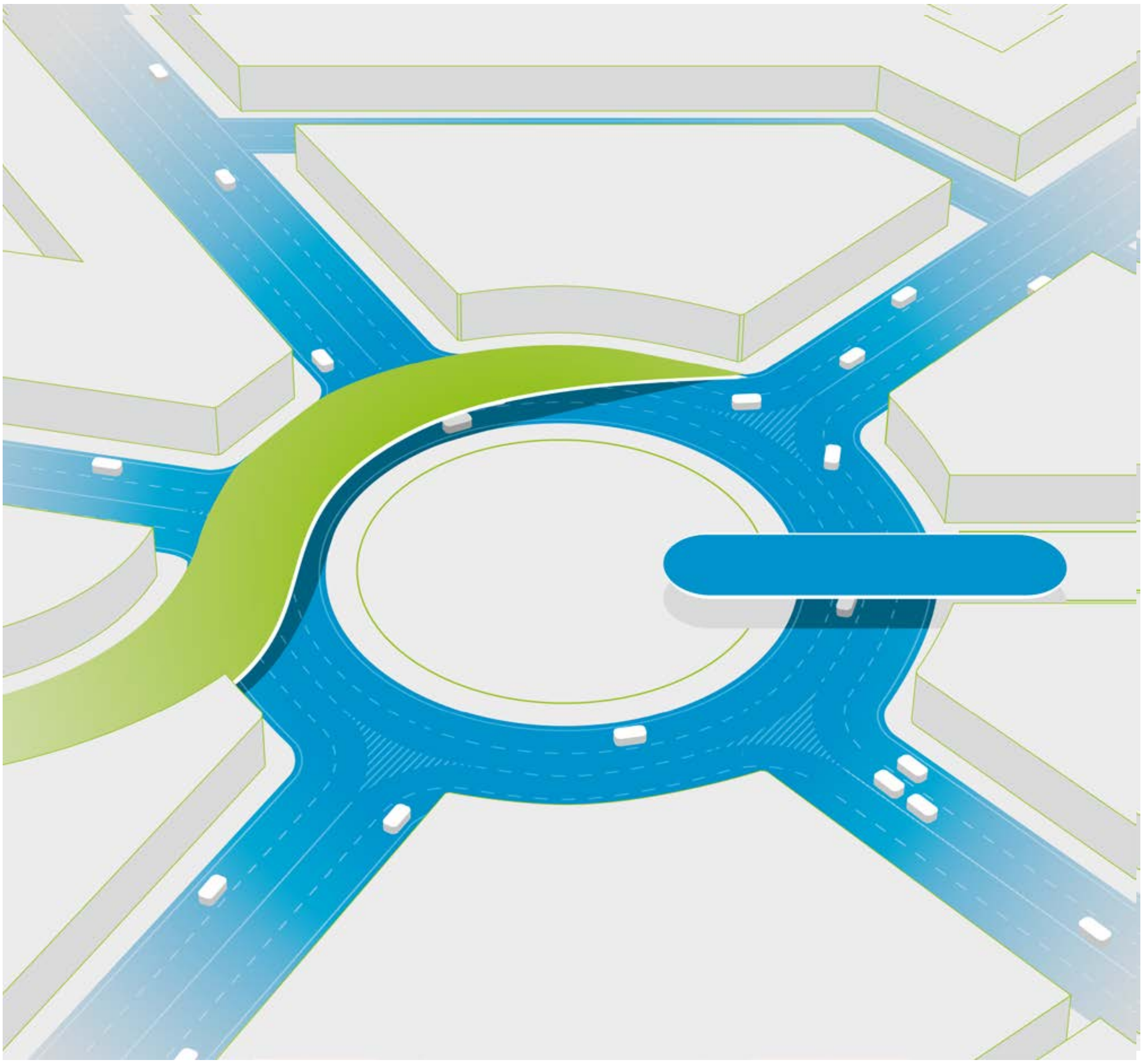
combining infrastructures for efficient electric mobility

Deliverable D502.3

Potential Business Model



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List of abbreviations

AC	Alternate current (slow)
ACEA	European Automobile Manufacturer's Association
B2B	Business-to-business
B2C	Business-to-consumers
BEV	Battery electric vehicle
CAGR	Compound Annual Growth Rate
CWD	Charge while driving
DC	Direct current (fast)
DBSE	Data based service enhancement
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FEV	Fully electric vehicle
FCEV	Fuel cell electric vehicle
GDP	Gross domestic product
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
ICT	Information and communication technology
IEA	International energy agency
ITS	Intelligent transport system
MV	Motorised vehicles
OEM	Original equipment manufacturer
PEV	Plug-in hybrid vehicle
PHEV	Plug-in hybrid electric vehicle
OBU	Onboard unit
POIN	Point of interest notification
REEV	Range extended electric vehicles
R&D	Research and development
TCO	Total cost of ownership

Legal disclaimer

Revision and history chart

version	date	comment
0.1	05.05.2015	Draft
0.2	11.05.2015	First peer review
0.3	13.05.2015	Second peer review
0.4	13.05.2015	Final version
1.0	29.05.2015	Final check and release

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Executive Summary

The European mass-market introduction of FEVs in general and the implementation of eCo-FEV platform in particular require considerable investments from various stakeholders. In order to decide on an investment, private investors expect viable business models. Public authorities on the other hand usually decide on investments on the basis of an economic impact analysis, where impacts such as CO2 reduction or improved traffic flow are valued and put in relationship. In order to meet these requirements the overall aim of this document is to develop a business study for eCo-FEV.

Within the European e-mobility market eCo-FEV as well as private investors and public authorities are faced with high dynamics and cross-country differences. A large number of different supporting initiatives and strategies lead to diverse CAGRs of electric vehicles. Being aware of the strong impact of these market characteristics on eCo-FEV a detailed market analysis is conducted in the first step. In addition to secondary research, more than 20 personal interviews with representatives from all relevant stakeholders have been conducted. Based on that market knowledge the second part of the document presents the business economics assessment for eCo-FEV.

1. Introduction

Electro mobility is considered to be a solution to reduce CO2 emissions and air pollution in urban areas, as well as for the minimization of oil dependency. Many governments in Europe already encourage and subsidize e-mobility and there is increasing number of electric vehicles already available on the market. The Netherlands and Norway are currently pioneers on the field of e-mobility and serve as role models for their promotion programs.

Still, the introduction of e-mobility in general and fully electric vehicles (FEV) in particular is a complex and long-term task as it must simultaneously solve technical (e.g. batteries), infrastructure (e.g. charging infrastructure) and psychological challenges (e.g. human mobility behaviour).
In order to successfully participate in “the mobility of the future” the automotive industry must rethink its strategy of universal autonomy towards positioning a mobility service provider. This new strategy implies fostering cooperation with unknown partners such as IT companies, public transport, and energy companies.

As soon as cooperation is required platforms are needed in order to bring different services and interest together. The eCo-FEV project aims at achieving a breakthrough in FEV introduction by proposing a general architecture for integration of FEV into the different infrastructure systems cooperating with each other – thus allowing precise EV telematics services and charging management service based on real time information. That is why, eCo-FEV´s integrated IT platform architecture focuses on the cooperation of FEV-related infrastructure systems plus the intelligent and effective use of advanced telematics services.

2. Methodologies for economic evaluation

The knowledge on the economic viability is crucial for the successful implementation of eCo-FEV technology in the European member states. Considerable investments into this technology are necessary from the different key stakeholders such as automotive OEMs, road authorities or the operators of the data back ends needed for data aggregation and processing.

Those investments will only be made, if they will pay off within a reasonable timeframe. This may be achieved by user fees, selling data to third parties or through vehicle owners willing to pay for the equipment. Paying off through money flow is one important aspect especially for businesses. But it is a common agreement that investment in the eCo-FEV system will also pay back through improved traffic management, decreased resource dependency as well as through positive environmental effects. The economic impact analysis, which is the basis for investment decisions of governments and public authorities, is quantifying these effects by calculating the resulting societal costs.

2.1. Data collection

The cogency of a document that is written as a support for decision makers is highly influenced by the information that is used as a basis. Therefore it is essential to identify the best available data sources.

These can be sources for rather quantitative questions as in a market potential analysis, but also more qualitative sources to understand the motivation of users and stakeholders.

The following sources have been used for data collection in this document:

Secondary sources

Due to the wide range of business cases and the related need for background information, secondary sources are playing an important role for the work in this document.

The main application fields for secondary data were:

- Results and conclusions from adjacent research projects
- Key indicators for market potentials behind business cases
- Key indicators to compare potentials on European level

- Cost indicators for infrastructure and OBU
- Trends in the automotive sector

Stakeholder and expert interviews

In order to receive the most immediate feedback on eCo-FEV technology and possible economic impact from those stakeholder groups that have the highest impact on market introduction, qualitative interviews have been accomplished.

Representatives from the most relevant stakeholder groups have already been identified within the network of eCo-FEV partners. These contacts have been enhanced based on online research and further networking (i.e. within the scope of the Green eMotion stakeholder forum taking place in Brussels in February 2015) until all relevant stakeholder groups were covered by several contacts.

The invitations for the interviews were sent out via email, including a short information brochure about the eCo-FEV project (see annex).

As the range of stakeholders and their involvement in the topic have been rather broad, the brochure included both, easy accessible information and the most important technical details.

The interviews have been conducted in personal form or by telephone. Based on the background of the interviewee, the depth of the discussion was varied, which led to different durations, between 45 and 90 minutes.

In addition to secondary sources, these interviews are a major source of knowledge and insights regarding the information and analyses given in this work. In the following, presented information outcomes of interviews will not be particularly highlighted. This is because gathered insights and knowledge are not just summarized in this work, they are rather analysed, correlated and directly integrated into the solutions this work will provide for the complex questions and requirements, which occur along the road to bring e-mobility and eCo-FEV to success.

2.2. Methodology for business economics assessment

Evaluation of business cases

The broad range of stakeholder insights generated in the interviews also provides the basis for the evaluation of the business cases. In order to structure the evaluation of the different business cases a well-approved business modelling approach has been applied: the Osterwalder business canvas. This analysis allows understanding the principles of the business case and helps identifying strengths as well as weak points related to their implementation. A more detailed description of this approach can be found in chapter 2.2.1.

As an enhancement to the business canvas analysis, the business cases are also analysed according to their economic viability. It should be noted that the prioritization of the objectives has been adjusted in the course of the analysis. Originally it was planned to have an in-depth financial project yield analysis of the business cases, which also included temporal effects. For reasons of accessibility and complexity it was decided to provide a rather top line quantification of financial key figures that should help to provide an indication about the financial potential.

Due to the wide range of potential business models that have been identified and will be discussed in this document, the focus of the analysis was directed towards a more qualitative and strategic discussion. Furthermore the limitations regarding available data as basis for the calculations – partly due to the highly dynamic and diverse market character - and therefore the need to define assumptions did not allow a level of accuracy that would have been appropriate for the analysis.

2.2.1. Osterwalder approach

When it comes to analysing business models with a strategic perspective, the Osterwalder business canvas is one of the most popular tools of younger business modelling history. It can be either used for developing new or redesigning existing business models.

The popularity and wide distribution of Osterwalder's approach is linked to its easy accessibility and applicability. The actual business model canvas is a visual chart with elements summarizing a company's value proposition, infrastructure, customers, and finances.

Also for this document accessibility and applicability have been the main reasons to choose the Osterwalder Canvas as the focus tool for the strategic evaluation of the business model. Even partners with low prior knowledge about business modelling can be involved in the development of the canvas.

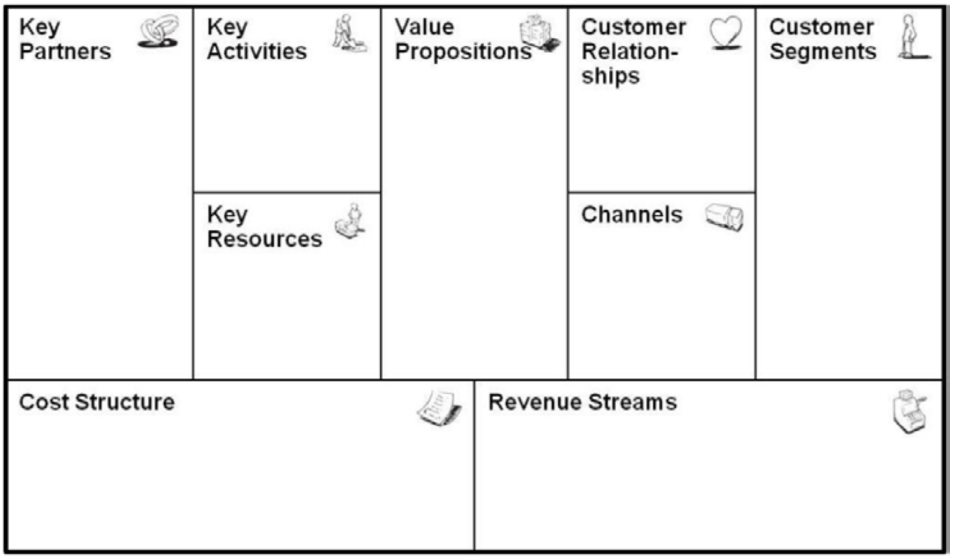


Figure 1: Osterwalder Business Canvas (Osterwalder & Pigneur 2010)

The Osterwalder canvas basically consists of nine building blocks as illustrated in Figure 1. These building blocks can be divided in four main components:

Offering/ Service Description

- **Value proposition:** What is the actual value that is created within the business model?

Customer

- **Customer segments:** Which are the customers for whom you create value?
- **Channels:** What are the channels that are needed to reach the defined customer segments?
- **Customer relationship:** How can the connection between the company and the customer groups be described?

Infrastructure

- **Key resources:** What are the key assets are that you need to create and deliver value?
- **Key activities:** What are the key things that you have to be good at performing?
- **Key partners:** Who needs to be involved in the value creation process?

Monetary evaluation

- **Revenue streams:** What are the revenues that are resulting from all possible sources?
- **Cost structure:** What kind of main cost needs to be considered for value creation?

This internal perspective will be enhanced by a discussion on the external influences on the business model. In the Osterwalder approach these are summarized as:

- **Key trends**
- **Market forces**
- **Industry forces**
- **Macroeconomic forces**

The structure of the canvas will be used to make sure that all relevant aspects for a viable business model are covered. The input to fill in the canvas will be collected through stakeholder interviews and internal workshops.

In the course of the discussion of the potential business models for the eCo-FEV system, various options will evolve. These optional business models will be unbundled and summarized in their own canvas in chapter 5.

Using this approach helps avoiding as much as possible redundancies in the discussion between the business models but still allows covering the most relevant components of the developed business models.

2.2.2. Value network diagram

The business model canvas itself is a strong tool to illustrate and summarize the structure and strategic foundation of the business case. Still, it has its weak spots if the process of value creation is rather complex and different stakeholders are involved that cannot clearly be defined as partners or customers.

The value network diagram is a helpful tool to illustrate the process of value creation and the involved stakeholders. In this diagram all relevant stakeholders and their interrelations will be shown at a glance.

This visualization can help to get an overview on the value creation process and identify critical relations and conflicting interests. The potential conflicts can then again be discussed in the market introduction plan. While there are various theoretical approaches how to create value networks, they are simply used as basic and intuitive form of visualisation. Also in this document this should be the case.

3. The e-mobility market

3.1. Introduction

There are more than 500 million consumers in the 28 European Union (EU) member states. The European automotive industry employs a total of 12.9 million people, generating as much as EUR 839 billion in annual revenues—6.9 % of the EU's GDP. In 2012, 13.7 million motorised vehicles (MVs) were newly registered in the region, adding to a total of 277 million MVs on Europe's roads.

While market shares for absolute annual electric vehicles (EVs[1]) sales are still marginal, EVs are the fastest growing vehicle segment in many European markets. Furthermore, the European Commission (EC) expects that by the year 2020, France will have 2 million, Germany will have 1 million, the United Kingdom will have 1.55 million and Spain will have 2.5 million EVs on their respective roads. (US Commercial Services 2014)

To raise the rate of adoption of EVs and to pave the road for e-mobility to become a future mass product, besides EV technology development, core drivers such as road IT infrastructure, EV backend infrastructure and charging infrastructure need to be fostered. As argued by (PwC 2012) subsidies and standard guidelines (on national and/or EU scale) may become further key drivers to make e-mobility a success. Additionally to these key drivers, in our opinion the uncoordinated developments in all areas of e-mobility – such as different charging and payment technology, ICT, road IT and propulsion technologies – represent a major barrier to e-mobility.

With its overall aim, to achieve a breakthrough in the introduction of fully electric vehicles to a mass market by developing a cooperative electric mobility platform that integrates all aspects of e-mobility into the transport infrastructures, eCo-FEV takes the next step in the development of e-mobility.

Beside the influencing factors on macro scale, European and global scale developments such as oil price development and upcoming EU-regulations e.g. fleet emission regulations have also a significant influence on the e-mobility industry development. Hence, this chapter firstly gives

[1] EVs includes Battery Electric Vehicles/Full Electric Vehicles + Plug-in Hybrid Electric Vehicles

information on the current market situation of the e-mobility ecosystem in Europe – beginning with the EV market, being the largest segment of the e-mobility market so far - discussing impacts, developments and key success factors.

The following e-mobility ecosystem shows the four relevant interactive segments that will be analysed in this chapter – EVs, infrastructure, customer and regulations and subsidies (Figure 2). Each of these segments is contributing to the overall system and has its own opportunities and risks. The common success factor for all segments is to have profitable business models. If only one single component of this system is missing, developing and integrating platform will come to a standstill [A.T. Kearney].

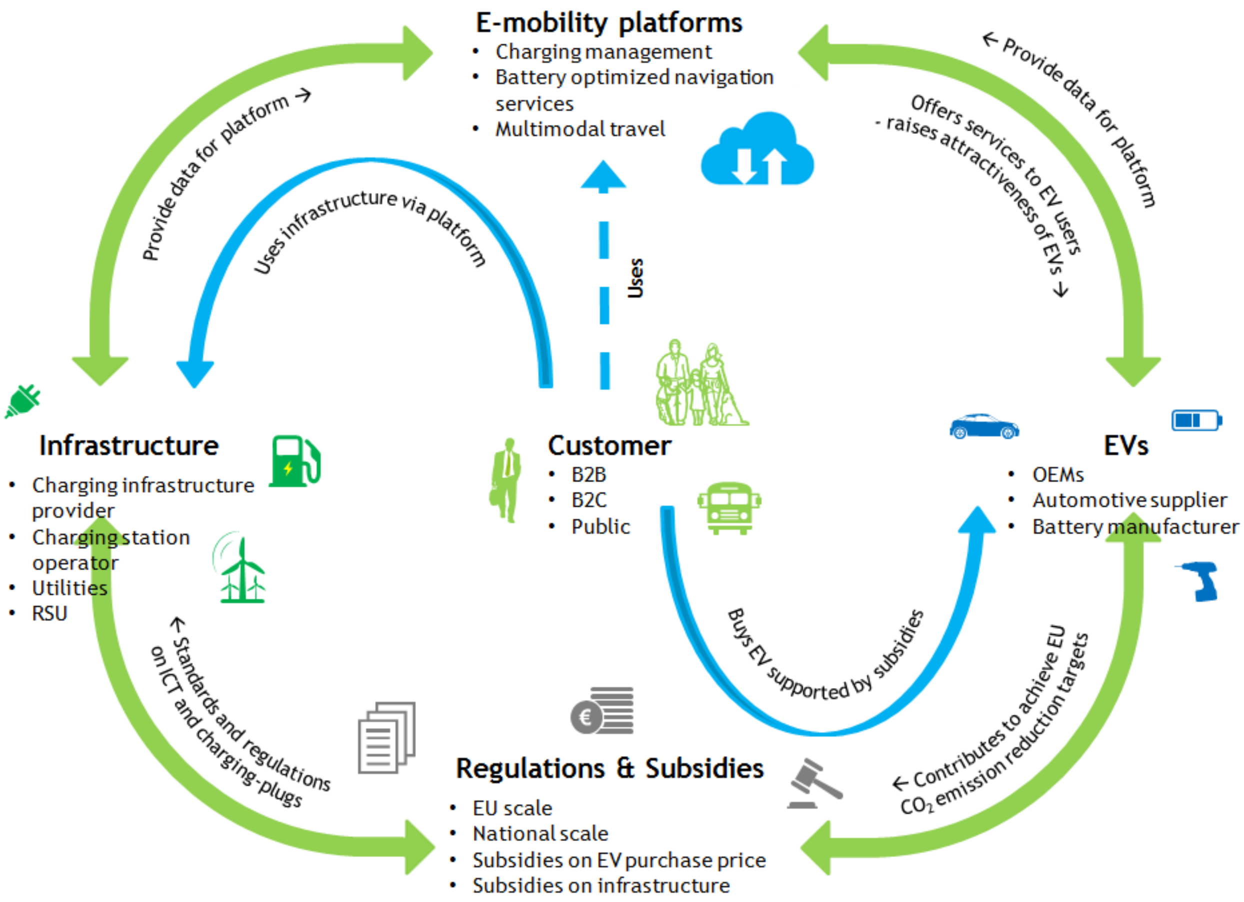


Figure 2: The e-mobility ecosystem

Electric vehicles definition

For a better understanding of electric vehicles (EV) market and the e-mobility industry as a whole, it is necessary to clarify what kind of EVs already exist and what the main differences are. E-mobility relates to electrification of the automotive power train. The eCo-FEV project concentrates mainly on fully electric vehicles (FEV), also called battery electric vehicles (BEV).

Due to the fact that the percentage of FEVs corresponding to total EVs is still low, the vast majority of studies about EVs do not exclusively consider FEVs. Hence, this work mostly speaks of EVs but wherever possible it is differed between EV and FEV. EVs include plug-in hybrid electric vehicles (PHEVs), range extended electric vehicles (REEVs), battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs), but excludes (conventional) hybrid electric vehicles (HEVs).

It should be noted that even though eCo-FEV project focuses on the services for FEV, motivated by the fact that the FEV poses most demanding requirements in terms of range anxiety overcoming, the designed back end platform is not limited only to this kind of EV. For this reason, our market analysis focuses also other types of electric vehicles, as illustrated in Table 1.

Table 1: Definitions of vehicles (based on Amsterdam Roundtable Foundation & Amsterdam Roundtable Foundation & McKinsey&Company 2014)

✓ Primary (✓) Secondary

From one technology ...

Internal Combustion Engine

... To a portfolio of vehicles

Vehicle		Description	Propulsion: ICE	Propulsion: E-Motor	Energy source: ICE[1]	Energy source: Plug-in[2]	Energy source: Fuel Cell[3]
ICE  VW Golf	**Internal Combustion Engine**	**Driving with conventional combustion engine only**	✓		✓		
HEV  Toyota Prius	**Hybrid Electric Vehicle**	**Driving with combustion engine and/or e-motor**	✓	(✓)	✓		
PHEV  Mitsubishi Outlander PHEV	**Plug-in Hybrid Electric Vehicle**	**Driving with combustion engine and/or e-motor, plug-in to recharge battery**	(✓)	✓	✓	✓	
REEV  BMW i3 with range extender	**Range Extended Electric Vehicle**	**Driving with e-motor only, ICE & plug in (or fuel cell) used to recharge battery**		✓	✓	✓	✓ Currently in pilots
BEV  Nissan Leaf	**Battery Electric Vehicle**	**Driving with e-motor only and storing energy in battery**		✓		✓	
FCEV  Hyundai ix35 fuel cel	**Fuel Cell Electric Vehicle**	**Driving with e-motor only and storing energy in hydrogen**		✓		(✓)	✓

1 In HEV, PHEV and REEV, energy is also generated through regenerative braking
2 To charge battery
3 Usually generates electricity that directly powers drive train; alternative concepts in discussion (e.g. fuel cell as range extender or FCEV with plug-in)
4 Primacy of ICE or E-motor in PHEV varies across models

3.2. The European EV market

3.2.1. State of the art - European EV market

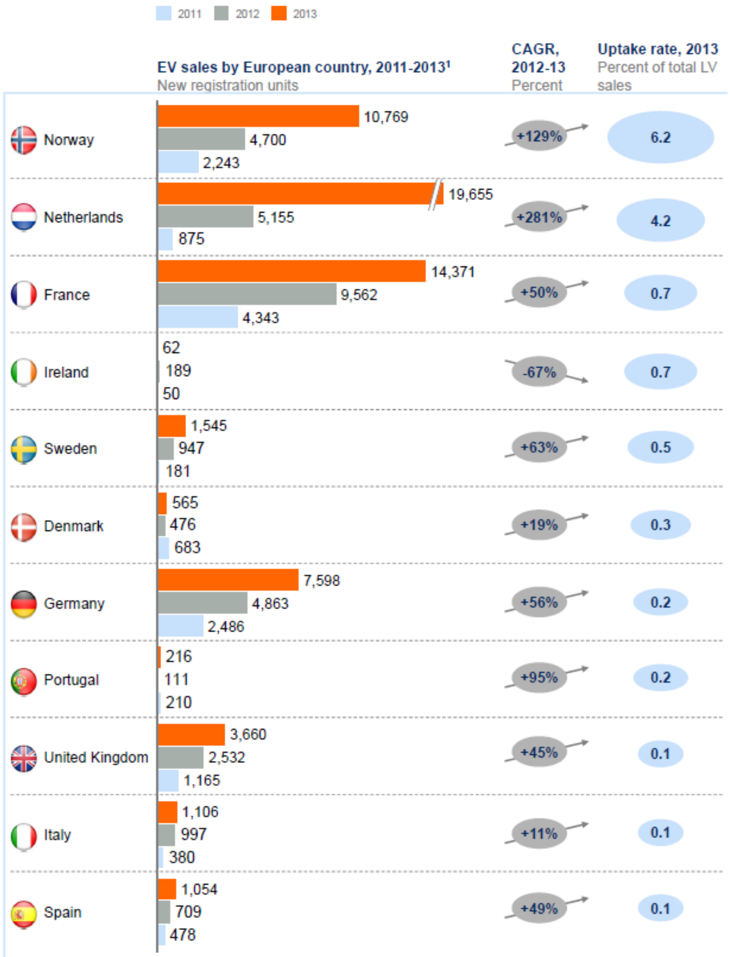


Figure 3: European EV market sales (Amsterdam Roundtable Foundation & Amsterdam Roundtable Foundation & McKinsey&Company 2014)

As a new and emerging market segment, the European Union (EU) EV sector offers substantial opportunities to investors, economy and society. The European market volume for EVs in 2014 is calculated with 75,331 sales, a 36.6 % rise comparing to 2013 /ACEA 2014).

The rapidly developing and very dynamic major EV markets in Europe (Figure 3) are led by Norway and the Netherlands as clear frontrunners in EV uptake, with France, Germany and UK growing significantly. The market has of 100,000 sales by 2015, 500,000 by 2021 and 1 million by 2025 (U.S. Department of Commerce 2014).

Compound annual growth rates (CAGR) of up to 281 percent can only be found in new emerging markets like the e-mobility market. Recent figures of new registration rates of overall passenger cars in Europe are not comparable as can be seen at Figure 3 and Figure 4. While e-mobility registers tremendous growth rates, the overall new registration rates of passenger cars decreased since 2007 (Figure 4). In 2014 a registration rates increased slightly again. Considering figures for EVs and overall passenger cars, it should be kept in mind that CAGR of almost 300 percent are typical for emerging markets in the very beginning.

Table 2: EU passenger car registrations Top 5 (acea.be)

	December 2014	% change	Jan-Dec 2014	% change
Germany	229,700	+6.7	3,036,773	+2.9
UK	166,198	+8.7	2,476,435	+9.3
France	163,354	-6.8	1,795,885	+0.3
Italy	91,518	+2.4	1,359,616	+4.2
Spain	73,440	+21.4	855,308	+18.4
EU	**951,329**	**+4.7**	**12,550,707**	**+5.6**

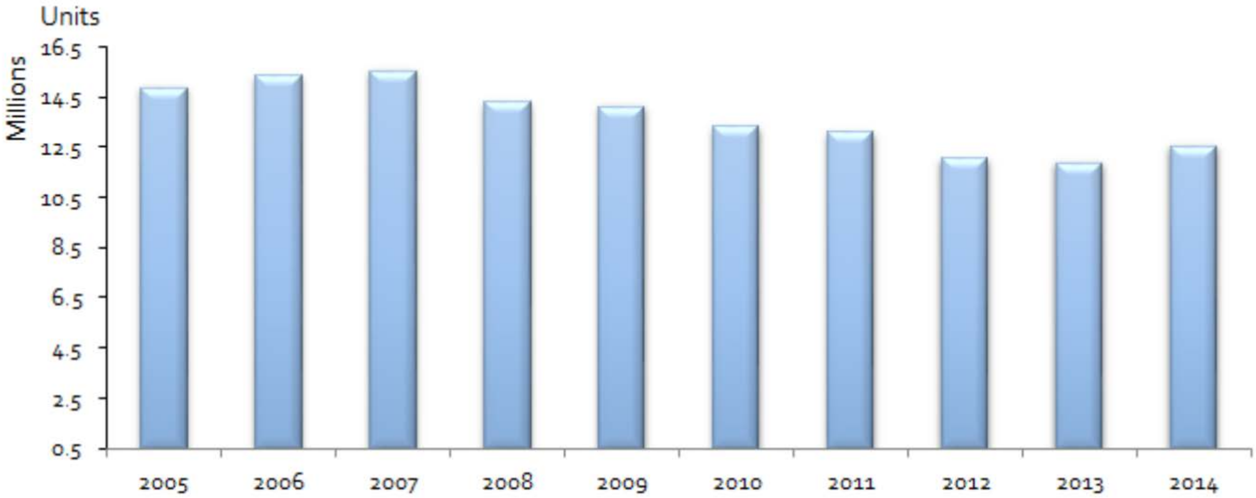


Figure 4: European passenger cars registrations – in units, 2005 - 2014 (acea.be)

Taking a closer look at the overall European EV stock market situation, France is in the lead with 20,000 EV stock in 2012 followed by United Kingdom, the Netherlands and Germany (Figure 5), calculation based on data from Amsterdam Roundtable Foundation & McKinsey&Co. 2014, ACEA and IEA, lead to an overall EV stock in European major markets of about 214,000 EVs through the end of 2014.

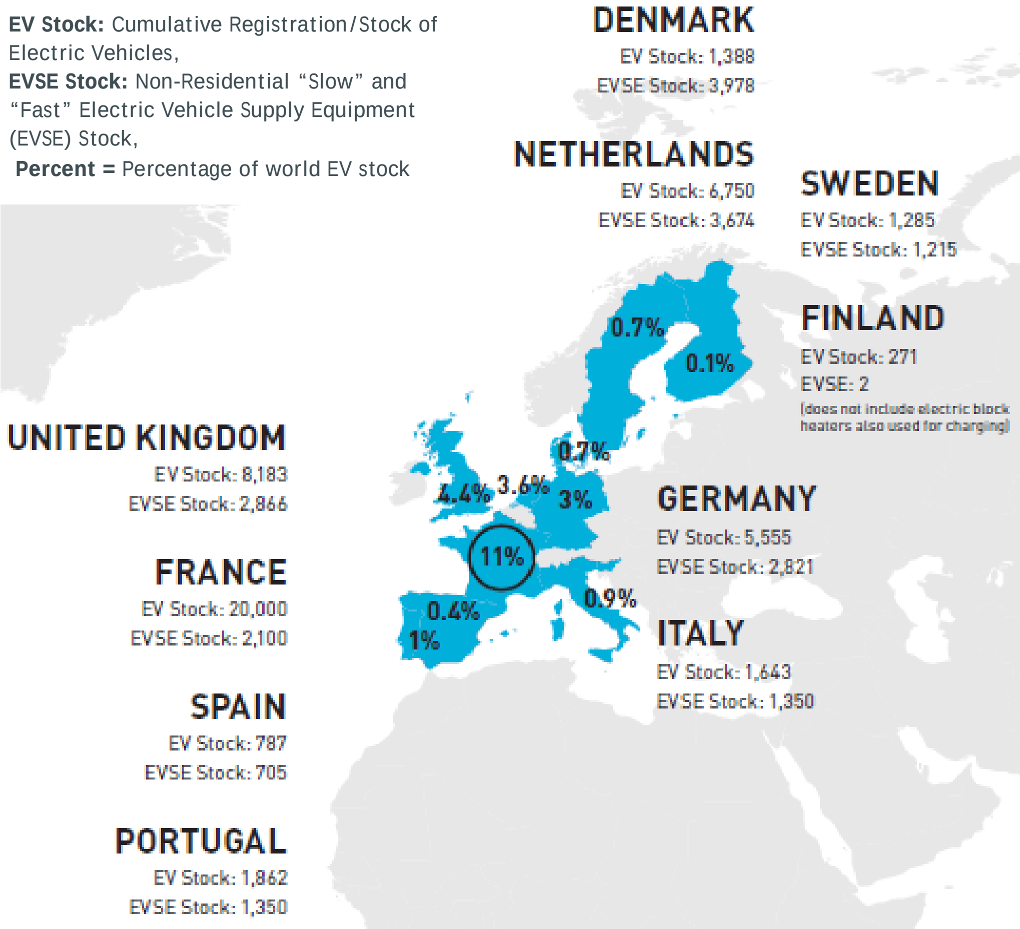


Figure 5: EV stock market Europe 2012 (IEA 2013).

Although global and European sales figures are still small (below 1 % of new car registrations), in some areas growth has increased – driven by governmental support, an improved offering of EVs by the automotive industry, and a growing familiarity and higher customer's willingness to buy an EV.

Norway can be characterized as such a growth market. The top-selling car models in September, October, and December of 2013 were battery electric vehicles (BEVs). In November of 2013, EVs reached 12 % of sales in Norway. As can be seen below, Norway managed to keep the lead with 19,767 new registered EVs in 2014, followed by UK (15,361) and Germany (13,118) (Amsterdam Roundtable Foundation, McKinsey&Company 2014, ACEA 2014). Current data about the development in the European EV market in the past three years gives proof of the high dynamics of this market (Figure 5).

Moreover, the Netherlands made tremendous efforts to boost the Dutch e-mobility market during the past three years. Comparing the 2012 EV stock of Germany and the Netherlands with the 2014 EV stock it becomes obvious how different national markets can develop in such a short period of time (Figure 6). The underlying causes for this CAGR spread are mainly related to different governmental support programs for e-mobility markets on national scale on the one hand and to subsidies stimulating the sales rates of EVs on the other hand.

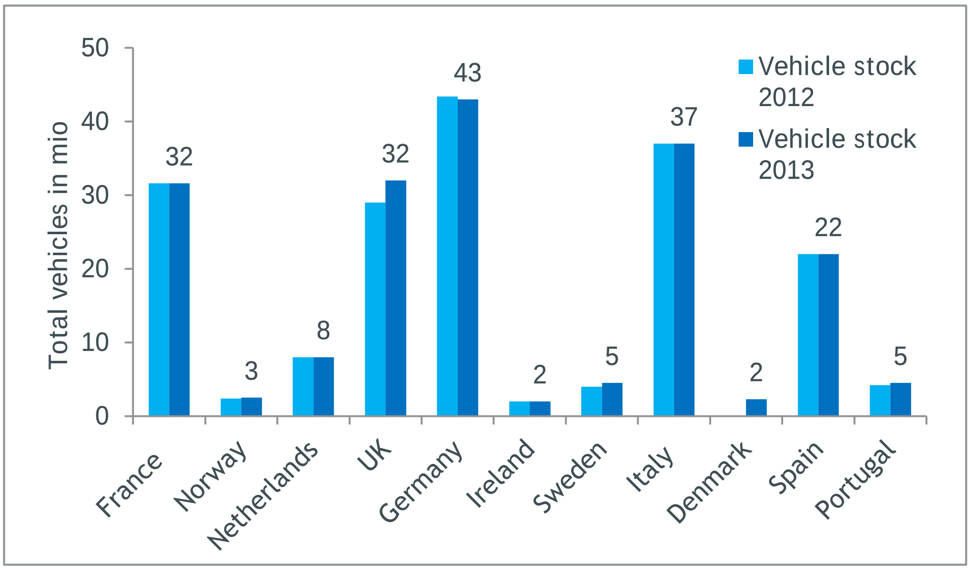


Figure 6: Vehicle stock market Europe 2012 - 2013 (Source: destatis.com; ec.europa.eu).

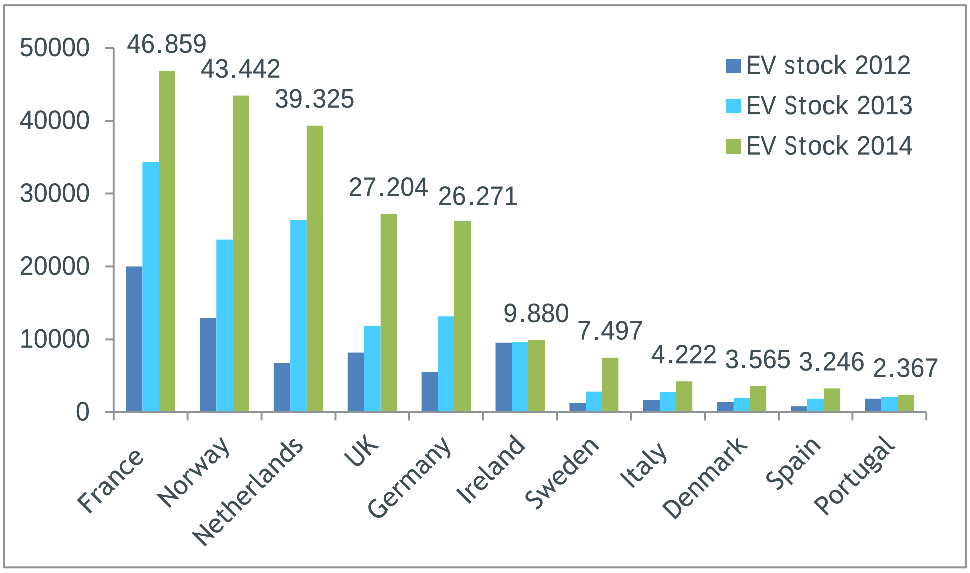


Figure 7: Total EV stock Europe 2012 - 2014 (Source: Amsterdam Roundtable Foundation & McKinsey&Company 2014 & ACEA 2014).

Having discussed before how sales rates and market stock of EVs have developed in recent years, this paragraph presents a more detailed view on Europe's major OEMs and on specific EV sales rates by type. Overall EV registrations in Europe rose by more than 60.9 % in 2014, as compared to 2013, according to recent figures. Unlike (P)HEVs section where Toyota is the market leading company with its Toyota Prius, as far as which manufacturers did the best performance in the BEV section, the answer isn't exactly surprising — Nissan-Renault took the top easily with 14,385 Nissan LEAFs registered in 2014, and 10,980 Renault ZOEs.

Tesla Motors did quite well, though — with 8,744 vehicles registered — despite production limitations. Straight after those three there was the BMW i3 (with 5,620); and the Volkswagen e-up! (with 5,170). The commercial market saw the Nissan e-NV200 and the Kangoo ZE land a good number of sales, as well. 2015 will pretty likely see continued growth in the portions of the European market that have been seeing growth in recent years. The relatively untapped portions, though, aren't really showing any signs of awakening (evobsession.com 2014).

