FUNDAÇÃO GETÚLIO VARGAS
ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO

SVEN DANIEL KÄMMERER

DEVELOPMENT AND EVALUATION OF A RANGE ANXIETY-REDUCING BUSINESS MODEL FOR CONNECTED FULL ELECTRIC VEHICLES

SÃO PAULO
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Dissertation presented to Escola de Administração de Empresas de São Paulo of Fundação Getúlio Vargas, as condition to obtain the Master title in Business Administration.

Field of Knowledge:
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Supervisor: Prof. Dr. Julia von Maltzan Pacheco

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ABSTRACT

This thesis develops and evaluates a business model for connected full electric vehicles (FEV) for the European market. Despite a promoting political environment, various barriers have thus far prevented the FEV from becoming a mass-market vehicle. Besides cost, the most noteworthy of these barriers is represented by range anxiety, a product of FEVs' limited range, lacking availability of charging infrastructure, and long recharging times. Connected FEVs, which maintain a constant connection to the surrounding infrastructure, appear to be a promising element to overcome drivers' range anxiety. Yet their successful application requires a well functioning FEV ecosystem which can only be created through the collaboration of various stakeholders such as original equipment manufacturers (OEM), first tier suppliers (FTS), charging infrastructure and service providers (CISP), utilities, communication enablers, and governments. This thesis explores and evaluates how a business model, jointly created by these stakeholders, could look like, i.e. how stakeholders could collaborate in the design of products, services, infrastructure, and advanced mobility management, to meet drivers with a sensible value proposition that is at least equivalent to that of internal combustion engine (ICE) cars. It suggests that this value proposition will be an end-2-end package provided by CISPs or OEMs that comprises mobility packages (incl. pay per mile plans, battery leasing, charging and battery swapping (BS) infrastructure) and FEVs equipped with an on-board unit (OBU) combined with additional services targeted at range anxiety reduction. From a theoretical point of view the thesis answers the question which business model framework is suitable for the development of a holistic, i.e. all stakeholder-comprising business model for connected FEVs and defines such a business model. In doing so the thesis provides the first comprehensive business model related research findings on connected FEVs, as prior works focused on the much less complex scenario featuring only "offline" FEVs.

Motivation

My motivation for writing this thesis results from the combination of two issues. First, I perceive climate change, which has been on the political agenda for years across Europe, as a pressing issue. Similar to many scientists, I hold the opinion that large parts of the world's population stand to loose from the consequences of an ever rising average temperature of this planet. Second, I have a keen interest in cars and technology. Writing a thesis within the ELVIRE enabled me to combine these two interests. Specifically, it gave me the possibility to devote half a year of scientific work to analyze how the promotion of electric vehicles as one of the biggest levers available to slow down climate change can be helped. Through my thesis, I hoped to generate new relevant knowledge and drive forward one of Europe's most heated discussions of recent years.

Key Words: Electric Vehicles, Electric Car, Business Models, Range Anxiety

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III. List of Abbreviations

BS	Battery swapping
BSS	Battery swapping station
Cf.	Confer to / See
CISP	Charging Infrastructure and Service Provider
CMC	Control and Management Center
CS	Charging station
e.g.	for example
ELVIRE	Electric Vehicle communication to infrastructure, road services, and electricity supply
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
FEV	Full Electric Vehicle
i.e.	that is
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
IT	Information Technology
Gt.	Giga tons
GUI	Graphical User Interface
Km	Kilometer
kWh	Kilowatt hour
OBU	On-board unit
OEM	Original equipment manufacturer (automaker)
PHEV	Plug-in Hybrid Electric Vehicle
REEV	Range Extender Electric Vehicle
TCO	Total Cost of Ownership
USD	United States Dollar
USP	Unique Selling Proposition

WP	Work Package

1 Introduction

1.1 Relevance of Problem / Industry Trends

If one is to believe Europe's policymakers, the future of mobility lies in alternative drive systems. Leaping on the bandwagon of the general public's current concern for environmental issues, politicians across Europe set challenging targets for CO_2 emission reductions in hope to slow down climate change. The plans to reach these goals count on changes in various industries, including the automotive industry. Automakers are confronted with ambitious CO_2 emission targets through 2020, which could require them to gradually replace traditional ICE cars with vehicles featuring new alternative drive systems in their fleets (Bain & Company, 2008; Lache, Galves, & Nolan, 2008; European Parliament, 2010).

On the one hand, such goals seem sensible. After all, burning fossil fuels, especially oil, is responsible for a significant part of global CO_2 emissions – 10.6 Gt. CO_2, or 37% of CO_2 emissions from fuel combustion were produced from oil in 2009 (International Energy Agency, 2011). Considering additionally that, in Europe, three quarters of all consumed oil go into transport (ELVIRE, 2012a), and that oil is a finite resource, which is bound to peak eventually, a shift to alternative means of transport is inevitable in the long run. On the other hand, it seems that the oil supply of significantly more than the next 40 years is secured (Kenny, 2012), and a change in vehicle drive technology, as desirable as it may be, is not yet imperative from a resource scarcity standpoint. This is reflected in both the oil price and the current behavior of customers, who seem hesitant to embark on the fully electric journey (Nemry & Brons, 2010).

Consequently, this raises the question whether policymakers, who wish to bring about change now, have reckoned without the only group that ultimately decides about whether electric vehicles (EVs) become a success or a flop: customers. Their purchase decisions will determine cash flows, investment decisions, and the overall future of the car industry. According to The Boston Consulting Group (2009), EVs will not reach significant market share until 2020, due to their limited battery capacities, high vehicle and particularly battery prices, as well as far from comprehensive charging infrastructure: The consultants forecast that less than 3% of all new vehicle sales globally will be EVs in 2020. It appears that customers are scared to commit themselves to an ecosystem that is still in its early stages of development and which cannot yet conclusively answer one of customers' most pressing questions, i.e., whether drivers will be negatively affected by issues brought about by their EV's limited range (Hyde, 2010; Oliver Wyman, 2009).

In order to help EVs gain market shares across Europe's car markets, the suppliers of the respective ecosystem are well advised to find a convincing, negating answer to this question. A vital part of a promising attempt to craft this answer could be the connected EV, i.e., an EV with a constant wireless connection to the infrastructure that makes it possible to provide drivers with crucial supporting services. While the connected EV solution is attractive, its requirements in regards to collaboration among stakeholders in the design of products, services, infrastructure, and advanced mobility management systems are very high. The complexity brought about by the high number of (potential) stakeholders and their interests, the intricacy of systems necessary, the uncertain development of technology, and the high scale that this market entails demand a comprehensive business model that creates value for stakeholders in general and drivers in particular.

1.2 Objectives / Research Question

The goal of the thesis at hand is to propose a business model for connected FEVs in the European market. To that end, it will attempt to answer the following general research question:

What business model characteristics are required to implement 'connected' FEVs in the European context?

The general research question can be broken down into three sub-research questions:

1. What business model characteristics would a range-anxiety reducing business model for connected FEVs feature?
2. What behavioral, technical, and economic strengths and limitations does the identified business model entail?
3. What actions by governments and stakeholders would strengthen the business model and help the creation of an environment in which it is applicable?

The research questions translate into six research objectives which are elaborated upon in chapter 3.2.

1.3 Research Frameworks and Theoretical Relevance / Contribution

Combining methods of both quantitative and qualitative approaches, this thesis employs a mixed-methods research approach and features a prospective, explanatory case study design, with the ELVIRE project (cf. 1.4) as its case.[1] In the course of the thesis, several proven research frameworks and concepts are used to address the identified research objectives while simultaneously ensuring a theoretically well-founded business model development. Initially, business models are demarcated from strategy to prevent the common mistake of accidentally confusing the two concepts. Subsequently, relevant insights from business model theory are introduced. By consolidating different definitions of the term business model and analyzing their similarities and differences, an understanding of the term is developed. Based on that understanding various approaches to business model analysis are explained. Because it is actionable, integrates the customer perspective, and is suitable for the analysis of partnerships, Osterwalder and Pigneur's (2009) business model canvas approach is ultimately determined to show great promise for the purpose of the ELVIRE business model development. The framework is therefore applied in the description of FEV stakeholders' business models and for the creation of the final business model. Subsequently, a

[1] The developed business model is therefore referred to as ELVIRE business model in some instances.

strengths-and-limitations approach is employed in the evaluation of the business model from a behavioral, technical, and economic perspective.

The theoretical relevance of this thesis' research results foremost from the lack of studies that suggest connected FEV business models in a holistic fashion, i.e. by integrating several market players into the investigation while simultaneously looking to reduce range anxiety. Thus far, most studies only focus on the perspectives of single companies or industries. Additionally, only very few works have attempted to address the topic of range anxiety-reduction. Thus, the theoretical contribution of this thesis lies primarily in the development of a comprehensive business model for connected FEVs that integrates all major FEV stakeholders.

1.4 Research Context – Aims, objectives, and scope of ELVIRE

The present thesis is part of the ELVIRE research project. ELVIRE is an acronym of **EL**ectric **V**ehicle communication to **I**nfrastructure, **R**oad services, and **E**lectricity supply, and represents the first project on FEVs which is partly funded by the European Commission. As such, the ELVIRE project is embedded in the *Seventh Framework Programme for Research and Technological Development*. The ELVIRE project takes a "customer-centric view on electric mobility" and "aims at solving acceptance issues stemming from Electric Vehicle's (sic) limited range" (ELVIRE, 2012b). The project's objective "is to develop an on-board electric energy communication & service platform for realistic use-cases including the relevant external communication and services, which interacts with off-board E-service providers" (European Commission, 2008). The project is organized in five different work packages (WP), one of which, WP 2000, is focused on the identification of realistic EV use cases, the subsequent development of a FEV business model, and the definition of stakeholder interactions. The present thesis contributes to the business model development task of WP 2000.

1.5 Thesis Structure

The thesis is structured in five chapters. The first chapter, which is concluded by this paragraph, gave an introduction into the topic, briefly presented the research questions and context. The second chapter introduces related work both from the ELVIRE project and the academic world, with the aim of providing a background for the remaining parts of the thesis. Chapter three shines light upon the identified research gap and the thesis' research questions. Further, the research design and its methodology are discussed. Chapter four represents the core of the thesis. It introduces the ELVIRE business model, carries out its evaluation, and, subsequently, derives recommendations for its improvement. Finally a conclusion in chapter five summarizes the findings, indicates the research's limitations, and suggests further research.

2 Background and Related Work

This chapter constitutes the theoretical backbone of the present thesis. It provides critical insights from both the ELVIRE (2.1) and the academic background (2.2) that this thesis leans on. Studying this chapter should equip the reader with the necessary understanding of essential FEV, ELVIRE, and business model knowledge and thus prepare him/her for the subsequent research and discussion of the thesis.

2.1 ELVIRE-related Background

Subsection 2.1 aims to highlight ELVIRE-related aspects that are important to be discussed in order to answer the research questions outlined in chapter 3.2. Specifically, this section will first briefly complement the description of the ELVIRE project of chapter 1.4 with more information (2.1.1). Subsequently chapter 2.1.2 will then inform about FEVs, before assessing FEV's main advantages and disadvantages vs. ICE cars (2.1.3). Based on this, the main barriers to FEV adoption will be shed light upon in more detail (2.1.4) before the discussion of a fundamental prior ELVIRE research finding, the ELVIRE storyline, concludes the chapter (2.1.5).

2.1.1 The ELVIRE Project

As stated in chapter 1.4, the ELVIRE project is a customer-centered project on electric mobility. The project's mission is to explore how acceptance issues caused by FEVs' limited range can be solved so that drivers will embark on the full electric journey (ELVIRE, 2012b).

The fundamental difference between the ELVIRE project and other electric vehicle research projects is ELVIRE's focus on connected FEVs (cf. 2.1.2.2). Other research projects (such as G4V – Grid for Vehicles, EVUE – Electric Vehicles in Urban Europe, ELVA – Advanced Electric Vehicle Architectures, etc.) mostly dealt with “offline” electric vehicles that do not have a constant connection to the infrastructure.

The ELVIRE project on the contrary maintains that for an effective range anxiety-reduction, a constant back-end connection of FEVs is vital, as it enables the provision of a range of driver-supporting services. This belief is the reason why a comprehensive Control and Management Center (CMC) was developed within ELVIRE that serves as a customer-neutral service platform. The CMC essentially connects FEVs (through their OBU), charging infrastructure, and the external infrastructure (e.g. billing services and electricity generation). The results of the ELVIRE project and the proof of concept of the identified solution will be demonstrated in a simulation that takes place in Denmark in 2013. Figure 1 below displays the ELVIRE architecture graphically.

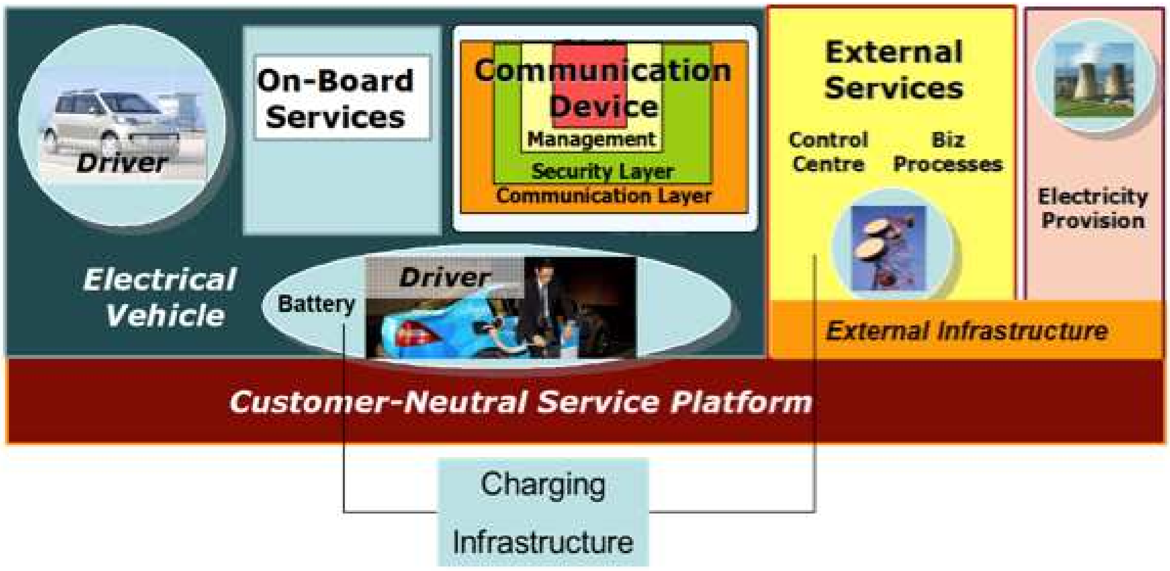

Figure 1: Visualization of the ELVIRE Architecture

2.1.2 FEVs

The following paragraphs will briefly position FEVs in the broader EV universe (2.1.2.1) and restate the reasons for their currently rising popularity (2.1.2.3).

2.1.2.1 Classification of FEVs

FEVs are one group of electric vehicles. EVs are vehicles that receive part or all of their operating energy in form of electric energy. Depending on the amount of electric energy in relation to the vehicle's total operating energy, various types of electric vehicles are distinguished (cf. Figure 2).

A general distinction is made between vehicles that obtain electric energy from external sources, as opposed to those that can only receive electric energy from an internal generator. The latter ones are commonly called mild or full hybrids. The group of EVs that can obtain electric energy from external sources consists of plug-in hybrids (PHEV), range extender electric vehicles (REEV), and FEVs (Lahl, 2009). FEVs get 100 per cent of their operating energy from electric sources and constitute the exclusive focus of the present thesis.

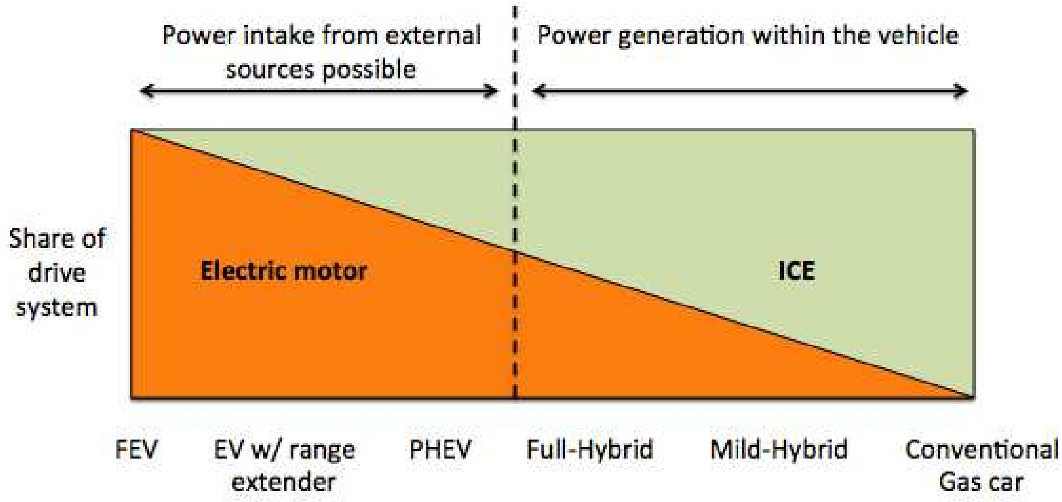

Figure 2: Types of EVs (adapted from Lahl, 2009)

Technically, two types of FEVs can be distinguished: Fuel cell electric vehicles (vehicles that generate electric energy through the burning of hydrogen, FCEVs) and vehicles that receive electric energy from the electric grid. To keep the scope of the thesis manageable, and because they are of no relevance for the ELVIRE project, FCEVs will not be regarded in the analysis.

2.1.2.2 Connected FEVs

This thesis and the ELVIRE project exclusively deals with connected FEVs. Connected FEVs are FEVs that are able to maintain a constant connection to the surrounding infrastructure to exchange data. This constant back-end connection of the FEV is one of the main prerequisites for the delivery of most range anxiety-reducing services. For the remainder of this thesis, whenever the term "FEV" is used in relation to the ELVIRE project or the analysis and findings of this thesis, it refers to a connected FEV.

Within the ELVIRE project two different types of connected FEVs are of relevance: car type A and car type B vehicles. The major difference between these two car types lies in the way that the communication with the CISP is organized. Car type A vehicles communicate with the CMC of the CISP via an OEM specific server, whereas car type B vehicles communicate directly with the CISP via wireless data communication (cf. ELVIRE Delivery D4200.2). While the technical requirements for both approaches in terms of necessary interfaces and algorithms differ, the driver experience remains unaltered. Both OEMs involved in the ELVIRE project, Renault and Volkswagen, plan to build car type A vehicles, yet only Renault is going to provide a car type B vehicle. The Renault Fluence, which is the vehicle that is going to be used in the ELVIRE demonstrators, is a car type B vehicle (ibid).

2.1.2.3 Historical background and current rationale for FEVs

FEVs are by no means a new phenomenon. In fact, FEVs were invented shortly before ICE cars, with the oldest models dating back to 1881 (Anglin, 2008). However, due to technological, especially battery-related limitations, FEVs could not gain relevant market share and soon seemed inferior compared to more reliable, convenient ICE cars (Høyer, 2007).

The recent emergence of environmental concerns and politicians' responding promises to globally cut down CO_2 emissions has reignited interest in FEVs. Whereas much of the content of todays' ubiquitous debates about climate change is still to a large part controversial, scientists mostly acknowledge a direct causal link between CO_2 emissions and global warming (The Boston Consulting Group, 2009). Since transport, as previously pointed out, consumes most of Europe's oil and thus constitutes a major CO_2 emitter, politicians are keen to induce a change in Europe's transportation systems. Because FEVs, when fueled with electricity from renewable resources, are zero emission vehicles, the EU supports their penetration of Europe's car markets (McKinsey & Company, 2009).

Responsible for 28% of total CO2 emissions, in Brazil, the transport sector is the second largest CO2 emitter (Ministry of Development, Industry and Foreign Trade, 2011). However, with its big sugar-ethanol industry, Brazil's approach to reducing the transport sector's CO_2 emissions has traditionally been focused not on FEVs but on biofuels. In fact, more than 90% of new sold cars in Brazil are equipped with flex-fuel engines that can burn ethanol-gasoline mixtures or ethanol alone (Biderman, 2010). However, this does not mean that the Brazilian government maintains a more hesitant stance towards FEVs than the EU. On the contrary, many states of the country offer large incentives for FEV drivers: road tax exemptions, tax breaks, and exemption from car-use controls in São Paulo (Brasil.gov.br, 2012). Moreover, the city of São Paulo has recently come to an agreement with French automaker Renault to employ electric vehicles in order to bring down pollution levels in Brazil's largest city. However, thus far this agreement has not produced tangible results and no definite time plans have been agreed upon (Biderman, 2010).

On a country level, Brazil also displays a considerable FEV enthusiasm. The government has clearly taken notice of the benefits of electric drivetrain technology and seems ready to support its development (Folha de São Paulo, 2010). That Brazil seriously considers the FEV as a potential future solution in its large cities show various projects currently ongoing across the country and the more than 20 companies currently developing, building and selling electric vehicles (Brasil.gov.br, 2012). The Poraquê Project, located in Aquiráz in Ceará for example looks into the possibility of converting ICE vehicles into FEV vehicles and is supported by big players from the industry, most notably the BNB Bank (Ministry of Development, Industry and Foreign Trade, 2011). Currently 72 electric vehicles are licensed across the country. According to Deloitte (2012), this number is bound to rise significantly: the consultancy reports that Brazilians are among the nations that most eagerly await a FEV mass-market success. Were the price of gasoline to remain above R$4.30, a significant FEV market would open up in Brazil (Deloitte, 2012). Spanish energy giant Endesa agrees and has already begun the installation of charge spots in Brazil (Evwind.es, 2012).

2.1.3 FEVs vs. ICE cars

The following paragraphs attempt to demarcate FEVs from conventional gas or diesel cars. Most of the analysis will be presented from drivers' perspectives, as the ELVIRE approach is centered on drivers as well, and focuses on economic (2.1.3.1), environmental (2.1.3.2), and driving-related (2.1.3.3) criteria. Generally, FEV drivers are faced with both advantages and disadvantages in these categories when compared to ICE drivers.

2.1.3.1 Economic Analysis

The economic analysis revolves around FEVs' vs. ICE cars' total cost of ownership (TCO), i.e. the combination of purchase price and yearly running costs.

1. Purchase price

Generally, the purchase price of FEVs is higher than the price of comparable ICE vehicles. This is due to

1.1) the high cost of lithium-ion battery packages
1.2) the high cost of FEVs' OBUs
1.3) the insufficient existence of subsidies for FEVs in most markets

Regarding 1.1) The Boston Consulting Group (2010) estimated battery package prices to be at USD 1,000 – 1,200 per kWh in 2009, and forecasted that they would drop to USD 570 – 700 per kWh until 2020. In 2010, John Gartner from Pike Research, estimated prices to be at USD 900 per kWh, dropping 10 – 15% per year (Hybridcars.com, 2010). ELVIRE consortium partner Better Place maintains that battery prices are already much lower, claiming that in 2012 they will purchase them at a price of USD 400 per kWh (Kanellos, 2010). Assuming the latter statement is correct, then the battery will add

*USD 400 * # kWh of battery package*

to a FEV's cost.

It must be pointed out that the USD 400 figure of Better Place appears to be at the very low end of prices to be found across all consulted sources. According to Lytton (2010), batteries may contribute up to 50% of a FEV's total cost.

Regarding 1.2) Most FEVs will require a complex computer system for the monitoring of the vehicle status and communication with driver and surrounding infrastructure. Some experts conceive that there may be cheap FEVs without a complex OBU solution (Zarcula, 2012). They posit it possible that mobile phone applications could provide basic FEV functionalities, which would help keep the price of FEVs low. However, it is generally held that the majority of FEVs will be equipped with a comprehensive OBU solution to neutralize range anxiety (Colet, 2011). Depending on the functionality offered by the OBU, prices will differ. The most simple OBUs available today cost about € 500 and offer basic features such as battery monitoring. These OBUs however will not have a graphical user interface (GUI) and no back-end connection to the Internet or service providers. A normal OBU solution with a GUI and a broader spectrum of services, encompassing for instance charge spot suggestions and navigation, cost about € 1,000. The most advanced systems that additionally provide back-end connections to service providers and allow for the provisioning of all use cases identified in the ELVIRE storyline (see Appendix A3), cost about € 2,500 (Zarcula, 2012). Experts believe that many FEVs will be equipped with such devices as they are conducive to reducing drivers range anxiety (cf. 4.4.2.3; Colet, 2011).

Regarding 1.3) Some governments subsidize FEV purchases, which have a purchase price reducing effect from the customer's perspective. The subsidies can take various forms. In Belgium, for instance, purchasers can deduct 30% of the FEV's purchase price from their income tax (ACEA, 2010).

In Denmark, FEVs are exempted from the vehicle registration tax. In the United Kingdom, the government directly pays for up to 25% of a FEV's list price (up to £ 5,000) (ibid). Another form of government policies that could support FEV adoption is the higher taxation of ICE cars (e.g. based on tailpipe emissions). As a survey conducted by Freas, Lang, and Lee (2011) revealed, subsidies can have a very significant effect on consumers' vehicle purchase decisions: 78% of the respondents stated that they would chose the FEV over the comparable ICE car if a government subsidy reduces the purchase price to an equal level (Freas, Lang, & Lee, 2011).

2. Yearly running costs

The running costs of FEVs are commonly assumed to be lower than those of ICE cars (Holzman, 2008; The Economist, 2012). This comparison depends on various aspects:

2.1) the vehicles' efficiency

2.2) the cost of electricity and gasoline / diesel

2.3) the annual mileage

2.4) the depreciation of vehicles and batteries

2.5) the cost of maintenance

2.6) the cost of insurance

2.7) and annual taxes

Regarding 2.1) The efficiency of ICEs is commonly stated in terms of liter per 100 km, i.e. the amount of liters of gasoline or diesel a vehicle needs to drive a distance of 100 km. For FEVs, the corresponding metric is kWh per 100 km, i.e. how many kWh are needed to travel a 100 km distance. Among other things, the vehicle's efficiency depends on the size of its engine, the vehicle's weight, the intensity of the use of supporting systems, such as heating, air-conditioning, and navigation, and the drivers' driving style (cf. 2.1.4.2).

Regarding 2.2) Electricity and gasoline / diesel prices impact yearly running costs as they represent the main input factors of FEVs and ICEs to ensure the operation of the vehicle. Prices differ strongly from country to country. At per kWh prices of € 0.0826 and € 0.0973, respectively, electricity for instance was cheap in Bulgaria and Estonia, whereas it was expensive in Denmark (€ 0.2908) and Germany (€ 0.2528) in 2011 (BMWi, 2012). The same source reveals that in 2010, diesel was expensive in the U.K. at € 1.39, but cheap in Luxemburg € at 0.99. Gasoline was cheap in Latvia at € 1.09 but much more expensive in the Netherlands at € 1.50 (ibid).

Besides the current level of prices, drivers must take into account the *future* price developments of electricity and gasoline / diesel. In that regard, it is generally held that FEV drivers benefit from the reduced dependency of the price of their mobility from the oil price. Oil as a finite resource is bound to become more expensive over time and constitutes a main driver of gasoline prices. Accordingly, the United States Energy Information Agency expects rising gasoline prices for the United States, whereas electricity prices are predicted to be stable (Baumhefner, 2011; cf. Figure 3).

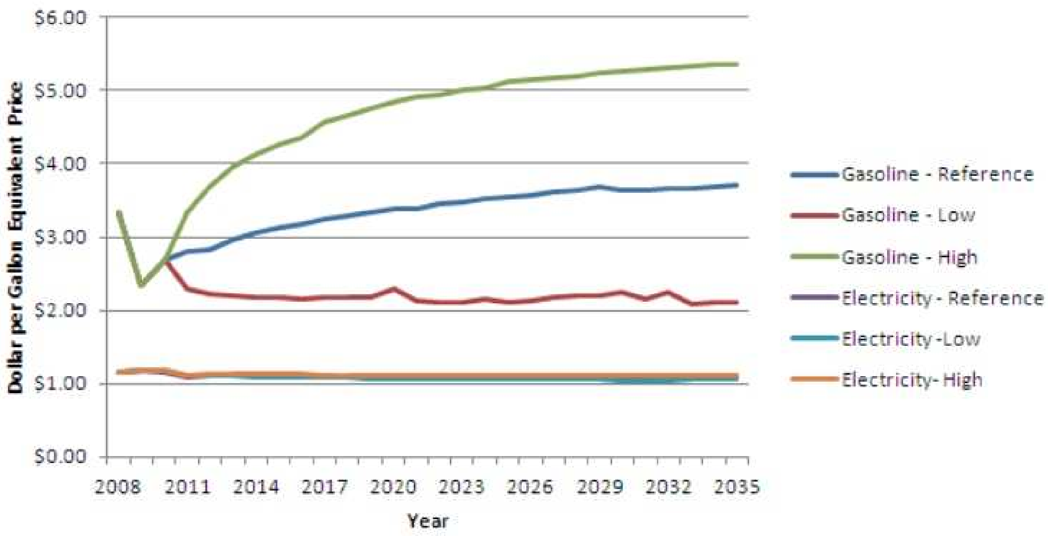

Figure 3: U.S. gasoline and electricity price forecasts (Energy Information Agency, 2010, as reported in Baumhefner, 2011)

Furthermore, oil prices have historically been more volatile than electricity prices. The graph below from the Edison Electric Institute (cf. Figure 4) exemplarily shows this for the United States, the second largest single auto market in the world.

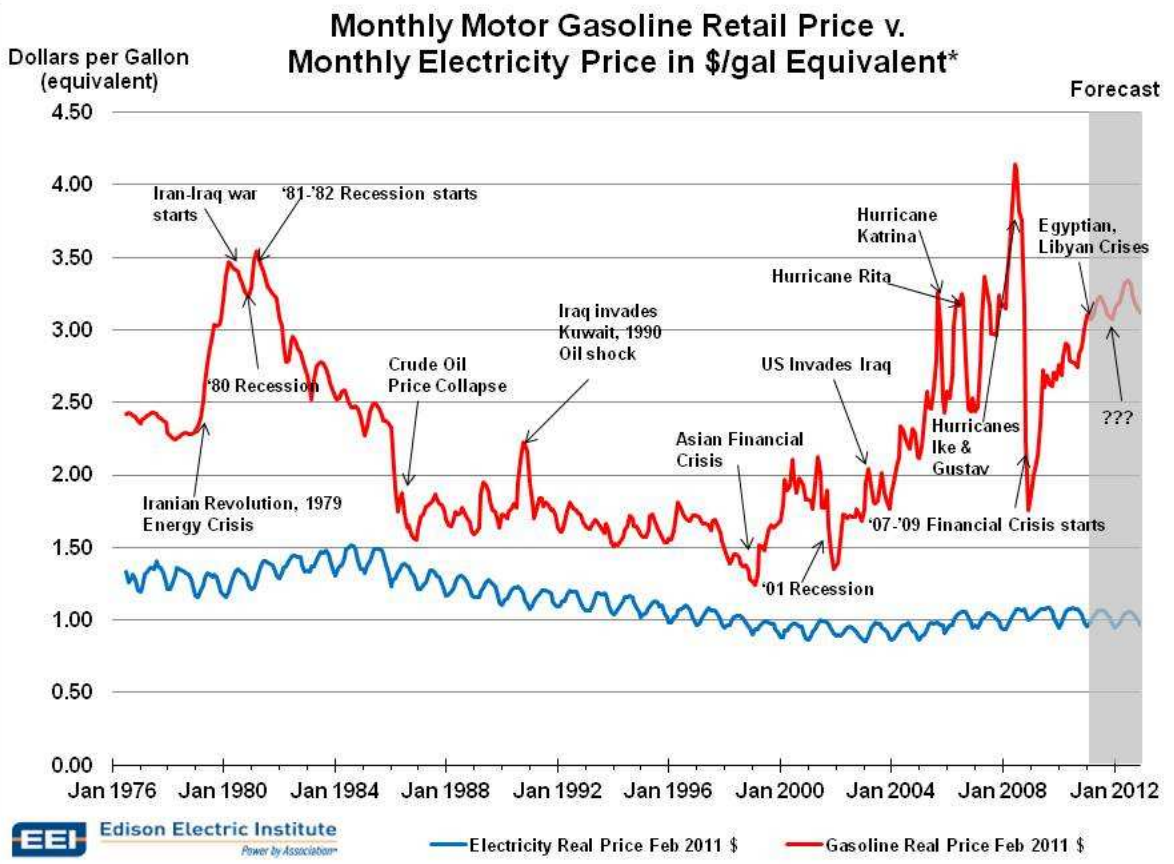

Figure 4: U.S. monthly gasoline vs. electricity prices (Edison Electric Institute, 2011, as reported in Baumhefner, 2011)

By driving vehicles powered through electricity, drivers thus benefit from a probably more benevolent price development and increased price stability.

