Grant number: 769016
Project duration: Sept 2018 - Aug 2021
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HORIZON 2020: Mobility for Growth
MG-4.2-2017
Supporting Smart Electric Mobility in Cities
Project Type: Innovation Action

GREEN CHARGE

greencharge2020.eu

GreenCharge Project Deliverable: D3.2

Initial Version of Business Models

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About GreenCharge

GreenCharge takes us a few important steps closer to achieving one of the dreams of modern cities: a zero-emission transport system based on electric vehicles running on green energy, with traffic jams and parking problems becoming things of the past. The project promotes:

Power to the people!	The GreenCharge dream can only be achieved if people feel confident that they can access charging infrastructure as and when they need it. So GreenCharge is developing a smart charging system that lets people book charging in advance, so that they can easily access the power they need.
The delicate balance of power	If lots of people try to charge their vehicles around the same time (e.g. on returning home from work), public electricity suppliers may struggle to cope with the peaks in demand. So we are developing software for automatic energy management in local areas to balance demand with available supplies. This balancing act combines public supplies and locally produced reusable energy, using local storage as a buffer and staggering the times at which vehicles get charged.
Getting the financial incentives right	Electric motors may make the wheels go round, but money makes the world go round. So we are devising and testing business models that encourage use of electric vehicles and sharing of energy resources, allowing all those involved to cooperate in an economically viable way.
Showing how it works in practice	GreenCharge is testing all of these innovations in practical trials in Barcelona, Bremen and Oslo. Together, these trials cover a wide variety of factors: *vehicle type* (scooters, cars, buses), *ownership model* (private, shared individual use, public transport), *charging locations* (private residences, workplaces, public spaces, transport hubs), energy *management* (using solar power, load balancing at one charging station or within a neighbourhood, battery swapping), and *charging support* (booking, priority charging).

To help cities and municipalities make the transition to zero emission/sustainable mobility, the project is producing three main sets of results: (1) *innovative business models*; (2) *technological support;* and (3) *guidelines* for cost efficient and successful deployment and operation of charging infrastructure for Electric Vehicles (EVs).

The *innovative business models* are inspired by ideas from the sharing economy, meaning they will show how to use and share the excess capacity of private renewable energy sources (RES), private charging facilities and the batteries of parked EVs in ways that benefit all involved, financially and otherwise.

The *technological support* will coordinate the power demand of charging with other local demand and local RES, leveraging load flexibility and storage capacity of local stationary batteries and parked EVs. It will also provide user friendly charge planning, booking and billing services for EV users. This will reduce the need for grid investments, address range/charge anxiety and enable sharing of already existing charging facilities for EV fleets.

The guidelines will integrate the experience from the trials and simulations. and provide advice on localisation of charging points, grid investment reductions, and policy and public communication measures for accelerating uptake of electromobility.

For more information

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Executive Summary

This deliverable provides an overview of the business models and use cases defined during the first round of workshops accompanied by requirements from a business perspective and an indication of potential markets for these solutions. The business models for the different sustainable urban mobility solutions that will be tested in GreenCharge's pilots have to be improved during the project. However, during the first round of workshops the first initial business models were already identified and discussed, resulting in the business models described in this deliverable. These business models can be seen as a starting point for further improvements based on experience gained during the project.

The initial versions of the business models were identified during the Business Model Innovation (BMI) game. In this game, local stakeholders had their chance to give input from their point of view. The goal of the BMI-game is to support in defining business models or parts of business models that can be tested in the real life pilot or can be simulated. Playing the game provides insight in:

- Considerations of participants in redesigning a business model
- Opportunities and considerations of experts in sharing charging infrastructure
- Validation of the business modelling concepts in their purpose to enable easy redesign of a business model.

The identified business models can be seen as customized business models for a specific situation (pilot sites). Due to the different nature of the pilots, a lot of differences can be found when comparing these initial business models. This is the result of variances in investment or operation costs, revenues, electricity provision, charging methods and modalities. The possibilities regarding these options show the opportunity to create a customized sustainable mobility solution for any place.

The actual revenue model for the commercial stakeholders depends on the product that will be sold. If this product is a service (e.g. renting a LEV), earning money by subscription and an additional payment each time the LEV is used is an attractive revenue model. Other stakeholders could sell their service (e.g. peak shaving software) through licensing in order to gain stable earnings. For the stakeholders that provide charging points their revenue model depends on the amount of local RES that can be used for charging the vehicles. If they are able to generate their own energy through PV panels, their initial investment costs will be higher but their overall revenue will grow due to the lower electricity costs that have to be paid to the DSO. A specific approach based on the local conditions is needed to identify a well-fitting business model. These initial business models will be revised based on experience gained during the project.

For identification of potential markets the HEMI index is used. This index compares the four components of the e-mobility ecosystem: market demand, market environment, national policies and complementary macro-economic indicators. Through this index the comparison of 33 markets (countries) can be simplified. The score on the index ranges from a minimum of 0 to a maximum of 5 points and is calculated for each country as a result of a mix of various indicators. The higher its HEMI is, the more a country is attractive for the development of services in the field of e-mobility. On the contrary, the lower the HEMI, the lower the performance and the maturity of the market is, and the more difficult any market entry might be. High ranked European countries are Norway, the Netherlands and Germany. European countries that are lower ranked are Greece, Bulgaria and the Republic of Cyprus. Spain, as one of the pilot countries, can be found in the middle of the ranking.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Table of Contents

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Table of Figures

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List of Tables

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List of Abbreviations

Table 0-1: List of abbreviations

Abbreviation	Explanation
V2G	Vehicle to grid
DSO	Distribution System Operator (related to electric power distribution)
CPO	Charge Pole Operator
SUMP	Sustainable Urban Mobility Plan
ESN	Energy Smart Neighbourhoods
SoC	State of Charge
SaaS	Software as a Service

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1 About this Deliverable

1.1 Why would I want to read this deliverable?

This deliverable aims to provide recommendations for decision makers to choose and develop relevant business models, based on the findings of the GreenCharge project. With this deliverable we hence aim to capture the first project results and the main practical learnings and tools from the first round of the business model workshops. It provides interested stakeholders related to the project and the transition to zero emission mobility a summary overview of these learnings and tools in the context of the Business Model Innovation (BMI) process.

This deliverable will form the first version of a set of collaborative business model designs involving all relevant actors. The business models will be based on stakeholder analysis and will be implemented and tested during the project.

1.2 Intended readership/users

Everyone with an interest in the GreenCharge project or EV charging, renewable energy, smart grids, smart neighbourhoods, smart mobility or car sharing in general might be interested in this deliverable. This deliverable is important as it is provides insight in relevant business models concerning the transition to zero emission mobility. Interested readers may find possible business model designs that will fit for their own organisation.

1.3 Structure

This deliverable can be divided in a general, theoretical part (section 2: Methodology) and another part, which is focused on the GreenCharge project itself. The same structure can be found in section 4, which starts with a general introduction to the possible value chain options and ends with the value chain choices that are made for the three pilot cities.

1.4 Other project deliverables that may be of interest

- **D3.1 Stakeholder Analysis** – Describes the results of the stakeholder analysis, identifying the concerns and needs from all stakeholders relevant for GreenCharge
- **D2.3 Description of Oslo Pilot and User Needs** – Describes the specific situation in Oslo pilot
- **D2.9 Description of Bremen Pilot and User Needs** – Describes the specific situation in Bremen pilot
- **D2.16 Description of Barcelona Pilot and User Needs** – Describes the specific situation in Barcelona pilot
- **D5.1-6.1 Evaluation Design & Stakeholder Acceptance Evaluation Plan –** Describes the evaluation methodology and schedule including data collection plan.

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2 Methodology

In this chapter the methodology of the business model design is described. In section 2.1, the theoretical background of the concept of business model innovation is described based on literature. In section 2.2, the role of the local reference groups in the process of business model design is described. This methodology is amongst others based on the works and learnings from the H2020 Inspire Project to which PNO also contributed.

2.1 Theoretical background

This section provides a short introduction to the concept of business model innovation in Section 2.1, before it describes the business model innovation process, following the Cambridge Business Model Innovation Process approach by Geissdoerfer et al. (2017). Section 2.1.3 is based on the H2020 INSPIRE project.

2.1.1 Participatory business modelling

Companies are increasingly dependent on other actors outside the organization to create business (Buur, 2012). Where Porter's concept of the value chain focused on the internal organisation of activities that lead to business (Porter, 1996), later management research has focused on the interactions in the value network between the company and its suppliers, customers etc. (e.g. Allee, 2000). One of the ways in which business innovation may come about, is when new partners are invited into the value network, or if partners within the network take on new roles. The transition to sustainable and green mobility forces partners in the value network to take on new roles or to cooperate with new partners in the network (e.g. distribution system operators).

Osterwalder's process of business model innovation banks on participation of a range of stakeholders, and his business model canvas has become immensely popular in the business world (Osterwalder & Pigneur, 2009). There are also other suggestions to engage a variety of participants in developing business, among which mapping the value flows between actors as coloured line graphs on flipcharts (Den Ouden & Valkenburg, 2011); describing business processes using acrylic flowchart symbols (Lübbe, 2011); mapping the company's key relationships with bric-a-brac materials (Buur & Mitchell, 2011); exploring stakeholder relations using theatric staging techniques (Ankenbrand, 2011); and developing business model alternatives using interactive sculptures (Mitchell & Buur, 2010). All these approaches are proposed as collaborative: they aim to engage groups of people in innovating business issues within the field elsewhere coined 'Participatory Innovation' (Buur & Matthews, 2008). For defining GreenCharge's initial business models, a business model canvas based on Osterwalder's business model canvas was used in the workshops.

2.1.2 Describing business models

Before discussing the innovation of business models in section 2.1.3, it is important to have a clear understanding of what it is that is to be innovated. In general the business model can be defined as a unit of analysis to describe how the business of a firm works (Gassmann et al., 2013). The business model is often depicted as an overarching concept that takes notice of the different components a business is constituted of and puts them together as a whole (Demil and Lecocq, 2010; Osterwalder and Pigneur, 2010). Business model literature is not unanimous about which components exactly make up a business model. In GreenCharge we will use the St. Gallen Business Model concept. This conceptualization consists of four dimensions: the Who, the What, the How, and the Value. This model will provide a clear picture of the GreenCharge business model architecture. A visualization of the St. Gallen business model concept can be seen in Figure 2-1.

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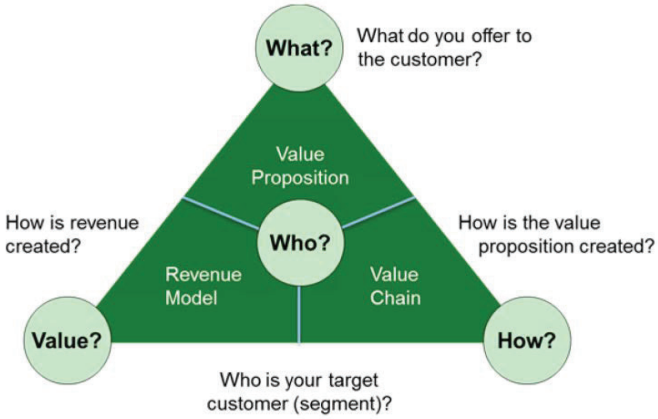

Figure 2-1: St. Gallen business model concept

The four dimensions which are combined to make up a business model are described below:

- **Who:** every business model serves a certain customer group (Chesbrough and Rosenbloom, 2002; Hamel, 2000). This dimension is used as a central dimension in designing a new business model. The *Who* can be find by answering the question: "Who is the customer?" (Magretta, 2002).
- **What:** this dimension describes what is offered to the targeted customer (*Who*), or what the customer values. In the St. Gallen business model this dimension is referred to as the *Value Proposition*. It can be defined as a holistic view of a company's assortment of products and services that are of value to the customer (Osterwalder, 2004).
- **How:** to build and distribute the value proposition, a firm has to master several processes and activities. These processes and activities, along with the involved resources (Hedman and Kalling, 2003) and capabilities (Morris et al., 2005), plus their orchestration in the internal value chain form the third dimension in the St. Gallen business model.
- **Value:** the fourth dimension is focused on the revenue of the business and explains why the business model is financially viable. It unifies aspects such as, for example, the cost structure and the applied revenue mechanisms. In this way it points to the elementary question of any firm: how make money in the business?

By identifying the target customer, the value proposition towards the customer, the value chain behind the creation of this value, and the revenue model that captures the value, the business model of a company becomes tangible and a common ground for re-thinking is achieved. This will be done during the duration of GreenCharge project.

2.1.3 Business model innovation

The business model concept gained popularity during the dotcom boom of the 1990's with a vibrant and diverse research activity more recently (Zott et al., 2011). This activity led to an extensive special issue in the Long-Range Planning journal in 2010 and a considerable range of literature reviews, like Bieger and Reinhold (2011), George and Bock (2011), Massa et al. (2017), Schallmo (2013), and Zott et al. (2011), which were integrated, updated, and synthesised into this literature review.

During the e-commerce boom of the 1990's, new innovative revenue mechanisms were introduced. In this context, the business model concept was originally used to communicate complex business ideas to potential investors within a short time frame (Zott et al., 2011). From there, the purpose of the concept developed to be now seen as both a tool for the systemic analysis, planning, and communication of the configuration and implementation of one or more organisational units and relevant parts of their environment in face of organisational complexity (Doleski, 2015; Knyphausen-Aufsess and Meinhardt, 2002), as well as a strategic

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asset for competitive advantage and firm performance (Afuah, 2004; Casadesus-Masanell and Ricart, 2010; Chesbrough, 2007; Hamel, 2000; Magretta, 2002).

For organisational decision-making and academic research in the context of emerging industrial phenomena, like Industry 4.0 (Bundesregierung, 2014) or Re-Distributed Manufacturing (Srai et al. 2016), the business model concept allows to extrapolate from potential customer and value chain benefits to the required configuration and implementation of the other business model elements (Osterwalder et al., 2014; Yang et al., 2017). The resulting potential business models provide the necessary information about the implementation of phenomena's conceptual and technological implications that is required as a basis for further research in these. In this project, we have leveraged this characteristic to the context of relocalisation.

The concept is either described as a model of an organisational system (e.g. Baden-Fuller and Morgan, 2010; Knyphausen-Aufsess and Meinhardt, 2002), as an abstract characteristic of an organisational unit, (e.g. Osterwalder and Pigneur, 2010; Teece, 2010), or with a reduced scope that equates the term with individual elements of other authors' definitions or reduce it to achieve certain means (e.g. Doganova and Eyquem-Renault, 2009). There is a central role of value in most definitions, roughly following the categorisation of Richardson (2008), value proposition, value creation and delivery, and value capture, with some authors also adding the value network (e.g. Zott and Amit, 2010). As Geissdoerfer et al. (2018a), we define business models as simplified representations of the value proposition, value creation and delivery, and value capture elements and the interactions between these elements within an organisational unit (Geissdoerfer et al. 2018a).

Business model innovation is a stream in the work on business models, and some authors of the latter assume it to be an implicit part of their conceptualisation. Schallmo (2013) and Foss and Saebi (2017) provided an extensive literature review on the topic.

The concept is investigated to understand and facilitate the analysis and planning of transformations from one business model to another (Schallmo, 2013). The capability for frequent and successful business model innovation can increase an organisation's resilience to changes in its environment and constitute a sustainable competitive advantage (Mitchell and Coles, 2003).