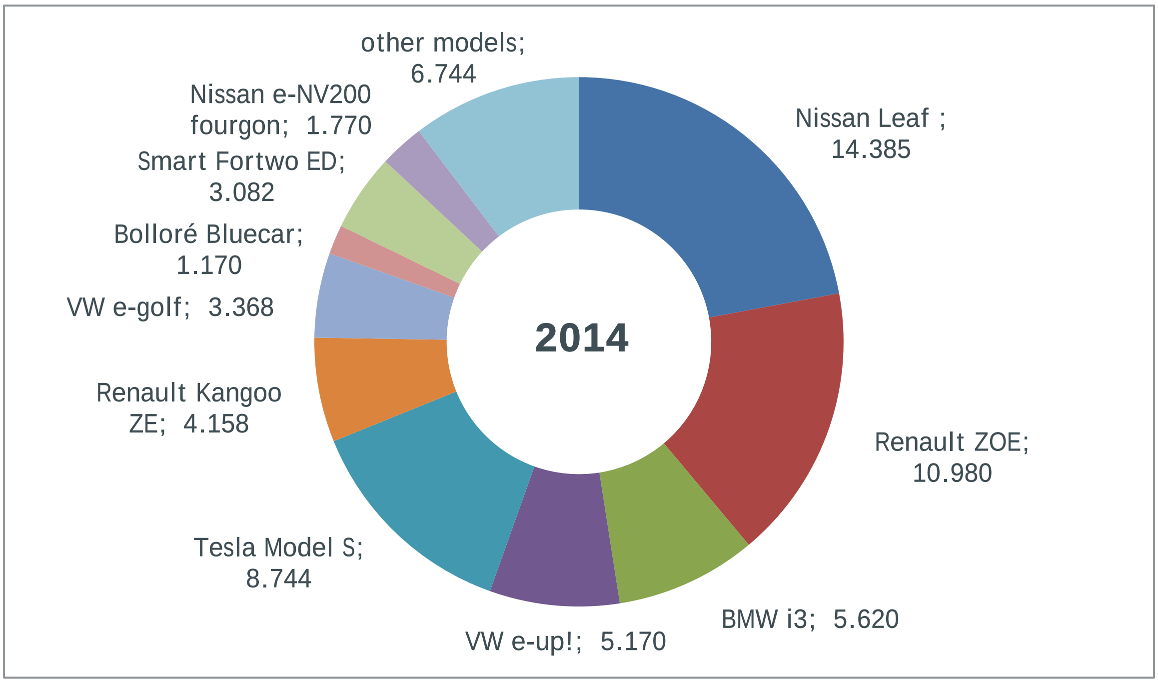


Figure 8: Europe FEV registered in 2014 (evobsession.com)

As could be expected, these figures lead to a market share breakdown by OEMs dominated by the Renault-Nissan alliance with 22 % followed by PSA Peugeot Citroën (14 %) and VW (12 %) (Figure 9). About four years after the launch of the world's first mass-market EV, Nissan LEAF, Renault-Nissan sold its 200,000th EV in total in early November 2014 (global scale). Nissan LEAF remains the best-selling EV in history while Renault remains the European market leader. From January 2014 till the first week of November of 2014, the alliance has sold about 66,500 units—an increase of about 20 % compared to the same period the previous year. The alliance sold about two out of three electric vehicles worldwide, including Twizy, Renault's two-seater urban commuter vehicle and the Nissan e-NV200 van on sale in Europe and Japan.

PSA Peugeot Citroën, holding the second place, was the first carmaker to introduce electric vehicles in Europe starting in late 2010, with the Peugeot iOn and the Citroën C-ZERO. The Group's EV line-up also includes two electric commercial vehicles, the Peugeot Partner Origin and Citroën Berlingo First, which were also brought to market in 2010.

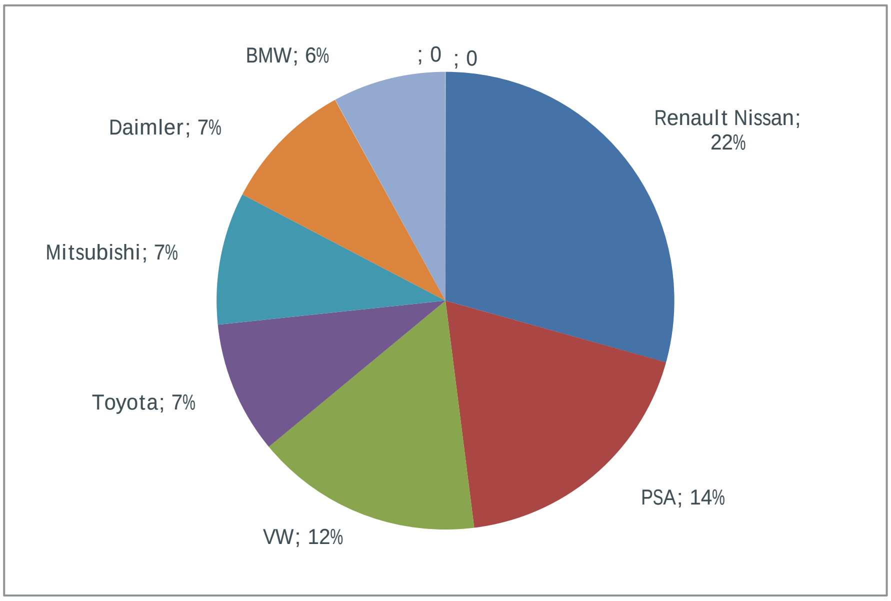
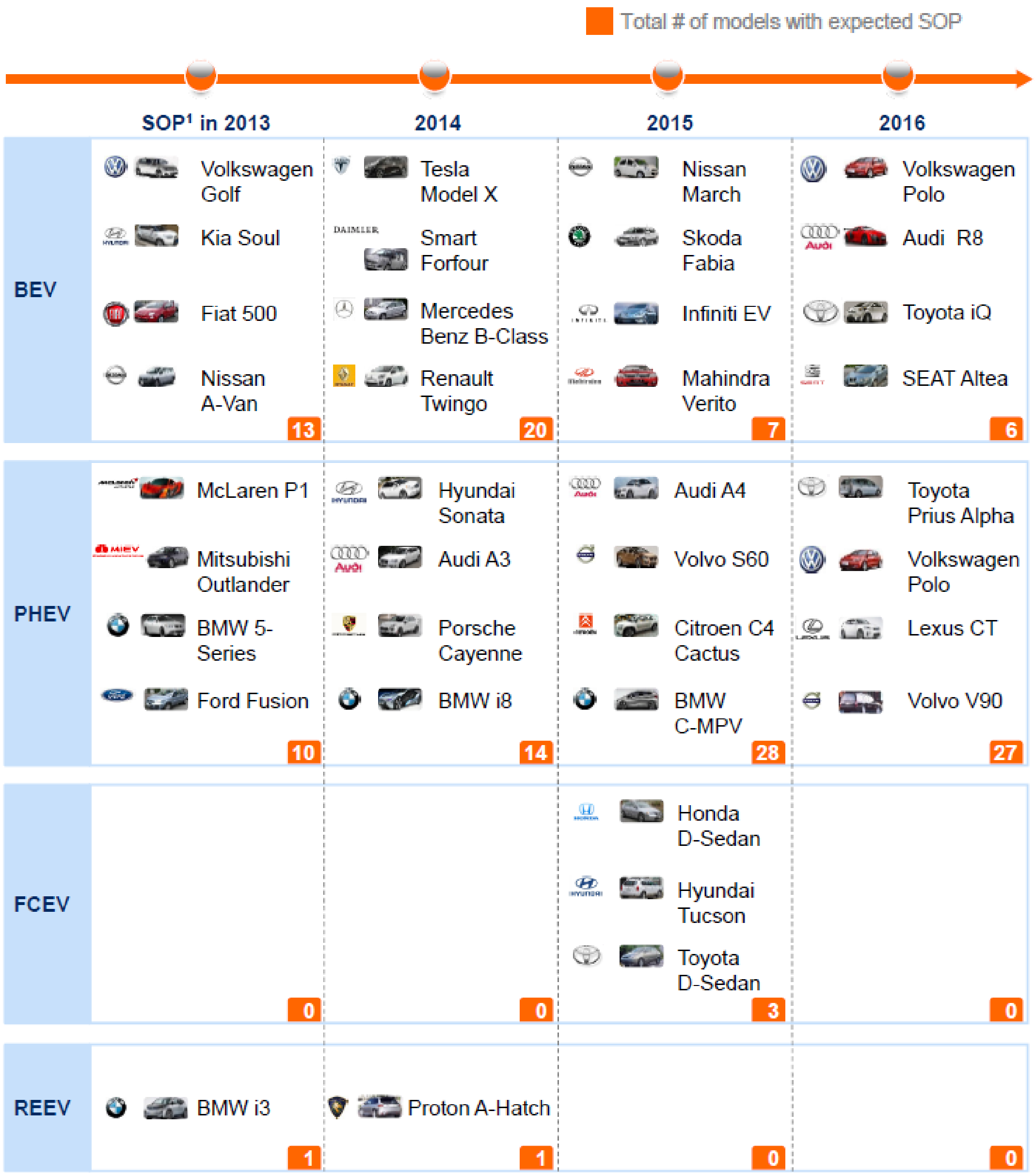


Figure 9: Market share breakdown by OEMs through 2017
(Source: Frost & Sullivan 2012)

VW in the third place, currently the world’s second largest OEM, has lost out to the likes of GM, Ford, Nissan, BMW, and Tesla in the fast growing electric vehicle segment. By accelerating investments, the German car company hopes to gain momentum in the plug-in electric vehicle space. But still they are suffering from a late start. Using the Volkswagen e-Golf exemplarily, an all-electric car launched in the U.S. at the tail- end of October 2014, has only around 70-90 miles of electric range. In contrast, the Tesla Model S can go 400-500 km on a single charge.

On a European as well as on a global scale we see a wide range of different OEMs developing and selling different kind of EVs based on different technologies. This diversity penetrates the whole e-mobility market and can also be found in the fields of national subsidies and incentives schemes. Furthermore this diversity continues in areas of ICT, road IT infrastructure and platform technologies. The following table proofs that, by showing the upcoming model launches, further diversifications in the next years are expected.



1 SOP = Start of Production, models expected to go in production as predicted by industry analysts
SOURCE: IHS Automotive DRIVEN BY Polk

Figure 10: Upcoming model launches suggest further diversification of EVs (Amsterdam Roundtable Foundation & McKinsey&Company 2014)

3.2.2. Drivers and barriers

3.2.2.1. EV specific drivers and barriers

Depending on different sources of energy and propulsion and therefore different technologies, each type of EV offers specific benefits and barriers, which influence the success of the market (Table 3). Beside this, there are further barriers and benefits to e-mobility at all. These will be discussed at a later stage of this document. In this section we concentrate only on EVs.

A PHEV for example offers similar range as an ICE and can already use existing fuel infrastructure, which occurs at the same time as a barrier due to high fuel costs and CO_2 emissions. Especially the usage of existing infrastructure decreases more and more if we look at REEVs, BEVs, and FCEVs. These three types of EVs increasingly benefit from lower running costs, lower CO_2 emissions and from a high Well-to wheel efficiency.

Table 3: Key benefits and barriers (Based on Amsterdam Roundtable Foundation, McKinsey&Company 2014)

	PHEV	REEV	BEV	FCEV
Environ-ment	Emission reduction because of battery and e-motor, but ICE still primary source of propulsion	Substantial emission reduction compared to ICE – emission only when range extender is used	Zero emission cars[2], far more efficient well-to wheel than ICE	Zero emission cars[2], far more efficient well-to wheel than ICE
Benefits	Use of existing fuel infrastructure Similar range as ICE	Extender provides higher range than BEV Real electric car, less range anxiety	Pure electric, zero emission car Charging possible at home/office etc.; infrastructure growing	Range is high Refuelling takes only minutes
Barriers	Low range on just e-motor ICE is still the primary source of propulsion – substantial emissions on longer trips	Additional complexity and cost compared to a BEV Extender offers limited additional range	Refuelling takes long, even with fast charge at least 20 - 30 minutes Relatively low current range Infrastructure required, availability limited but growing	Energy-intensive to produce hydrogen Hydrogen infrastructure required – currently very limited

2 Excluding electricity generation for charging the vehicle

3.2.2.2. Costs

The most significant technological challenge the production of EVs is currently facing is about the costs and performance of the components, particularly the battery. Price per usable kWh of a lithium-ion battery ranges between EUR 440-580 and is therefore responsible for a large share of an EV's cost, depending on the size of the battery pack. A Nissan LEAF, for example, has a 24 kWh battery installed inside the vehicle that costs approximately EUR 10,600 representing about a third of the vehicle's retail price. Likewise, Ford uses a battery that costs about EUR 10,000-13,500 for its Focus Electric, an electric version of its petrol-powered Focus that itself sells for around EUR 19,500. PHEVs may be even more expensive due to the cost and complexity of dual power trains. A Chevrolet Volt only uses a 16 kWh battery pack, but its purchase price is nearly EUR 4,400 more than a LEAF, due in large part to its hybrid technology (IEA 2013).

Hence, most EVs will remain more expensive in the near future than their ICE equivalents, although the overall purchase price is a key barrier for EVs. Until technology and economic development offers better prices, EVs seem to rely on governmental support in form of (purchase) subsidies[2] offered in many countries (see chapter 3.5). In Norway, the government offers subsidies, which lower the purchase price of a Nissan LEAF to EUR 37,000 while VW Golf with EUR 36,800 costs almost the same price (Haugneland 2014).

Moreover, the difference of EV purchase prices in Norway, Sweden and Denmark can explain why the EV sales are much higher in Norway. A VW e-Golf or e-Up will cost less or the same as a petrol version of the model in Norway. In Sweden, the electric version costs over EUR 10,000 more than the petrol version. This is due to the price reduction of about EUR 4,300 for cars with low emissions in Sweden. In Denmark, the e-Golf is priced similar to the petrol version, but the smaller e-Up is like in Sweden EUR 10.000 more expensive than the Up (Figure 11).

[2] For more information on subsidies see chapter

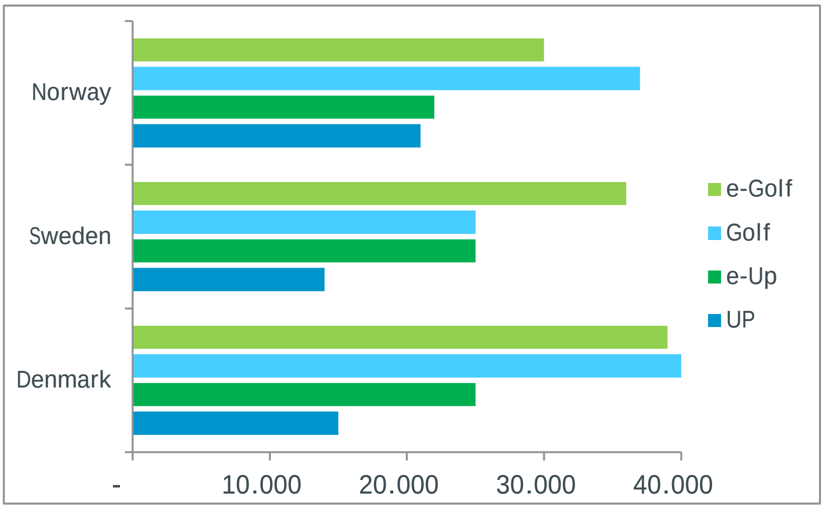


Figure 11: Cost of EVs compared to traditional cars in Norway, Sweden and Denmark (based on Haugneland 2014)

Although the Norwegian case (competitive and cheap prices) may be an exemption in Europe, it shows the range of how e-mobility can (‘t) be supported by the government. The exact opposite to Norway is Germany – still one of the five major markets in Europe – with almost no purchase incentives at all (IEA 2013). This comparison shows again the diversity of the national EV markets within Europe, a fact, which has influence on e-mobility and the eCo-FEV project at several levels. Due to its high importance, this issue will accompany us through this report.

The (perception of) cost competitiveness, whether in terms of total cost of ownership (TCO) or purchase price, is the most critical of all the factors that may motivate consumers to buy an EV for large-scale EV adoption. Experts believe that for most consumers, price respectively costs is the key decision driver (PwC 2012, IEA 2013, Frost & Sullivan 2012, Roland Berger 2013). In Norway for 41 % of EV buyers, the primary reason to buy an EV was “to save money”. This share of price-conscious EV buyers is likely to be even higher in the general population compared to early EV adopters.

A substantial share (almost 50 %) of the passenger cars in Europe are not individually owned, but belong to a corporate fleet. For some fleet managers, the adoption of (partially) electric vehicles is easier to implement and more attractive than it might be for individual consumers. This will especially be true for companies that have a fleet with predictable driving patterns and thus vehicle or range requirements, combined with an intensive use of vehicles (long distance per vehicle per year), which would improve the relative TCO of EVs in comparison to

ICEs due to lower fuel and maintenance costs (Amsterdam Roundtable Foundation & McKinsey&Company 2014).

Corporations that have started to “green” their fleets are also driven by ambitious emission reduction plans, attractive subsidies, or both. As in the case of individual early adopters, both the environment and TCO seem to be important decision factors. Intermediary actors, such as lease companies, are also active in the EV market to meet increased demand from fleet customers.

Looking at the total costs of an EV, we can see that costs/kWh decreased in the last years and they will further decrease in the future. E-mobility experts are of the opinion that due to economics of scale and intensive R&D in all fields of e-mobility, in Germany TCO of EVs will undercut the TCO of ICEs in 2018. Considering the current oil price development it might take possibly two more years. Hence, the tipping point where costs for EVs will turn from a barrier into a key driver is in the worst case only five years ahead of us.

3.2.2.3. Range limits – real and perceived

The purchase price of an EV perhaps would be acceptable for a large number of consumers if the vehicles offered more range or differentiated functionality than is currently on the market. With an average range of about 190 kilometres, BEVs achieved in 2013 a little more than a third of the range of a comparable ICE vehicle (fueleconomy.com 2015). BEVs with larger battery packs, such as the 85 kWh Tesla Model S, may offer much greater range (480 km) but also come with significantly higher retail prices, which will likely deter most consumers. PHEVs eliminate range constraints, but many only offer about 15-65 km of electric-only range and thus may not fully deliver the benefits of electric drive - such as cheaper fuel and lower emissions - if driven predominantly in petrol-mode.

The United States and France were the most sensitive to range. Yet in the United States the average daily vehicle distance travelled per person is 46 km and average vehicle trip distance is 15 km. Given the fact that U.S. average travel distances are the longest in the world, it is likely that most of today’s EVs have sufficient range for a majority of consumers worldwide. Nevertheless, as long as this gap remains between range expectations and actual driving needs, negative perceptions about EV range and notions of range anxiety will persist (IEA 2013).

Great efforts were already made in different countries and by different companies to overcome these barriers. Tesla for example developed a battery swap charging station that charges/swaps batteries of two Tesla Model S in a row within three minutes, which is exactly as long as one convenient ICE needs to be refuelled completely. Furthermore inductive charging technologies like charge while driving (CWD) and tremendous efforts in the fields of battery technology will push the range limits of BEVs further and further ahead resulting in unlimited range for EVs eventually. At the same time several countries raise their supporting initiatives for charging infrastructure to meet their e-mobility development aims.

Hence it is a matter of time until the barrier “limited range” will be overcome and even might be turned into a driver for e-mobility when CWD succeeds eventually. Given the current situation characterized by incomplete charging coverage, range limits and high TCO, this is exactly where eCo-FEV can be very effective and successful. By bringing together different services of different companies and by providing all primary and secondary services around intelligent road, IT structure solutions like optimized navigation, charging management and payment eCo-FEV can overcome existing barriers. Furthermore, thinking of all services and functions that eCo-FEV will provide, driving EVs may become even more convenient as driving an ICE considering assets like unlimited range, very low energy costs and TCO, less (air) pollution and noise reduction in urban areas and mega cities.

The European EV market - Summary

The European EV market is very dynamic and can be characterized by a high diversity. Each country has its own market share of PHEVs and FEVs. Furthermore EV stock rates vary as well as CAGRs and national e-mobility supporting initiatives (chapter 3.5). For the following analysis it should be kept also in mind, that talking about European EV or e-mobility market means most of all talking about five major markets France, Norway, Netherlands, UK and Germany followed by a view smaller markets like Ireland, Sweden, Italy, Denmark, Spain and Portugal.

Based on the latest data from the European Manufacturers Association (ACEA) only 16 of 28 EU-member states show significant markets for EVs. But as can be seen through the example of Norway, things may change very fast. Additionally to the European EV market major markets as the US, Japan and China need to be kept in mind. They also have impact on the European market as been shown by the examples of NISSAN Leaf or Tesla – both major players not only in their home markets. In line with the information given in this chapter, charging infrastructure development has obviously a major impact on EV market development as well. Due to its complexity and importance to e-mobility, this issue will be the core of the following part.

3.3. Infrastructure

3.3.1. Road IT infrastructure

This infrastructure system monitors the road traffic flow, collects road traffic information, detects abnormal road hazard situations from vehicles and/or from roadside equipment, and provides road users with traffic management information and road hazard information. These applications can be achieved via existing road IT infrastructure and/or via IEEE 802.11p based cooperative systems infrastructures (Road Site Units). In eCo-FEV, road IT infrastructure can provide road traffic status and road event information for infrastructure systems in order to be able to take real time road traffic information into account in potential use cases.

3.3.2. EV Backend

This infrastructure system provides central based EV management, vehicle relationship management and navigation services to EV users. Currently the deployment of such backend infrastructure has been foreseen in the automobile industries. However, it is also conceivable that EVs communicate with a platform specific backend. Data can provide added value by using the advantages of swarm intelligence. Data stored on proprietary EV backend owned by the OEMs cannot provide the same service quality as collective data.

3.3.3. Charging infrastructure

In recent years, the growing sales of PHEV and FEV models have already led to an increased amount of charging infrastructure in European countries. Beyond this, smart service platforms offer solutions, which connect end users with a diverse set of EVSE providers. The provision of charging infrastructure as one segment within the e-mobility ecosystem is a new and complex construct with new strategic partnerships evolving. The main issue about charging infrastructure is related to the high investments needed for the required coverage of public charging stations on the one hand and the question about maximizing the exploitation of EVSEs on the other hand. That is why the deployment of charging stations requires a smart approach. It doesn't have an effect on the EV uptake in the future if charging stations are deployed randomly. It is more effective to optimise rather than maximise the deployment of EVSEs.

Today, charging infrastructure can be classified on the basis of different aspects depending on charging behaviour, charging technologies and charging locations. In this chapter EVSE deployment and charging technologies will be outlined.

3.3.3.1. EVSE deployment

In recent years there have been some instances of EVSE experiencing only little or no customer utilization. There is no formula of the appropriate number of public and semi-public EVSE required in a specific area, of course. Ensuring EVSE to be placed in relevant areas in order to avoid over-investment depends on region-specific variables such as EV penetration rates, consumer charging and driving behaviour. The responsibility of gathering and sharing such data, which can be collected through demonstration projects, for instance, lies with the government. Observing charging behaviour of European EV users can result in a more efficient deployment of EVSE and therefore it can be a win-win situation for both the EVSE operator achieving faster refinancing and the driver locating EVSE where they are really needed.

The fact that vehicles are parked 90 % of the time, at home or at work, represents the opportunity for EVSE to be deployed at locations where drivers plan a longer stay rather than where it is easiest to construct the equipment. Such ideal locations could be shopping centres, park and ride stations, parking garages or grocery stores.

3.3.3.2. Types of charging

In fact, only (full) BEVs and FCEVs are totally reliant on the new infrastructure to be deployed. In the following figure three different forms of charging are described: conductive (wired) charging, inductive (wireless) charging and battery swapping.

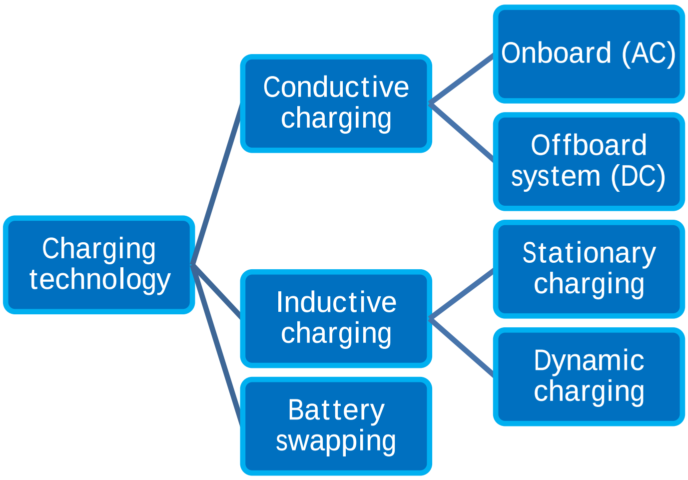


Figure 12: Charging solutions

In the following chapters conductive charging and dynamic inductive charging (CWD) will be analysed in detail as these are the main types of charging within charging infrastructure in eCo-FEV.

3.3.3.3. Conductive charging

This type of charging in Europe involves the actual plugging in of the car at an appropriate station.

Conductive charging allows two charging technologies (NPE 2014):

- **AC charging:** The charging unit that transforms the AC into the required DC is installed on board. The vehicle is connected with the AC voltage grid by means of a supply unit such as a *wallbox.*
- **DC charging:** The charging unit is installed off-board. The EV battery is directly charged with the required DC by the DC-charging station.

Figure 13: Different plugs for AC and DC charging (samochodyelektryczne.org).

Currently there is a variety of plugs and sockets to connect the EV with the respective charging station. The most common plug for slow charging (AC), the Type2 Mennekes (left side on the above figure), has been proposed as European standard. For fast charging purposes (DC) there are currently three standards in use: US/European CCS “Combo2”, the Japanese CHAdeMO, and Tesla Supercharger. The European Automobile Manufacturer’s Association ACEA recommends the combined charging systems as future charging interface standard for all EVs by 2017 at the latest because of its ability to allow both, AC and DC charging with only one interface.

Table 4: Types of Plugs (fastned.com)

Outlet	CCS (DC Combo)	CHADEMO (DC)	Type 2 “MENNEKES” (AC)	TESLA Supercharger (DC)
Charging Speed	Fast-charging up to 80% in 15-30 min	Fast-charging up to 80 % in 15-30 min	Charging speed depends on type of car (slow and fast-charging)	Fast-Charging up to 80 % in 30 min
Deployment				
Max. Power Output	50 kW	50kW	22kW	120 kW
Suitability	BMW i3 Volkswagen e-up Chevrolet spark EV Volkswagen e-Golf	Nissan Leaf Nissan e-NV200 Mitsubishi Outlander Peugeot iOn Citroen C-Zero KIA Soul EV Tesla with CHAdeMO adapter	Renault Zoe BMW i3, i8 TESLA Model S (semi-fast) Smart Electric Drive (semi-fast) BYD E6 (semi-fast)	TESLA Model S

Due to the variety of plugs and outlets, a high coverage of charging stations doesn’t necessarily ensure the driver access to the entire charging infrastructure. Today there are various charging networks established by different partners with individual identification and payment solutions. This fragmented market of charging providers and not yet standardized plugs leads to confusion and desperation instead of meeting the customers’ needs by offering a simple and standardized solution.

By 2013, more than 20,000 public EV charging stations with more than 1,000 public DC fast-charging stations have been installed throughout Europe. However, current deployment is mostly focused on cities, not yet facilitating intercity travel.

In order to take EV travel from local to intercity, some European countries, including Estonia, Norway, Denmark, and the Netherlands have started governmental initiatives to install more fast-charging stations along the highways (Amsterdam Roundtable Foundation & McKinsey&Company 2014). Having by far already the highest amount of charging stations installed within Europe, the Dutch government has even set itself the objective to use the world's largest network of multi-standard electric vehicle fast-chargers by the end of 2015, which are said to be capable of charging EVs from all major brands with no charger further away than 50 km from any of the country's inhabitants (ABB). This initiative underlines the increasing willingness of governments to spur EV development.

In order to understand the current requirement of conductive charging in Europe it is unavoidable to discuss the charging behaviour of the EV user. Many surveys on EV user behaviour were conducted throughout Europe. In summary they all show how distinct EV drivers in Europe are, not only because of different climate conditions. Private users generally mainly charge their EV at home overnight and use public charging only when necessary. Compared to smart phone charging behaviour, people don't want to leave home with an uncharged EV or smart phone. In Norway for instance there is only a low need for public charging stations, although the respondents of the survey value network of public charging stations high.

3.3.3.4. Inductive charging

With this technology, the battery of an EV is charged using an electromagnetic field generated in the surface underneath the car. Several years have gone by since researchers from the scientific and industrial communities have found ways to use induction to charge electric vehicles.

The current approach to mount induction coils on the underside of the vehicle and install charging stations in the ground comes along with *a number of significant challenges:*

- The coils need to be very powerful for the method to work because of the significant gap of up to 15 cm between car and ground.
- Powerful coils are large in size – and large coils are expensive and therefore an important cost driver.
- There is also the problem of objects or animals impeding the charging process by blocking the transmission of power. A particularly problematic issue is that metallic paper such as chewing-gum wrappers or cigarette packaging can blow under the car and into the induction zone, where it can get so hot that it bursts into flame.

There are two possible forms of inductive charging: Static and dynamic charging. With static charging an EV is being charged while standing still. This unplugged form of charging is especially interesting if the conductive charging option is impracticable, i.e. at the traffic lights, the bus stop or the taxi stand. Dynamic charging, however, is a derivate of inductive charging that is not mature for deployment yet.

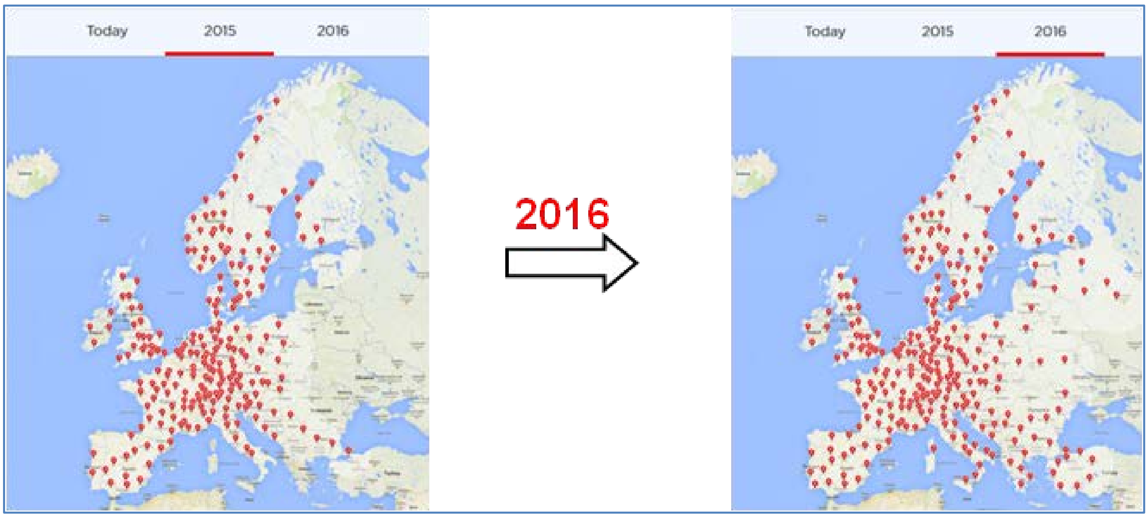


Figure 14: Development of Tesla superchargers (teslamotors.com)

3.3.3.5. Battery Swapping

Initially battery swapping has been piloted by Better Place who acted as a pioneer on this field but it lost much of its attractiveness since its bankruptcy in 2013. According to the business model, the higher price of electric cars compared to gasoline cars, mainly related to high prices for the batteries installed in the electric cars, should be lowered by enabling manufacturing and sales of different electric cars separately from their standardized batteries just in the same way as gasoline cars were sold separately from their fuel. Better Place installed ~55 battery swapping stations in Denmark and Israel but as a matter of fact, almost none of the delivered BEV models supported battery swapping except Tesla who showed how to make the idea of battery swapping a success story. Today, battery swapping is a service offered in addition to plug-in “supercharging” at the Tesla Charging Stations. The driver gets the possibility to choose between: “faster charging or free charging”. To swap for a fully charged pack, Tesla owners will have to pay a fee around $50 to $60 to reduce the "recharge" time to a few minutes. Knowing that in case of time pressure there will always be a solution to charge the EV in half the time compared to refuelling at a gas station will lower range anxiety tremendously.

However Tesla’s business model seems to be somewhat like an exemplary solution to refinance charging stations, the proprietary nature of Tesla’s charging system is hindering the spread of EVs as a whole by further fragmenting charging infrastructure. Besides that fact, people realized that economic experts were wrong and engineers explained that designing EVs with the capability of removing the battery will make the vehicle’s weight heavier.

3.3.3.6. Leading charging networks/charging service provider in Europe

The improvement of charging infrastructure and the scale-up of EVs are mutually dependent. The increasing establishment of charging infrastructure and the trend of “mobility as a service” led to an increasing amount of partner networks. However, this development of isolated solutions ironically leads to a further fragmentation in the EV market.

RWE Effizienz, as one of the leading operators for charging infrastructure in Europe for instance, is tremendously expanding its charging network by cooperating with partners from different industries such as car manufacturers, municipal public utilities, and nationwide energy suppliers. Alone in Germany RWE Effizienz is cooperating with 80 partners. Within this network RWE acts as technology consultant and is responsible for networking all charging points. Furthermore, RWE performs the allocation of external charging processes among the partners particularly when the current is supplied by municipal public utilities outside the home region.

Offering a broad charging network to the EV customers is one important competitive advantage for OEMs. In order to reach this goal, OEMs cooperate with leading charging operators in the respective countries such as RWE Effizienz in Germany or Blue Corner in Belgium who already have an extensive charging network. This kind of cooperation ensures a win-win situation for both partners. OEMs need to offer the network, EVSPs need a distributor. One product that emerged out of this partnership is BMW ChargeNow. ChargeNow is a mobility service that enables BMWi customers to access the partner charging network with one single card.

However, it should not be neglected that the establishment of IT infrastructure is related with tremendous investment costs that somehow needs to be refinanced. ChargeNow positions itself as premium service provider and charges higher usage costs compared to other providers. Experts estimate that ChargeNow invested EUR 3 Mio in the establishment of ChargeNow infrastructure. These high investment costs still hinder OEMs to offer a proprietary IT infrastructure. Furthermore, since urban public charging is assessed to show the highest mismatch between desired and actually used charging solutions amortization of investment costs is expected to be unprofitable. This issue is considered to be one of the main important barriers on the field of e-mobility. ChargeNow offers country-specific tariffs varying from monthly fees (i.e. in Germany EUR 9, 50) and time-dependent variable usage-fees for charging to free-of-charge charging i.e. in Austria.

Infrastructure - Summary

Even though the deployment of infrastructure for e-mobility has developed well in the past years it can be observed that the high degree of fragmentation makes it necessary to foster standardisation. Some experts say that the market will regulate itself over the time but others say that standards must be set in place by governmental institutions to accelerate the development of infrastructure expansion. When it comes to charging infrastructure in Europe, there are significant differences notable among the European countries. The Netherlands and Norway are pioneers on the field of charging infrastructure while experts rate Germany as laggard in the field of e-mobility. Key success factors are subsidies by public authorities and the amount of fast charging stations located in so called "waiting zones" where the driver parks his car for a longer time.

Given that the costs for large-scale deployment of charging infrastructure in Europe are too significant to be covered by public sector alone, one of the most critical challenges for the EV sector is to achieve commercial viability in the deployment of charging infrastructure in the coming years.

3.4. E-mobility platforms

3.4.1. Purpose

E-mobility introduces an entire set of new services, coming from existing and/or new market players. With the increase of the number of players in the e-mobility market and the increase of different services and solutions for the same purpose, which exist parallel but are not able to interact, there exists a growing demand for these differences and B2B and B2C interactions to be handled in an automated way. Otherwise customers are prevented from buying EVs because of a too fragmented service provider market. This issue is exactly what e-mobility platforms – like eCo-FEV - seek to solve.

As a matter of fact, there are already some platforms following a similar approach like eCo-FEV. Offering digital market places for B2B as well as B2C communication and cooperation, the platforms e-clearing.net and hubject (will) bring together different infrastructure-, service - and mobility service providers to offer a wide range of solutions like charging, navigation, reservation, payment etc. through only one account and thereby reducing the complexity and diversity of existing solutions offered to the customer. To ensure this exchange of authentication-, authorization-, and accounting data (Triple A data) both platforms offer digital intermediary platforms. Provider can use these, so-called “clearinghouse” to make up new roaming cooperation all over Europe.

The overall goal of these platforms is to make it possible to drive and charge everywhere in Europe at any time, as far and as long as we want and as convenient as with an ICE. To reach this goal these platforms are about to expand their network of cooperation and to extend their area of influence because with every new charging provider joining their network more customers can be reached. As stated by experts, the market will show if one platform will succeed or if the customer shows a demand for several platforms at the same time.

Beside the two e-mobility platforms respectively marketplaces described below, another type of platform should be mentioned as well. This platform does not concentrate on e-mobility but mobility as a whole. As been stated by several experts, this could be an additional element that should be considered for eCo-FEV as well. Hence most of the services eCo-FEV seeks to provide to FEV-Travellers may also be attractive to all kind of mobility users. Such services are for example multimodal travelling and route optimized navigation. Especially in the initial phase offering services to both FEV-Travellers and usual mobility customers can help to attract more customers.

3.4.2. Cases: clearing.net and Hubject

e-clearing.net – an international open e-mobility platform offers border-crossing interoperability for charging EVs at more than 4500 already connected charging points.

Launched on October 2014 at eCarTec, e-clearing.net, a data hub developed by the German smartlab Innovationsgesellschaft mbH and the Dutch foundation ElaadNL aims at connecting relevant market participants by providing the opportunity mutually data exchange. “The target of our platform is to interconnect the market partners in a way that they can exchange all relevant data for their businesses. For a driver this means that he can use the infrastructure of different operators via roaming, even cross border,” (Hauke Hinrichs, Technical Director of smartlab). E-clearning.net allows uncomplicated roaming nationally and internationally as well as bi- and multilateral. Payment is organized correlated to the customer’s company, offering to do as much business as intended, paying only one yearly fee. E-clearing.net itself only offers the clearinghouse and is therefore not directly involved into B2B relationships and transactions.

As stated by e-clearing.net, even today, customers of any of the three member organisations Blue Corner (Belgium), ladenetz (Germany) and e-laad (Netherlands) can charge at the other side of the border. Figure 15 shows the complete e-clearing.net network and its members representing a cross-border network of more than 4500 charge points.

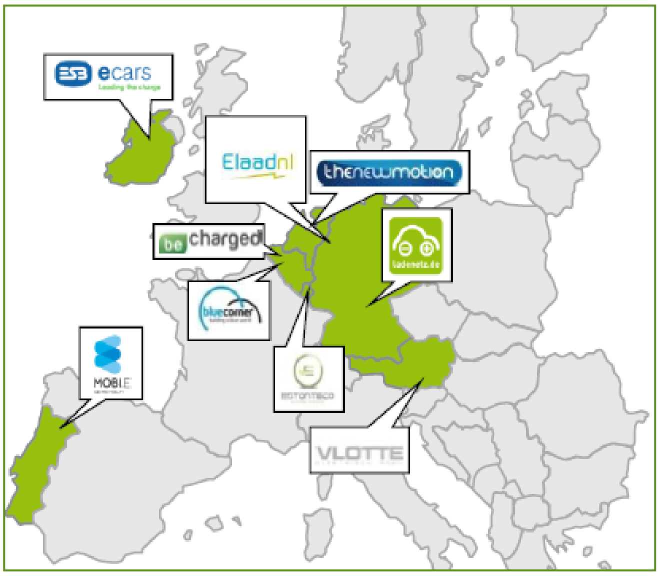


Figure 15: e-clearing.net Network (e-clearing.net)

Besides the functionalities of e-clearing.net the open interface of the platform is very crucial. The OCHP (Open Clearing House Protocol) is open for everyone and also the usage outside the platform is possible. “This is essential for us as the operator of the platform. There has to be more to an open protocol than simply publishing it on the internet. An open protocol has to be free of any property rights and fees. Our aim is further development in cooperation with all market partners” (Arjan Wargers, Manager Development and Innovation at ElaadN/EVnetNLL) (e-celaring.net).

Hubject - How can e-mobility become something we take for granted?