Regarding 2.3) The number of kilometers a vehicle is driven each year affects its yearly running costs. That is because the total distance determines how large a relative per km cost advantage of one drive system over the other is over a whole year. According to AXA (2009), the average European drives 19,669 km each year. With a distance of 22,875 km, Spanish drive the most, whereas Belgians drive the least with 16,803 km.

Regarding 2.4) Both ICE and FEV vehicles lose value both over time and for each km driven. It is generally maintained that ICE vehicles lose 10% of their value per year, and 2% of their purchase price value for each 10,000 km driven (Luiginbühl, 2011). Due to their novelty, it is not certain yet how FEV value losses will compare to these numbers, making it impossible to provide a rule of thumb. Experts agree however that FEVs' highest share of value losses will be a result of battery depreciation. Mitsubishi, for instance, acknowledges that "its electric i-miev will depreciate by nearly £15,000 in its first three years" and that its battery "should work, at least partially, for up to 100,000 miles" (Milligan, 2010). Better Place on the other hand, is more optimistic and forecasts a lifetime of 200,000 miles for their battery (Wolkin, 2011) – and thus roughly assumes a depreciation rate half as high as Mitsubishi.

Regarding 2.5) Cars have to be maintained, be repaired, and undergo certain inspections in regular intervals. The costs for this depend, among other things, on the model, on the yearly driving distance, and on the vehicle's age. It is generally believed that FEVs will incur lower costs for maintenance as they have a significantly smaller number of moving parts than ICE vehicles, their electric motors do not require maintenance, and no fluids need to swapped (besides brake fluids). Additionally, the energy recuperation mechanisms (regenerative braking) significantly help conserving the brakes (U.S. Department of Energy, 2012). According to Touchstone Energy (2012), during a field test conducted by the U.S. Postal Service it was found out that FEVs' maintenance costs accumulated to just 54% of that of ICE vehicles.

In terms of insurance, it is currently expected that FEVs will be slightly costlier to insure because of the lack of long-term accident statistics and higher chances of vehicles being totaled in case of a crash (Blanco, 2010).

Regarding 2.6) The tax burden for vehicles is different from country to country. However, there are many countries that support FEVs with tax incentives (ACEA, 2010), indicating that they will be less costly in terms of taxes (Sonnenschein, 2010).

The above paragraphs split up the most relevant yearly running costs for FEV drivers in separate items. However, the detailed breakdown of these costs might not be interesting for all FEV drivers. Those, who purchase a mobility package from e.g. a service provider such as Better Place, may find some of these costs being bundled in a package. In the case of Better Place, for instance, the cost of electricity is irrelevant for drivers, as they are guaranteed free of charge recharging and battery swapping at the Better Place stations.

TCO

The preceding paragraphs should have conveyed that a vehicle's TCO depend on many different, partly interrelated, factors. It can thus not be definitely stated in which direction a TCO comparison of FEVs and ICE cars would go. Pro-FEV-minded interest groups generally proclaim that FEVs have lower running costs which offset the purchase price premium, resulting in lower TCO for FEV drivers than for ICE drivers. One of many examples for such groups is ESB from Ireland, which, without further explaining its calculations, claims that FEVs' TCO are roughly 70 per cent of those of ICE cars (ESB, 2012). However, this position is highly controversial, with most experts arguing that FEVs' TCO will be above the 100 per cent figure. This opinion is mainly attributed to the high value losses that are expected to be incurred by FEVs' battery packages (Milligan, 2010), or consumers' holding periods that are too short to recoup the purchase price premiums through low running costs (The Economist, 2012).

2.1.3.2 Environmental Analysis

Environmental benefits for drivers come in the shape of reduced CO_2 emissions, zero tailpipe emissions, and lower levels of air and noise pollution through cars. Bree, Verbong, and Kramer (2010) point out that besides causing global warming, CO_2 emissions worsen “local air quality” (p. 529). This aspect grows in importance as more and more people move to megacities for which traffic density becomes an increasingly pressing topic. Interestingly, the last point has recently been put on its head and used to argue against FEVs: Researchers from the University of Tennessee discovered that in China FEVs could prove more harmful to the environment and humans than ICE cars. The reason for this was found in hazardous particle emissions from Chinese coal-burning electricity generation plants that are worse for the environment than ICE vehicle’s tailpipe emissions (Cherry, 2012). At this point it must be pointed out that the Chinese energy mix is more dependent on coal (>75%) than the European one (30% coal in 2007, decreasing) and that Chinese coal plants are dirtier than those in the west (VDMA, 2010; Koebler, 2012). Nevertheless there is a fervid debate in the general public as to whether FEVs are really greener than ICE cars.[2] The two reasons generally given for this are:

1.) FEVs run on electricity. Electricity has to be produced. In its production, fossil fuels are burned and CO_2 is emitted (Johnson J. , 2012; Reid, 2010). And

2.) FEVs need batteries. Batteries are extremely energy-intensive in their production and recycling (CNW Marketing Research, 2007; Webster, 2011; Will, 2007).

Both arguments have been refuted multiple times (for counters to the first argument cf. to Gordon-Bloomfield (2012), Lampton (2011), and Wirtschaftswoche (2010) for rebuttals to the second argument cf. to Notter et al. (2010), Gleick, (2007), Holleb (2009)), however, the dispute goes on.

2.1.3.3 Driving-related Analysis

In terms of driving related characteristics, FEVs bring about a range of benefits that the FEV industry frequently advertises. Since electric motors are quieter in operation than internal combustion engines, high noise levels experienced in the car while driving even at high velocities are a thing of the past. Further, the almost constant torque of electric motors greatly increases FEVs’ acceleration performance in relation to that of internal combustion engines with comparable motor power (Lache, Galves, & Nolan, 2008; Gibson, 2010). Additionally, for drivers with low daily driving distances, trips to and/or stops at the gas stations will no longer be necessary. Drivers can just plug in their vehicles over night at home and thus save time (Autos.com, 2010).

In spite of all these advantages, there is still at least one very significant disadvantage: After driving a certain distance the FEV is inevitably grounded for a certain time and needs to be recharged. If not at home, the driver needs to find a charging station and wait a certain time during which the FEV cannot be used. Most FEVs built by mainstream OEMs in the market today have a maximum range of 160 km and the average ground time after this drive is 4-6 hours, unless the vehicle is quick charged, which may reduce the ground time to less than 1 hour (Frost & Sullivan, 2009; Frost & Sullivan, 2011a; Zarcula, 2012).

[2] Cf. http://www.macrobusiness.com.au/2012/01/weekend-musing-electric-cars/ and the responses below for one of many examples of arguments revolving around the greenness of FEVs.

Table 1 summarizes FEVs' main advantages and disadvantages in the discussed categories.

Category	Economic	Environmental	Driving-related
Strengths	- In most instances lower yearly running costs esp. due to - low prices for electricity - better well-to-wheel efficiency of electric motors - Less maintenance requirements	- Reduced overall CO2 emissions given current European energy mix - Potential of reaching zero CO2 emissions if FEVs powered with renewable energy - Zero tailpipe emissions, thus better air quality - Reduced noise pollution	- Quiet motors - Very good acceleration - Time saving effect for driver segment with low daily ranges (no petrol station stops)
Weak-nesses	- Higher TCO in most countries through - High purchase prices - Insufficient subsidies	- "Greenness" of FEVs dependent on countries' energy mix - Battery production and recycling is energy intensive	- Limited range - Limited recharging infrastructure availability - Long recharging times

Table 1: Strengths and Weaknesses of FEVs vs. ICE cars

2.1.4 Barriers to FEV adoption

The preceding chapter indicates that FEVs have certain benefits and disadvantages if judged upon from a consumers' perspective. Even though they are appealing for various economic, environmental, and driving-related reasons, customers are hesitant to purchase FEVs: According to Aral (2011), 0.3% of Germans planning to purchase a vehicle in 2012, consider buying a FEV. The analysis suggests that FEVs' popularity suffers from technological limitations that manifest themselves in

- economic barriers (in the following referred to as affordability) and
- driving-related aspects that partly clash with consumers' perceptions and expectations, causing what is known as range anxiety.

The following paragraphs are devoted to briefly highlighting these points. The focus will be slightly in favor of the discussion of range anxiety, as it constitutes the ELVIRE project's main concern.

2.1.4.1 Affordability, price and payment

FEVs are certainly impeded by the high cost of today's battery technology that drives up the vehicles' purchase prices and in most countries tends to result in higher TCOs (Squatriglia, 2009). Depending on the parameters of the country, the purchase price premium can be significant: Tsang et al. (2012) state that in the case of Britain, FEVs' prices rank at least £ 15,000 higher than those of popular ICE cars.

Freas, Lang, and Lee (2011) have surveyed and confirmed the relevance of affordability as a major FEV adoption barrier. They found that fuel cost per km and upfront vehicle cost were, together with range and recharge times, among the top four criteria when it comes to choosing a vehicle. Thus they conclude that "with cost highlighted as such an important factor, countries with governments offering either high subsidies for FEVs or levying high taxes on ICE vehicles should be the focal points when trying to achieve a high penetration" (p. 34). This finding concurs with Lache, Galves, and

Nolan (2008) who state that “government sponsorship is a key variable” (p. 11) to reduce upfront cost and increase affordability.

Besides the technology-induced cost issue, technology presents hurdles to FEV adoption as it creates perceptual barriers in drivers. Most notably, FEVs instill feelings of range anxiety in drivers (Streeter, 2012). The following subchapter will deal with the latter in detail.

2.1.4.2 Range Anxiety

Next to high upfront costs, range anxiety is commonly reported as the major hindrance preventing mass market FEV adoption (Nilsson, 2011). To understand the meaning of the term, one best begins with analyzing its two components: *Anxiety* comes from the Latin noun *anxietas* and refers to a psychological and physiological state characterized by uneasiness and concern about a future event whose occurrence is uncertain (Davison, 2008). *Range* relates to the autonomy, i.e., the driving distance a vehicle can go on one charge. Consequently, Tate, Harpster, and Savagian (2008) define range anxiety as “continual concern and fear of becoming stranded with a discharged battery in a limited range vehicle” (p. 3). Searching for the sources of range anxiety, Kirsch, Goldfarb, and Jaguste (2009) find the phenomenon is the result of consumers’ wish to be able to take long trips combined with FEVs’ comparatively small range when compared with ICE cars.

It thus appears as if range anxiety is the product of drivers’ fears stemming from multiple issues:

1.) Insecurity whether FEVs’ driving ranges are sufficient for their needs

2.) Sparsely distributed charging infrastructure

3.) Long recharge time spans

Regarding 1: Today’s FEV battery packages offer driving ranges of about 160 km (Frost & Sullivan, 2011b; Zarcula, 2012). This is significantly (ca. 500 km) less than the distance an ICE car can drive on one full tank. However, statistically speaking, a range of 160 km per charge should be more than enough for most daily trips of the average driver (Lache, Galves, & Nolan, 2008). Multiple studies have analyzed driving behaviors of people in various car markets. Freas, Lang, and Lee (2011) conducted a survey in Switzerland and found that 93% of the driving distances on a typical day fall within the advertised 185 km range of the Renault Fluence. Interestingly, a very similar outcome was the result of a study conducted by PhD students from the University of Columbia. They found that 93% of all drivers on U.S. streets drive less than 100 miles (161 km) in a day (Van Haaren, 2011). Looked upon from that perspective, one might conclude that range anxiety often is a psychological construct (Taylor, 2009) without a rational foundation. Sonnenschein (2010) shares this view. He states: “the problem is not range, but range anxiety” (p. 52). Van Haaren, as cited in Streeter (2012) assumes that range anxiety is thus a result of the high level of comfort and independence that drivers are traditionally used to from ICE vehicles.

Besides the lower range as such, range anxiety is also strengthened by the high insecurity whether the advertised distance will really be delivered (Nemry & Brons, 2010). The reason for this might lie in the multitude of factors that affects driving range in a FEV such as vehicle specific consumption data (e.g., powertrain, auxiliaries, vehicle weight, and payload), battery-related factors (e.g., energy density, age, and temperature performance), driver specific aspects (e.g., driving style, usage intensity of heating and air conditioning), and route specific aspects (e.g., road classes, topography, outside temperature) (Lüttringhaus, 2011; Nilsson, 2011). Some of these elements might even result in different autonomies for two trips of the same length. The argument that the abovementioned aspects are also valid for an ICE car is partly correct. However it seems that the novelty of the battery technology amplifies worries related to range volatility and leaves consumers unsure what to expect (Streeter, 2012). Additionally, volatility appears scarier for a range of 160 km than for a range of 700 km.

Regarding 2: Brown, Pyke, and Steenhof (2010) emphasize that the "development of supporting charging infrastructure such as commercial charging stations or battery exchange facilities, similar to that of the refueling infrastructure available for the internal combustion engine, will be essential in supporting broad-based deployment of the EV" (p. 3802). However, unlike traditional gas stations, charging stations for electric vehicles are currently sparsely distributed. Melaina and Bremson (2008) explain the problem as a vicious cycle: OEMs do not want to build cars that will not be bought, drivers do not want to purchase cars that cannot be universally refueled, and service providers do not want to build up infrastructure for vehicles that nobody drives.

The exact number of charge stations in Europe is hard to come by. LEMnet, which claims to be Europe's most comprehensive private and public charging spot data base (LEMnet, 2011), lists 3,593 charge stations across Europe as of March 13, 2012 (LEMnet, 2012). A comparison with other charge station data bases such as Austria's ElektroTankstellen internet database (www.elektrotankstellen.net), reveals some but far from perfect overlap between the data sets, indicating that the 3,572 figure is definitely too small. In fact, Frost & Sullivan (2011b) claims that in 2010, the fourteen most western European countries had 4,860 CS installed across Europe. The research firm forecasts this number to reach 2 million by 2017 (ibid). Nevertheless, the sources suggest that today's real number of CS will by no means come close to the number of more than 100,000 gas stations in Europe (Retail-Index, 2012). Considering additionally that a charging process takes significantly longer than a refueling process of an ICE car, the current lack of infrastructure becomes apparent and seems to aggravate range anxiety.

Regarding 3: The Society of Automotive Engineers (SAE) distinguishes between direct current (DC) and alternating current (AC) charging. AC charging, which allows energy to flow bi-directionally, is generally slower than DC charging, which allows only one-directional energy flows (D. Dutkiewicz, 2011). Currently, depending on the amount of energy transferred over a given time span, three types of both DC and AC charging are being distinguished.[3]

For simplicity, experts often refer to AC level 1 and 2 as regular charging, whereby DC level 1 to 3 are commonly mentioned as level 3 DC fast charging (Coulomb Technologies, 2012). Fast charging is currently still very expensive, so that the majority of charge spots across Europe offer regular

[3] For detailed current charging standards given by SAE (2011) please refer to Appendix A4.

charging (Deloitte, 2011). ELVIRE consortium partner Better Place also provides regular charging only (Better Place has no need for fast charging as they offer Battery Switching), and states that it may take four to eight hours to recharge a completely depleted vehicle (Better Place, 2012a). This circumstance makes FEVs comparably less attractive to ICEs that only need a few minutes to refuel (Tsang et al., 2012), and the thought of having to recharge during a journey in a FEV, without being able to resort to BS, relatively daunting.

2.1.4.2.1 Range anxiety mitigation

Nilsson researched the topic of range anxiety in depth in her 2011 paper "Electric vehicles. The phenomenon of Range Anxiety". In what may be the most comprehensive piece of research on the topic up to date, the author suggests five distinct approaches that help the mitigation of range anxiety. The approaches revolve around information, prevention, dissolving, risk-reduction, and consequence elimination and are displayed in Table 2 below.

Underlying approach	Service
Inform about the situation	– Inform about current range and status of the EV
Provide strategies to prevent the situation	– Award good behavior – Provide warnings on low battery – Give suggestions on actions to best extend your range – Pre-heat the car while charging – Remote access of the vehicles status – Social competition – Energy usage information – Provide accurate and transparent information
Provide solutions to solve the situation	– Information about nearest charging station – A gasoline engine as a back up – Use a second battery as back up
Limit the risk for the occurrence of the situation	– Inform about areas reachable by the EV – Suggestions base (sic) on personalized driving pattern – Fast charging abilities – Simulate you (sic) expected range usage before the buy – Improve the range with new technology solutions – Provide as many publicly available charging station as possible – Charge the EVs at a (sic) interesting place
Eliminate the consequences of the situation	– Rescue in case of out of energy – Provide a "loan car"

Table 2: Approaches to limit the situation in which drivers experience range anxiety (adapted from Nilsson, 2011, p. 6)

A detailed discussion of the approaches and their underlying services can be found in Nilsson (2011), pp. 6-9.

2.1.5 ELVIRE storyline and use case development

One crucial goal of the ELVIRE project is to identify which essential requirements FEVs will have to fulfill from customers' perspectives in order to reduce their range anxiety. This was achieved in a two-step process.

First, the ELVIRE storyline was created. Essentially, the storyline describes a typical FEV driver's driving behaviors and mobility needs in four different phases of his driving day: Driving with a plan (i.e. using the OBU's navigation system), charging, driving without a plan, arriving and parking at home. The phases were subsequently broken down in various scenarios. Scenarios were chosen so as to cover most conceivable FEV needs an average driver would have in terms of both driving and charging (pre-drive services, continuous monitoring, navigating to target destination, charging the vehicle and the monitoring thereof, responding to problems during the charging process, smart navigation, battery swapping, and home charging among others) (cf. ELVIRE Delivery D2100.1&2).

In a second step, crucial functional requirements that the FEV ecosystem will need to offer were derived from the storyline. In other words, it was analyzed how drivers' charging and driving needs could be met effectively through products and services (= use cases). In this process three fundamentally different types of services were identified: driving services, energy services, and general services. Driving services refer to services the user can access whenever he is in the car, such as smart navigation or range notifications. Energy services comprise services related to charging. General services mean services that do not fit either of these categories, such as billing and roaming.

The storyline, i.e. customers' direct needs, was thus the foundation of the FEV business model's customer-targeted value propositions. This process ensured that a high understanding of both drivers' needs and effective solutions was generated in order to maximize customer satisfaction. For the entire storyline and the identified key products and services that will need to be offered, and therefore the answer to research objective number 1, please refer to Appendix A3.

2.2 Academic Background: Business Models

The present subchapter aims to give the reader the necessary background knowledge on business models. Therefore, various business model frameworks and theories will be described to lay the groundwork for understanding the succeeding description and analysis of the ELVIRE business model. As a basis for this discussion, the term *business model* shall first generally be distinguished from *strategy*, as researchers suggest that these two terms are often falsely used interchangeably (Magretta, 2002). The separation of the two concepts prepares for the second subchapter in which various definitions of the term business model are provided to deepen the understanding of the term. The third subchapter then presents various theoretical approaches to business models. Due to the vast amount of research done in the field, the number of approaches is numerous and not all can be portrayed here. Thus the most suitable ones were selected for discussion.

2.2.1 Business Model vs. Strategy

The fields of strategy and business model research deal with different concepts. The older of the two fields, strategy research, deals, according to Mintzberg and Quinn (1991), with five central elements: strategy as a plan, ploy, pattern, position, and perspective. Whittington (1993) presents four basic approaches to strategy: classical, evolutionary, processual, and systemic. Just these two views taken together already hint at the broadness of the strategy research field and indicate that it is hardly possible to present the entire universe of strategy's schools of thought in the present thesis. Instead, a brief explanation of what is usually understood by strategy should help to demarcate it from the main concept of interest: business model.

Chandler (1962) defines strategy „as the determination of the basic long term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out those goals” (pp. 15-16). Three years later, Ansoff (1965) explained that strategy is about “decisions on what kind of business the firm should seek to be in” (p. viii). The works cited above suggest looking at strategy from a strengths and weaknesses-centered resource-based view and emphasize the need for a match between a firm’s strategy and structure (Hoskisson et al., 1999). Porter (1980, 1996), among others, took the strategy discussion to the field of industrial organization economics, developing Hunt’s (1972) concept of “strategic groups” and stating that “competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value” (p. 64). According to Porter (1996), strategy is thus the choice of activities that a firm must tailor to its industry and company specifics in order to gain a competitive advantage and outperform competitors. He suggests three generic strategies for firms to choose from and customize to their specific environments and needs: low cost leadership, differentiation and focus (Porter, 1985).

Researchers identified a number of methods of how strategies are formulated and set in organizations. Hart (1992) proposes five distinctive categories of strategy making modes that differ along the influence that top management has in the strategy formation as opposed to the influence that can be exerted by other organizational members. Mintzberg (1990) distinguishes 10 schools of thought of strategy formation.

Irrespective of how exactly a strategy is decided upon, once the decision is made, the concept of business model comes into play. While the exact definitions of business models will be given in the following subchapter, it can be forestalled that business models define how a firm relates its assets, policies, and governance to one another so that a coherent logic is formed that allows for value creation along the chosen strategy. According to Lechner (2010) strategy can thus be likened to a vector and business model to a machine or system as displayed in Figure 5.

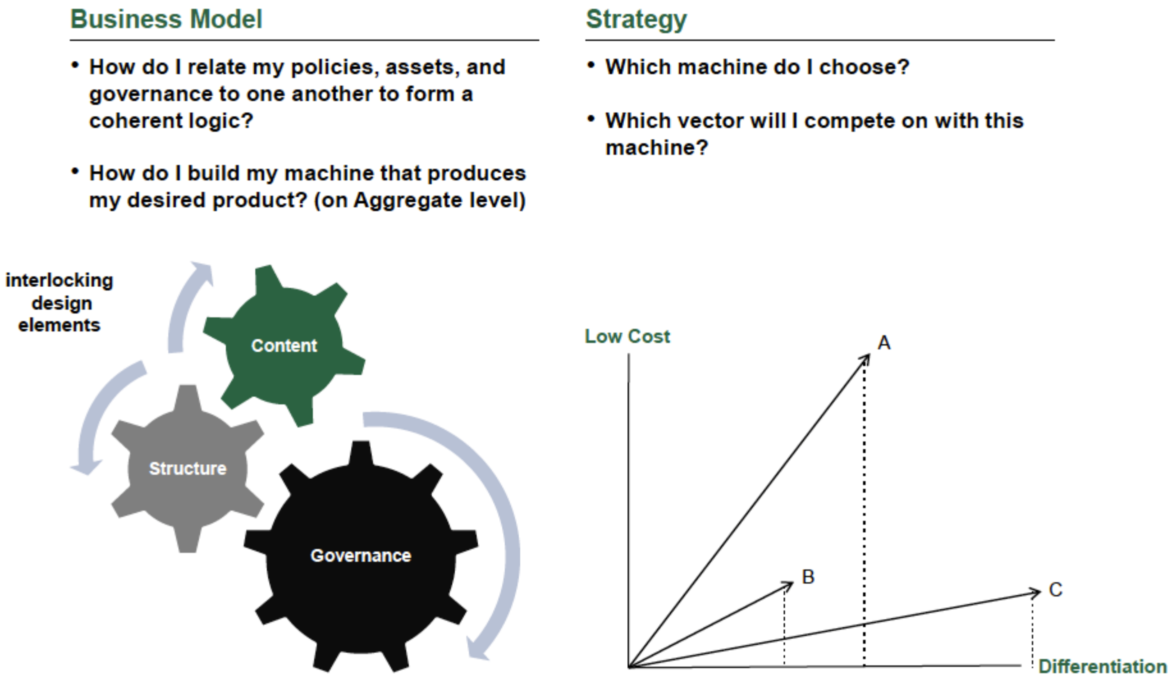

Figure 5: Strategy vs. Business Model (Lechner, 2010, p.3)

2.2.2 Business Model Definition

Despite the term's long tradition in business theory - "business model" was first introduced by Drucker in 1954 - there is little consensus among researchers as to what is actually meant by the term business model (Casadesus-Masanell & Ricart; 2007; Linder & Cantrell, 2000; Shafer, Smith, & Linder 2005). Chesbrough (2007) noted that whereas "the term `business model´ is often used", it is "not often clearly defined" (p. 12). The likely reason for this observation is that business models within the same industry did not tend to differ too much prior to the 1990s. Only with the large-scale introduction of new business models across many industries (e.g. IT, computing and bottom of the pyramid businesses), researchers' interest was sparked and the term gained prominence in business literature (Casadesus-Masanell & Ricart, 2007).

Because of the difficulties to provide a clear-cut, universally accepted definition of the term business model, the following paragraphs are dedicated to the presentation of various definition efforts by different researchers. Afterwards, the common characteristics of these definitions will be highlighted in order to serve as a starting point for the following discussion of theoretical approaches.

Magretta (2002) defined business model by likening it to an explanative story that sheds light on how a firm works. Accordingly, a business model specifies the different customer segments and articulates what they value. Additionally, the business model describes how a firm provides value to customers at sensible costs. Casadesus-Masanell and Ricart (2007) argue that this definition appears rather vague and imprecise. However, the two researchers pinpoint that in spite of the definition's apparent broadness, it indirectly hints at two seemingly central factors: value creation and value capturing.

Chesbrough (2007) also defined business model in his paper "Business model innovation: it's not just about technology anymore". After pointing out the general vagueness of the construct, he proposes a working definition comprising six specific functions of a business model: specification of value proposition, market segments, value chain structure, sources of revenues and costs, firm positioning in the inter-company value chain, and competitive strategy. Realizing the lacking crispness of this definition, Chesbrough (2007) summarizes that "at its heart, a business model performs two important functions: value creation and value capture" (p.12).

Amit and Zott propose another definition of business model in their 2001 paper dealing with value creation in e-business. In this paper, the authors understand "business model" as a construct that allows for value creation through business opportunity exploitation. Realizing that business opportunities usually come along in the shape of transactions of some sort, the authors explain that a business model is a portrait of the "design (…) of content, structure, and governance" (p. 493) of transactions.

Osterwalder and Pigneur (2009) define business model as the logic behind value creation, delivery, and capturing within companies. Further, the authors explain that a business model essentially functions as "a blueprint for a strategy to be implemented through organizational structures, processes and systems" (p. 15).

In summary, it can be concluded that there indeed is no universal definition of the term business model. However, the analysis of the four sources above reveals that researchers agree on certain elements that seem to be reoccurring in most works that put forward definitions of the term business model. These elements are

- Value creation
- Value delivery
- Value capturing and
- "Content, structure, and governance" (Amit and Zott, 2001, p. 493) of transactions

The following paragraphs will now closer analyze various theoretical approaches in light of the identified fundamental elements. Finally, one approach will be selected for the creation of the ELVIRE business model.

2.2.3 Business Model Theories and Frameworks

Now that a common ground of understanding has been established through the adumbration of the term "business model", a few business model theories will be explored. The multitude of definitions of the term is closely matched by a similarly large number of business model concepts. The following presentations of different approaches provide the basis for the final selection of a business model concept that will be followed for the remainder of the thesis.

2.2.3.1 Amit and Zott

Amit and Zott's (2001) analysis of value creation in e-business is an interesting starting point, because by looking at the creation of value, the authors begin at a seemingly logical first step. In their research, Amit and Zott (2001) discovered four major interdependent determinants of successful value creation in e-business:

- **Efficiency** means the efficacy of transactions. Efficiency is higher, the lower the costs for each transaction become. Consequently, efficiency can rise due to a number of factors such as lower information asymmetries, search costs, bargaining costs or distribution costs. The authors acknowledge that this finding "is consistent with transaction cost theory" (p. 503).
- **Complementarities** are existent when two products jointly create more value than each would in singularity. The value of complementarities had been acknowledged multiple times before in business research, for instance through Brandenburger and Nalebuff (1996) and Gulati (1999) who focused on complementarities' importance in network theory.
- **Lock-in** is essentially a form of customer and strategic partner retention. By avoiding customer and partner churn, lock-in creates value through repeat transactions and "increased wtp (author's note: willingness to pay) of customers and lower opportunity costs for firms" (p. 505).
- **Novelty** means innovation. Firms innovate the content, structure, and governance of transactions. "They create value by connecting previously unconnected parties, eliminating inefficiencies in the buying and selling processes through adopting innovative transaction methods, capturing latent consumer needs, and/or by creating entirely new markets" (p. 508).

Because of the abovementioned interconnectedness of these categories, Amit and Zott (2001) accordingly state that the value creating potential of companies cannot be described by one single theory, but only by various theoretical approaches taken together. Additionally, the authors explain that the above described value creating elements are deployed along three dimensions: transaction content, structure and governance. Essentially, the authors conclude "a firm's business model is an important locus of innovation and a crucial source of value creation for the firm and its suppliers, partners, and customers" (p. 493).

2.2.3.2 Casadesus-Masanell and Ricart

Six years after Amit and Zott (2001), Harvard's Casadesus-Masanell and IESE's Ricart published a working paper titled "Competing through Business Models". In this paper, the authors define a business model as "(1) a set choices and (2) the set of consequences arising from those choices" (p. 3). Casadesus-Masanell and Ricart (2007) suggest three dimensions in which choices have to be made:

- **Policies**: Choices in policies regard the actions of the firm in the field of operations

- **Assets**: Decisions about the tangible resources the firm employs
- **Governance**: Choices regarding "the structure of contractual agreements that confer decision rights" (p. 4) over policies or assets.

Similarly, they envision two kinds of consequences: flexible consequences and rigid ones. A consequence is deemed flexible when it reacts heavily to choices that cause it. Alternatively, a consequence is rigid if it only reacts to choices over time. Their understanding of a business model can be visualized as follows:

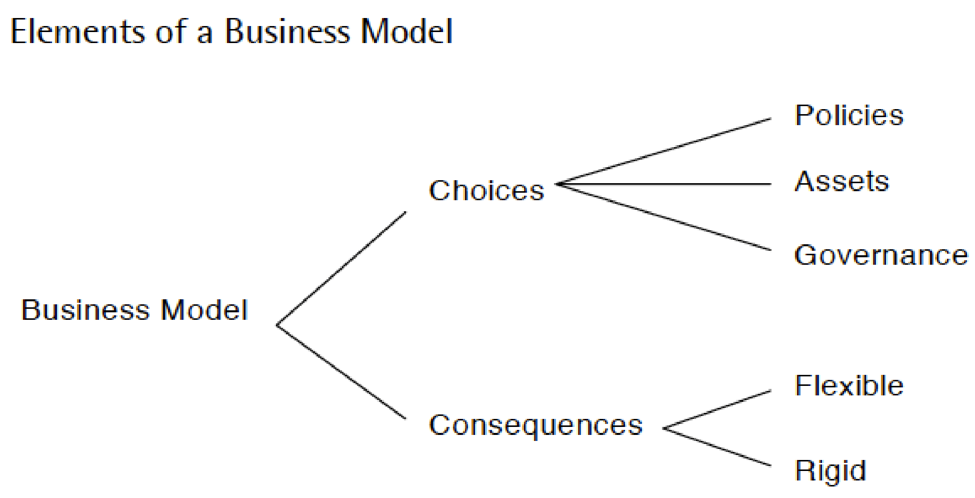

Figure 6: Elements of a business model (Casadesus-Masanell and Ricart, 2007, p.3)

According to Casadesus-Masanell and Ricart (2007), choices and consequences are inextricably tied to each other in a causal-loop diagram. Portraying a business model in its entirety is therefore a very complex task, which can only be achieved through models that allow for a breaking down of the business model in smaller, more manageable parts.

2.2.3.3 Osterwalder and Pigneur

Osterwalder and Pigneur (2009) published a book named "Business Model Generation". In this book, the authors propose a tool for business model analysis and development called "Business Model Canvas". The Business Model Canvas is divided into nine building blocks, each of which deals with different aspects of a business model. The canvas segments are for the most part mutually exclusive and collectively exhaustive, i.e., in its entirety the canvas covers all essential elements necessary to explain how a company earns money. Specifically, the canvas casts light on "customers, offering, infrastructure, and financial viability" (p. 15) by allotting the following nine segments:

- **Key Partnerships** describe all horizontal and vertical partnerships that are essential for the business model's successful operation

- **Key Activities** list the most important things a company does to make its business model work.
- **Key Resources** specify all assets that a company needs to carry out its key activities and deliver its value proposition.
- **Customer Segments** entail all groups of individuals who the company intends to cater to.
- **Value Proposition** summarizes the value of a company's goods and services to customers.
- **Cost Structure** informs about the various costs connected with the operation of the business model.
- **Customer Relationships** formulate the types of relationships a company establishes with its customer segments.
- **Channels** are the means of how a company gets in touch with its customers, either for communication or for value proposition sale and delivery.
- **Revenue Streams** articulate all cash flows generated from different customer segments

Similarly to Amit and Zott (2001), Osterwalder and Pigneur (2009) do not stop at merely proposing a tool that helps with the analysis of business models of companies, but go one step further and explain how business models are put into practice. They conclude that a business model is "implemented through organizational structures, processes, and systems" (p. 15) – a thought which is not too distant from Amit and Zott's (2001) conclusion highlighted above.

2.2.4 Selection of the thesis' conceptual framework

After the presentation of various business model theories in the prior subchapters, this section will evaluate the theories in light of their adequacy for the thesis' research context.