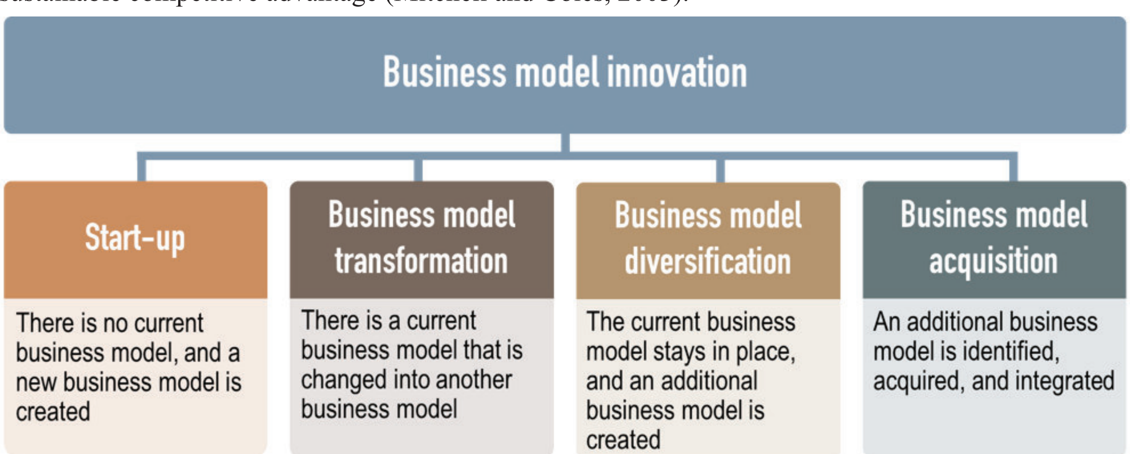

Figure 2-2: Types of business model innovation (Geissdoerfer et al., 2018a)

These definitions refer to business model innovation as a change in the configuration of either the entire business model or individual elements of it, either as a reaction to opportunities or challenges in the organisation's environment or as a vehicle for diversification and innovation. Consequently, the concept's

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main fields of application have been in corporate diversification (Ansoff, 1957) and business venturing and start-up contexts. Based on the described business model innovation examples, four generic configurations of business model innovation can be distinguished. These comprise start-ups, business model transformation, business model diversification, and business model acquisition (Figure 2-2).

The differentiation between other forms of innovation and diversification is not clearly defined by the reviewed publications. For example, Lindtgardt and Reeves (2009) define that at least two business model elements have to change for an innovation to qualify as a business model innovation. However, the thresholds for changes in a company's activities to qualify as a change in a business model element remain unclear, for instance, when a product innovation constitutes a new value proposition. Thus, it remains conceptually underexplored under what circumstances, for example, product innovation, service innovation, or changes in the supply chain qualify as a business mode innovation.

Based on this analysis, we follow Geissdoerfer et al. (2018a) definition of business model innovation as the conceptualisation and implementation of new business models. This can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another. The transformation can affect the entire business model or individual or a combination of its value proposition, value creation and deliver, and value capture elements, the interrelations between the elements, and the value network.

2.1.4 Business model evaluation

Business model innovation cannot be done in a single step. Rather, it is an iterative process of defining, testing, evaluating and redefining the business model. This 'evaluation roadmap' is depicted in Figure 2-3.

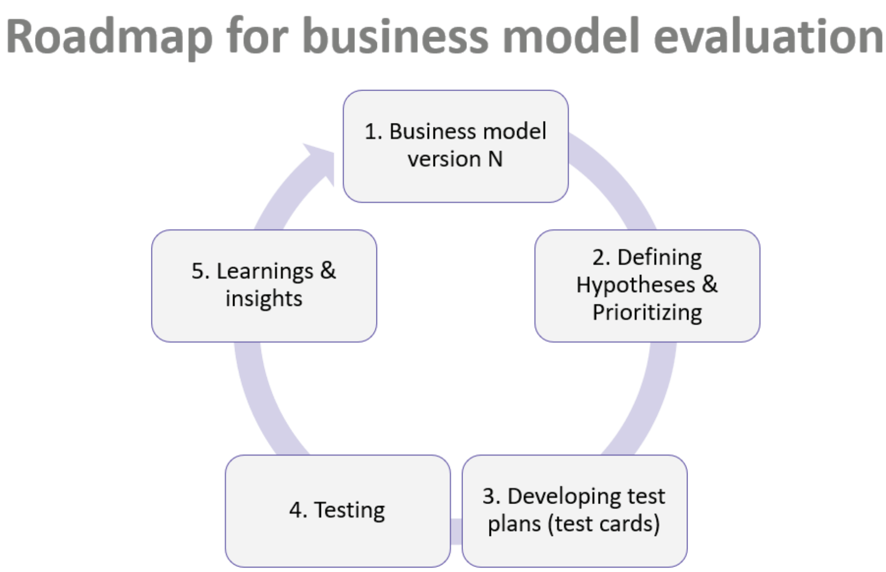

Figure 2-3 The iterative process of business model evaluation

Each iteration consists of five steps:

1. Defining the business model
2. Defining hypotheses & prioritizing the hypotheses
3. Developing test plans
4. Testing
5. Learnings & Insights

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The first step, defining the business models, will contain all information of a business model as described in section 2.1.2. The business model innovation game (section 2.2.1) will serve as an input for this step for each demonstrator.

During the second step, a set of hypotheses will be defined. These hypotheses are basically statements about the business model that need to be validated through tests. The third step will then specify *how* exactly these hypotheses will be validated. In this step, test plans will be written, specifying:

- What is to be validated?
- How will this be verified?
- What will be measured specifically?
- When is the hypothesis validated?

The fourth step is executing the test plans. The fifth and last step of the iteration reflect on the outcomes of the tests. These outcomes may provide:

- **Learnings about the hypothesis:** validated yes/no? Why (not)?
- **New insights:** these can be used to improve the current business model.
- **Decisions and actions:** results from one test may create the need for further testing. What actions can be taken to further evaluate the business model?

At the end of the evaluation loop, the current business model can be improved/changed if necessary. This can be the start of a new iteration. However, it is also possible to have multiple evaluation iterations with the same business model version.

2.2 Local Reference Groups

At each pilot site, Local Reference Groups (LRG) will be recruited among relevant stakeholders (citizens and business in ESN, city representatives, interest groups, etc.). They will be actively involved through for example business model workshops, surveys, interviews, etc. to provide input to needs, requirements and feedbacks for the project development, evaluation and exploitation. An overview of the LRG participants at the three pilot sites is displayed in Table 2-1, Table 2-2 and Table 2-3.

Table 2-1: Local Reference Group Oslo

Company name	Main business activities
ABB	Electrification and Power grids
Incube	Architecture (unique focus on materials technology and renewable energy)
E2U	Energy Management
StartupLab	Startup Network
Hafslund Nett	Electricity Grid Owner
Norsk Elbilforening	Electric Vehicles Association
University of Oslo	University
Nissan Nordic Europe	Car manufacturer
OBOS	Housing association
Solenergiklyngen	Solar Energy Network
Hyre/Møller Gruppen	Car Import/Dealer
Bymiljøetaten	City of Oslo, Department for Urban Environment

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Company name	Main business activities
Byrådsavdeling for samferdsel og miljø	City of Oslo, Department of Environment and Transport
Klimaetaten	City of Oslo, Climate agency
Bravida	Technical service provider (electricity, etc.)
Flexibility	Car Charging software
FutureHome/Get	Smart Technology

Table 2-2: Local Reference Group Bremen

Company name	Main business activities
BSAG	Public Transport provider
Cambio Mobilitätsservice GmbH& Co. KG	Car Sharing provider
Ecotec GmbH	Technical Engineering
Gewoba GmbH	Housing Association
Meshcrafts AS	Charging Management
UniBremen SOLAR eG	Solar Energy, Sustainable electricity
Swarco Traffic Systems GmbH	Traffic systems, Charging infrastructure
Swb AG	Electricity provider
ZET GmbH	Car Sharing provider
PMC eG	E-mobility
Aenon Dynamics UG	Software/Mobility Solutions
City of Bremen	Local Authority

Table 2-3: Local Reference Group Barcelona

Company name	Main business activities
Eurecat	Innovative Technology
Atlantis IT S.L.U	Innovative Services (e.g. Internet of Things, big data)
Motit World SL	LEV Sharing provider
Enchufing	Charging Points
BSM (Barcelona Municipal Services)	Local Authority

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Company name	Main business activities
ICAEN (Catalan Energy Institute)	(Renewable) Energy
AMB (Metropolitan Area of Barcelona)	Regional Authority
Efimob	Electromobility, Charging Infrastructure
RACC (Catalan Automobile Association)	Car Association

2.3 Business Model Innovation Game

The business model design will follow the participatory business modelling methodology (section 2.1.1) and is based on a strong involvement from the LRG. Per pilot site, three workshops will be organised based on the input and requirements from the business model design and the evaluation plan. The setting required for these workshops is a group of around 9 to 12 mixed academic/industry participants and 1 or 2 moderators.

The business model designs are developed in a cyclic and iterative approach in collaboration with the pilots. Initial work on the business cases and business model design is done in the first round of the business model workshops at the end of 2018. The first workshop round has generated a baseline for business models to ensure a clear insight in the local possibilities and the starting position of the different urban living labs. The second and third workshop will evaluate the pilots and define new promising business models. The outcome from these workshops will be the basis for assessing the social and economic viability of the business models.

Business Model Innovation Game

PNO and TNO together developed the Business Model Innovation Game as part of the H2020 Inspire project. At the business model workshops the Business Model Innovation (BMI) game will be played. The goal of the BMI-game is to support in defining business models or parts of business models that can be tested in the real life pilot or can be simulated. Playing the game provides insight in:

- Considerations of participants (LRG) in redesigning a business model
- Opportunities and considerations of experts in sharing charging infrastructure
- Validation of the business modelling concepts in their purpose to enable easy redesign of a business model.

When playing the game, players acquire capabilities to redesign the business model of a specific case and get insight in case specific drivers and barriers to follow up after the redesign. To achieve this goal the players should be knowledgeable about specific parts of the value chain involved.

The format of the BMI game is a roleplay played by the participants and directed by the moderator (Figure 2-4). The play is the joint (re)design of a specific case in each of the three pilot cities. The moderator asks questions, summarizes responses (for check) and keeps time. The game starts with a short explanation of goals and rules of the game. Additionally a presentation is held by the case-owner who is knowledgeable about the domain and describes the challenges and goals of the specific pilot. The case-owner can also give feedback on the proposed design. All of the other participants are divided into 3 teams: the Vallies, Techies or Assessees. Vallies consider the case each from a specific type of value pattern (e.g. flat rate, pay per use). Techies consider the case each from a specific technology cluster and technologies (e.g. ICT). Assessees consider the case from a specific evaluation aspect (e.g. scalability, sustainability). Specific roles are assigned by handing out the corresponding cards.

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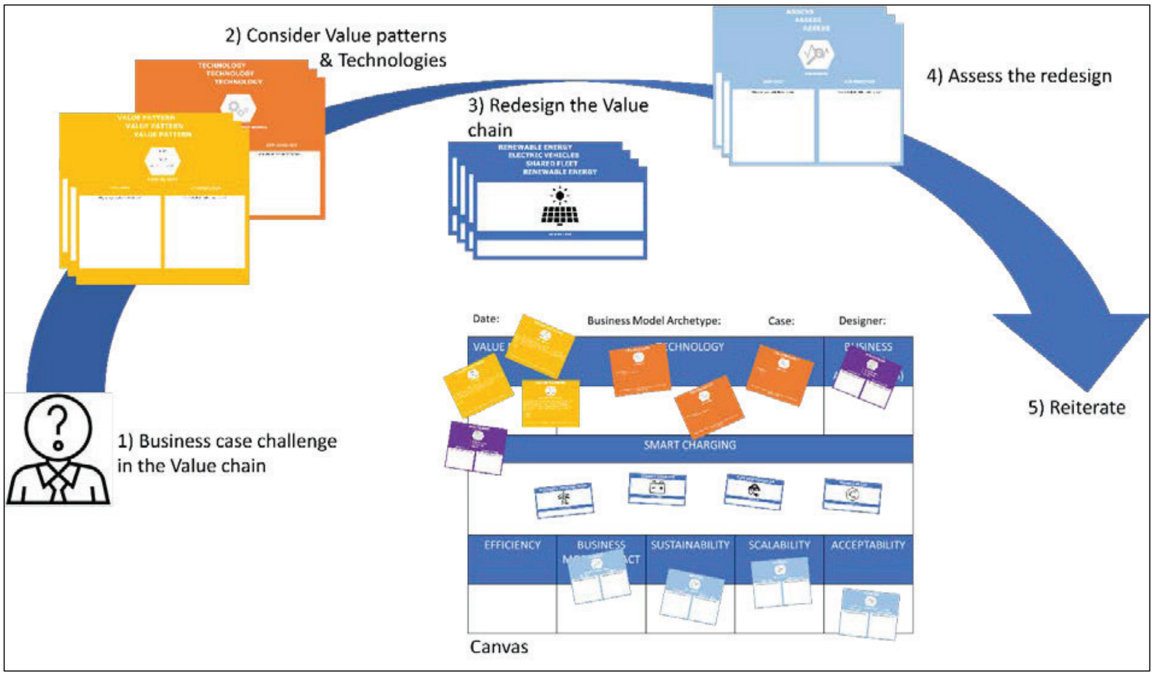

Figure 2-4: Business Model Innovation Game

After handing out the cards, the case-owner introduces the current value chain and explains the design challenges (e.g. sharing of charging infrastructure, roaming). The case-owner uses the canvas to illustrate the current value chain involved. All participants receive at least 1 playing card fitting their team; each Vallie receives a value pattern card, each Techie receives a technology card and each Assessee receives an assessment card. The moderator invites the Vallies and Techies to think (5 minutes) about applicability of their card. The moderator also invites the Assessees to keep their assessment aspect in mind and evaluate the design displayed on the canvas on this aspect. Wildcards are available as well for technologies or value patterns not considered yet. After 5 minutes, Vallies and Techies report on applicability of the cards and place the cards on the canvas. Reasons for not considering a specific value pattern or technology can be captured as well.

In the next phase of the game, the moderator invites the case-owner to respond briefly with an encouraging comment. The moderator invites the Vallies and Techies to redesign the current value chain using the existing cards and/or other supply chain function cards. The Vallies and Techies are encouraged to explain each modification on the canvas. The moderator may ask for additional clarification or challenging questions.

Implementation of value patterns and technology can be expressed by a (marker) line between the card and the value chain. After 15 to 20 minutes of redesign, the moderator invites the Assessees to comment on the design from their perspective. Next, the moderator invites all Vallies, Techies and Assessees to reflect on the design from their perspective and finalizes the final business model design.

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3 Business model options

The possible options for the GreenCharge business models are displayed in the form of decision-trees in this chapter. The decision-trees will show all possible business model options for the three parts of the primary value chain (Energy, Charging, EV). The business model is divided in this three connecting parts because it is impossible to display the whole business model (with the possible options) on one page in the report.

In the first subsection of each section a general overview and description of the possible business model options for one part of the value chain is given. In the following subsectionss, the business model choices for the three pilots are described. These pilot descriptions are based on D2.3, D2.9 and D2.16.

3.1 Energy value chain

In this section the Energy value chain part of the business model is displayed and described. In the first subsection the possible business model options are displayed. In the following subsections the current situation and the pilot situation regarding the business model of the Energy value chain in the three pilot cities is displayed and described.

3.1.1 General Energy value chain options

In this subsection the possible business models options for the Energy value chain are displayed in a decision-tree.

As can be seen in Figure 3-1, energy for charging EVs can be derived from different sources. Energy from local sources can be used in a direct way (e.g. from PV-panels via charging pole to EV) or can be stored in batteries, hydrogen or heat pumps. Batteries can be used for storing energy in stationary form or mobile form (non-stationary). A mobile battery can be swapped for a fully charged battery when its energy level is running low.

