, I think most of the people is adopting due to the taxes incentives. Also the reduced price for driving is beneficial and less than on gasoline station. I pay around 60 to 70 cents for a full charge that gives me 20 to 25 Km range to drive. This may also be a factor in the future if the gasoline prices increase, more people would consider electric.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1 best - 3 least) (2) Traditional (X) Service (1) Leasing (3) Semi-lease (X) Company

Can you tell me what motivates you to think like that? For me the leasing would be the best option, because I see the technology mainly used in offices as in my case. You can have the infrastructure at offices, with a lot of cars which are from the same company. I think the car should be provided by the employer. The traditional and semi-leases as I like owning my car. Service for me doesn’t work unless you only use it briefly in a month.

INTERVIEW 19

General Information

Gender: X Male Female Age: 63 Occupation: Retired
Commuting -> from: Den Haag to Randstaad Education level: High school

Transportation preferences and use

1. Which transportation mode do you use most of the time? (1 most – 3 least) _2_ Bicycle __1_ Car __ Public __ Other________
2. What distance do you travel every day in average? 60 km
3. Do you have a car? _X_ Yes __ No
4. What type: _X_ Gasoline/Diesel __ Battery Electric __ Hybrid
5. What is the model and brand? Sedan Toyota
6. How frequently do you use the car? 1 days per week (from 7 days)
7. In case you have a car, what is the most frequent destination? Work
8. Please, order the destination from most frequent to less frequent (1 most-5 least): __ Visit family / friend _2_ Shopping _1_ Work __ Education center __ Other: _______

9. Are there cases when you use public transportation? __ Yes _X_ No

10. Do you consider buying a car in the future? __Yes __No X_May be

11. In case Yes, in what timeframe? __ <1 year __ 2-5 years __X__ > 5 years

12. Technology preference: _ Gasoline/Diesel _X_Battery _Hybrid _Fuel Cell _No idea

13. What would be your preferred brand / model? Toyota.

14. What are the main factors behind your selection (technology and brand)? I would like battery because is good for the environment. Tax reductions would also be important in case they extend the subsidies in the future. Toyota because I have had a good experience, this cars are common to drive, easy, less problems in general. It is a low cost car, with low maintenance.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: What I think first is about clean air, the environment, they are a lot of vehicles already around the Netherlands, so I think they are easy to use. I don't think they are so expensive in comparison with regular cars. Infrastructure has to be developed more, but also people can be narrow minded, so it is important also to show them and explain people how do things work. Recently I’ve seen a lot of news about this technology, I associate them with the future.

2. What can you say from your experience with Electric Vehicles? I haven’t driven an Electric car yet, but an industrial vehicle, it was a forklift. I used to operate one, plug it in the night and use them again next day. They perform very well in the refinery, specially we used electric because at some areas in the plant it was more safe to use than other technologies. I never experienced running out of battery, they were very silent which is good on a way, but to compensate they was a light that people could see when walking around.
3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I believe it is a very good idea, specially for people retired like me because you don’t really use the car most of the time. Usually the car is parked at home all the time and I have to pay for it. I think it would be useful to have the power plants were one could park the car near the apartments were we live so I can leave my car there, instead of paying for parking were I live now and even get payed with this system so I don’t pay anything. May be also useful if system installed in my current parking spot.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? My main thing would be the environment and second paying less money for having a car, because having a car is very comfortable to use instead of using the common public transportation, specially in cases for emergency or to reach people in a fast way. I don’t think that cars will not be used, but increase in usage, specially cars like this were you save on costs and pollution. After having some previous experiences I don’t really see a lot of concerns, but may be when using the car to go on holidays abroad, like to Spain they won’t have the fuelling stations. Many Dutch people do that in caravans and I thinks could be a concern for other people. I don’t have a problem with hydrogen, because in the past in my job I used to work with Shell and at the plant I used to work which was called Hycon they reformed the natural gas into hydrogen. In general it was safe to work with it.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? I don’t think is a problem, because you can connect a meter in between your car and the connection. To me is familiar to manage this and it can be done, when you leave your car you can write it down and we you come back you write it down again. I am not afraid of loosing something because it can be measured in the end. I know is possible to do this.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? I’ll be the first of few people, so yeah I would be very interested on trying it. For the price premium
thinking on having less pollution I would go for it, may be a couple of thousand euros.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? It would be more convenient when having this car near the home, as I mentioned before is possible to have a power plant nearby the house and it would be better for people like me, since we leave the car there most of the time.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? Clean air, low cost as well for the total amount of investment as a global calculation. It can be done in short term, but we have to start thinking on long term, because nowadays you just pay something for the short term and money goes away but you don’t get anything back, whereas with a system like this you get a lot of things back. Of course also the reductions in the tax would be relevant, or may be no tax at all at that moment. I would be happy to have a bigger car, but now I can not afford it and by having a car as a power plant I might afford to get a bigger car as they can deliver more energy to the power grid.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1 best - 3 least) (3) Traditional (X) Service (2) Leasing (1) Semi-lease (X) Company