With their business model canvas, Osterwalder and Pigneur approach business models in a very structured way. The structured organization of their approach allows for a deep and detailed analysis without running the risk of ending up with an overly complex depiction. Furthermore, through the integration of customer segments, relationships, value propositions and revenue streams, Osterwalder and Pigneur clearly attach a very high importance to the customer perspective – a crucial aspect when researching solutions to overcome range anxiety. The flip side of this approach is the massive amount of information needed for its proper application. However, it is expected that the ELVIRE consortium will grant access to a large amount of high-quality information. Therefore Osterwalder and Pigneur's business model canvas (cf. Appendix A6) is chosen to be this thesis' conceptual framework.

As outlined above, Casadesus-Masanell and Ricart's business model theory is centered on companies' choices in terms of assets, policies, and governance and their entailing flexible and rigid consequences. The researchers' perspective is relatively company-focused, i.e., they focus on the viewpoint of a single entity and attempt to describe the business model from what seems to be an internal perspective. The approach's strong focus on assets, policies, and governance implies that Casadesus-Masanell and Ricart's approach is especially suitable for the illustration of stand-alone companies. The present master thesis' focus however lies on the definition of a business model of a whole network of stakeholders from different industries, and thus very different policies, assets and governance choices. If Casadesus-Masanell and Ricart's approach were chosen for the thesis' purposes, the above-mentioned causal-loop diagrams linking choices and consequences would reach immense complexity. For this reason, it is questionable whether Casadesus-Masanell and Ricart's business model theory could appropriately describe a FEV communication platform in the European context and still be comprehensible at the same time. Consequently, the importance of network aspects in the business model that this thesis aims to describe, make Casadesus-Masanell and Ricart's approach look rather unsuitable.

Amit and Zott view business models as concepts that enable value creation through the exploitation of business opportunities. By pinpointing to the four fundamental sources of value creation, efficiency, complementarities, lock-in, and novelty, they cover vital aspects of elements that one would expect a FEV business model to contain. Additionally, by reflecting that these value creating elements are deployed along the lines of transaction content, structures, and governance, their approach seems to, at least weakly, integrate a customers' perspective – something that Casadesus-Masanell and Ricart do not focus on. However considering the importance of the customers' viewpoint for this thesis' research objectives, the optimal business model approach would attach even more attention to this aspect. What is more, Amit and Zott's approach is quite company-focused. Just as Casadesus-Masanell and Ricart's theory, their approach does not seem to be able to elegantly describe the business model of a large network of stakeholders, which is why it Amit and Zott's approach will not be followed in the remainder of the thesis.

3 Research Gap, Methodology, and Design

The following paragraphs aim to achieve three things: First, the thesis' underlying research gap is clarified (3.1) from which, second, the research questions and objectives are derived and stated (3.2). Third, the method and design applied in the research are explained to give the reader an understanding not only of why but also of how the research was conducted (3.3).

3.1 Research Gap

This subchapter sheds light on the identified research gap from both a theoretical and a practical point of view.

3.1.1 Theoretical Research Gap

It is generally held that business model theory provides a comprehensive set of tools for explanatory research, i.e., research that does not attempt to validate an existing theory, but aims to identify innovative ideas and concepts (Kagermann & Österle, 2006). It thus comes as no surprise that business model research has discussed a wide range of applications (Osterwalder, Pigneur, & Tucci, 2005; Zott, Amit, & Massa, 2010; Shafer, Smith & Linder, 2005). Nevertheless, despite the suitability of business model theory for the task, it has not yet been employed to explore the realms of a comprehensive FEV business model, i.e. a model that ties together different industries' FEV stakeholders across multiple countries. While numerous business model frameworks have been applied in the analyses of single FEV stakeholders' business models, it is unclear which frameworks would be most suitable for the description of a business model encompassing all stakeholders.

Besides the mere inexistence of a holistic study up to this point, the sighting of the present research has also revealed a lack of business model-related findings for the *connected FEV* industry. Considering a.) the utmost importance and relevance of theoretical insight in the practical world and b.) the significant market potential of connected FEVs across Europe, a substantial gap is revealed. Thus, from a theoretical perspective, the thesis tries to close the research gap that is presented by the absence of a holistic business model for connected FEVs. To close the gap and develop and evaluate such a holistic, i.e. all stakeholders-comprising, business model for connected FEVs in the European context, today's comprehensive theoretical business model knowledge and theories will be leveraged.

The gap becomes even more evident upon the realization that until very recently, vital pieces of research that a study dealing with comprehensive connected FEV business models would need, were inexistent. For instance, D. Dutkiewicz's (2011) development of generic CISP business model components was the first work of its kind, even though it appears very likely that CISPs will play a central role in any connected FEV ecosystem scenario. The groundbreaking novelty of a study devoted to fill the abovementioned research gap can thus not be overemphasized.

3.1.2 Practical Research Gap

As already indicated above, with the introduction of electric vehicles the automotive industry is undergoing significant transition. As ELVIRE Delivery D2200.1&2 M15 pointed out, the introduction of FEVs across European car markets will require incumbent automotive players to significantly modify their business models to allow for a mass offering of this “new” vehicle type. Additionally, new industries will enter the automotive landscape.

Up to now, researchers and the ELVIRE project have illustrated the impact FEVs may have on various stakeholders’ industry, revenue, and enterprise models. Additionally, various works have analyzed stakeholders’ generic business model options of how to strategically respond to the FEV-related market changes (Cf. Arbuthnot, 2009; Kirsch, Goldfarb, & Jaguste, 2009; May & Mattila, 2009; Piepenbrink, 2009; Singh, 2009; Valentine-Urbschat & Bernhart, 2009; Deloitte, 2011; Roland Berger, 2011; van Essen & Kampman, 2011, etc.).

The results of this research are comprehensive and represent the basis of the present thesis. It is now clearer what types of stakeholders will play a role in the FEV ecosystem and what their options in terms of business model innovation are. Yet, this newly generated knowledge raises further questions: Considering the broad spectrum of options for different industries to serve the FEV market, the question of how a definite, comprehensive FEV business model could look like appears ever more vague. The picture blurs even more, once one takes into account that the above-mentioned research not only laid out various options for individual industries, but simultaneously revealed that the FEV market will only be successfully served through intense collaboration across industries: Prior works continuously emphasize the importance of value chain covering collaboration between stakeholders in order to overcome the two main barriers of FEV adoption, affordability and range anxiety.

Thus, earlier research reports both a multitude of options for stakeholders and the absolute necessity of stakeholder collaboration. This leaves the consequential gap of *how* stakeholders should collaborate. Despite all the acquired knowledge, it has not been clarified yet how all stakeholders will coordinate their activities to create a sensible, attractive FEV ecosystem. This lack of clarity, i.e. the lack of a study integrating all ELVIRE knowledge into one final business model for the ELVIRE environment, constitutes the thesis’ quintessential research gap from a practitioner's perspective.

3.2 Research Questions and Research Objectives

The research question of the present thesis is derived from the research gap outlined above. Consequently, this thesis aims to sight all knowledge derived so far, enrich and deepen it by collecting additional information, and eventually synthesize all the collected information by leading it to its logical conclusion: Prior research works were targeted at presenting the FEV-related changes for stakeholders and their business model options. The present thesis builds on these works, expands the knowledge and simultaneously streamlines the focus. The goal is to formulate a definite business model tailored to the ELVIRE project’s partners by incorporating both scientific knowledge and practical insights. For this purpose, the thesis attempts to answer the following general research question:

What business model characteristics are required to implement ‘connected’ FEVs in the European context?

By answering the research question, the thesis hopes to add crucial information to fill the gap and contribute to the overall research area of business models in a FEV context. It is thus the ultimate goal of the present thesis to propose a final business model for the FEV communication platform in the European context. Under the umbrella of the general research question, three sub research questions are explored:

1. What business model characteristics would a range-anxiety reducing business model for connected FEVs feature?
2. What behavioral, technical, and economic strengths and limitations does the identified business model display?
3. What actions by governments and stakeholders would strengthen the business model and help the creation of an environment in which it is applicable?

First, the thesis explores how ELVIRE stakeholders can collaborate to jointly craft a business model that could neutralize range anxiety of drivers. Specifically, the thesis endeavors to describe the *characteristics* of such a business model. Second, since the business model is derived from the business models' of individual ELVIRE stakeholders, it is a unique, *possible* but, in all likelihood not *optimal,* business model. Therefore, the thesis aims to evaluate the business model's performance along three key dimensions. Behavioral, technical, and economic perspectives are taken to assess the business model's strengths and limitations. The third sub research question is targeted at the improvement of the business model, based on the limitations identified. Here two dimensions are of importance. First, as ELVIRE is a politically motivated research project funded by the European Commission, the thesis aims to analyze whether, and if so, what policy adjustments can help the business model's success. Second, the thesis explores conceivable actions that stakeholders could undertake to strengthen the business model.

The research questions translate into six different research objectives. First, an understanding of range anxiety and methods for its mitigation are identified (Cf. 2.1.4.2 and 2.1.4.2.1) For this, a customer centric viewpoint is taken to ensure the inclusion of the most relevant aspects. A brief description highlights how this insight was translated into the development of products and services within the ELVIRE project. Second, the thesis assesses what industries from the FEV universe would be most qualified to deliver these products and services (Cf. 4.1). In this step, light is cast on the various industries' business model options for the proper delivery of abovementioned products and services. Third, based on the results up to this point, it is evaluated which specific business models the key industry representatives in the ELVIRE project will choose (Cf. 4.2). Their respective business models are then described. Fourth, the conclusive business model is defined through the integration of stakeholders' individual business models (Cf. 4.3). Fifth, the final business model is critically assessed from a behavioral, technical, and economic perspective to uncover strengths and limitations (Cf. 4.4). Finally, it is explored how policy adjustments and stakeholder actions could help the business model's success across ELVIRE member states (Cf. 4.5).

3.3 Research Methodology

This subsection will discuss the methods underlying this study. The following paragraphs will thus describe the research approach and state the reasons why it was chosen.

3.3.1 Research approach

Since data constitute the natural link between content and methods, the sort of data that are needed to answer the research questions will be indicative of the appropriate research methods. In general, there are two types of data: quantitative and qualitative. Punch (2005) notes that "quantitative data are numerical: they are information about the world, in the form of numbers" (p. 55), whereas qualitative data are "defined as empirical information about the world, not in the form of numbers" (ibid, p. 56) but in the form of "written or spoken words, actions, sounds, symbols, physical objects, or visual images" (Neumann, 2006, p. 110).

3.3.1.1 Quantitative approaches

Quantitative and qualitative research approaches differ in their respective goals. Quantitative research is highly selective and strives to explain relationships of a small number of variables. Following a deductive approach, the ultimate goal of quantitative research is to reject or support a given theory with the help of standardized measurement instruments. Researchers usually take up an external viewpoint and only establish indirect contact with the research subjects via abstract data. Research is carried out in a monologue form, with research subjects often treated as objects. Commonly used methodologies of quantitative research approaches are, among others, mathematical and statistical tools, laboratory-bound experiments, and surveying (Punch, 2005). Overall, quantitative research's perspective is similar to that of the natural science model and follows the credo *better knowing few things exactly, than knowing many things vaguely* (Punch, 2005; Walter-Busch, 1996). Okasha (2002) finds that results derived with quantitative research methods tend to be more accepted by the academic community.

3.3.1.2 Qualitative approaches

Qualitative research on the other hand follows a holistic approach and attempts to generate understanding of a phenomenon in its entirety and context. Following an inductive approach, qualitative research is open-ended and exploratory, with the ultimate goal of creating a theory with the help of flexible, open methods. Commonly employed qualitative methodologies encompass, among others, thick descriptions, interviews, case studies, and focus groups. Researchers commonly take up an internal viewpoint and establish personal contact with the research subjects. Research is carried out in a dialogue form, with research subjects treated as partners. Overall, qualitative research's perspective is similar to that of the human science model and follows the credo *better knowing the important things vaguely, than knowing small things in absurdly precise ways* (Lee, 1999; Punch, 2005; Walter-Busch, 1996). It is held that qualitative research can help to deepen knowledge by offering explications beyond numerical reasoning and thus deliver insights with a high degree of applicability to social reality (Creswell, 2009).

3.3.1.3 Mixed-methods approach

Black (1999) implied that no research approach or methodology could be regarded as perfect, because of their idiosyncratic limitations and natures. Taylor and Bogdan (1998) believe that quantitative research is inferior to qualitative research when it comes to the accurate representation and explanation of multifaceted sociological phenomena such as patterns of thought and behavior, emotions, attitudes, and lifestyles. At the same time, the authors maintain that findings of qualitative research often lack validity and transferability. A research approach that combines the virtues of both qualitative and quantitative approaches is the mixed-method approach. By combining, yet not merging methods from both social and natural sciences, the mixed-method approach can be seen as interplay between both methods (Flick, 2006; Strauss & Corbin, 1998).

As it is the goal of this study to identify business model characteristics for a FEV ecosystem, much of the data will necessarily be of qualitative nature, namely in the form of words and visual elements. Some of the thesis' findings, however, are quantitative and calculations have been made to assess the business model from an economic perspective. For instance, extensive calculations were made to compute various vehicles' total costs of ownership. Therefore, the thesis employs a mixed-methods approach with a slight dominance of qualitative over quantitative data. By combining both quantitative and qualitative approaches, the possibility to select the most suitable methods is ensured for each of the thesis' research questions and objectives. Simultaneously the mixed-method approach raises the level of validity and analytic generalizability of the findings this thesis provides.

3.3.2 Research design

This subchapter elaborates on the design of the conducted research. Punch (2005) distinguishes four qualitative research designs: grounded theory, ethnography, action research, and case studies. Thomas (2011) defines case studies as "analyses of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame—an object—within which the study is conducted and which the case illuminates and explicates" (p. 513). The thesis follows a prospective, explanatory case study approach with the ELVIRE consortium as its case: As FEVs as a mass-market product are a relatively new phenomenon there are currently only few testable theories available. Therefore, the thesis does not aim to validate a theory, but, on the contrary, its research is exploratory and strives to generate understanding. This is done through the consultation of various sources and partly through personal contact with the research subjects, the ELVIRE stakeholders.

The following paragraphs cover and explain the data collection and data analysis procedures in detail.

3.3.2.1 Data collection

For the present thesis, both primary and secondary data were collected.

3.3.2.1.1 Secondary data collection

Secondary data refers to "data that were originally recorded or left behind or collected at an earlier time by a different person from the current researcher often for an entirely different purpose from the current research purpose" (Tashakkori & Teddlie, 2003, p. 314). Thus, most of the literature analyzed for this thesis classifies as secondary data.

To benefit from the advantages of secondary data, e.g. comparatively easier gathering and pre-selection, a comprehensive literature review was conducted for various parts of the thesis. In chapter 2, “Background and related work” various types of literature were reviewed to account for both the ELVIRE-related background (2.1) and the academic background (2.2). Additionally, a thorough literature review both provided the basis for the current chapter and enhanced the findings and discussion in chapter 4.

Throughout the thesis, information stems from literature sources derived from electronic databases, physical books, academic journals, electronically accessible newspaper articles, consultancy reports, industry reports, project findings, and websites of companies, universities, and public institutions.

Besides literature, various interviews were analyzed that also constitute secondary data as they were originally conducted for other ELVIRE deliverables. Specifically, 27 expert interviews were assessed and interpreted (cf. Appendix A1.2) to derive findings for the specific purposes of the present thesis’ purposes. It is important to note that the *transcripts and recordings* of the interviews were analyzed, not the original researchers’ interpretations of them. This ensured findings that are both highly comprehensive and free from personal biases of other researchers. The insights gained from these interviews provided the backbone for subchapter 2.1, “ELVIRE-related background”, and added valuable pieces of knowledge to chapter 4, “Findings and Discussion”.

3.3.2.1.2 Primary data collection

Besides secondary data, primary data was collected for the present thesis in order to find more fitting data for the thesis’ purpose. According to Bortz and Döring (2006), primary data is data that is being collected by researchers to create new content for their specific research purposes at hand. Common ways of primary data collection are communication methods such as interviews, questionnaires, and tests and observation methods, such as focus groups (Tashakkori & Teddlie, 2003).

According to Punch (2005), interviews are one the “most powerful ways” (p. 168) of understanding others, specifically their “perceptions, meanings, definitions of situations, and constructions of reality” (ibid). Accordingly, for the present thesis, semi-structured oral expert interviews were of special relevance. This is due to the nascent nature of the FEV field that made it hard to gather relevant information from other sources. Interviews, however, promised access to the most significant data in a fairly efficient manner. Furthermore, the semi-structured organization of the conducted interviews allowed for the necessary flexibility for the theory-generating, mixed-method research approach chosen: Propositions could be made and tested while simultaneously an open stance towards unanticipated aspects brought forward by experts could be taken. Over the course of the data collection process, propositions and explanations were thus gradually developed.

Naturally, some of the topics discussed were of very sensitive nature to the organizations with which the experts interviewed are affiliated. This complicated the interview process and made it necessary to guarantee the confidentiality of the interview contents. Overall, the primary data collection process spanned six months and comprised not only the abovementioned interviews, but also extensive email communication and conference calls with the experts to clarify interview content and verify findings.

In short, the ELVIRE research, the basis on which this thesis rests upon, has so far been based on a range of assumptions derived from prior research. In order to deepen the knowledge and interpret it correctly in the present thesis, more interviews appeared necessary. Experts from the ELVIRE consortium represented the target group of investigation. Specifically, for this thesis, five additional interviews were conducted through tools of telecommunication and videoconferencing:

1	Better Place	C. Gabay, M. Shany	FP7 Project Manager and System Analyst	CISP	December 19th, 2011
2	ENDESA	A. Villafane	Business Development Manager	Utility	February 8th, 2012
3	Continental	H. Lüttringhaus	Business Development Manager	FTS	February 9th, 2012
4	Renault	F. Colet	FEV System Architect	OEM	March 2nd, 2012
5	Volkswagen	A. Zarcula	Manager Telematic Systems	OEM	March 12th, 2012

Table 3: List of expert interviews

These five one-hour interviews, combined with the extensive email communication complemented, verified, and significantly expanded the insights derived from the transcripts of 27 prior expert interviews of the same length. All 32 interviews were subsequently analyzed in an unbiased fashion to derive the findings of this thesis.

3.3.2.2 Data analysis

For the subsequent data analysis, the interviews were first transcribed. The transcriptions focused on the important parts of the interviews, i.e., they are not exhaustive in a sense that they reflect everything that was being communicated during the interviews. Especially non-verbal expressions and answers that did not contribute to the thesis' scope were discarded.

After the transcription, the interviews were further reduced to allow for the necessary focus during the subsequent analysis. Next, the condensed interviews were sorted according to topics and then coded, by assigning a label (word or sequence of words called a 'code') to a piece of text in order to recognize the existence of a topic or a theme of relevance to the research at hand (Johnson & Langley, 2007). After this open coding process, the coded segments were compared (axial coding). Finally, after a selective coding process the remaining core categories could be interpreted. Figure 7 visualizes the data analysis process.

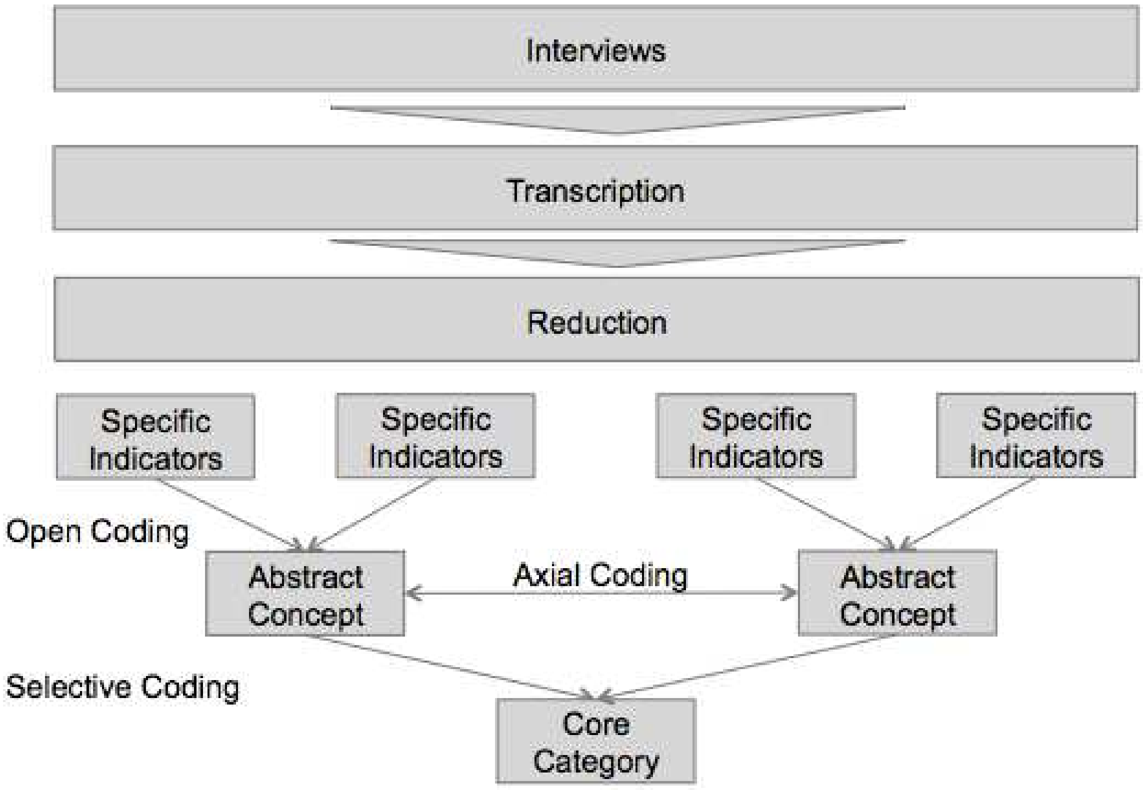

Figure 7: Interview data analysis (own illustration, adapted from Punch, 2005)

4 Findings & Discussion

The findings of this thesis will be presented in 5 subchapters. First, the generic business models of the FEV industry's stakeholders are presented in chapter 4.1. Following, chapter 4.2 builds on these generic business models by customizing them to the relevant ELVIRE project's consortium partners. Said differently, this subchapter informs about the contributions of different stakeholders to the FEV business model in the ELVIRE context. The comprehensive ELVIRE business model is then presented in subchapter 4.3. Subsequently, subchapter 4.4 evaluates the presented ELVIRE business model along different dimensions before subchapter 4.5 explores recommendations for business model improvements.

4.1 Description of FEV Industry Stakeholders' Generic Business Models

The purpose of this subchapter is to lay the groundwork for the fundamental understanding of the generic roles and business model options of the most important FEV stakeholders. In line with research objective number 2, it is also intended to give an indication of which stakeholders can be expected to be involved in the offering of the crucial products and services identified through the ELVIRE storyline. Lastly, the generic business model descriptions in this subchapter serve as an illustration of how Osterwalder and Pigneur's business model canvas will be employed in the following subchapters of chapter 4, especially in the upcoming description of the ELVIRE business model. For this purpose, the generic industry business models defined hereafter will be customized to the specific project partners from each industry (4.2). Subsequently, the project partners' business models will be integrated within one all-encompassing ELVIRE business model (cf. 4.3).

The generic business models presented hereafter were derived from an extensive literature review and from the analysis of various expert interviews (cf. Appendix A1).

4.1.1 CISPs

Key Partnerships: Generally, CISPs will have important partnerships with at least five stakeholder groups: Utilities, OEMs, FTS, communication enablers, and governments.

Utilities are a vital partner because they provide the energy that CISPs sell to drivers. They thus take up a supplier role to CISPs. Additionally, it is likely that the grid will be designed in a way that allows bidirectional electricity flows in the future (Jud, 2011). If that happens, concepts such as V2G will be put in place and the customer-supplier relationship between CISPs and utilities will transform into a more bidirectional partnership.[4]

OEMs are crucial partners for CISPs because they build and sell the product to which the services of CISPs are tailored. CISPs will collaborate with OEMs to develop suitable service offerings for different FEVs. Especially in product development, OEMs are therefore an essential partner for CISPs (D.

[4] With V2G technology, vehicles communicate with the grid to sell demand responses. In times of energy demand peaks, EVs connected to the grid could then either lower their charging rates or return energy to the grid, reversing the traditional flow of energy. CISPs could thus discharge their large battery inventories and resell energy back to utilities. Ergo, with V2G CISPs and utilities would enter a relationship in which both parties would be suppliers and customers, depending on the specific situation.

Dutkiewicz, 2011). Further, as the Better Place-Renault alliance shows, OEMs are crucial partners for CISPs that aim to offer mobility packages that include the sale or leasing of a vehicle.

CISPs will have to adapt the technical aspects of their service offerings according to the requirements of FEVs. Because of their significant influence on the design and technical specifications of FEVs in general, and batteries in particular, the decisions of FTS will heavily impact the technical aspects of CISPs' offerings. Vice versa, it may also occur that CISPs, after having partnered up with an OEM, communicate their specific component requirements to FTS and thus determine the products of FTS. This can currently be observed in the Better Place-Renault-Continental OBU set-up, which is led by the CISP Better Place. Either way, CISPs will aim to collaborate with FTS to co-develop technical, especially battery-related specifications of FEVs.

Communication enablers are relevant partners because of the need of CISPs to have their infrastructure communicate with FEVs on the road. CISPs alone will not possess the technical prowess to enable this real-time communication. Consequently, communication enablers are essential.

Finally, CISPs will have to build relationships with governments as they decide about building permits for infrastructure, support infrastructure projects financially, and set further incentives for FEV drivers.

Key Activities: CISPs will carry out three sets of key activities. First, CISPs will perform activities related to the build up and management of CS and, possibly, BSS infrastructure (Not all CISPs may have a BSS option). Sub-tasks include the definition of CS and BSS locations, the build up of infrastructure in said locations, and the management of this infrastructure.

Secondly, CISPs will work on activities related to the provision of mobility services. Sub-tasks in this stream encompass the development of mobility packages and service offerings that can be marketed to customers and the execution of charging / swapping services.

Thirdly, CISPs will perform various activities related to customer management, such as collecting and transmitting capacity and billing related real-time information.

Key Resources: For the execution of above-stated key activities, CISPs will predominantly need three different types of key resources. For one thing, CISPs will need an asset base, i.e. standardized infrastructure, to deliver any sort of services to customers. Additionally, CISPs will need partnerships with the stakeholders described above to ensure the proper functioning of their business model. Lastly, CISPs will need strong financial backing to build up a network of critical size and maintain the necessary inventory of batteries.

Value Proposition: CISPs aim to be a one-stop-shop FEV service provider and infrastructure manger / operator. In that sense, CISPs offer value to customers in the form of mobility and autonomy, by

1.) providing services that increase the range of FEVs and
2.) offering mobility packages

Regarding 1.) CISPs provide a tight grid of easy and safe-to-use CS and, possibly, BSS to their customers. These stations will allow customers to recharge their FEVs at a per-km price lower or comparable to that of traditional gas stations that serve ICE cars. Charging and swapping services will be completed within an acceptable time frame for the driver and can be monitored by him / her in real-time.

Regarding 2.) CISPs will offer mobility packages that allow drivers to purchase FEV service plans tailored to the individual driving behaviors and preferences of drivers. Customers will have the choice between different yearly km plans, vehicle types, and financing concepts for the batteries.

Cost Structure: The main cost drivers of CISPs will be fixed costs for infrastructure, battery and replacement-car inventory, administration, and personnel. Main variable costs will encompass electricity, mobility package contents (such as batteries, services, and FEVs), and, possibly, fees for real-time data provided from OEMs.

Customer Relationships: CISPs will endeavor to establish semi to fully automated relationships with customers. Both the charging / swapping process and the billing process will be automated. However, in cases of customers requiring personal assistance because of problems, they will be able to contact CISP personnel either via phone, online or directly on the CISP premises.

Channels: CISPs will employ both physical premises (CS / BSS and visitor centers) and websites (their own and potentially partner sites) as channels. It is conceivable that both physical premises and websites will extend beyond CISPs' own assets and also include partner locations and sites. In this regard, especially OEM dealerships and websites could be interesting channels for CISPs. In fact, Better Place already markets its mobility packages over the website of Renault.

Customer Segments: CISPs will target both private and commercial customers. The private segment will likely be further divided according to criteria such as driven kilometers per year. The commercial segment will be comprised of companies who support their own fleets and car sharing networks.

Revenue Streams: The main revenue streams of CISPs will be pay-per-charge revenues and monthly subscription fees for mobility and service packages. Additionally, it is conceivable that CISPs will generate further revenues through, e.g., road services, advertising, fees for fast charging, and services for utilities, such as the V2G service explained in the section "Key Partnerships".

4.1.2 (Automotive) FTS

Key Partnerships: FTS will be embedded in a network of five key partner groups: OEMs, CISPs, telematics providers, communication enablers, and pre-FTS value chain players (raw material, battery, and other second tier suppliers). Because the latter ones are rather obvious key partners, the following paragraphs will not deal with them any further.

As a general rule, OEMs will remain the number one key partner of FTS. Not only will FTS continue to work closely together with OEMs and sell components and parts to them, but also will they collaborate on R&D and production topics as the recent electric motor joint venture between Bosch and Daimler suggests (Loveday, 2011). However, there will be exceptions to the rule as shown by the current set-up of the partnership between Renault, Better Place, and Continental. According to Lüttringhaus (2012), for the OBU component Continental exclusively deals with Better Place and both players develop the component together. Continental then manufactures the components and sells them to Better Place. The role of Renault is ultimately limited to integrating the OBU into the Fluence, i.e. building the rest of the vehicle in such a way that it can host the OBU. This set-up is a novelty in the automotive industry, as never before an OEM was told by a FTS or CISP what components to integrate in its vehicles (Lüttringhaus, 2012). This example shows that the importance of CISPs as key partners must not be underestimated. Another aspect pinpointing the importance of CISPs is that they will be the stakeholder on the receiving end of most communication that takes place between FEVs and the environment. To guarantee the technical compatibility of systems used in FEVs and in the infrastructure, FTS and CISPs will partner up to develop solutions.

Telematics companies and communication enablers constitute key partners in the fields of R&D and product development. Most FEVs will contain an OBU, which will integrate telematics technology and enable the vehicle to communicate with the surrounding infrastructure. For this reason, it seems likely that FTS (the builders of OBUs), communication enablers and telematics providers will get together and jointly develop OBU solutions (e.g. data exchange protocols) for FEVs.

Lastly, the cooperation and know-how exchange among FTS is likely to increase due to the big amount of necessary investments in both battery R&D and production (Fraunhofer Institut expert, 2011). Evidence for this can be found in the battery-focused cooperation between Bosch and Samsung (Lee, 2011). According to Fischbacher (2011), the number of inter-FTS co-operations is likely to increase due to FEVs.

Key Activities: The key activities of FTS will center on the development, manufacturing and sales of FEV components and software. In the field of components, especially the OBU, which will enable the delivery of most driving (e.g. continuous monitoring) and pre-drive services to drivers, will be of relevance. Batteries and electric motors constitute other central components, whose production could represent a key FTS activity. In terms of software, FTS will aim to deliver OBU software (both back-end and GUI), such as range calculation algorithms.

Because of the general insecurity as to which technologies will establish themselves, FTS will also be keen to hedge their risks by joining multiple (R&D) partnerships with OEMs, CISPs, and other FTS. Through these collaborations, FTS will be able to take part in the definition and development of FEV driving and charging services, which could help them to diversify their product offerings.

Theoretically, FTS could aim to become CISPs. In this case they will certainly add some of the key activities of CISPs to their activity portfolio. For the remainder of this section, it will however be assumed that FTS do not become CISPs.

Key Resources: With the introduction of FEVs, FTS will draw on both traditional and new key resources. The former will mainly be composed of very efficient sourcing networks and production facilities. In terms of new resources that FTS have to build up or acquire, abovementioned partnerships and technical know-how in hardware and software development are relevant. Additionally, electric engineering competencies will be important. The range of sources of the required know-how will inevitably be broad and it seems likely that FTS' key suppliers play an important part in their provision (Fischbacher, 2011).

Value Proposition: The value proposition of FTS will mostly mirror the components that they supply to OEMs and CISPs. Since for FEVs, the battery, the OBU, and the electric motor are the most crucial components supplied by FTS, the value proposition will center on these components: safe batteries with a high energy density and accurate information of drivers about vehicle status, range, and charging process. The value proposition is directly targeted at OEMs, even though the value proposition itself will be tailored to the needs of drivers.

Cost Structure: FTS main FEV-induced cost drivers will be R&D and production of OBUs, electric motors and potentially battery packages. Since these are new items for FTS, expenses for R&D and testing (e.g. new machines, personnel, raw materials, production facilities) will be significant.