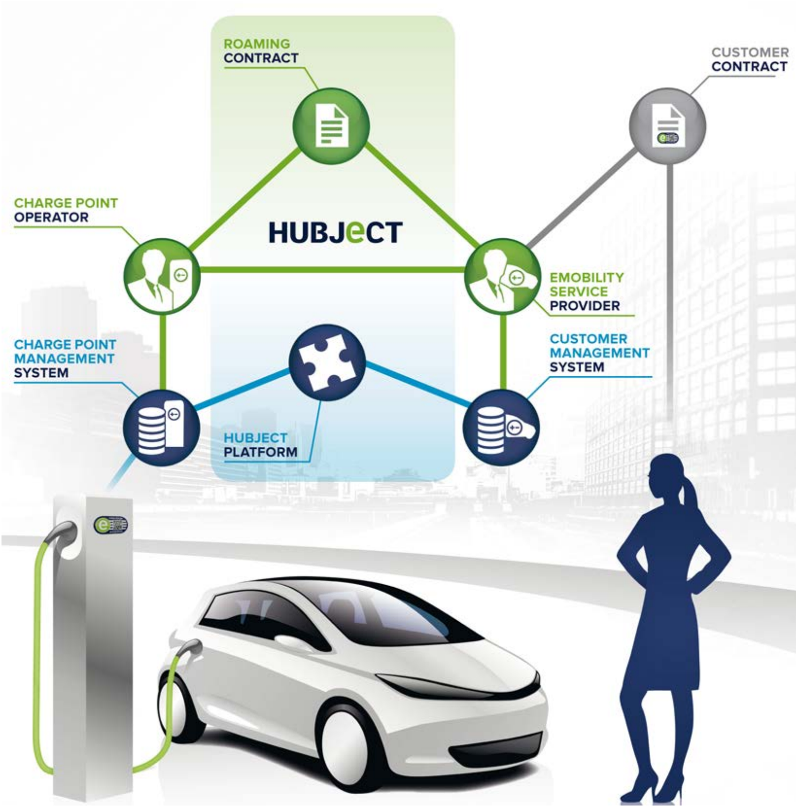


Figure 16: Hubject's market understanding (Hubject 2015)

"Ubiquitous access to charging infrastructure, attractive vehicle models and economically viable business models – all these are equally important prerequisites for the future success of e-mobility. Appropriate solutions, a number of companies from the automotive, energy, and IT-development sector have come together to form the Hubject GmbH joint venture. In keeping with our stated mission and promise of "connecting e-mobility networks", we have been working since 2012 to create a pan-European market place for e-mobility services. Thanks to our business and IT platform, the concept of "eRoaming" – the freedom to select from among multiple providers when charging electric vehicles – has become a reality since 2013, when intercharge was launched". This is how Hubject, a joint venture of BMW, Bosch, Daimler, EnBW, RWE & Siemens, describes itself (Hubject 2015).

Founded in 2012 by six companies, today Hubject covers about 13 national markets in Europe by itself or via cooperation with local business partners. In Germany they currently cover 60 % of the (semi) public charging infrastructure. The eRoaming platform is fully automated - which saves costs of manual maintenance - and enables real-time communication. As well as e-clearing.net, Hubject understands itself as a market place provider, only being active in the B2B business.

To become a member of Hubject, business partners need to integrate Hubject's interface solution into their own system. B2B customers pay an annual fee plus a set-up fee. If connected, each customer of a Hubject member has access to all charging station connected to the Hubject market place. The overall goal is to set up a Europe-wide charging eRoaming network. Hence, according to Hubject eRoaming allows for an efficient connection of different charge point management systems beyond city and country borders to enhance e-mobility success. Using the intercharge logo Hubject provides a symbol that identifies all compatible charging points that can be used to seize the opportunity to provide customers with the possibility to charge their EVs all over Europe (Hubject 2015).

In autumn 2014 one step closer to this overall goal was taken. Several clearinghouses and platforms like Hubject, e-clearing.net as well as other companies and institutions of countries all over Europe jointed together in the so-called “Pan-European eRoaming Initiative” (Figure 17).

Figure 17: Pan European eRoaming Initiative Network (Hubject 2015)

Beside the companies given in Figure 17, other companies as RWE, Nissan, Renault, TheNewMotion, Vattenfall, VW, allego, eViolin.nl, Ricardo, edf and eRDF joined the Pan-European eRoaming Initiative.

“The Pan-European eRoaming initiative was launched by representatives of these companies in the autumn of 2014 to join forces with more than 30 other companies from different industry backgrounds. Their common goal is the reduction of the existing barriers for using an electric vehicle. By committing themselves to interconnect their individual platforms the members are following a path that is desired by European policymakers. The Pan-European eRoaming Initiative thrives on the experience of the participating companies. Therefore e-mobility entities are invited to take part in the initiative” (Hubject 2015).

Of special interest for the eCo-FEV concept are these two examples because of their structural concept. Furthermore, their key element is the offering of an online market place where business partners can interact and develop new business models and cooperation. They refinance themselves via user fees but both do not intervene in any manner in the data exchange and businesses between their customers. And last but not least, one additional difference between these concepts and eCo-FEV is the business structure. It is the target of eCo-FEV project to support both, B2B and B2C services. It will be up to the implementer to provide one of them or both. Hubject and e-clearing.net decided only to offer B2B services. According to their statements, offering B2C services additionally to their B2B services would make themselves a competitor to their own customers and furthermore raise doubts on their compliance.

moovel – We make your way easy, personal and intuitional

Figure 18: moovel user interface (moovel.com)

Moovel, a complete other type of mobility platform comparing to the two presented above, is already on the market. Contrarily to hubject and e—clearing.net moovel focuses on overall mobility instead of just e-mobility alone. Furthermore their core value is not related to charging.

Furthermore Daimler's mobility platform moovel offers "the best way to get from A to B". Moovel brings together different means of travel by bundling the offers of diverse mobility providers and presents suitable travel options via app and mobile website. The pilot version has been continuously implemented from further mobility service providers.

With moovel users only have to log-on once to book and pay offered transport services from all their partners – even when the trip uses a combination of several.

Moovel is already available in the following countries: Germany, Austria, Canada, Denmark, United Kingdom, Italy, Netherlands, Sweden, and the United States of America.

For eCo-FEV moovel is of special interest because it shows solutions for several questions that need to be addressed in the following. These questions concern mainly aspects like payment, customer relationship and integrating secondary service provider.

E-mobility platforms- Summary

Additionally to EVs and infrastructure e-mobility platforms represent another element of the e-mobility ecosystem. On the one hand the two examples of hubject and e-clearing.net put eRoaming in the spotlight. On the other hand moovel concentrates on connecting general mobility services to make mobility easier, more personal and more intuitional.

eCo-FEV aims to cover both parts charging and mobility services. For the ongoing of this work aspects are of special interest.

- A map-based user interface seems to be a adequate solution
  - Easy usability is of high importance and should include
  - All services in one app
  - Possibility to book all services
  - Pay via one account
- Integration of similar and various services is possible and already takes place
- All three platforms do not intervene in customer relationships

3.5. E-mobility supporting initiatives

Regulations and subsidies play a decisive role in ensuring the economic attractiveness of e-mobility. This is the case not only for drivers but also for industry in 2020, roughly USD 30 billion to USD 40 billion will be raised in subsidies worldwide, with direct and indirect buyers' premiums accounting for around 85 % of this and industry subsidies accounting for the remainder (ATKearney 2011).

In June 2010 the EU approved a strategy for intelligent, sustainable and integrative growth, known as "Europe 2020". In this strategy three core elements were identified: R&D is to be promoted, an environmentally friendly and resource saving economy shall be supported and an overall high level of employment is to be accomplished by 2020. Out of these three core elements, five major targets were developed. Particularly the last two targets are of special interest for the e-mobility industry (europa.eu).

On the one hand, the yearly promotional volume provided by EU-member states has to be three percent of the national GDP. On the other hand the EU intends to cut CO_2 emissions by 20 % by 2020 (reference 1990) where at the same time, share of renewable energies as well as energy efficiency shall be raised by 20 percent. E-mobility is identified as a core element on the path to meet these goals. In accordance with the structure of the EU, these decisions were transferred into national strategies, regulations schemes and supporting initiatives leading to different manifestations in each country (europa.eu).

Governments in countries with major OEMs are prioritizing the development of EV technology with the aim to pioneer the technology and keep the value chain in the country. Examples therefore are Germany - as presented before – but also France made tremendous investments into its own automotive industry, above all Renault and Peugeot/Nissan.

Therefore this chapter aims at giving a brief summary of the different supporting initiatives existing within the European EV market. The first type of supporting scheme aims at promoting EV sales. The second type focuses on promoting and supporting R&D of charging and battery technology and the implementation respectively extension of charging infrastructure. Here once more, there is a high level of diversity on national scale regarding this core element of the European e-mobility market. If we correlate the information given in this chapter to the information of the two preceding chapters, we get one step closer to a holistic understanding of the European e-mobility market out of which we will derive possible business models and services for eCo-FEV.

3.5.1. Subsidies and incentives for EVs

The range of subsidies and incentives on EVs is huge and heterogeneous among European countries. While Germany offers exemptions of annual tax circulations of about EUR 28/a/EV, in Norway EV buyers profit from exemptions, free charging programs, free road tolls, free parking and several other incentives of about EUR 7,300/a/EV in total. In Norway an EV buyer profits of an overall amount of about EUR 60,000-70,000 cumulated over the years.

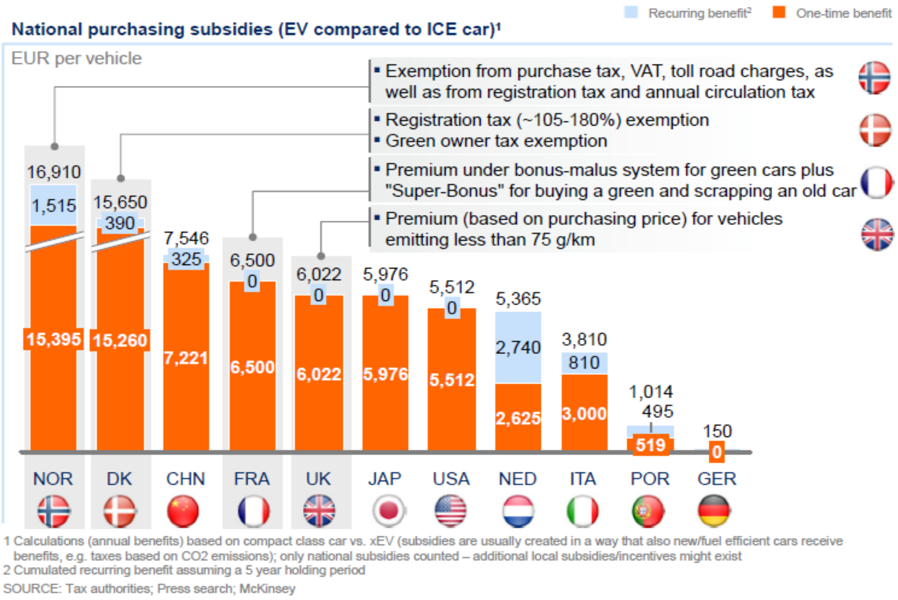


Figure 19: subsidies on EVs (Amsterdam Roundtable Foundation & Amsterdam Roundtable Foundation & McKinsey&Company 2014)

At first sight, the Norwegian subsidies seem to be a perfect tool to stimulate e-mobility. Taking a closer look, we see that Norway raises a very high tax on convenient ICEs generating a significant loss of income if subsidies of this range are granted. This example shows the huge cost involved – one that only a country like Norway, which has escaped the global economic slowdown thanks to vast revenues from oil and gas, can afford. Using a subsidy approach, which is not applicable to other countries, none the less it made Norway the second biggest EV market in Europe.

Subsidies and incentives do play a key role in ensuring the attractiveness of EVs. But not every country is able to afford them in the dimensions of Norway. As Figure 19 shows a lot of other countries use incentives and subsidies to stimulate EV demand. Otherwise, if we think of Germany again - the fifth biggest EV market, lead provider of e-mobility technology and with the fourth highest EV sales rates in 2013[3] but almost no subsidies at all – it can be argued that either some kind of subsidy or incentive scheme is necessary to stimulate EV demand or there already is a key player in the global automotive industry aiming at strengthening its position as technology provider for e-mobility.

[3] All three positions regarding Europe

3.5.2. Supporting initiatives on infrastructure

Having discussed supporting initiatives on EVs in the last section, this section focuses on supporting initiatives on infrastructure at European and national scale. Hereby several kinds of R&D projects can be found all over Europe. In particular the EC is undertaking or funding R&D projects all over Europe. Test sites to develop several kinds of charging infrastructure can be found in Sweden, France, Italy, Belgium, Germany and Spain.

Furthermore to reduce CO_2 emissions, the flagship initiative "Resource efficient Europe", aims at electric engines. Moreover a unified standardization of charging technologies for EVs shall be developed and promoted. This initiative foresees the national governments as executers who can ask for financial support from the European Investment bank (BEM 2015).

In line with the 7th European Research Framework (part of Europe 2020) overall funds of EUR 54 billion were available between 2007 and 2013. These funds are divided into five specific programs whereof e-mobility can hope for funding out of the subgroups Traffic, Energy, Environment and ICT as well as Nanotechnologies, Advanced Materials, Advanced Manufacturing and Processing. For these subgroups funding of EUR 21 billion are available.

In 2014, the 7th European Research Framework was replaced by the "Horizon 2020" framework. *"Horizon 2020 is the biggest EU Research and Innovation program ever with nearly EUR 80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market"* (europa.eu 2015). The overall promotional volume amounts to EUR 87 billion and aims at merging and standardizing research and technology all over Europe. Horizon 2020 is separated into three core elements. Especially the third element offers EUR 31.7 billion for research on decisive future questions like the need for a clean and efficient energy supply followed by the issue of environmental friendly traffic and transport systems, which is of high relevance for e-mobility. Especially the aspect of merging and standardizing of charging and IT infrastructure technology is of great importance. On the one hand, this is a key service, eCo-FEV could provide. On the other hand eCo-FEV's success depends on its attractiveness, which is correlated to the cooperation of all the stakeholders involved. All involved stakeholder are analysed in chapter 5.2.2. But for now we should keep in mind, that some of them are direct competitors, which might affect their extent of cooperation.

Excursus: ZeEUS, the Zero Emission Urban Bus System

In October 2014, the International Association of Public Transport (UITP)-coordinated Zero Emission Urban Bus System (ZeEUS) project launched its first charging demonstration in Barcelona, Spain. Local operator Transports Metropolitans de Barcelona is trialing four fully electric vehicles.

In June 2015 Polish company Solaris will deliver two buses that will charge opportunistically along the route, using a retractable roof-mounted pantograph to reach overhead cabling. Among other participating cities, Cagliari (Italy), Glasgow (UK), London (UK), Münster (Germany), Plzen (Czech Republic), and Stockholm (Sweden) will all trial opportunity charging. Co funded by the EC Directorate-General for Mobility and Transport with a budget of EUR 22.5 million, the project aims to demonstrate solutions for a range of urban bus networks.

Potential Business Model

version 1.0

Country	Subsidies/Incentives on EVs	Policy Supporting Initiatives on Infrastructure	Policy Development Goals	Non residential charging points installed 2013
Norway	• EVs are exempt from all fees and annual taxes plus 25 % VAT. Price of EV and ICE shall be comparable e.g. Nissan Leaf (EUR 37,000) vs. VW Golf (EUR 36,800) • Overall subsidy volume of EUR 60,000- EUR 70,000/EV	• EUR 1,200 as a subsidy if you put up a EV charging station in Oslo • Member of E-Mobility NSR	• Reduce CO_2 emissions from new cars to 85g/km by 2020 • In 2020 around 2 %of private cars shall be replaced by Electric vehicles	. Slow charger: ~ 1,300 . Fast charger: ~ 87
France	• Eco Bonus of 20 %of purchase price up to EUR 6,300 max. • French government is offering exemption from TVS (annual tax) on company cars.	• EUR 50 million to cover 50 %of EV charging infrastructure(cost of equipment and installation) • Local administrations are involved in EV infrastructure projects and stimulating sales by increasing the EV share of their fleets and initiating car-sharing projects	• 100.000 EVs purchased by government until 2015 • Overall EUR 10 billion investment in e-mobility (subsidies, R&D, incentives, credits)	. Slow charger: ~ 1,700 . Fast charger: ~ 100
Germany	• EVs are exempt from annual tax circulation (about EUR 28/a)	• Four regions nominated as showcase regions for BEVs and PHEVs • German government supports R&D activities for inductive and quick charging technologies and encourages local authorities to establish charging infrastructure • However, build-up of charging stations seen as task of private economy • Member of E-Mobility NSR	• 1 Million EVs until 2020	. Slow charger: ~ 2,800 . Fast charger: ~ 50
Netherlands	• Exemption of taxes and fees • EUR 5,324 for private/EUR 19,000 for corporate owners	• The Netherlands currently has roughly 1.1 charging stations per vehicle, the most EVSE per capita worldwide • Government introduced tax incentives to support creation of charging infrastructure	• 1 Million EVs until 2025 • In Amsterdam EV coverage almost 100% in 2040	. Slow charger: ~ 6,000 . Fast charger: ~ 120
UK	• 25 %grant on a new EV up to approx...EUR 6,800 max. • up to EUR 10,700 for vans	• EUR ~44 million for charging points for residential, street, railway, and public sector locations (available until 2015, plans to install 13,500 domestic and 1,500 on-street points)	• London (Target 100.000 EV's, 25.000 loading stations till 2015)	. Slow charger: ~ 3,000 . Fast charger: ~ 150
Portugal	• EVs are fully exempt from all taxes • Incentive of EUR 5000 for the first 5000 EVs and EUR 1500 if an old car is turned in for a new EV	• Subsidy of EUR 5,000 for the first 5,000 new electric cars sold in the country • EUR 1,500 incentive if the consumer turn in a used car as part of the down payment for the new electric car	• n/a	. Slow charger: ~ 1,000 . Fast charger: ~ 70
Spain	• Direct subsidy on 25 %of the purchase price of new EVs up to a max of EUR 6000	• Public incentives for a pilot demonstration project. Incentives for charging infrastructure in cooperation between national and regional government • Movele program (2008-2011, investments EUR ~10 million) targeted ramp up of infrastructure and dispersion of EVs in Barcelona, Madrid, and Seville	• Spain's national government sets the goal of putting 343,510 charging points throughout Spain until 2015	. Slow charger: ~ 800 . Fast charger: ~ 20
Italy	• Exempt from annual circulation tax	• Only small development programs on regional scale	• National plan for e-mobility is required	. Slow charger: ~ 400[2] . Fast charger: ~ n/a
Denmark	• Direct subsidy on purchase price up to EUR 17,000 max. (exemption of VAT 25%, and administration tax)	• EUR ~10 million for development of charging infrastructure	• As sub-supplier Denmark's growth potential includes: Smart Grid, V2G technology, Charging Infrastructure , ICT Solutions, Design Solutions, Operating systems for batteries	. Slow charger: ~ 3,800 . Fast charger: ~ 150
Sweden	• Bonus of EUR 4,180 per new EV • Tax exemption for the first 5 years	• Until 2015 about EUR 35 million for RD&D (EV, charging infrastructure) • Member of E-Mobility NSR	• n/a	. Slow charger: ~ 1,000 . Fast charger: ~ 20
Ireland	• Bonus of EUR 5,000 on a new EV	• 2010 scheme to deploy 1,500 electrical recharging stations for EVs and 30 high voltage fast charging stations providing a high speed recharge facility every 60 km on interurban routes. Free electricity at these stations initially	• targeted objective is to have 250,000 EV and 25,000 public charging points by 2020	. Slow charger: ~ 700 . Fast charger: ~ 50

Source McKinsey&Company 2014, gtai.de, europa.eu, IEA 2013.

E-mobility supporting initiatives - Summary

The issue of e-mobility supporting initiatives is rather complex. Regarding the variety in terms of types of supporting initiatives as well as in terms of financial extension, the range differs a lot. The top five countries in table above are the countries with the highest growth rates considering EV sales rates. All of them but Germany show significant supporting initiatives on both infrastructure and EV purchase price. Hence supporting initiatives are an appropriate tool to support e-mobility.

Being one of the third biggest automotive producing countries worldwide Germany represents a special case with according structural implications. In 2014 about 775,000 people were employed in the automotive industry which reached a total sales volume of EUR 367.9 billion (statista 2015). These numbers and the fact that every seventh job is related to this industry imply the special meaning and thereby power the automotive industry in Germany has. Hence development in this country needs to be seen different to the other countries.

Summarizing it could be stated that either a wide range of supporting initiatives need to be implemented or a tremendous automotive industry needs to exist in a country to promote e-mobility. Whereby direct interrelations between aspects discussed above are much more complex and interdependent as it can be elaborated in this work.

3.6. The Customer

3.6.1. Customer segmentation

Since e-mobility still struggles with a number of issues that are hindering its acceptance, the uptake appears to be restricted to specific customer segments in selected countries in Europe. Early adoption started off in 2013 and seems set for further expansion. Today, the major restrictions to the mass adoption of EVs are high initial investment, range anxiety, low awareness and insufficient, not standardized infrastructure.

Studies indicate that European EV customers are homogenous in concerning their socio-demographic data. According to a survey among owners of FEVs and PHEVs in Germany conducted by DLR institute, the following user profile can be roughly transferred to other countries. It can be assumed that there will only be slightly differences (Frenzel et al. 2015):

- Predominantly male
- ø age 51 years
- 2-4 person households
- 51% university degree, high income

- 53% households live in detached house
- 40% live in towns with less than 20,000 inhabitants

Furthermore, there are several motivational characteristics that define early adopters in the field of e-mobility both as individuals and in the business context (Hodam et al. 2012).

Cost motivated individuals

- *Ecologically-oriented people (image motivated):*
  They accept higher costs related with ecological aspects. Value-added services, like green route navigation, charging spot finder and reservations are also highly appreciated and necessary.
- *Technologically-oriented people*

Image motivated individuals

- *Commuters* (no need of charging during their travel to work and back home → distance to work < 50km)
- *Second car owners*

Cost- and image-motivated businesses/companies

- *Car sharing companies*
  Charging infrastructure at dedicated car sharing parking sites
- *Taxi companies*
  Charging infrastructure at dedicated sites or taxi ranks, charging also via inductive charging
- *Company cars*
  Charging infrastructure at the company site, small need of public charging due to business travel within a city
- *Transport fleets*
  Charging infrastructure at dedicated company sites, no need for public charging

The following table offers an additional overview and classification of other attributes.

Table 5: Overview and classification of customer segments (Hodam et al. 2012)

USAGE FACTOR	Image Benefit	High mileage per year	Short distances	Convenient charging facility
RATIONALE	Intangible benefit	Higher invest is compensated by low energy cost per km	No need for charging infrastructure along the traveled route	Easy access to user-friendly charging facility as prerequisite
COMMUTERS	o	+	+	+
ECOLOGICAL ORIENTED PEOPLE	+	o	o	o
2ND CAR OWNERS	o	o	+	+
TECHNOLOGICAL ORIENTED PEOPLE	+	o	o	o
CAR SHARING COMPANIES	+	+	+	o
TAXI COMPANIES	+	+	+	+
COMPANIES CARS	+	+	+/o	+
TRANSPORT FLEETS	+	+	+/o	o

When it comes to the relevance of motives influencing the decision of buying an EV the DLR study came to an interesting result. Intrinsic motivation such as enjoy driving with electric engine or interest in innovative vehicle technology has been rated as most important while extrinsic motivation, especially political incentives such as free charging infrastructure, vehicle tax remission or free parking hardly played any role in the purchase decision.

3.6.2. EV driving behaviour

The EV driving behaviour seems to be predominantly influenced by battery status and related range anxiety and thus, EV user would drive less than their average mileage with a conventional ICE. However – contrary to expectations - “Nissan reveals that European owners of its 100 %electric car, the Nissan LEAF, travel more than 50 % further per year (16588 km) than the European average for a traditional internal combustion-powered vehicle (10816 km)," (automotiveworld.com). This helps to clear up the myth that electric cars are inadequate for the average driver, and that electric car drivers don't drive very much. Spanish Nissan Leaf drivers top the list covering on average more than 367km each week, Swedish drivers come second (340 km) and the UK third with 323km. With regard to the driven mileage, Nissan LEAF drivers seem to represent the European average EV driver. In Green eMotion project within the scope of research on driver behaviour and user acceptance it was observed that the average driven mileage with an EV per week during private use is 240km which is just a little lower than the average distance driven in Germany.

The following figures show that the average mileage per week driven with the LEAF in Europe (319 km) is even higher than the average mileage driven by petrol and diesel drivers (208 km).

Table 6: Nissan Leaf (based on automotiveworld.com)

Country	Total km Recorded per Week (LEAF)	Total km Recorded per Annum (LEAF)
Spain	367	19084
Sweden	340	17629
UK	323	16847
Norway	317	16483
Italy	306	15859
France	303	15756
Germany	278	14507

It seems to be surprising that EV driving behaviour differs significantly when looking at the driven mileage per day. Studies presumed that due to range anxiety EV drivers would drive fewer miles compared to the traditional car. Nissan director of electric vehicles got the answer on these observations directly from his customers who frequently tell that they buy the Nissan LEAF as a second car, but end up using it far more than their other vehicle. This gives a rough idea of how different the expected driving behaviour is compared to the actual behaviour.

The insight about this mismatch of expected and actual driving mileage can also be applied on charging behaviour analysed in the following chapter.

3.6.3. Charging behaviour

When it comes to charging infrastructure and its deployment it is necessary to analyse the charging behaviour of EV drivers.

Charging locations can be divided into three categories:

- Public charging, i.e. Street sides, highways
- Semi-public charging, i.e. Parking house, shopping centre, working place
- Private charging, i.e. Household

It is a fact, that more than 90 % of the time, vehicles are usually parked at home or work (IEA 2013). This fact leads to the question of the most efficient charging infrastructure deployment strategy. It can be assumed that EVSE should better be deployed where cars are most often parked in order to fully charge the EV while the vehicle owner is busy working or being at home (overnight charging). Reality shows that the actual charging point location in Europe does not respond to the driving behaviour. According to the Green eMotion project, where in eight European countries during three years a fleet of EVs and e set of charging points have been monitored, the ratio of installed and used charging points in Europe is shown in the following figure:

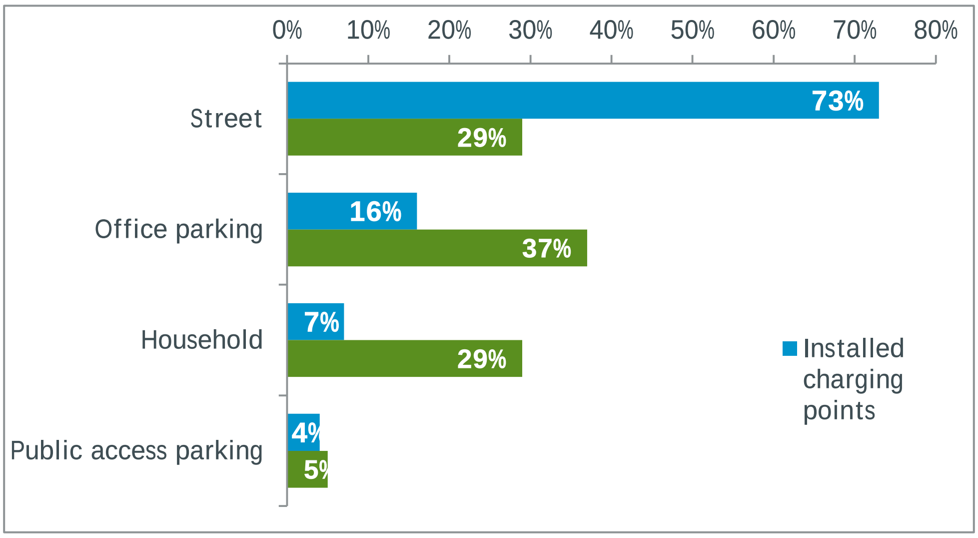


Figure 20: Charging point deployment and uses (Green eMotion 2012)

The above figure shows that the current ratio of installed and used charging points is very unbalanced. Street charging points that are the most spread charging points in Europe show the most under-utilized infrastructure. One reason for the high domination of street side charging points could be the existing range anxiety of EV owners. There are several studies that analyses the expectations (potential) EV owners have towards an EV. One of the most persistent concerns is related to range anxiety. However, the monitoring of the EV driving behaviour showed that less than 2 % of the trips end with a battery state of charge lower than 20% (Green eMotion 2012). In conclusion it can be said that there is a mismatch of used and desired charging facilities that can be considered as one major question: Who would invest in EVSE with the main purpose to lower range anxiety?

To give a short summary of EV driving and charging behaviour, there is still high uncertainty concerning the actual behaviour. It is human nature that changes in behaviour lead to uncertainty. This phenomenon can also be transferred to the changes in behaviour that e-mobility evokes. Current EV usage shows that range anxiety seems to be one of the most overrated concerns non-EV drivers have.

3.6.4. User acceptance

In the previous chapters we have learned that European countries have anticipated the requirements that have to be put in place in order to lead FEVs towards a mass market. One issue that is still not fully determined yet is about drivers that influence user acceptance. One mission that is defined in eCo-FEV project is achieving a breakthrough in FEV introduction. In order to reach this goal the most important prerequisite is to understand the potential FEV buyer.

Of course, FEV travellers require a FEV specific infrastructure to satisfy their needs of charging for example. There are Europe-wide activities going on to offer a dense network of public charging stations on the one side and public authorities are supporting the FEV deployment by introducing incentive systems to the FEV buyer. But in spite of all these efforts there is still a widespread reluctance to accept FEV. That is why all these activities are ineffective as long as they don't meet the potential FEV buyer's needs.

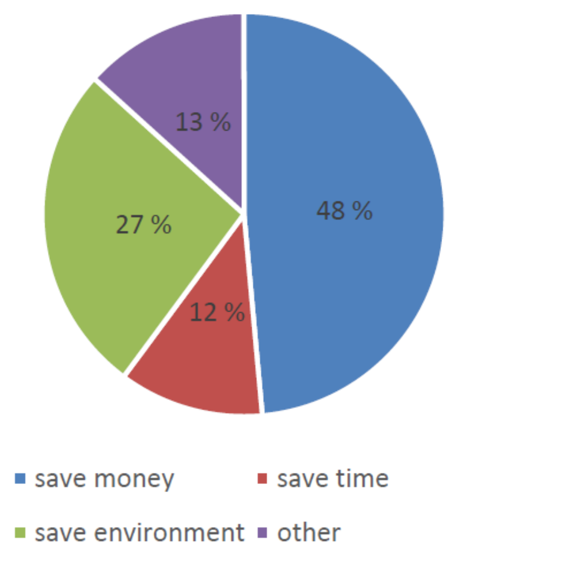


Figure 21: Most important reason for choosing an electric car (Haugneland 2014)

Norway, having the highest number of electric vehicles per capita worldwide, has a role model function in Europe. In 2014 over 35 % of total EV sales in Western Europe was generated in Norway. What makes this figure so exceptional is the fact that unlike many other countries, the vast majority of EVs sold in Norway is fully electric, not plugin hybrids. Norway is also exceptional in the field of e-mobility when it comes to subsidies. Moreover, as shown in the following Figure 21 the survey shows that economy is the most important reason for choosing an EV.

Still, it plays a major role what kind of subsidy is offered to the EV user. Incentives that influence the purchase costs of an EV are rated as far more important than incentives on running costs (Haugneland 2014).

One more influence factor on user acceptance is general reluctance towards novel mobility concepts in urban environment as described in Ziefle et al. 2014. Compared to the American culture, for instance, European culture is mainly characterised by safety-mindedness. Americans adopt new technologies much faster and raise credits more often than European citizens do. This risk aversion can especially lead to low willingness of citizens to tolerate risks as well as uncertainties in how far a new technology brings an added value compared to the existing technology. This mind-set is not only typical for consumers but also for the business sector. While Europe was discussing about how to install a widespread network of charging facilities, at the same time the American company Tesla was the first who started to equip American and European streets with a dense network of Tesla superchargers. Never did Tesla seem to have any doubts concerning the usefulness of this strategy. European companies seemed to wait for a company like Tesla who takes the first step with all related risks and to learn from possible mistakes. The missing risk aversion of European citizen more and more leads to scrutinising a new technology with all its benefits and barriers. Together with the increasing diffusion of modern technology with a diversely skilled user group this risk to avoid attitude even seems to have increased in recent years (Ziefle et al. 2014).

When it comes to owning a car, citizens value the huge potential of having a car, directly associated with the feeling of independence and universal access, which has a profound tradition in history.

In conclusion it can be stated that on the one hand for electric mobility there is yet not sufficient knowledge about perceived benefits and barriers and on the other hand some governments in Europe such as Germany have to focus on supportive incentives that subsidise the purchase price rather than incentives affecting the actual usage of the EV.

The Customer - Summary

It can be assumed that user acceptance - among early adopters – will only increase if driving and charging an electric car becomes as convenient and simple as a traditional car. The main challenge behind that issue is due to the stakeholders that need to be integrated into the e-mobility value chain. These stakeholder groups range from OEMs, IT services, energy and infrastructure providers. They are all willing to contribute to the e-mobility development but they are all struggling with the underlying complexity due to diverging interests and perspectives that are needed to be aligned in order to present an appropriate level of simplicity to users.

eCo-FEV can play an important role in controlling the mentioned complexity by providing a cooperative platform.

3.7. SWOT – the E-Mobility market

STRENGTHS

- Energy efficiency and no local air pollution
- Reduced noise pollution
- Positive driving experience
- Lower vehicle maintenance costs
- Positive sustainable image for EV drivers
- Low operation costs
- Growing number of e-Roaming initiatives makes charging easier

OPPORTUNITIES

- Smart grid Integration (Increases the uptake of renewable energy)
- Sustainable energy sources and low emissions in right energy mix
- EVs in public transport, freight delivery and car sharing
- Low CO_2 emissions with the right energy mix
- Independence of energy resources (except production)
- Range extension of 300 km max. Thanks to next generation of batteries
- Battery costs are about to decrease
- Increasing cooperation of stakeholders leads to advantages for customers
- Intermodal solutions and awareness of mobility needs
- Use of existing energy structure
- New employments and new business opportunities
- Incentives for a better TCO
- Enabling synergies with technological developments in the field of connected cars, internet of things, smart cities/homes, telematics and smart grid

WEAKNESSES

- Dualism of high initial costs and limited range
- Highly fragmented market of charging providers
- Mismatch between expected/desired charging coverage and actual needs respectively actual charging behaviour → low profitability of public charging stations
- Mismatch between expected/desired range limits and actual mobility behaviour/needs
- High diversity in technological and ICT-solutions → no interoperability
- Missing laws and regulations for data security, data privacy and data ownership
- National supporting initiatives differ a lot
- Some supporting initiatives on EV operating costs failed
- No consistent standards for charging plugs in Europe, especially fast charging

THREATS

- Low EV sales rates due to high costs and limited range
- Lack of interoperability slows down e-mobility development
- EVs charged with grey energy causes higher energy demand of non renewable energy
- Missing ICT and technological regulations and standards lead to interoperability
- Attractiveness of EVs partially depending on volatile oil price level
- Communication and opposing interests on political scale delay e-mobility's success
- Missing solutions for data issues are a threat for potential EV users
- (Perceived) mismatches hinder customers of buying EVs
- Conservative character of especially German but also European OEMs slow down e-mobility in Europe
- Missing cooperativeness of OEMs
- High amount of e-mobility service providers tend to confuse the consumer
- Demarcation of different stakeholders becomes complicated for the customer e.g. due to transitions of OEM to e-mobility provider like BMW

4. eCo-FEV

4.1. Introduction

The eCo-FEV project aims at achieving a breakthrough in FEV introduction by proposing a general architecture for integration of FEV into the different infrastructure systems cooperating with each other – thus allowing precise EV telematics services and charging management service based on real time information.

FEV users want to rely upon their vehicles. Where is the next available charging spot? Is there any traffic congestion, which will prolong my travel time? Battery information, real time traffic news, charging opportunities — all FEV-related information have to be merged by one platform giving FEV users the possibility and enough time to react.

That is why, eCo-FEV´s integrated IT platform architecture focuses on the cooperation of FEV-related infrastructure systems plus the intelligent and effective use of advanced telematics services.

However, the proposed general architecture is seen very differently by the various stakeholder groups. The most decisive aspect is about the grade of centralization. Initially eCo-FEV was regarded as a platform providing a bundle of services to the actors of e-mobility as seen in Figure 22.

Figure 22: eCo-FEV ecosystem

If only mobility services would be considered by eCo-FEV it would be rather simple to establish such a platform just as other platform operators already do.

The fact that eCo-FEV considers the data generated inside the vehicle through connectivity the platform architecture becomes more complex. Vehicle generated data becomes more and more relevant for car manufacturers, especially in the context of after sales services. Vehicle specific data plays an increasing role for customer relationship management especially in the area of after sales service. It enables the OEM to stay connected with each vehicle that is sold. The high value of vehicle data leads to the fact that OEMs prefer offering specific standards that vehicles are communicating with.

Figure 23: Real time information through connectivity but isolated standards (Vogt, A. 2015)

Figure 23 shows the effect of isolated standards on the idea of connectivity. Only vehicles by one manufacturer are in communication with each other. Security related functions for instance do not work as reliable as they would if there were a homogeneous standard.

eCo-FEV strives for a comprehensive integration by offering a cooperative platform bringing together not only secondary mobility service providers but also OEMs following a coopetition strategy.

4.2. Project overview

The limited range of the FEV is a technical challenge to be met in order to ensure a safe and efficient introduction of FEV in overall traffic flow and at the same time the user acceptance by providing a sufficient degree of service continuity and user comfort during the whole trip. Such requirements cannot be satisfied without the strong support from the infrastructure. Currently, different infrastructure has been defined and deployed in the EU for FEV services. Among many, the most relevant infrastructures are road IT infrastructure that provide road traffic information to road users; EV backend infrastructure that provides EV driving support services; and charging infrastructure that provides FEV battery charging services. However, these infrastructures are rarely cooperating with each other. According to the eCo-FEV consortium an efficient cooperation between different infrastructures will further improve the service quality and reliability for the FEV users.

4.3. Objectives and key benefits

The eCo-FEV project aims at achieving a breakthrough in FEV introduction by proposing a general architecture for integration of FEV into the different infrastructure systems cooperating with each other – thus allowing precise EV telematics services and charging management service based on real time information.

The general concept of eCo-FEV is based on the development of innovate next generation E-mobility infrastructure by mutual system cooperation among FEV and independent FEV-related infrastructures being networked. This concept is illustrated in Figure 24. The cooperative e-mobility infrastructure enables the information exchanges between independent infrastructure systems.

The proposed architecture is flexible and modulate, being able to accommodate different infrastructure systems, satisfy local requirements at the implementation site and enable additional services, facilitating the exploitation potential of the system.