The same applies to energy derived from a micro grid. This energy can be used directly from the grid or from energy storage sources such as batteries, hydrogen or heat pumps. Micro grids can be seen as smaller versions of the traditional grid. They consist of power generation, distribution, and controls such as voltage regulation. However, micro grids differ in that they provide a closer proximity between power generation and power use, resulting in efficiency increases and transmission reductions.

Energy derived from the “traditional” grid is mostly grey energy; energy produced from fossil fuels.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

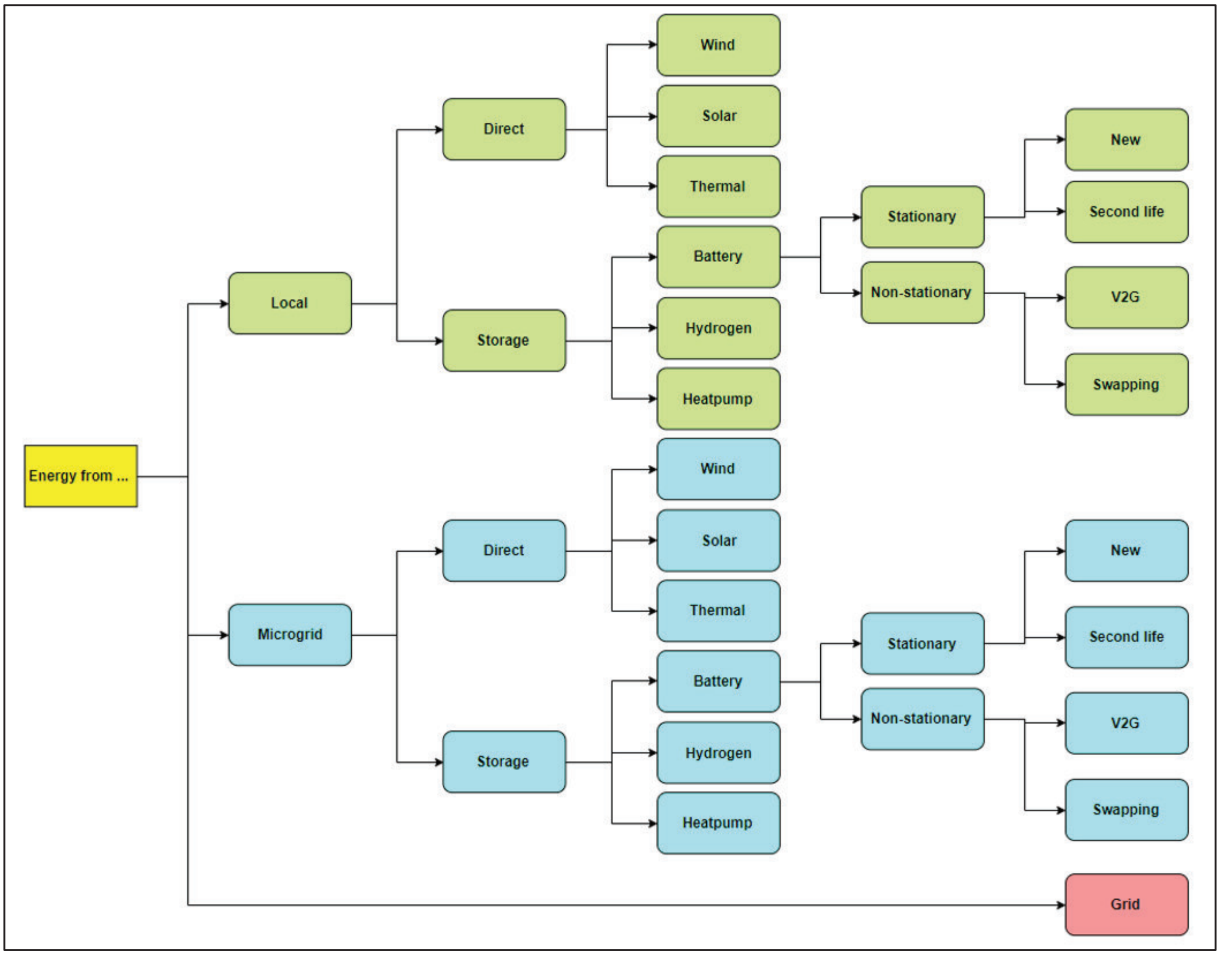

Figure 3-1: Energy value chain options

3.1.2 Oslo Energy value chain

In the current situation in Oslo, 99% of the energy derived from the public grid is renewable energy. This renewable energy is derived from hydropower plants. For the future, there are ambitious goals on solar energy (150 MW in 2030). Nowadays, the energy used for charging EVs at the Oslo pilot site is derived from the public grid.

3.1.3 Barcelona Energy value chain

The composition of the energy mix in Spain varies according to the energy market, but on average, 40% of the energy is produced by renewable sources[1]. The graph below shows the distribution of the renewable energy mix in Spain in 2016 (Figure 3-2).

1 https://www.ree.es/sites/default/files/11_PUBLICACIONES/Documentos/InformesSistemaElectrico/2019/presentacion-avance-informe-2018.pdf

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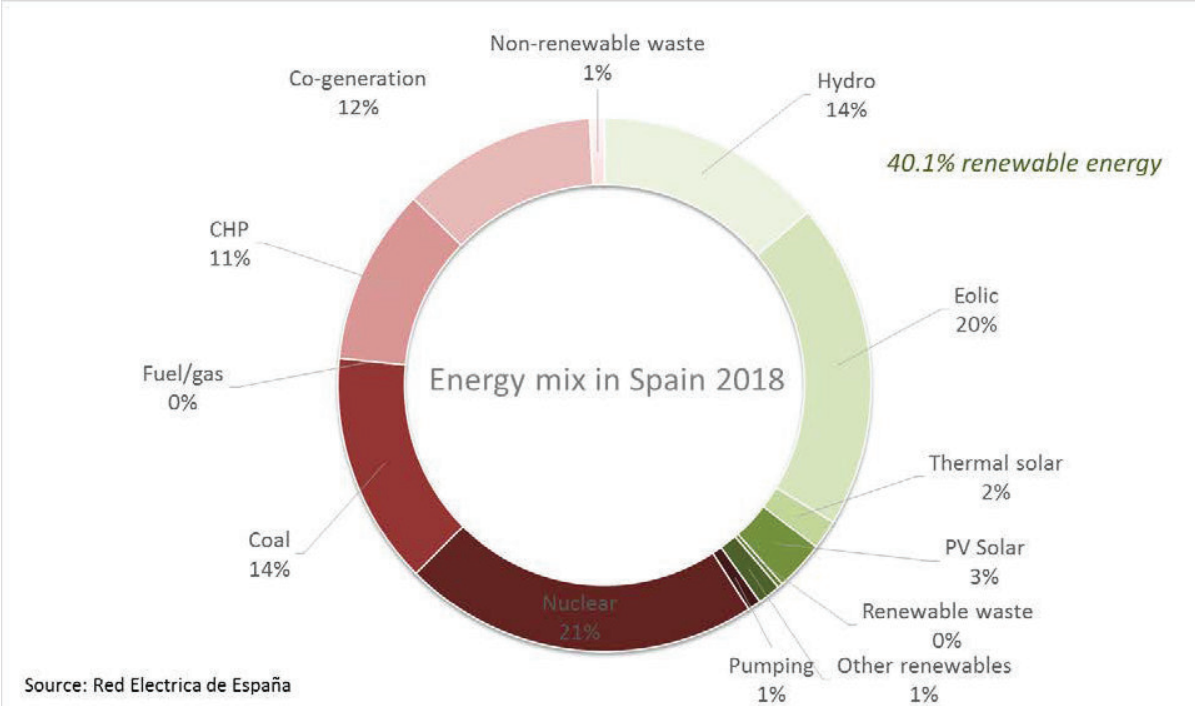


Figure 3-2: Energy Mix Composition

At the Manresa Eurecat premise, which is part of the Barcelona pilot, an energy monitoring system and some distributed energy resources are available. There are 2 PV panel installations with a rated power of 6.48 kWp and 1.35 kWp. The thermal solar installation covers an area of 2.33 m^2. The mini wind turbine has a rated power of 1 kW and the energy storage capacity is 4.8 kW. The energy locally produced is consumed in the installation. The annual production is around 9.3 MWh.

The energy used for the MOTIT LEVs is derived from non-stationary batteries. These batteries will be replaced for a fully charged battery when their state of charge is low. At battery hubs these batteries will be charged with grey energy derived from the grid. Because of the particular location of the hubs (downtown buildings), replacement for energy derived from PVs is difficult.

3.1.4 Bremen Energy value chain

Currently, most of the public charging points in Bremen are operated by the local utility SWB delivering 100% "green" electricity to these sites. For its charging stations, ZET also uses electric energy stemming 100% from renewable sources (wind, photovoltaic, biomass and hydropower – "Öko-Strom") provided by the local utility SWB. The charging stations managed by PMC are also supplied by the local utility SWB, but contracted with the grey Bremen electric power mix. One of the corporate charging sites (with two charging points) managed by PMC is covered by a solar carport. The solar energy derived from the carport is used to recharge the cars at the "IFAM-1" site.

The graph below shows the distribution of the renewable energy mix in Bremen in 2016 (Figure 3-3).

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

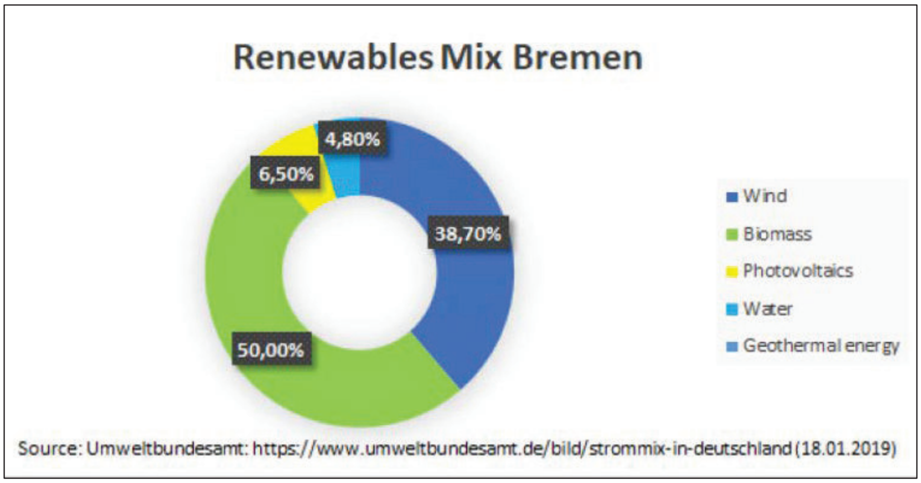


Figure 3-3: Renewable Energy Mix Composition

3.2 Charging value chain

In this section the Charging value chain part of the business model is displayed and described. In the first subsection the possible business model options are displayed. In the following subsections the current situation and the pilot situation regarding the business model of the Charging value chain in the three pilot cities is displayed and described.

3.2.1 General Charging value chain options

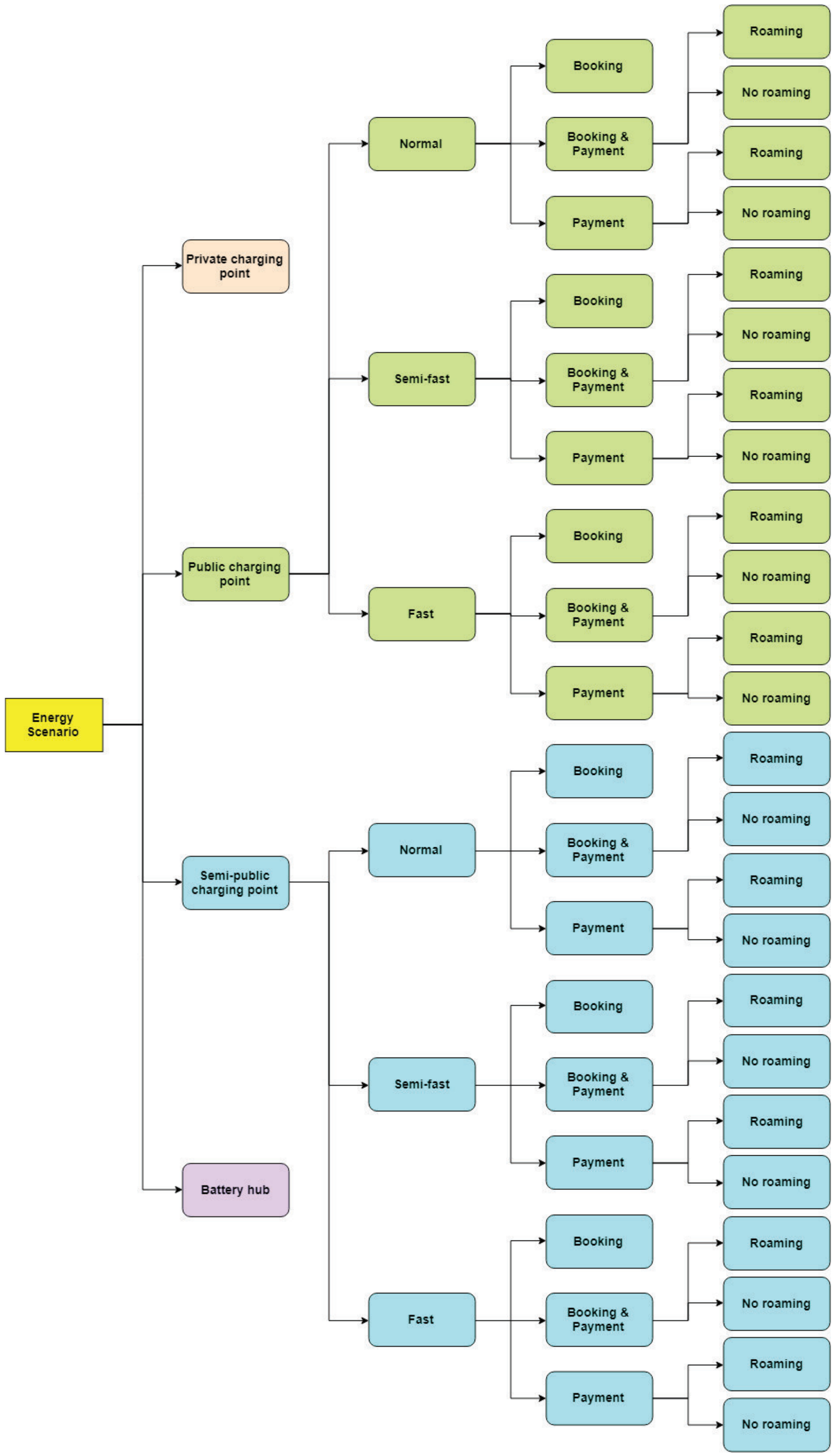
In section 4.1.1, the different energy sources that can be used for charging EVs are described. In this section the different charging options will be described and can be seen in Figure 3-4. EV users can make use of different charging options for charging their EVs such as private CPs, public CPs, semi-public CPs or battery hubs.

Private charging points are CPs installed on a private site and connected to a private electricity supply. These CPs are often not accessible to electric cars other than those belonging to the owner of the CPs. These private CPs provide a guaranteed availability for the owners of these points. The public and semi-public CPs are CPs that are accessible for all EV users. The main difference between public and semi-public CPs is their location; public CPs are located on public grounds while semi-public CPs are located on private ground. There may be restricted public access to these semi-public CPs because of parking or opening times. Examples include CPs in underground car parks, hotels or service stations. There may be also restrictions on use, such as the requirement to make use of the associated facilities. The public CPs provide 24/7, non-discriminatory access to users. Non-discriminatory access may include different terms of authentication, use and payment[2].