Customer Segments: FTS will primarily cater to OEMs, who constitute the by far largest customer group. Nevertheless, as the abovementioned example of Better Place and Continental showed, CISPs represent another customer group, especially for FTS that engage in battery and OBU manufacturing. In situations in which CISPs take up the customer role, the bargaining power of OEMs within the FTS-CISP-OEM set-up will necessarily be lower than if OEMs were the lone deciders. In the most extreme case, when OEMs' decision making power over the design of certain components reaches zero, they would merely play the part of an implementer of decisions made by FTS and CISPs. However, such set-ups are unlikely to be seen frequently (Lüttringhaus, 2012).

Customer Relationships: The nature of FTS' customer relationships will remain traditional B2B relationships. FTS have always had very close relationships to OEMs, their traditional customers (Fischbacher, 2011). With a new customer group, the CISP, being added to the picture, and the strong degrees of collaboration induced by the general insecurity in the FEV market, these relationships will become even tighter.

Channels: The range of channels that FTS employ will broaden with the introduction of FEVs. CISPs will become a new channel through which FTS can market their products.

Revenue Streams: The revenue streams of FTS will stem from the sale of components such as OBUs, batteries, and electric motors. Completely new revenue models are unlikely to be seen.

4.1.3 Utilities

Key Partnerships: Utilities will look for four key partners: Governments, communication enablers, other utilities and CISPs. Close relationships with governments will be relevant for at least three reasons: For one, utilities will depend on governments when it comes to obtaining the permits for the expansion of the energy transmission and distribution infrastructure. Secondly, governments will develop charging and equipment standards jointly with the utility industry and other players (European Commission, 2010a; European Commission, 2010b; European Commission, 2011). Additionally, it is conceivable that utilities will receive certain FEV related subsidies and tax breaks (e.g. for substituting conventional energy for a greener energy-mix).

Communication enablers will be crucial partners for the creation and operation of the IT system infrastructure, which will enable utilities to improve load distribution in their grids through better demand forecasting and new concepts such as V2G. Additionally, since it is well possible that utilities strive to add CISP-like features to their e-mobility offering, by, e.g., operating charge stations under their own brand, communication enablers seem essential in fields such as FEV-to-grid-communication, smart charging processes, billing and roaming.

Especially the latter aspect – roaming – indicates the third key partner group: other utilities. As every utility's coverage is limited by certain geographical boundaries, utilities will strive to collaborate with each other to ensure drivers have the same charging experiences no matter where they drive. Thus, utilities will need to partner with each other in the fields of load management, billing and roaming.

The fourth key partner group will be CISPs, which will purchase energy from utilities, bundle it together with other services, and sell it to drivers. Due to the potentially massive volumes of energy that CISPs may demand, and the impact that these volumes will have on utilities' grids and capacities, close partnerships appear crucial. This way, energy loads can potentially be distributed in a more efficient way and demand forecasts improved through demand side data provided by CISPs.

Besides these four key partners, there is an extended partner network filled with stakeholders that will be more or less relevant for utilities. According to Hell (2011), utilities might enter engineering partnerships with OEMs. However, he admits that the influence of utilities in any such partnership would be minor. Nevertheless, according to all interviewed experts from Europe, OEMs could become a relevant partner in another field: Should utilities decide to enter the CISP-field, they could consider selling mobility packages, similar to what is currently done by Better Place in Israel or Denmark. OEMs, who offer the FEVs, would then become natural partners for utilities, who complete the mobility package by offering the kilometers in form of kWh (Günther, 2011).

Key Activities: Utilities will focus on six key activities. Initially, utilities will further develop their physical grid to be able to handle the increased volume that the mass employment of FEVs will bring along. According to the experts Chirazi (2011), Haddow (2011), and Alpiq (2011), especially the distribution grid appears to require augmentation to facilitate the mass build-up of charge stations. Simultaneously utilities will endeavor, together with governments, to set standards for energy-related FEV infrastructure. Third, they will employ their energy generation facilities to produce sufficient power which they will then, fourth, transmit and distribute over their grids to customers: private and public charging spots and CISPs. Fifth, according to the interviewed European experts, it appears likely that utilities will look to capture as much value as possible from the new FEV market, which could induce them to install their own charging stations in public and private grounds. In fact, various players, such as RWE, already do so (Stromtipp.de, 2011). Finally, utilities will be very active in the development of smart grid processes and demand side management to optimize the utilization of their grid. For instance, they will carry out real-time energy demand analysis and possibly introduce dynamic price plans based on this to reduce peak loads and better integrate power generated from renewable sources. This also includes the inter- and intra-system integration of various utility subsystems in fields such as data and asset management, roaming, and billing (Hell, 2011). Alpiq (2011) in fact states that the integration of FEVs constitutes a smart grid activity in itself. Jud (2011) in turn concludes that "smart grid, like decentralized power generation, cannot be isolated from the EV introduction and therefore, is part of the EV triggered industry innovation model" (p. 40).

Key Resources: The main new key resource of utilities to be a successful player in the FEV ecosystem will be the abovementioned partnerships. Moreover, technical competences related to smart grid software and hardware will be essential with the introduction of FEVs. Additionally, tangible assets, such as the grid itself and power generation facilities, will be necessary. However, with the exception of charge spots and related infrastructure, these resources are not new and specific to changes brought about by FEVs.

Value Proposition: The value proposition of utilities will be threefold. First, utilities will probably offer to install charging spots on private and public premises. Second, leveraging these charging spots, utilities will supply dynamically priced, electricity from diverse sources, thus providing a pre-condition of mobility. Third, utilities will offer value in the form of integrated charging solutions with CISPs, by providing interfaces for both charging and billing systems.

Cost Structure: Besides utilities' traditional costs for power generation, distribution, grid development and maintenance, FEVs will add some new cost items to the cost structure of utilities. Most notably, they will have to cover costs related to the data exchange with CISPs, roaming fees, and administrative costs related to contractual agreements. Additionally, utilities will likely incur costs related to the development, installation, operation and maintenance of charging spots. Further, both hardware and software development and production for the operation of smart grids, will add a new line to the cost statement. However, besides new cost items being added through FEV-related businesses, utilities' cost structure will improve through better grid capacity utilization and new concepts such as V2G.

Customer Relationships: Utilities will develop different relationships depending on the type of customer group. Relationships with private individuals will be characterized initially by personal assistance (installation of CS). From there on after, relationships will be mostly automated and self-service based. Because of the bilateral transactional relationship (electricity and data) CISPs will likely be viewed as partner-like key accounts by utilities. With them, relationships characterized by dedicated personal assistance seem therefore likely.

Channels: Utilities will lean on various channels to promote their offerings. The most important channels are likely to be CISPs, private and public charging spots, and the (mobile) Internet. Additionally, utilities will probably employ traditional channels such as T.V., print, and the radio to market their solutions for private individuals. Also, it should be pointed out that utilities could leverage their existing customer relationships. From an efficiency standpoint, informing customers through, for instance, a leaflet coming with the monthly bill seems to be an attractive channel.

Customer Segments: Utilities will target three different customer segments: private individuals (home-chargers, and on-the-road chargers), corporate and commercial customers (car sharing networks, supermarkets, company fleets), and CISPs. A fourth conceivable customer segment could be energy aggregators, e.g. big charging parks that bundle many decentralized customer demands (Alpiq, 2011).

Revenue Streams: Utilities will generate both one-time (CS installation fees) and reoccurring revenues (sale of electricity). Regarding the former, most revenues will come from the installation of private charging spots and smart meters. Regarding the latter, the majority of turnover will stem from electricity being sold to CISPs, corporate and private customers. In this regard, innovative pricing schemes with dynamic rates for electricity may help to increase revenue. Hell (2011) for instance proposes that there could be different classes of customers, distinguished by at what times of day they may charge their FEV. Additionally, it is conceivable that utilities can get monthly access fees from their customers or lease CS to commercial users. Furthermore, if utilities chose to become public charge spot operators, it seems plausible that they could obtain some revenues related with advertising on their premises.

4.1.4 OEMS

Key Partnerships: Similar to CISPs, OEMs will form a large number of key partnerships with various stakeholder groups: Governments, telematics providers, FTS, battery (cell) producers, utilities, communication enablers, and CISPs.

Governments will be crucial partners in the sense that they are expected to set economic incentives for FEV production and adoption. Thus, governments have significant influence over both the supply and demand side of the FEV market and are therefore important partners.

FTS will be crucial partners because OEMs need to develop radically new cars. With the ICE and drivetrain gone, and batteries and electric motors added, the inner workings of FEVs will be drastically different from cars we know today. These differences and the accompanying changes in key components indicate that OEMs will need strong relationships with FTS to ensure a smooth shift to FEVs. Nevertheless the conducted interviews revealed that, over the long run, the shift to FEVs would narrow down the FTS network of a typical OEM (Colet, 2011; Keller, 2011; Neri, 2011; Zarcula, 2011; Öhman, 2011). In the short and medium term however, when FEVs will be produced simultaneously with traditional ICE cars, the supply base will expand.

The importance of information and communication technology (ICT) companies such as telematics providers and communication enablers is bound to increase with the mass production of FEVs. This is because telematics devices, and their proper functioning, will be crucial elements of FEVs from the customers' perspective. Drivers will need these devices for their accurate real-time information (e.g. battery status, CS availability, etc.). Without them, Zarcula (2011) argues, people will be hesitant to adopt FEVs, especially in the beginning when infrastructure will be only sparsely distributed. According to the interviewed experts, the importance of software and information technology is paramount for FEVs (Öhman, 2011; Zarcula, 2011). With many new software-based services such as continuous monitoring, preconditioning of vehicles, and smart navigation, the amount of data exchanged between vehicles and the surrounding infrastructure will be extensive. Because some OEMs will want to govern and control the data flow between their FEVs and the surroundings, OEMs will look to partner up with new ICT players such as communication enablers. Such partnerships promise access to technical capabilities that OEMs currently lack but need for the abovementioned services.

Mass production of FEVs will require OEMs to tie relationships with a few new stakeholders. New players on the partner radar of OEMs will be battery producers. Batteries typically constitute the most valuable and most limiting components of FEVs and cause the most insecurity in consumers (Pfister, 2011; Zarcula, 2011). Furthermore, battery technology changes rapidly and OEMs will need to ensure constant supply of up-to-date technology to position themselves successfully in the EV market. Partnerships with battery producers will therefore be of utmost importance.

Further new partners are utilities (Pfister, 2011). For one thing, utilities need to expand their grid and electricity generation capacity to account for the additional electricity demand generated by FEVs. Additionally, utilities are believed to be interested in building up part of the necessary charging infrastructure (especially home CS) for FEVs (Stromtipp.de, 2011).

CISPs will constitute a further new key partner. CISPs create and operate most of the FEV ecosystem, which will raise customers' trust in the new mobility solution "FEV" and reduce their range anxiety. Accordingly, there will be a lot of collaboration between CISPs and OEMs. Conceivable fields of co-operation are the development of standards and vehicle components. Further, a joint development and marketing of FEV services and mobility packages seems likely.

Key Activities: OEMs will perform various key activities to successfully cater to the FEV market. Besides rather obvious activities such as FEV and battery development and manufacturing, customer management, and after-sales activities, some OEMs are expected to engage in the FEV service provision market. Colet (2011) and Zarcula (2011) posit that OEMs will go as far as becoming a full-fledged CISP. While this may be farfetched, it seems reasonable that OEMs will begin to offer a selection of FEV services. According to the interviewed experts, OEMs will look to establish themselves with an FEV service offering to help overcome shortcomings of FEVs and in order to offset declining revenues in the comparably smaller FEV after-sales market: “Next generation EVs will be completely electrified. These cars will have no liquids and they will have even fewer parts. There will therefore be much less need for aftermarket activities” (Öhman, 2011).

Further key activities will result from OEMs’ wish to control car-to-infrastructure communication. Together with partners, OEMs will thus build up competences in information technology. Moreover, to reduce drivers’ range anxiety, OEMs will constantly carry out real-time battery checks. This continuous battery monitoring will be another key activity. Additionally, one of the most pressing OEM key activities is the scouting for competitive suppliers of FEV technology (battery, OBU, drive train, etc.). As it is currently not yet clear which technologies will establish themselves, OEMs are well advised to hedge their risk of having bet on the wrong technology by broadening their supplier base.

Key Resources: OEMs will need several key resources in order to perform abovementioned key activities. Some of these resources, such as brands, production facilities, and integration knowledge, OEMs have traditionally had in very good qualities due to their relevance for the common ICE car business. Other key resources for the FEV business, OEMs will have to build up organically or acquire on the market through either M&A or alliances and partnerships. Especially noteworthy in this regard are resources related to R&D for FEVs and their new components such as OBUs. Additionally, knowledge in battery development and production will be a crucial resource. Furthermore, the partnerships described earlier, constitute a key resource. On the one hand, they are important because OEMs need to be assured that there will be a sustainable ecosystem for their products. The creation of this ecosystem will inevitably be the result of collaboration. On the other hand, partnerships are a necessity from a competitive point of view as Keller (2011) notes: "Even if you have the best battery and electrical drive train engineering competences there is still a long way to go to build an entire car. The biggest challenge is the networking necessary so that all parts of the whole car fit together and the car still functions properly after 10 years".

Value Proposition: With the introduction of FEVs, the value proposition of OEMs ever more shifts towards mobility provisioning. OEMs will provide mobility in two ways. On the one hand, OEMs will manufacture and sell affordable FEVs that will possess a range large enough for the vast majority of driver’s daily trips. FEVs will be equipped with an OBU, which informs drivers in due time about low battery charges and that presents an assortment of CS and BSS at which drivers can recharge their vehicles within an acceptable time frame. On the other hand, OEMs may decide to offer mobility packages that bundle FEVs together with a yearly mileage and service plan from a service provider.

Cost Structure: With the onset of FEVs, new cost items will augment the cost structure of OEMs. Most striking will be R&D costs, manufacturing costs and costs for FEV components such as OBUs and batteries. Additionally, the contents of abovementioned mobility packages will entail new costs. To cope with the differences in design and configuration between FEVs and ICE cars, additional personnel costs will likely be incurred. Further costs will result from offered services such as the preconditioning of the car or issued warranties.

Customer Relationships: The nature of OEM's relationships with customers will change with the introduction of FEVs. Prior to the sale of a vehicle, the relationship will be one of generic personal assistance. After the sale of the vehicle, the design of the relationship will depend on OEM's respective strategy. Generally, as FEVs are not as maintenance-intensive as ICE cars, a traditional maintenance-focused after-sales relationship with customers will be harder to establish. However, the FEV service market entails new options for OEMs. It is likely that some automakers will be more protective about being in control over their customer relationships than others. OEMs who wish to further "own" their customers will be hesitant to collaborate too deeply with CISPs and look to establish their own FEV service offerings (e.g. a FEV help hotline) to which they can tie their customers. However, it can already be observed in the market that this strategy will not be followed by all OEMs. In its collaboration with Better Place, Renault for example hands the customer over to Better Place completely. Accordingly, a Renault Fluence driver with a Better Place plan calls the Better Place hotline if he has a problem with the vehicle.

Channels: OEMs will employ different channels for different kinds of customers. For commercial customers OEMs will have a sales force. Private customers will be catered to over OEMs' broad network of retailers and car dealerships. Additionally, for the sale of mobility packages, CISPs may lend themselves as attractive channels.

Customer Segments: Generally, OEMs will distinguish between two customer groups: private customers and commercial customers. Target customers from the private segment will likely be intercity travelers, city-dwellers, and households looking to purchase a second car. Commercial customers will be comprised of companies that support their own company fleets, leasing corporations, and car sharing companies. CISPs, which sell mobility packages such as Better Place, also constitute a customer group.

Revenue Streams: OEM's will aim at securing a range of different revenue streams. Conceivable sources of revenue are FEV sales, FEV leasing rates, mobility package rates, pay per use rates, battery leasing rates, after-sales services (incl. solutions for drivers with depleted batteries), and revenues from CISP-similar services. The composition of revenue streams will differ across OEMs and countries according to national leanings. For Germany, for instance, Keller (2011) does not yet believe in a big success of battery leasing rates: "a typical German customer wants to possess the car. Customers today do not understand why they should lease the battery and buy the car. A lot will have to happen to make that widely acceptable".

4.2 Description of Stakeholder's Project-specific Business Models

4.2.1 Better Place

Key Partnerships: In 4.1.1 it was explained that CISPs will partner with at least five stakeholder groups: Utilities, OEMs, FTS, communication enablers, and governments. With the exception of governments, this also applies to Better Place in the ELVIRE context. Endesa is an obvious key partner as it is the electricity supplier of Better Place.[5] Besides this commercial relationship the two companies also collaborate on a technical level and develop methods to share real-time demand data to guarantee efficient and constant supply safety. In the field of OEMs, Renault is the most visible ELVIRE partner of Better Place. Together the two firms develop products, such as the Fluence, and FEV services, such as charging and monitoring services. Additionally, they co-operate in the marketing of their joint solution. With the ELVIRE consortium's FTS, Continental, Better Place is co-operating in the development of components, especially the OBU. Given the high significance of OBUs for FEVs, the effectiveness of this partnership is fundamental to the ELVIRE project's success. Lastly, SAP is a relevant partner because of Better Place's need to have its infrastructure communicate with FEVs on the road. Together with SAP, Better Place builds the technical infrastructure to make this real-time communication possible.

Key Activities: In the ELVIRE context, Better Place carries out all three key activities outlined in 4.1.1. It builds and operates infrastructure with both CS and BS capabilities. Additionally, Better Place performs activities related to mobility packages. The definition of mobility packages and services on the one hand, and the actual provision of the mobility services on the other hand constitute subtasks in this area. Examples for mobility services are charging and battery swapping services that are conducted by leveraging the newly built infrastructure. Thirdly, Better Place is active in customer management tasks. These tasks include, for instance, processing billing related information and supporting drivers who need help with the service offerings. Simultaneously, Better Place constantly collects real-time energy demand information that it transmits to Endesa.

Value Proposition: Better Place is a full service EV service provider and infrastructure manger / operator. In the ELVIRE context, the company delivers value to drivers in exactly the way outlined under "Value Proposition" in 4.1.1. Essentially, Better Place acts as a one-stop-shop service provider for FEVs that operates a network of CS and BSS. The firm offers mobility by providing FEVs combined with a battery leasing option, greatly reducing FEVs' upfront costs. Moreover the firm offers mobility packages that bundle relevant FEV services and products (mileage, insurance, etc.) at a fixed monthly rate.

[5] As pointed out before, during the demonstrators, no actual Endesa-generated power will flow. Instead, Endesa will simulate the power transfer.

Key Resources: For the performance of the key activities, Better Place needs three types of key resources. For one thing, Better Place requires standardized (physical and IT) infrastructure to deliver FEV services to customers. Additionally, it will need the before-mentioned partnerships and a standardized inventory of batteries for the swapping procedures.

Customer Segments: Chapter 4.1.1 posited that CISPs will target both private and commercial customers. While this also applies for Better Place, in the ELVIRE context, the focus will be on private customers only. The most relevant segments of private individuals are constituted by people looking to purchase a second car or by individuals who need a vehicle mostly for city driving.

Customer Relationships: Better Place establishes semi to fully automated relationships with private individuals. Both the charging / swapping process and the billing process will be automated. However, in cases of customers requiring personal assistance because of problems, they will be able to contact Better Place personnel either via phone, online or directly on the Better Place premises. Also the initial sale of the vehicle will likely be conducted through a personal relationship between Better Place staff and drivers.

Channels: Better Place will employ CS / BSS, its visitor centers, its website, and Renault's mobility package offers as channels. Additionally, the OBU, through which drivers can be accessed, serves a channel function as well.

Cost Structure: The main cost items of Better Place are fixed costs for infrastructure, battery inventory, administration, and personnel. The firm's variable costs encompass electricity, mobility package contents, such as batteries, services, and FEVs.

Revenue Streams: In the ELVIRE context, Better Place will generate revenues through subscription fees for mobility and service packages. The offered services will include battery charging and swapping, road side assistance, insurance, emergency hotlines, etc. Besides the subscription business model, pay per charge / swap pricing models will be established for FEV drivers who are not Better Place subscribers.

<table>
<tr>
<td rowspan="2">Key Partnerships

Governments

Communication Enablers

Utilities

FTS

OEMs</td>
<td>Key Activities

1. Real time Activities related to:
- EV Service provision
- Development and sale of mobility packages (service plan + car / battery)
- Activation & Profile Configuration
- Insurance
- Billing

2. Infrastructure Provision and Management
- Definition of locations for CS and BSS
- Build up of CS and BSS infrastructure
- Electricity provisioning
- Monitoring of the 'connected infrastructure'

3. Customer management
- Real Time Data collection, transmission (capacity -, billing-related etc.)
- Customer 2 Business assistance services (i.e. FEV Hotline)</td>
<td rowspan="2">Value Proposition / Use Cases

Be a one-stop-shop EV service provider and Infrastructure Manager / Operator, Provide Range / Autonomy / Mobility through

1. Charging Spots (CS) that
- Allow L2 / L3 charging at a per mile cost less or equal to ICE cars
- Are safe and easy to use
- Are allocated within convenient distances
- Promise a recurring satisfying charging experience
- Are accompanied by POI (in best case)
- Offer different billing options (i.e. mobility package; (non) cash; monthly /pay per charge, etc.)

2. Battery Swap Stations (BSS)
- That offer reliable services (availability of charged batteries)
- Available at strategically useful locations

3. Continuous Monitoring of charging process

4. Mobility packages
- Different pay per mile price plans
- Lease of battery
- Single point of contact for all related FEV services

5. ELVIRE WP3000 related tasks, such as CMC and CMP integration</td>
<td>Customer Relationships

Customer 2 Business assistance services (i.e. FEV Hotline)

B2B assistance services

Self-service

Automated service</td>
<td rowspan="2">Customer Segments

Private customers
- City-dweller
- 2nd car owners
- Intercity traveler

Car sharing networks

Fleet customers</td>
</tr>
<tr>
<td>Key Resources

Infrastructure

Partnerships / Alliances

Electricity

Standardized Equipment & Inventory

Financing / Funds</td>
<td>Channels

Mobility packages

CS/BSS

FEV / OBU</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Infrastructure (CS, BSS)

Electricity

Battery inventory (incl. Insurance etc.)

Administrative costs (billing etc.)

OEM real-time data fees

Personnel

Personal assistance services (FEV Hotline)

Maintenance

Batteries and their replacement as part of mobility packages</td>
<td colspan="2">Revenue Streams

Monthly fee for mobility and service package: With fixed pay per mile plan, FEV / battery leasing, charging, switching, services, insurance package, road assistance service, 24hrs emergency hotline;
Advertising;
Charging fees for fast charging;
Charge spot reservation;
Utility services (V2G, Battery swap station as storage device);
Charging parks (for commercial customers);</td>
</tr>
</table>

Figure 8: Better Place and CISP generic Business Model Canvas

4.2.2 Continental

Key Partnerships: Chapter 4.1.2 posits that FTS will be embedded in a network of five key partner groups: OEMs, CISPs, telematics providers, communication enablers, and pre-FTS value chain players (raw material, battery, and other second tier suppliers).

Continental, in the ELVIRE context, has relationships with the OEMs, especially Renault, and the CISP, Better Place. Better Place and Renault are both customers and R&D partners of Continental. All three play a vital role regarding the communication platform's central FEV component, the OBU. Better Place and Continental jointly develop it. Subsequently, Continental manufactures and sells the component to Better Place, which has it delivered directly to Renault. Renault then integrates the OBU into the Fluence, the vehicle that will also be used in the ELVIRE demonstrators.

Key Activities: The ELVIRE key activities of Continental are twofold. One set of activities revolves around the definition of FEV driving, monitoring, and charging services jointly with other stakeholders, most notably, Better Place. The second (related) set of activities centers on the development, manufacturing, testing and sales of FEV components, most notably the OBU, which will enable most driving and pre-drive services (e.g. continuous monitoring). Continental will be involved in both hardware and software development of the OBU. On the software side, Continental will focus on back-end software, such as range calculation algorithms, which represents the company's most important activity according to Lüttringhaus (2012). Further, the manufacturing of the OBU will be Continental's responsibility exclusively.

Value Proposition: Continental provides value within the ELVIRE context most notably through its OBU solution, which enables FEVs to communicate with surrounding infrastructure. Essentially, Continental's OBU reduces drivers' range anxiety through its accurate display of vehicle status, driving range, energy notifications and related features. The highest value is attached to the range calculation algorithms (Lüttringhaus, 2012).

Key Resources: In the ELVIRE project, Continental draws on various key resources, some of which are ELVIRE-specific. For the development of FEV services and the OBU component, Continental needs R&D related resources and partnerships with other players. Regarding the latter, especially the partnership with Better Place and Renault appear essential. Concerning the former, personnel with electric engineering and software development competences are key. For the actual manufacturing of the OBU, Continental will require "traditional" resources, such as efficient sourcing networks, production facilities, and labor.

Customer Segments: As the focus of the ELVIRE project is the design of advanced mobility management systems, the OBU plays a fundamental role. Within ELVIRE, Continental sells the OBU to Better Place and VW, which thus represent Continental's main customers. Simultaneously, Continental sells other FEV components to Renault and VW.

Customer Relationships: As a FTS, Continental operates in an industry in which, caused by the immense competitiveness and importance of innovation, customer relationships have traditionally been very tight. With the onset of FEVs, (R&D) collaboration intensity between Continental and its customers is bound to increase, as can be seen in Continental's OBU collaboration with Better Place. Concluding, it can be stated that Continental's customer relationships do not change in nature, but in their intensity.

Channels: Continental's value proposition is delivered through a range of channels encompassing Renault, Better Place, and the FEV itself.

Cost Structure: The cost structure of Continental resembles the items described under "Key Resources" in this subchapter. Continental's main ELVIRE-related cost drivers are R&D and production of OBUs. As the OBU is a new component for Continental, expenses for R&D and testing (e.g. new machines, personnel, raw materials, production facilities) will be manifold: Continental has to add new production facilities, machines, and secure new raw materials and personnel (Lüttringhaus, 2012).

Revenue Streams: Continental's revenue streams stem from the sale of components, most importantly OBUs. Besides this obvious source of revenue, Continental might get reimbursements for their development efforts from Better Place.

Key Partnerships	Key Activities	Value Proposition / Use Cases	Customer Relationships	Customer Segments
Telematics OEMs Communication enablers CISPs Other FTS 2nd tier suppliers and raw material suppliers Battery producers (cell and package)	Software / hardware development (i.e. algorithms / OBU) R&D, testing, production, and implementation of the FEV related Components (OBU, electric motors, batteries etc.) Manufacturing / production / sales of FEV components Definition and solutions development for FEV services (driving (monitoring) & charging) together with CISPs and OEMs Establishment of R&D collaborations Backward integration (securing of supply base) **Key Resources** Production facilities, supplier network, finance for additional R&D projects Partnerships / Alliances with key partners (see left) Technical know-how, Software / Hardware engineering competences (Smart Navigation etc.)	To CISPs and OEMs: Hardware / Software for OBU, other components, infotainment To drivers (use case related solutions): Information, transparency, feeling of security (i.e. Range Anxiety) through OBU - That provides info on status of car, remaining range, charging progress, etc. - That is accurate and easy to use - That enables C2B communication / vehicle connection to the back-end system - That proactively notifies in case of unexpected occurrences, problems, range, etc. - That stores driver related data in profiles (driver authentication, charging preferences) - That also replaces / is an alternative to all other electronic ""toys"" and appliances in today's cars (radio, entertainment, GPS) - Personalised range prediction based on the driving behaviour - Development of the algorithms that would be reliable and scalable	Customer 2 Business assistance services (i.e. FEV Hotline) FEV services (charging & driving services) Self-service Automated service Convenience/efficiency-driven Collaborative Development of software for OBU **Channels** OEMs CISPs FEV Car 2 infrastructure	Direct: - OEMs - CISPs - Other suppliers Indirect: - Users of product: Drivers

Cost Structure	Revenue Streams
R&D and production of Hardware, Software, OBU, components Personnel Raw materials (esp. for battery cells) Production facilities	Component sales (OBU, electric motors, and other) Battery cell sales / potentially battery packages

Figure 9: Continental and FTS generic Business Model Canvas

4.2.3 Endesa

Key Partnerships: The analysis of utilities' generic FEV business model in 4.1.3 revealed that utilities would look for four key partners: Governments, communication enablers, CISPs and other utilities. In the context of the ELVIRE project, Endesa only partners with a communication enabler, SAP, and a CISP, Better Place. Besides the fact that the ELVIRE project is partly funded by the European Commission, Endesa has no relationship with a government for the scope of the project.

While there is no relationship with any government, there does exist a very deep relationship with Better Place. Better Place purchases energy from Endesa, bundles it together with other services and sells it to drivers. These transactions have both a technical side (focusing on energy and data flows and specific, technical aspects) and a commercial side (focused on monetary aspects) but are, according to Villafane (2012), not governed by any contractual agreements.

The relationship that Endesa holds with SAP revolves around the creation and operation of the IT system infrastructure. Specifically, together with SAP, Endesa develops a solution for the communication between CISPs and the grid. Looking into the future, this partnership could be further leveraged to develop communication solutions for V2G concepts as outlined in 4.1.1 (Jud, 2011), or to develop roaming solutions if Endesa and other utilities decided to operate their own charge spots.

Key Activities: Out of the six generic utility key activities, two seem especially relevant for Endesa in the ELVIRE context. Within ELVIRE, Endesa will analyze FEV-induced requirements for electricity grids. Along these lines, the company will develop "smart grid" soft and hardware (cf. 4.1.3) to cater to policy makers' whishes for "greener" grids and real CO_2 reductions through FEVs. For instance, Endesa will analyze real-time energy demand data. Doing this enables Endesa to adequately respond to peaks in energy demand by for instance customizing energy prices. With service providers such as Better Place as a new big customer group, which, for a big part of its energy demand is not bound to specific times of the day, such dynamic pricing tools will enable Endesa to smoothen its grid loads and overall increase the reliability of the grid. Additionally, besides reducing peaks in energy demand patterns, it will support a better utilization of renewable energy.

The second key activity of Endesa will revolve around the management of the energy distribution from an IT and communication perspective. As pointed out above, in this respect Endesa is engaged with SAP to develop protocols, algorithms, and interfaces for a communication platform, which will also be leveraged in the ELVIRE demonstrators in Denmark. This second set of key activities also lays the foundation for the handling of more complicated scenarios that e.g. require roaming solutions.

Value Proposition: The value proposition of Endesa differs from the generic one defined in 4.1.3. Because the demonstrators of the ELVIRE project will take place in Denmark, where Endesa does not have any operations, Endesa will not supply any physical energy in the demonstrators. Instead, Endesa will simulate the flow of energy. Consequentially, Endesa proposes value neither through the installation of charging spots nor through the supply of electricity. In fact, Endesa's value proposition is limited to the provision of an integrated charging solution with Better Place. For this solution, Endesa provides interfaces to both the Better Place CMC and the SAP billing system. Further, picking up on the idea of smart grids and better grid utilization, Endesa offers solutions for an optimized use of power generation and distribution assets. Lastly, Endesa provides real-time pricing and tariffs for the demonstrator. It thus can be concluded that Endesa takes the role of a very advanced traditional utility within the ELVIRE demonstrators, except for the fact that it does not provide any physical energy.

Key Resources: Endesa's main new key resource for the ELVIRE project is intangible and is constituted by the network of ELVIRE partners and smart grid related R&D capabilities.

Customer Segments: Whereas 4.1.3 explained that utilities will target three different customer segments: private individuals, corporate and commercial customers, and CISPs, only the latter ones play a role in the ELVIRE context. In fact, Better Place will be the only customer of Endesa.

Customer Relationships: Within ELVIRE, Endesa will only have one customer, Better Place, with whom it will have a key-account style B2B relationship. Endesa however has not only a customer relationship with Better Place, but also, as pointed out before, a partnership devoted to energy demand forecasting and similar features.

Channels: Better Place's charging spots, through which the firm transmits electricity to drivers, constitutes Endesa's only channel in the ELVIRE context.

Cost Structure: Just as Endesa's value proposition, its ELVIRE-related cost structure is similarly limited compared to the generic one outlined in 4.1.3. Endesa will neither incur any costs for the installation or expansion of any physical assets, nor will it face significant expenses for power generation and distribution. Merely the smart grid hardware and software development and production will find their way on Endesa's income statement as R&D expenses.

Revenue Streams: Endesa principally generates revenue through the electricity it sells to Better Place.[6] In the future, it is conceivable that it will record revenues through the operation of its own charging spot network.

[6] Nevertheless, as pointed out before, in the ELVIRE demonstrators, Endesa will not sell electricity to Better Place, but merely simulate the flow of energy.