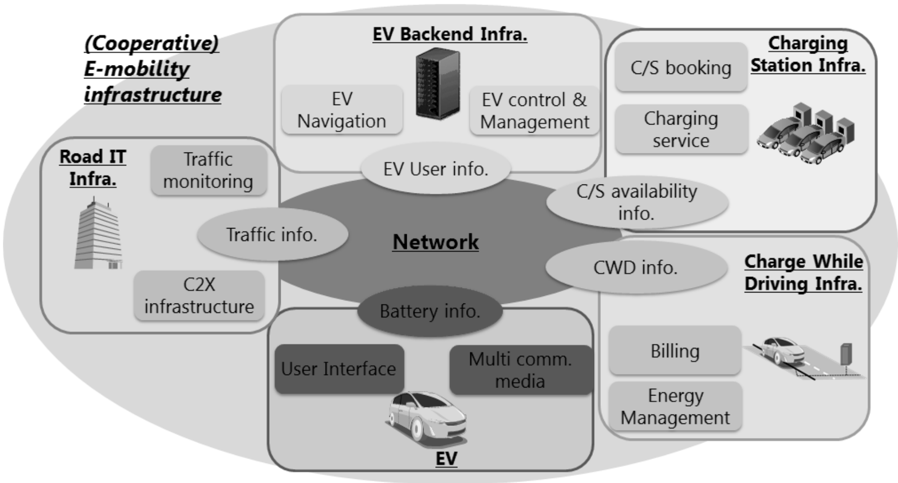


Figure 24: eCo-FEV basic concept (Vogt 2015)

Within the scope of eCo-FEV, the systems being considered are:

- **Road IT Infrastructure** provides road traffic status and road event information for infrastructure systems in order to be able to take real time road traffic information into account in eCo-FEV use cases
- **EV backend infrastructure** provides EV user booking request and telematics services information to other systems
- **Charging station infrastructure** provides real time C/S availability information for the real time C/S booking use case.
- **Charge while driving infrastructure** provides an additional charging mode integrated in flexible designed eCo-FEV architecture

FEVs provide its geographical position, and its battery status information to the backend infrastructure. They also provide road traffic information to OT road infrastructure in cooperative systems. This requires the communication between FEV and the infrastructure systems.

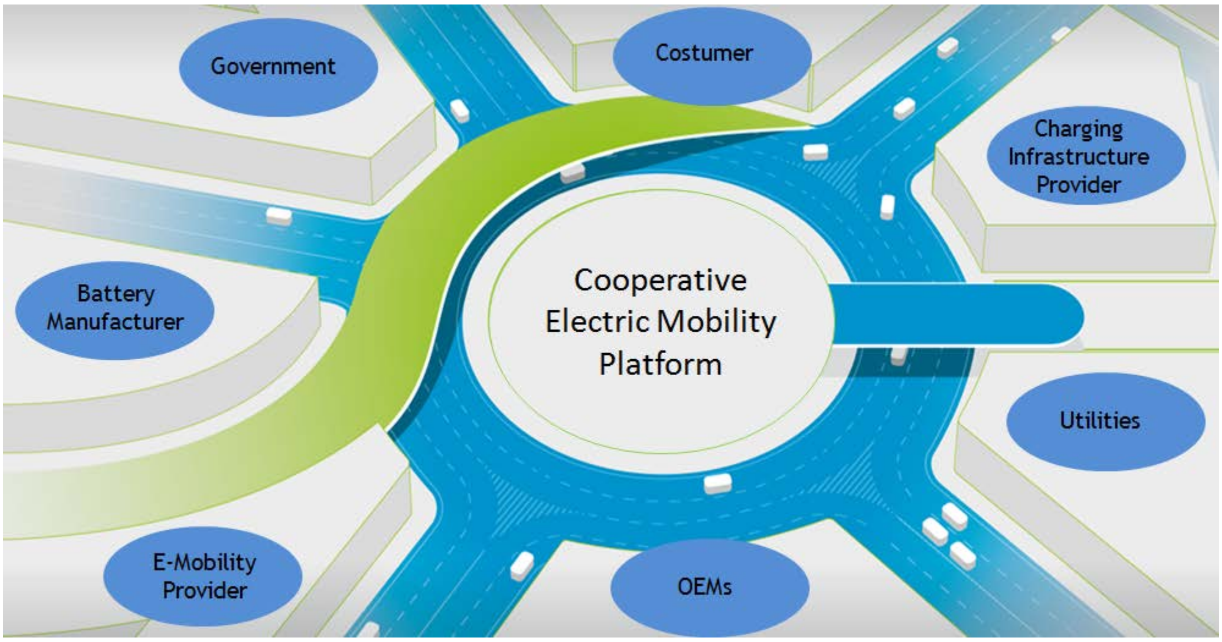


Figure 25: eCo-FEV Stakeholder

Application areas - overview and evaluation

For a proper evaluation of the business potential of eCo-FEV it is necessary to analyse the services and the added value that can be offered by the platform.

Differently from the core idea of eCo-FEV a special focus is put on secondary commercial services enabled by the platform. The commercial services cover a broad range of application areas that generate their added value for e-mobility based on different features. Moreover, all of the chosen application areas are prospectively suitable for refinancing the core idea of eCo-FEV – establishing and operating a cooperative platform in Europe.

The following application areas are derived from both the eCo-FEV use case description and from stakeholder interviews. Some of the application areas are limited to the usage of FEVs others can provide an added value also for conventional vehicles.

The following table shows an exemplary evaluation of the commercial services. It will be applied to summarize the evaluation of the application areas in an easily accessible form. The respective ratings can be understood as a qualitative evaluation based on the stakeholder interviews and secondary research.

Criteria	Description		Scale
Relevance for e-mobility	Describes the relevance of the application area for the automotive industry in general		Main topic for e-mobility
			Important topic for e-mobility
			Side topic for e-mobility
			No influence on e-mobility
Overall commercial potential	Describes the revenue potential behind the application across all involved stakeholders		High potential
			Medium potential
			Only niche potential
			No commercial potential at all

Added value by eCo-FEV	Describes to which extent eCo-FEV is contributing additional value to existing technologies		Core value, can only be provided by eCo-FEV
			eCo-FEV is not necessary but provides significant added value
			eCo-FEV provides incremental added value
			No added value by eCo-FEV
Relevance as Day 1 application	Describes to which extent the application is relevant in a short term perspective after introduction of eCo-FEV		High relevance
			Medium relevance
			Only low relevance
			Not relevance at all

Multimodal travel

Multimodal means considering various means of public and private transportation when planning a route from A to B. Multimodality is gaining recognition as one potential strategy for reducing automobile reliance and therefore decreasing traffic volume as well as increasing the efficiency and sustainability of transportation systems. In eCo-FEV multimodality is considered as one important application area because it provides opportunities for FEV travellers to change transport modes while charging the vehicle, for example.

Exemplary functionality:

- Considering favoured transportation modes when being routed from A to B
- Paying for each mode via eCo-FEV (taxi bill, bus ticket, car sharing, etc.)
- Choosing the fastest, the cheapest, or the most ecological route

There is an increasing need for a demand-oriented transport system in Europe. Public transport can hardly substitute the comfort of a privately owned car, especially in rural areas. Therefore, fostering multimodality means optimizing transport as a whole, which comes along with an integration of all available modes including public transport and cars. eCo-FEV strives to make both complements rather than substitutes by integrating all modes of transport on one platform. Data collected by the eCo-FEV system helps to provide detailed and accurate travel time information, which in turn helps to optimize intermodal trips as it becomes more attractive, e.g. to switch from car to another mode on a determined travel distance. Especially urban mobility can benefit from immense optimization effects if public transport and individual transport is effectively linked.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

Charging Management

One of the main goals in the future of e-mobility will be the reduction of complexity when it comes to the charging network in Europe. As described in the previous chapter eCo-FEV can contribute to this goal to a large extent. The integration of charging networks and the connection to the charging backend systems is one of the most important application areas within eCo-FEV. In the scope of the project charging management means the localization, booking, identification, and finally the payment of charged energy.

Exemplary functionality:

- As long as charging station operators offer contracts to the FEV user, eCo-FEV can offer the service to display only those charging stations that are part of the contract.
- If the charging station is able to communicate with the FEVs OBU, the user will be identified automatically
- Automatic payment through wireless communication between FEV and charging station
- Offering charging stations depending on route planning

VISA is already working on connected car commerce services. Visa Checkout, the online payment service that lets consumers make purchases with just a few clicks is integrated into the dash of a connected car.

By offering the entire network of available charging stations and by processing the payment procedure, the user can choose his preferred operator and also free accessible charging stations that don't require a contract. This option will probably have a high impact on the acceptance and usability of FEVs.

The added value by eCo-FEV will be the integration of other services like navigation or current weather conditions. With the big data approach eCo-FEV will be able to analyse all data that are related to the charging management and to provide exact information of charging behaviour, utilization of charging spots, and link this information with data about driving behaviour and other information.

Relevance as Day 1 application depends on the time it will take to integrate existing charging station operators and/or existing charging networks in the eCo-FEV platform. Market experts see a big challenge in this process due to the high amount of regional charging station operators with only a few charging stations in their portfolio.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

Fleet Management

Another target segment with special interest for eCo-FEV is fleet management. In eCo-FEV fleet management considers commercial fleets such as taxi companies, car sharing and car rental provider, and corporate fleet management. This application area is strongly related to the idea of multimodal travelling. In eCo-FEV fleet management companies can be regarded as service providers on the one hand and as customers on the other hand. Fleets can be equipped with eCo-FEV functions in order to offer the drivers access to the platform. In addition to that, commercial fleet management companies are able to integrate their services on the platform.

Exemplary functionality:

- Solution for corporate car sharing and enhancing the EV usability
- Car sharing and car rental companies can consider eCo-FEV as another distribution channel for their services and secondly offer eCo-FEV functionality in their fleet
- Fleet management companies obtain an overview of usage profiles and based on that, improve and optimize their services or the customer contact

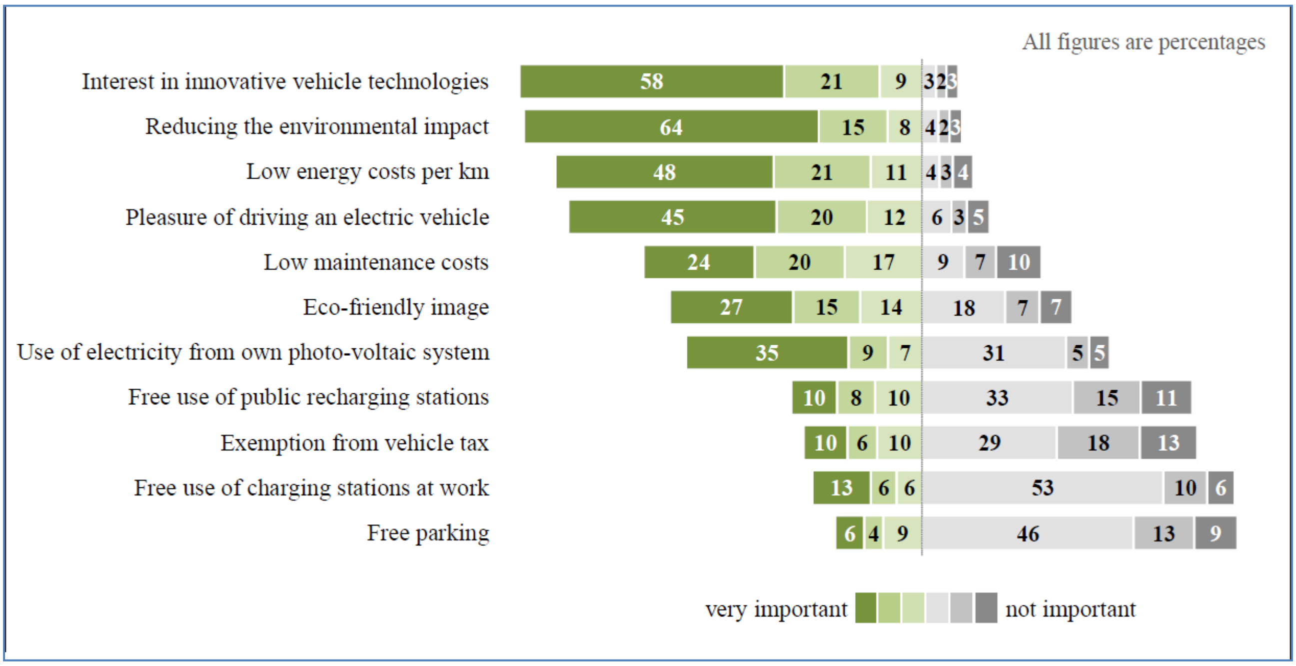


Figure 26: Motivational factors in buying EVs (Green eMotion 2015)

It is the overall stakeholders' opinion that all commercial services that offer potential FEV drivers the possibility to experience driving electric have a huge potential to raise acceptance towards electric vehicles. This opinion has been confirmed by a study conducted by the German DLR institute within Green eMotion project, as illustrated in Figure 26. It showed that the pleasure of driving an electric vehicle was one of the dominating motivational factors in buying an EV. This result shows that people should be given as many opportunities as possible to experience driving electric (Green eMotion 2015).

Due to this insight the relevance of fleet management services can have a high impact on e-mobility. One important commercial aspect can be seen in an improved brand image and therefore a competitive advantage.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

Route optimization

Navigation systems are increasingly used by car drivers to find the shortest, the fastest or the most ecological route to their destination. Unfortunately, the current navigation systems installed inside EVs do not take into account the battery status. One of the main functionalities of eCo-FEV is about the enhanced trip assistance that dynamically guides the EV driver during the trip until the destination taking into account real-time traffic and weather conditions, route preferences and battery status. The eCo-FEV system monitors the trip progress with regards to an individual travel plan. If unexpected situations are expected, also due to connectivity functions – the trip plan or charging plan may be dynamically adjusted.

Exemplary functionality:

- Providing guiding assistance for FEVs to drive to a charging facility
- Information about point of interests in the vicinity
- Considering only those charging facilities that are suitable for the FEV driver, depending on charging station operator, payment facilities, and charging mode.

Route optimization is said to be supportive for FEVs but still a niche application because the added value by eCo-FEV only appears when planning longer trips that exceed the disposable range. The average driving distance doesn't exceed the currently disposable range, though. Even though there are only few limitations to offer this application from day one, the impact on e-mobility is expected to be very low.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

Urban Delivery

The application area of urban delivery can be regarded as a B2B offering for logistic companies serving the last mile delivery. It combines route optimization with fleet management. Based on the daily delivery requirements, this application area provides assistance to define the daily delivery plan for goods delivery operators. The added value for the B2B customer is a system that on the one hand plans the most cost efficient route by taking into account the battery status. Logistic companies utilizing a zero-emission fleet, on the other hand, cut down fuel costs and create a forward-thinking and “green” image.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

Parking Management

With the increasing urbanisation and the increasing amount of motorized vehicles in urban areas the significance of parking space gains importance. Besides that, most people who are living in urban areas don’t have a private parking space to install a private charging station. By integrating information about available parking spots in combination with a reservation and paying option on the eCo-FEV platform one important barrier potential EV buyers have can be dismantled.

Criteria	
Relevance for e-mobility	
Overall commercial potential	
Added value by eCo-FEV	
Relevance as Day 1 application	

5. Business economics assessments

5.1. Introduction

With the background of a highly dynamic and - for the moment - unsecure electro mobility market, the willingness to invest in a cooperative platform like eCo-FEV mainly rise and fall with viable business models.

It is the goal of this chapter to provide a sound economic analysis and to suggest viable business models for the introduction of the eCo-FEV platform into the European e-mobility market. This will be done considering which prerequisites key actors and stakeholders have in order to participate in a cooperative service and information platform like eCo-FEV.

For the understanding of the business models it is necessary to give an overview over the specific business environment.

5.2. Business environment

5.2.1. Legislation & trends

5.2.1.1. Technical trends

Battery Development

A battery is the core part of an EV and the major cost driver at the same time. In fact, the user is paying a huge amount of fuel costs on purchase. Depending on the type of EV the costs of the battery can make up one third of the overall purchase price. The state-of-the-art standard for EV batteries is lithium-ion, which offers three times the energy density of traditional technologies used in hybrids. Energy density is the key to provide greater range for EVs. Traditional batteries such as nickel-metal hydride are generally cheaper, safer and easier to produce. Since batteries implemented in the EVs can only store electricity in DC and the energy provided by the grid is in AC, the electricity provided by the grid has to be converted before it can be stored in the battery. Those cars that are able to charge at an AC charging station are equipped with an AC-to-DC converter.

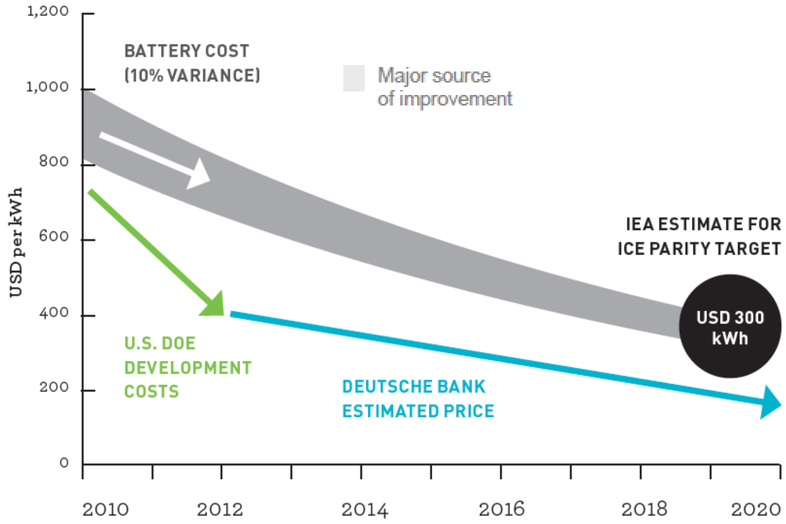


Figure 27: EV battery cost development through 2020 (IEA 2013)

Relevance for eCo-FEV	Battery technology development has a major impact on e-mobility. It influences costs and especially range limits of EVs and therefore user acceptance, willingness to pay, charging behaviour and driving behaviour of its consumers. A change in charging behaviour due to a higher range, the demand of charge supporting services might slightly decrease.

Smart Cities

In recent years the concept of smart cities gained significance, especially in the policy area. In particular the EU has devoted great efforts in the advancement of the cities in a smart way. Since 2007 the Vienna University of Technology team works on the issue of smart cities. In cooperation with different partners they developed the European Smart City Model. Following this model a Smart City is a city well performing in six characteristics: Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance. (Giffinger et al. 2007, europeansmartcities 3.0 2014)

Relevance for eCo-FEV	eCo-FEV is able to be incorporated into smart cities making mobility and transport in cities even smarter, reducing air- and noise pollution. Furthermore it can make transport and intermodal travelling more efficient

Autonomous driving

Autonomous technology permeates throughout nowadays society. This also affects the infrastructure. Prototypes of autonomous cars already exist. Cameras, sensors and high-performance computer units allow self-regulated steering, stabilization and navigation (Knight 2013). In addition, the future autonomous car would be highly probable to be also connected, and considers that vehicle to vehicle/infrastructure as additional sensor to sense the driving environment.

Relevance for eCo-FEV	The success of eCo-FEV relies to some extend on direct and fast communication and information exchange between cars and the related service providers. Thanks to autonomous cars deployment, infrastructure and surrounding vehicles are able to directly connect to each other. Therefore autonomous driving technology can be very useful for eCo-FEV.

Internet of Things

The predictable pathways of information are changing. The physical world itself is becoming a kind of information system. Nowadays, the main communication form on the Internet is human-to-human. While most data on the Internet are being produced and consumed by people (text, audio, video), it is foreseeable that soon any object will have a unique way of identification and can be addressed individually.

This leads to a revolutionary communication form with more and more information that is produced and consumed by machines, communicating between themselves to improve the quality of life. Some of these systems are already deployed, and some of them even work largely without human intervention (Chui 2010).

Relevance for eCo-FEV	eCo-FEV can be considered as one part of the internet of vehicles and will be taking one step forward by optimizing e-mobility processes which exceeds human intelligence. Moreover eCo-FEV needs to consider these new developments correlated to Internet of Things.

Connected cars

OEMs all over the world are currently developing, producing and marketing new (electric) vehicle features that enable the exchange of information with the internet via specific interfaces. There is a growing demand for e-mobility related information (battery status), commercial B2B services, and in-car infotainment (Bechmann 2011).

Relevance for eCo-FEV	Connectivity will provide a completely new environment for the automotive market by enabling innovative services but also innovative business models as they have been learnt in the context of internet based services. Thus, new opportunities will be available to generate revenues based on the use of eCo-FEV technology.

Smartphone Technology

The significance of smart phones all over the world has reached a level where living without it seems impossible, especially for the younger generation. By the end of 2014, 1.76 billion people were expected to own and use smart phones monthly, up more than 25% over 2013. More than 50% of the people in Europe's biggest countries will own a Smartphone in 2015 (emarketer.com 2015). The smart phone increasingly establishes as versatile instrument even affecting the automotive industry as it is progressively employed as navigation provider. Further on, payment customs change to flat rates instead of pay per-use concepts.

Relevance for eCo-FEV	With smart phones offering eCo-FEV functions fast increase of penetration rates can be achieved. Smartphone technology as part of connected vehicles also means a confrontation of immensely different lifecycles (ITC vs. automotive) that need to be considered by all involved stakeholders when services and hardware solutions are designed.

HMI and Usability

The significance of user interfaces has become increasingly clear over the last years. Apple's iPhone or iPod are examples of how appealing and intuitive user interfaces have become. The main difference between automotive HMIs and user interfaces of consumer electronics is the level of attention the user pays to the device.

The main objective of developing the automotive HMI of the future is to minimize the mental workload for the driver and to keep the increasing amount of information easily accessible, provide the right information just in the right moment by avoiding distraction as best as possible. Therefore prioritization of information will become more important the more information is being provided. Especially further development of driver assistant systems will present new challenges for the communication between driver and vehicle.

Relevance for eCo-FEV	E-mobility technology provides a lot of added information in terms of driving assistance that is supposed to make driving safer and more convenient. Thus, HMI solutions will be a key success factor for the user experience and also the acceptance of eCo-FEV services.

5.2.1.2. Market trends

Automotive market

Over the last decades, the automotive market has experienced major changes. The main drivers for this change are global competition, legislation and consumer demand.

Relevance for eCo-FEV	The growing amount of EVs in the streets will raise the demand for e-mobility services. This also has a significant effect on the way how cars will be sold in the near future. When the relevance of services will increase significantly in the future compared to selling hardware, also the economical relevance of eCo-FEV components and related services will increase and offer good opportunities to refinance the invest of the providers.

Big Data

Businesses of all sectors are entering a new era of computing that is customer-centric and fuelled by big data. It is characterized by an exponentially growth of data every day. There are 30 billion pieces of content shared on Facebook every month, the projected growth in global data generated per year is 40% and there is 60% potential increase in retailers' operating margins possible with big data. Companies all over the world capture trillions of bytes of information about customers, suppliers, and operations. Millions of networked sensors stored in devices such as mobile phones and automobiles generate positioning data (Manyika 2011).

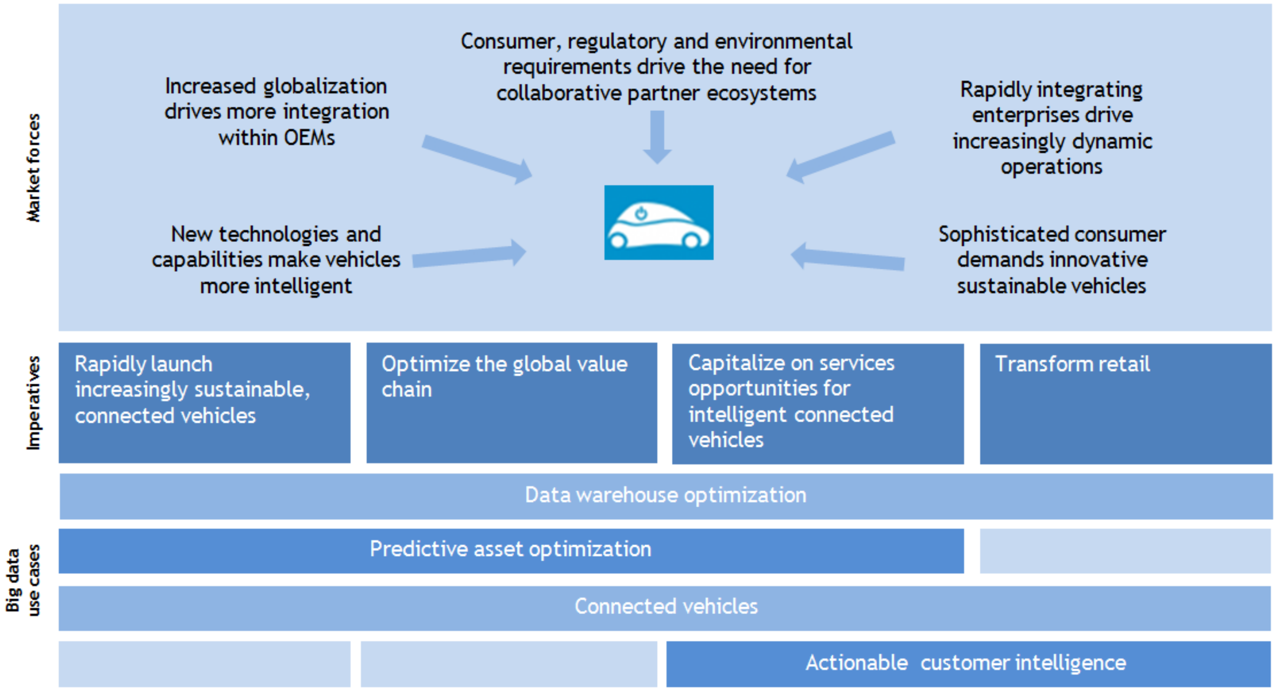


Figure 28: Big Data market framework (based on IBM 2013)

Relevance for eCo-FEV	Big data is considered as the most promising market in the future within the e-mobility ecosystem. Thanks to its unique position, eCo-FEV can be financed by big data related revenues

Telematics Market

While the mobile internet is one of the most relevant trends of the last years and internet connectivity based on mobile devices such as smart phones and tablets reflects the growing demand to access information anywhere at any time, cars remained mostly an exception, even though they have been equipped with high tech on board media centres for many years.

Experts believe that the improving technical opportunities will change this completely in the next years. The exchange of data and added services accessed via in-car internet will rise significantly in the next years. The most relevant areas of demand will be mobility-related information, commercial B2B services and in-car infotainment. OEMs are already starting to bring these new solutions to the market, starting with their medium and premium car segments (Bechmann 2011).

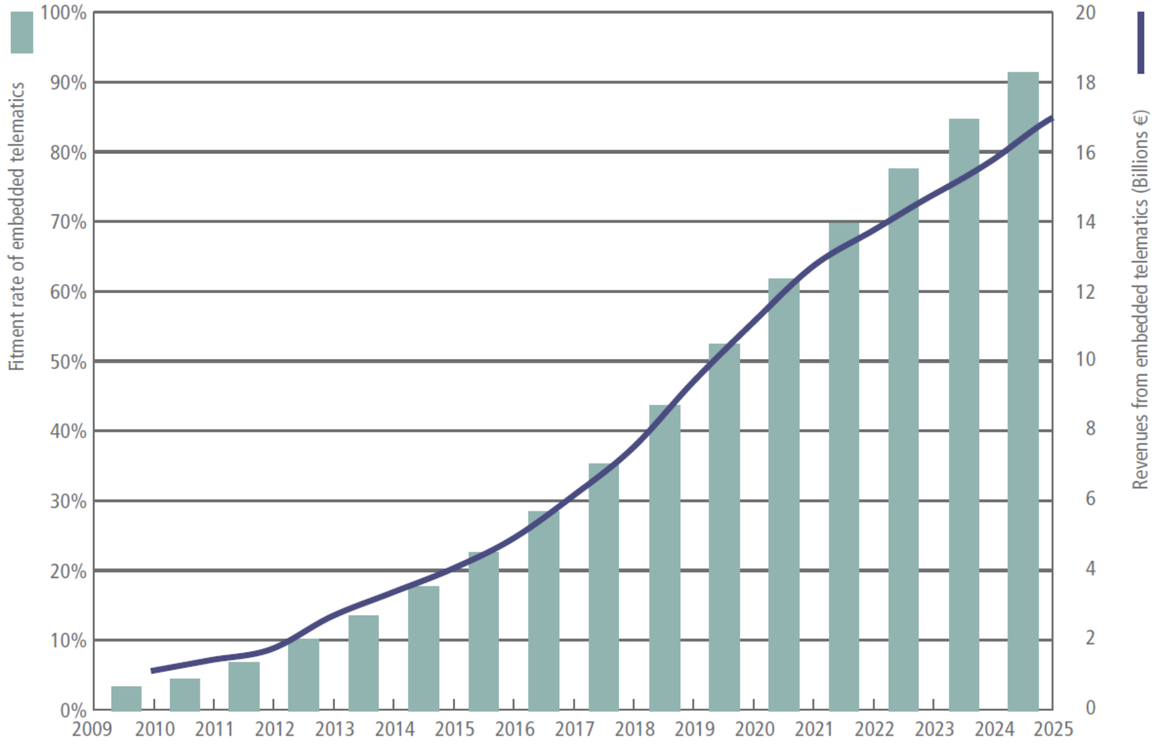


Figure 29: Forecast for Total Revenue Opportunities from Embedded Telematics (SBD 2010)

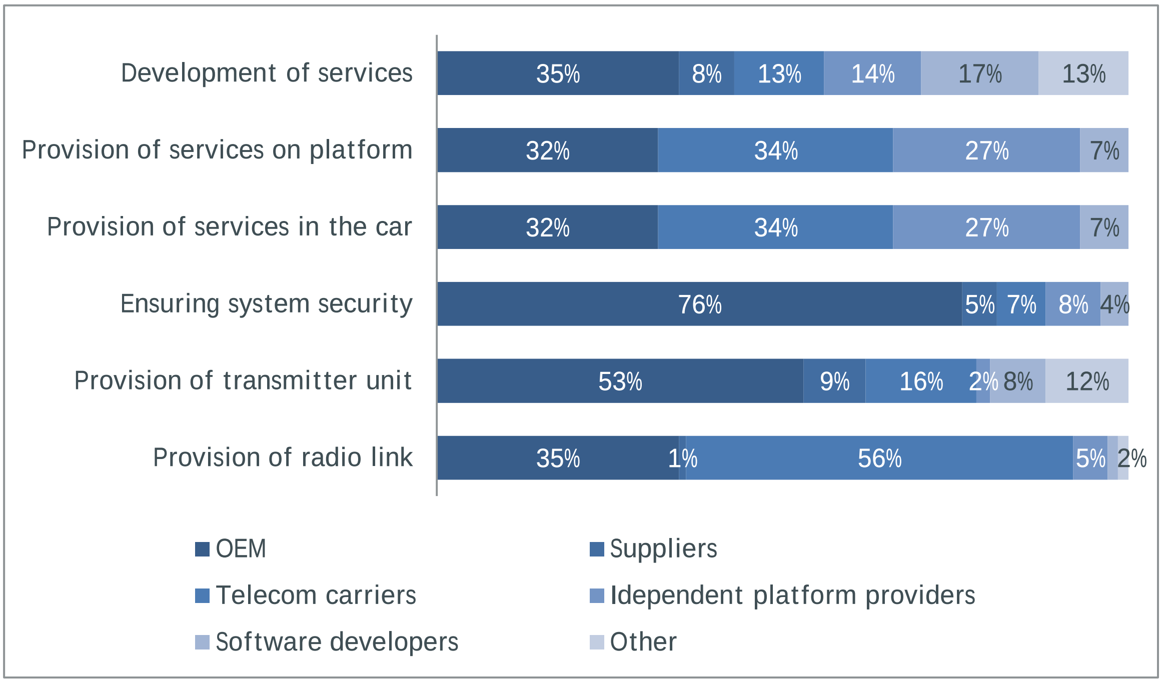


Figure 30: Service providers and expected share of revenues (Bechmann, 2011)

Relevance for eCo-FEV	All telematics data can be transmitted, used and exchanged via eCo-FEV. In a few years telematics services are expected to be the most relevant element for OEMs to differentiate their products and create extra value for the customer. This will also affect the way that customers evaluate eCo-FEV functions and influence their willingness to use and purchase.

Oil Price and Resource Scarcity

As stated by the FIA in 2012 the reduction in the cost of batteries, tax incentives and the increase of oil prices will be the driving factors towards a progressive transition to EVs. Back then they couldn`t anticipate the fall of the oil price in the near past. The last time the oil price reached a comparable level as today was the collapse of price caused by the financial crisis in 2007/2008.

In contrary to this short-term collapse caused by a financial crisis, the current oil price situation caused by worldwide rising output of oil and gas. One major player in this field is the U.S. who turned from an oil based fuel importer into an exporter. This turn can be led back mainly to a decreased energy demand since the financial crisis and to an efficiency increase at their refineries. But as stated before by Gernot Lobenberg from eMO, this can be seen as a short period of time because prices for oil and gas will rise eventually in medium and long term mostly as a consequence of worldwide rising demands for oil and gas.

Relevance for eCo-FEV	The oil price has a tremendous impact on the attractiveness of EVs. Following the expert's expectations, oil price will become a driver for e-mobility again in the next years. Additionally eCo-FEV can contribute to integrate FEVs into the smart grid which will support renewable energies and the EU goal for increased resource independency.

5.2.1.3. Societal trends

Data / privacy protection

Data protection becomes a major issue when considering vehicle connectivity. Concerns of data privacy as well as data security face all major innovations. The widespread loss of trust is unmistakable. Individuals are growing concerned that companies and governments are not protecting data about them and that they are instead using it in ways which are not necessarily in their best interests (World Economic Forum 2014).

Relevance for eCo-FEV	The societal fear of data misuse from customer as well as from business partner perspective can affect the introduction of a technology like eCo-FEV. Media coverage and recent scandals can have great impact on the acceptance of this technology. A clear data framework needs to be built up and data security needs to be assured. As mentioned before, the data issue is crucial to eCo-FEV.

Urbanisation

Already today every second person worldwide lives in a city. In Western Europe the urban population will increase to 80% by 2020. This bears varying challenges for the city management and development. The trend of a growing urbanization is imminent (Hofmann 2012). Air pollution, noise emergence and traffic collapses are major issues that come along with (uncontrolled) urbanisation. Hence, e-mobility is considered as one way to fight these problems in mega cities around the world. Although most mega cities facing these problems are primarily located in Asia, there are cities fighting such problems in Europe as well. In March 2014 Paris was facing tremendous air pollution comparable to cities like Beijing, Mexico City or Ulaanbaatar. Being renamed from "City of Light" to "City of Smog", the French government issued an alternating driving ban to deal with emergency levels of pollution.

Relevance for eCo-FEV	The increase of urban population will lead to a higher traffic density which will stress the issue of air pollution and noise emergence. This represents an important motivation to find solutions of intelligent and clean infrastructure that optimize traffic efficiency. With eCo-FEV all these issues can be addressed accordingly.

Networking society

Due to the spread of networked, digital information and communications, society is increasingly interlinked. Social networks and steady availability and exchange coin everyday life. Constant and diversified mobility possibilities are increasingly expected and demanded.

Relevance for eCo-FEV	eCo-FEV can be considered as most relevant platform for the EV sector. The overall existing attitude towards a connected society represents good initial conditions for a platform like eCo-FEV. Furthermore sharing EV related experiences via social media might further increase the attractiveness of EVs

Globalisation

Globalisation is one of the most influential emerging trends in the last decades. Even though mostly countries from outside of EU are affected by this trend, enabled by trade liberalization agreements and innovative developments in transport and communication, the indirect effects are also highly relevant for the EU countries. The strong economic development of many developing countries also implies further growth in transport. One important factor affecting the EU is migration (Shangquan 2000).

Relevance for eCo-FEV	This global network builds the world we live in. eCo-FEV fulfils the criteria's of an innovative technology which affects the scarcity of the world's fossil fuels. An increased demand for mobility will then positively influence the demand for a traffic optimization technology like eCo-FEV.

Multimodal travel

Multimodality has become an important key characteristic of a future sustainable transport system. Making transport cleaner, safer and more efficient, that is the European Commission's goal and turning transport to a seamless system across modes and countries. Taking a look at the transport system today, its challenges and characteristics, clear drivers can be identified that have the potential to increase the share of intermodal trips. At the same time, weaknesses are revealed, which require a stronger integration of all modes:

Relevance for eCo-FEV	New mobility patterns especially in urban areas raise the need for multimodal travel. eCo-FEV addresses these needs at 100 percent by offering multimodal travel throughout all means of travel

Sharing economy

In recent years, a transition from ownership towards accessibility can be observed across a wide variety of markets. In the conventional situation consumers would buy products and become the owners, whereas in an accessibility-based system consumers pay for temporary access-rights to a product. There are several macro-economic factors driving the growth of the sharing economy. One such factor is decreased consumer trust in the corporate world as a result of the financial and economic crisis. In addition, unemployment rates have risen and the purchasing power of consumers has dropped. Therefore people are in need of ways to earn or save money, which is why consumers are currently more receptive to peer-to-peer business models centred on consumer needs both as a potential supplier and buyer. Furthermore, the required technology for hosting an online peer-to-peer market has, in recent years, become available at more reasonable cost. As a result, the potential of the sharing economy is significant, with annual growth exceeding 25 percent. Two trends can be observed in the evolution of this rental-like economy.

Relevance for eCo-FEV	As being an economy sector with 25 percent annual growth, the sharing economy will have significant impact on people's mobility behaviour and therefore on e-mobility itself. By providing services for multimodal travel or car sharing providers, eCo-FEV can profit from this trend, which represents a growing demand for e-mobility services related to these two types of travelling.

5.2.1.4. Ecological trends

Climate change - CO2 emission reduction targets

To fight - or at least reduce the impacts of - climate change, governments and supranational institutions worldwide have put on initiatives and have set up targets to reduce CO_2-emissions (e.g. Europe 2020). These initiatives have major impacts on automotive industries around the globe. On the one hand OEMs are forced to meet the governmental CO_2 emission targets for vehicles. On the other hand governments support the e-mobility industry with a wide range of instruments (see chapter 3.5). As Figure 31 shows, CO_2 emission targets are quite different comparing Europe, US, Japan and China.

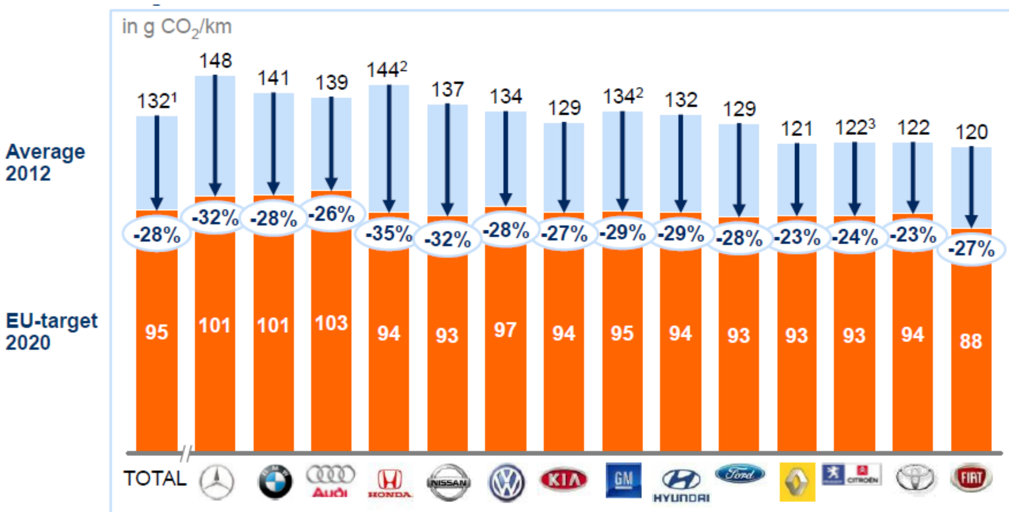


Figure 31: CO2 emissions of selected OEMs and brands 2012 in Europe (Amsterdam Roundtable Foundation & McKinsey&Company 2014)

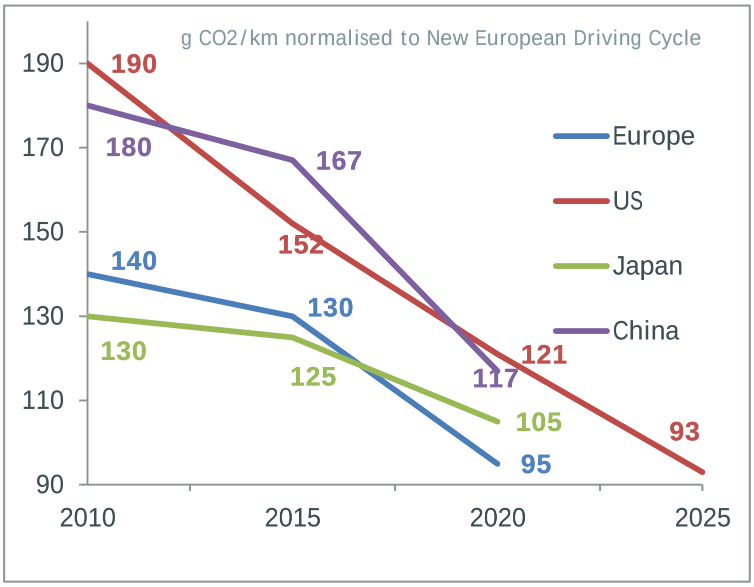


Figure 32: Targets for light vehicle CO2 emissions in select regions (Own data, Amsterdam Roundtable Foundation & McKinsey&Company 2014)

Relevance for eCo-FEV	The CO2-emission targets of the EU are forcing the OEMs to invest into green technologies such as e-mobility and light vehicles. Great efforts accompanied by high investments into e-mobility technologies can be derived from that. Hence, OEMs having great interest in boosting E-mobility will be open for cooperative projects like eCo-FEV

5.2.2. Stakeholder Profiles

5.2.2.1. Introduction

In this chapter all relevant[4] stakeholder groups are presented by giving background information, their interest in eCo-FEV, drivers and barriers as well as their relevance for eCo-FEV. Beside these primary stakeholder groups, there are also secondary stakeholders who have an indirect interest in e-mobility and eCo-FEV, such as energy providers, automotive suppliers, charging infrastructure manufacturers or battery manufacturers. Due to the fact, that these secondary stakeholders have no or very few contact points respectively interactions with eCo-FEV they are only mentioned for the sake of completeness.