Charging speed of (semi-)public CPs can vary between normal (regular CPs, less than or equal to 22 kW power), semi-fast (about 50 kW) or fast (up to 175 kW) charging. In some cases, for ensuring availability of a CP, EV users can make use of a booking system. This booking system can also include payment options. EV roaming enables EV users to charge at each charging station and manages the billing of the charge action towards the driver. Condition for roaming is an open charging infrastructure for EV users. It means a shared use of charging infrastructure, independent of technology, without fiscal and legal obstacles. Roaming systems will make it much easier for EV users to find an available CP and pay their charging costs.

[2] Directive 2014/94/EU, art. 2.7

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.



The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Figure 3-4: Charging Value Chain Options

3.2.2 Oslo Charging value chain

Currently, four outdoor, semi-fast CPs are available at Røverkollen. Only EV owners registered at Røverkollen are allowed to use these outdoor CPs. The residents have to move their car back from the outdoor CP to its regular parking spot (in the car garage) when fully charged, which is very inconvenient for the users.

After signing a contract for using the charging station, the users are given access with a card that activates the CPs. Then, via an online spreadsheet, the EV owners can book the CP for up to six hours at a time, which means that there are four charging periods per day per CP.

Residents pay a flat rate of 400 NOK per month (about 43 EUR) for access and use of the charging infrastructure. This is paid together with the monthly common costs to the housing cooperative. A quarter of this flat rate covers the electricity costs, the other part of the flat rate covers the fixed costs for down payment of infrastructure.

3.2.3 Barcelona Charging value chain

Barcelona Metropolitan Area

The development of the public charging infrastructure around Barcelona started with the deployment of slow CPs. There are multiple sites and apps to check the location of these CPs. There is a smartphone app that allows to interact with some of the CPs interoperable with the app or and RFID key ring. When available, the status of the CP is also displayed, either because the CP is equipped with a communication module or because a user has notified that it is out of order or it is occupied by this user. In general, slow CPs are not bookable and the use is free of charge. The public CPs can be accessed with the LIVE card. This card is granted to Barcelona citizens or companies that own an EV (registered in the city), upon request to the municipality.

Other municipalities issue their charging access cards for EV owners as well. To foster interoperability, the Alliance of Municipalities for Interoperability created a card that enable compatibility to use the public charge infrastructure of all the municipalities of the alliance[3]. Another method to access CPs is through QR codes and apps. This method is used at the CPs managed by AMB or Granollers municipality.

Similarly, AMB (Barcelona Metropolitan Area) also provides a map with real-time information of the 10 fast CPs managed by the organization. The particularity of these CPs is that they can be booked 15 minutes in advance. The municipality of Barcelona deployed a network of 14 fast CPs addressed to cover the need of e-taxis.

Eurecat premises

The charging infrastructure at Eurecat is quite limited, but consistent with the low number of EV drivers. The Eurecat headquarters have CPs in their parking garages. These offices are owned and managed by a third party. Some of the employees based at Eurecat-Barcelona, according to their position, have access to a parking spot with charging capabilities (if needed). Employees based at other premises can only book a parking spot without charging facilities at the Barcelona office. Apart from the Eurecat parking, it is possible to rent a parking slot in a public parking owned by BSM (Barcelona Municipal Services) that provides charging infrastructure for some parking spots.

At the Cerdanyola del Vallès Eurecat premises, the building is owned and managed by Eurecat. There is a community parking garage accessible by some employees, according to their position. In this garage there are 8 sockets for charging purposes. Employees with access to the garage can request a card that enables EV charging; the employee pays for the energy used. There is also a semi-public CP at the visitors parking that is open for public use (currently out of order).

[3] Currently, the alliance includes 29 municipalities, including Barcelona city, Barcelona Metropolitan area, 4 public parking garage operators and a *comarcal* council (similar to a county).

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

For the other Eurecat offices there is no charging infrastructure available and employees should search for public CPs.

MOTIT

The MOTIT e-scooter sharing service "charge" their LEVs by swapping the batteries. Initially they charged their batteries at their headquarters in Hospitalet de Llobregat, but to increase efficiency they have realised 2 battery hubs spread all over Barcelona city. MOTIT staff drives with e-scooters to the location of the e-scooter with an empty (or low state of charge) battery. The empty battery is replaced with a full battery. On average, a battery is replaced every three days and serves 5 trips, which means a total mileage of 30 km. Batteries are usually replaced with 50% of SoC to avoid the driver's range anxiety. The MOTIT staff can carry up to 3 batteries for each trip. The empty batteries are taken to one of the hubs where they are charged to full charge by using slow charging points.

Sant Quirze e-bike sharing service

The e-bikes of Sant Quirze e-bike sharing service are charged at the same parking spot where they are stored. To access these parking spots a key is needed. The users of the bikes are responsible for plugging in the bicycles after finishing their trip. Most of shared bikes are parked in nearby factories during the shift (8-9 hours), but due to the short trips no infrastructure for charging at the workplace is needed.

3.2.4 Bremen Charging value chain

Since public CPs in Bremen are mostly funded by federal ministries, the terms and conditions set by the Federal Ministry of Transport and Industry (BMVI) for charging stations must be met in accordance with the LSV ("Ladesäulenverordnung") and EmoG ("Elektromobilitätsgesetz"), i.e., CP regulation and the federal law regarding electric vehicles, respectively.

As described at section 4.1.4, most of the public CPs are operated by the local utility SWB. Customers of these CPs are charged either time-based (€/min) or by a fixed amount. Currently, payment in €/kWh is not allowed, since calibrated dc-stations are still lacking. In general, payment after invoice from SWB is made per direct debit.

Currently, the public CPs (normal charging speed) operated by ZET are only accessible for car sharing EVs. Therefore there is no specific payment system implemented so far. RFID technique is used for user authorisation. One CP is available for each vehicle registered at that specific station. Therefore, currently there is no particular booking process for chargers needed: for each EV registered for car sharing there is a guaranteed parking lot available. The frequency of use depends on the utilisation of each car sharing vehicle and varies quite a lot from one site the other. In the current situation, the general objective is to charge the EVs immediately after each rental event.

The corporate charging stations operated by PMC are semi-public charging stations located on private ground. Besides the normal speed charging points, PMC also operates two fast speed charging stations (combined output power to 100kW). Usage of the PMC charging points is restricted to user groups, i.e., employees of PMC member entities. Access is restricted through an access code and RFID authentication. Currently, pre-booking capability of any of the PMC charging stations is neither offered nor it is needed.

3.3 EV value chain

In this section the EV value chain part of the business model is displayed and described. In the first subsection the possible business model options are displayed. In the following subsections the current situation and the pilot situation regarding the business model of the EV value chain in the three pilot cities is displayed and described.

3.3.1 General EV value chain options

In section 4.1.1 and 4.2.1, the energy and charging value chain are already described. This section describes the possible options for the EV value chain. Three different EV options are displayed in Figure 3-5; Light

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Electric Vehicles (LEVs), Electric cars (EVs) and public buses. LEVs and EVs can be used as private vehicles, semi-public vehicles or public vehicles.

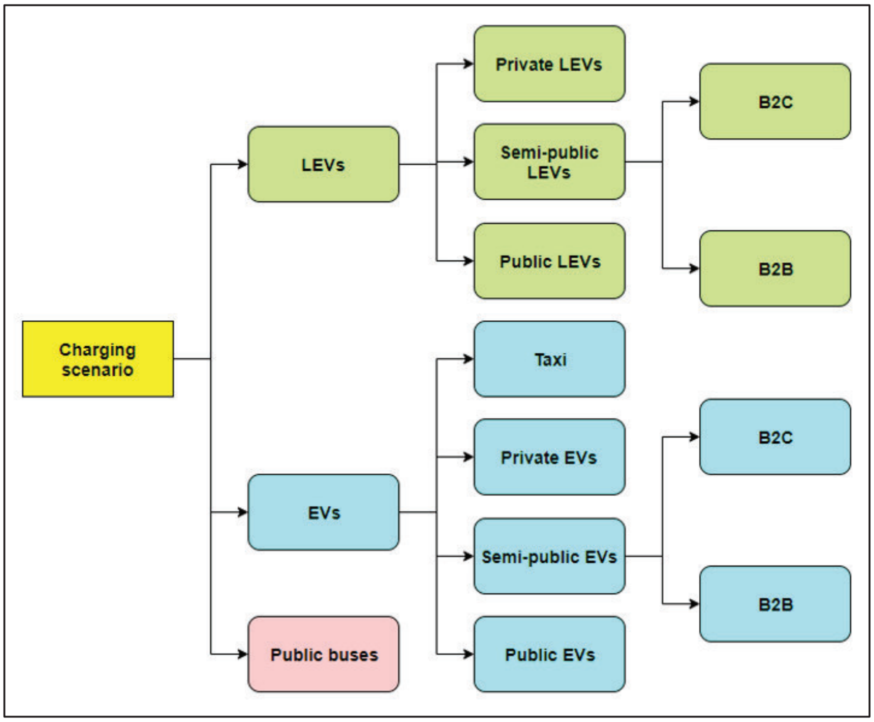

Figure 3-5: EV Value Chain Options

Public electric buses form the fastest-growing part of the EV market, with a compound annual growth rate of more than 100 per cent since 2013, compared with 60 per cent for fully electric passenger cars (Heid et al., 2018). As public electric buses are not part of the GreenCharge pilots, no further description of the business model options for electric buses is given.

Semi-public vehicles (LEV or EV) or public vehicles are part of the "sharing economy", which consists of new business models exploiting underutilized assets by replacing ownership by access (Botsman & Rogers, 2010). Just as other forms of shared mobility such as bike sharing and ride sharing, car sharing is growing rapidly in many places around the world (Münzel et al., 2019). Car sharing can be defined as a system that allows people to use locally available cars at any time and for any duration (Frenken, 2015). Within car sharing, various business models have been distinguished (Remane et al., 2016). These different forms of car sharing are displayed in Figure 3-6.

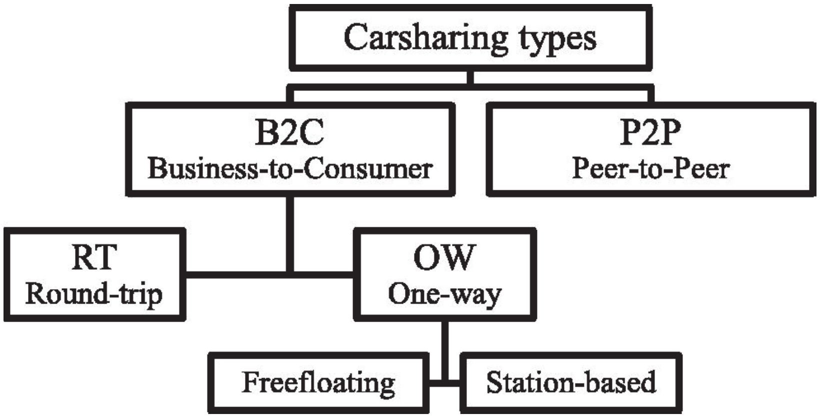

Figure 3-6 Different forms of car sharing (Münzel et al., 2019)

The first car sharing initiatives started with a B2C car sharing service. In that situation, the car sharing organization owns a fleet of cars that it rents out to its customers. This can be done in a round-trip system, where the cars have to be returned to the same parking spot at the end of the trip as where they were rented from. Another option for B2C car sharing is a one-way system. In a one-way system, the cars do not have to be returned to the spot where the trip was started but can be dropped off either anywhere in a designated city area (free-floating) or at a different station of the provider (station based).

Another business model for car sharing are peer-to-peer platforms on which car owners can rent out their own car to fellow consumers. The platform takes a fee for matching supply and demand and usually offers additional services like insurances (Shaheen et al., 2012).

For semi-public car sharing, the business model options are more limited. These semi-public cars are owned by companies (e.g. employers) and can be used by specific groups of users, such as employees of these companies. Another less occurring option are semi-public cars that are owned by companies and can be used by local residents when these cars are not used or booked by employees (e.g. outside office hours). For LEVs, the business model options for sharing are the same as for EVs. However, a majority of the LEV sharing companies makes use of a free-floating system.

3.3.2 Oslo EV value chain

In Oslo municipality the number of EVs (including BEV, PHEV, FCEV) amounts to 48,733, out of a total number of registered cars of 368,445 (i.e., a share of about 13.2%). At Røverkollen, the total number of chargeable vehicles is 17 (16 BEVs, 1 PHEV)[4]. All of the cars that are charged at the Røverkollen charging station are private EVs.

3.3.3 Barcelona EV value chain

In this subsection the current situation regarding the business model of the EV value chain in Barcelona is displayed and described.

EVs

The total share of EVs in Barcelona is very low, as can be seen in Table 3-1 which shows the vehicle pool for 2018 at country level, region level and city level. However, the share of EVs is increasing in recent years. For the Eurecat premises, 5 employees have been identified that drive EVs (BEV and PHEV). There are no EV sharing services in Barcelona.

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[4] Note that these numbers do not include vehicles owned by car leasing companies and are therefore probably a bit lower than the real use of EVs.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

LEVs

In Barcelona there are several mobility operators offering e-scooter sharing services. MOTIT, partner of GreenCharge, is one of these operators. MOTIT's fleet accounts 200 e-scooters. The particularity of these scooters is that they are manufactured by the company itself and have been especially designed for this sharing service (robust and with few "breakable" parts), integrated navigation system and space for the helmet. Other e-scooter sharing services operating in Barcelona are: eCooltra (1150 scooters), Scoot (500 scooters), Yego (450 scooters), Muving (350 scooters) and AccionaMobility (50 scooters).

E-bikes

Barcelona city council operates a bike sharing service called Bicing. It has been updated recently reaching 519 stations and 6,000 bicycles, 1,000 of them are electric. Over 100,000 users are subscribed to the service, paying an annual fee of €50. For e-bikes, an extra €0.35/30 minutes have to be paid.

The e-bike sharing service operated by Sant Quirze del Vallès municipality accounts 6 e-bikes. The approach of the municipality is to offer the service to one company at a time for a limited time period (3 months). The final goal is that after successfully testing the acceptance of users, the factories themselves will buy more bicycles as part of their mobility plans. To use the service, users get a key to access the "Bicibox" where the bicycles are parked and charged. The service is meant to cover the last mile between the train station and the factories in the several industrial areas in the town. Currently, the service is free of charge.

Table 3-1: Vehicle Pool in 2018

		Spain	**Catalonia**	**Barcelona**
Scooters	Total	23,878	4,714	3,811
	Electric	2,006	1,089	1,073
	Share of EVs	8.40%	23.10%	28.16%
Motorbikes	Total	144,905	38,243	30,604
	Electric	2,707	389	330
	Share of EVs	1.87%	1.02%	1.08%
Cars	Total	1,344,794	225,836	178,052
	Electric	7,067	1,460	1,273
	Share of EVs	0.53%	0.65%	0.71%
Vans	Total	111,062	17,509	13,484
	Electric	856	211	186
	Share of EVs	0.77%	1.20%	1.38%
Buses	Total	4,037	543	387
	Electric	39	6	6
	Share of EVs	0.10%	1.10%	1.55%
Trucks < 3,500 kg	Total	63,362	10,578	7,996
	Electric	198	52	41
	Share of EVs	0.31%	0.49%	0.51%

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

		Spain	Catalonia	Barcelona
Trucks > 3,500 kg	Total	9,709	1,973	1,528
	Electric	8	4	4
	Share of EVs	0.08%	0.20%	0.26%

3.3.4 Bremen EV value chain

In the state of Bremen the number of EVs in private or business ownership amounts to 307 plus 288 plug-in hybrid vehicles, out of a total of 290,188 in 2017[5] (i.e., a share of about ~0.10% for both segments). For the City of Bremen, there are in total 240,790 registered vehicles[6], with 264 BEV (battery electric vehicles) and 252 plug-in hybrids. Besides these privately owned EVs, there are 3 car sharing companies active in the City of Bremen: ZET GmbH, Cambio GmbH and Flinkster. All of them offer station-based car sharing services, i.e., currently there are no free-floating car sharing activities in Bremen.