Can you tell me what motivates you to think like that? Semi-lease is the best option, because I don’t like the idea of other people using my car, I am the only owner, while at the same time you have a kind of a guarantee to cover any problem with the hydrogen system, so this ensures you always have a working car. My next options would be Leasing and Traditional because I am the only owner of the car. Service wouldn’t work for me.

That covers the things I wanted to ask. Anything you would like to add? I am surprised by this system, in the past I’ve been working in refineries and I’ve also seen the world by working on ships. I’ve worked on the engines on several types and the auxiliary and I am surprised to hear this concept because I’ve never heard of it before, but I think it makes sense. I’ve also worked with natural gas cars and they work very well, there are already two points in The Hague. We are using this already for my part time
work in a VW Transporter, Mercedez and Opel vehicles. I already see alternatives working, so I am very positive this may work in the future.

**Interview 20**

**General Information**

Gender: Male X Female Age: 33 Occupation: Policy advisor
Communting -> from: Delft to Delft Education level: Master degree

**Transportation preferences and use**

1. Which transportation mode do you use most of the time? (1 most – 3 least) __ Bicycle __ Car __ Public __ Other: Walking

2. What distance do you travel every day in average? 1 km

3. Do you have a car? _X_ Yes __ No

4. What type: _Gasoline/Diesel __Battery Electric X_Hybrid

5. What is the model and brand? Prius plug-in

6. How frequently do you use the car? 5 days per week (from 7 days)

7. In case you have a car, what is the most frequent destination? Work

8. Please, order the destination from most frequent to less frequent (1 most-5 least): __ Visit family / friend _2_ Shopping _1_ Work __ Education center __ Other: _______

9. Are there cases when you use public transportation? _X_ Yes __ No

10. How frequently does this happen? 1 times per month

11. In case Yes, please describe in which cases do you use public transportation: When going to the city center, or another city like Den Haag or Rotterdam.

12. Do you consider buying a car in the future? X_Yes _No _May be

13. In case Yes, in what timeframe? __ <1 year __ 2-5 years X_ > 5 years

14. Technology preference: _ Gasoline/Diesel X_Battery X_Hybrid _Fuel Cell _No idea
15. What would be your preferred brand / model? Not known yet.

16. What are the main factors behind your selection (technology and brand)? Because is more fuel efficient, it is comfortable, the tax incentives and my husband is an entrepreneur working in the field so I think is also an additional factor.

CaPP Qualitative questionnaire

1. Please describe in a few words what comes to your mind when you think about Electric Vehicles: I think first about less emissions, the environment, but also about limited range if they are Battery electric.

2. What can you say from your experience with Electric Vehicles? Well, a hybrid car is almost as a regular car with the difference that is less noisy in certain situations and you can plug it. We have noticed is more fuel efficient, so we are having savings in fuel in comparison to our previous car. My husband usually drive it to work and I get to use it during the weekends, I really like it because it feels smooth and I feel I contribute a little bit to the environment.

3. In general, what do you think about the idea of the CaPP where the future electric cars are not only used for transportation but also as source of electricity / water and heat? I believe it is a good idea to take advantage of the cars being idle most of the time. However I think it could useful in a big scale. I think using Fuel Cells is a good option, since you are actually producing the power in comparison to Battery electric cars that would be only transferring electricity back and forward.

4. What are the main benefits you perceive as a customer by using this technology?, what are your biggest concerns? I think making use of my car would be very beneficial for the environment, but also for the user as it can get money back from its car. The concerns would be related to the use of hydrogen in the cars and the reliability of the technology. The advantage is that by the time this technology is available also regulations would be in place.

5. What do you think of the idea that a third party on a remote location might be making use of the fuel cell of your car when you are away in order to produce power or regulate the electric grid? For me it wouldn't be a problem, as long as I know what is going on and I can drive back home at the end of
the day. If regulations are applied to this parking areas it should be ok and even you can have an insurance on the parking or the car to cover for any unexpected problem.