<table>
<tr>
<td rowspan="2">Key Partnerships

Governments

Communication Enablers

CISPs

Other Utilities

Mobility package partners (i.e. OEMs, car sharing companies)

EV R&D partners</td>
<td>Key Activities

Smart Grid development

Charging Station installation and operation

Power generation / transmission / distribution

Real Time Data analysis and dynamic pricing based on it

Development of charging related standards w/ govt & other players

Inter utility system integration

Demand Side Management</td>
<td rowspan="2">Value Proposition / Use Cases

Mobility through:

1. Installation of charging spots
- At home
- In public places
- On private grounds
- That are hassle-free to use (convenient) and safe
- That promise a similar charging experience throughout the whole continent
- That are capable of Level 2 (+) charging

2. Supplying of Electricity
- With a renewable energy mix
- Smart energy provisioning (peak vs. off peak tariffs)
- At sufficient quantities
- That allow for customized energy flow (energy flows when it is cheap)
- V2G

3. Integrated Charging solution with CISP
- Interfaces to charging and billing systems</td>
<td>Customer Relationships

Dedicated personal assistance (CISPs)

Self-service

Automated service

Convenience/efficiency driven</td>
<td rowspan="2">Customer Segments

Energy aggregators

Private customers:
- Home chargers
- Frequently on-the-road chargers

Corporate customers:
- Supermarkets
- Car sharing comps
- Restaurants, etc.

CISPs

Governments (public charging spots)</td>
</tr>
<tr>
<td>Key Resources

Grid / Network

Partnerships / Alliances

Power generation facilities

Customer access

R&D, technical competences related to smart grids</td>
<td>Channels

Existing customer relationships and associated CRM activities

Private homes charging spots

Public charging spots

CISPs

Internet

Mobile phone

Traditional channels</td>
</tr>
<tr>
<td colspan="2">Cost Structure

Electricity / power generation

Data exchange from /CISPs

Administrative costs

Maintenance costs of CS and related grid

Contractual agreements' expenses

Cost structure changes through better grid capacity utilization (i.e. Fast charging)

Electricity / power generation</td>
<td>

Smart Grid development

Planning of the grid (considering new type of consumer/charge units)

Hardware and Software equipment deployed for smart grids

Data exchange (with CISPs, OEMs, other Utilities)

Roaming fees</td>
<td colspan="2">Revenue Streams

Charging Spots installation and maintenance fees

Dynamic electricity rates

Charging fees i.e. flat rate recharging packages fees

Public charging spots

Advertising</td>
</tr>
</table>

Figure 10: Endesa and Utility generic Business Model Canvas

4.2.4 Renault and VW

Key Partnerships: According to 4.1.4, OEMs will form key partnerships with governments, telematics providers, FTS, battery (cell) producers, utilities, communication enablers, and CISPs. In the ELVIRE context, Renault and VW will have relationships with Continental, the FTS, and Better Place, the CISP.

Continental is a key partner for both OEMs, as they need to develop drastically new cars with new value-driving components, such as the OBU. As Continental is the supplier of these components, Renault and VW collaborate with it to guarantee a smooth integration of these components into their vehicles.

Not so much for VW, but even more so for Renault, Better Place constitutes a further key partner. Renault, unlike VW, believes in Better Place's BS concept and thus relies on the proper functioning of the EV ecosystem that Better Place aims to build up. Accordingly, Renault and Better Place collaborate to technically and commercially attune their respective offerings to each other, especially with respect to the BS option. VW will not equip their vehicles with a swappable battery, thus its cooperation with Better Place touches charging aspects only.

Key Activities: Renault and VW manufacture FEVs that are based on different types of communication architecture. VW provides a concept of the eGolf, a car type A vehicle that communicates with the CISP through a VW specific server. Renault provides the Fluence, which is a car type B vehicle that transmits its data directly to the CISP without detours of any kind. Besides the provisioning of the FEVs, the OEMs will therefore perform data related key activities within the ELVIRE project. Specifically they will be engaged in battery monitoring and real-time data collection (e.g. location, energy consumption, driving speed). VW will then transmit this data first to its own server and then to Better Place, whereas Renault will transfer the data from the vehicle directly to Better Place.

Value Proposition: The value proposition of VW and Renault is the provisioning of mobility and FEVs. With the Fluence, Renault manufactures and sells an affordable FEV that possesses a range large enough for the vast majority of driver's daily trips. It is equipped with an OBU, which informs the driver in due time about ending battery capacity and that presents a selection of CS and BSS at which drivers can recharge their vehicles in an acceptable time frame. VW offers a FEV as well, the eGolf. This car type A vehicle is not commercialized yet and mainly serves to test the data provisioning processes associated with the communication architecture of car type A vehicles. It will not have a swappable battery, however it will be equipped with an OBU. Both OEMs thus offer vehicles that are able to realize key ELVIRE use cases to neutralize range anxiety.

Key Resources: Renault and VW need two types of key resources. For one thing, they need R&D and engineering competences for the development of FEV services, use cases, the FEVs, and new components, most notably the OBU. For another thing, the partnerships described, constitute a key resource.

Customer Segments: Renault and VW both target private individuals, especially city dwellers and people looking to buy a second car, as customers. Additionally, for Renault, Better Place constitutes another customer segment.

Customer Relationships: In Israel, Renault has no relationship with drivers besides potential vehicle maintenance appointments. For all other affairs, Better Place takes care of the customer completely. Thus, Renault's main customer relationship is the relationship with Better Place – a tight B2B relationship. In Denmark, Renault will have a two-fold approach. On the one hand, it will, together with Better Place, have the same offering as in Israel. On the other hand, it will target drivers directly and hold relationships with them similar to the way the company conducts its ICE car business. VW, on the contrary, aims to further serve its customers over the entire customer lifetime in all markets, and thus has only traditional OEM-to-driver relationships.

Channels: Renault and VW employ their websites and local dealerships and retailers as channels. Besides, Renault employs Better Place as a channel.

Cost Structure: Renault and VW will incur several ELVIRE-related costs: R&D expenses, manufacturing costs, and procurement of FEV components (e.g. OBU and batteries). Additionally, especially VW will incur significant IT costs for the server and additional IT infrastructure it needs for its car type A concept.

Revenue Streams: VW and Renault will both generate revenues from FEV sales, leasing, and potentially battery leasing. Additionally, both OEMs will consider after-sales service provision as a further revenue stream.

Key Partnerships	Key Activities	Value Proposition / Use Cases	Customer Relationships	Customer Segments
Governments Utilities FTS Communication enablers CISP Battery producers (cell and package) Telematics	Car-2-infrastructure communication After sales / Service provider role Battery monitoring Alliance governance, and Product/Offering development with BP Customer management, Service provision Marketing of FEVs (esp. in the early stage) FEV & battery mass production and development / FTS management Back-end operations: Real Time Data collection /storage / transmission to CISP	"Trusted" Mobility through: 1. FEVs - With sufficient autonomy for daily standard trips - That are rechargeable wherever necessary through a tight network of interoperable recharging spots - That are rechargeable according to CISPs' and utilities' requirements - That are affordable/purchasable at no premium to ICE cars - That are safe and provide a greener means of transport than ICE cars at lower total costs of ownership (TCO) - That are hassle-free in operation (convenient), silent, and help to save time - That accurately provide driving/range-related real-time information - For which after sales services exist 2. Mobility packages - That offer the FEV as described above in combination with a mileage plan and further services, e.g. warranty etc.	Generic personal assistance (pre-sales etc) Dedicated personal assistance (B2B) Self-service Value-quality-driven Customer 2 Business assistance services (i.e. FEV Hotline) After sales services	Private customers - City-dweller - 2nd car owner - Intercity traveler Corporate customers - Company fleets - Leasing corps Car sharing companies CISPs
	Key Resources R&D for FEVs (ELVIRE-specific, e.g. OBU) Battery development/production knowledge Partnerships / Alliances with key partners (esp. BP&Conti) Service provider mindset / culture Brand, Production facilities, integration knowledge		**Channels** Traditional OEMs' channels - Retailers (OEMs' car dealers) - OEM Online "shop" - Sales force (for B2B) CISPs	

Cost Structure		Revenue Streams	
Battery	Personnel	FEV sales	Services related to CISPs
OBU	Advertising	FEV Leasing rates	Mobility package rates
Rest of FEV	R&D	Pay per use rates	Battery leasing rates
Mobility package contents (warranty, maintenance, electricity, etc.)	Administrative costs	Driver data provision fees (from CISPs, utilities)	
ELVIRE services (telematic, charging services etc.)		After sales once FEV and/or battery is depleted (Maintenance, Inspection, etc.)	

Figure 11: Renault and VW and OEM generic Business Model Canvas

4.3 Description of the Final ELVIRE Business Model

Key Partnerships: The final ELVIRE business model unites 6 different stakeholders (of 5 types): the government, Better Place (CISP), Continental (FTS), Renault and VW (OMEs), SAP (Communication Enabler) and Endesa (Utility). Together, these players possess the necessary set of capabilities and competences to deliver the ELVIRE value proposition and reach the required clout to make a change in member state's markets. The diversity of the stakeholders ensures not only the existence of key resources in the consortium but also a variety of ideas and solutions proposed and discussed. Partnerships between the stakeholders are the cornerstone of the ELVIRE business model due to the benefit of shared knowledge, collective contribution and entailed risk sharing.

Key Activities: Each abovementioned partner is engaged in one or more key activities.

VW and Renault build various types of EVs that differ in communication architecture. As explained in 2.1.2.1, VW provides car type A concept vehicle eGolf, whereas Renault is active in providing car type B vehicle Renault Fluence Z.E. for ELVIRE. Car type A vehicles communicate with the service provider's systems through an OEM specific server: VW engages in back-end real-time data collection, storage, and transmission, to enable this communication. Car type B vehicle specific data is transmitted directly to the CMP/CMC developed and operated by Better Place (cf. D3000.1 for more technical specifications). Irrespective of the car type, both Renault and VW run constant battery checks, enabled through the EVs OBU, whose development and production represents one of Continental's key activities. Continental (FTS) develops both hardware and software for the OBU. On the software side, Continental will focus on back-end software, such as range calculation algorithms, while Better Place is responsible for the front-end software development and the GUI. Besides OBU activities, Continental designs OBU solutions that enable the realization of the key services (Use Cases: i.e. Activation, Plan drive, Driving, Charging)) defined jointly with other stakeholders.

Better Place builds and operates CS/BSS infrastructure, develops mobility packages (service plan + car) that bundle various services into one offering for the driver i.e. mileage sales (pay per mile instead of kWh), insurance, maintenance, etc. Further, Better Place acts as a first point of direct contact for consumers regarding the services offered within the mobility packages (i.e. customer assistance). Besides key activities targeted to drivers, Better Place constantly collects and transmits real-time energy demand information to Endesa. The latter company analyzes this data and responds to peaks in energy demand by e.g., customizing energy prices to flatten grid loads and better utilize energy from renewable sources. Along these lines, Endesa further performs energy demand management supported by IT and communication systems developed by BP and Endesa. Additionally, Endesa collaborates with SAP to develop protocols and interfaces for the communication platform for the real-time data processing within ELVIRE scenarios and use cases. SAP is also responsible for the design and implementation of the roaming and mobility service platform HORST (cf. ELVIRE Delivery D3300.1&2).

Value Proposition: The ELVIRE business model contains value propositions for both drivers and stakeholders. To drivers, the central value proposition is the provisioning of electric mobility with all its advantages:

a) Mobility via end-2-end package is provided by Better Place, which offers a 'one –stop- shop' for FEV services and access to Charging Infrastructure. Better Place offers mobility packages that bundle pay per mile plans, insurance, and access to the network of CS and BSS. Additionally lease of battery also addresses the affordability issues experienced by consumers i.e. reduced up-front costs as well as depreciation of the battery, which becomes especially relevant in case of reselling a vehicle (cf. ELVIRE Delivery D2200 M27).

b) Services and vehicles mitigating range anxiety.

VW eGolf is a concept car for the ELVIRE project which contributes towards testing the vehicle data provisioning processes of the car type A, whereas Renault does actually provide fully operational vehicle (type B) that is already commercialized and offers sufficient autonomy for standard daily trips while being rechargeable according Better Place's standards. Both vehicles are equipped with an OBU, which was designed in accordance with requirements of both service provider and OEMs, in order to realize the key ELVIRE use cases that mitigate range anxiety. Those services are: Profile activation, personalized feedback on the battery range based on the individual driving behavior, charging notifications, route planning considering access to CS/BSS available, etc.

Endesa's value proposition is more tailored towards CISPs, i.e., Better Place. Together with the latter it developed a charging solution (including interfaces to both the Better Place CMC and the SAP billing system) and functions as its electricity provider. The rates that Endesa charges to Better Place are dynamically priced, to ensure optimal utilization of grid capacity and resources. In more complex scenarios that go beyond ELVIRE, it is conceivable that Endesa would also have a value proposition to drivers, i.e., if it installs a charging spot network and/or offers roaming solutions. This would then further leverage SAP's core value proposition, which consists of IT solutions for communication systems, such as roaming and mobility services.

Similarly to Endesa and SAP, Continental provides value to other stakeholders: Better Place and Renault, which base their solutions on Continental's OBU. The OBU enables EVs to communicate with surrounding infrastructure and services.

Key Resources: The ELVIRE business model is founded on various key resources, most of which are new engineering knowledge and thus personnel related. Besides production facilities, Renault, VW, and Continental need R&D competences for the development of FEV services, use cases and new components, most notably the OBU. Endesa requires R&D capabilities especially for the smart grid development. Better Place needs standardized (BSS, CS and IT) infrastructure to deliver EV services to customers, and inventory of batteries for the swapping procedures. For the latter, and for its role as infrastructure provider, significant financial means are key. For all stakeholders, the partnerships described, constitute a key resource.

Customer Segments: Within the ELVIRE consortium Better Place constitutes a customer for Continental and Endesa. However, as the consortium is not an end in itself, the main customer segments (private or business) to use the ELVIRE solution are drivers looking to buy a second car and/or searching for a city car solution.

Customer Relationships: Just as ELVIRE contains value propositions for both drivers and stakeholder's there are two fundamentally different types of customer relationships: those with drivers and those with other stakeholders. The former differ across countries. In Israel, Better Place, establishes semi automated relationships with private individuals, to who it sells FEVs and mobility packages. After the purchase, both the charging / swapping process and the billing process will be automated. However, customers who require personal assistance are able to contact Better Place personnel via phone, online or directly on the Better Place premises. Depending on what exactly the customer need, they are taken care of locally at Better Place or directed to the next Renault dealership if they need vehicle maintenance. Despite the provision of maintenance, Renault however has no customer touch points. In Denmark the situation is slightly different: There, Renault is active both through a cooperation with Better Place, and on its own. Thus, drivers who wish to join the Better Place network can do so in the same way as it was described for Israel. If eGolf would be commercialized one would see a more traditional approach to mobility: sales of vehicles with non-swappable batteries as well as no mobility package option. Renault would also support Better Place relationships with EV drivers in a similar manner to the relationships they traditionally hold with ICE car customers.[7]

Inter stakeholder customer relationships will mostly be traditional B2B and transactional relationships. The new players, such as communication enablers (SAP) and utilities (Endesa), provide a service or product to the CISP (Better Place). It is worth pointing out that relationships within partners are formed in order to develop and deliver the ELVIRE solution, therefore some are regarded as both key partners and customers. For example, Better Place buys the OBU from Continental to have it implemented in Renault vehicles, although all three firms contribute towards the OBU's development. Also, Better Place would buy electricity from Endesa while at the same time they work together towards the energy demand management related solutions as discussed in the key activities section.

Channels: Two types of channels will be required to deliver the ELVIRE solution. Firstly, there are sales channels: Traditional OEM channels such as dealerships and retailers, CISPs (e.g. Better Place's network (Israel, Denmark)), as well as Renault's and Better Place's websites through which mobility packages are promoted.

The OBU constitutes a second channel type, since it enables drivers and service providers to access each other. Also, through the OBU key services as defined in key use cases are delivered.

[7] E.g., customers are eligible to receive technical support and can come in for maintenance in regular intervals.

Cost Structure: An analysis of the value chain reveals that R&D and production expenses heavily impact the ELVIRE business model. Endesa incurs costs for the development and subsequent production of smart grid hardware and software. Similarly, Continental's main ELVIRE-related cost drivers are R&D and production of OBUs, whereas Renault and VW incur R&D expenses, manufacturing costs, and procurement of FEV components (e.g. OBU and batteries). An analysis of cost elements reveals that items driving R&D and production costs are personnel, production facilities, raw material, and IT costs. Besides costs incurred in R&D and production stages, the ELVIRE business model entails costs for infrastructure, battery inventory, administration, and personnel, most of which find their way on Better Place's income statement. Additionally Better Place records costs for electricity and other mobility package contents, such as batteries, services, and FEVs. Whereas not in the ELVIRE scope, it nevertheless shall be pointed out that if a utility, such as Endesa, were to enter the CISP business, it would share some of Better Place's costs (e.g. infrastructure).

Revenue Streams: In the ELVIRE context, the largest revenue streams are generated in the last part of the value chain: Better Place generates revenues through subscription fees for mobility and service packages. The offered services include battery charging and swapping, roadside assistance, insurance, emergency hotlines etc. Revenue streams for Renault and VW connected to FEVs are sales or leasing, battery leasing, and after-sales service provision. Endesa records revenues for the electricity it provides to Better Place, and in more advanced scenarios, potentially through its own network of charging stations. Earlier in the value chain, Continental generates revenues from the sale of OBUs and related components. SAP would receive revenues from the software licensing related to HORST services.

Key Partnerships	Key Activities	Value Proposition /Use Cases	Customer Relationships	Customer Segments
Governments (infrastructure building permits, tax breaks, subsidies)				
Better Place	**- Development and sale of mobility packages (service plan + car) - EV Service provision as defined in the ELVIRE scenarios to support the driver and reduce range anxiety - Use cases: Activation, Plan Drive, Driving, Charging - Infrastructure Provision and Management - Definition of locations for CS and BSS - Build up of CS and BSS infrastructure - Electricity provisioning with support of utility provider - Data collection for prediction services (i.e. demand, routing) - Customer management**	**Be a one-stop-shop EV service provider and Infrastructure Manager / Operator 1. Provide Mobility through an End2End mobility package** (different price/mile plans, lease of battery, infrastructure by CS and BSS, insurance, single customer touch point for all ELVIRE services, ELVIRE WP3000 related tasks such as CMC and CMP) **2. Reliable connectivity of EVs to the Service Provider Network (CMP and CMC)**	**First point of contact (<u>direct</u> contact) for services offered within the mobility package (i.e.customer assistance, before, during, after driving). <u>Indirect</u> contact through services offered by the OBU (i.e. driver profile managment, find next available charge spot).**	**Private customers - City dwellers / 2nd car owners / Intercity travelers**
Renault, VW	**Car manufacturing / and provision of vehicles (car type A (VW) & B (RN)): - (VW) Back- end operations (in-house): Real Time Data collection, storage, transmission and processing. - (RN) Back-end operations (with BP): Real Time Data collection and transmission to BP - Battery monitoring**	**Provide FEVs (sufficient autonomy for daily standard trips, rechargeable according to BP's standard)** *VW: Provision of the eGolf prototype and relevant data to test the technology. RN: Provide full operational Renault Fluence vehicle*	**RN: Transactional (B2B) relationships with BP and Conti (customer service carried out by BP) VW:** First point of contact for the eGolf / vehicle and Transactional (B2B) relationships with BP.	
Conti (for monitoring and charging services, profile download, OBU provision)	**1. R&D of OBU (Hardware, especially <u>Software)</u> 2. Software: Definition and solutions development for FEV services (Activation, Plan Drive, Driving (monitoring) & Charging) together with BP 3. Production, testing, and implementation (OBU)**	**Hardware & Software (OBU):** Overall **- Supports driver during driving (reduction of Range Anxiety) - That provides Infotainment - That enables (Continuous) Monitoring/PreDrive/Driving, Energy and Generic services - Development of the software algorithms that would be <u>reliable and scalable</u>** Directly for consumer: **- Provides info on status of car, remaining range, charging progress etc - That enables C2B communication / vehicle connection - That proactively notifies in case of unexpected occurrences, problems, range etc. - That stores driver related data in profiles (driver authentication, charging preferences) - That enables personalised range prediction based on the driving behaviour**	**B2B relationships with BP, RN, VW**	**Better Place VW Renault through Better Place**
ENDESA	**1. Energy Supply 2. Real time data management and pricing 3. Grid development: grid planning in terms of future resources and installations required, 'green grid' 4. Energy distribution from IT communication perspective (communication to grid simulation and support, but no energy provision for the simulation)**	**Optimisation of the assets (energy generation, distribution and supply, grid balancing) Real time pricing and tariffs**	**Transactional (B2B) relationships with BP and SAP**	**Better Place**
SAP	**HORST (creation and maintenance of Roaming and New Mobility services platform)**	**Enabled Roaming and New Mobility services (i.e. real time electricity pricing information)**	**B2B relationship BP through service provisioning via the HORST system**	**Better Place ENDESA**

Figure 12: ELVIRE Businss Model Canvas (1/2)

Key Resources	Channels
Infrastructure (Israel and Denmark) (BSS, CS) Standardized equipment and inventory	Better Place (Israel, Denmark) Renault retailer (Israel, Denmark) Renault and Better Place websites
R&D for FEVs, Brand, Production facilities, integration knowledge, Partnerships (esp. with BP and Conti)	Renault: Additional to the above: Traditional Channels (OEM dealerships, retailers) VW: Traditional Channels (OEM dealerships, retailers)
Engineering competences in OBU development Technical know-how in hardware and software	RN through Better Place, VW
Partnerships / Alliances with key partners (see left)	Better Place
	Better Place

Cost Structure		Revenue Streams
Infrastructure (CS, BSS) Electricity provisioning Battery inventory (incl. Insurance etc.) Administrative costs Maintenance (infrastructure and battery) Personnel (i.e. personal assitance service) R&D	R&D related to prototype creation and related systems (hardware, software system equipment for the smart grid intelligence) Grid planning related activities	Monthly fee for mobility and service package: With fixed pay per mile plan, battery leasing, charging (smart charging & charge me now), switching, services, insurance package, road assistance service, 24hrs emergency hotline, etc.
	Battery, R&D costs related to ELVIRE use cases, Mobility package contents, ELVIRE services VW: IT Infrastructure (costs of servers & maintenance) and implementation (since they provide car type A)	VW: FEV sales, after sales maintenance services RN: FEV sales, battery leasing rates, after sales maintenance service
	OBU R&D, hardware and software development Engineering personnel	Sales of OBU and related components, licensing / sales of the software Traditional revenue streams (electricity sales) but from new customers, new distribution channels
	R&D related to prototype creation and related system	Software licensing related to HORST services

Figure 13: ELVIRE Business Model Canvas (2/2)

4.4 Evaluation of the ELVIRE Business Model

The following subchapters aim to analyze the ELVIRE business model in light of its strengths and limitations. The evaluation is conducted along three dimensions. Initially, a behavioral perspective is taken that will attempt to mirror relevant aspects from drivers' behaviors and perceptions to identify strengths and limitations of the business model. Following, both technical and economic viewpoints are taken, to further find strengths and limitations of the business model. The limitations identified in this chapter will then provide the basis for the elaboration of improvement suggestions highlighted in 4.5.

4.4.1 Evaluation from a behavioral perspective

Recollecting one of ELVIRE's and the business model's main purposes, this subchapter will initially evaluate in how far the business model can be considered range anxiety-reducing. Subsequently, the remainder of this subchapter will look into the issues of affordability, price, and payment, value proposition, and other aspects to uncover strengths and limitations of the business model. This approach guarantees that all aspects from chapter 2.1.4 find consideration in the business model evaluation.

4.4.1.1 Range Anxiety

As explicated in chapter 1.4, the ELVIRE project was called upon to find ways to neutralize range anxiety in order to help the mass scale adoption of FEVs. It thus seems natural to begin an evaluation of the ELVIRE business model with an analysis of its range anxiety-reducing features. Overall, it must be stated that the business model provides reasons to be hopeful regarding this dimension. When mirroring the ELVIRE technical solution's product and service spectrum to the known approaches that can be employed to reduce range anxiety (cf. 2.1.4.2.1) it can be stated that the most promising approaches are being employed. The following paragraphs will now first elaborate upon key range anxiety-related aspects of the ELVIRE business model using the structure given in 2.1.4.2. Subsequently, follows a discussion of further range anxiety related issues. Chapter 2.1.4.2 held that there are three primary elements responsible for causing range anxiety: FEVs' limited range, infrastructure availability, and long recharging times.

FEVs' limited range: Various features within the ELVIRE business model aim at informing drivers of, and helping them deal with, their FEVs' limited driving range. Continental's OBU and underlying range calculation algorithms not only inform drivers about their remaining range, but also do so on a personalized basis. Individual customers' driving behaviors can be stored in profiles, so that personalized range predictions, POI locations, and charging-related preferences can be offered to drivers. This even works across cars thanks to the centralized storing of drivers' profiles: If a driver swaps to a different car, he can download his/her profile and the new vehicle will not have to "relearn" all the driver-specific aspects, but will have them readily available.

Features as the above are enabled through the many synchronous communication protocols that are run to facilitate the communication between vehicles and Better Place's Control and Management

Center (CMC). Each vehicle is equipped with an integrated SIM card that provides for a constant connection to the back-end system. Chapter 4.4.2 will offer more insight in this regard.

Infrastructure availability: The back-end connection itself provides a great range anxiety-reducing value proposition to drivers as it supplements basic in vehicle-FEV features, such as range notifications and warnings, with real-time information regarding the availability of surrounding infrastructure. Drivers will thus not only be alerted through hard-to-ignore pop up windows at certain energy thresholds, but will, thanks to their connection to the back-end system, immediately receive support and recommendations as to how, where, and under what conditions they can recharge.

Upon receiving a notification drivers can choose to be directed to charging and battery swapping stations. The CS and BSS are recommended to the drivers based on their planned driving routes that were entered into the OBU prior to the journey. If no entry was made (ELVIRE use case “driving without a plan”), then the system employs smart navigation to suggest CS and BSS based on the expected drivers’ routes. As Freas, Lang, and Lee (2011) found out, this form of smart navigation has a range anxiety reducing effect as it gives drivers a feeling of security.

What is more, the infrastructure is already a proven technical concept as it is up and running in Israel and Denmark. Another key strength of the holistic infrastructure solution can be found in the openness of the system: “The Better Place network of charge spots not only will provide charging services to Better Place subscribers, but also will enable drivers of almost any plug-in vehicle to charge” (Better Place, 2012b). This open approach is economically sensible and simultaneously certainly helps the acceleration of FEV dissemination throughout Europe by reducing non-Better Place customers’ range anxiety.

Long recharging times: The selection of infrastructure available for drivers constitutes another key range anxiety-reducing feature in the ELVIRE business model: drivers will be granted a swapping possibility that is time-wise comparable to refueling an ICE car at a gas station. The thought of being forced to kill four to eight hours (cf. 2.1.4.2) while waiting for the FEV to recharge is thus banished through the ELVIRE business model’s solution. Drivers without a Better Place mobility package will be steered to easy-to-use CS.

During the use of the infrastructure, no matter what charging or swapping option the driver selects, it is always possible to monitor progress in real-time through the vehicles’ OBU and/or smartphone applications. In case of any problems, both on the road and while using the infrastructure, drivers have access to a 24/7 support hotline. Following both information-based and support-based approaches, the business model employs technology in the shape of hardware, software, and infrastructure in order to neutralize range anxiety – similarly to the way Nilsson (2011) proposes (cf. 2.1.4.2.1).

The following table exemplarily shows a range of identified use cases and states for each of them which of Nilsson's (2011) approaches are applied. It should be noted that the ELVIRE storyline does not contain a scenario in which a driver has to be saved because he is out of energy. Thus, the underlying table does not feature an example for Nilsson's (2011) fifth approach "Eliminate the consequences of the situation". Nevertheless, with the offered 24/7 free roadside assistance the ELVIRE business model covers also this approach.

Business Use Case	Explanation	Approach type (Nilsson, 2011)
2.2 Driver Identification	Driver Identification is required to load personalized settings (Profile) such as destination history (needed for smart navigation) or consumption data (for continuous monitoring). Driver assignments can be downloaded from CMC. There is also a Guest Profile selectable so that unknown drivers are still able to operate the car, however with lower precision in the supporting algorithms.	Prevention, Risk-reducing
2.3 Profile Update	Profiles can be updated (details t.b.d.) they are locally stored on-board the vehicle system, however they can also be transferred, uploaded, downloaded, copied and deleted.	Prevention, Risk-reducing
2.4 Calculate a route	Route planning algorithm under FEV constraints, taking energy supply infrastructure locations into account, as well as route topology and corresponding energy consumption.	Dissolving, Risk-reducing
5.1 Continuous Monitoring based on battery level	This function is constantly running, comparing energy consumption with battery levels and range predictions. It also monitors the distance to surrounding charge infrastructure locations. Depending on the mode of operation (with or w/o plan) this function produces different strategies to prevent vehicles from stranding.	Information, Prevention
5.2 Continuous Monitoring based on traffic situation (if available)		
5.4 Continuous Monitoring based on charge spots availability		
5.5 Re-Routing (if requested by the monitoring module)		
5.6. Range Notifications and Warnings	Notifications and warnings are some of the results of reaching thresholds in the continuous monitoring function.	Prevention
13.1 "Smart" navigation	Smart Navigation is an approach to pinpoint a destination in case the user does not provide one. Since range problems can only be avoided effectively when the destination is known this function will analyze historical data to identify patterns which allow predicting current destination probabilities. It continues to compare vehicle movements to further eliminate unlikely possibilities and to single out the most likely destination. This destination could be automatically defined in case the user does not interrupt the process (tbd.)	Prevention, Dissolving, Risk-reducing
17.1 Receive information on expected availability of Battery Switch Stations	Energy infrastructure availability data will be requested from CMC in order to provide a selection of well-suited locations. These can be both, charge spots as well as battery switch stations. Their expected availability can be used to sort results on the in-car display.	Risk-reducing

Table 4: ELVIRE use cases matched to Nilsson's range anxiety mitigation approaches

Besides these positive aspects, there seems to be one aspect that needs additional remarks. The universal use of infrastructure, i.e. the possibility to recharge at any provider / plug, is not given in the business model. However, in a mass-market scenario it appears, customers will demand roaming, both on a national level and across countries, as consumers might otherwise feel constricted. In spite of this, Better Place maintains that all its customers can only recharge at Better Place certified CS. An imaginary driver who drives to a friend's house to stay over night will not be able to charge his Better

Place vehicle unless his friend has a Better Place contract and an installed Better Place CS as well. Reaching the goal of establishing the EV as a mass-market vehicle somewhat suffers from such consumer constraints, and would be helped more if drivers could plug in their vehicle in every conventional plug. This must be viewed as a major drawback of the business model in regards to range anxiety reduction as Freas, Lang, and Lee (2011) found out that customers view the freedom of choice in regards to service providers as most critical.

Thus, with the exception of roaming issues, the ELVIRE business model appears to be well equipped from a range anxiety standpoint: With both charging and swapping stations, a broad range of technical charging solutions is being leveraged. Additionally, consumers are being informed on both their vehicle's status and the available infrastructure surrounding them. The constant connection to the back-end allows them to establish contact with service providers beyond the 24/7 customer hotline in place. Lastly, the free roadside assistance (including towing) as part of the mobility packages should additionally ease drivers' minds.

Besides range anxiety, other perceptual barriers may hinder the mass-adoption of FEVs and thus threaten the success of the ELVIRE business model in reaching its objectives. The following chapters will discuss how the ELVIRE business model stacks up to a few groups of potential barriers often found in the literature with regard to FEVs: price and payment, value Proposition, image, and vendor preferences.

4.4.1.2 Affordability, price and payment

As elaborated upon in 2.1.3.1, FEVs currently cost a significant premium over ICE cars, due to high prices of battery technology. Chapter 2.1.3 explained that it is debatable whether the higher purchase prices will be offset through lesser yearly costs of operation over the whole vehicles' useful lives. Chapter 4.4.3 is going to look into the numbers in detail. However, independent of the economic benefits or drawbacks for consumers, the question of *how* consumers think about vehicle prices and fuel efficiency, and thus *how* the optimal FEV pricing and payment plan should be designed, requires some analysis. The following paragraphs are devoted to this inquiry.

In their consumer study, Freas, Lang, and Lee (2011) found out that drivers would much prefer paying high to medium costs upfront and be reimbursed through low operating costs when purchasing a vehicle. Given that this is exactly the logic of FEVs, it should affect purchases of FEVs positively. However, ICE cars are becoming more efficient and will do so at an impressive rate in the next years (Lache, Galves, & Nolan, 2008; The Economist, 2011). Drawing upon the research of Ricardo, an engineering consultancy, and Sanford C. Bernstein, an investment bank, the Economist (2011) concludes that this development is inevitable because otherwise OEMs would not be able to comply with politicians' CO_2 emission targets: "given motorists' aversion to the cost of electrics and hybrids, the quickest route towards meeting the deadlines for cutting emissions is to invest heavily in cleaning up their petrol and diesel cars".[8] Already today, there are vehicles on the market with significantly better fuel efficiency than the ICE Fluence's 6.8 liter/100 km. Audi's A3 1.4 TFSI nips 5.7 liters gasoline, the Opel Astra 1,4 Turbo 5.9 liters (Auto Scout 24, 2012). VW's Golf BlueMotion is satisfied with 3.8 liters diesel (Volkswagen, 2012), the Passat BlueMotion requires only 4.1 liters (Volkswagen, 2012). Accordingly, Deloitte (2011) warns: "Though the tipping points may vary slightly from country to country, (…) across the globe consumers will be less likely to consider purchasing an electric vehicle as the fuel efficiency of ICEs improves" (p. 16).