It is of major importance for further proceeding to know that some stakeholders can't be distinctly allocated to one single group of the stakeholder groups discussed in the following. In

[4] Relevant to eCo-FEV

fact they take active parts in several stakeholder groups. Examples like RWE, edf, BMW or Tesla rather show that drawing clear lines between the different stakeholder groups becomes quite difficult. Key insights and understanding of special affiliations of several players was gained during expert and stakeholder interviews.

Nevertheless, especially the function they fulfil, respectively the role they play in the eCo-FEV system is of vital importance.

5.2.2.2. eCo-FEV Stakeholder Groups

Stakeholder group:

Vehicle OEM

Background Information:

OEMs face tough competition and therefore achieve competitive advantages mainly through differentiation. Production and distribution facilities are established worldwide offering country-specific variants in large quantities. Severe R&D costs characterise the worldwide platforms responsible for the different variants; in early development phases the functionalities are determined and later adaptations are coupled with high investments.

The trend towards e-mobility, also triggered by the EU legislation setting mandatory emission reduction targets for new cars means that the relevance of green and clean mobility will increase for the next generations and innovative models as car sharing and multimodal travelling will become more attractive. Vehicle OEMs may need to develop new concepts and may transform into or at least cooperate with mobility service providers. Charging and optimized navigation services as well as extended ranges and overall EV convenience can become essential differentiation factors.

Interest in eCo-FEV:

The interest in eCo-FEV bases in the urge to fulfil customer needs concerning low operation costs, comfort, driving pleasure as well as ecologic and economic driving. The associated benefits strengthen the strategic positioning of the brand and offer differentiation possibilities, through optional services further revenue could be generated, such as increase customer retention by collecting driving data or become mobility provider instead of car

producer.
Drivers: • Possibilities to be a first mover/pioneer → gain advantages in the market (image, customer loyalty) • Become a major player or at least don't miss the next technological trend • Profit from green, sustainable and ecological image of e-mobility • New service possibilities, new revenue sources of income through optional services (optimized navigation, charging services) • Increased interest in services as future positioning as mobility provider • Increased possibilities for customer relationship management • Cooperation and standardization as positive effects on telematics platform development • Differentiation possibilities (increased customer retention, collect driving data, enlarge the portfolio of service offers)
Barriers: • Cooperation between OEMs needed → coopetition scenario • Benefits of eCo-FEV only available after minimum penetration rate is reached • Need to share data with third parties • Need to grant access to OBU/Can bus • Dependency on uncertain development of penetration rates • Dependency on infrastructure invest by public authorities • Dependency on ICT providers as key supplier for connectivity • Risk of new players entering the market and participate in value chain • Data security as considerable challenge and risk • Improved HMI solutions needed to avoid driver distraction • Uncertainty related to regulative framework (national vs. EU scale)
Relevance: Focus stakeholder and key player for eCo-FEV implementation. eCo-FEV can solve major issues like charging, optimized navigation etc. but its success depends on OMEs cooperation.

Stakeholder group:

Public authorities (government, EU)

Background Information:

Next to the European Commission and national governments as guiding decision-makers also transport and traffic authorities as well as road authorities account as governmental institutions. CO_2-emission reduction, technological progress and economic growth lie in the basic interests of these stakeholders.

Interest in eCo-FEV:

Public Authorities see in eCo-FEV the possibility to ensure and improve mobility itself as well as a great opportunity to reduce CO_2-emissions, to promote renewable energies and to increase energy efficiency. Furthermore eCo-FEV can contribute to develop an efficient economic and ecologic traffic flow. An enhanced database for improved traffic – and charging - infrastructure management needs to be generated. Moreover automotive industry is a major employee and economic factor in Europe. Hence, e-mobility identified as the future of mobility, Europe wants to be a key player as leading market but also as leading provider for e-mobility

Drivers:

- Socio economic benefits
- EU-claim to increase energy efficiency and environmental goals (2020 climate and energy package)
- Economic opportunities for innovative technologies
- Increasing traffic demands → improved traffic efficiency needed
- Compete with other e-mobility leading markets and leading providers such as the US, China or Japan

Barriers:

- Need for regulative framework (ICT protocols, charging technologies, CO_2-emissions) but risk of overregulation

- Issue of eCo-FEV platform operator not yet clarified → who will benefit from possible investments
- eCo-FEV gathers and concentrates tremendous amount of data → (security) regulations necessary
- Data privacy and security concerns
- Limited willingness to invest as certain benefits of eCo-FEV are already given through other providers (e-mobility networks)
- Political pressure due to risk of not being re-elected in subsequent legislative period
- Dependency on vehicle OEM to equip OBU
- Opposing interests within the EU
- Uncertainty related to financing possibilities of the eCo-FEV technology

Relevance:

Focus stakeholder and key player for eCo-FEV implementation and public awareness. Key provider of legal frameworks and standardizations. Driving force behind eCo-FEV development and implementation.

Stakeholder group:

Public authorities (municipalities)

Background Information:

The aim of municipalities is the provision of a safe, efficient and clean traffic infrastructure in its region. Competitive positions of cities are impacted by the development and application of modern traffic technologies. For example multimodal travelling gains more and more importance.

At the same time the support of individual traffic is mostly not a prioritized topic on the agenda. Furthermore decision-making processes are very heterogeneous and regional circumstances vary widely.

Nonetheless most megacities are fighting the same problems. An increasing traffic volume and therefore critical levels of air pollution.

With exceptions like city organisations as ICLEI, POLIS or Eurocities the majority of decision

makers is not organized centrally, which leads to different status of information about innovative solutions. Actively visiting public authorities in their own region to inform them about eCo-FEV and its benefits to urban traffic systems can lead to a common status of information and deriving from that to more participating municipalities. In some countries municipalities provide free public charging stations or special permission for FEV-Travellers like free parking or use of bus lanes. Hence municipalities can significantly support e-mobility and thereby can become a key partner for eCo-FEV.
Interest in eCo-FEV: Interests of municipalities and national government are based on the same idea; nevertheless municipalities have further aspects as interest factors that need to be considered. For example the reduction of air and noise pollution as well as the acceleration of multimodal travelling and the provision of a comprehensive traffic information for society. eCo-FEV gains influence on traffic flow by centralized data interfaces and can thereby reduce traffic jams while increasing utilization of public charging stations at the same time. eCo-FEV can reduce and optimize the traffic volume in inner cities by improving multimodal travelling and traffic guidance systems.
Drivers: • Same drivers as national governments plus: • General interest in connectivity and process optimization (e.g. traffic management, parking management) • More efficient and overall improved usage of infrastructural data collection • Exemplification of technology use on public transport and multimodal travel systems • Positive attitude towards eCo-FEV as part of multimodal mobility concept • Opportunity to improve public perception as innovative cities • Appropriate solution to support operation of public transport and urban (freight) delivery services
Barriers: • Same barriers as national governments plus: • Heterogenic organization and decentralized decision making • Limited financial capabilities depending on size of city respectively municipality • Scarce budgets and broad range of competing purposes with higher public awareness

- Small cities do not have appropriate expertise and awareness for decision making and operation of innovative and complex traffic systems
- Limited interest to support individual traffic
- Limited understanding and awareness of eCo-FEV benefits

Relevance:

Key stakeholder group for eCo-FEV implementation as a solution without availability of eCo-FEV services in cities is not considered as realistic. Especially as provider of traffic data for their urban areas, municipalities are essential to eCo-FEV's success in urban areas. Furthermore they become key partners when it comes to smart grid integration and public transport respectively multimodal travel.

Most challenging role due to heterogeneous and decentralized organisation structure and currently missing awareness and conviction related to eCo-FEV.

It will be essential to analyse the needs of the municipalities and develop customized solutions. Most convincing arguments are successful case studies from other cities.

Stakeholder group:

E-mobility provider

Background Information:

E-mobility provider can offer several kinds of services. Some provide eRoaming services on B2B level, others provide charging solutions for private EV buyers. This includes all services from consultancy until the purchase of charging stations and their implementation and access to the local power grid. Beside these two examples there are several more e-mobility services like optimized navigation or battery leasing services. A significant amount of these services is characterized not only by the offer of one specific service but also by a combination of more than one service in one service package for the customer. BMW for example sells EVs but also offers a membership in its own EV-charging network. Hence e-mobility provider may have varying interests in eCo-FEV on a very detailed level but quite similar interest in general.

Interest in eCo-FEV:

In detail every e-mobility provider is interested in promoting its own special sector of e-mobility. But in the end all service providers profit from an overall success of e-mobility. The more EVs are sold, the more potential customers can be won. Offering the integration of any kind of e-mobility related service into eCo-FEV's structure, the platform can promote all kinds of e-mobility services at certain stages. But most of all, eCo-FEV allows each provider to access much more potential customers as the provider would be able to reach by himself. Hence if a service is invented, it can be distributed to all eCo-FEV users with only a small financial effort.

Drivers:

- Access to more potential customers
- Roaming possibility between operators
- Development of new business models by combining already existing business models
- Offering "service packages" to the customer
- eCo-FEV can serve as distribution and sales channel
- E-mobility provider can become key partners by participating in eCo-FEV. Already existing platforms can be integrated and thereby play a significant role as platform operators

Barriers:

- Data exchange with eCo-FEV
- eCo-FEV can be seen as a competitor
- Strong dependency on eCo-FEV
- Very high level of trustworthiness and credibility is necessary to convince e-mobility providers to share their data
- Opposing interests depending on penetration rate between eCo-FEV and potential e-mobility provider B2B customer → No interest to be integrated into eCo-FEV if e-mobility provider already gained significant market position/market share

Relevance:

Key stakeholder group for eCo-FEV implementation as a solution without integration of external services is not considered as realistic (integration of already existing eRoaming platforms much cheaper as integration of every single charging provider).

Most challenging role due to already existing strong players in the e-mobility service market.

It will be essential to analyse specific reasons for each B2B customer to join eCo-FEV and to develop appropriate and customized incentives/solutions. The most convincing arguments are the access to more potential customers and the overall positive effect of eCo-FEV on e-mobility.

Stakeholder group:

Charging station operator

Background Information:

Charging station operator can be energy suppliers, OEMs, municipalities, companies and a lot of other actors. They all operate public or semi public charging stations equipped with AC or DC chargers. Semi-public charging stations are charging stations at malls, shopping centres or parking sites. They are not owned by companies but publicly available. Public charging stations can be owned by energy suppliers, municipalities or petrol station operators. These charging stations can be free or subject to charges. In some countries municipalities offer free charging at public charging stations to attract customers but mostly to promote e-mobility itself. As we figured out in this work, public charging viewed in isolation does not make a profitable case. Refinancing of public charging stations depends most of all on its utilization (chapter 5.5). But due to the fact, that most EV owners charge at home or at work up to now public charging remains an exception for most EV drivers. If not provided by governmental institutions, combining public charging with other services, such as multimodal travelling or as part of an e-mobility service package, seems to be the only solution.

Interest in eCo-FEV:

As stated before the success of public or semi-public charging use cases is strongly related to the utilization of its charging station. By joining eCo-FEV, charging station operators can reach out to a significant higher amount of potential customers. Furthermore being part of one European-wide platform raises the attractiveness of the provided service.

Drivers:

- Access to more potential customers
- Higher utilization of charging stations
- Embedding of public or semi-public charging case in more attractive service packages

- Potential embedding in smart grid will be easier if charging stations are already connected to European Network

Barriers:

- Linking own charging stations to eCo-FEV may be too expensive for small charging infrastructure provider →depending on business model
- Some charging station operators are already member of charging networks with opposing interests.
- Sharing of user specific data
- High interoperability requirements
- Missing standardisations for ICT- and technological interfaces

Relevance:

Being charging a core element of e-mobility, charging infrastructure provider is a key partner for eCo-FEV.

The biggest challenge will be to decide either to connect every single charging operator one by one to eCo-FEV (very expensive elaborate) or to integrate already existing charging respectively eRoaming networks (cheaper but depends on the willingness to cooperate of already existing networks).

Stakeholder group:

eCo-FEV traveller

Background Information:

Generally eCo-FEV travellers need to be separated into two groups. First group are EV users, representing the B2C scale.

For the first group studies indicate that European EV customers are homogenous in concerning their socio-demographic data. According to a survey among owners of FEVs and PHEVs in Germany conducted by DLR institute, the following user profile can be roughly transferred to other countries. It can be assumed that there will only be slightly differences (Frenzel 2015):

- Predominantly male

• ø age 51 years • 2-4 person households • 51% university degree, high income • 53% households live in detached house • 40% live in towns with less than 20,000 inhabitants Furthermore, there are several motivational characteristics that define early adopters in the field of e-mobility both as individuals and in the business context (Hodam et al. 2012). As described before in chapter 3.6 these are cost motivated individuals, Cost- and image-motivated businesses/companies and Image motivated individuals.
Interest in eCo-FEV: This group of customers (B2C) is interested in the most cheap, convenient and safe way to use EVs. Furthermore range extensions, one contract for all services and improved interoperability are of special interests to eCo-FEV Travellers. All this can be provided by eCo-FEV.
Drivers B2C customer: • More convenient EV driving →charging and range comparable to ICE • Be part of the next big technological development (EV as part of smart home, smart grid network) • Enjoying new and better driving respectively mobility experience thanks to optimized navigation, multimodal travel and all-time connectivity
Barriers B2C customer: • Concerns about data privacy and data security • Use of alternative platforms • Attractiveness of HMI as decision criteria
Relevance: Besides B2B customers, B2C customers are the most important stakeholders of eCo-FEV because this is where revenues are generated. Furthermore eCo-FEV depends on data of EV user to create eCo-FEV services.

Stakeholder group:

B2B customers

Background Information:

This group represents all service providers who are integrated into the eCo-FEV platform, representing the B2B scale. It includes providers of charging stations, eRoaming networks, navigation service providers, OEMs or municipalities. Depending on the business model (see chapter 5.4 and 5.5) B2B customers of eCo-FEV will be integrated in certain ways into eCo-FEV.

Interest in eCo-FEV:

Beside the common interests in raising attractiveness of e-mobility itself by meeting the before (see eCo-FEV Traveller) described user demands, different interests occur depending on the specific customer. OEMs for example – and OEMs of the premium segment in particular – are interested in ensuring a certain level of driving quality and user experience which is expected by their customers. These customers (OEMs) therefore will be interested in joining eCo-FEV as soon as this criterion – beside others – can be guaranteed. Other customers such as eRoaming service provider are interested in enlarging their area of business and in raising the number of available charging stations in their network. Both can be achieved by joining eCo-FEV.

Drivers:

- Access to more potential customers
- Increase attractiveness of e-mobility and thereby the attractiveness of their own services/products

Barriers:

- Need to share and transfer data into eCo-FEV system
- Concerns about data privacy and data security
- eCo-FEV can be seen as competitor to already existing platforms and networks
- eCo-FEV can be seen as competitor due to its active role on B2C and B2B scale
- Doubts on eCo-FEV compliance due to its active role on B2C and B2B scale

- Depending on eCo-FEV operator, anxiety of creating a too powerful player respectively an unilateral dependency

Relevance:
Beside B2C customers, B2B customers are the most important stakeholders of eCo-FEV because this is where revenues are generated. Furthermore eCo-FEV depends on data exchanges respectively data transfer between B2B customers and the eCo-FEV Backend to create eCo-FEV services.

5.3. Business Model Development

In this chapter three primary business models and three secondary business cases are presented. The next section describes the approach, which was followed to develop these models and cases. Within each model and case first the Osterwalder business canvas was used to identify and organize significant elements. Based on that, value networks were created to point out the most important relationships.

5.3.1. Structure

The economical evaluation of a highly complex platform idea such as eCo-FEV requires as well a structured approach. One of the most important specifications of a platform idea is the involvement of multiple stakeholders and customers.

Primarily there will be a differentiation between eCo-FEV backend system and services provided by the eCo-FEV backend. This differentiation will also be used for the top level structuring of the business cases.

While the primary business case focuses on how the overall eCo-FEV backend system can be refinanced, the secondary business cases will focus on possible services offered by the platform based on the defined use cases. The goal of this document is to provide an independent evaluation about the economic viability of both business cases.

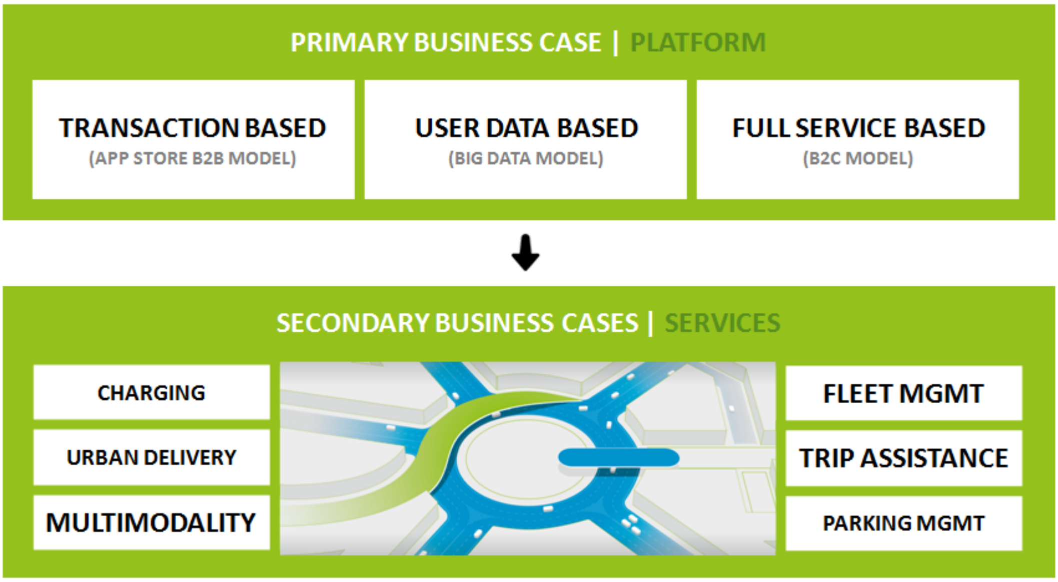


Figure 33: Business Case Structure

This kind of business case structure reflects the two possibilities of refinancing investment costs as well as operating costs of eCo-FEV. The stakeholder interviews showed that particularly for the primary business case there is no common business case. Business case 2 primarily considers services described in the various use cases. As long as the primary business case allows eCo-FEV to be able to create an added value compared to the original service it can be considered as one source of refinancing the platform.

The goal of the following chapter of the document is to describe these philosophies and the business models behind. Furthermore the philosophies will also be evaluated and commented based on the feedback of the stakeholder interviews and secondary research.

However, it became clear in the interviews that in the end there will not be a determination that one of these philosophies is the key to the eCo-FEV business model. The best approach to make eCo-FEV come viable will finally be a mixture of these philosophies.

The figure below provides an overview of the two business cases and the related philosophies. In the following part of the document recommendations will be elaborated about what could be the ideal combination of primary and secondary business models based on the stakeholders' assessment.

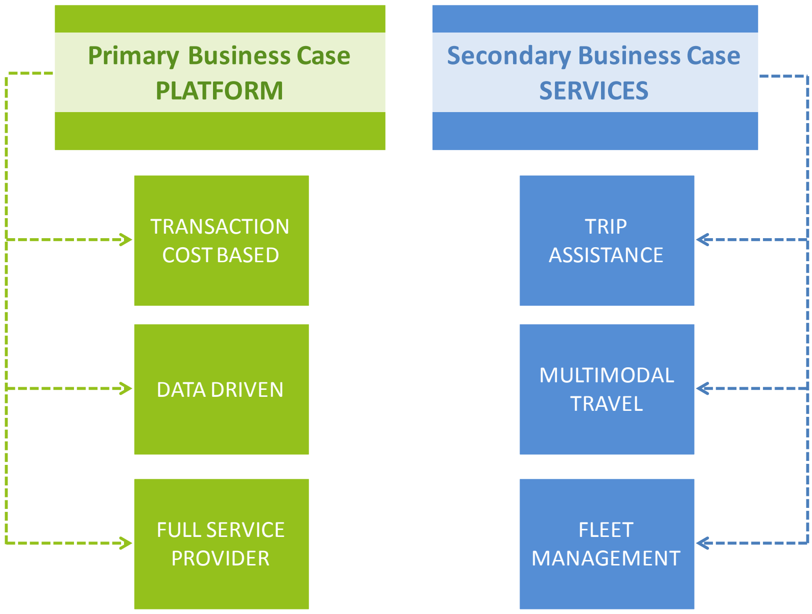


Figure 34: Business Case Structure - Second Level

5.3.2. Simplifications

The interviews with many different stakeholder groups indicated that there is a broad range of opinions regarding eCo-FEV and behind that also a broad range of potential services and business models connected to eCo-FEV.

With this background, the following simplifications have been made:

- Quantitative input for the business model calculations are derived from stakeholder interviews and secondary sources; most values should still be considered as simplified assumptions that have been chosen to provide a schematic understanding of the business models
- Because of the highly dynamic and rapidly developing e-mobility market all scenarios presented in this work have to be considered as conservative approximations which do not raise the claim of absolute validity. In fact they are supposed to give an impression of the economic potentials of each business model.
- Despite the applied structure for the business cases it is not possible to avoid overlaps between the different business models; thus a simple aggregation of the indicated potentials will not lead to an estimation of the overall commercial potential
- In order to provide an easy accessible picture of business models, the business models are described from a single perspective in each business case, even though the main value generation is provided by a third party
- Business models are calculated on a general or on European level; national perspectives are only considered on a qualitative level

5.4. Primary Business Case: eCo-FEV Platform

5.4.1. Introduction

In order to make the eCo-FEV platform a success story a high amount of investment needs to be considered. The feedback about eCo-FEV received from the different stakeholder groups in the interviews was very heterogeneous. It demonstrated that there is more than one approach about how to refinance eCo-FEV and make it a viable business.

In this chapter three different philosophies are described that were identified in the stakeholder interviews.

The distinguishing aspects of the different scenarios are:

- Value proposition
- Motivation
- Relationship to the end customer

From a technical point of view, various scenarios can be realized by offering a flexible system. However, the business perspective is much more complex due to the fact that OEMs and service providers already have their own customer relationship management which is crucial for customer loyalty strategies. OEMs stated that they would rather use their own OBU that is compatible with interfaces proposed by eCo-FEV backend instead of installing an eCo-FEV specific OBU. Furthermore, it is also necessary to take into account that some OEMs are undergoing a fundamental change of positioning from being a car manufacturer towards being a mobility service provider. An example for this transformation is BMW offering - besides selling cars - mobility services such as ParkNow (parking), ChargeNow (charging) and DriveNow (car-sharing). In this case OEMs can also be considered as competitors for eCo-FEV.

5.4.2. Model 1: Transaction cost based model

5.4.2.1. Description

The transaction cost based model is designed based on the idea of a market place where various stakeholders come together with the purpose of offering their services together with eCo-FEV services to FEV travellers. eCo-FEV services consist of vehicle specific data like battery status and traffic data. Secondary services can include existing e-carsharing services like multicity in Berlin or autolib' in Paris as well as e-roaming networks etc. Figure 35 provides an overview of the interrelations within the transaction cost based business model.

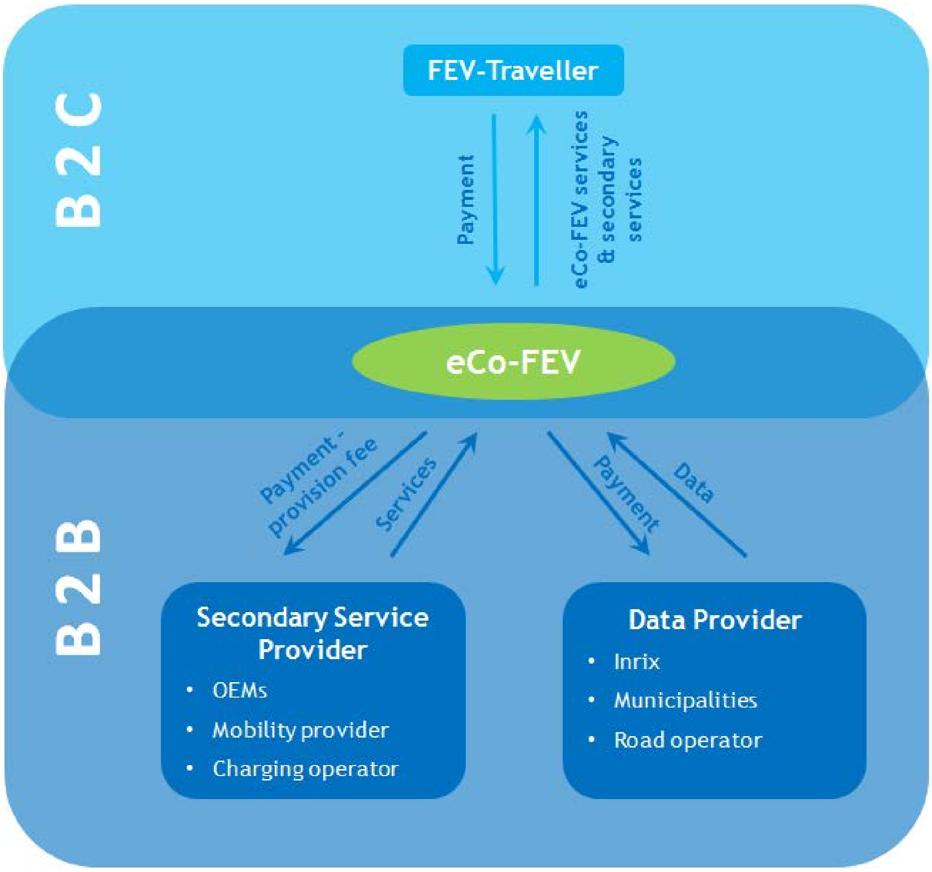


Figure 35: Transaction costs based business model overview

The transaction cost based model requires uniform IT standards accepted by all OEMs in order to allow data exchange with the eCo-FEV backend.

It's the stakeholders' opinion that public authorities should be responsible for setting this IT standard, i.e. the EU or ETSI. However, German top three OEMs seem to have understood that new emerging competitors such as Google, Apple and Tesla force them to move closer together with a strategy of coopetition by announcing the willingness to share traffic specific data leaving behind the status of isolation (Vogt, A.). Current developments in the field of standardisation might encourage the idea of integrating vehicle generated data on one platform.

5.4.2.2. Strategic evaluation

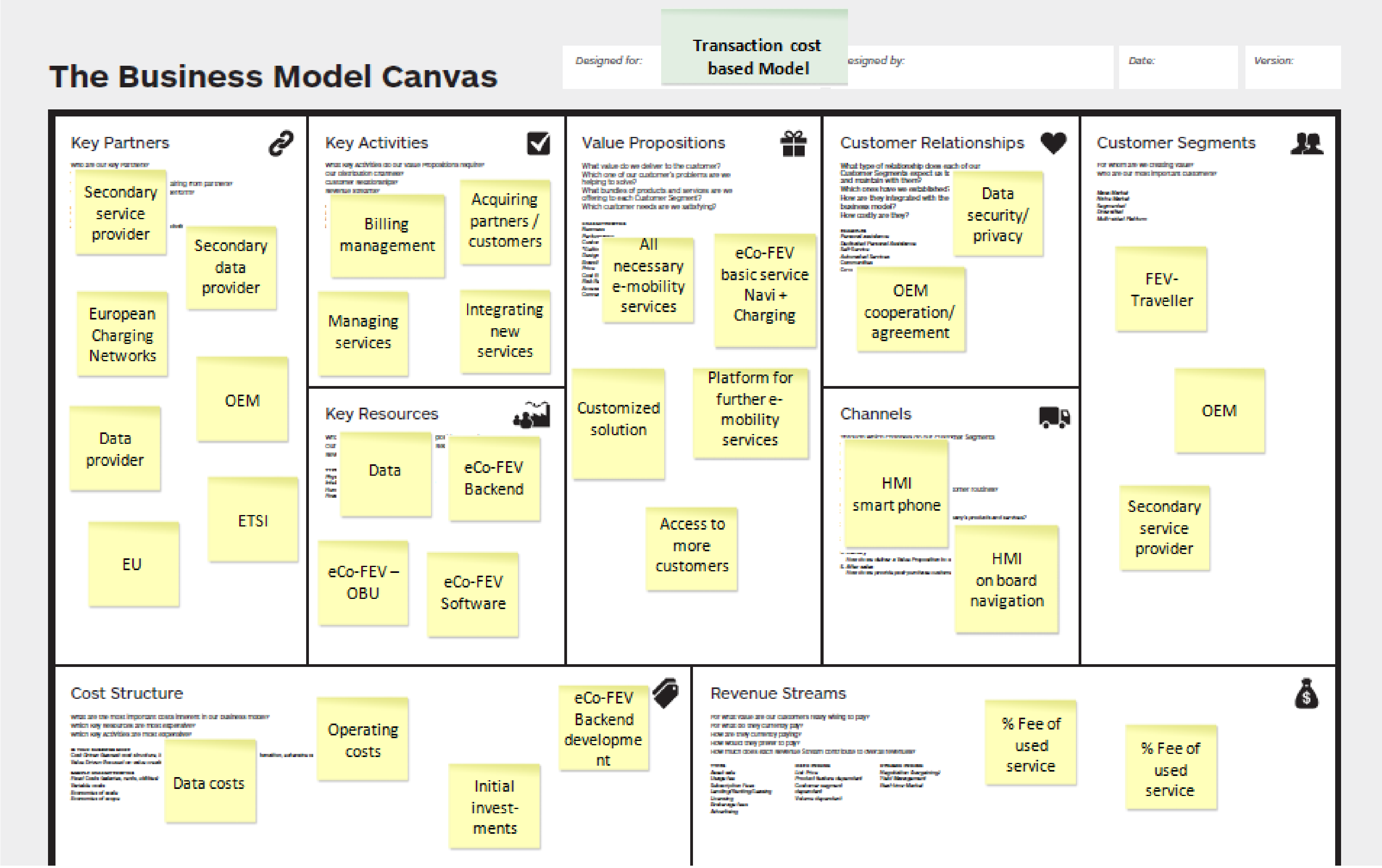


Figure 36: Osterwalder business model canvas – transaction costs based business model

5.4.2.3. Roles and value network

As described in chapter 2.2.3 the business model canvas itself is a strong tool to illustrate and summarize the structure and strategic foundation of the business case. Still it has its weak spots if the process of value creation is rather complex and different stakeholders are involved that cannot clearly be defined as partners or customers.

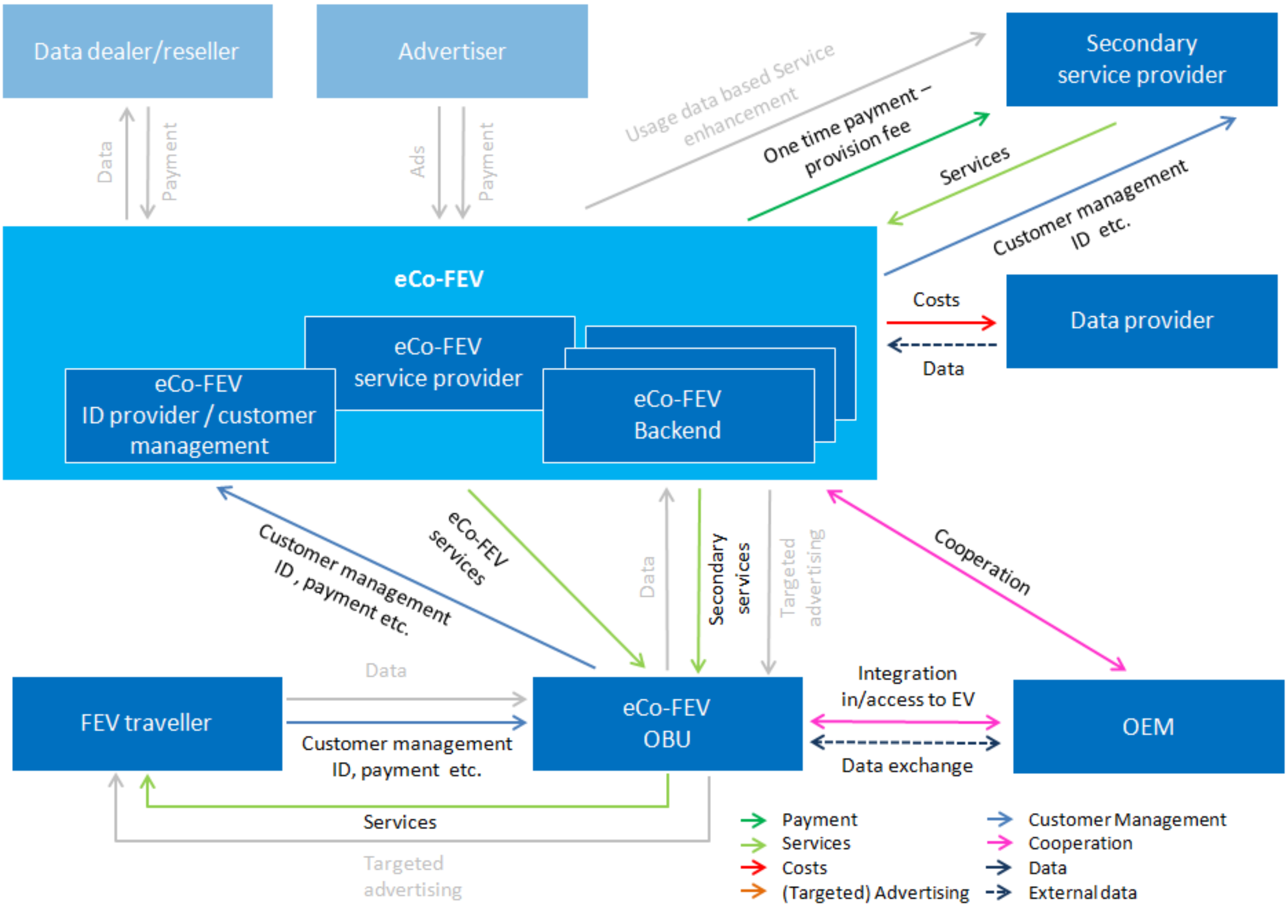


Figure 37: Value network – transaction costs based business model

5.4.2.4. Strengths and weaknesses

Generally this business model is fostering close cooperation with OEMs.

Therefore it is one of the main advantages of this model that this cooperation automatically leads to a higher reach of customers with every FEV sold. Furthermore, this model brings together various stakeholders in order to share their services via eCo-FEV.

The main strength from a financial point of view lies in the brokering function.
eCo-FEV provides navigation service as a basic cost-free functionality. For any further service offered on the platform that end customers have to pay for, such as FEV charging or car sharing the respective provider is being charged for each transaction that is processed via eCo-FEV.

Looking at the business model under current circumstances, the greatest weakness lies in the low penetration of FEVs in Europe. Since this model assumes a certain reach of customers the attractiveness of the platform for service providers will likely be low.

5.4.3. Model 2: Data driven model

5.4.3.1. Description

While the first business model was designed as a marketplace raising provision fees on transactions, the core of this business model is aggregating and selling (big) data mostly to OEMs who have great interest in using this data to enhance their customer loyalty. Furthermore data is sold to secondary service providers and data resellers. As a third element data is used to provide targeted advertising similar to Google. Figure 4 gives an overview of the data driven business model structure.

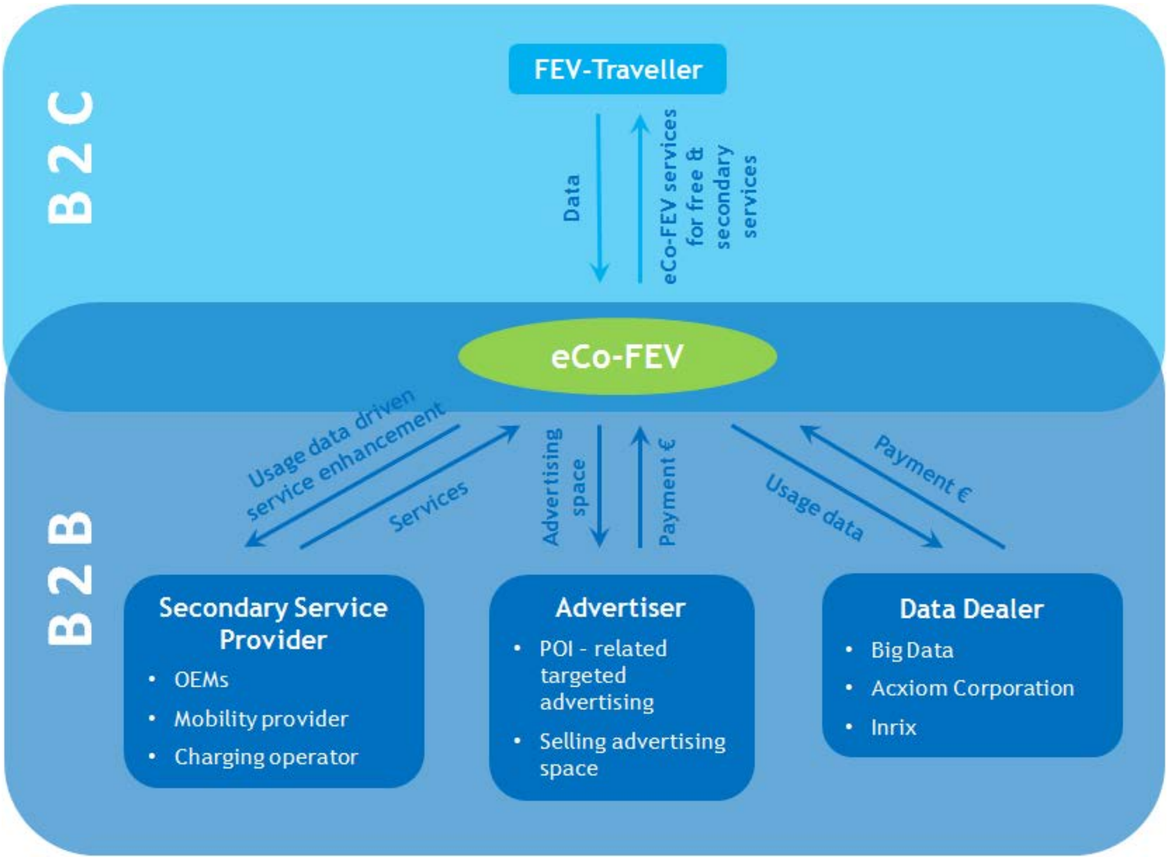


Figure 38: Data driven business model overview

According to the interviews conducted with experts and stakeholders, the integration of EVs into smart grid, the usage of EVs as mobile real-time sensors and selling data will be the future markets for e-mobility. The core element of all three aspects is big data. To address these three trends this business model is based on big data. For a better understanding of the business model all three aspects are discussed briefly below. Afterwards the usage of data for advertising is described.