6. Let’s suppose we are already in the future (10 years from now), the technology is available, would you be willing to buy one of this vehicles?, what price premium would you be willing to pay if compared to similar gasoline cars (500 Eur, 1,000 Eur, 5,000 Eur, 10,000 Eur)? It depends on many things, but may be I could pay a couple of thousand euros for this technology.

7. Can you describe in which situation do you see yourself using this technology (home, work, emergency situations, remote locations, etc)? For me, I think the biggest use would be at work, since the car spends most of the time at my husband’s office or at my home. Emergency situations or remote locations won’t be as beneficial.

8. Can you mention what factors would be the most relevant for you when considering to adopt a technology like this?, I understand the price is fundamental, but what other (internal, external) factors would be the most important for you? Of course the cost, incentives from the government and to be sure the technology works as intended and it really is environmentally friendly.

9. Let’s assume you are interested in using the technology. If there was a wide range of options to get a vehicle, which one would you be more interested in (1 to 3)? (1best -3least) (1)Traditional (2)Service (X)Leasing (X)Semi-lease (X)Company

Can you tell me what motivates you to think like that? In my case my first option would be the traditional scheme, because even though it implies a higher up front cost, in the end the total cost would be less than for instance on a leasing or semi-lease. As a second choice I might go for the service, but the problem I see is that we prefer to own our car as it is one of the main advantages of having a car.
APPENDIX: QUANTITATIVE DATA CODING

This Appendix indicates how the information from the questionnaires was coded into SPSS. It follows the same structure of the sections introduced by the interview format presented in Appendix B.

General Information

GROUP Student(1), Gasoline car driver(2), Electric car driver(3)

GENDER Male(0), Female(1)

AGE Direct entry

OCCUPATION Student(1), Employee(2), Professor(3), Director(4), Retired(5)

EDUCATION High school(1), Bachelor(2), Master(3), PhD(4)

Transportation preferences and use

TRANSPORTATION Walking(0), Bicycle(1), Public(2), Car(3)

CAR No(0), Yes(1)

CARTECHNOLOGY None(0), Gasoline(1), Battery(2), Hybrid(3), Plug-in hybrid(4)

FUTURECAR No(0), Yes(1), May be(3)

TIMEFRAME 1 year(1), 2 to 5 years(2), >5 years(3)

PREFERREDTECHNOLOGY No idea(0), Gasoline(1), Battery(2), Hybrid(3), Plug-in hybrid(4)

CaPP Quantitative questionnaire

VARIABLES(12) Strongly disagree(1), Disagree(2), Neutral(3), Agree(4), Strongly agree(5)
This Appendix contains some relevant SPSS results that serve as a support for Chapter 4.

Figure 28: Box plot: Performance expectancy by group

Figure 29: Box plot: Effort expectancy by group
Figure 30: Box plot: Attitude towards technology by group

Figure 31: Box plot: Social influence by group
Figure 32: Box plot: Facilitating conditions by group

Figure 33: Box plot: Self efficacy by group

Figure 34: Box plot: Anxiety by group
Figure 35: Box plot: Perceived safety by group

Figure 36: Box plot: Environmental concern by group

Figure 37: Box plot: Environmental behavior by group
Figure 38: Box plot: Opinion leadership by group

Figure 39: Box plot: Behavior intention by group

Figure 40: Cronbach’s alpha
Figure 41: Histogram: Performance expectancy

Figure 42: Histogram: Effort expectancy
Figure 43: Histogram: Attitude towards technology

Figure 44: Histogram: Social influence

Figure 45: Histogram: Facilitating conditions
Figure 46: Histogram: Self efficacy

Figure 47: Histogram: Anxiety

Figure 48: Histogram: Perceived safety
Figure 49: Histogram: Environmental concern

Figure 50: Histogram: Environmental behavior

Figure 51: Histogram: Opinion leadership
Figure 52: Histogram: Behavior intention

Figure 53: Behavior Intention vs. Attitude Towards Technology, with Opinion Leadership as a moderator
This Appendix contains the proposed Business Model structures as a support for Chapter 6.

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Figure 54: Base model
### Figure 55: Service model

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Legend:
- E: Services (A) & B: Subscription (U)
- Leasing car (U) & Selling car (U)
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Figure 57: Leasing model
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