Confusing the picture somewhat more is the fact that there seems to be a discrepancy between what people answer in surveys and what they really do. Turrentine and Kurani (2007) conducted a study interviewing 57 households in California in depth and discovered that not a single one of them had calculated the present value of future fuel savings at the time of the vehicle purchase. Similarly Tsang et al. (2012) explain that most consumers put very high implicit discount rates on FEVs, i.e. they expect unreasonably short payback periods for FEVs. While this is worrisome by itself, this information is aggravated by studies finding that most consumers would not tolerate a premium for FEV cars. VW (2012c) cites an Aral study from 2009 stating that 72% of respondents would not pay more for a FEV than for an ICE car (Aral, 2009). Aral (2011) finds that respondents expect a price of € 22,309 for FEVs – even though the average price paid for ICEs in Germany is € 26,030.

Thus, even if TCO are lower, the requirement of paying a high sum upfront is certainly still a psychological, and for some households also an economical, barrier. This barrier seems even more daunting through the current insecurity towards battery qualities and life spans. Probably because of the technology's novelty, consumers understandably worry about the batteries' depreciation (Niedermayer, 2011). Freas, Lang, and Lee (2011) determined that more than 80% of their sample would prefer leasing the battery for € 79 per month than paying € 15,000 for it upfront. The ELVIRE business model offers such a battery leasing option and thus effectively tears down a major barrier to FEV adoption as it makes the vehicles more affordable and takes the risk associated with owning an expensive high tech product away from the consumer.

According to Lüttringhaus (2012), consumers' acceptance of battery leasing models will depend on the cultural specificities of the market. In Germany, where people take pride in owning a vehicle, this model may be harder to communicate than in other markets, such as Israel, which rank much higher in uncertainty avoidance and do not have a strong emotional connection to cars (Lüttringhaus, 2011; Hofstede, 2012). Nevertheless, the option by itself is a powerful element of the ELVIRE business model and should support its success. Adner (2012) agrees and believes that a battery leasing model, as implemented by Better Place, is the only approach to the electric car that would enable it to become a mass-market vehicle. According to him, for most people the purchase of a vehicle is an investment and the resale value of the car influences the purchase decision dramatically. The Economist (2012) backs up this statement, stating that Americans sell their cars on average after 3 to

[8] Automakers employ various methods to increase fuel efficiency of their ICE cars: they downsize engines and equip them with turbochargers and superchargers, they add start-stop systems, optimize road resistance with new tire designs and rubber mixes, improve aerodynamics through better grill design, and equip vehicles with fuel-injection systems and more efficient valve trains (Auto Scout 24, 2012).

4 years. In Germany this time is slightly longer, yet not decisive: Motorvision (2012) found that 18 to 29 year old German drivers exchange their vehicles after 5.5 years. A FEV, whose value is determined mostly through the expensive battery, which gets used up over time, may see its resale value decline very fast which would significantly worsens the economic proposition of the FEV as a mass-market vehicle (Adner, 2012). The ELVIRE business model effectively solves this problem by taking the battery off consumers' minds completely: the high price, the reliability and the resale value of batteries are nothing an ELVIRE FEV customer has to worry about. Herein lies one of the main behavioral strengths of the proposed solution. By selling an expensive item, the FEV, and the "miles" to operate it, Better Place resembles telecommunication companies (The Climate Group, 2012).[9] Interestingly, Freas, Lang, and Lee (2011), found out that consumers show great interest in a mobile phone-like payment plan for FEVs.

Lastly, the ELVIRE business model has another perceptual strength regarding the way customer relationships are organized. Freas, Lang, and Lee (2011) discovered that customers prefer solutions in which all operating costs are being bundled, i.e. solutions in which they only have to pay one party as opposed to having to deal with various entities for different services. The ELVIRE business model caters to this demand as it centralizes the commercial side of customer relationships in Better Place's hands.

4.4.1.3 Value proposition

Chapter 4.3 has made clear that the ELVIRE business model is fundamentally different from that of today's auto industry. The reason for these business model differences can be traced back to the technological differences (and their consequences) between FEVs and ICE cars. FEVs have lower ranges, can barely be recharged in timeframes that consumers are used to from ICE cars, are comparably expensive, drive differently, are comparatively unproven with regards to their technical reliability, and lack encompassing infrastructure. Additionally, it appears as if the customer-serving entities in the FEV market will be new players with whom customers have not yet established relationships characterized by neither familiarity nor trust.

Along with all these novelties, some experts claim that consumers will perceive FEVs differently from conventional ICE cars: buying a car was yesterday, purchasing mobility is today (Fraunhofer ISI, 2011). Consequently, to promote FEVs, the ELVIRE consortium has seized the chance to tailor a drastically new value proposition that centers on mobility instead of on the car. Naturally, the question arises whether this is the most promising value proposition to introduce the FEV as a mass-market vehicle.

There is at least one aspect that raises some doubts. In a few countries, especially in Europe's largest auto market, Germany, cars as items themselves, are of utmost importance. Probably as a heritage owed to the country's large automobile industry, its worldwide reputation and the pride connected therewith, for many German families the car is more than a means to an end, coming almost close to being treated like a proper family member (Kanellos, 2009). According to Forsa (2008) Germans value cars as Germany's most important product – ahead of beer and soccer – and the Handelsblatt finds that the choice of his/her car is the average German's most beloved form to express himself/herself

[9] Telecommunication companies also sell an expensive item (the phone) and the minutes to operate it.

(Kewes, 2010).[10] The ELVIRE value proposition however pushes the vehicle itself out of the limelight and instead promotes mobility. This may be a promising concept for traditionally unemotional car markets such as Israel or Denmark, but the example of Germany shows that it is questionable whether this approach is the right one in every country across Europe. Nevertheless, not everyone is as peculiar about cars as the average German, and Freas, Lang, and Lee (2011) ascertained that the mobility focused value proposition does have a strong appeal for a significant part of the society, e.g. environmentally concerned families and the young city population.

In conclusion, it seems that the abrupt switchover to a new mobility-focused value proposition is intriguing for various reasons but has to be approached carefully in the pan-european context. It is hard to see how an attempt to completely commoditize vehicles will help FEV mass adoption in some countries in the short-term. Consumers' minds cannot be changed over night, thus a longer transition period with an incrementally changing value proposition might promise more success. In any case, the value proposition should be customized according to cultural differences of the markets (cf. 4.5.1.1).

4.4.1.4 Other perceptual limitations

The study of the literature has revealed further potential behavior related limitations to the ELVIRE business model. The following paragraph does not aim to discuss these issues in detail but merely point them out.

- Fuel efficient vehicles may suffer from a bad (quality) image and be regarded as cheap by some people (Turrentine & Kurani, 2007). FEVs in particular may be regarded as ugly and not well designed, more resembling toy cars than real vehicles (Ulk et al., 2009).
- Consumers may regard FEVs as more dangerous in terms of collision safety and electrical hazards (Tsang et al., 2012). Thomas (2010) points out that there may be safety issues for visually impaired people due to FEVs' silence.

Concluding, there are many aspects that the ELVIRE business model does very well from a behavioral perspective. This chapter pointed out various aspects that generate optimism when estimating the likelihood of the business model being accepted by consumers. Nevertheless, there is further room for improvement, especially with regards to the roaming issues outlined. Table 5 summarizes the most important elements discussed in this chapter.

[10] For an interesting disquisition about Germans and their love for their cars please cf. Boyes (2007).

Category	Range Anxiety	Price and Payment	Value Proposition	Other
Strengths	- Range information and continuous monitoring - Holistic infrastructure solution (home charging, work place charging, CS & BSS) - Availability of infrastructure (CS, BSS) can be checked beforehand - Infrastructure standards: The most common CS standards are employed, thus a very open system - Comparable recharging times as ICE vehicles through BSS - Free roadside assistance - E-mobility services (monitoring of charging through smartphone application, 24/7 customer hotline, etc.)	- Battery leasing reduces high upfront cost barrier - Lower operational costs supposedly valued by customers - Customers like operational costs being bundled - "Mobile phone-like" payment plans	- Value Proposition ideal for young people, city dwellers, and environmentally concerned drivers	
Limitations	- Roaming across service providers - Roaming abroad	- Consumers do not value fuel efficiency as much as they say they do - Efficient ICE vehicles very competitive to FEVs in terms of operating costs - Prefer vehicles to be sold by OEMs	- Promotion of "mobility" as opposed to "cars" could be problematic in some countries - Low CO2 emissions not as big of an argument for most people looking to purchase a vehicle as commonly believed	- Social Stigma - Safety Concerns

Table 5: ELVIRE business model evaluation from a behavioral perspective

4.4.2 Evaluation from a technical perspective

ELVIRE has two technical key dimensions that will be discussed in the next sections. The first of these key dimensions is ELVIRE's infrastructure solution. Accordingly, chapter 4.4.2.1 will assess infrastructure related aspects in light of their benefits and limitations. The second key dimension is the developed communication platform. This dimension will be dealt with in two separate subchapters. The first one, chapter 4.4.2.2, will deal with the intangible parts of the platform, i.e. aspects that are related to data exchange. A second subchapter, 4.4.2.3, is then devoted to the evaluation of the central, tangible part of the communication platform – the OBU.

Before delving into the individual chapters, a general remark concerning privacy needs to be made. Privacy and data security is an important question for all technical components in question. All components deal with data that belongs to customers and contains sensitive information such as travel routes and banking information. In the European context there are already laws and restrictions that describe the use of such sensitive data e.g. the European Data Protection Directive (95/46/EC), which is why this aspect will not be analyzed closer in the following.

4.4.2.1 Infrastructure

From an infrastructure standpoint, the ELVIRE business model seems strong. With Better Place as a project partner, the consortium can draw upon the infrastructure solutions of the world's largest CISP (Tsang et al., 2012). Both CS and BSS were tested under real-life conditions in various countries such as Japan, USA, Israel and Denmark (Andersen, Mathews, & Rask, 2009). Besides public CS and BSS, the business model additionally provides for CS installations at residential homes and work places and thus provides infrastructure at all locations were FEVs will be parked the longest times (Better Place, 2011).

The charging infrastructure and the concept of leasing the battery for an increased charging price is a strong advantage of the ELIVRE business model. It allows customers to buy their FEVs for a cheaper price and therefore, decreases the entry barrier to the FEV market. Nevertheless, the model has some limitations, especially when it comes to roaming and BS.

Roaming: First, Better Place's requirement that its vehicles can only be recharged at Better Place CS seems constraining. It is for instance not possible to recharge a Fluence at a shopping mall charging outlet, if the outlet is not Better Place owned. That is economically sensible from a Better Place perspective, yet cumbrous from drivers' perspectives. Theoretically, roaming could solve the problem. In fact, the ELVIRE project established a roaming model based on a centralized entity that manages all the processes and data flows concerning roaming. From a technical point of view, this approach is sensible (cf. ELVIRE Delivery D3300.1&2 for a detailed description), however, if this solution were transferred to a real-world scenario problems of commercial nature would appear: Because of the mileage-based mobility package-focused business model of CISPs, it is not trivial to create an interconnected multi CISP market in which electricity (i.e. mileage) is universally obtainable.

To prepare for the roaming scenario, it thus appears crucial to reconsider the proprietary nature of the system and work out technical standards (sockets, plugs, batteries for swapping procedures) and usability standards (payment and handling) to ensure a universal charging environment for drivers (Deloitte, 2011).

There are two institutions that deal with standardization: the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). Whereas the IEC deals with all electrical issues, the ISO deals with all other technologies. Collaboration between ISO and IEC has been established since the early 1970s. In this collaboration the ISO is responsible for the electric vehicle as a whole and the IEC works on the electric components and the electric supply infrastructure (cf. ELVIRE Delivery D1300.4).

The decision for a common standard for sockets and plugs is difficult because there are already several options to connect to a network in operation throughout Europe. For the decision an understanding of the different charging modes is necessary (cf. Appendix A5).

There are several standards in productive use that are used in different countries and have proven track records. The simplest approach is the use of standard domestic plugs defined in various national standards mainly for Mode 1 and Mode 2 charging. The use of those, in particular the low-cost versions used in consumer equipment, entails several disadvantages such as problems with the use under outdoors conditions or long charging times. Also consumers who want to charge their cars in foreign countries would need an adapter as already known from normal electrical equipment. Another possibility is the use of industrial plugs that are defined in the international standard IEC60309-2. These plugs are widely used in Europe for industrial equipment but also for outdoor uses in camping sites or marinas. The widespread availability and the low production costs make them a preferred solution for Mode 1 or Mode 2 charging. A more sophisticated solution is the use of dedicated accessories. The international standard IEC62196 defines the requirements for those plugs and sockets. There are different types of plugs with varying physical dimensions. The two most known ones are based on the realization of the German company Mennekes and the Italian company SCAME.

All the standards introduced above concern the connection to AC network, the standards for accessories for DC charging, described in IEC62196-3, are still on the working draft level. The solution proposes to include the DC connector proposed by the CHAdeMO association and to combine AC and DC connections in one unit, called “combo” connector (Cf. Appendix A8).

All solutions introduced above have their advantages and are useful for different scenarios. Generally, it is important to ensure that customers can charge without worrying about different regional standards. The optimal outcome would be a solution where the customer can drive to every charging site and just plugs in the cord as it can be done for gas stations. This is not possible in the short term because there is already too much infrastructure and to replace all this would be very cost-intensive. In the long term there should be a common standard to achieve an experience as described. In the short term a possible approach is to use adapters wherever it is possible to achieve the highest level of compatibility.

Beside the technical standardization, the contractual relations between the involved stakeholders have to be defined. This involves on the on hand, the roaming agreements but on the other hand also the billing and clearing. It might be helpful to define a standard for billing and clearing however this is subject of political decisions.

Battery swapping: BS technology is a very important piece of the ELIVRE business model. Currently, the appeal of BS is given due to the limited driving ranges with the energy densities of current batteries and limited fast charging possibilities. BS is especially convenient for drivers and it is more advanced than other fast charging or inductive charging methods. Better Place CEO Shai Agassi additionally maintains that “a half-hour stop on the side of the road”, which would be necessary with fast charging today, is no “competition for a three-minute switch” (Agassi as cited in Shoebridge, 2011). Moreover, unlike fast charging, it is more considerate to the electric grid as the CISPs can recharge the batteries at off-peak hours (Deloitte, 2011). This enables better use of renewable energy and avoids expensive energy demand peaks. Despite all these advantages, future relevance of BS technology is highly controversial. The fast development of battery technology and a potential sudden advance of fuel cell technology could soon render BS redundant. It is thus debatable whether BS should be kept as an integral part of the ELVIRE business model. Since for now, FEV target customers are mostly people looking to purchase a second vehicle for intra-city trips, the demand for battery swapping appears limited to begin with as longer distances will be covered in ICE cars. Colet (2012) explains that the BS technology is Better Place's USP, but simultaneously argues that the provision of ICE vehicles will be an indispensable element of mobility packages in the future. Besides the potential problems of BS, another technical flaw seems to be inherent with them: the issue of standardization. For the battery to be swappable, OEMs need to collaborate with Better Place and inevitably make concessions in terms of battery size, type, and in-vehicle placement. Equipping all FEVs with standardized batteries would heavily limit the number of overall vehicle designs available. Peter Rawlinson, VP and Chief Engineer for Vehicle Engineering at Tesla, agrees, stating the shape of the battery is fundamental to the design of the whole car (Fehrenbacher, 2010). Standardized batteries would thus constrain OEMs in the selection of FEVs' most valuable component, heavily limiting their possibilities to differentiate FEV offerings (Lüttringhaus, 2011). The fact that this standardization will inevitably have to be established not only along car portfolios of one OEM but across different OEMs raises a problem concerning the future of battery swapping, claims Dan Sperling, director of the Institute of Transportation studies at UC Davis, as cited in Holzman (2008). In the same article, Greg Nowell from the University at Albany is cited positing that summer holidays, in which driving distances traditionally exceed daily averages significantly, could lead to supply problems in a BSS network. This seems reasonable as the increased driving distances entail an increased demand of energy, and thus batteries that would need to be provided.

Nevertheless, experts generally find the BS concept very appealing and are confident that it can help overcoming the shortcomings of today's batteries (limited ranges and long recharge times) (Andersen, Mathews, & Rask, 2009).

The discussion above outlines that BS is a promising solution to overcome range anxiety and to introduce FEVs to a widespread audience. However, since the development of fast charging technologies goes on quickly one could make the argument that fast charging will replace battery switching in the long term.

4.4.2.2 Communication platform - Data

The development of a multi-partner communication platform for FEVs that allows for the provision of FEV pre-drive, driving, and charging services is one of the tasks at the heart of the ELVIRE project. The platform that has been developed not only successfully leverages technology to directly suit the driver, but also bases the inter-stakeholder communication on it. The developed communication systems, which enable FEV-to-CISP (car type B) and FEV-to-OEM-to-CISP (car type A) communication, must be considered a technical strength of the business model. The benefits of the communication system lie in the possibility of establishing a constant connection between the driver and the back-end (e.g. the Better Place CMC), thereby enabling the ELVIRE partners to provide the driver with advanced FEV services for pre-drive, driving and charging use cases.

While the solution is sound in theory and within the scope of prototype solution, it does have certain limitations for a mass-market scenario. For one thing, the ELVIRE project has revealed that both of the proposed car architectures, car types A and B, are not feasible for mass-market implementation. The architecture of car type B offers an easy implementation of the OBU and communication between vehicle and back-end. This direct solution is cost-efficient because there is no further IT infrastructure required. However, this advantage causes a problem in car type B's requirement of having an OBU, which is developed by Better Place, within the vehicle. The issue with this communication unit is that the physical dimensions of such a unit would have to be different across different car types. Thus, each car type would require the development of a unique OBU that would be very cost-inefficient (Colet, 2012). This issue will be further elaborated upon in 4.4.2.3, however it can already be forestalled that Colet (2012) argues that car type B has little future in a mass-market EV scenario and that, consequently, it should be OEMs who develop car components as opposed to CISPs.

Car type A also has its advantages, such as increased data security. However, the high cost of this approach for IT infrastructure and data exchange prevents its commercialization in a mass-market context.

Thus, both car types can be used for the prototype implementation but are not useful for the final product presented to end consumers. Therefore, it is necessary to create a model that uses the advantages of both concepts and is feasible for a broad scale introduction of the business model. This has to be subject of further research among the OEMs and CISPs (cf. 4.5.1.2).

Essentially, CISPs and OEMs will need to come to terms regarding what sort of data to exchange when, at what prices (if at any price at all), which protocols and communication standards to use, etc. It shall be pointed out that none of these issues have to be a deal-breakers, yet they require early addressing, as the situation increases in complexity the larger the number of CISPs and OEMs grows. Consequently it will be vital to further develop the ELVIRE business model beyond the interfaces already defined, by adding standards for roaming, charging, and billing communication.

Standardization in communication

The communication between vehicle and charging spot is already subject of standardization. An example for this is IEC61851 that defines the communication through the control pilot function and mainly aims at increasing safety.

For the ELVIRE scenarios another type of communication has to be defined. The communication between the vehicle and the back-end systems is essentially for the defined use cases. In order to have a cost-efficient and feasible solution, every player should use the same communication channels. From a technical point-of-view such communication is nothing new and web services provide an optimal solution for this problem. However, the data that is exchanged is defined for each use case separately. The prototype implementation shows that the approach works and the next step is the introduction of a common standard that can easily be extended to new scenarios. The earlier this is brought on its way, the sooner the ELVIRE business model's communication platform could be leveraged to its full potential.

Inter-stakeholder communication

Besides the communication between vehicle and the back-end, there is much communication between the stakeholders themselves. One example that was already discussed in this chapter is roaming. Another typical case is energy demand prediction. It requires large amounts of real-time data that have to be transmitted from CISPs to utilities. Communication protocols for such purposes are already implemented in similar applications such as in the integration of photovoltaic generation plants, a feat that is confronted with similar issues as the communication between CISPs and utilities. This implies that the standards for inter-stakeholder data exchange could potentially be based on already existing protocols that would bring down implementation costs and increase system stability.

Beside this technical definition of communication formats, a contractual base for the data exchange has to be created. This is a task that has to be done on the business or political level.

The remainder of this chapter dealing with the technical evaluation of the business model is devoted to the component, which is at the heart of the communication platform's technical concept: the OBU. Conceptually, the OBU must be considered a part of the communication platform. However, due to the component's distinct importance within the ELVIRE project, a separate chapter will be used to highlight its strengths and limitations, which have partially already shined through in the paragraphs above.

The evaluation of the component will be conducted along three categories: its functionality, its (standardization) requirements, and potential supplements.

4.4.2.3 Communication platform - OBU

In terms of functionality the OBU performs very strongly. A large number of the developed pre-drive, drive, and charging services are enabled through the device. Services such as range notifications, continuous monitoring, monitoring of charging progress, and receiving of charge spot availabilities are all communicated to the driver through the OBU. Figure 14 below for instance shows how a driver will be informed through the OBU about the estimated energy level of his battery throughout his journey.

Figure 14: OBU displaying energy consumption preview on Route (Source: ELVIRE Delivery D2200 M15)

The OBU and its technical features thus contribute fundamentally to the translation of Nilsson's (2011) identified approaches to reduce range anxiety (cf. 2.1.4.2.1) into driver accessible services.

The technical requirements of the OBU however raise a question mark. The device is entirely built to Better Place's specifications by Continental. While the solution works well in the ELVIRE case, it is questionable whether such a set-up worked in a mass market EV scenario. Better Place has been having trouble to find partners from the automotive industry – besides Renault no European automaker is currently willing to enter a deep partnership with Better Place – partly because of the firm's OBU requirements. With Better Place and the Fluence, Renault has been assigned the role of a mere OBU implementer, without any significant say regarding the features of this component (Lüttringhaus, 2012).

It is understandable that the majority of automakers - which are constantly looking for ways to differentiate their offerings - will be hesitant to commit to a service provider's bidding. Especially the fact that the OBU is, together with the battery and the engine, a FEV's most crucial component – automakers will think twice whether they want to outsource this potentially very visible element of differentiation. Besides this strategic reasoning, there may as well be vehicle architecture related reasons why automakers will not bow to Better Place's requirements. Colet (2012) indicated that already with Renault, Better Place has voiced demands that cannot physically be met with the current design of the Fluence. It thus does not seem reasonable to assume that a small vehicle such as the VW Fox could accommodate the same OBU as a Renault Fluence.

In conclusion, it seems as if the current version of the Better Place / Continental OBU, which provides for much of the attractiveness of the ELVIRE business model, will have to be rethought in terms of its requirements in a mass-market scenario. Most FEVs will have an OBU (Lüttringhaus, 2011; Zarcula, 2012), yet it seems more likely that OEMs will be leading in the design of such components and not the CISPs. To foster the mass-adoption of FEVs, it could be more beneficial for CISPs to perform the role of an integrator, not developer, of components (Colet, 2012). CISPs that are able to work with different OEMs' OBU systems appear to have a strong value proposition in such a context. The idea could be: “No matter what you drive, you can get services at Better Place”. This idea will be take up again in 4.5.1.2.

As it has been pointed out, the OBU, as developed by Better Place and Continental, is very powerful and functional. Nevertheless, it could be supplemented and made even more valuable for drivers through Internet or mobile based services and devices that enable e.g. pre-drive services remotely. An example of such a service could be a smart phone application with which the pre-heating of the vehicle is possible without direct car access. However, the current version of the OBU is a closed system, with drivers and third parties sidelined and reduced to a user, not developer, status. This is a stark contrast to considerations of some OEMs that contemplate establishing the OBU as a platform on which various applications can be run and multiple devices be connected, similar to Apple’s Appstore (Zarcula, 2012). If such a platform was launched, independent developers could increase the value of this OEMs’ OBUs through their contributions. Consequently, this is a development that has to be taken into consideration when applying the ELVIRE business model to a future mass-market situation in which various OEMs’ OBU solutions will be offered.

Concluding, Table 6 summarizes the key points that the present chapter touched upon. It is clearly visible that the assessment of ELVIRE business model’s technical merit brought about many positive aspects in all three sub-dimensions. On the side of limitations, it has been revealed that especially the development of contractual agreements and various standardization issues demand consideration.

Category	Infrastructure	Communication Platform – Data exchange	Communication Platform – OBU
Strengths	- Proven infrastructure solution in public, private and semi-public premises	- Successful provision of pre-drive, driving, and charging services - Constant FEV to back-end connection - Enabling of inter-stakeholder communication	- Functionality (Range-anxiety reducing features) - Potential extensibility of component
Limitations **(Mass-market / multi-stakeholder scenario will require …)**	- Reconsideration of proprietary nature of Better Place offering - Development of technical (plugs, sockets, etc.) and usability standards - Procuration of broad OEM-CISP alliance for Battery Swapping	- different FEV communication unit solution (car type C?) - A solution for contractual agreements for data exchange - Standards and communication protocols for roaming, charging, and billing communication	- Technical and vehicle design requirements (standardization) - Transition of CISP from a developer role into a less-dominant integrator role

Table 6: ELVIRE business model evaluation from technical perspective

4.4.3 Evaluation from an economic perspective

Economically, the business model could be assessed from both the point of view of drivers and stakeholders. However, as ELVIRE takes a customer-centric approach to e-mobility, only drivers' perspectives will be taken to analyze the business model from an economic perspective. It is understood that the business model in the medium to long-term naturally has to generate profits for stakeholders as well. The economics behind stakeholders' ELVIRE-related projected profit and loss statements however are still so vague, especially due to the massive share of EV-related R&D and infrastructure investments that a profound analysis is not feasible at this point. Instead it is assumed that demand-side changes for FEVs will entail the necessary, economically sensible supply-side changes allowing for a profitable serving of the market. With this understanding, the following lines will zoom onto consumers' perspectives exclusively.

The following paragraphs are devoted to the discussion whether the ELVIRE business model creates monetary value for drivers, i.e. whether choosing a FEV as opposed to an ICE car makes drivers better off, given the parameters of the business model. Additionally, It will be assessed how TCO of a Better Place customer will differ from a "normal" non-Better Place FEV driver.

Building upon chapter 2.1.3.1, the comparison will be conducted along two aspects that drive vehicles' TCO: Purchase price and yearly running costs. The comparison assumes a holding period of four years and is conducted exemplarily for Israel, the country in which Better Place is most established as of March 2012 (Tsang et al., 2012). As pointed out in 2.1.3.1, it must be understood that different countries' parameters will significantly change the calculation's outcome, so that a generalization of the result is not possible.

Three vehicles will be compared:

- The Better Place Fluence Z.E. (BP Fluence),
- the Renault Fluence Z.E. (Fluence Z.E.) purchased outside of the Better Place network
- the ICE version of the Fluence (1.6 16V 110 with five-speed manual gearbox, ICE Fluence).

The BP Fluence and the ICE Fluence are currently being offered in Israel. The Fluence Z.E. is currently not offered in Israel. Thus, for the comparison, certain assumptions are made.

4.4.3.1 Purchase Price

The ICE Fluence retails at NIS 122,900 (€ 24.826 as of March 17, 2012). The BP Fluence is offered in two versions: the Expression for NIS 122,900 (ca. € 24,826) and the Dynamic for NIS 129,900 (ca. € 26,260) (Better Place, 2011).

Along with the vehicles, Better Place offers seven mobility packages: one that requires a one-time payment of NIS 34,600 (ca. € 6,994) and involves no further charges. This package grants 25,000 km annual mileage and the Better Place service package for three years. The service package includes free of charge CS installation and maintenance, unlimited access to public CS and BSS, the OBU (sold as "Oscar"), 24/7 customer assistance, and road-side assistance (Better Place, 2011). The six other mobility packages run for four years and include this service package as well. However they differ in price and annual mileage:

Mobility P.	1	2	3	4	5	6
Km p.a.	20,000	23,000	26,000	30,000	35,000	40,000
Price (NIS / €) monthly	1,090 / 220	1,300 / 263	1,470 / 297	1,599 / 323	1,850 / 374	2,100 / 424

Table 7: Better Place Mobility Package Prices in Israel (Source: Better Place, 2011)

The analysis assumes the purchase of the cheaper BP Fluence version (Expression).

As pointed out, there is no official offering of the Fluence Z.E. Accordingly, its retail price is estimated using the price of the BP Fluence and adding the assumed cost of the vehicle's battery: € 24,826 + € 7,500[11] = € 32,326. Certainly this calculation can only be an approximation of the Fluence Z.E.'s purchase price if it was offered in Israel. Nevertheless, as the price for the BP Fluence does not include the cost of the battery (as it is understood that the battery will be paid through the customers' monthly installments), the calculation in its essentials appears to be sensible. It is conceivable that the price would be a little lower if Renault decided to offer the Fluence Z.E. with a smaller, less powerful OBU than Better Place (cf. 2.1.3.1). However, for the sake of simplicity, this analysis will assume that both the Fluence Z.E. and the BP Fluence will feature the same OBU.

Subsidies

Along the lines of chapter 2.1.3.1, the subsidies resulting in the consumer purchase prices will be looked upon in a little more detail.

The breakdowns of the consumer end prices into their different elements are as follows:

[11] Using the formula given in 2.1.1.3.1 Economic Analysis, one can approximate the BP Fluence's battery costs. € 6,700 of the vehicle's cost seem to stem from the battery (USD 400 * 22 kWh battery package = USD 8,800 = € 6,700). Two things must be noted here: € 6,700 appears to be a rather low cost value for the Battery. Other sources usually speak of prices higher than € 8,000 (The Climate Group, 2012). Accordingly, the sources are triangulated to yield a price in the middle, € 7,500, for the calculation.

	BP Fluence	Fluence Z.E.*	ICE Fluence*
Dealer price	12,928	16,833	10,100
Sales tax	1,293	1,683	7,070
VAT	2,275	2,962	2,828
Total	16,496	25,860	19,796
Consumer price	**24,826**	**32,326**	**24,826**

Table 8: Price breakdown BP Fluence vs. Fluence Z.E. vs. ICE Fluence; (Source: Haselkorn, 2011); *values partly estimated

As visible in Table 8, the two FEVs receive support from the government through a sales tax reduction from 70% (for ICE cars) to 10%. This allows dealers to have a higher margin with the FEVs than a Renault dealer can achieve with the ICE version of the car.

4.4.3.2 Yearly Running Cost

As determined in chapter 2.1.3.1, the yearly running costs of a vehicle depend on various elements.

Vehicle efficiency: The two electric Fluences have an all-electric maximum range of 185 km (Better Place, 2012c). Given that the range will decrease over the vehicle's lifetime, an average range of 170 km is assumed. Given its 22kWh battery, the FEV Fluence's efficiency is roughly given through the equation

$$22\ kWh / 170\ km = 0.129\ kWh/km$$

or 12.9 kWh / 100 km. The ICE Fluence demands 6.8 liters of petrol for the same distance (Renault, 2012).

Cost of electricity and petrol: A kWh of electricity costs about 0.5 NIS or € 0.1 in Israel (Trilnick, 2012). The price for gasoline is ca. € 1.6 per liter (Jones, 2012).

Annual mileage: The analysis assumes a yearly driving distance of 20,000 km (mobility package 1), as this comes closest to the average Israeli's assumed yearly driving distance.[12]

[12] Given the small size of Israel, it is assumed that Israelis do not drive more than the average person in France (18,108 km, according to AXA, 2010), as France is Western Europe's largest country by area.

Depreciation of vehicles and batteries: A common rule of thumb for ICE cars holds that a car loses roughly 10% of value per year (Luiginbühl, 2011). After four years, the ICE version of the Fluence would thus roughly score 65% of its purchase price on the used vehicle market. Adjusting additionally for the fact that every 10,000 km driven lower the vehicle's resale price by another 2% of the vehicle's original purchase price (ibid), one ends up at roughly 51.9% resale value for the ICE Fluence with 80,000 km (€ 12,873).

The case is a little more complex for the electric Fluences. The Fluence Z.E. driver would have to worry about both vehicle and battery depreciation, as he owns the battery. It is assumed that a FEV without the battery depreciates similarly to an ICE car at 10% per year. The depreciation rate for each 10,000 km is set to 0%, because it is assumed that the driven distance will mainly lead to battery depreciation, not vehicle depreciation. Given FEVs' significant lower complexity compared with ICE cars this seems sensible. The battery depreciation is given through the equation

*Battery depreciation = (Total battery's cycles / Cycles needed per year) * cost of battery*

with

Cycles needed per year = Yearly mileage / all-electric range.

Plugging in the numbers yields a yearly battery depreciation of only € 441. The calculation is obviously strongly dependent on the correctness of its input values: Would it be revealed that the battery costs not € 7,500 but € 15,000, would not last 2,000 but only 1,000 cycles, and would be driven 40,000 km per year, the battery would depreciate € 3,529 p.a. or € 14,117 over four years. However, given the information from Better Place,[13] the driver would be left with 50.4% of his/her vehicle's value after four years (€ 16,228).