ZET offers a fully electrified fleet with 15 passenger cars located at 10 charging stations. Cambio is running 101 car sharing stations in Bremen, whereas 5 full electric vehicles are offered at just 4 of these stations. Flinkster is only offering conventional cars at 1 single station. All of these car sharing companies offer their services to registered users.

PMC operates CPs which are only accessible for a specified user group: users of corporate shared cars. These semi-public EVs can only be used by company employees. Some of the PMC CPs are also accessible for private EVs used by company employees.

“Conventional” car sharing parking spaces (without CPs) are generally prepared for electric charging in the City of Bremen, if street space allows. Thus, if a car sharing provider intents to install a CP, the grid connection is already in place.

[5] https://www.kba.de/DE/Home/home_node.html 1. Jan 2018
[6] https://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/Umwelt/2018_b_umwelt_dusl.html?nn=663524

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

4 First round of business model workshops

In this chapter the results of the first business model workshop round are described. First, the choices of the stakeholders and their interests and values are identified. Per stakeholder, business model elements are identified. Second, the business model elements are integrated in the St. Gallen Business Model.

4.1 Oslo

In the Oslo pilot, there is a particular focus on providing cost efficient home charging facilities for inhabitants living in the blocks of flats. For piloting, the project has selected the Røverkollen housing cooperative, comprising 246 apartments distributed over five blocks. The housing cooperative has a stand-alone four-storey parking garage where most residents have their own parking spot. As of 14.01.2019, there were 17 chargeable vehicles at Røverkollen (based on data from the Norwegian Public Roads Authority). The housing cooperative has established four outdoor semi-fast chargers. These are accessed through a rudimentary booking scheme. At the start of the project, 15 residents have signed a contract for using these outdoor chargers. Results from the conducted survey indicate that approximately 50% of the residents at Røverkollen consider buying their own chargeable vehicle within two years.

The expected growth in ownership of EVs, and the need for charging these EVs, is a challenge for the housing cooperative. This is both related to investment costs and the increased demand for electric power. To satisfy user needs a new charging infrastructure need to be deployed in the parking garage. This needs to be implemented with demand management to ensure that the usage will not overload the electricity grid. A scheme of the infrastructure is shown in Figure 5-1, including the stakeholder involvement.

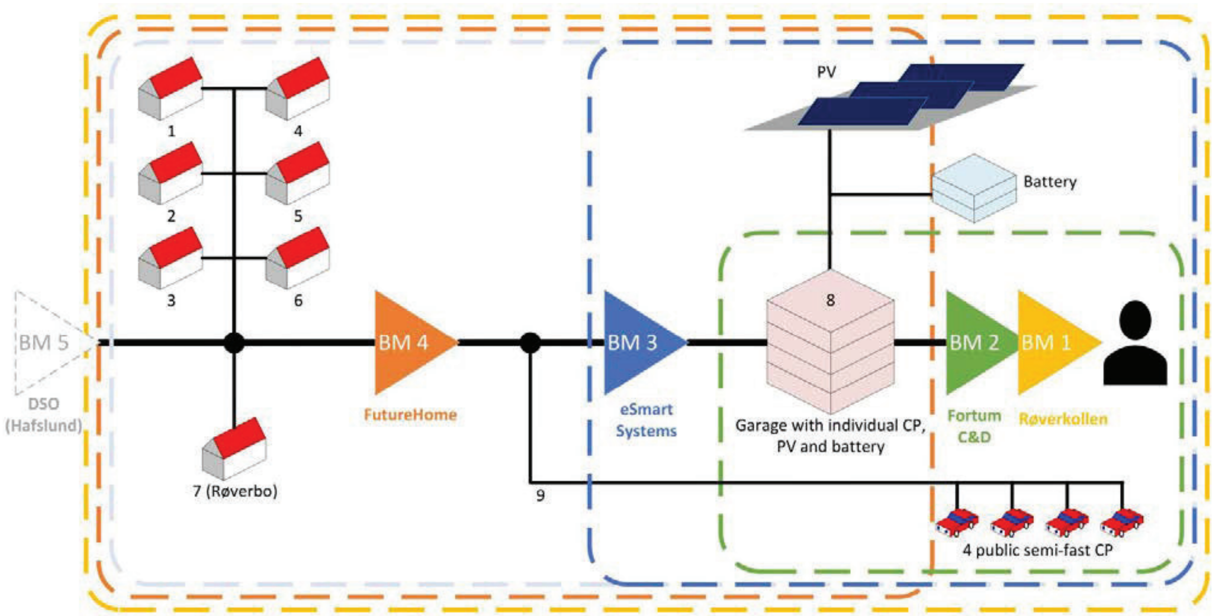

Figure 4-1: Oslo pilot energy flow and stakeholder involvement

4.1.1 Workshop results

All participants in the Oslo pilot identified their business model elements before defining their initial version of business models. All participants discussed their value proposition, value chain and revenue model. This has led to the following tables in which stakeholders presented their findings (Figure 4-2, Røverkollen; Figure 4-3, Fortum; Figure 4-4, eSmart Systems).

Røverkollen

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

The Røverkollen housing association has identified four main value propositions:

1. **Provide a mobility solution to the residents**. As a housing association, Røverkollen wants to offer its tenants an efficient and sustainable mobility solution. In the current situation tenants who use the CPs outside the parking garage have to remove their car after charging has finished. In the pilot situation, tenants who drive an EV can charge their car at their own parking spot in the garage and do not have to remove the EV after charging.
2. **Provide lower energy prices to the residents through obtaining electricity from the photovoltaic system (PV).** Through using PV panels Røverkollen can save money on electricity purchasing costs and can provide lower energy prices to its tenants.
3. **Lowering peak loads and postponing potential infrastructure investments to the DSO through load balancing.** By the use of load balancing it is possible to cope with a larger number of EVs without investments in the electricity infrastructure. This will save costs for the DSO and for Røverkollen as well.
4. **Providing an e-mobility (charging) facility to visitors.** Since the EV market in Norway is still growing fast[7] Røverkollen wants to enable visitors to charge their EV while visiting the flats.

Behind the value proposition Røverkollen identified the following value chains:

1. **Transporting energy to Røverkollen by the DSO.** The DSO (Fortum) takes care of transporting energy to the Røverkollen buildings.
2. **Providing kWh for energy use and buying excess PV energy by the electricity provider.** The electricity provider provides energy that can be used by residents of the buildings. This provider also purchases the excess energy derived from the PV panels.
3. **Providing electricity to parking spaces for the CPO.** Røverkollen takes care of the electricity provision at the parking lots in the garage.
4. **Providing electricity to semi-fast-chargers for the CPO.**

This results in a revenue model with the following elements:

- **Grid fee which varies per month.** Røverkollen has to pay a monthly grid fee to the DSO for using the electricity grid.
- **Monthly fee for used energy balanced with excess energy sold.** In addition to the grid fee, Røverkollen has to pay a monthly fee for the electricity that is used. This monthly fee will be balanced with the profit received by selling the excess PV energy.
- **Payments for electricity usage of residents plus an add-on to cover infrastructure costs**. Instead of Røverkollen, Fortum will receive payments from residents for electricity that is used for charging. Residents that will use the charging infrastructure also once have to pay an add-on to cover the infrastructure costs.
- **Payments for solar power used to charge EVs.** Røverkollen will receive payments for solar power that is used for charging EVs.
- **Reduced grid fee.** Since Røverkollen is lowering peak loads, infrastructure investments (responsibility of the DSO) can be postponed. This will lower the investment costs for the DSO and will cause a reduced grid fee for Røverkollen.
- **Payment per minute by visitors charging (through Fortum).** Visitors who charge their EV at Røverkollen will pay per minute for the electricity used. Fortum will receive these payments.

[7] In the first quarter of 2019 more than 50% of the passenger cars sold were BEVs. (Source: https://elbil.no/norway-reaches-historic-electric-car-market-share/)

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Organisation	Value Proposition	Value Chain	Revenue Model
Røverkollen	1. Residents: Providing mobility solution to residents	• DSO: Transporting energy to Røverkollen • Electricity provider: provides kWh for use & buys excess PV energy	• Grid fee varies per month (3 elements) • Monthly fee for energy used (varies per month); balanced with excess energy sold • Residents pay for electricity used for charging (through Fortum) with add-on to cover costs • Add-on for infrastructure costs
	2. Residents: Lower energy prices (PV)	• Residents: provide electricity to parking spaces (through CPO)	• Residents pay for PV electricity used to charge EVs
	3. DSO: Lowering peak loads & postponing potential infra investment		• Reduced grid fee (DSO) • Visitors pay for minutes used for charging (through Fortum)
	4. Visitors: providing e-mobility (charging) facility	• Visitors: provide electricity to semi-fast-chargers (through CPO)	

Figure 4-2: Business model elements Røverkollen

Fortum

Fortum has identified only one value proposition: provide charging and charging solutions for residents at the lowest possible cost. Behind the value proposition, Forum has identified four value chains:

1. **Transporting energy to Røverkollen.** As DSO, Fortum will transport energy to Røverkollen through the grid.
2. **Providing kWh for energy use and buying excess PV energy.** Fortum will provide electricity to Røverkollen. Fortum will also buy the excess PV energy that is produced at Røverkollen.
3. **Routing energy to the CPs for Røverkollen.** Fortum makes sure that electricity is transported to the CPs located at Røverkollen..
4. **Transporting CP energy to EV owners or residents for Fortum.** Fortum enables EV riders to charge their car at a CP.

Fortum has identified three revenue models:

1. **Installing charging points.** Residents that want to have a CP at their own parking spot at Røverkollen have to pay NOK 17,000 for installing a CP.
2. **Providing electricity.** Residents have to pay Fortum for the electricity used for charging their EV. They pay per use (kWh per session) plus an add-on of NOK 50 per month.
3. **Electricity refund.** Fortum monthly returns the revenue received from residents for the total kWhs used for EV charging to Røverkollen.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Organisation	Value Proposition	Value Chain	Revenue Model
Fortum	Provide charging & charging solutions for residents at the lowest possible cost	• DSO: Transporting energy to Røverkollen • Electricity provider: provides kWh for use & buys excess PV energy • Røverkollen: Energy to CP • Fortum: CP Energy to EV owner / resident	Residents: • CP: Residents pay NOK 17k for installing CPs • Energy: Residents pay per use / kWh per session + add-on NOK 50 per month (using the app) Røverkollen: • Electricity refund: Fortum monthly returns the revenue received from residents for total kWhs used by residents for EV charging

Figure 4-3: Business model elements Fortum

eSmart Systems

eSmart Systems has the following value proposition: "Reducing peak load cost for Røverkollen by optimizing planning for load balancing of EV chargers and totals by using energy from grid, solar power and a stationary battery". Behind the value proposition, eSmart Systems has identified four value chains:

1. Transporting energy to Røverkollen for the DSO
2. Providing kWh for energy use and buys excess PV energy for the electricity provider
3. **Offering an eSmart Flex platform for load balancing.** The eSmart Flex Platform calculates how incoming and locally produced electricity (through PV panels) and stored energy (in stationary batteries) can be used optimally to reduce peak load cost.
4. **Offering an Optimal Capacity Plan (OCP).** The OCP performs load balancing between the Fortum Charge & Drive system and eSmart Flex Platform. This will reduce the peak loads and the need for electricity infrastructure investments.

The revenue model of eSmart Systems during the pilot is unknown yet, after the pilot it will be through a SaaS agreement (license-based access to the system).

Organisation	Value Proposition	Value Chain	Revenue Model
eSmart Systems	Reducing peak load cost for Røverkollen by optimizing plan for load balancing of EV chargers; and totals by using energy from grid, solar power and a stationary battery.	• DSO: Transporting energy to Røverkollen • Electricity provider: provides kWh for use & buys excess PV energy • Røverkollen: eSmart Flex platform calculates how incoming and locally produced (PV panels) and stored energy (stationary battery) can be used optimally to reduce peak load cost. • Fortum: An Optimal Capacity Plan (OCP) is sent to perform load balancing between the Fortum Charge & Drive system and eSmart Flex Platform	Røverkollen: • Pilot: …TBD… • After: SaaS agreement (license-based access to the system)

Figure 4-4: Business model elements eSmart Systems

Business models

During the workshop, the consortium realized there are multiple business models applicable in the Oslo pilot. As shown in Figure 4-5, the orchestrator of the pilot is the Røverkollen housing association, which has his

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

own, separate business model. As an *orchestrator*, the company's focus is on the core competencies in their value chain (Gassmann et al., 2013). For Røverkollen as a housing association, the core competency is to provide good houses for a reasonable price. The other value chain segments (electricity, charging possibilities) are outsourced and actively coordinated. This allows Røverkollen to reduce costs and benefit from suppliers' economies of scale. Furthermore, the focus on its core competencies can increase performance.

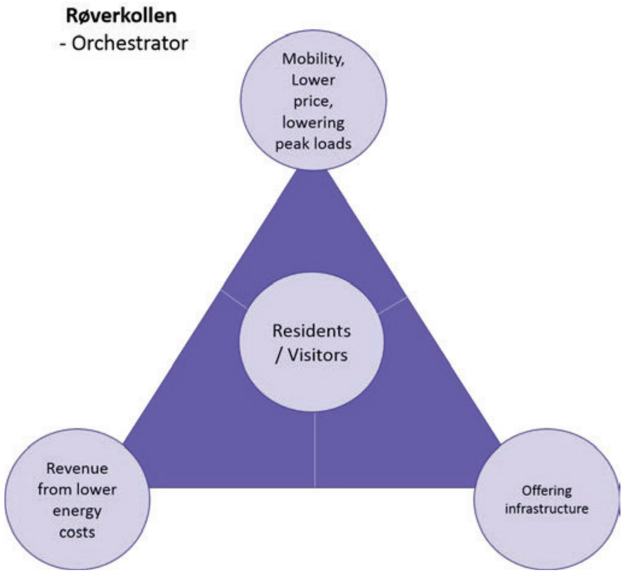

Figure 4-5: Røverkollen business model

The Oslo pilot business model is a layered principle with Røverkollen as the customer of Fortum and eSmart Systems, as can be seen in Figure 4-6 and Figure 4-7. One of two main business model drivers of Fortum is *Guaranteed availability*. The availability of the product (electricity) is guaranteed, resulting in almost zero downtime. The customer (Røverkollen) can use the offering as required, which minimizes losses resulting from downtime. Fortum uses expertise and economies of scale to lower operation costs and achieve these availability levels. The other main business model driver is called *Cash machine*. In the cash machine concept, the customer pays upfront for the product sold to the customer before the company is able to cover the associated expenses. This results in increased liquidity which can be used to amortise debt or to fund investments in other areas.