Integrating EVs into smart grid is considered as future market for e-mobility. EVs will be used as swarm energy storages to buffer volatile renewable energy streams. For this exact information on user behaviour – especially charging patterns – is needed. As intersection between all stakeholders, eCo-FEV is predestined to aggregate an enrich data gathered from all connected EVs respectively FEV Travellers.

This will be possible because EVs will become mobile real-time sensors gathering data 24 hours a day. Already today cars are able to communicate with each other or with roadside units to exchange information on traffic. In the near future all new cars/EVs could be able to gather and share further information like energy status, weather conditions, driving patterns and user data. All this data is of great value. Therefore, this business model aims at using eCo-FEVs unique position to aggregate this data and use it as major source of revenues.

Dialogue with OEMs in Europe showed that they have a major interest in this usage data to enhance their own services and eventually transform themselves from an OEM into a (e-) mobility provider (e.g. BMW). But at the same time a fully centralized solution (see chapter 5.4.4) with an eCo-FEV operator obtaining a monopoly position on the market of mobility platforms including the storage – not neglecting data sovereignty - of all relevant usage data on an own backend is rejected by OEMs. These concerns need to be considered within this business model.

Besides selling data to OEMs or secondary service providers, data will also be sold to data resellers to access another source of revenues.

In addition to revenues from data selling, targeted advertising was identified as a secondary source of revenues. Following the example of Google, offering free eCo-FEV services is supposed to attract a high amount of users on the B2C side of the platform, which will raise the attractiveness of the platform for advertisers on the B2B side (see chapter 5.3). All value propositions are described in detail in the next section.

All the aspects discussed in this section are graphically worked up in the figure below. It shows all relevant arguments, perspectives and aspects from which this business model was derived from.

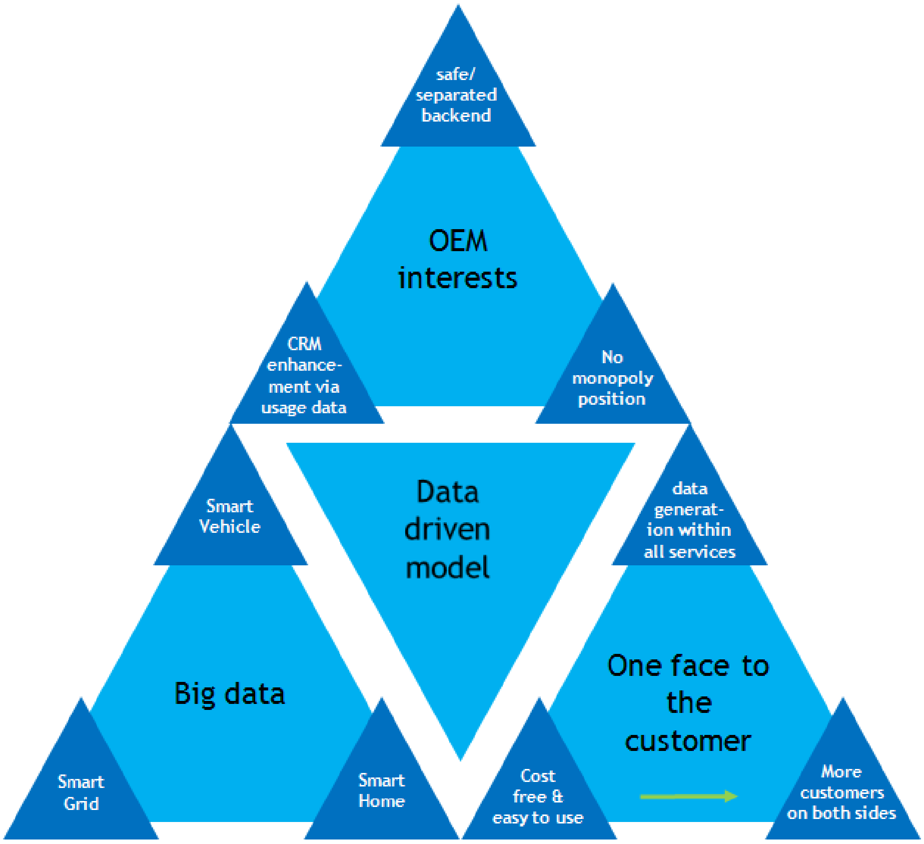


Figure 39: Derivation triangle matrix – data driven model

Because of the dynamic and volatile character of the e-mobility ecosystem, several assumptions were determined for this business model:

- Agreement on cooperation between all stakeholders considering data exchange of all e-mobility service relevant data
- An European wide accepted operator for the eCo-FEV platform can be identified
- E-mobility development will speed up with technological development in the near future → crucial amount of potential users can be reached
- eRoaming for charging will become redundant because future technological and ICT interoperability will enable new payment systems like payment via credit (visa) card, PayPal, Apple Pay or Google Wallet.
- EVs will become smart vehicles due to the Internet of Things development
- EVs will become mobile sensors gathering a wide range of data
- EVs will be integrated into the smart grid as swarm energy storages to compensate volatile energy peaks caused by renewable energies

The biggest difference between the transaction based business model presented in the last section and the data driven business model presented in this section is based on what services revenues will be generated. While in the first business model revenues are gained by raising provision fees on secondary service, the data driven business model gains its revenues basically from data that is sold to OEMs, secondary service providers or data resellers.

5.4.3.2. Strategic evaluation according to Osterwalder

In the following the business Osterwalder business canvas is presented and discussed in detail. Because of their different importance and overlapping meanings respectively interrelations, for description some segments were added to other sections for better understanding.

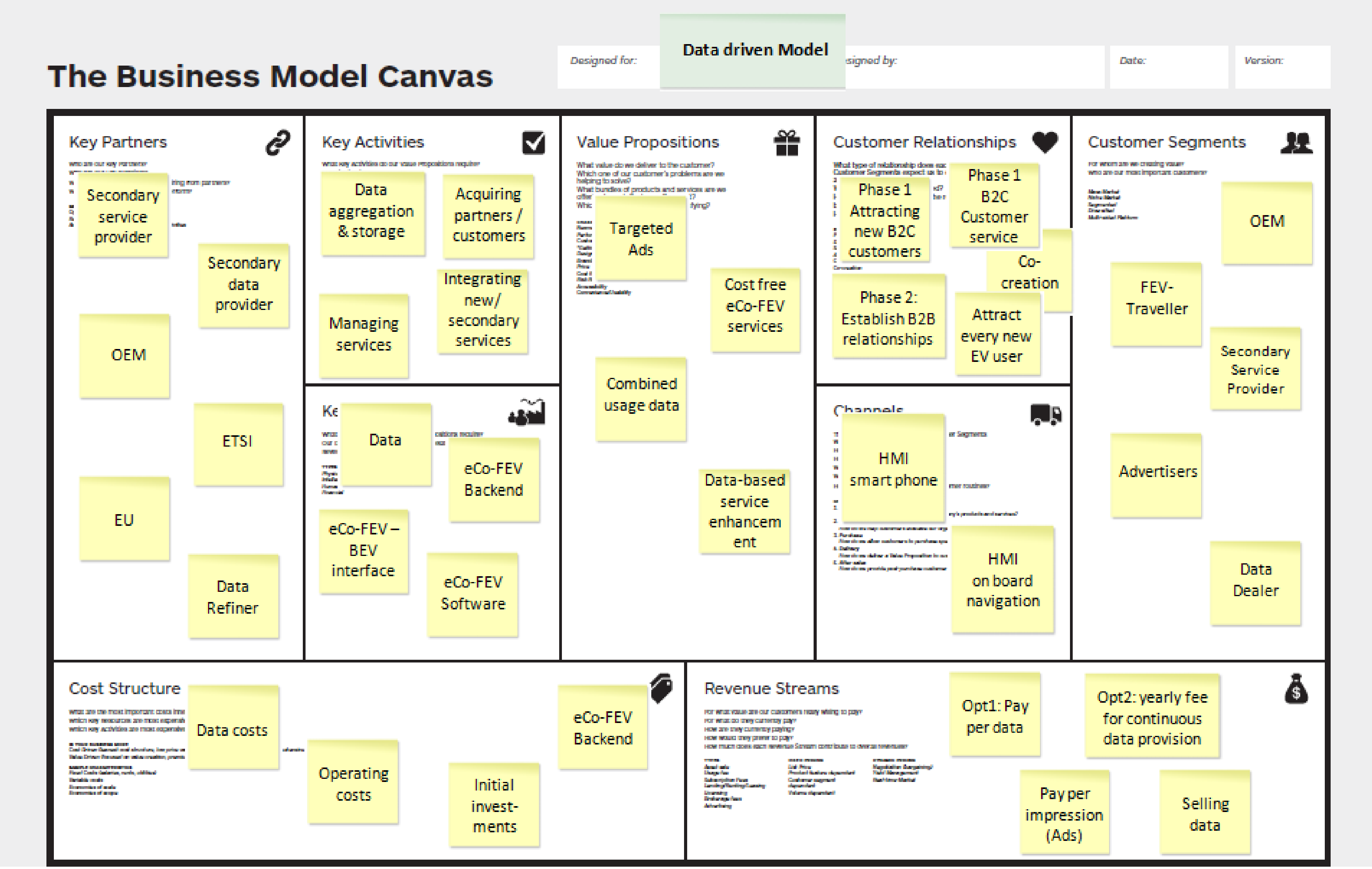


Figure 40: Business canvas data driven business model

5.4.3.3. Roles and value network

The value network shown below shows the stakeholders and their interrelations within this business model. On the right side the B2B customer can be found. Additionally to the interrelations already described in the sections before the connections between the customer, eCo-FEV OBU and the eCo-FEV system are presented. The OBU will function as central junction between the customer and the eCo-FEV system whereby the customer will send its account information together with usage data via the OBU to the eCo-FEV system. The other way around the customer is provided with services including targeted POIN advertising. Furthermore the value network shows a stakeholder who was not presented in detail so far, the data provider. Data provider can be municipalities providing traffic data, navigation service provider, road operators providing data from roadside units or telemetry data provider.

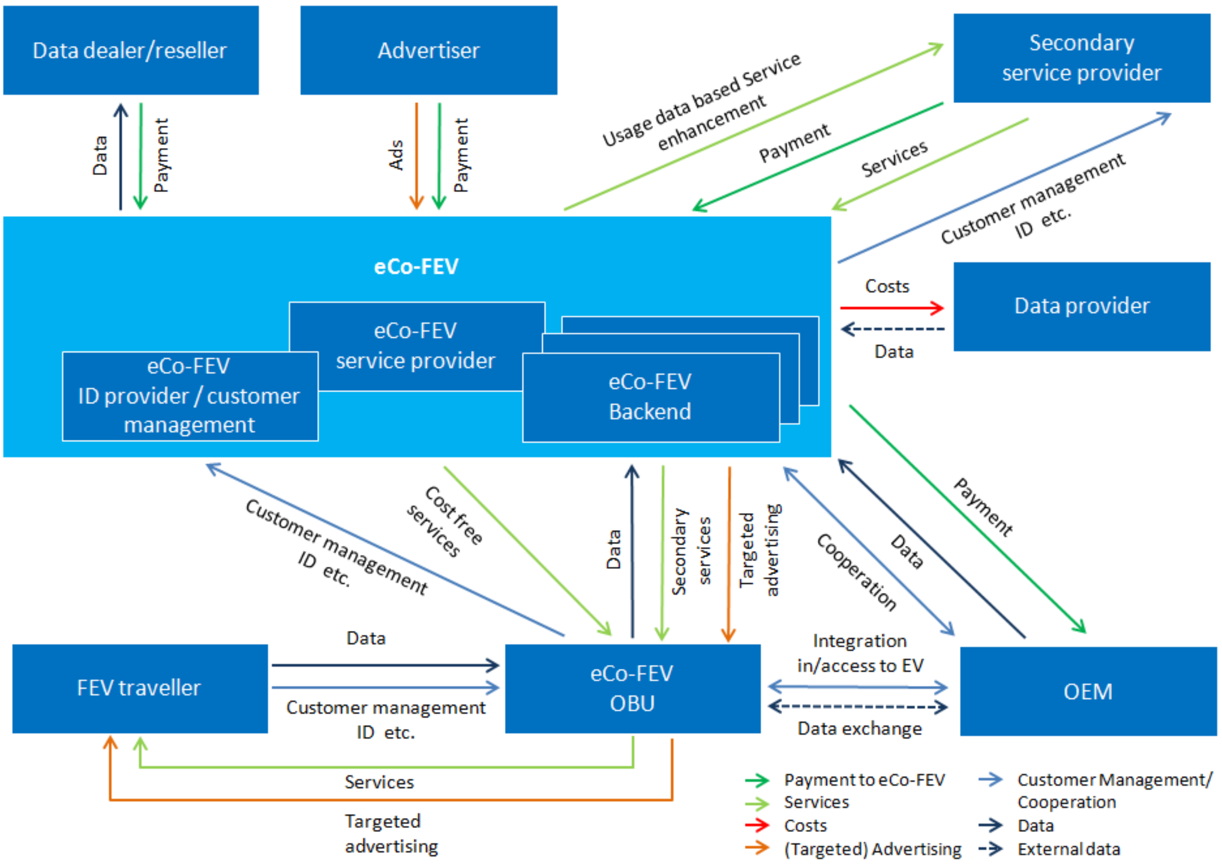


Figure 41: Value network data driven business model

In line with the eCo-FEV OBU, OEMs as stakeholder gain high importance being the junction and decision-maker on what data will be exchanged and to what conditions. As stated before, this relationship can be seen as a one with specific meaning.

The coloured arrows in Figure 41 show the different kinds of streams and relationships between the several stakeholders. All of them are discussed in detail in the table below.

5.4.3.4. Strengths and weaknesses

The data driven business model picks up major trends like big data, internet of things, smart triangle and mobility development itself. Therefore this business model is clearly future-oriented. As soon as OEMs pick up on the mentioned trends – most of all big data – this business model will develop its full strength (given the predicted e-mobility development).

Furthermore combining strengths of several other already successful business models like Google, this business model relies on at least three separated sources of revenues, such as advertising, usage data (big data) and DBSE. This fact makes it a business model with high potential.

Assuming the e-mobility development described in chapter 3.2 and assuming furthermore the smart triangle and internet of things development described before, positive back coupling effects can be generated and used to boost eCo-FEVs success. Hence, as soon as a significant amount of customers is attracted to join eCo-FEV, secondary service providers and advertisers will be attracted on the other side of the platform. Adding now the assumptions mentioned above, conditions for a platform like eCo-FEV are quite promising. On the one hand, e-mobility development provides a steadily rising number of potential customers. If usual (ICE) mobility users are also taken into account, the range of potential customers expands even more. On the other hand, the first phenomenon (steady rise of potential customers) leads to a growing market for secondary service providers and advertisers. To put it in a nutshell: perfect market conditions for a data driven eCo-FEV business model.

Clearly the second business model relies on revenues from advertising and the sale of user data. Moreover a high demand of B2C customers already in the initial phase derives from that. Although offering basic eCo-FEV services for free, attracting a critical amount of B2C customers still remains a weakness. This is especially because of the up to now limited amount of EVs registered in Europe – about 214,000 in 2014. Contrarily to typical advertising and data aggregation known from the internet, currently there are just not that many users. It can be argued, that introducing the eCo-FEV platform into the market may boost EV sales in Europe to become a mass market product eventually – which is the overall goal of eCo-FEV – but it remains a weakness of this business model that need to be mentioned.

In addition to the up-to-date limited amount of potential customers, interviews raised the concern that looking at the customer behaviour of today's EV users, a very limited demand for further e-mobility services can be noticed. Hence the range of offered services may exceed the actual customer demand – at least at an early stage.

It is not within the scope of this work to discuss possible eCo-FEV platform operators or owners. However this business model raises one concern respectively will not be appropriate if eCo-FEV should be run by a public or semi-public institution. Thus, a public institution financed by taxes or likewise is not appropriate to act as advertising (space) provider.

Summarizing it can be stated, that the data driven business model has very much potential in order to bring eCo-FEV to a success. Only two major questions remain. At first: Considering the demand for a crucial amount of B2C customers, when is the right time for eCo-FEV to enter the market. And secondly: Who could be appropriate to run eCo-FEV. Following the information and discussions of the conducted interviews, for the first question it can be concluded, that at least some major player in the e-mobility ecosystem are already working on comparable projects.

5.4.4. Model 3: Full service provider

5.4.4.1. Description

While business model one and two both put business interests first, the third business model now puts the end customers' needs and demands in the spotlight. The overall structure of the third business model is shown in Figure 42.

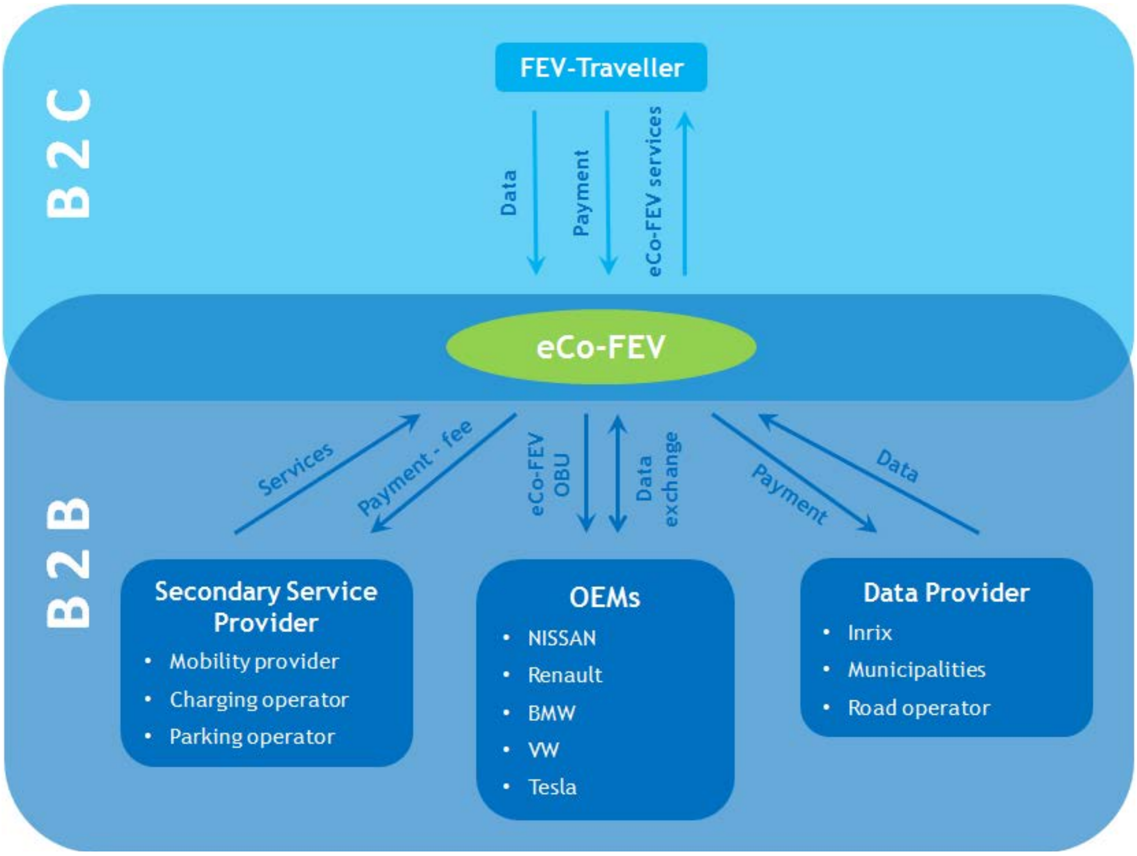


Figure 42: Development of total revenues – full service B2C mobility provider

As stated before, currently the customer can chose from a diverse offer of different services. Furthermore almost similar services are offered by different providers. But in the end the biggest problem remains the missing interoperability of existing services.

Based on insights gained during the conducted interviews, the best solution for the customer would be having only one application that covers all necessary services. The less complicated it appears, the more attractive e-mobility becomes. This knowledge is far away from being any kind of secret. However up to day the majority of stakeholders is still hesitating to cooperate for the sake of this customer demand in a manner that would really promote e-mobility.

Furthermore each stakeholder is more concerned about reaching their own goals instead of purchasing common goals – which may lead to a much greater success as acting alone. Of course cooperation to a certain degree as well as common research projects can be found all over the market. Still so far, there is no solution to be foreseen at the end of the road like the one suggested in this section.

Therefore this business model seeks to create a structure, which puts customers' interests in the spotlight. A full service providing approach was chosen as most suitable for the third business model. Full service hereby means channelling all services through the eCo-FEV platform offering the customer one eCo-FEV service that covers all the customers' needs related to e-mobility. Secondary service providers will provide eCo-FEV with a white label version of their services, which enables eCo-FEV to offer all services labelled with its own brand. Figure 43 shows the value this business model brings to the customer.

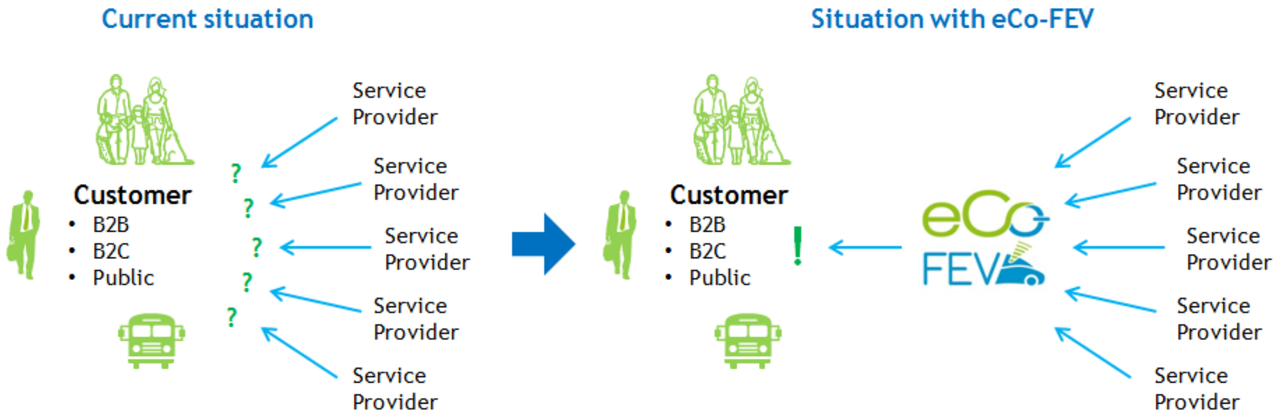


Figure 43: Value proposition of the full service provider business model

From an economic perspective, two major advantages can be identified. The first one considers the fact that all secondary services integrated into eCo-FEV will be provided in a white label. Thus all services will be offered to the customer with the eCo-FEV label. This will lead to a higher customer loyalty.

Secondly eCo-FEV will gain revenues out of every service, which is provided by the platform because every service will be provided by eCo-FEV. Considering the financial part, this business model uses the same approach as the transaction cost based model. But there is one important distinction to the other business models. The distinction affects most of all the area of customer relationship. Contrarily to the other two models, here customer relationships only exist between the customer and eCo-FEV. This model is derived from the “one-face-to-the-customer” approach to make the product as attractive as possible.

According to the insight gained in the conducted interviews this is the most favoured solution of the customer. Stakeholders as well as experts confirmed this information independently from each other.

Additionally a segmentation of the customers according to a freemium model can be a further element to this business model. It remains to discuss at which stage of the business enterprise the freemium structure develops its full potential.

As well as for the other business models the question “who may be an appropriate platform operator?” remains once again unanswered. But in contrary to the data driven business model, in this case – because of the lack of advertising as a revenue stream - an involvement of national or supranational institutions like the EU is possible.

Because of the dynamic and volatile character of the e-mobility ecosystem, several assumptions were determined:

- Agreement on cooperation between eCo-FEV and all secondary service providers considering white label provision of all e-mobility related services
- An European wide accepted operator for the eCo-FEV platform can be identified
- E-mobility development will speed up with technological development in the near future
- EVs will become smart vehicles due to the Internet of Things development
- OEMs and other stakeholder overcome their concerns about monopolistic positions due to the involvement of public institutions

5.4.4.2. Strategic evaluation

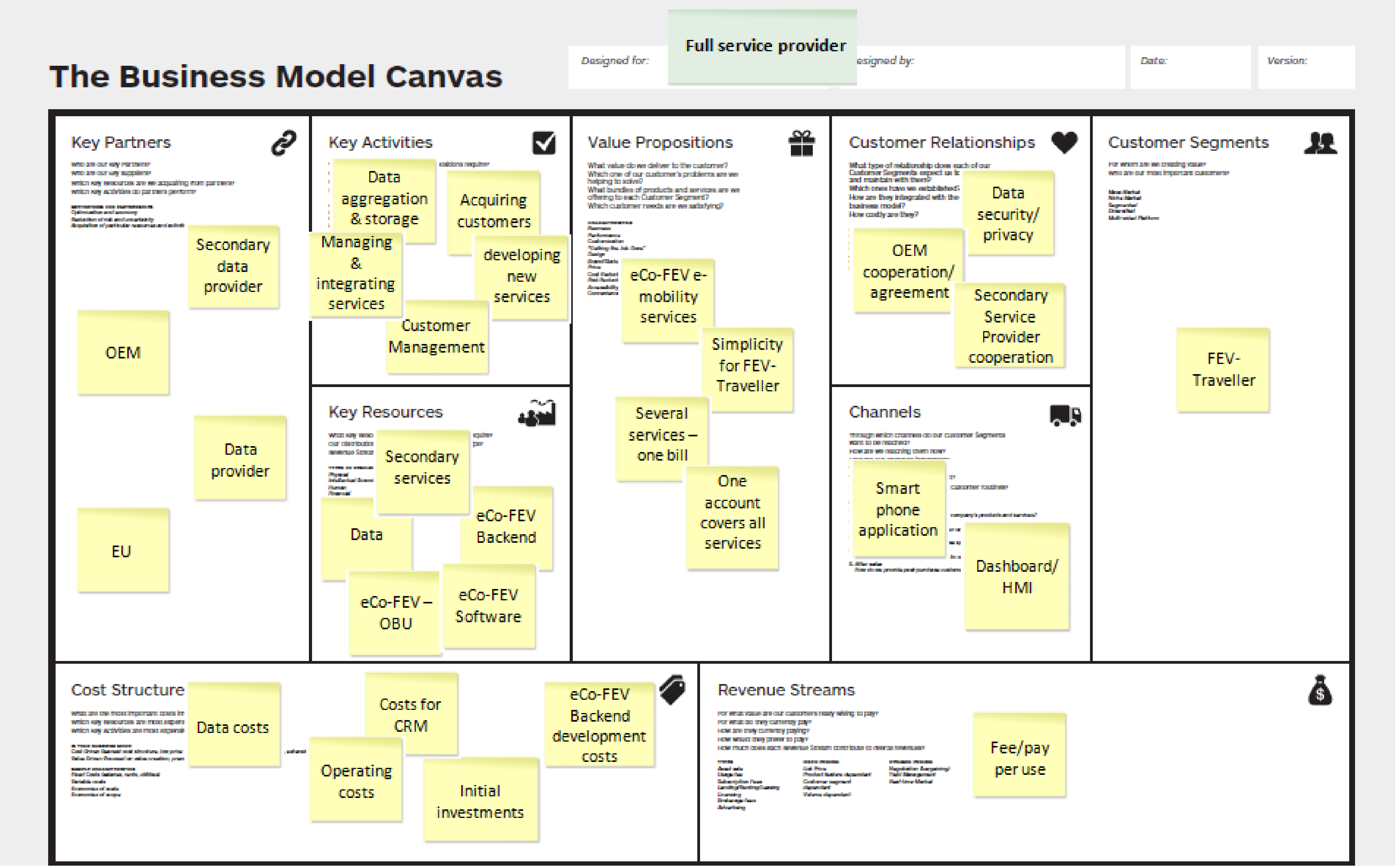


Figure 44: Business canvas – full service provider

5.4.4.3. Roles and value network

The value network of this business model shows fewer stakeholders as the one from the second business model. The boxes coloured transparent are not supposed to play an active role in the initial phase. At a later stage these stakeholders and related services may be added to the business model to create new revenue streams.

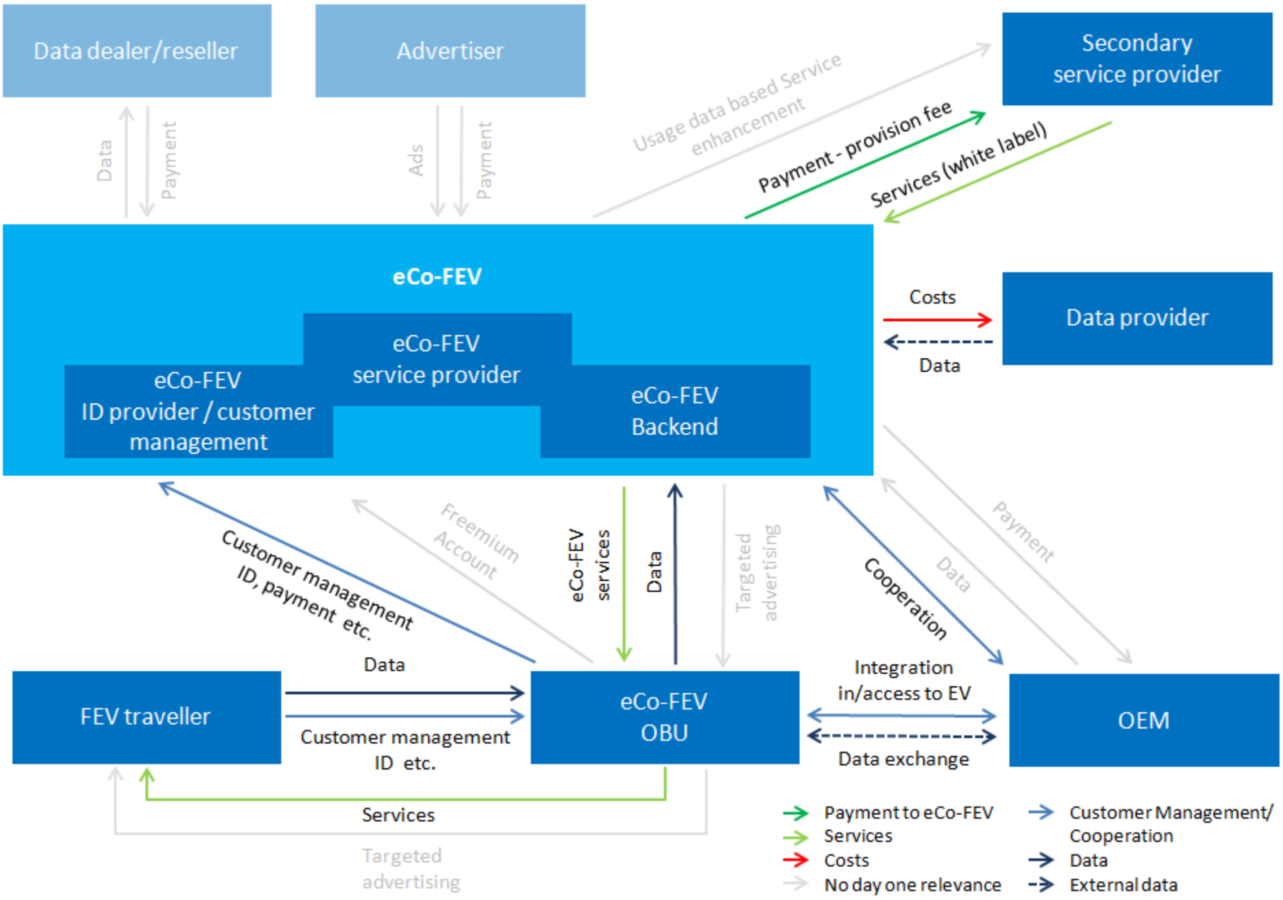


Figure 45: Value network – full service provider

Comparing to the other two value networks the main difference is the transfer of the complete customer relationship management away from the secondary service providers to eCo-FEV. Similar to the business canvas, the value network is rather simple comparing to the one discusses before. This is most of all because only one existing customer segment leads to one revenue stream. All services are provided by eCo-FEV, which also manages the whole customer relationship and all payment modalities. The fees gathered for services requested by the customers are transferred to its original provider minus a provision, which represents the only source of revenues at this stage. As indicated by the transparent boxes and arrows further revenues can be generated at a later stage basically relying on usage data which can easily be generated following the examples presented for business model two. Nevertheless the table below shows the stakeholder evaluation to discuss each stakeholder and its role in this business model.

5.4.4.4. Strengths and weaknesses

The most important strength of this model is that it puts customer demand in the spotlight. As each model has its own incentives to attract customers, offering one solution by one provider, which covers all customers' needs, is the absolute strength of the full service B2C mobility provider model.

As mentioned in the description of this section there are many weaknesses, which need to be discussed. First of all it is most unlikely, that both stakeholders and OEMs are willing to give up their customer relationship in such an extent. Furthermore the monopolistic character this model clearly submits will be another barrier to its implementation. This model relies on a high amount of customers on the B2C side of the platform because reaching a higher amount of customers is the main argument for secondary service providers to cooperate with eCo-FEV. Only one further aspect might be an additional motivation. A lot of interviewees raised the point, that the overall success of e-mobility will bring profits to each stakeholder group. But since this aspect being a rather indirect, uncertain and altruistic one, it is quiet unlikely that it will contribute in a significant way.

Limited amount of EV users and therefore limited amount of potential customers means a weakness as well as a risk to this business model in a similar way as this is the case for the other business models.

In addition to the up to date limited amount of potential customers, interviews raised the concern that looking at the customer behaviour of today's EV users, a very limited demand for further e-mobility services can be noticed. Hence the range of offered services may exceed the actual customer demand – at least at an early stage.

5.4.5. Summary

The third business model puts customer needs in the spotlight, which leads to a monopolistic like position. All secondary services – provided to eCo-FEV as white label solution - will be integrated into the platform and offered to the customer under the eCo-FEV label. Although it seems to be the best solution for the customer, it is a rather undesired solution for B2B customers. Especially OEMs and other already existing players in the e-mobility market will argue against this business model. Hence very convincing and profitable arguments and incentives need to be developed to give this model a chance.

In comparison to the third business model, the first and secondary business model do not foresee to interfere into the customer relationships between customers and secondary service providers to the extent the third business model does. Although the first and the second business models appear quite alike considering the value network and the their structure, by taking a closer look at the figure illustrated below it becomes clear, that the data driven business model possesses – by far – the biggest economic potential[5]. Moreover it is important to keep in mind that revenues and benefits related to developments like smart triangle and the internet of things are not even taken into consideration at this stage. Hence the overall potential of this business model might be much bigger as it could be shown within this work. This result matches absolutely the statement made several times within the interviews – especially by experts.

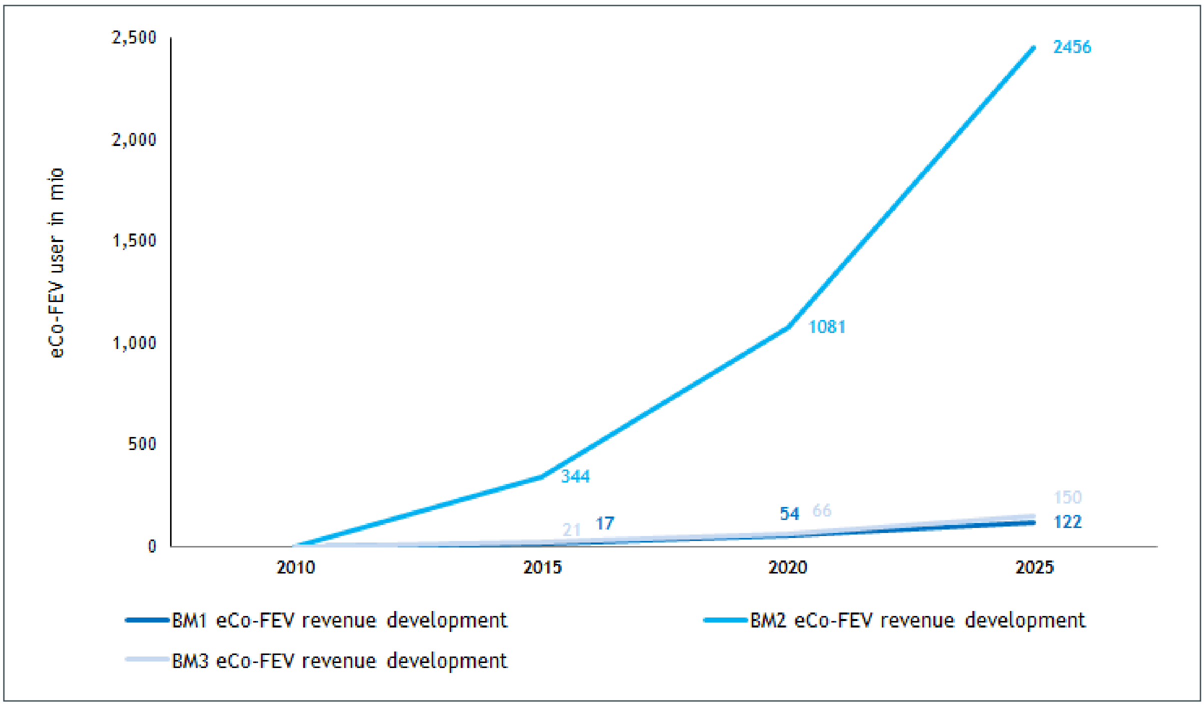


Figure 46: Development of total revenues – all business models in comparison

[5] Calculations of figure 46 are based on assumptions. Therefore results do not give accurate and valid figures but first impression of economic potential of all three business models.

All three business models were designed with focus on special motivations, value propositions and end customer relationships. With this differentiation this work tries to point out several perspectives and interests, which were raised within the interviews. Each business model focuses on diverse aspects, which lead to different economic potentials. Obviously the data driven business model appears to be the most promising one, but especially at an early stage – due to a very limited amount of customers – a combination probably with the first business model can liberate further potential.

Beside the overall business model structure of the eCo-FEV multisided platform, the related services are at least of the same importance. Hence the next section picks up on the most promising secondary business cases, which were already introduced in chapter 4 and correlates them with the business models of this section.

Excursus – Possible eCo-FEV operator

As it was mentioned at several points in this chapter it is not within the scope to address the question of who could be a potential eCo-FEV platform operator. Nevertheless first thoughts on this question raised during the interviews can be presented briefly.

For the first business model a company with great experience as market place provider like Apple is conceivable. Also global players of the ICT industry could are worth considering.

The second business model as it is based on big data could be run by a company like Google. Again a global player of the ICT industry is possible. The involvement of a public authority is ruled out due to the advertising element.

However for the third business model the involvement of public authorities is recommended to address the concerns about monopolistic situations. Besides that utility companies are worth considering

5.5. Secondary business cases: services

5.5.1. Introduction

As in the previous chapter three approaches were described concerning how to refinance the eCo-FEV platform depending on the type of architecture and grade of centralization behind it, this chapter is dedicated to the purpose of eCo-FEV platform: being an enabler for FEV related services. While the primary business cases were addressed to B2B partners participating in the platform, the secondary business cases are addressed to the FEV traveller consuming eCo-FEV services.