In case of the BP Fluence, the driver does not own the battery, thus he is only bothered with the depreciation of his vehicle excluding the battery. Analogous to the calculation for the Fluence Z.E., the BP Fluence thus would score 65.6% of its purchase price on the used vehicle market (€ 16,228).

At this point it must be pointed out that there are no sources to date that break down exactly how much value electric cars will lose over time and, due to FEVs novelty, no market for used models has yet been established. Especially noteworthy in this regard is the case of Better Place customers that look to sell their Fluences. Essentially, these drivers are going to attempt to sell a FEV shell, a vehicle without battery. As of now, it is incalculable what the market would pay for such a vehicle as it is contingent on a variety of factors including:

- Whether FEVs have achieved mass market acceptance
- Whether Better Place installs a re-purchase program enabling customers to trade-in their old vehicles
- Whether Better Place sells mobility packages to customers who have not purchased a vehicle from the company beforehand and how these packages will be priced

[13] Which is ok to use fort he Fluence Z.E. since the vehicles are essentially the same.

- Whether Better Place Fluences begin to encounter unforeseen technical problems[14]
- How new FEVs compare in price and value
- How battery technology evolves and
- Whether new batteries will still be compatible with the old Fluences

The above list is by no means exhaustive and is only meant as an indicator of how much insecurity is connected with FEVs' resale prices. Resale prices for vehicles with switchable batteries could reflect a significant premium or a discount to ICE cars, depending how the factors above (and others) play out. Experts are of mixed opinion. As explained in 4.4.1.2, Professor Adner (2012) is thrilled by the battery leasing solution and maintains that it solves the resale issue of FEVs. Israeli experts, who have to make the purchase decision today, are more skeptical. According to Mitnick (2011) rental agencies, which account for more than half of the 216,000 vehicles leased to corporations in Israel, are not interested in doing business with Better Place because of the insecurity connected with the resale values. Mitnick (2012) quotes Moni Bar, chief executive of Budget Rental Cars Israel-Domicar Ltd. and chairman of the Association of Israeli Rental Agencies, who expects FEVs with switchable batteries to lose 70% of their purchase price value over four years, and simply states he "will not take the risk at this time" (Mitnick, 2011).

Cost of maintenance: According to Autokostencheck (2012), the maintenance costs for an ICE Renault Megane Fluence 1.6 that drives 20,000 km per year clock in at € 42 per month. Assuming that this figure would also be valid for Israel and that maintenance cost for electric cars are 54% of those of ICE cars (cf. 2.1.3.1), the BP Fluence and the Fluence Z.E. will require maintenance of € 22.68 per month.

Cost of insurance: The ADAC maintains that the full-blown cost of insurance for the ICE Fluence in Germany would be € 126. Assuming that this rate is roughly equivalent to what is paid in Israel for car insurance and that Better Place's statement that the electric versions of the Fluence bring about insurance savings of € 265 p.a. or € 22 per month (Bronfer, 2011), the FEV insurance fees come in at € 104 per month. It should be pointed out that the Better Place statement contradicts what has been stated in 2.1.3.1, where it was held that FEVs would be more expensive to insure than ICE cars.

Taxes: To the author's knowledge there are no tax benefits with the exception of the sales tax advantages at the time of purchase in Israel.

4.4.3.3 TCO

Nitzan Avivi, editor of Israel's auto magazine said: "In the beginning, those that move to the Fluence electric won't do it for economic reasons. They'll do it for environmental reasons, or to be early adaptors" (Avivi as cited in Lavers (2011)). The following paragraphs will put the numbers together and attempt to evaluate this claim.

[14] E.g. occurrences of batteries catching fire etc.

	Israel		
	Fluence Z.E.	**BP Fluence**	**ICE Fluence**
1. Purchase Price			
Vehicle purchase price incl VAT & Subsidies	160,029	122,900	122,900
in €	**32,326**	**24,826**	**24,826**
- potential subsidies (1.3)	X	X	X
2. Yearly running costs			
Efficiency (kwh or liter / 100 km	12.9	12.9	6.8
Electricity price (€/kwh)	0.101	X	X
Gasoline price (€/l)	X	X	1.6
Cost per 100 km (€)	**1.30**	**13.21**	**10.88**
Annual mileage (2.3)	20,000	20,000	20,000
BP package	X	2,642	X
Yearly depreciation (2.4)	2,576	2,134	2,988
of battery	441		
of rest of vehicle	2,134	2,134	2,988
Yearly maintenance cost (2.5)	272	272	504
Insurance (2.6)	1,248	1,248	1,511
Yearly taxes (2.7)			
Total cost per year (€)	**4,356**	**6,297**	**7,179**
Total cost per km (€)	0.22	0.31	0.36
3. Holding period	4	4	4
4. TCO	**17,425**	**25,187**	**28,717**

Table 9: TCO comparison

The approximation of TCO in Table 9 reveals that in Israel, the two electric versions of the Fluence would beat the ICE Fluence in regards to TCO over a four year period. Better Place's claim that their offering guarantees savings in a family's auto expenses in the range of 15 - 30% compared with an ICE car (Better Place, 2011), could almost be reproduced in the analysis which yields a 14% savings potential of the BP Fluence over the ICE Fluence.

Further, the Fluence Z.E., which is the vehicle purchased outside of the Better Place network, beats the BP Fluence in TCO by roughly 30%. This is the result of the significantly higher cost per 100 km[15] that only partly get offset by lower depreciation rates. It may be arguable whether the BP Fluence's cost per 100 km should be ten times higher than those of the Fluence Z.E. However, it is generally not surprising that they are higher because of the additional mobility package contents (home charging spot, roadside assistance, BS service etc.) that the BP Fluence driver will get but the Fluence Z.E. driver will not have. Whether these services are worth the € 0.09 per km is left for drivers to decide.

Once again it must be pointed out that the result of the comparison can only as good as the data that went into the analysis. Due to the limited availability of data one thus has to be careful and should not take the exact numbers for granted, but merely view them as an indicator. There are aspects that would improve the picture in favor of the electric cars even more, whereas there are other elements that would put their top position in the austerity table in jeopardy.

Favoring FEVs, for instance, is the fact that the 6.8 l/100km for the ICE car may be overstated and only achievable by defensive drivers. Second, the Better Place contract lasts four years, and the

[15] calculated as: Annual Mobility Package Price divided by 200

mobility package prices are fixed over this time span. The price of gasoline however is volatile and might rise in the coming years as explained in 2.1.3.1, making Better Place customers potentially better off as the calculations above make it seem.

On the other hand, Better Place's data regarding battery lifetime and cycles appear optimistic, as they cannot be corroborated with other independent sources. Additionally, the analysis assumed that the Better Place customers would use up all the kilometers that they purchased (i.e. they would drive exactly 20,000 km p.a.), which appears unrealistic. Would drivers only drive 19,000 km, they would still have to pay the full package price and the relative price per km would rise accordingly. Overall it seems as if the Better Place mobility package offering neglects the driver segment of people with annual mileage lower than 20,000 km. They would need to purchase the 20,000 km package and, depending on how much lower their actual yearly mileage is than 20,000 km, accept relatively higher prices.

Concluding, the analysis showed that electric vehicles as such appear to be a more frugal mobility solution than ICE cars in the state of Israel. Statements such as the one from Avivi, thus seem only to be supportable if one seriously doubts Better Place's information regarding their battery technology.

4.5 Recommendations for Business Model Improvement

The preceding chapter has revealed the ELVIRE business models strengths and limitations along various dimensions. This chapter is now determined to derive recommendations that would help neutralize the business model's shortcomings and make it stronger and more applicable to a mass-market scenario. The recommendations are subdivided into two sets.

First, potential business model improvements that the stakeholders could take care of themselves, will be elaborated on. However, as experts agree that battery technology will not develop fast enough to make FEVs competitive to ICE cars over the next five years (van Essen & Kampman, 2011), a second set of recommendations, targeted at policymakers, is called for. If it is their declared goal to bring forward innovation and the mass-dissemination of FEVs, they will need to draft a set of sensible government policies, for which general suggestions are given in 4.5.2.

4.5.1 Recommendations to stakeholders

4.5.1.1 Stakeholder actions to reduce behavioral limitations

Recommendation 1: Rethink mobility packages or solve the roaming issue so that the CS restriction on Better Place customers can be lifted

Freas, Lang, and Lee (2011) found out that consumers consider it of utmost importance to be able to charge their FEVs universally, regardless of charge spot operator. Drivers thus demand a feature that is still in a very early phase of development in the ELVIRE business model: roaming. Chapter 4.4 has revealed the business model's shortcomings in regards to and potential upsides of roaming on various occasions. To cater to consumers' needs and wants and increase their comfort when dealing with FEVs, it thus seems logical to get rid of the proprietary nature of Better Place's system. Especially in the beginning, when infrastructure coverage will not be comprehensive, customers' minds could be eased by giving them as many CS alternatives as possible. Chapter 4.4.2 has already indicated that this is a Herculean task as it raises the question of how the proprietary nature of the ELVIRE business model can be broken up without Better Place losing its economic foundation and mobility packages still making sense. It appears as if a solution would either entail the solving of roaming issues or a rethinking of mobility packages.

Recommendation 2: Let OEMs, not new entrants, sell FEVs

Chapter 4.4.3 mentioned the ELVIRE finding that consumers would prefer buying FEVs from OEMs and not from new market entrants such as Better Place, suppliers as Bosch, or technology companies such as Google or Apple. Thus, a redesign of the ELVIRE business model could be considered that puts the vehicle sales in OEMs' hands, while leaving all FEV mobility services in the CISPs role. The latter seems important, as Freas, Lang, and Lee (2011) has discovered that drivers would prefer receiving all running cost related services bundled from one provider.

Recommendation 3: Reconsider ELVIRE value proposition to account for market peculiarities

Chapter 4.4.1.3, indicated that consumers' emotional attachment to vehicles differ across European countries. Especially in countries with a strong car industry, such as France, U.K, and Germany, people may see more in their cars than just a means to an end. Therefore it may make sense to reconsider the ELVIRE business model's value proposition for certain countries and slightly replace the central aspect of "mobility" with a stronger focus on the "FEV" itself.

4.5.1.2 Stakeholder actions to reduce technical limitations

Recommendation 4: Consider transforming the role of CISPs towards being integrators, not developers

Chapter 4.3.2.3 OBU traced the idea that it could be worthwhile rethinking the role of the CISP in the ELVIRE business model. More specifically, transforming the role of Better Place away from being a developer of systems and components towards becoming an integrator of these elements could be valuable for both CISPs and drivers. On the one hand, Better Place, if it was be able to work with different OEMs' systems, would have a strong value proposition in the market. On the other hand, this would severely reduce the ELVIRE business model's outlined limitations with regards to standardization issues (of components, and data communication) and would represent a first step towards a roaming solution. It thus becomes clear that such a shift of roles would carry merit in different dimensions. Were CISPs taking up integrator instead of developer roles and focusing on service provisioning for all types of FEVs (similar to gas stations do today for ICE cars), solving the communication issues outlined, would be facilitated. CISPs could develop key competencies in managing data and information from different OEMs and reduce the issues related to data security and privacy. Drivers would benefit, as this would represent a significant leap towards opening up the proprietary nature of Better Place's network. Additionally, more FEVs could receive a constant connection to the back-end in an easier fashion. As pointed out in 2.1.4.2, this would facilitate the reduction of range anxiety in the mass-market scenario.

Recommendation 5: Research new car type solution

One of the technical limitations outlined in 4.4.2.2 was the circumstance that neither car type A nor car type B appear suitable for a mass-market scenario due to their cost inefficiency (A) and standardization requirements (B). Nevertheless, both car types have their merits that should be reshuffled and combined in a new car type C solution.

Recommendation 6: Consider supplementing mobility packages with ICE technology for special occasion long trips

Chapter 4.4.2.1 elaborated upon the benefits and disadvantages of battery swapping. Essentially, the chapter's conclusion was that BS appears necessary to neutralize range anxiety in the short term but will eventually be replaced by the less cumbrous fast charging technology. Instead of building a comprehensive BSS network across Europe, it could be recommendable to only build BSS at strategically excellent locations which are likely to amortize in the near future and additionally supplement mobility packages with ICE cars that can be rented free of charge for special occasions (e.g. for longer holiday trips). This might be a sensible compromise that would limit the investments into BS that otherwise might never amortize

4.5.1.3 Stakeholder actions to reduce economic limitations

Recommendation 7: Implement FEV repurchase programs and guarantee future batteries' downward compatibility

4.4.3 analyzed FEVs' cost items, as incurred by drivers, in a detailed manner and found a large amount of insecurity related to FEVs resale values. With technology advancing quickly, consumers are uncertain as to how fast FEVs will depreciate. Better Place could counteract these worries by institutionalizing FEV repurchase programs and giving guarantees that future batteries will be downwardly compatible, i.e. that Better Place will make sure that its next generation batteries will still fit the older vehicles. Offers like these could help taking some steam of the hard fought FEV depreciation disputes.

Recommendation 8: Extend mobility package offering with packages featuring lower mileage plans

The economic evaluation 4.4.3 also touched upon the fact that there are no mobility packages for drivers with yearly mileage of less than 20,000 km. This puts a significant part of the driving population at a cost disadvantage since, as stated before, the average European's driving distance is less than 20,000 km. The Better Place mobility package offering would probably find more approval if it was extended with packages featuring e.g. 10,000 km and 15,000 km plans.

Recommendation 9: Explore ways to increase the FEV's value to drivers

FEVs' cost still represent a significant barrier for many customers as explained in 2.1.4.1. The Better Place offer of leasing the battery instead of buying it helps to improve this situation, however, the offer could be made even more interesting for consumers if the value of the FEVs itself could be raised. An idea to achieve this is by realizing V2G concepts that could translate the FEV into a revenue-generating asset for drivers. Nevertheless, V2G would put additional strains on the Better Place owned batteries, which is why models like this will have to be explored in a detailed fashion in light of their benefits and costs.

4.5.2 Recommendations for government policies

Policymakers could support the mass-adoption of FEVs in all three areas of evaluation of the ELVIRE business model. Before delving into the discussion of the separate areas, it shall be pointed out that governments are in a tight spot – it is important for policy makers to remain fair to all types of energy-efficient drive systems, without privileging the FEV industry unfairly (van Essen & Kampman, 2011). With this understanding in mind, the following paragraphs will highlight governments' potential influence to neutralize the behavioral, technical and economical limitations of the business model.

4.5.2.1 Governmental action to reduce behavioral limitations

Recommendation 10: Employ FEVs in public transport

Chapter 4.4.1.4 explained that FEVs currently suffer from social stigma resulting from people's low levels of exposure to the new technology. As this is something that the ELVIRE business model itself can only do very little about, it seems as a sensible area for governments to step in. Policy makers for instance could endeavor to bring FEVs into public transport. Especially busses and taxi fleets seem to be interesting points of applications for FEVs. On the one hand, their driving patterns (short distances and frequent stops) seem to be tailored to current FEV technology. On the other hand, busses and taxis are of high visibility in most cityscapes and would thus help citizens getting in touch with FEVs. Besides brand-related promotional aspects, such projects provide concrete advantages to FEV adoption as they display the technology's benefits and prove its applicability for daily usage. How exactly this could work has already been demonstrated by Better Place in a taxi project in Japan (Tsang et al., 2012).

Recommendation 11: Further tweak European energy mix towards renewable energies

Moreover, as chapter 2.1.3.2, explained, FEV critics frequently pinpoint that FEVs were not really green, as the energy that they run on needs to be produced before. While these critics have been disproven in so far that even with today's European energy mixes, FEVs are significantly "greener" than conventional ICE cars (Notter et al., 2010), the critics do have a general point. The level of environmental-friendliness of FEVs is dependent on factors outside of drivers' influence and could still be greatly enhanced. Therefore policy makers should further push renewable energies into

European countries’ energy mixes. The smaller the emissions figure in the energy production process, the better FEVs’ emission footprint, and the easier it becomes to market FEVs.

Recommendation 12: Put CO_2 tax emphasis on the vehicle purchase prices through non-recurring taxes

A further recommendation is related to the paragraph above. As explained in 2.1.3.2, one of FEVs’ main advantages is that they have lower levels of emissions of one particular environmentally harmful gas: CO_2. The fact that in many countries, such as Germany and Israel, cars are being taxed according to their CO_2 emissions is a step that goes into the right direction and should help the popularity of FEVs. In fact Aral (2009) found out 58% of people looking to purchase a vehicle declare CO_2 emissions as “important” or “very important”. Alarmingly, this figure decreased to 47% in 2011 (Aral, 2011). Even worse, as pointed out in 4.4.1.2, when it comes to the actual purchase decision, 72% of the people state that they would not pay a premium for a vehicle with a smaller CO_2 footprint (Aral, 2009). This finding nicely corroborates Turrentine and Kurani’s (2007) finding that people tend to put insufficient values on future savings (cf. 4.4.1.2). Tying these insights together yields a further recommendation for policymakers: instead of taxing vehicles’ carbon footprint monthly, the CO_2 tax burden should have to be shouldered at the time of the purchase of the vehicle, as the findings imply that this would result in a higher FEV adoption among drivers. Alternatively one could think about cross-subsidizing FEV purchases through the CO_2 taxes on ICE cars.

4.5.2.2 Governmental action to reduce technical limitations

Recommendation 13: Subsidize infrastructure roll-out

Better Place has so far done business in geographically tiny and isolated markets such as Israel and Denmark, where the overall EV legislative and industry environment is very beneficial, or in selected areas of large countries such as Canada, USA, Australia and Japan (Tsang et al., 2012). Generally, building up encompassing infrastructure in small countries/regions is easier as it requires less financial investment and less transaction costs due to the smaller number of partners necessary. Moreover, smaller markets tend to be more homogenous and thus easier to serve (Mitnick, 2011).

Implementing the ELVIRE business model across Europe would entail having to reach a decent coverage across a very large area, as experts indefatigably point out the high importance of standardized charging infrastructure (Arup-Cenx, 2008) and the lack of it leads to range anxiety (cf. 2.1.4.2). However, rolling out the infrastructure will be hard, for the investments necessary are immense. Governments could thus make a vital contribution by subsidizing the infrastructure build-up. This could spur more investments from private players who otherwise might be scared away by initially low utilization rates and long amortization periods. It must be pointed out at this point, however that governments, which support Better Place on large-scale national levels, might need to respond to cries that Better Place is monopolizing the electric car market – an accusation the company has shrugged off in the past (William Davidson Institute, 2010). Some cities, such as Oslo, have therefore gone over to rolling out infrastructure themselves and providing electricity for free (Cars21, 2011a).

Recommendation 14: Analyze whether cross-country joint venture for infrastructure roll-out could make sense and how it could be supported

Recommendation 4 raises the question if it would be feasible for Better Place to partner up with other CISPs, utilities, and other players to share resources and build up a network together. While this does seem like an interesting solution in theory, it will be hard due to the highly fragmented energy distribution market in countries such as Germany or Austria. According to Colet (2012) it is impossible for Better Place, or any CISP for that matter, to have profitable relationships with the 750 energy providers in Germany because the transaction costs for telecommunication, billing, and roaming would not be offset by the profits that could be earned through the sale of electricity. A sensible solution could be provided through a joint venture of various industries' big players that would have the financial means to roll out infrastructure continent-wide and could take care of abovementioned transaction costs internally. Policymakers could assess the support worthiness of such a solution and screen for ways how a multi-stakeholder joint venture could be called into being.

Recommendation 15: Ensure standardization efforts are maximized and sped up

Chapter 4.4.2.1 elaborated upon the grand importance of quick standards for charging related equipment, such as sockets and plugs, as one of the main prerequisites for roaming. Policy makers should thus drive necessary standardization projects forward and ensure that countries across Europe develop standards jointly and not separately.

4.5.2.3 Governmental action to reduce economic limitations

Recommendation 16: Find ways of reducing the relative costs of FEVs, especially the upfront costs

Recommendation 3 already pointed out that drivers care more about the purchase price than about vehicle's running cost. Aral (2011) supports this finding stating that price is the foremost criterion that drivers care about when looking for a passenger car. Since FEVs currently cost a significant premium, it appears crucial that policy makers find ways to reduce the price gap, either by subsidizing FEVs or by penalizing ICE vehicles. An example for a country that does this very stringently is Denmark. In Denmark vehicles are exempted from a non-recurring vehicle registration tax, which constitutes an impressive subsidy of FEVs. According to the European Automobile Manufacturers Association, the registration tax depends on the vehicle's price. For vehicles priced up to DKK 79,000 (€ 10,623 as of March 29, 2012) the tax weighs in at 105% of the vehicle's purchase price, for vehicles priced above DKK 79,000 (€ 10,623), the tax amounts to 180% of the vehicle's purchase price (ACEA, 2010).[16] Considering that FEVs weighing less than 2 tons are exempted from this tax, and assuming that an average FEV costs € 30,000, this implies that the average Danish FEV buyer receives an indirect state subsidy of € 54,000. ACEA (2010) provides a collection of government incentives currently in place that could serve as a starting point for crafting policy frameworks. Besides reducing upfront costs, a running cost reduction through e.g., an exemption from congestion

[16] http://www.acea.be/images/uploads/files/20100420_EV_tax_overview.pdf

charges (as carried out in London (Tsang et al., 2012)) or exempts from taxation for company car benefits or free electricity (both offered in Oslo (Cars21, 2011a)), would certainly also be helpful (Lache, Galves, & Nolan 2008). In conclusion, any means governments have to reduce TCO of FEVs for consumers should be considered, with upfront cost reductions prioritized.

Recommendation 17: Increase the value of FEVs for their owners

Besides reducing the relative price of vehicles, there is another strategic option for governments. Policy makers can attempt to increase the value that FEVs generate for their owners. There are various ways of how this could be achieved. One method is to open up special fast lanes for FEVs only, similar to some cities that have dedicated lanes to busses and taxis (Oslo), or families on highways (USA). The Canadian province of Ontario is currently experimenting with such a solution of dedicated lanes (Tsang et al., 2012). Another method is to provide free parking to FEVs in areas where parking normally is a hassle. This is momentarily offered in downtown Copenhagen (Dealbook, 2009). Providing FEVs with special access rights to, e.g., city centers where usually cars are not allowed to go, is a third way to increase FEVs' value to drivers. Various cities in France currently experiment with this approach (Cars21, 2011b). Beijing in China takes it one step further by forbidding ICE vehicles on its streets on Mondays (ibid). In summary, besides reducing cost, manifold FEV value increasing policies can be thought up that support FEV adoption.

5 Conclusions, Limitations and Future Research

5.1 Conclusion

The point of departure of the thesis at hand was the realization that FEVs will drastically transform the nature of the automotive industry. Prior research has already revealed that not only automakers, FTS, but also companies traditionally not active within the automotive sphere, namely utilities, and communication enablers, will modify their business models to participate in the growth opportunities the FEV market offers. Further, the ELVIRE project has described the emergence of an entirely new business model that accompanies the rise of the FEV: the CISP.

Earlier research assessed the current state and the changes in industry, revenue, and enterprise models of all these stakeholders in light of the increased attention FEVs have recently received. The present thesis thus built on a thorough foundation of knowledge covering the options various industry players are faced with concerning FEV-induced business model innovation. Accordingly, this thesis aimed to leverage the knowledge gathered in order to take the discussion one step further and explore how a FEV business model could be designed that would facilitate connected FEV adoption. A special focus was given to range anxiety, as prior research had revealed that this issue, alongside with cost, constitutes one of the main barriers to FEV adoption.

Essentially, this thesis examined how stakeholders, given all the options they have, can collaborate to raise the market share of FEVs across Europe through an offering that neutralizes range anxiety. For this purpose, Osterwalder and Pigneur's (2009) business model canvas was employed in the design of the ELVIRE business model and used to investigate, what characteristics a business model of the communication platform between FEV, driver, road and electricity supply services would require to reduce drivers’ range anxiety.

The analysis revealed that 6 stakeholders of 5 types would enter *key partnerships* and populate the final ELVIRE business model canvas: governments, the two OEMs Renault and VW, the FTS Continental, the CISP Better Place, the utility Endesa, and the communication enabler SAP. The collaboration of these 5 stakeholder groups is one of the cornerstones of the ELVIRE business model, as each one of them is necessary to carry out certain *key activities*. VW and Renault build FEVs with different types of communication architecture and continuously monitor the vehicles. This monitoring is enabled through the OBU, whose hard and software development and manufacturing resembles Continentals key activity. Better Place operates CS and BSS infrastructure and provides a range of FEV services in mobility packages aimed at the reduction of range anxiety. Additionally, it serves as the main point of contact with drivers and manages customer relationships while simultaneously transmitting energy demand data to Endesa. The utility then leverages this data to calculate dynamic tariffs, optimize grid loads, and deliver the desired amount of energy at the right time and place. SAP develops and implements the roaming and mobility platform HORST. The stakeholders' joint *value proposition* to the business model's *key customer segment*, drivers looking to buy a second car or for a city car solution, consequently revolves around electric mobility. Specifically, the value proposition comes in the form of a an end-2-end package provided by Better Place (mobility packages incl. pay per mile plans and battery leasing, charging and BS infrastructure) and FEVs equipped with an OBU combined with additional services tailored at range anxiety reduction. The value proposition will be delivered through two types of *channels*: Sales channels, such as OEM dealerships, Better Place premises, and OEMs and Better Place's websites, will for instance provide access to FEVs and mobility packages. A second channel is constituted by the OBU through which certain ELVIRE services will be delivered.

Jointly, the five stakeholder groups guarantee that the complexity of crafting the above value proposition of the ELVIRE business model is met with the necessary range of resources and capabilities. The partners combine all *key resources*, which mostly come in the nature of intangible assets, such as engineering competences and R&D capabilities. Tangible assets that the business model depends on include, among others, the automakers’ production facilities, Endesa's grid and power generation facilities, and Better Place's infrastructure. These resources also mirror the items that dominate the *cost structure* of the business model. For the ELVIRE project, especially R&D costs are significant; in a mass-market scenario costs for FEVs, infrastructure, and service provision would lead the cost charts.

Revenue streams are mostly located in the end of the ELVIRE value chain and connected to the sale of FEVs, mobility packages, and electricity. Additional revenue streams are battery leasing rates. Moreover, inter-stakeholder revenues will be generated through the sale of OBUs (Continental) and software licensing related to HORST services (SAP).

Subsequent to the design phase, the ELVIRE business model was evaluated along three dimensions.

Initially, a behavioral viewpoint was taken to explore the range anxiety-reducing potential of the business model. Additionally, the business model was evaluated along the lines of affordability, price, and payment, it's value proposition, and other aspects. The behavioral analysis provided highly promising results: Through the ELVIRE service universe, the functionality of the back-end-connected OBU, and the BSS network, the business model successfully addresses the three core range anxiety causing aspects 1.) FEVs' limited range, 2.) infrastructure availability, and 3.) long recharging times. Further, the ELVIRE business model appeals from an affordability standpoint, as the battery leasing concept effectively reduces drivers' upfront costs. Moreover the business model bundles FEV-related operational costs in one monthly payment and resembles a mobile phone plan, which appears to be a solution much preferred by consumers.

The main limitation that was identified from a behavioral perspective was the lack of roaming in the business model: the possibility to charge irrespective of location and service provider would consequently contribute to an even more effective range anxiety neutralization.

Secondly, the business model was evaluated from a technical perspective. The evaluation focused on two key dimensions: The infrastructure and the communication platform. The latter was assessed with a focus on both data exchange and OBU. The evaluation revealed a range of positive aspects: The general ELVIRE infrastructure solution is both holistic and proven for its applicability in a real world context. The data exchange solutions of the communication platform enable the successful provision of pre-drive, driving, and charging services through a constant connection of the FEV to the back-end. Additionally, it allows for vital inter-stakeholder communication, which among other things enables Endesa to receive real-time energy demand and forecast data for the calculation of dynamic energy tariffs. Moreover, the potential extensibility of the OBU component through, e.g., smartphone applications that allow for remote car access, speaks in favor of the ELVIRE solution. Nevertheless the technical analysis revealed a few limitations, which should be addressed in order to further strengthen the business model. Most notably, the proprietary nature of the Better Place offering, the limited relevance of battery swapping with fast charging advancing, and standardization issues with regards to OBU and battery design, infrastructure (plugs, sockets), and contractual agreements for advanced roaming scenarios need to be addressed to prepare the business model for mass-market implementation.

Thirdly, the business model was analyzed from an economic viewpoint. The analysis was exemplarily conducted for Israel and determined to compare the TCO of three vehicles: a FEV offered by Better Place, the same FEV if not purchased through Better Place, and a very similar ICE vehicle. The comparison revealed that in Israel, assuming a four-year period and a yearly driving distance of 20,000 km, FEVs constitute a more frugal vehicle option than ICE cars. Additionally, it showed that even though the Better Place FEV is more expensive than the regular FEV on a mere € per km basis, it also offers higher value through the additional services offered as part of the mobility packages and should overall be easier to procure, as upfront costs are effectively reduced through the battery leasing option. In conclusion, while the economic analysis depends very much on country-specific parameters, its results for Israel provide a favorable signal for the ELVIRE business model.

The results from the business model evaluation provided the basis for the derivation of recommendations to further strengthen the solution. The identified recommendations fall into two categories: Recommendations for stakeholders and for policymakers.

To stakeholders, a first set of recommendations is aimed at reducing perceptual barriers. It appears very important that customers are granted the possibility to recharge their vehicles irrespective of service provider or location in order to reduce range anxiety. Better Place should therefore reconsider mobility packages by not basing them on “mileage” or, alternatively, find a way to solve roaming issues to lift the constraining proprietary nature of the ELVIRE business model from customers. Secondly, as research has revealed that customers prefer buying vehicles from renowned automakers, it should be Renault and not Better Place who sells the FEV. Lastly, the ELVIRE value proposition should be customized to account for market peculiarities, as consumers in some countries may put more emphasis on vehicles as opposed to mobility.

A second set of recommendations targets the technical limitations of the business model. As the issue of standardization has come up multiple times as a limiting factor, CISPs could add a lot of value if they were able to reduce their standardization requirements and instead develop capabilities to work with different systems and components. Accordingly, it is recommended that Better Place shift its role from being a developer of components (e.g. OBU) towards being an integrator of components. The ideal scenario would have Better Place and the company’s services be universally accessible for all FEVs, irrespective of OBU and communication architecture, similar to how every ICE car can use any gas station. As long as this is not the case, a further recommendation holds that the development of a new car type would be desirable to combine the advantages of both car type A and B, which unfortunately are not feasible for mass-market scenarios due to standardization and cost drawbacks. Another recommendation stemming from the technical evaluation concerns the BS infrastructure solution of ELVIRE. While the benefits of BS are enormous and the technology must therefore be considered a vital part of the business model, the infrastructure will be hard to roll out nationwide in big countries. Therefore, to not constrict customers living in rural areas or cities without a comprehensive BSS network, the offering should be complemented with frugal ICE cars, which customers can rent in case they need to make long journeys in areas where BS locations are only sparsely available.

A third set of recommendations reflects ideas on how economic limitations of the business model could be overcome. It has been stated that, due to the novelty of the technology, there is a lot of insecurity as to how quickly FEVs will lose value over time. Therefore, it seems sensible to institutionalize FEV repurchase programs to take depreciation worries of customers’ minds. Secondly, as the evaluation has maintained that the mobility packages offered are mainly targeted at high mileage drivers, while the value proposition is tailored at people looking to buy a second / city car that is usually driven a below average distance per year, it is recommended to broaden the mobility package spectrum towards the lower mileage end. 10,000 km or 15,000 km packages may be a sensible addition to the offering. Thirdly, as FEVs still suffer from high purchase prices due to expensive battery technology, a last recommendation for stakeholders is to explore ways of how to increase the value of FEVs to consumers. An example for such a way could be V2G, which would enable drivers to make money with their FEVs. This would consequently then make it easier to justify the high purchase prices of the vehicles.

The second category of recommendations encompasses suggestions to policy makers on how to support the ELVIRE business model.

From a behavioral perspective it first seems crucial to raise FEVs' visibility in cityscapes to bring the general public in touch with the new technology. Governments are advised to support this step decisively by introducing FEV technology into public transport systems. It is assumed that consumers who see electric busses and taxis work faultlessly on a daily basis will drop their potential preconceptions faster than those who do not. Secondly, policy makers can substantially contribute to improving the CO_2 footprint of FEVs. Critics often point to the fact that CO_2 is emitted in the generation process of the energy that FEVs run on, and conclude that FEVs are not really environmentally friendly. While experts have disproved this argument, its frequent discussion among the general public indicates that FEVs environmental friendliness is a long way from being universally accepted. Policymakers could help take the wind out of the critics' sails by further pushing the European energy mix towards renewable energies, thus reducing the CO_2 footprint of electricity across Europe and improving the environmental friendliness of FEVs even more.