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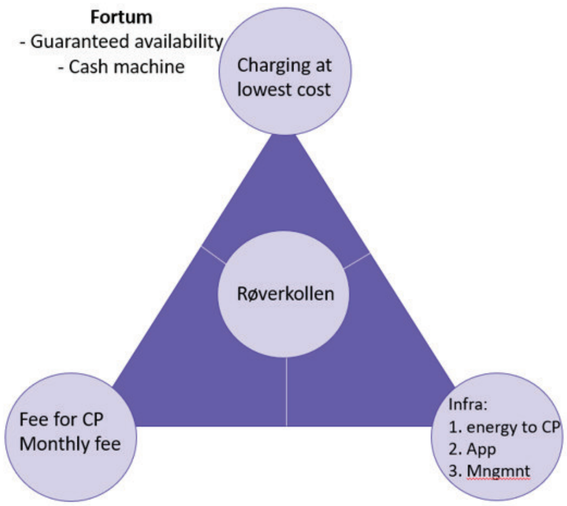

Figure 4-6: Fortum business model

The eSmart Systems business model for the Oslo pilot is also focused on Røverkollen as customer. As described before, their business model is focused on licensing. For this driver, efforts are focused on developing intellectual property that can be licensed to other manufacturers. This model, therefore, relies not on the realization and utilization of knowledge in the form of products, but attempts to transform these intangible goods into money. This allows a company to focus on research and development. It also allows the provision of knowledge, which would otherwise be left unused and potentially be valuable to third parties.

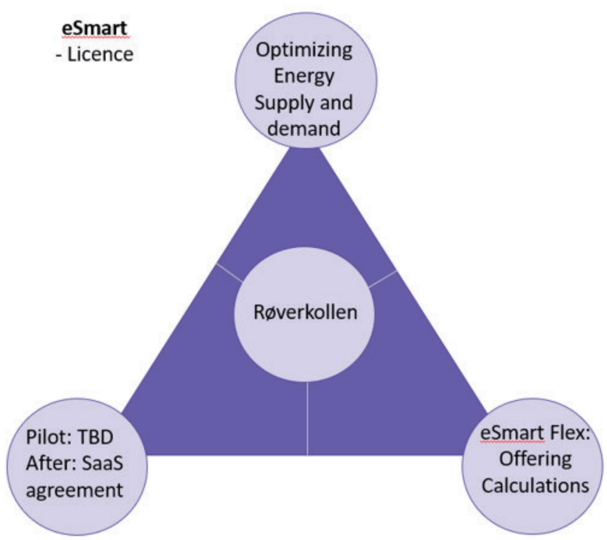

Figure 4-7: eSmart Systems business model

4.1.2 Business requirements

The feasibility, desirability and viability of the business model can be assessed by various key performance indicators (KPIs). The KPIs selected for assessing the Oslo pilot and business models are derived from D5.1-D6.1 (Evaluation Design and Stakeholder Acceptance Evaluation) and can be seen in Table 4-1.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Table 4-1: KPIs Oslo pilot

KPI	Description
5.1 - Number of EVs	Number of electric vehicles with respect to the total number of vehicles. The number of EVs is relevant for the energy requirement and the infrastructure investment costs. A larger number of EVs will reduce the infrastructure investment costs per charging point.
5.2 – Parking with charging	Number of parking spaces available for charging. If more parking spaces are equipped with charging points, the infrastructure investment costs per charging point will decrease.
5.3 – Utilization of charging points	Amount of time that a charging point is used. Especially the utilization of the charging points outside the parking garage is important. These points will be used by visitors. When fully charged cars are blocking these charging points, the availability of charging points is limited. This will affect the operation revenue of these charging points. The charging points in the parking garage are only available for the residents. The utilization of these charging points will only affect the peak loads and the amount of energy used.
5.4 – Share of battery capacity for V2G	Amount of energy storage that can be used to accumulate energy-surplus, and to return it when needed. This energy storage is relevant to reduce the consumption of grey energy and to reduce peak loads. A higher battery capacity reduces the need for electricity infrastructure investments.
5.5 – Charging availability	Charging service level offered to the users who would like to avoid waiting time and want to charge as much energy as they needed. If EV drivers are able to choose between priority and ‘normal’ charging, it will be possible to charge higher prices for priority charging.
5.6 – Average operating cost	Average operation costs for the charging infrastructure. The average operation costs for charging infrastructure consists of energy costs and costs for installing and operating the charging points. The average operating costs can be reduced by using a higher share of energy derived from the Røverkollen solar panels.
5.7 – Capital investment costs	Investment costs for acquiring and installing charging equipment. These investment costs are dependent of the number of charging points that will be realized in the parking garage. The electricity infrastructure adaptions will be made for every parking spot in the garage. The residents who want to make use of their own charging point have to make a one-off payment for acquiring and installing charging equipment. If more people want to have a charging point on their own parking spot, the average capital investment costs per charging point will be reduced.
5.8 – Average operation revenue	Average charging operation revenue. The charging point operator will earn more money when the utilization of charging points is high. The average investment costs will be reduced when more people want have their own charging point. The average operation revenue is thus dependent on the number of charging points, their average utilization and the grid energy price.
5.9 – Energy mix	Share of energy from local RES in the neighbourhood grid. A higher share of local RES will reduce the energy costs and the operating costs for the charging point provider.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

KPI	Description
5.10 – Peak to average ratio	Power peak with respect to the average energy ratio. A higher peak load will increase the need for electricity infrastructure investments.
5.11 – Savings	Savings derived by using local produced energy for charging. A higher amount of local energy used for charging will reduce the costs that have to be paid for grid electricity.

For the Oslo business model, it is important that a high share of the Røverkollen residents wants to make use of their own parking spot. The largest part of the electricity infrastructure investment costs has to be made prior to the start of the pilot. Through these investments, it is possible to install a CP at each parking spot. These initial investment costs have to be paid by the DSO. Residents who want to have their own CP have to pay one-off investment costs for acquiring and installing the CP.

The revenue of the DSO (originating from Røverkollen) depends on the number of people that are using their own CP. The average investment costs per CP will be much lower if there are more CPs installed and used. Due to the high initial investment costs, the number of users is crucial for the viability of the Oslo business model.

4.1.3 Technology requirements

One of the findings of the first Oslo pilot workshop is that it is not possible to provide a V2G solution with AC chargers. AC chargers have equal bidirectional charging and decharging speed, making them to slow for V2G load balancing. Therefore, the Røverkollen infrastructure does not have the requirements to test V2G. The GreenCharge consortium will therefore simulate V2G.

The results of the survey presented in section *4.3 Use cases and user needs* of Deliverable 2.3 (*Description of Oslo pilot and user needs*) states that it is likely that 50% of the residents at Røverkollen will have their own chargeable vehicle within two years. 50% of the respondents also says that charging possibilities in the parking spots in the garage is *very* or *a bit important.* Most of the respondents, as much as 57%, state that they do not want to share a charging spot with someone else through a booking system – they want to be able to charge their own vehicle at their own parking spot in the garage.

Today's charging infrastructure and booking system at Røverkollen is not suited to handle an increase in EVs this size. The parking garage requires a new charging infrastructure, providing the residents at Røverkollen the possibility of buying their own CPs. The parking spots are legally registered and cannot be moved between residents. Therefore, the new charging infrastructure must include all four storeys of the parking garage.

Read more about the technological architecture, specification of interfaces and protocols for interoperability in GreenCharge Deliverable 4.1 (*Initial Architecture*). The technology requirements for the Oslo pilot can be seen in Table 4-2.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Table 4-2: Technology requirements Oslo pilot

Use Case	Use Case #	Technology	Stakeholder(s) involved	Demo Site
Normal charging in the garage	1	Car connected to charge point Charging app – user to enter required information to start charging Charging Management System - Charging started from app, relevant information transferred to NEMS Neighbourhood Energy Management System - Receives data from CEMS, update predictions and creates plan and sends it to CEMS Charging Management System - Performs charging to connected cars	Fortum and eSmart Systems	Røverkollen housing cooperative parking garage
Long-term parking (V2G possibilities) in the garage	2	To be decided	Fortum and eSmart Systems	Røverkollen housing cooperative parking garage

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

Use Case	Use Case #	Technology	Stakeholder(s) involved	Demo Site
Drop-in charging (4 semi-fast chargers outdoors)	3	The chargers will be connected to Fortum's backend system for management and operation of the charging stations at the site. Typically, the available methods of starting and stopping a charging session are Fortum's C&D App, RFID-tag and SMS. For bookable charging stations the user needs to use the App. If the user is on site and has no app the user needs to download the App. Roaming is available through the Hubject's Intercharge network[8]. The App will guide the user to the location and list the available chargers, showing the current state of the chargers. The procedure for charging is: • Connect car to the available charging outlet • Chose the outlet in the app and press "start" to initiate the charging session, or The charging session will start immediately after authentication and can only be terminated through the same tool as the starting of the session. The cost of the charging session will be calculated according to the price plan of the specific charging point after end-of-charge, and the amount will be drawn from credit/debit card.	Fortum	Røverkollen housing cooperative semi-fast outdoor charge points

[8] It is uncertain if booking is possible through the Intercharge network and associated App. See deliverable D2.4 for further details regarding the Intercharge network

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Use Case	Use Case #	Technology	Stakeholder(s) involved	Demo Site
Charging with booking (4 semi-fast chargers outdoors)	4	Booking of charging can only be done through the App interface. Depending on the regulations of the site in question, a user may be allowed to reserve a specific outlet for charging for a specific period (from DDMMYY/hhmm to DDMMYY/hhmm) When arriving at the charging point, only the user with the approved reservation can start the charging process. The process of start and stop of a charging session is identical to the above procedure, but only the App will be allowed to start charging.	Fortum	Røverkollen housing cooperative Semi-fast outdoor charge points

4.2 Barcelona

The pilot site in Barcelona covers 3 different demonstrator areas in Barcelona province:

- One of these demonstrators is the Eurecat demonstrator, spread over 8 Eurecat premises in Catalonia. The aim of Eurecat is to put in place a booking service for in-house CPs open to Eurecat employees driving an EV and travelling from their workplace to other premises. Besides, an energy management system will be added to optimally charge the vehicles taking into account locally produced energy and the rest of loads of the premises.
- MOTIT demonstrator: apart from their headquarters located near Barcelona in Hospitalet de Llobregat, MOTIT has several premises spread over the city of Barcelona where batteries can be charged in hubs. The goal of this demonstrator is to develop tools to optimize the charging process of a fleet of e-scooters from the perspective of the fleet operator of a sharing service. An incentive scheme to engage users to drop the e-scooter near the hub will also be tested.
- Sant Quirze public e-bike sharing service: goal is to upgrade the existing e-bike sharing service open to commuters travelling by train to reach the factories spread over a wide industrial area in the town. The introduction of ICT tools will allow to enhance traceability of assets, increase security and extract valuable information to extend and improve the service offered to the workers.

4.2.1 Workshop results

All participants in the Barcelona pilot identified their business model elements before defining their initial version of business models. All participants discussed their value proposition, value chain and revenue model. This has led to the following tables in which stakeholders presented their findings (Figure 4-8, Atlantis; Figure 4-9, Enchufing Eurecat demonstrator; Figure 4-10, Enchufing St Quirze demonstrator).

Atlantis
Atlantis has identified three main value propositions for the Barcelona pilot:

1. **Improving the e-bike sharing service for users.** An improved e-bike sharing service will increase the attraction to users.

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2. **Improving the e-bike sharing service for the City Hall.** An improved e-bike sharing service will increase the attraction of the service. More people will make use of the shared e-bikes and the number of conventional vehicles around the City Hall will be reduced.

Behind this value proposition Atlantis identified the following value chains:

1. **Providing and increasing the number of shared e-bikes.** By increasing the number of bicycles offered for sharing, the availability of e-bikes will be more certain. Atlantis will also offer the most charged e-bike available at that moment to the users. This will increase the user's experience.
2. **Providing information about the use of e-bikes to the City Hall.** By providing information about the use of e-bikes it will be possible to improve the sharing service. Atlantis installs a geo-tracker in each e-bike and provides an Internet of Things (IoT).
3. **Providing an app to the end-users.** End-users can book an e-bike via the app provided by Atlantis.

Atlantis has identified only one (long-term) revenue model in monetary terms. The other revenues identified are indirect benefits. Atlantis' technology is not sold to the users in this pilot situation. However, there is a potential business opportunity for Atlantis to sell its technology (SaaS) to exploit a service for sharing EVs (public and private operators) and expand this experience to other city halls or private companies.

Besides this possible monetary revenue model there are multiple indirect benefits, such as:

1. **Less CO2-emission.** Usage of e-bikes instead of other conventional transport modes will decrease the CO2-emission.
2. **Less traffic jam problems due to the use of public transport solutions.** The e-bikes are located at a train station and will be used mostly in combination with train travelling. The opportunity to cover the last mile by e-bike will increase the attraction of commuting by train instead of commuting by car.
3. **Greater wealth in the territory (because it is more attractive for companies to stay in there).** The multimodal combination of e-bikes and train travelling decreases employees' commuting time. This will increase the attraction of St Quirze region for companies.
4. **Improvement of the mobility services for citizens.** A good working e-bike sharing service will increase the number of travelling opportunities for commuters and other citizens.

Organisation	Value Proposition	Value Chain	Revenue Model
Atlantis Pilot B : public (non-profit) e-bike sharing service Sant Quirze del Vallès city hall	1. City Hall : • Improved e-Bike sharing service • Increase the number of bicycles offered and/or expand this service to other neighbourhoods due to the success of this service. 2. Users : better sharing service/experience	1. City Hall : providing real information about the use of the e-bikes + a sharing platform, by installing a geotracker in each e-bike + other IoT devices in the e-bikes station + an IoT platform + end user App 2. Users : • providing more secure infrastructure • +control = better availability of bicycles • offering the most charged e-bike available in each moment • Identifying the real user of each e-bike, so only good users can use the service 3. Enchufing: providing IoT devices to the e-bikes station, in order to : • monitor the charge state of the battery of each e-bike • Lock/unlock the entrance door of the e-bikes charging&parking station • Activation/deactivation of the charging point of each e-bike	This proposed pilot has no direct business model (in monetary terms), but there are some indirect benefits: 1. less CO2 emission 2. less traffic jam problems due to the use of public transport solutions 3. greater wealth in the territory (because you make it easier for companies to stay in there) 4. sell over-production of solar cell electricity to the distribution network 5. improvement of service to the citizen And there is a potential business for us : to sell our technology (SaaS) to exploit a service for sharing electric vehicles (public and private operators) beyond this pilot, and expanding this experience to other city halls and private companies

Figure 4-8: Business model elements Atlantis

Enchufing (Eurecat demonstrator)

Enchufing has identified two value propositions for the Eurecat demonstrator:

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1. **Improving the e-mobility infrastructure at Eurecat premises.** Enchufing increases the number of CPs at Eurecat premises by providing and installing CPs. This will improve the e-mobility infrastructure and the attraction of driving an EV for Eurecat employees.
2. **Increasing usage of green energy derived from solar panels.** Enchufing uses the green energy derived from solar panels that will be installed at Eurecat premises for charging EVs. The amount of grey energy used will be reduced.

Behind this value proposition Enchufing defined the following value chains:

1. **Providing charging infrastructure for Eurecat.** By providing CPs to Eurecat premises the charging infrastructure will be improved. If there are several CPs at different Eurecat premises it will be easier for employees to switch from a conventional car to an EV.
2. **Providing green energy for charging EVs.** The green energy derived from solar panels at Eurecat premises will be used for charging EVs. If there is no green energy available grey energy from the grid is used.
3. **Providing excess green energy to the electricity grid.** The excess green energy derived from solar panels at Eurecat premises will be distributed to the electricity grid.