5.5.2. Discussion and selection of exemplary services

During the interviews stakeholders and e-mobility experts pointed out that eCo-FEV provides added value especially for the end users. Compared to existing mobility services the modular architecture of eCo-FEV allows new functionalities and services that are mainly related to the specific FEV characteristics.

The selection of exemplary services is based on both the use case description within WP 200 and also the stakeholder's opinion about services with the greatest added value for FEV travellers.

The first case in this chapter will discuss rout optimized charging since charging is the most unfamiliar issue about electric vehicles and at the same time the most relevant distinctive feature compared to existing platform services.

Furthermore multimodal travel service and fleet management service are both regarded as closely linked to FEV specifications.

In summary, the selection of secondary business cases was influenced by

- The stakeholders' and experts' assessment,
- The results from the use case description within WP 200,
- The impact on FEV attractiveness.

5.5.3. Service 1: Trip assistance

5.5.3.1. Description

With the trip assistance service the eCo-FEV traveller is dynamically guided during the trip until the destination taking into account traffic and weather conditions, preferences and most FEV relevant, battery status. The eCo-FEV system monitors the trip progress with regards to a travel plan. If unexpected situations are detected the trip plan or charging plan may be dynamically adjusted.

5.5.3.2. Strategic evaluation

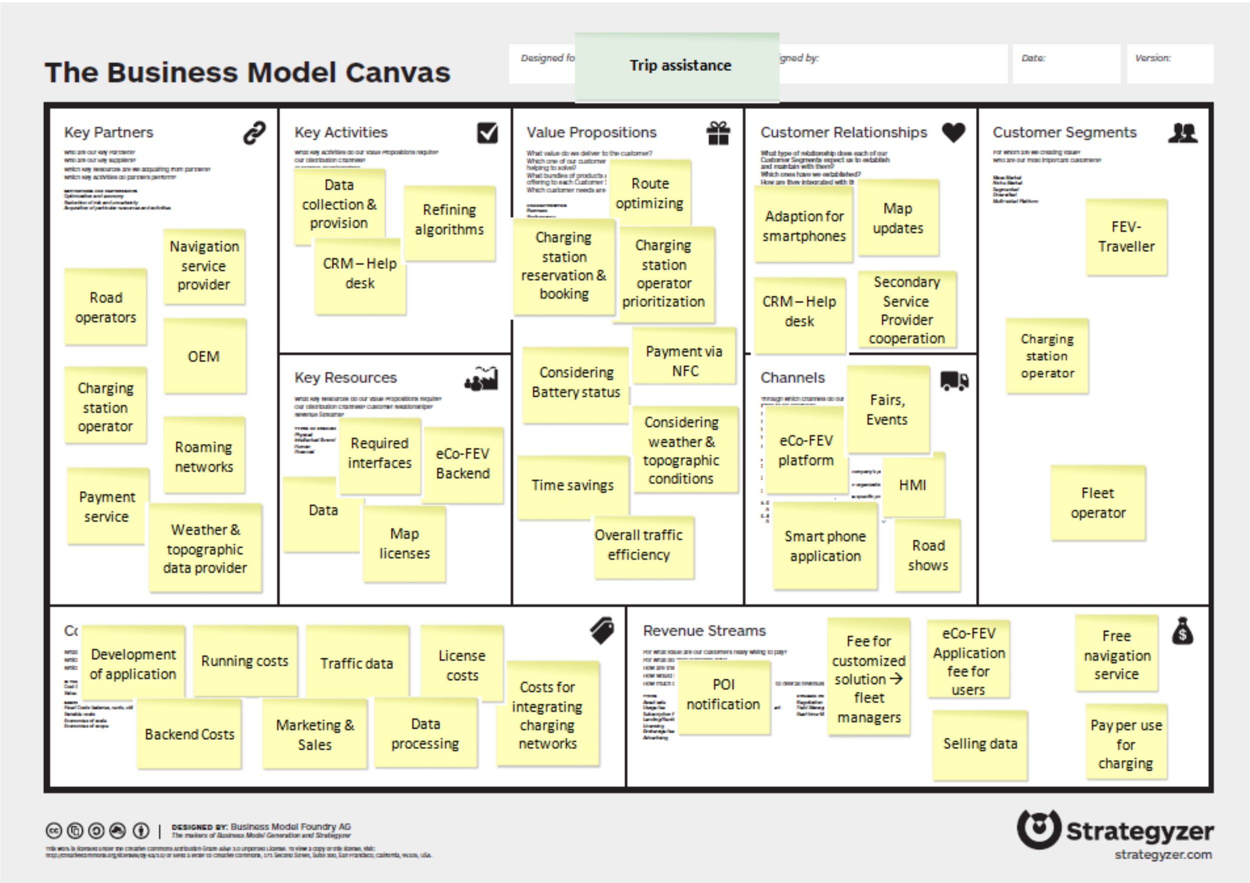


Figure 47: Osterwalder business model canvas– trip assistance business case

5.5.3.3. Roles and value network

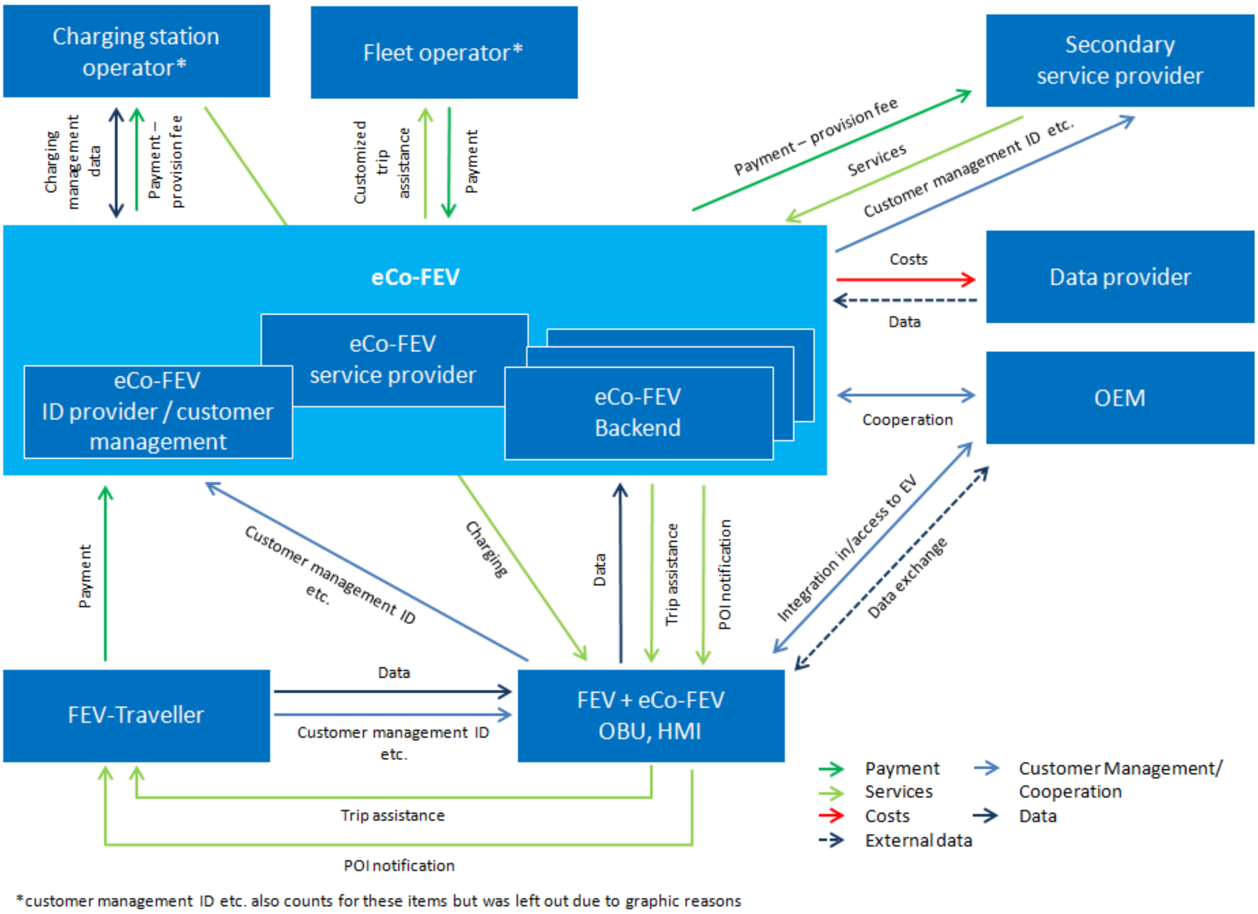


Figure 48: Value network – trip assistance business case

Table 7: Stakeholder evaluation – trip assistance business case

Stakeholder	Contribution	Benefit	Evaluation
FEV Traveller	• Uses trip assistance • Provides user data and travel behaviour data to eCo-FEV backend • Pays for use of eCo-FEV services	• Optimal route considering battery status, route preferences, and real-time traffic data • Recommendation of available charging spots	+++ ✗ • eCo-FEV brings together navigation and charging on one platform

		• Management of entire travel process through one platform • Reduced complexity	
Fleet operator	• Installation of eCo-FEV services into fleet • Offering access to FEVs → accustoming	• Higher travel efficiency • User and driver data enhanced by eCo-FEV • User specific settings can be saved, particularly interesting for car sharing and car rental • Customized solution • Positive impact on image • Competitive advantages through higher efficiency	• eCo-FEV can provide possibilities to get accustomed to FEVs which leads to a higher probability of considering FEVs when planning on buying a new car
Charging station operator	• Integration of charging station network on eCo-FEV platform via open interface • Permission of payment processing	• Higher utilisation of charging spots • Improved localization strategy → detailed data about charging behaviour together with travel behaviour	• High attractiveness for charging station operators and roaming networks • Actial demand of public charging is predicted as rather low

5.5.4. Service 2: Multimodal travel

5.5.4.1. Description

Multimodal travel planning is a key element of Intelligent Transport Systems (ITS) deployment. Existing and future electrified public transport infrastructure should serve as a backbone providing charging facilities for electric road vehicles, while also facilitating seamless multimodal travel. Multimodal travel considers more than one mean of transport when planning a route from A to B.

Taking a closer look towards today's transport system, its challenges and characteristics, there are clear drivers that could strengthen the share of intermodal trips. At the same time, weaknesses can be revealed that require a stronger integration of all modes:

- Around three fourth of the passenger kilometres in Europe per year are covered by car (European Commission 2012).
- Depending on the definition of multimodality, the estimated share of intermodal trips in Europe varies around 20% (interconnect 2011)
- There is a big gap between expectation towards travelling and perception of public transport:
    - Consumers expect travelling to be quick, cheap, comfortable and flexible
    - Public transport is often perceived as unreliable, cumbersome and inflexible
- In average, the car remains unused 23 hours per day (Lell 2013).
- External factors, such as the dependency on oil, the environmental impact of emissions and increasing congestion additionally stress the current transport system.

It is common sense that public transport can hardly substitute the car, particularly in rural areas. Therefore, fostering multimodality means optimizing transport as a whole, which comes along with an integration of all modes including public transport and cars. It is about making both complements rather than substitutes. Here, eCo-FEV provides significant potential. Due to the cooperative approach data on driving behaviour, movement patterns, energy consumption can be easily generated. These data helps in turn to optimize eCo-FEV services due to detailed and accurate travel information all merged on one platform. Thus, multimodality will become more attractive if public transport and individual transport is effectively linked. Having exact data on FEV's energy consumption e.g. can help to find the optimal balance between FEV usage, required charging time, and public transport. Beyond that multimodal travel will become more comfortable by providing exact costs information to the FEV traveller.

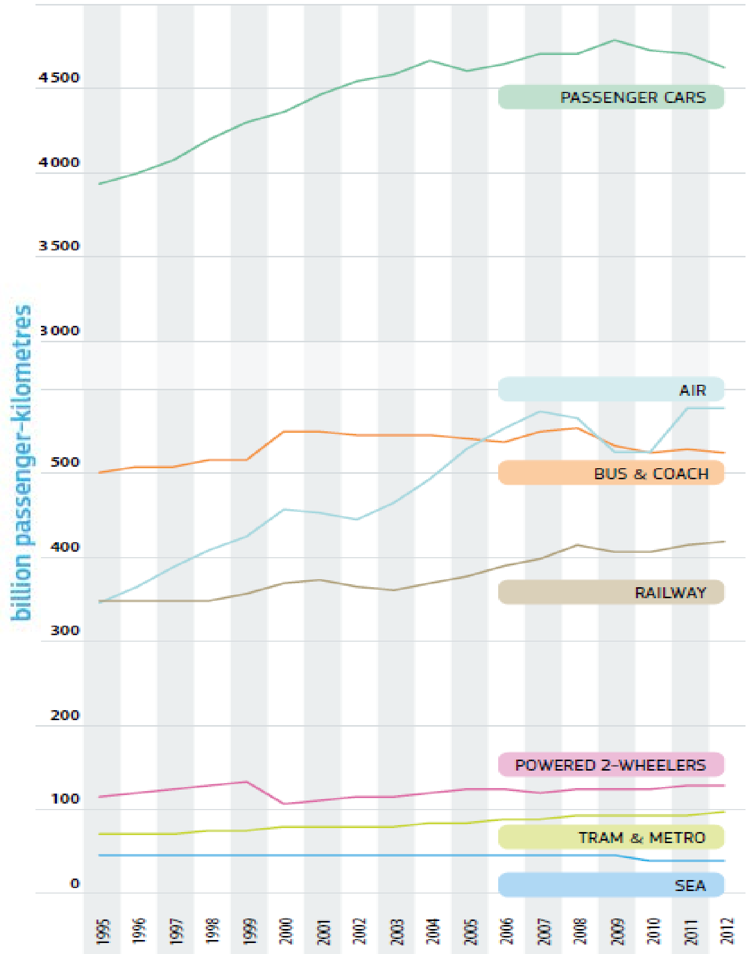


Figure 49: EU-28 Performance by Mode for Passenger Transport (1995-2012)

Figure 49 shows the development of performed kilometres of modes for passenger transport. While kilometres performed by passenger cars are decreasing since 2009, there is a slight increase in the performance of public transport, apart from buses and coaches. The graphic suggests that people in urban areas already changed their mobility patterns towards public transport.

With its multilayer architecture eCo-FEV platform is predestined for this service. The user sends a request to the eCo-FEV backend and algorithms calculate the best possible way taking into account the individual demand of modes. Thus, eCo-FEV provides added value by offering and integrated solution rather than isolated mode related solution, which results in an increase of comfort, flexibility and travel time.

Thanks to multimodal travel service, eCo-FEV meets one of the major challenges travellers will be faced with in the future by providing orientation within the increasing complexity of new mobility services. Especially in competitive situations, when competing service providers i.e. car sharing companies offer their services via eCo-FEV the user will be given the possibility to find the best possible individual solution.

5.5.4.2. Strategic evaluation

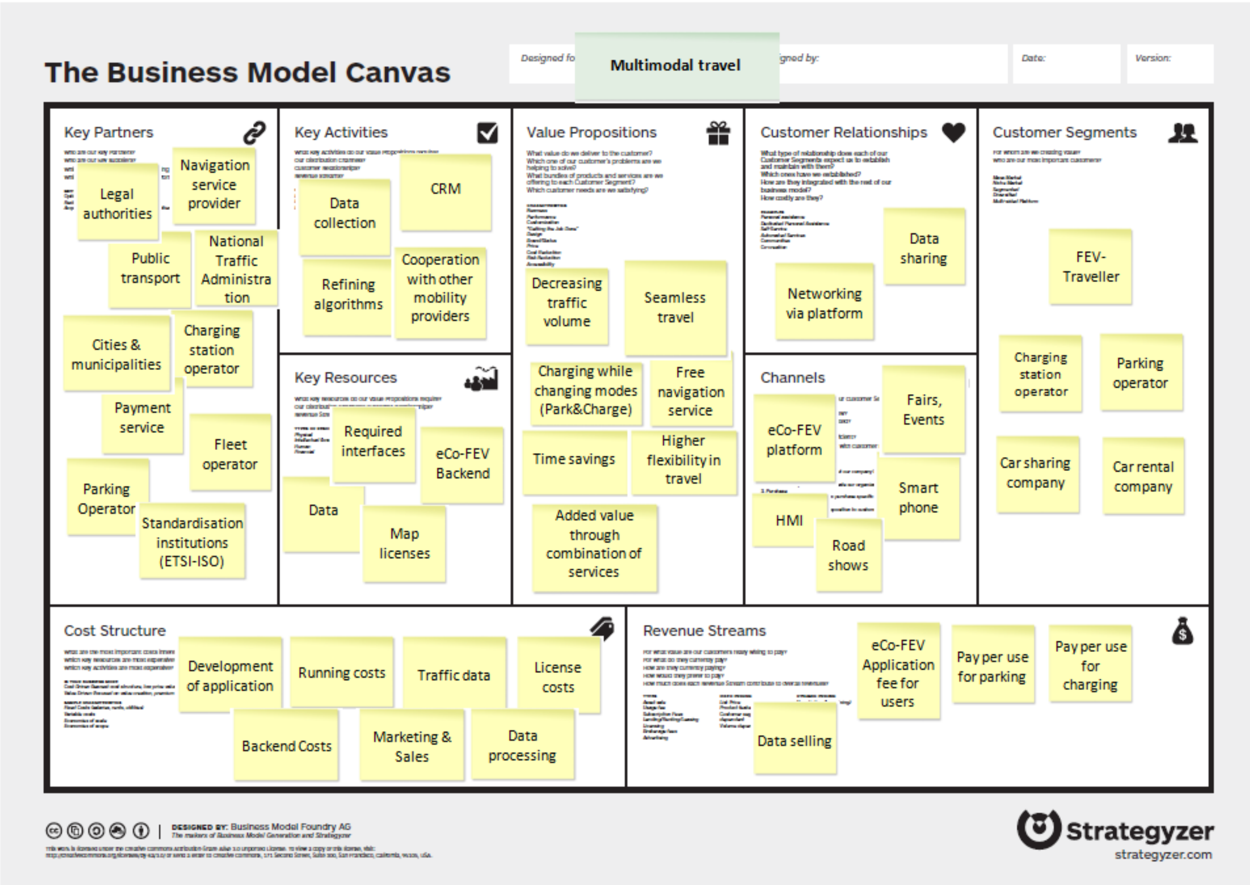


Figure 50: Osterwalder business model canvas – Multimodal travel

5.5.4.3. Roles and value network

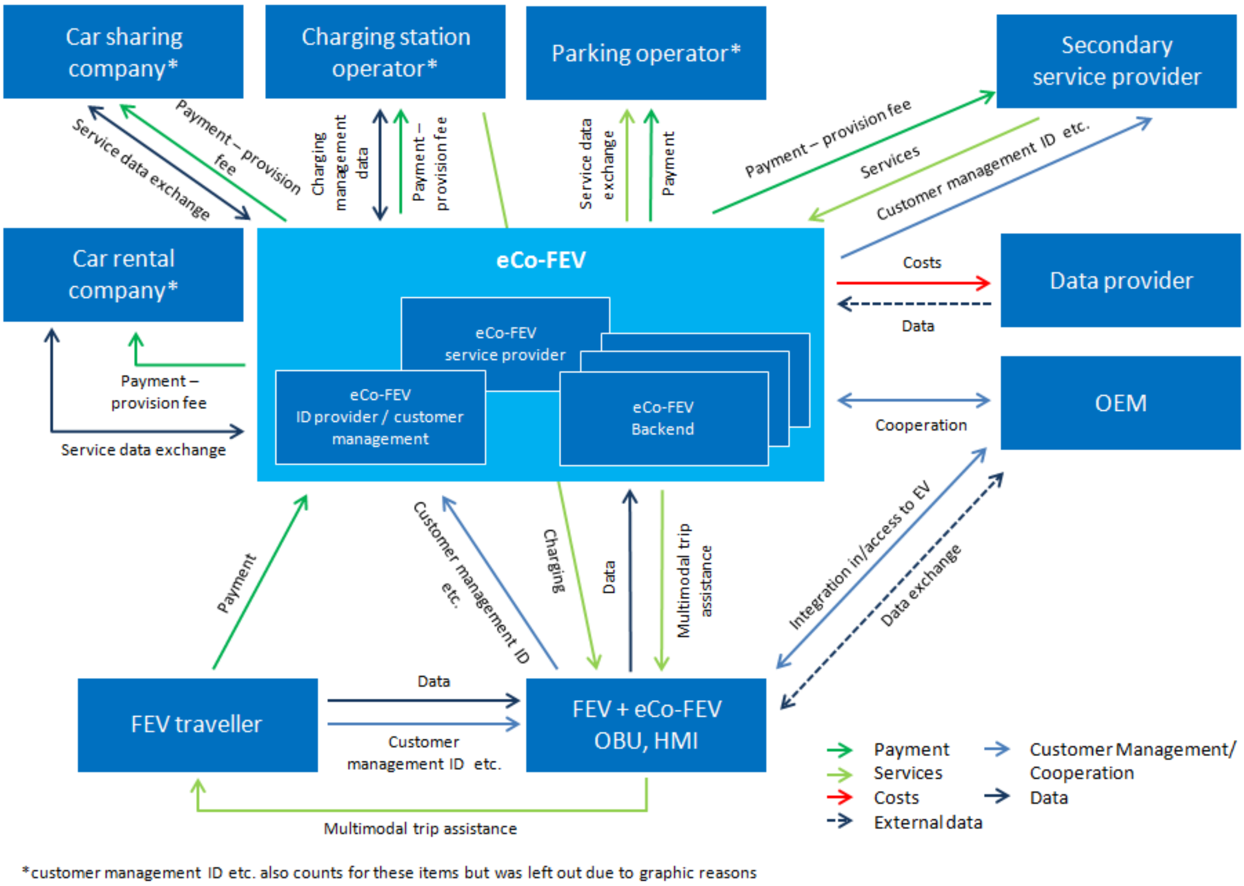


Figure 51: Value Network – Multimodal travel

Table 8: Stakeholder evaluation – Multimodal Travel

Stakeholder	Contribution	Benefit	Evaluation
FEV Traveller	• Uses trip assistance • Provides user data to eCo-FEV backend via OBU • Pays for use of service	• Higher flexibility • Integration of charging plan into travel plan • Information about different means displayed on one user interface	⊕ ⊗⊗ • Acceptance depends on general attitude towards public transport • Added value through multimodal travel depends on geographic location (urban > rural)
Secondary Service Provider	• Provide e-mobility services • Pays provision for FEV traveller using a service via eCo-FEV platform	• Higher convenience increases attractiveness of e-mobility itself • Potentially advertises its own service via eCo-FEV • Further dissemination →further communication channels • Enhancement of service quality by eCo-FEV data • Networking with other service providers	⊕⊕ ⊗ • The more services the higher value for eCo-FEV • Willingness to participate depends on current market position (fear of competition instead of cooperation)
OEM	• Provides FEV + access to and exchange of data via OBU	• Higher attractiveness of FEVs → more supporting services • User and driver data enhanced by eCo-FEV	⊕⊕⊕ ⊗⊗ • Cooperation is needed to ensure data access and exchange via OBU. Vehicle data is very sensitive → high security and trustworthiness

			requirements • OEMs do not foster multimodal travel
Public Transport	• Provides information about public transport for integration in eCo-FEV such as schedules and costs • Possible to offer ticket-buying via eCo-FEV • Promote park and ride facilities with charging options	• Receives valuable data about individual travel behaviour → service enhancement • Fostering use of public transport through integration of trip assistance • Attracting new passengers → higher comfort, higher flexibility • Benefit particularly in urban areas	• eCo-FEV facilitate new possibilities of multimodal travel • Contrary interests to OEMs • Added value through multimodal travel depends on geographic location (urban > rural)
Charging Station Operator	• Promote multimodal travel by installing charging stations at interchange possibilities	• Receives valuable data about individual travel behaviour → service enhancement • Higher utilisation of charging station at interchange possibilities	• eCo-FEV provides possibilities to drive a FEV even in rural areas by offering interchange stations with charging options.

5.5.5. Service 3: Fleet management

5.5.5.1. Description

This service takes up two trends, which correlate with each other - the trend of sharing economy and the trend of urbanisation. Especially in urban areas and metropolitan regions sharing economy is gaining more and more followers. Furthermore these urban areas are growing. Geographers call the 21st century the century of cities. In 2015 about 53% of the world's population lives in cities. Until 2030 forecast expect this figure to rise up to 60 % (statista.com 2015). Combining the growing of urban populations with the upcoming trend of sharing economy within this population, a growing demand especially for car sharing and car rental can be derived. Furthermore growing cities will lead to a growing demand of urban delivery. Hence this service faces a growing market with an even higher percentage of urban population in Europe.

One special feature of this case is the customer segmentation. In contrary to all other services here the primary customer segment represents fleet manager in the fields of car sharing, car rental, urban delivery, taxi, company fleets or transportation – thus B2B customer. Only at a second stage the FEV-Traveller becomes secondary customer segment (B2C). Furthermore contrarily to the multimodal service presented above, services of car sharing companies, taxi companies or rental car companies are integrated into the platform whereas in this case eCo-FEV is implemented in the FEVs of the fleet.

eCo-FEV offers several value propositions to fleet managers. These were discussed in detail in chapter 4.4. The main benefits are customized solutions for each fleet manager, enhanced services based on aggregated data, higher efficiency and improved fleet coordination and control.

Because of its special feature in terms of customer segmentation, it is difficult to assign this service to one primary business model.

Locating fleet management into the transaction cost based business model, the issue of licence occurs. Being FEVs part of a fleet will spend much more time driving as private owned FEVs. Hence the demand for eCo-FEV is much higher considering FEVs used in fleets. Therefore special agreements and licences need to be developed.

On the one hand to enhance services based on user data and data aggregation is necessary. But on the other hand, companies will have restrictions against eCo-FEV aggregating all the data provided by their fleet. But data in this case represent the main source of revenues for eCo-FEV. Hence, customized solutions must be developed considering special requirements of each B2B customer.

The same problem as with the first business model occurs with the third business model. Moreover, the full service B2C mobility provider business model, being the less probable one because of its monopolistic character, it is not further discusses at this stage.

5.5.5.2. Strategic evaluation

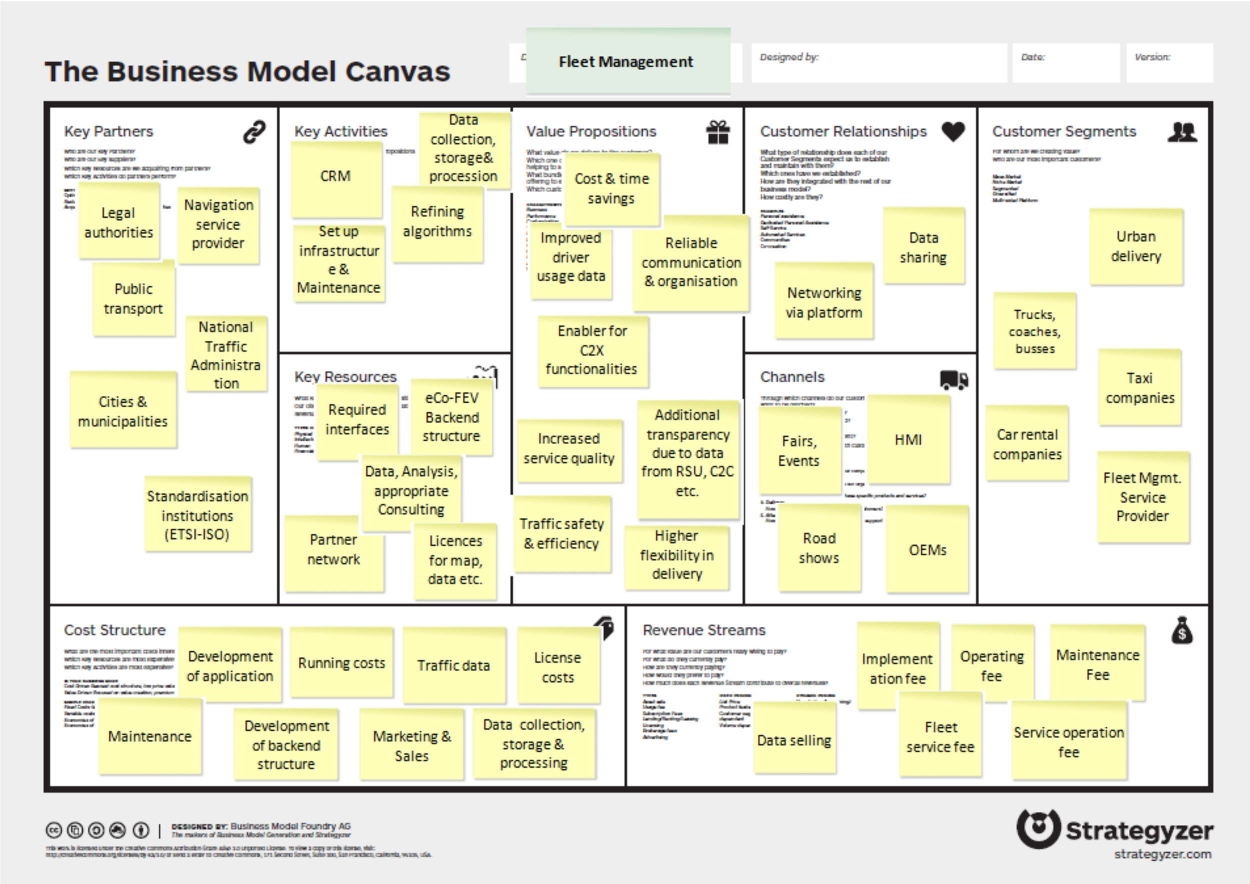


Figure 52: Osterwalder business model canvas – Fleet Management

5.5.5.3. Roles and value network

The value network for this service remains rather easier than the others. This is mostly because all B2B customers can be summarized in one customer segment. Although customized solutions differ for each customer, the value streams remain quite similar. All remaining elements are comparable to those in primary business model one as well as to those in primary business model two.

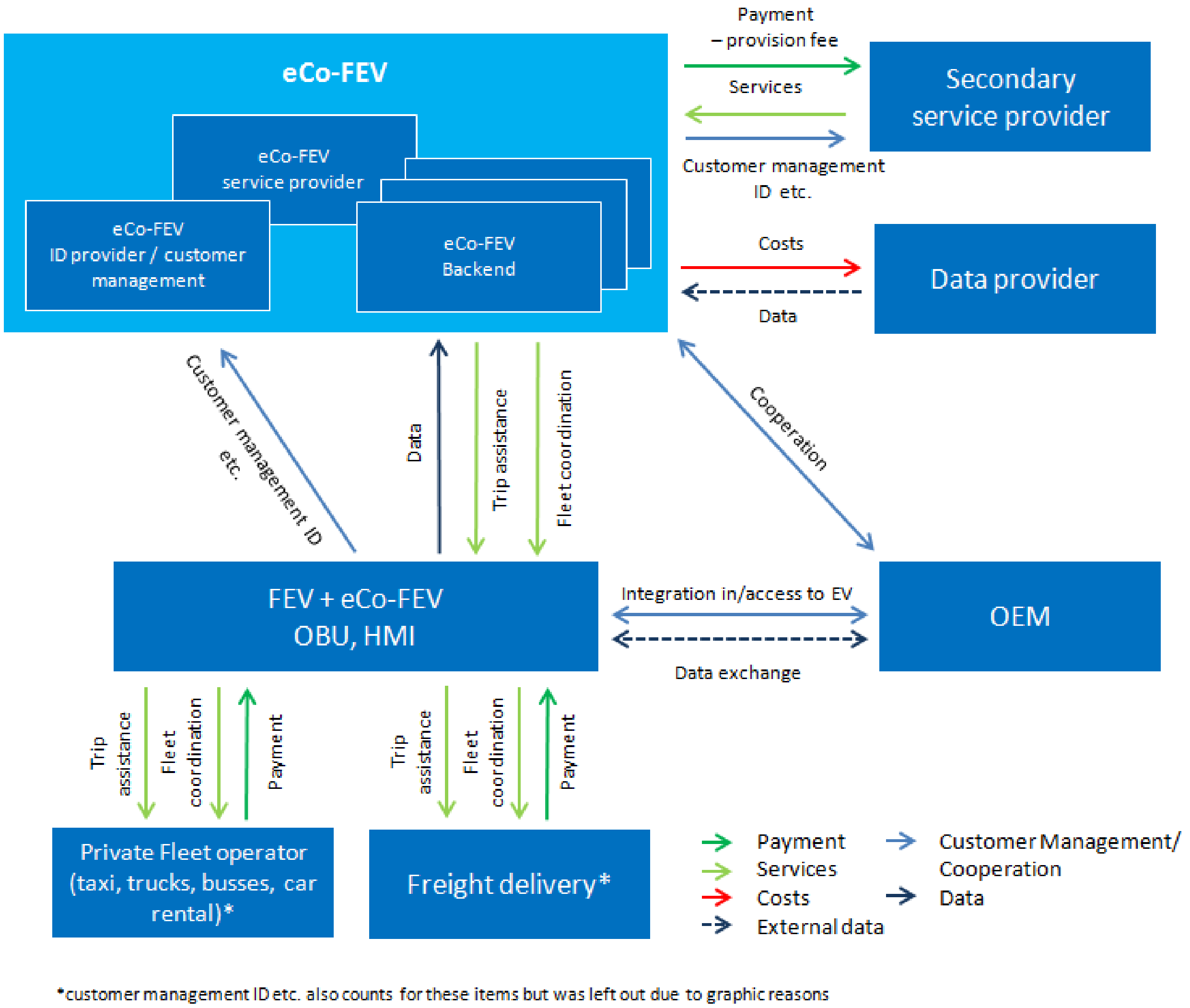


Figure 53: Value Network – Fleet Management

Table 9: Stakeholder evaluation – Fleet Management

Stakeholder	Contribution	Benefit	Evaluation
Fleet manager	• Pays fee for customized eCo-FEV services • Pays for customized service, maintenance and service enhancement	• Revenues finance eCo-FEV multisided platform • Creates E-mobility user experiences via FEVs in fleet → promotes (potential) customer enlightenment to remove mental barriers	⊕⊕⊕ ⊗ Acceptance depends on primary business model and related solutions. Fleet manager can become a major (continuously) source of revenues for eCo-FEV
Secondary Service Provider	• Provide e-mobility services • eCo-FEV withholds provision fee	• Integrated services raise overall value of eCo-FEV • Higher convenience increases attractiveness of e-mobility itself	⊕⊕ ⊗ Generally willing to participate in eCo-FEV → more customers can be reached. Willingness to participate depends on incentives and on what is the case for them
OEM	• Provides EV + access to and exchange of data via OBU • Channel to distribute eCo-FEV to fleet managers	• Higher attractiveness of EVs • Reduced range anxiety and concerns about charging (duration, availability)	⊕⊕⊕ ⊗⊗ Cooperation is needed to ensure data access and exchange via OBU. Vehicle data is very sensitive → high security and trustworthiness requirements
Data Provider	• Provides necessary data for eCo-FEV services	• Basic for eCo-FEV services	⊕⊕ Typical B2B relationship: payment - data

5.6. Conclusions and recommendations

Nevertheless all figures used to calculate the financial potentials of the three business models are based on assumptions the results still give an impression of the financial potential. Comparing the financial calculations, the data driven model shows by far the highest potential regarding the revenues. Having in mind, that on costs side no big differences can be identified between the business models, the data driven business model is the most promising one.

As argued at the beginning of this chapter, the three business models were developed to show the different approaches in order to finance a platform like eCo-FEV, which were discussed during the interviews. Summarizing all facts, perspectives and arguments worked up in the three business models, this work comes to the conclusion that a combination of the transaction cost based business model and the data driven business model is considered as the best solution.

This is for several reasons. Besides showing the highest economic potential, the data driven also pick up on major trends like big data, internet of things and the smart triangle development. Moreover the data driven model meets the interests of a major stakeholder group – the OEMs. Furthermore if all concerns related to data aggregation, storage and exchange can be overcome this business model wins over a major stakeholder of the e-mobility ecosystem.

However the economic potential and its structural advantages of the data driven business model should not be ignored and contrarily to the data driven business model the transaction cost based business model doesn't depend on a crucial amount of customers on the B2C side of the platform from the very beginning. Therefore it appears that the combination of these two approaches represents the best solution.

In the initial phase revenues can be generated via the transaction cost approach. At a later stage when a significant amount of customers was attracted to eCo-FEV, the data driven approach can develop its full potential. With this solution a sound business model approach is presented that takes the characteristics of the current e-mobility market into consideration as well as future trends. But most of all this solution can be economically feasible regardless of the e-mobility deployment and the amount of potential customers, which derive from it.

Excursus – Possible eCo-FEV operator

As it was mentioned at several points in this chapter it is not within the scope to address the question of who could be a potential eCo-FEV platform operator. Nevertheless first thoughts on this question raised during the interviews can be presented briefly.

For the first business model a company with great experience as market place provider like Apple is conceivable. Also global players of the ICT industry could are worth considering.

The second business model as it is based on big data could be run by a company like Google. Again a global player of the ICT industry is imaginable. The involvement of a public authority is ruled out due to the advertising element.

However for the third business model the involvement of public authorities is recommended to address the concerns about monopolistic situations. Besides that, utility companies are worth considering.

6. Deployment

6.1. Challenges

The broad range of stakeholder groups that participated in the interviews provided insights from many different perspectives. While generally all participants showed a positive attitude towards eCo-FEV, challenges and concerns for the market introduction were also present and diverse.

Generally, it was the concurring opinion that reconciling the multiple stakeholders' interests would be the most important challenge eCo-FEV will face.

While several specific aspects are already been discussed in the business case discussion, the focus at this point is about aspects related to market introduction in generals. The different aspects could be summarized under the following categories:

- **Standardization**
  The cooperative idea of eCo-FEV requires a high level of standardization. Currently the missing standardization leads to confusion among consumers and investors. There already are two different types of fast charging protocols deployed, for example, which leads to further restrictions in the usage of charging facilities. Experts and stakeholders agreed that the European Commission should accelerate European e-mobility development by setting standards to foster cooperation and foster accessibility to the entire European charging network.

- **Collaboration**
  The eCo-FEV idea is about bringing multiple inter-dependent stakeholders into collaboration. At the same time this is seen as one further challenge. While on the one side the relation between competitors in a free market is based on business rivalry, others promote the point of view that is based on the establishment of strategic alliances, especially on multisided platforms as eCo-FEV. One of those strategic partnerships is named today "coopetition". It became dominant in the automotive industry over the past years, as it is one of the most capital and technology intensive industries.

- **User acceptance**
  Even if all previous challenges are overcome the end user decides about the success of eCo-FEV. The success of eCo-FEV depends on the further deployment of FEVs on the streets of the European Union. However, there are still barriers and doubts towards e-mobility in many countries that need to be overcome in order to allow a mass-market introduction of FEVs.

6.2. Strategic implications

Opportunities

In chapter three the current e-mobility market situation has been discussed in detail. According to eCo-FEVs goal to achieve a breakthrough in the introduction of EVs to a mass market, several challenges have been identified, such as high purchase costs, range limitations, mental barriers and missing interoperability of the existing solutions and services. This chapter now points out opportunities, which derive on the one hand from these challenges and on the other hands from trends and developments discussed partially in chapter 5.2.1. Furthermore arguments and structural elements from the Global EV Outlook (IEA 2013) are worked up within this section especially the opportunity matrix is inspired by it. At the end of this section all opportunities discussed in this section are visualized. Since eCo-FEV strongly correlates with all elements of the e-mobility ecosystem (see 3.1), opportunities not only for eCo-FEV but also for e-mobility itself will be mentioned and put into context.