The technical evaluation of the business model revealed the importance of the infrastructure solution for the ELVIRE business model to work. As rolling out the infrastructure across Europe would entail both large investments and low utilization rates in the beginning, governments could support the business model by conceptualizing ways to subsidize infrastructure investments. Potentially, they may even explore ways to support a cross-border joint venture of various companies to craft a solution for the European context. Additionally, it appears crucial that governments jointly press for the development of infrastructure standards, such as plugs and sockets, to leverage the roaming potential of the business model.

Lastly, governmental action could also help mitigate the economic limitations of the business model. For one thing, governments could improve the relative cost position of FEVs compared with ICE cars. This could be done by either subsidizing FEV purchases, i.e. lowering their purchase and running costs, or penalizing ICE purchases. Various taxes, such as purchase taxes or vehicle registration taxes could be tweaked in favor of FEVs. Secondly, governments could increase the value of FEVs to drivers by endowing them with special privileges, such as preferential parking, access to city centers that are inaccessible to ICE cars, etc.

5.2 Limitations

This thesis aimed to use current knowledge and expectations to create a sensible business model for connected FEVs. This raises two limitations. For one thing, the FEV market is an emerging environment that is developing rapidly. The emergent nature of the sector entails uncertainties, which, by definition cannot be predicted. It must therefore be kept in mind that the business model and the expert opinions it is based upon were voiced at a time in which prevalent conditions made certain future scenarios look likely. Whether these scenarios become reality remains to be seen, hence, the empirical findings should be viewed with caution.

Furthermore, the business model development, evaluation, and the subsequent derivation of recommendations were carried out in a case study approach. The research was conducted in affiliation with the ELVIRE project. Thus, the business model presented in chapter 4.3 is to some extent the result of the unique ELVIRE conditions: i.e. the result of a specific selection of business models of the stakeholders within the consortium and assessments by industry experts. The business model is therefore uniquely tailored to the ELVIRE context and may require changes if applied outside the ELVIRE context. Especially in a mass-market scenario, as the evaluation already revealed, modifications will be inevitable.

5.3 Recommendations for Future Research

The previous subchapters hint at a few interesting facets that could be promising research topics in the future.

First, more cases should be examined to be able to undertake cross-case comparisons. This may reveal insights beyond the limitations and idiosyncrasy of the ELVIRE consortium. These comparisons could potentially even extend across continents. China and the U.S. state California for instance, also heavily promote FEVs. Comparing different ways of FEV ecosystem development could be fruitful.

Second, researching more complex scenarios than the one proposed by the ELVIRE project seems to be called for. Especially since the evaluation in chapter 4 uncovered the strong need for roaming to effectively reduce range anxiety, the analysis of how business models that allow for roaming could be laid out in the European context promises to be a relevant research topic. Especially the question of whether, and if so, how, mileage-based mobility packages could be marketed in these more realistic scenarios appears interesting. Another promising topic in this regard is represented by the question of whether a joint venture comprised of companies from various European countries makes sense in such an environment and how it could be structured sensibly and transaction costs-efficient.

A. Appendix

A1 List of Interviews / Expert Talks

A1.1 Conducted expert interviews

1	Better Place	C. Gabay	FP7 Project Manager and System Analyst	CISP	December 19th, 2011
2	ENDESA	A. Villafane	Business Development Manager	Utility	February 8th, 2012
3	Continental	H. Lüttringhaus	Business Development Manager	FTS	February 9th, 2012
4	Renault	F. Colet	FEV System Architect	OEM	March 2nd, 2012
5	Volkswagen	A. Zarcula	Manager Telematic Systems	OEM	March 12th, 2012

A1.2 Analyzed expert interviews (secondary data)

Nr.	Company	Position	Industry	Date
1	Vattenfall	Business Development E-Mobility	Energy	March 07th, 2011
2	Better Place	Europe Business Development	CISP	March 08th, 2011
3	Renault	FEV System Architect	OEM	March 09th, 2011
4	Endesa	Innovation & Technology PM	Energy	March 09th, 2011
5	Illwerke VKW	CEO of the Vorarlberger EV Planning and Consulting GmbH	Utilities	March 10th, 2011
6	Mitsubishi Motors	Manager marketing & PR Switz.	OEM	March 29th, 2011
7	Renault	FEV System Architect	OEM	March 31st, 2011
8	LH Science Park	Programme manager	R&D	April 5th, 2011

9	The Mobility House	Partner and Sales Manager	CISP	April 14th, 2011
10	Daimler (Smart)	PM Smart Electric Drive	OEM	April 16th, 2011
11	M-Way	Strategic Consultant for M-Way	CISP	April 19th, 2011
12	Endesa	Innovation and Technology PM	Utilities	April 20th, 2011
13	BMW	Managing director BMW Switz.	OEM	April 27th, 2011
14	Audi	Director electrification processes	OEM	May 13th, 2011
15	SAP	Senior Researcher FEVs	IT	May 14th, 2011
16	SAP	Senior Researcher ITS	IT	June 03rd, 2011
17	VW	Project manager telematics	OEM	June 07th, 2011
18	Continental	Business Development Manager	FTS	June 07th, 2011
19	Roland Berger	Partner Automotive Competence Centre	Consultin g	June 14th, 2011
20	Frauenhofer Institut	Researcher Sys. and Innovations	Research	June 16th, 2011
21	Viktoria Institute	Researcher Hybrids and FEVs	Research	June 20th, 2011
22	RWE	Strategy E-Mobility Manager	Energy & CISP	June 22nd, 2011
23	Volvo	Senior Research Engineer	OEM	June 23rd, 2011
24	The City of San Diego	Clean Tech Program Manager	Governm ent	July 28th, 2011
25	SDG&E	Clean Transportation Manager	Utilities	September 15th, 2011

26	Alpiq	Business Development Manager	Utilities	September 15th, 2011
27	RWE Effizienz GmbH	Product Innovation Manager	Utilities	September 16th, 2011

A2 Description of ELVIRE Stakeholders

Better Place: Better Place is a charging infrastructure and service provider (CISP) founded in 2007 headquartered in Palo Alto, CA, USA. 285 employees develop, build, and operate market-oriented infrastructure for the current EV generation. The company's goal is to establish sustainable mobility solutions and thereby reduce society's dependency on oil through advancing current business models and battery technology. Better Place combines competencies from a range of different sectors (e.g. EVs, batteries, charging stations, battery swapping stations, renewable energies) and thus contributes to the development of sustainable and ecological mobility solutions for the future. The company's business model is widely acknowledged as a very innovative and disruptive one (Businesweek, 2009), which has enabled the company to, thus far, raise USD 700 million from investors (ELVIRE, 2012c).

The company's business model is based on subscriptions: At the point of purchase or leasing of an EV, customers can sign a contract with Better Place and purchase a service package for a certain yearly driving range (e.g. 10,000 km). The service package contains the energy necessary for driving, the provision of batteries and charging and swapping infrastructure and the unlimited use thereof. Today, the battery swapping concept is the only emission-free "range extender" which avoids additional weight on board. However, the term "range extender" is technically not correct since no additional generator is required. The range extending technology remains the same. The Better Place concept is thus able to increase vehicle range without having to switch drive technologies.

Continental: Continental is an automotive FTS which was founded in 1871. In 2010, the firm recorded sales of € 26 billion and employed 164,000 people across 45 countries (ELVIRE, 2012c). The company, which is among the world's leading automotive suppliers, is organized in two strategic divisions: The automotive group delivers chassis, safety, powertrain and interior components for passenger and commercial vehicles. The rubber group focuses on the manufacturing and sales of tires for passenger vehicles, busses and trucks, bicycles, and industrial applications.

In the field of alternative vehicle technologies, Continental is among the pioneers in the production and development of components for hybrid and full electric vehicles. Already in the mid-1990s Continental began conceptualizing "components such as power electronics, electric machines and energy-storage devices for hybrid and electric drives" (Continental, 2012). In the latter field, Continental advanced high-voltage battery systems based on lithium-ion technology (ibid). Additionally, Continental has significant knowledge in the field of automobile communication (ELVIRE, 2012c).

Endesa: Endesa, part of Enel group, is Spain's largest utility and one of the largest electric power companies globally (Endesa, 2011a). Worldwide the firm employs 26,300 people and leverages 36,640 MW installed capacity to serve 25 million customers (ELVIRE, 2012c). The company's main activities lie in the electricity, gas, and renewables sector in selected European countries such as Spain and Portugal and in Latin America. Endesa is strongly committed to Technology and Innovation as it feels that these forces will be the drivers of the company's future growth. As part of that commitment, Endesa strives to respond to its businesses' technological and scientific challenges as brought about by, e.g., e-mobility.

Specifically, Endesa is working towards energy efficiency concepts, such as smart grids, and is closely involved in various projects. In Spain, the company is currently involved in the installation of 13 million smart meters, and two smart city projects in Malaga and Barcelona "which entail(s) the deployment of state-of-the-art technologies in power generation and storage, demand management, efficient lighting, e-mobility, and energy efficiency in corporate and residential buildings" (Endesa, 2011b). In e-mobility in particular, Endesa is active through the installation of charging spots and agreements with OEMs (ibid). In fact, the company identified the development of EVs as one of the most useful strategic initiatives for reaching the company's 2008-2012 strategic plan's main goal: the reduction of climate change (ELVIRE, 2012c).

Renault: The Renault Group, active in car development, manufacturing, and sales, was founded in 1899. 111 years later, the company was present in 118 countries and sold roughly 3.2 million vehicles under three brands: Renault, Dacia, and Renault Samsung Motors. In 2010, the company generated revenue of € 39 billion and employed a workforce counting 123`000 (Renault, 2012a).

Among the world's full-range carmakers, Renault is a first mover in terms of FEV development and manufacturing. This position was established through collaborating in more than 100 partnerships aimed at promoting, developing, and manufacturing FEVs. Renault's partner base is diverse. Besides the public sector, Renault for instance collaborates with other OEMs, such as Nissan with whom they have invested € 4 billion in FEV R&D projects. Renault also partners with CISPs, such as Better Place with whom they promote and sell FEVs in various countries. FEV sales commenced in 2011 and are one of the main pillars of Renault's long-term strategy (Renault, 2012b; Renault, 2012c). Together with its strategic partner Nissan, Renault strives to establish itself as the globe's leader in providing zero emission vehicles (ELVIRE, 2012c).

VW: Wolfsburg-based Volkswagen Group represents one of the world's largest automobile manufacturers. With 6.3 million cars sold and a market share of 11.3 per cent of the globe's passenger car market in 2009, it is about twice the size as Renault. The Group owns nine brands: Volkswagen, Audi, SEAT, Skoda, Volkswagen Commercial Vehicles, Bentley, Bugatti, Lamborghini and Scania, enabling the company to offer the whole product range from economical mini cars to luxury sports cars. Collectively, the group employs 370,000 people and sells its vehicles in 153 countries. The group's goal is to produce and sell "attractive, safe and environmentally sound vehicles (…) which set world standards in their respective classes" (ELVIRE, 2012c).

VW views electric mobility as a central component of its future strategy. CEO Martin Winterkorn recently announced that VW will offer electric vehicles for all customer segments in the future (VW, 2012a). The first FEVs, the Up! Blue-e-motion and Golf Blue-e-motion will be offered by 2013 (VW, 2012b).

Other: Further stakeholders in the ELVIRE consortium are CEA-LIST, the Erasmus University College, ATB Bremen, Lindholmen science park cluster, and ERPC (ELVIRE, 2012c).

A3 ELVIRE storyline

A3.1 ELVIRE storyline by scenarios

Phase	#	Scenario Name	Scenario Explanation
Driving with Plan	1	**Pre Drive Service**	Creation of John's driver profile by the service operator before he enters the car for the first time. The information is necessary for the service operator to be able to communicate with John in the car according to his profile. John has an important meeting 100km from his office and therefore needs to plan his route to reach the destination on time.
	2	**Getting into the car**	John gets into the car, the on-board system turns on, and he is identified by the system.
	3	**Checking before driving**	John sets the target destination for his trip. Before he starts driving, he checks the route details. The energy plan has been calculated. The charge spot or switching locations are identified by the system, including their degree of availability.
	4	**Starting driving**	John starts driving from his office to the business meeting, which is 100km away. On the route, John picks up Marie, his workmate. Marie drives now the car as John has to prepare something for the meeting.
	5	**Continuous monitoring**	John or Marie is supported by a continuous monitoring system which compares his/her current energy consumption with the battery level. While driving he/she will receive safety or range notifications, depending on the monitoring status.
	6	**Reaching target destination**	John and Marie reach the destination which is equipped with a charge spot. The system offers instructive multimedia help on how to charge an FEV. Marie switches off the car.
Charging	7	**Connecting to charge spot**	John leaves the car and connects the car to the charge spot.

Phase	#	Scenario Name	Scenario Explanation
			Charging process starts.
	8	**Charging**	The car is charged according to the regular charging program. John can decide to change the charging program (e.g. to shorten the charging cycle or Charge me now = Charges the car without a charging program and the driver solely connects the car to the charge spot.
	9	**Monitoring of charging process**	The charging process is monitored by the service provider. John can always check the charging status via his mobile device.
	10	**Problem during charging process due to unexpected infrastructure problems / policy change**	John is suddenly notified by the service provider/charge spot that an unexpected failure / problem (i.e. no electricity available from utility provider, malfunction of charging spot, cable stolen etc.) has occurred. Hence, the charging process was interrupted. Thus, the car could not be charged any further.
	11	**Supporting call / Hotline**	After the business meeting John calls the support hotline to get further details why the charging process was interrupted. John is informed that the energy provider needed to reduce the load on the grid temporarily, because it was a period of peak demand in the area. Hence, his car was not be fully charged this time.
	12	**Stopping charging process and entering car**	John decides to return to the car and pulls out the charging cable.
Driving without a plan	**13**	**"Smart" navigation**	Since it is already late, John decides to drive home to make it to the dinner with his family. He is driving without a plan, since he roughly remembers the route. The system analyses his typical mobility patterns and tries to predict the target destination.
	14	**Continuous monitoring**	John is supported by a system which continuously monitors his current energy consumption and remaining driving range. While driving he will receive safety or range notifications, depending on the monitoring status.
	15	**Low energy notification**	The system is indicating that the battery level is getting low. The system automatically starts scanning the surroundings for energy supply infrastructure.
	16	**Driving extension**	The system finds and displays the following options: He can decide whether to drive to a near by battery

Phase	#	Scenario Name	Scenario Explanation
		scenario	switch station, or to a charging spot for a fast charge.
	17	**Driving directions to Battery Switch Station**	John decides to switch the battery since he does not want to be late for dinner. After selecting this option, the system is indicating him the way to the next battery switch station.
	18	**Battery switching**	His depleted battery is exchanged at a battery switch station.
Home	**19**	**Resume driving**	John resumes driving home with a full battery.
	20	**Arriving at home**	John arrives at home and connects his car to the charge spot at home.
	21	**Home charging**	The car is charged according to the regular charging program and could be connected to the Customer Service Centre or not, depending on the contract the customer has with the service provider.
	22	**Receiving / Reviewing bill**	John can review his bill online.

A3.2 ELVIRE storyline by business use cases

Phase	Scenario	Business Use case
Driving with a Plan		
	1. Pre-Drive Services	
		1.0 Activation & Profile Configuration
		1.1 Offline Pre-Climatization
		1.1.1 the car to not drain the battery during driving
		1.1.2 the battery to bring it to the optimal heat level
		1.1.3 Pre climatization function in a web portal and/or smart phone
		1.2 Offline route planning
		1.2.1 plan frequent trip with known destination
		1.2.2 plan trip within driving range/ not within driving range
		1.2.3 plan most eco-efficient trip
		1.2.4 review previous planned/ unplanned trips
		1.3 Get POI – FEV CS and BSS sites
		1.4 Select car park for charging
		1.4.1 Get CS Availability
		1.4.1.1 CS Availability
		1.5 Select a Battery Switching Station
		1.5.1 get BSS availability
		1.5.1.1 BSS Availability
		1.6 Offline Energy Consumption prediction
	2. Getting into Car	
		2.1 Download Driver Profile

Phase	Scenario	Business Use case
		2.2 Driver Identification
		2.3 Profile Update
		2.4 Calculate a route
		2.4.1 Receive charge spot availability
		2.4.2 Review charge spot availability
		2.4.3 Get POI – FEV CS and BSS sites
		2.4.5 Select a charge site from a list
	3. checking before driving	
		3.1 Review route
		3.2 Change route manually
		3.3 Decide to charge battery or switch
		3.4 Call control center to confirm aspects of the route
		3.5 Check pre-climatization of the car
		3.6 Check pre-climatization of the battery
	4. Starting Driving	
		4.1 Guidance to Destination
		4.2 Change Driver
	5. Continuous Monitoring	
		5.1 Continuous Monitoring based on battery level
		5.1.1 Energy notification during driving
		5.2 Continuous Monitoring based on traffic situation (if available)
		5.3 Continuous Monitoring based on weather (if available)
		5.4 Continuous Monitoring based on charge spots availability
		5.5 Re-Routing (if requested by the monitoring module)
		5.6. Range Notifications and Warnings
	6. Reaching Target Destination	
		6.1 "Advisor" when approaching the charge spot
Charging		
	7. Connecting to Charge Spot	
		7.1 Driver & Car Authentication
		7.2 Credit Card Check
		7.3 Roaming Services
	8. Charging	
		8.1 Charge Planned Program
		8.2 Change charging program 'Charge Me Now'
	9. Monitoring Charging Process	
		9.1 Energy Notification: During Charging: Charge Progress

Phase	Scenario	Business Use case
		9.2 Monitor current charging level
		9.3 Monitor the time driver can go back to the car
		9.4 Change charging program
		9.5 Preview costs of charging
	10. Problem during charging process due to unexpected infrastructure problems/policy change	
		10.1 Display hotline number
		10.1.1 Energy Notification: Charge Process Interrupted
		10.1.2 Call the service provider
	11. Supporting call / Hotline	
		11.1 Roadside assistance
		11.2 Support call to the service provider
	12. Stopping charging process and enter car	
		12.1 De-authentication
		12.2 Review bill and confirm amount
		12.3 Pay bill directly or via the service provider contract at the end of the month
Driving without a Plan		
	13. "Smart" navigation	
		13.1 "Smart" navigation
	14. Continuous monitoring	
		14.1 Continuous Monitoring based on battery level
		14.2 Continuous Monitoring based on traffic situation (if available)
		14.3 Continuous Monitoring based on weather (if available)
		14.4 Continuous Monitoring based on charge spots availability
		14.6. Range Notifications and Warnings
	15. Low energy notification	
		15.1 Low energy notification
	16. Driving extension scenario	
		16.1 Range extension option deep charge
		16.2 Range extension option battery switch

Phase	Scenario	Business Use case
		16.3 Range extension option fast charge
	17. Driving directions to BSS	
		17.1 Receive information on expected availability of Battery Switch Stations
		17.1.1. BSS availability
		17.2 Select a switch station from a list
		17.3 "Advisor" when approaching the switch station
	18. Battery switching	
		18.1 Driver Authentication
		18.2 Battery switched
		18.3 Credit card check
		18.4 Roaming services
Home/ Driver Support		
	20. Arriving at home	
		20.1 Select or Modify Charging Program in the car
	21. Home Charging	
		21.1 Select or Modify Charging Program on a remote device
	22. Receiving/ reviewing bill	
		22.1 Review bill on the internet or mobile phone

A4 Charging Standards

AC - On-board vehicle charger			
Level	Specifications (Voltage/Current/Power):	Charging Time (for 25kWh)*	Standardiz. Status
1	120V / up to 16A / up to 1.9kW	17 hrs (20% to full)	SAE J1772
2	240V / up to 80A / up to 19.2kW	1.2-7 hrs (20% to full)	SAE J1772
3	> 20kW, single phase and 3 phase /TBD/TBD	TBD	In progress
DC - Off-board vehicle charger			
Level	Specifications (Voltage/Current/Power):	Charging Time (for 25kWh)*	Standardiz. Status
1	200-450V / up to 80A / up to	1.2 hrs (20% to full)	In progress

	36kW	@ 20kW	
2	200-450V / up to 200A / up to 90kW	20 min. (20% to 80%) @ 45kW	In progress
3	200-600V / up to 400A / up to 240kW	< 10 min. (20% to 80%) @ 45kW	In progress

*25kWh refers to a midsize car lithium-ion battery capacity. For comparison: A Renault Fluence Z.E. has a 22kWh battery capacity that allows a driving range of up to 185km (Better Place, 2012c).

Table 10: Charging Level Specifications (Source: SAE, 2011)

A5 Charging Modes

	Mode 1	Mode 2	Mode 3
General	◦ Connection to AC ◦ Standardized socket-outlets ◦ Currents up to 16A	◦ Connection to AC ◦ Standardized socket-outlets ◦ In-cable control box (ICCB) with control pilot function	◦ Direct connection to AC ◦ Dedicated EV supply equipment
Safety Issues	Need of ◦ A fuse or circuit-breaker to protect against overcurrent ◦ A proper earthing connection ◦ A residual current device (RCD)	◦ Control box only protects the downstream cable and vehicle ◦ No protection for the plug	Advantages: ◦ IEC 61851-1 standard ◦ additional protection measures ◦ control pilot ◦ no vehicle connected to the socket-outlet -> the socket is dead.
Usage	◦ Most common ◦ Outlawed in a number of countries (e.g. US) because of RCD ◦ Some countries: Not allowed for public charging (e.g. Italy) ◦ Preferred Mode for private charging	◦ Initially mainly aimed at the United States ◦ Receiving new interest to replace Mode 1 Recommended: ◦ To use for occasional charging ◦ At private premises	◦ Private or public charging stations Recommended: ◦ For public charging stations and home charging using dedicated outlet

Table 11: Charging Modes Overview (Source: Delivery 1300.4)

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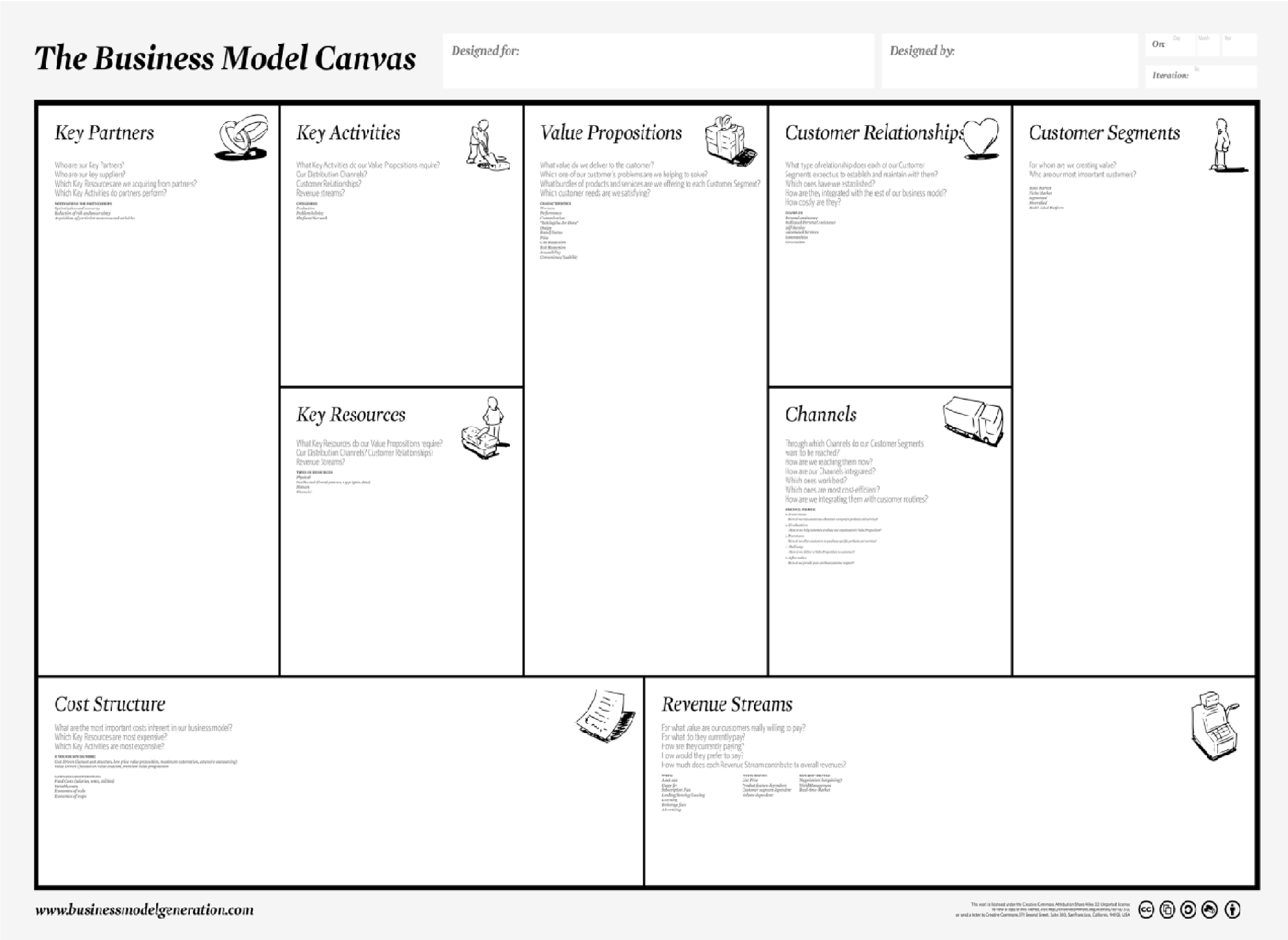
A6 Osterwalder & Pigneur's Business Model Canvas



A7 ELVIRE Business Model Canvas

<table>
<tr><th>Key Partnerships</th><th>Key Activities</th><th>Value Proposition /Use Cases</th><th>Customer Relationships</th><th>Customer Segments</th></tr>
<tr>
<td>Governments (infrastructure building permits, tax breaks, subsidies)</td>
<td rowspan="4">- Development and sale of mobility packages (service plan + car)
- EV Service provision as defined in the ELVIRE scenarios to support the driver and reduce range anxiety
- Use cases: Activation, Plan Drive, Driving, Charging
- Infrastructure Provision and Management
- Definition of locations for CS and BSS
- Build up of CS and BSS infrastructure
- Electricity provisioning with support of utility provider
- Data collection for prediction services (i.e. demand, routing)
- Customer management</td>
<td>Be a one-stop-shop EV service provider and Infrastructure Manager / Operator
1. Provide Mobility through an End2End mobility package (different price/mile plans, lease of battery, infrastructure by CS and BSS, insurance, single customer touch point for all ELVIRE services, ELVIRE WP3000 related tasks such as CMC and CMP)
2. Reliable connectivity of EVs to the Service Provider Network (CMP and CMC)</td>
<td>First point of contact (direct contact) for services offered within the mobility package (i.e.customer assistance, before, during, after driving).

Indirect contact through services offered by the OBU (i.e. driver profile managment, find next available charge spot).</td>
<td rowspan="2">Private customers
- City dwellers / 2nd car owners / Intercity travelers</td>
</tr>
<tr>
<td rowspan="3">Better Place</td>
<td>Provide FEVs (sufficient autonomy for daily standard trips, rechargeable according to BP's standard)
VW: Provision of the eGolf prototype and relevant data to test the technology. RN: Provide full operational Renault Fluence vehicle</td>
<td rowspan="2">RN: Transactional (B2B) relationships with BP and Conti (customer service carried out by BP)
VW: First point of contact for the eGolf / vehicle and Transactional (B2B) relationships with BP.</td>
</tr>
<tr>
<td rowspan="5">Hardware & Software (OBU):

Overall
- Supports driver during driving (reduction of Range Anxiety)
- That provides Infotainment
- That enables (Continuous) Monitoring/PreDrive/Driving, Energy and Generic services
- Development of the software algorithms that would be reliable and scalable

Directly for consumer:
- Provides info on status of car, remaining range, charging progress etc
- That enables C2B communication / vehicle connection
- That proactively notifies in case of unexpected occurrences, problems, range etc.
- That stores driver related data in profiles (driver authentication, charging preferences)
- That enables personalised range prediction based on the driving behaviour</td>
<td>Better Place
VW
Renault through Better Place</td>
</tr>
<tr>
<td>B2B relationships with BP, RN, VW</td>
<td>Better Place</td>
</tr>
<tr>
<td>Renault, VW</td>
<td>Car manufacturing / and provision of vehicles (car type A (VW) & B (RN)):
- (VW) Back- end operations (in-house): Real Time Data collection, storage, transmission and processing.
- (RN) Back-end operations (with BP): Real Time Data collection and transmission to BP
- Battery monitoring</td>
<td>Transactional (B2B) relationships with BP and SAP</td>
<td>Better Place
ENDESA</td>
</tr>
<tr>
<td rowspan="2">Conti (for monitoring and charging services, profile download, OBU provision)</td>
<td rowspan="2">1. R&D of OBU (Hardware, especially Software)
2. Software: Definition and solutions development for FEV services (Activation, Plan Drive, Driving (monitoring) & Charging) together with BP
3. Production, testing, and implementation (OBU)</td>
<td>B2B relationship BP through service provisioning via the HORST system</td>
<td rowspan="4"></td>
</tr>
<tr>
<td rowspan="3"></td>
</tr>
<tr>
<td>ENDESA</td>
<td>1. Energy Supply
2. Real time data management and pricing
3. Grid development: grid planning in terms of future resources and installations required, 'green grid'
4. Energy distribution from IT communication perspective (communication to grid simulation and support, but no energy provision for the simulation)</td>
<td>Optimatisation of the assets (energy generation, distribution and supply, grid balancing)

Real time pricing and tariffs</td>
</tr>
<tr>
<td>SAP</td>
<td>HORST (creation and maintenance of Roaming and New Mobility services platform)</td>
<td>Enabled Roaming and New Mobility services (i.e. real time electricity pricing information)</td>
</tr>
</table>

Key Resources	Channels
Infrastructure (Israel and Denmark) (BSS, CS) Standardized equipment and inventory	Better Place (Israel, Denmark) Renault retailer (Israel, Denmark) Renault and Better Place websites
R&D for FEVs, Brand, Production facilities, integration knowledge, Partnerships (esp. with BP and Conti)	Renault: Additional to the above: Traditional Channels (OEM dealerships, retailers) VW: Traditional Channels (OEM dealerships, retailers)
Engineering competences in OBU development Technical know-how in hardware and software	RN through Better Place, VW
Partnerships / Alliances with key partners (see left)	Better Place
	Better Place

Cost Structure		Revenue Streams
Infrastructure (CS, BSS) Electricity provisioning Battery inventory (incl. Insurance etc.) Administrative costs Maintenance (infrastructure and battery) Personnel (i.e. personal assitance service) R&D	R&D related to prototype creation and related systems (hardware, software system equipment for the smart grid intelligence) Grid planning related activities	Monthly fee for mobility and service package: With fixed pay per mile plan, battery leasing, charging (smart charging & charge me now), switching, services, insurance package, road assistance service, 24hrs emergency hotline, etc.
	Battery, R&D costs related to ELVIRE use cases, Mobility package contents, ELVIRE services VW: IT Infrastructure (costs of servers & maintenance) and implementation (since they provide car type A)	VW: FEV sales, after sales maintenance services RN: FEV sales, battery leasing rates, after sales maintenance service
	OBU R&D, hardware and software development Engineering personnel	Sales of OBU and related components, licensing / sales of the software Traditional revenue streams (electricity sales) but from new customers, new distribution channels
	R&D related to prototype creation and related system	Software licensing related to HORST services

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A8 Charging Connectors

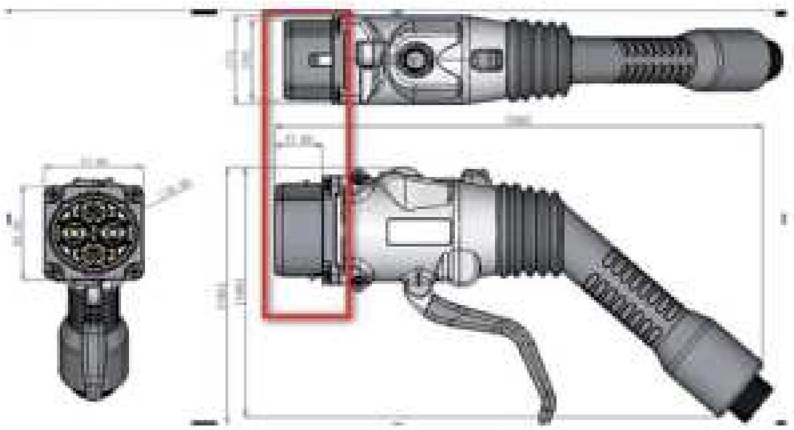

Figure 15: CHAdeMO connector (Source: D1300.4, p. 29)

Figure 16: Combo connector example (Source D1300.4, p. 29)

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Declaration of Authorship

„I hereby declare

- that I have written this thesis without any help from others and without the use of documents and aids other than those stated above,

- that I have mentioned all sources and that I have cited them correctly according to established academic citation rules."

Munich, Oct 16, 2012 signature___________________________