This results in a revenue model with the following elements:

1. **A grid fee which varies per month.** This grid fee is paid to the DSO for using electricity from the grid and depends on the amount of grid energy that is used for charging.
2. **A monthly fee for green energy shared to the grid.** This monthly fee will be paid to Enchufing by the DSO and varies dependent on the amount of green energy shared to the grid.
3. **A fee paid for energy used for charging.** This fee will be paid to Enchufing by Eurecat and depends on the amount of energy that is used for charging.

Organisation	Value Proposition	Value Chain	Revenue Model
ENCHUFING Pilot A	1. Company: providing e-mobility (charging) infrastructure 2. Employees: using recharging infrastructure 3. Electricity provider: obtaining green energy coming from solar panels when not used by the company or the visitors and employees.	. Electricity provider: provides kWh and kW for recharging the electric vehicles when there is no energy from the solar panels . Enchufing Customer A: provides kWh and kW from solar panels for recharging the electric vehicles.	• Grid fee varies • Monthly fee for energy shared to the grid • Recharging fee (exempt for specific visitors)

Figure 4-9: Business model elements Enchufing (Eurecat demonstrator)

Enchufing (St Quirze demonstrator)

Enchufing has identified two main value propositions for the St Quirze demonstrator:

1. **Improving the e-mobility charging infrastructure for e-bikes.** Enchufing increases the number of e-bike CPs at St Quirze by providing and installing CPs. This will improve the e-mobility infrastructure and the attraction of using an e-bike in combination with train travelling for commuting.
2. **Increasing usage of green energy derived from solar panels.** Enchufing uses the green energy derived from solar panels for charging the e-bikes. The amount of grey energy used will be reduced.

Behind this value proposition Enchufing defined the following value chains:

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1. **Providing e-bike charging infrastructure.** By providing more e-bikes and CPs the e-mobility charging infrastructure will be improved. If there is no guaranteed availability of e-bikes at St Quirze, many commuters are not convinced of using a train and e-bike instead of travelling by car.
2. **Providing green energy for charging e-bikes.** The green energy derived from solar panels at St Quirze will be used for charging e-bikes. If there is no green energy available grey energy from the grid is used.
3. **Providing excess green energy to the electricity grid.** The excess green energy derived from solar panels at St Quirze will be distributed to the electricity grid.
4. **Using second-life batteries for storing energy.** Second-life batteries will be used for storing energy derived from the solar panels.

This results in a revenue model with the following elements:

1. **A grid fee which varies per month.** This grid fee is paid to the DSO for using electricity from the grid and depends on the amount of grid energy that is used for charging.
2. **A monthly fee for green energy shared to the grid.** This monthly fee will be paid to Enchufing by the DSO and varies dependent on the amount of green energy shared to the grid.
3. **A fee paid for energy used for charging.** This fee will be paid to Enchufing by the train transport company and depends on the amount of energy that is used for charging.
4. **A fee paid for renting the second-life battery.** The second-life batteries that will be used for storing green energy are rented from Millor Battery. Enchufing will pay a monthly fee for renting these batteries.

Organisatio n	Value Proposition	Value Chain	Revenue Model
ENCHUFING Pilot B	1. Train transport Company: providing e-mobility (charging) infrastructure 2. Employees: using recharging infrastructure 3. Users: using the recharging infrastructure for the electric bicycle fleet 4. Electricity provider: obtaining green energy coming from solar panels when not used by the company or the visitors and employees. 5. Millor Battery: providing second life batteries 6. Enchufing: Providing installation and maintenance of the recharging infrastructure	. Electricity provider: provides kWh and kW for recharging the electric vehicles when there is no energy from the solar panels . Train transport company: provides kWh and kW from solar panels for recharging the electric vehicles.	• Grid fee varies • Monthly fee for energy shared to the grid • Recharging fee (exempt for specific visitors) • Second life MILLOR Battery rent fee

Figure 4-10: Business model elements (St Quirze demonstrator)

Business models

During the workshop, the consortium realized there are multiple business models applicable in the Barcelona pilot. As shown in Figure 4-11, the role of Atlantis in the St Quirze demonstrator is to provide an improved e-bike sharing service. Atlantis sells its product (service) through *licensing*. Its efforts are focused on developing intellectual property that can be licensed by other users. This model relies not on the realization and utilization of knowledge in the form of products, but attempts to transform these intangible goods into money (Gassmann et al., 2013).

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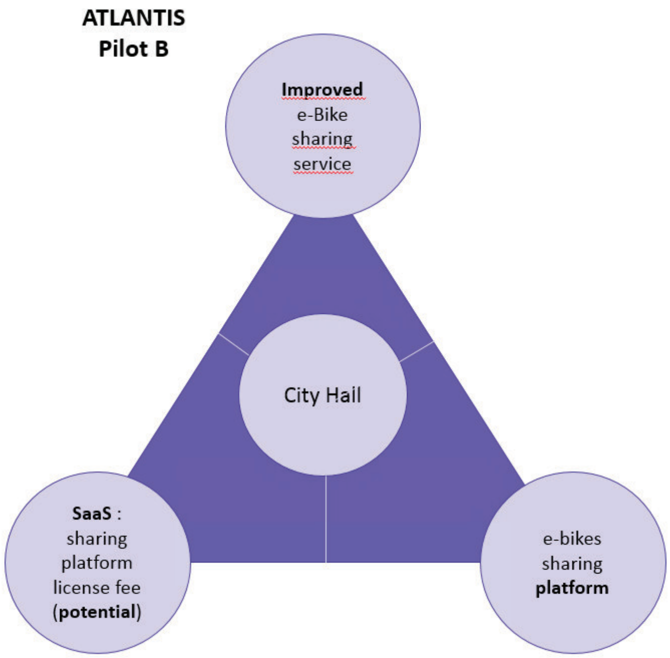

Figure 4-11: Atlantis business model

For the City Hall and the Train Transport Company, there is no business model regarding the shared e-bikes. They provide a location for the e-bikes but they are not the owner of the e-bikes. The payments for using these e-bikes will be received by the bike-owner.

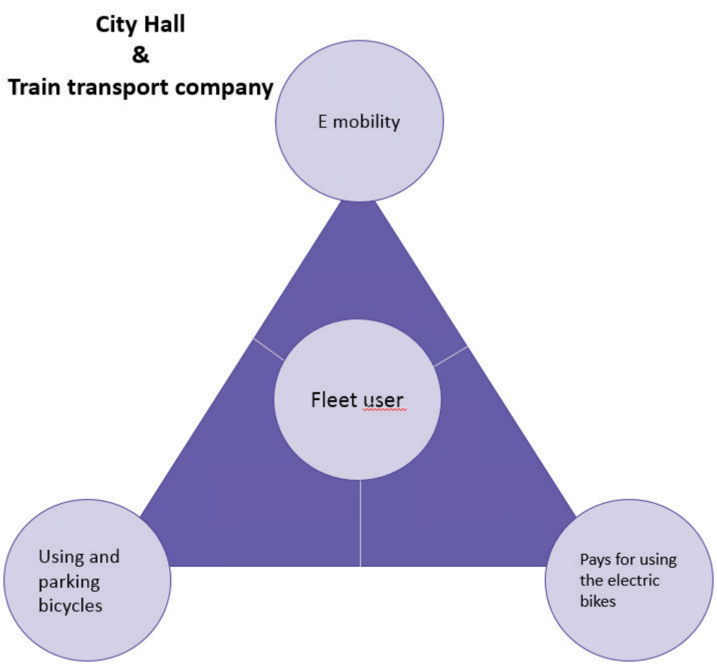

Figure 4-12: City Hall & Train transport company business model

Enchufing provides the charging infrastructure for the e-bikes in St Quarze and the charging infrastructure for the Eurecat premises. Their business model is based on *Pay-per-use*. The customer pays on the basis of what he or she effectively consumes (the number of bike trips made). The company is able to attract customers who wish to benefit from the additional flexibility, which might be priced higher.

Due to uncertainty about the contribution of MOTIT in the Barcelona pilot when arranging the business model workshops, the business model for MOTIT is not described in this deliverable. Of course their business model will be described in the revised business models deliverable.

4.2.2 Business requirements

In this subsection the requirements from a business perspective for this specific business model are described. The feasibility, desirability and viability of the business model will be assessed in this subsection. The KPIs selected for assessing the Barcelona pilot and business models are derived from D5.1-D6.1 (Evaluation Design and Stakeholder Acceptance Evaluation) and can be seen in Table 4-3.

Table 4-3: KPIs Barcelona pilot

KPI	Description
5.1 – Number of EVs	Number of electric vehicles with respect to the total number of vehicles. The number of EVs is relevant for the energy requirement and the infrastructure investment costs. A larger number of EVs will reduce the infrastructure investment costs per EV.
5.4 – Share of battery capacity for V2G	Amount of energy storage that can be used to accumulate energy-surplus, and to return it when needed. This energy storage is relevant to reduce the consumption of grey energy and to reduce peak loads. A higher battery capacity reduces the need for electricity infrastructure investments.
5.6 – Average operating cost	Average operation costs for the charging infrastructure. The average operation costs for charging infrastructure consists of energy costs and costs for installing and operating the charging points. The average operating costs can be reduced by using a higher share of energy derived from solar panels.
5.7 – Capital investment costs	Investment costs for acquiring and installing charging equipment. These investment costs are dependent of the number of charging points that will be installed.
5.8 – Average operation revenue	Average charging operation revenue. The charging point operator will earn more money when the utilization of charging points is high. The average investment costs will be reduced when more charging points will be installed. The average operation revenue is thus dependent on the number of charging points, their average utilization and the grid energy price.
5.10 – Peak to average ratio	Power peak with respect to the average energy ratio. A higher peak load will increase the need for electricity infrastructure investments.
5.11 – Savings	Savings derived by using local produced energy for charging. A higher amount of local energy used for charging will reduce the costs that have to be paid for grid electricity.

4.2.3 Technology requirements

The critical technology requirements identified refers to the interoperability of the systems and the need to exchange information between them.

The scheme of the architecture shown in Figure 4-13 depicts the numerous interactions existing from the several components; each letter from *a* to *p* represents an interface between components that has to be defined and implemented. This diagram was developed as part of project proposal preparation, and is part of the Grant Agreement. A more detailed descriptions of the interfaces to be implemented by each demonstrator is presented

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

in *D2.17 Implementation plan for Barcelona pilot*. Besides, a more specific work on the architecture definition is being performed in WP4. The results will be provided in *D4.1 Initial Architecture Design*.

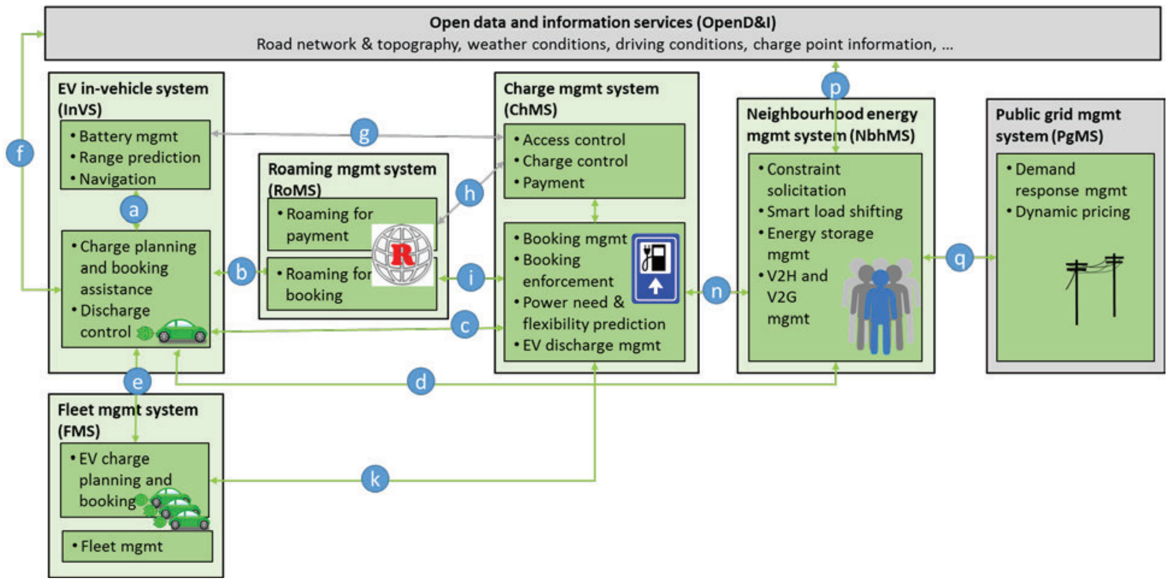

Figure 4-13: GreenCharge interfaces (from Grant Agreement)

At another level, the charging infrastructure needs to be compatible with the charging needs of the vehicles. In the case of the sharing services, MOTIT and St. Quirze e-bike sharing service, the charging infrastructure was designed by the service. An issue of incompatibility would arise if the battery hub was offered to third parties that use different batteries or if the e-sharing station was open to individuals that park and charge their bicycles. These scenarios are out of the scope of GreenCharge.

Finally, there is a technological use coming from the side of the user. The main interaction with the user is performed through apps. Thus, the users are required to have smartphones. The apps will be developed to support Android and iOS operating systems, which covers most of the market share. The features of the smartphone required are very basic (3G/4G communication, camera and potentially GPS).

4.3 Bremen

The Bremen pilot site consists of a variety of charging stations addressing different types of users. These CPs are embedded in different environments and apply basically to car sharing users (people without own car, sporadic usage in combination with public transport, etc.). The charging stations are either integrated in the grid of a local electric utility company or are part of the local grid in a quarter area. Two types of CPs can be distinguished in the pilot: CPs on public ground and CPs on private ground.

Before GreenCharge started, booking of CPs for shared EVs was not needed since each car was attributed to one specific charging place. These CPs will be made available to other users during absence of the shared EV. Priority charging will be tested at CPs on private ground (business areas). The rules for priority charging can be set by the employer. Smart charging capability would decrease the cost of power supply.

The special focus of the Bremen pilot is on combining the promotion of e-cars with car sharing, and the use of stationary batteries to balance peak demand from charging. It includes new housing projects built to avoid privately owned cars, charging facilities at intermodal hubs and the use of 2nd life car batteries as stationary storage.

4.3.1 Workshop results

The participants in the Bremen pilot identified their business model elements before defining their initial version of business models. They discussed their value propositions, value chains and (possible) revenue

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models. This has led to Figure 4-14, Figure 4-15 and Figure 4-16 in which stakeholders presented their findings.

ZET

Car sharing provider ZET has identified two main value propositions:

1. **Providing a sustainable mobility solution.** ZET provides a sustainable mobility solution through car sharing for private persons, either directly or via organizations. ZET is mainly focused on people between 20 and 40 years old who are aware of the environment.
2. **Providing (public) charging facilities for EVs.** At moments when the shared EVs are away from their parking spot, this parking spot can be used by other EVs for charging their car. In this way the existing charging infrastructure can be used efficiently.

Behind the value proposition ZET identified the following value chains:

1. **Purchasing EVs.** These EVs are purchased at EV manufacturers (OEMs) and will be used by ZET for car sharing purposes.
2. **Purchasing and installing CPs.** These CPs will be purchased at a charging facility manufacturer/retailer and will be used for charging the shared cars. In the Bremen pilot these CPs will also be used for charging other EVs (only if the shared EV is away from its parking spot).
3. **Purchasing electricity from DSOs.** This electricity will be used for charging EVs at the CPs.
4. **Developing ZET site and app.** This app and website can be used for communicating with clients. It will provide booking options for customers.