6.2.1. Technology

Costs

The issue of costs must be approached in two different ways. On the one side, there are costs related to eCo-FEV itself. On the other hand there are costs related to EV purchase and TCO. As discussed within the business model descriptions, costs for eCo-FEV are quiet similar no matter which business model is considered to be the most successful one. Costs for EVs however are very dynamic and can be reduced via several ways. The absolute EV purchase costs will fall in the next years mostly because of developments in battery technology. Following the aggregated insights, oil price will rise again in the near future, which lowers the relative TCO of EVs furthermore in comparison to TCO of ICEs. On the long term, economies of scale will also pay off. Furthermore integration of EVs in the smart triangle and internet of things will make EVs much more attractive. If eCo-FEV can contribute to this development, a major step towards mass market can be achieved.

Synergies through integration

E-mobility is only one element in a major technological driven shift. Mobility itself is about to change and connectivity, digitalisation and internet of things will have a major impact on human life, behaviour and consumption as well. Furthermore, in line with the integration of EVs in the smart triangle and the development of renewable energies complete, new opportunities for business will occur enabled through identified and utilized synergy effects of the described developments. Cloud based services will complete the picture of the future technological development which will be of great importance and potential for eCo-FEV. The multisided platform can make use of and contribute to all these developments in the near future. The biggest opportunity for eCo-FEV will be the chance to become a major player in all these fields by correlating significant actors, technologies and developments related to the aspects discussed above.

Range limitations and mental barriers

Technological development will lead to improved performances of EV considering range and charging patterns. But up to today customers are concerned about limited range of FEVs and the still small amount of available charging stations and their interoperability. But as this work has stated, a lot of these barriers are mental barriers. Hence, most EV owners charge their vehicle at home or at work. Public charging remains an exception. Furthermore most private owned FEVs are used as second car and/or for commuting. One survey of American consumers found that 75% of respondents considered range to be either a major disadvantage or somewhat of a disadvantage of EVs (Carley et al. 2013). Another survey showed that consumers in the United States and France were the most sensitive to range (Deloitte 2011). Yet in the United States the average daily vehicle distance travelled per person is 46 km and average vehicle trip distance is 15 km (U.S. Dept. of Transportation 2009). Given the fact that U.S. average travel distances are the longest in the world, it is likely that most of today's electric vehicles have sufficient range for a majority of consumers worldwide. Hence, as soon as this gap between range expectations and actual average driving needs can be closed, negative perceptions about EV range and notions of range anxiety will vanish. First step will be to integrate FEV into car sharing or car rental fleets. Also several municipalities offer community

FEVs, which can be rented. Technological developments in battery and charging technology will also contribute to close this gap.

6.2.2. Finance

The immediate challenge of high purchase prices exposes the need for different EV financing options than are widely available at present. Should cost reductions in batteries and vehicle systems not materialise quickly enough, attractive financing mechanisms may be needed to maintain sales growth, particularly as government purchase subsidies are phased out. Vehicle leasing is one potential pathway, and there is some evidence that competitive lease rates have already helped to bolster EV sales (Vandezande 2012).

Along with new technological and digital developments new opportunities and ways to make business will occur. For these opportunities financial support and suitable instruments is necessary. These financial instruments must cover all scales and dimensions starting with seed investments in new ideas, products and markets and ending up at developing European-wide supporting initiatives for R&D for all areas of the e-mobility ecosystem. This also means to improve multilateral communication and cooperation in the fields of successful supporting initiatives. Governments in Europe need to exchange knowledge and experiences made with several kinds of supporting initiatives to develop adequate financial instruments to invest in common areas of need. These areas need to be identified and addressed throughout which investment cost into these areas can be spread via several EU-members and stakeholders.

Whereas national governments have a unique role to play in supporting R&D and offering fiscal incentives, private businesses can assume a larger role with regard to financing EVSE deployment. Meeting market demand for public charging through innovative business solutions is a necessity for the long-term viability of electrified transport. Of course, public investment can still assist in seeding new markets by catalysing initial EVSE deployment and encouraging private sector participation. Public-private cost sharing for EVSE deployment can be particularly transformative in early markets.

Governments can also provide more clarity to EVSE service providers on how they will be regulated. In some jurisdictions, only regulated utilities are allowed to sell electricity directly to consumers, which could diminish the business model of non-utility EVSE service providers. Such providers will need to establish some type of service fee instead of charging for electricity use. In any event, as much regulatory certainty as possible will help encourage more private investment

During all interviews that were conducted one common sense was mentioned unrestricted. The common benefit occurring from e-mobility - speaking in economic, ecologic and societal terms - will be greater than all barriers. Hence a joint effort will pay off for everybody.

6.2.3. Market

Optimising EVSE deployment

Not only do sustainable funding models for infrastructure provision needs to be identified, but the scale and location in which infrastructure is deployed require a smarter approach. Early attempts to cover cities with charging stations (much of them publicly-funded) in anticipation of large-scale EV uptake resulted in some instances of EVSE experiencing little or no customer utilisation (Hagerty & Ramsey 2011; Williams 2011). In other instances, initial widespread deployment of EVSE did not lead to the expected jumpstart of EV sales (Hinds 2012). Instead of solely maximising EVSE, it is better to optimise its deployment and integrate it properly with the broader e-mobility ecosystem. This means deploying EVSE more intelligently outside the home.

Information and data sharing

As a best practice, public EVSE deployment should be driven as much as possible by robust data on EV driver location and travel patterns, infrastructure utilisation, and charging behaviour to ensure that equipment is placed in relevant locations and to avoid overinvestment that may result in unused assets. Governments have a role in gathering and sharing such data, which can be collected through demonstration projects and other rigorous research initiatives. The recently announced “European Electro Mobility Observatory” sponsored by the European Union includes the public-private “EV Project” as an example of existing data-driven demonstration project (AVERE 2013). eCo-FEV as a multisided platform with access to a tremendous amount of data can play a key role in aggregating, storing and redistributing data. As business model 2 has shown, big data also hold immense economic potential, which should be seen as a driver to e-mobility and eCo-FEV.

Planning security

Experts but most of all stakeholders from OEM and EVSE perspective raised the concern about volatile regulatory frameworks within the EU. Each member state has its own regulations and supporting initiatives. Additionally on EU scale several regulations have been approved, such as the CO_2 emission fleet regulations or EU the development goals considering energy efficiency and resource independency. All these regulations are the product of distinguished interests, which exist on all scales and within all stakeholder groups. Hence shifts in the political, economic or ecological dimensions always have impact on the current regulations. As the most prominent example of the last years Fukushima and the related energy transition which was passed in Germany hast to be mentioned.

Such shifts of the regulatory framework can boost some industries while it can harm others as can be seen for the industry of renewable energies on the one side and the industry of nuclear energy on the other side. Hence a major challenge for the market, which can become a great opportunity to e-mobility and eCo-FEV, will be if the current established regulations and committed goals are followed by concrete measures.

Interoperability through international cooperation

Beside costs and range limitations, interoperability remains one major challenge to e-mobility. As it is formulated in eCo-FEV's goals, it is aimed to enlarge interoperability by integrating all relevant stakeholders into one platform. Besides integration into one platform, technical and ICT standards and regulations, which enable interoperability, are necessary in the first place. For developing these standards and to harmonize technical and ICT solutions, this work suggests a European "E-mobility Task Force". Such a task force should consist of political, economical and scientific actors. The overall aim should be to improve communication and cooperation between several areas - spatial and economical - within Europe. Furthermore such a task force can identify areas of common needs and enhance the exchange and transfer of gained knowledge between involved partners. At the same time perspectives of all relevant stakeholders are considered within the process of defining new goals, regulations or processes. All related actors will benefit from synergies and knowledge gained through this task force. Being a project of the European Commission, eCo-FEV can contribute and benefit in large scale, especially when it comes to data aggregation, transfer and exchange.

Raised attractiveness through combination

As this work has proven, some cases don't pay off if considered isolated. But in combination the same cases become highly attractive and thereby profitable. For example public charging will not be a profitable case in the next years due to its high implementation costs on the one side and very low utilization rates and very low revenue streams on the other side. The attractiveness of public charging rises if combined with multimodal travelling. As described in secondary business case 2, public charging becomes one element in a Cascadian network of services and thereby gains attractiveness.

Hence depending on customer segment, distinguishing user demands occur and therefore different e-mobility service packages need to be developed. Big differences for example occur between urban and rural areas. As interviews have shown, completely different usage patterns can be derived depending on the area where FEVs are used. By diversifying e-mobility service packages more customers might be reached. Having access to all necessary e-mobility services, eCo-FEV is in the unique position to identify these different user demands and derive adequate service packages for each customer segment.

Payment systems eRoaming vs. PayPal, Visa & co

The examples of Hubject and e-clearing.net show that a major part of e-mobility stakeholders currently bets on payment via eRoaming, comparable to payment known from mobile phones. Other, rather small companies like E-WALD develop alternative payment systems, which are based on already existing systems like PayPal. They are supported by projects undertaken by major players like VISA who aim at the same direction. Experts stated that simple and already proven payment systems like VISA are more likely to succeed. This simply because they are easier to use and already known from the customer. While eRoaming connects hundreds of different charging station providers and thereby different interfaces, E-Wald and VISA will enable the customer simply to pay by credit card or online payment. For the customer, charging at public or foreign charging stations will be like charging at any gas station. With eRoaming the customer needs to consider the charging station operator, interoperability and price fluctuations. Hence this work recommends eCo-FEV to concentrate on payment systems based on conventional systems like credit card or online payment. Moreover interviews raised the concern, that integrating each single charging station operator one by one will raise immense costs. Otherwise integrating already existing platforms like Hubject or e-clearing.net may be also difficult because of the competitive power relations. Such platforms already have a significant market share. Therefore they will hardly agree on being integrated into one bigger platform, which takes advantage of their already integrated customers.

6.2.4. Policy

Data security and privacy

In line with developments of big data, internet of things and smart triangle, data and therefore issues concerning data privacy and data security gain more and more importance. Hence it is of great urgency to develop adequate regulations that take care of these concerns. It is in the responsibility of European politicians to set up a framework for data issues. Moreover regulations for interoperability are needed as well. As interviews have shown regulations like the CO_2 emission reduction goals are widely preferred because they enable each effected company to develop their own solutions to meet these regulation goals.

As soon as adequate regulations are passed many problems can be solved and addressed. Especially for eCo-FEV this issue is of great importance because it relies on data to a large extent.

Identify and utilize synergies

Each stakeholder group has its individual perspective on the e-mobility ecosystem. Hence it is one result of this work that a systemic approach, which considers all major developments, can be of great value to each of them. These major developments are: climate change, energy transition, mobility transition, e-mobility, smart triangle and internet of things. The only possible actor who is able to follow such an approach is EU policy. By combining these major developments great synergy effects can be identified and can be benefited from. Experts mentioned that the integration of FEV into smart grid can solve the problem of volatile energy currents originating from renewable energies. Furthermore making use of FEVs as swarm energy storages will lower TCO of FEVs because charging costs will turn into revenues origin from making FEVs available for utilities to storage renewable energy. Based on this scenario further synergies derive. Such synergies can be a strong e-mobility uptake and in line with that a boost for renewable energies, which leads to less CO_2 emissions, less air pollution and to reduced resource dependency.

Synergies profitable for economy and ecology are only one benefit. If politicians start to communicate this systemic approach publicly including all synergies that derive from it, the acceptance of, and engagement for each of these major developments will rise within the society.

From the very beginning it is the aim of eCo-FEV to integrate all relevant stakeholders into one platform to make e-mobility a mass market. Identifying and utilizing the described benefits within the range of eCo-FEV is a great opportunity to contribute to this goal. Furthermore communicating the systemic approach together with politicians towards customers, stakeholders and public will raise the attractiveness of eCo-FEV and e-mobility in general.

Opportunity Matrix

Sector	Opportunity	TECHNOLOGY	FINANCE	MARKET	POLICY
PUBLIC	Optimize Infrastructure Development	Subsidize digital and mobility infrastructure ★	Seed EVSE investments in new technologies & markets	Support Market driven EVSE provision	Improve governmental cooperation and knowledge exchange
PUBLIC	Develop Regulatory for Data Privacy & Security			Provide data on driving and charging behaviours via pilots ★	EU regulatory for data security & privacy → Big Data ★
PUBLIC	Develop regulatory framework			Ensure planning security through consistent regulations	Set framework for interoperability of European infrastructure ★
PUBLIC	Live up to commitments				Ensure predictable fuel economy & adequate emission regulations
PUBLIC	Develop common (EU) goals & incentives		Develop & enlarge EU-wide supporting initiatives for R&D		Extent successful supporting instruments from national → EU
PUBLIC	Combine related issues to profit from synergies	Connect/integrate EVs into smart triangle & internet of things ★			Combine climate change, resource scarcity, energy change and e-mobility within political agenda setting and public communication ★
PUBLIC/PRIVATE	Sustain R&D Investment	Reduce battery costs ★ Enhance performance ★	Share deployment costs PPP		Clear fuel economy labelling Public education & awareness
PUBLIC/PRIVATE	Coordinate International RD&D	Address common areas of need			
PUBLIC/PRIVATE	Address information Asymmetries	Spread costs to accelerate breakthrough		Set up European "E-mobility Task Force" (Policy+Private+Science) ★	
PUBLIC/PRIVATE	Harmonise/Develop Standards	Support R&D for common areas of need			Demonstrate proof of concept
PUBLIC/PRIVATE	E-mobility Integration in Smart Grid, ITS etc.	Support research project on technical development		Support industry-led efforts Support interoperability ★	Lead by example Explore public/private acquisition models
PUBLIC/PRIVATE	Support Fleet Procurement		Create financial incentives for fleet procurement	International cooperation on harmonisation ★	
PRIVATE	Develop EV Financing Markets		Traditional & battery-only leasing		
PRIVATE	Enlarge/Increase Cooperation & Coopetition	Connected vehicle ★ Charge while driving ★	Develop resale & after sales market ★ Define clear revenue models	Develop several e-mobility packages for different user demands → urban / rural ★	
PRIVATE	Identify Sustainable EVSE/EVSP Models	Cloud based services (multimodality) ★	Create Retail Partnerships	Integrate convenient payment systems like PayPal, Visa, etc. ★	
PRIVATE	Increase Model diversity	On-board E-mobility apps ★		Introduce Differentiated Range, Styling & Functionality	
PRIVATE	Create opportunities for consumer experiences			Integrated EVs in car rental, car sharing and public authority fleets	Promote customer enlightenment to dismantle mental barriers ★

★ special significance to eCo-FEV

6.3. Roadmap

In the chapter before, strategic implications were discussed which are necessary to eCo-FEV's success. Those with the highest relevance to eCo-FEV are worked up in the e-mobility roadmap shown below.

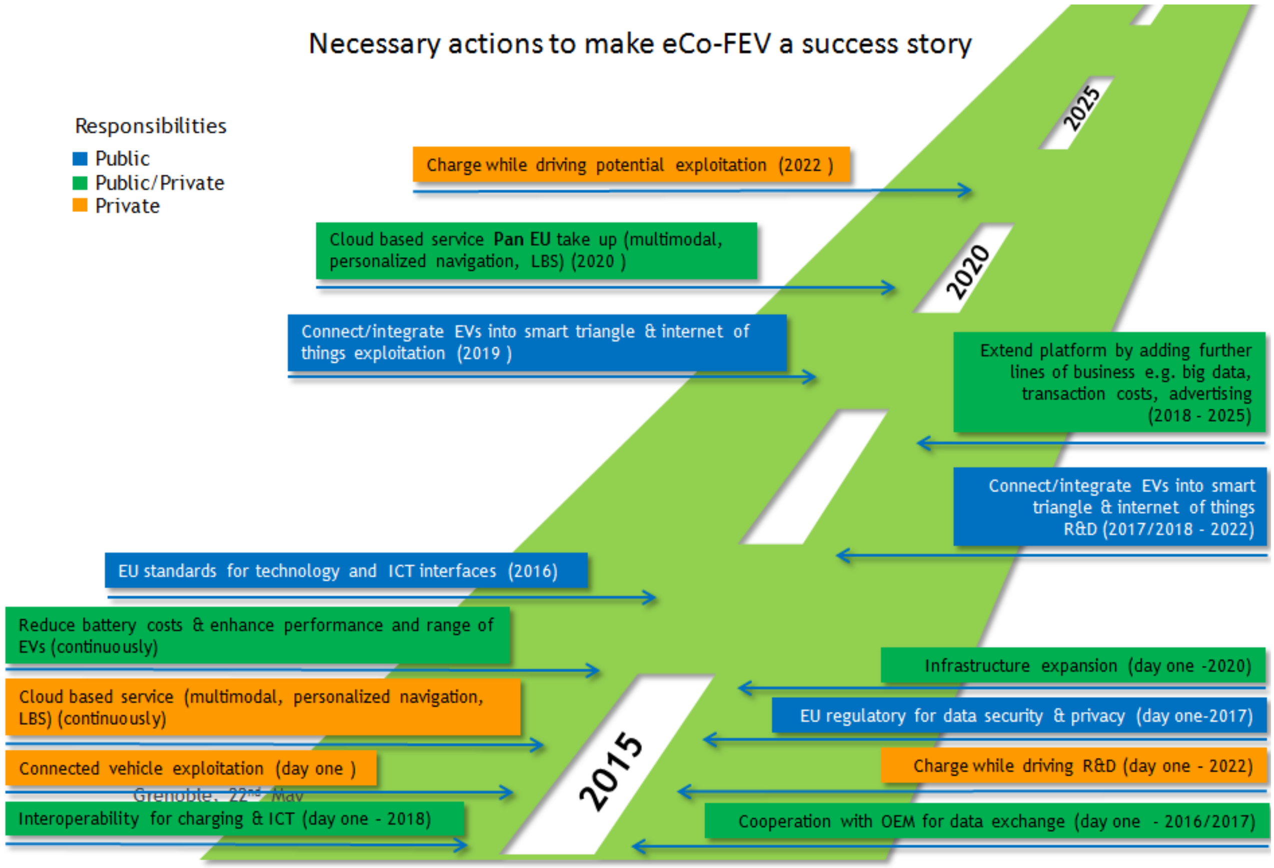


Figure 54: Recommendations for Action - E-mobility Roadmap for eCo-FEV

7. Economic impact analysis

7.1. Economic situation and electric mobility

The market for electric mobility is an emerging market. However, there are empirical limitations: due to the fact that time series data are not yet available, which again hinders a detailed insight into the market and especially into the future market performance. Nevertheless, it is possible to gain more information and insights into emerging markets by using the comparable market approach.

When the market for wireless services emerged, the characteristics were market heterogeneity, socio-political governance, chronic shortage of resources, unbranded competition, and inadequate infrastructure (Sheth, 2011). These market characteristics are more or less similar to the current situation of the electric mobility market. Therefore the market for wireless services can be used for comparative analysis. Blackman, Forge, Bohlin, and Clements (2007) analysed the effect of different economic framework conditions on the demand for wireless service. Five economic scenarios were created (SMOOTH – general economic and social move up due to lifestyle factors; DECLINE – economic stagnation; CHANGE – changing regions of prosperity, FINANCIAL CRASH – meltdown; MAJOR DISASTER). A central result is that in the first ten years after the introduction on the market, the demand differences between the scenarios are relatively small. Following these findings, it can be argued that the economic situation is not significantly relevant in the market introduction phase and market growth phase of emerging markets, however, other factors dominate the market growth such as market entry of newcomers with product innovations, venture capital investments, and demand.

Furthermore, looking at the current economic developments in EU28, the prospects can be described as follows: In 2015, the economy of EU28 is in a better shape compared to the year 2011. The current growth in 2015 by +1.3% is faster than expected. For 2016, an average economic growth rate in the euro zone by 1.9% is expected (EC, 2015). Against the background of current economic forecasts and regarding the findings of Blackman et al. (2007), the recent economic situation for electric mobility services is normal. There are no indications for an economic crisis affecting the market development of electric mobility.

In the next step, the status quo of the electric vehicle markets for France, the Netherlands, and Germany is analyzed. The objective is to find out whether market failures exist, and if they exist, how they can be overcome.

7.2. Electric mobility demand

For France, the Netherlands and Germany it is possible to look deeper into the market for electric passenger cars to understand the mismatch between policy targets for the number of EVs and the actual market demand for EVs. Table 1 compares the market conditions and political objectives for these EU-Member States.

Table 10: Electric vehicle market characteristics for France, Netherlands and Germany in 2014 and growth rates of electric vehicle share of new car registrations (Source: Automobile Propre 2015; AVERE 2015; Kane 2014; Rowney, Straw 2013; Rijksdienst 2014; KBA 2014; cleantechnica 2014; CECRA 2015)

	France	Netherlands	Germany
Number of electric vehicles in 2014	43,605	45,020	19,000
Policy Objective: electric vehicles in 2020	2,000,000	200,000	1,000,000
Electric vehicle share of new car registrations in 2014	0.5%	0.6%	0.4%
Expected Growth rate of electric vehicle share of new car registrations	+67%**	+9.4%*	+78%**
Passenger car registrations in 2014	1,795,913	387,835	3,036,773

Annotations:
* Between 2011 and 2014 the growth rate of electric vehicle share of new car registrations in the Netherlands has a huge variance between +0.6% and +186%. The last growth rate was the lowest one; therefore, it seems appropriate to use the geometric mean.
** Both rates were over the last two years relatively stable. Therefore, the latest value is used. However, it is too optimistic because until 2020 diminishing value can be expected.

Based on table 15, it is possible to dynamically analyse whether the politically given electric vehicle number for the year 2020 can be reached. The annual changes in passenger car registrations are relatively low; therefore the ceteris paribus assumption is used. Table 10 shows figures from France, the Netherlands, and Germany. In Figure 55, Figure 46 and Figure 57 the blue line (EV-objective) always represents the national given linear path to the national target value of electric vehicles in the year 2020. The orange line (EV-Market Demand) shows the path of electric vehicle car deployment given the circumstances of the current market conditions.

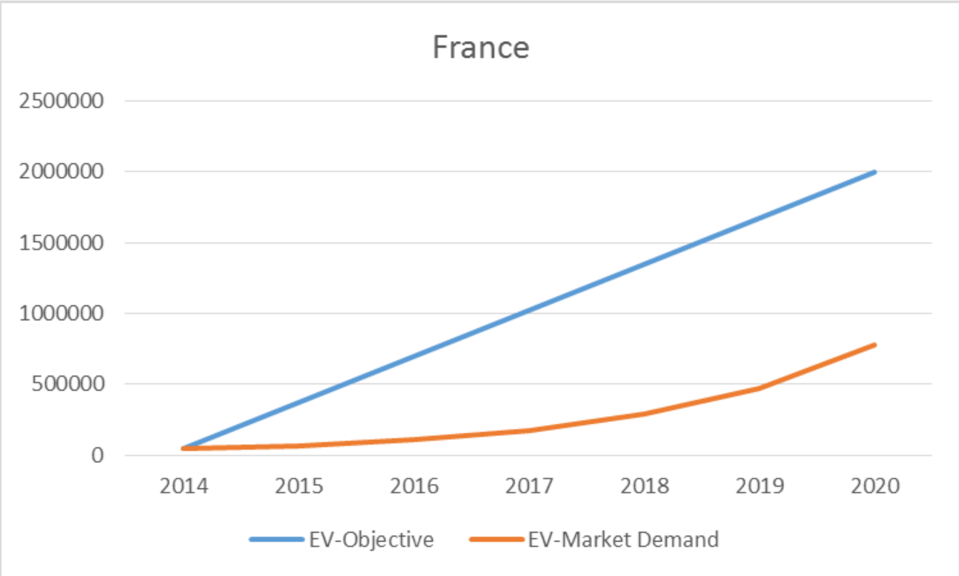


Figure 55: Electric vehicle development in France – policy given path and market expected path until 2020 (source: own estimation)

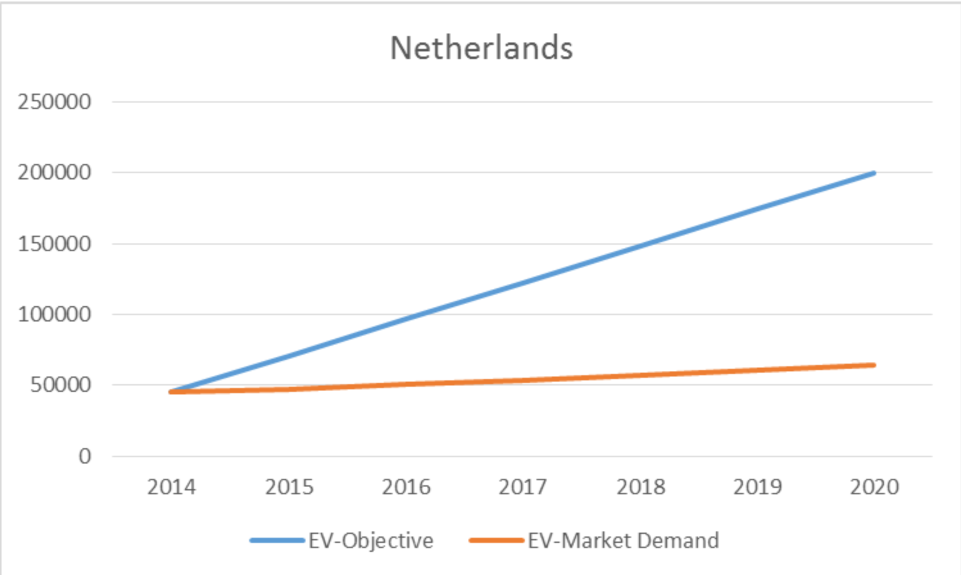


Figure 56: Electric vehicle development in Netherlands – policy given path and market expected path until 2020 (source own estimation)

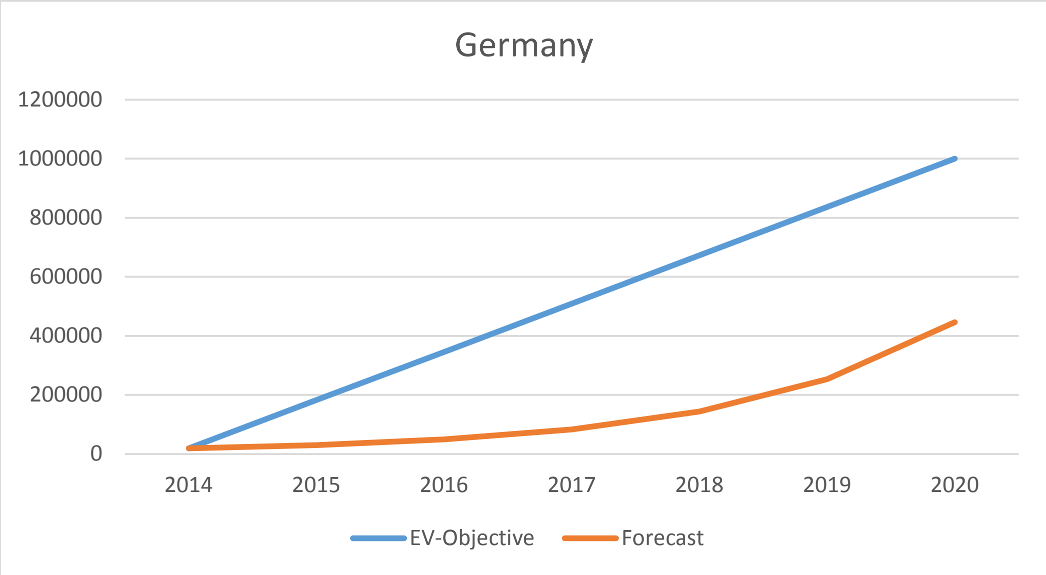


Figure 57: Electric vehicle development in Germany – policy given path and market expected path until 2020 (source own estimation)

In France, the Netherlands and Germany, the electric vehicle share of new registered cars show approximately the same trend. The main difference is the expected growth rate of this share. France and Germany can be grouped together because they have comparable market conditions contrary to the market conditions in the Netherlands. The Netherlands faced strong increases in electric car sales in 2013, which however were extremely low in 2014. The market demands seem to be unsteady. Reaching the policy objective of 200,000 EVs is limited because the general demand for cars in the Netherlands is significantly lower compared to France and Germany.

France and Germany do not have this kind of demand restrictions. However, they are not able to shift the demand from regular cars to electric cars. This means that although both France and Germany will realize an over-proportional increase in the demand for electric vehicles, they will not be able to close their gap to the politically given number of electric vehicles in 2020.

7.3. eCo-FEV impact to electric mobility

eCo-FEV can be seen as a key project to foster the market success of electric mobility because the technical solutions overcome some of the technical barriers identified by Sovacool and Hirsh (2009) and the lack of workable business models, which was identified as a main existing barrier by Steinhilber et al. (2013). However, at this stage, it is not possible to calculate the full costs and benefits of eCo-FEV because eCo-FEV's focus is the development of a workable implementation strategy. Only with the knowledge of an implementation strategy, it is possible to calculate the costs and benefits of eCo-FEV. Nevertheless, based on the previous literature, it is possible to illustrate how eCo-FEV can accelerate the introduction of EVs into the European market. Therefore, as an integrative approach, the technology acceptance model (TAM) developed by Davis, Bagozzi, and Warshaw (1989) can be used to identify the impact channels of eCo-FEV. One possible theoretical approach is the TAM. With the TAM-approach it is possible to model how users come to accept and use EVs. Figure 4 gives an overview how eCo-FEV can be integrated into the technological acceptance model. eCo-FEV will have direct impacts on the perceived usefulness of electric mobility and the perceived ease of use of electric mobility.

The perceived usefulness (PU) of electric mobility is defined as the degree to which a person believes that using electric vehicles improves his or her life conditions.

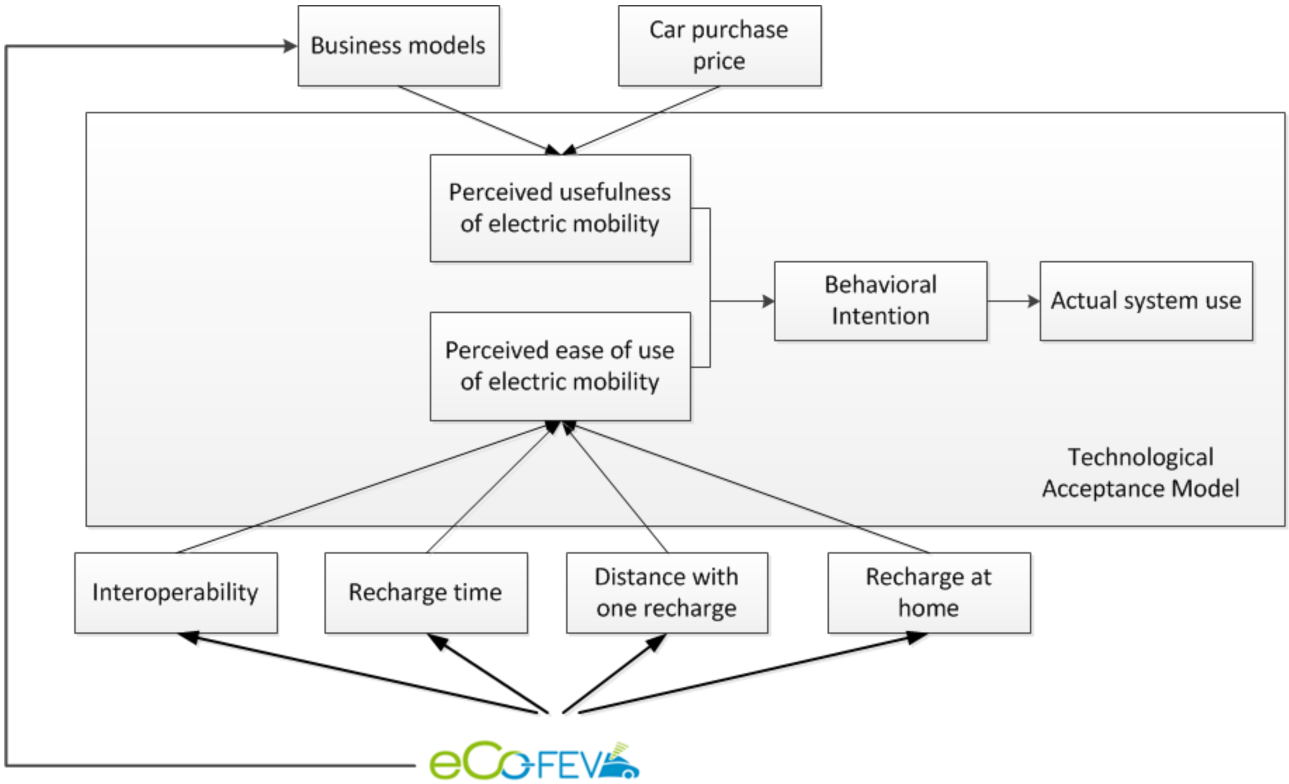


Figure 58: Technology acceptance model for electric mobility and eCo-FEV contribution to foster the market success (Source: own graphic referring to Davis et al. (1989) and Sternad and Bobek (2013)

The perceived ease of use of electric mobility (PE) is the degree to which a person believes that using electric mobility would be free of additional effort. Both PU and PE determine directly the behavioural intention to electric mobility. In economic terms, the impact on the behavioural intention means that for example the likelihood to buy an electric vehicle is increased. Whether the change of the likelihood to buy an electric vehicle affects the purchase decision is measured by the actual system use. The difference between behavioural intention and actual system use reflects the transformation ratio from a willingness to buy to real purchase.

The findings of Thiel et al. (2012) concerning the consumer preference for EVs can now be matched to the technological acceptance model. Furthermore, the findings of Steinhilber et al. (2013) stating that existing business models are necessary for a higher consumer acceptance are integrated. In a next step, the arrows illustrate the impact of eCo-FEV on the most chosen features, which are relevant for the willingness to buy an EV. The empirical advantage of the study of Thiel et al. (2012) is that the perfect completion of the favourited features leads to an average likelihood of buying an electric car of 38.4%. eCo-FEV can be interpreted as a mean enabling the fulfilment of the consumers' feature related wishes. However, to show the expected impact of eCo-FEV, it is assumed that 30% of the likelihood of buying an electric car is enabled by eCo-FEV.[6] These assumptions might be too optimistic, however, eCo-FEV as an electro mobility platform has a high potential to become a market dominant solution for service provision in the field of electric mobility because charging times are shortened, travel distances without charging will be longer, and the ease of use will be increased. Also, eCo-FEV aims at more than 50% of the identified features by Thiel et al. (2012).

Figure 5 shows the possible impact of eCo-FEV on the market introduction of EVs in France. The gap between the market path and political path can be narrowed. In 2021, it will be possible to reach the political objective of 2 Million electric vehicles. Due to the low growth of electric vehicle share of car registrations, the gap cannot be closed this fast in the Netherlands. However, the political objective of 200,000 electric vehicles might be reached by a possible eCo-FEV impact in 2023. The possible eCo-FEV impact in Germany would contribute to reaching the political goal of 1 Million electric vehicles in 2020.

[6] The likelihood is 38.4% with six attributes. Assuming an average distribution each attribute contributes to the total likelihood with 6.4%. eCo-FEV fulfills 5 attributes the likelihood to buy for all five attributes is 32%. So it is appropriate to use 30% as assumption.

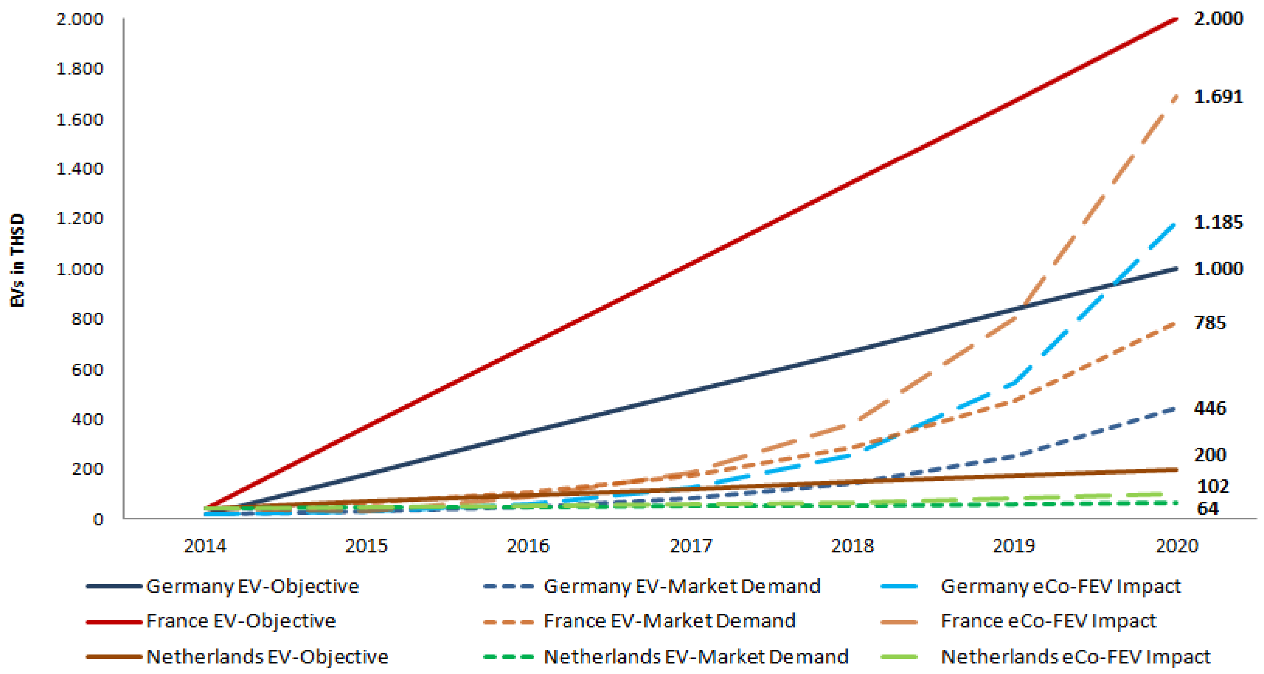


Figure 59: eCo-FEV possible impact on EVs market introduction in Germany, France and Netherlands (source own estimation)

8. Conclusion

Even though the broad deployment of electric vehicles in the European Union remains one of the biggest challenges in the field of e-mobility the need for an open e-mobility platform integrating cooperative infrastructure like eCo-FEV was mentioned by various stakeholders in the interviews. This conviction is mostly based on the assumption that an open system will provide essential synergetic effects. Besides supporting the mass market introduction of FEVs in the European Union it is conceivable for most of the stakeholders that also convenient vehicles can be integrated in the eCo-FEV platform contributing further traffic data and benefitting from eCo-FEV services.

The main advantage of eCo-FEV compared to existing e-mobility platforms is seen in solving the problem of interoperability. However, interoperability requires uniform standards. The role carrying responsibility for standardisation is seen on behalf of the European Commission because otherwise national political interests would impede this important requirement by enforcing different standards. A comparable situation can be observed in the field of charging plugs where countries didn't manage to agree on a standardized solution yet.
Furthermore, eCo-FEV is assessed to be mostly beneficial for end customers due to higher comfort.

The stakeholders' opinion towards regarding the charging case defined within eCo-FEV project was very ambivalent. One the one hand it is generally understood that simplifying the EV charging process is one of the biggest challenges in the field of e-mobility on the other hand there is no single business case for charging. Moreover, it has to be combined with other (commercial) services that co-finance required investments for charging. eCo-FEV has the great potential to realize this kind of business model. Whether there will be a transaction cost based model or a full service provider approach it is essential for the economic success of eCo-FEV to include the data driven model as data will be the most valuable asset of eCo-FEV.

Besides that, in the long term eCo-FEV should consider itself not solely as e-mobility platform but as a platform that provides services to any kind of vehicles, ICEs included.

In conclusion, mass market introduction of FEV in the European Union will not be solely dependent on a platform idea as eCo-FEV but it will contribute to the attractiveness of FEVs due to higher comfort and trust in the vehicles range. The most decisive factor influencing the success of eCo-FEV will be the OEM’s acceptance. Therefore, great emphasis should be put in the cooperation with OEMs.

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