This results in a revenue model with the following elements:

1. **Monthly fee for car sharing members.** People who want to make use of ZET's car sharing service have to register themselves. Each member has to pay a monthly fixed fee, independent of actual usage.
2. **Additional fee for usage of shared cars.** Each time a member wants to use a shared car he has to pay an additional fee for usage. This additional fee will be based on the amount of kWh that is used or the total number of kilometres that is driven.
3. **Payments for usage of the CPs by other EVs.** An additional source of income for ZET are the payments for usage of the CPs by other EVs. When the shared cars are on the road and their parking spot is empty, their CPs can be used by other EVs. These EV drivers will pay per kWh.

Organisation	Value Proposition	Value Chain	Revenue Model
MoveAbout	1. Sustainable mobility carsharing for private persons, either directly or via organization (e.g. company) -> target groups 20-40 yrs, environmental aware	• Assets: buy & install CPs (25 in Bremen), buy & use EVs (23 in Bremen), buy electricity • Own assets: develop site & app to communicate with clients (only booking & using cars, no charging)	• Monthly subscription • Pay per use (per km or kWh)
	2. Access to EV charging	• Electricity provider: provides kWh for use at CP	• Pay per use (per kWh)

Figure 4-14: ZET business model elements

PMC

Only one value proposition is identified by PMC: providing knowledge that will be used for efficient and effectively usage of EVs by combining the knowledge, assets and experience from PMC members. This knowledge can be used for developing and managing EV projects.

Behind this value proposition, two value chains are identified:

1. **Receiving knowledge, business models and assets from PMC members.** PMC's members are companies active in different branches. However, all of them are related to e-mobility providing EVs,

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CPs, and/or are engaged in renewable energy affairs. PMC interacts with its members and provides them services regarding EV maintenance, access to CPs and EV sharing. In the opposite order, its members provide knowledge, business models and assets to PMC to create a transferable community-related concept for electric mobility.

2. **Adding and combining own knowledge about CPs and energy management with knowledge received from members.** PMC is almost 10 years active in the field of electro mobility. Adding and combining their own knowledge with knowledge received from members can form an attractive value proposition for their members.

The revenue model for PMC consists of two parts:

1. **A yearly membership fee.** Each member of PMC has to pay a yearly membership fee to PMC, independent how often they will use PMC's knowledge for assignments.
2. **Clients pay per assignment.** Clients using PMC's knowledge for their assignments will pay an additional fee. The revenue is divided between PMC and its members involved and will be based on the amount of input in the project.

Organisation	Value Proposition	Value Chain	Revenue Model
PMC	We provide the knowledge so you can efficient and effectively make use of EVs by combining the knowledge, assets and experience from our members to develop and manage EV projects	• Members provide knowledge, business models and assets if needed • Own knowledge about CP / energy management is added	• Membership fee (€ … per year) • Clients pay per assignment (revenue divided between PMC and members involved based on input in project)

Figure 4-15: PMC business model elements

City of Bremen

For the City of Bremen, one value proposition is identified: modernising mobility to improve quality of living in the city and reduce car ownership at the lowest possible costs (relative). Behind this value proposition, City of Bremen identified three value chains:

1. **Providing regulation.** The City of Bremen provides regulation which enables the shift to sustainable mobility. For example, one of these regulations provided by the City of Bremen is to expand the pay parking area. This will make people think about using a shared car instead of their own car to lower their costs.
2. **Developing urban planning focussed on sustainable urban mobility (SUMPs).** City of Bremen is the winner of the 2014 SUMP award. In the city's SUMP approach, sustainable modes are seen as an alternative to owning a car. This approach will be integrated in the city's urban plans to make car sharing a more attractive alternative.
3. **Stimulating initiatives like GreenCharge.** Through initiatives like GreenCharge the City of Bremen can draw attention to sustainable mobility.

It is not possible to compare the revenue model of the City of Bremen with the revenue models of non-public organisations. The revenues for the City of Bremen are an improved quality of living and an improved efficiency of the total transport system. This cannot be expressed in a financial way on the short term, but on long term inhabitants will be more satisfied and costs can be saved on other aspects (e.g. health costs due to polluted air).

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Organisation	Value Proposition	Value Chain	Revenue Model
City of Bremen	Modernise mobility to improve quality of living in the city at lowest possible cost (relative) & reduce car ownership	• Regulation • Urban planning • Etc. • Stimulating initiatives like GreenCharge	• Improved of quality living • Improved efficiency of the total transport system

Figure 4-16: City of Bremen business model elements

Business models

During the workshop, the consortium realized there are multiple business models applicable in the Bremen pilot. As shown in Figure 4-17, the orchestrator of the pilot is the City of Bremen, which has his own, separate business model. As an *orchestrator*, the city's focus is on the core competencies in their value chain (Gassmann et al., 2013). For the City of Bremen, the core competency is to improve the quality of living in the city at the lowest possible costs. This will be done by modernising mobility and reducing car ownership. The other value chain segments (car sharing, charging facilities) that are needed for achieving these goals are outsourced and actively coordinated. This allows the City of Bremen to focus on their main responsibilities and benefit from other companies' economies of scale.

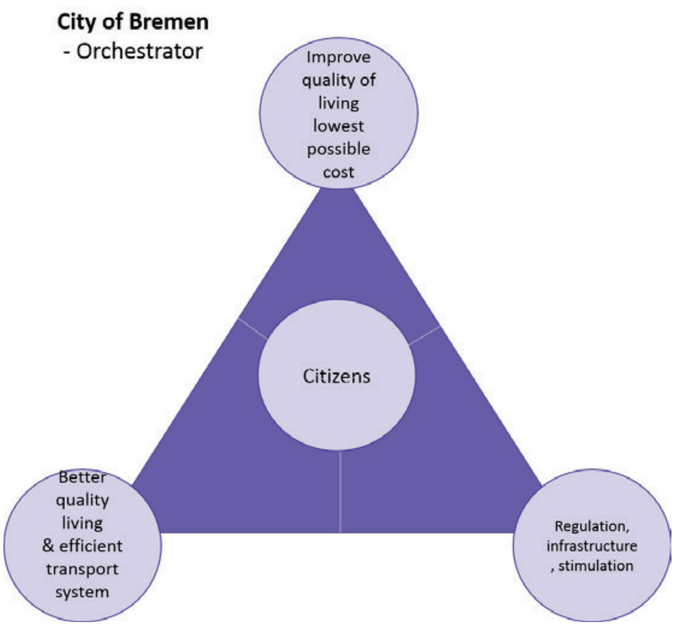

Figure 4-17: City of Bremen business model

The business models for the non-public organisations differ completely from the business model for a public authority as can be seen in Figure 4-18 and Figure 4-19. The business model driver for ZET is *Integrator*. An integrator is in command of the bulk of the steps in a value-adding process. The control of all resources and capabilities in terms of value creation lies with the company. Efficiency gains, economies of scope, and lower dependencies from suppliers result in a decrease in costs and can increase the stability of value creation.

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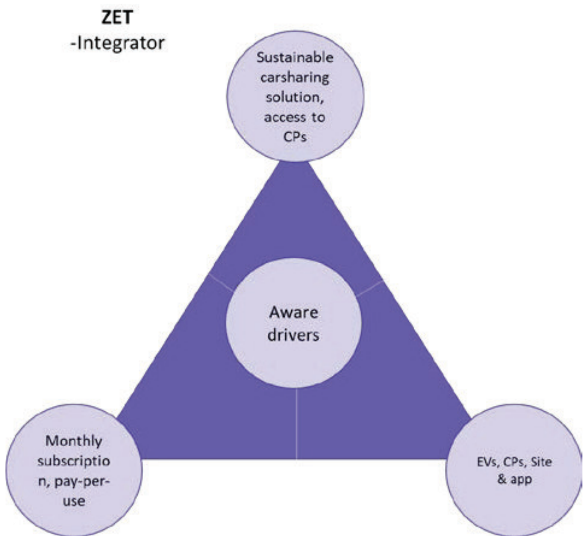

Figure 4-18: ZET business model

The PMC business model for the Bremen pilot is focused on SMEs and smaller communities as customers. Their business model can be seen as an *Open business model*. In open business models, collaboration with partners in the ecosystem becomes a central source of value creation. Companies pursuing an open business model actively search for novel ways of working together with suppliers, customers, or complementors to open and extend their business.

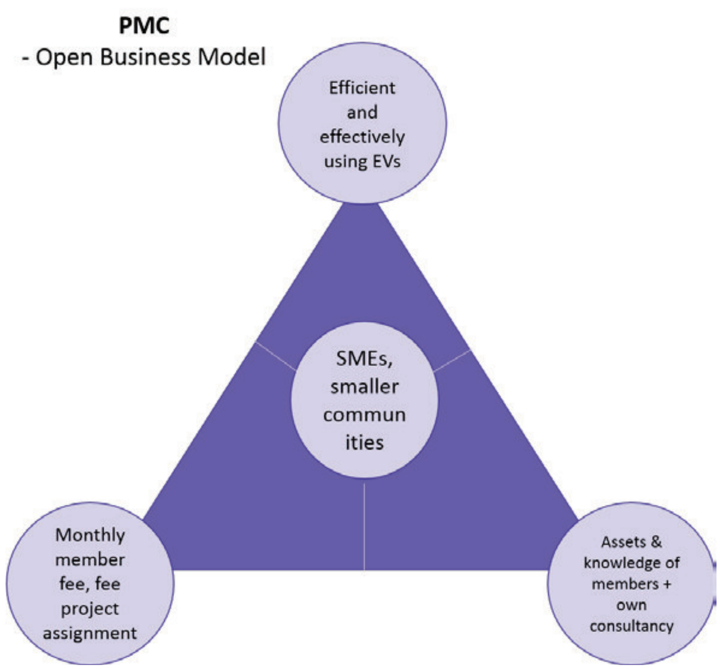

Figure 4-19: PMC business model

4.3.2 Business requirements

The feasibility, desirability and viability of the business model can be assessed by various key performance indicators (KPIs). The KPIs selected for assessing the Bremen pilot and business models are derived from

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D5.1-D6.1 (Evaluation Design and Stakeholder Acceptance Evaluation) and can be seen in Table 4-4: KPIs Bremen pilot.

Table 4-4: KPIs Bremen pilot

KPI	Description
5.1 – Number of EVs	Number of electric vehicles with respect to the total number of vehicles. The number of (private) EVs is relevant for the revenue of the car sharing services. If there is a larger number of private EVs, the CP utilization will be higher (also at the CPs that are only appointed to a shared EV nowadays). The number of shared EVs is relevant for the attractiveness of the car sharing service (also see KPI 5.15).
5.2 – Parking with charging	Number of parking spaces available for charging. A larger number of CPs at parking spaces is important for the attractiveness of EVs in general. This can be achieved by making the CPs only used by shared cars available for all EV drivers.
5.3 – Utilization of charging points	Amount of time that a charging point is used. Especially the utilization of the charging points outside the parking garage is important. These points will be used by visitors. When fully charged cars are blocking these charging points, the availability of charging points is limited. This will affect the operation revenue of these charging points. The charging points in the parking garage are only available for the residents. The utilization of these charging points will only affect the peak loads and the amount of energy used.
5.5 – Charging availability	Charging service level offered to the users who would like to avoid waiting time and want to charge as much energy as they needed. If EV drivers are able to choose between priority and ‘normal’ charging, it will be possible to charge higher prices for priority charging.
5.6 – Average operating cost	Average operation costs for the charging infrastructure. The average operation costs for charging infrastructure consists of energy costs and costs for installing and operating the charging points.
5.7 – Capital investment costs	Investment costs for acquiring and installing charging equipment.
5.8 – Average operation revenue	Average charging operation revenue. The charging point operator will earn more money when the utilization of charging points is high. The average investment costs will be reduced when more people want have their own charging point. The average operation revenue is thus dependent on the number of charging points, their average utilization and the grid energy price.
5.9 – Energy mix	Share of energy from local RES in the neighbourhood grid. A higher share of local RES will reduce the energy costs and the operating costs for the charging point provider.
5.10 – Peak to average ratio	Power peak with respect to the average energy ratio. A higher peak load will increase the need for electricity infrastructure investments.
5.11 – Savings	Savings derived by using local produced energy for charging. A higher amount of local energy used for charging will reduce the costs that have to be paid for grid electricity by the CP operator.

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KPI	Description
5.15 – Car sharing development and impacts	This KPI shows the density of the car sharing development in Bremen. The higher the density is, the more attractive the service is for (potential) users. A higher density of car sharing stations will make it easier for potential users to make the transition from having their own car to using a shared car.

For the Bremen business model the utilization of the CPs and the shared cars is most important. The CPs that are appointed to shared cars could also be used by private EVs at moments when the shared car is being used. This will increase the revenue for car sharing services and will lower payback time for the charging infrastructure investment costs. As described above, a higher density of shared cars will make the car sharing services more attractive for potential users. This will lead to a higher number of members (monthly fee) and shared cars that are used more frequently (pay-per-use).

4.3.3 Technology requirements

The actual situation in terms of usability of charging stations served by various stakeholders does not fulfill requirements for interoperability. In particular, the different backends that are employed for the various charging sites make a comprehensive performance in providing 'Mobility as a Service' inconvenient to potential users. On the other hand, interoperability is a requirement for testing the use cases in the above scenarios. The technological requirements for the Bremen pilot can be seen in Table 4-5.

Table 4-5: List of user needs referred to Use Cases, technologies, and demo sites

User Need	Use Case	Technology	Stakeholder involved	Demo Site
fully charged car	#1, 2, 3, 4	Booking of cars with respect to SoC	-/-	all
optional charging sites	#1, 2, 3, 4	Link to appropriate street maps that indicate free charging stations	-/-	all
km-range	#3, 4	Option to choose appropriate EV during booking process	-/-	Ricarda-Huch, Kissinger
charging time	#1, 2, 3, 4	Charging time shown in comparison to charging technique	-/-	all
Charge and Ride	#3	Public transport booking platform (ticketing, timetable) integrated in CarSharing software	BSAG	Ricarda-Huch
reservation	#3	Public transport booking platform integrated in CarSharing software	BSAG	Ricarda-Huch
Fare-ticket	#3	Purchase of fare-ticket for public transport integrated in CarSharing software	BSAG	Ricarda-Huch
Application	#3	Public transport services integrated in CarSharing software	BSAG	Ricarda-Huch
Attractive parking site	#4	contracts	landlord-company Gewoba	Kissinger

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Attractive pricing	#4	Automatic address comparison to put user in special pricing category	-/-	Kissinger
Reservation/ blocking	#4	Booking platform for charging points/ SmartCharge	-/-	Kissinger
Towing service	#3, 4	contracts	tbd	Ricarda-Huch, Kissinger

4.4 Evaluation of business models

To attain the quantifiable perception of a given business model, one has to undergo the business model evaluation process. In general, for evaluation, it is necessary to conduct a systematic and structured process. Such evaluation process starts with the determination of evaluation objectives. Based on the objective(s), a suitable evaluation approach and suitable evaluation methods have to be chosen.

Due to the limited number of KPIs that will be measured, it will be difficult to evaluate the business models in a complete way. The KPIs that will be measured are a mix of quantitative and qualitative KPIs and will be measured during the project and at the end of the project.

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5 Indication of potential markets

The electro mobility market emerges constantly. The GreenCharge pilots, Oslo-Barcelona-Bremen, represent markets with a higher maturity of the electro mobility market compared with other emerging countries. The Hubject Emobility Market Index (HEMI) compares the four components of the emobility ecosystem, namely the market demand, the market environment, the national policies and complementary macro-economic indicators.

5.1 The concept of the market analysis using HEMI

The Hubject Electromobility Market Index (HEMI) (Figure 2-1) has been developed by Hubject as part of its market development strategy. Initially covering 27 European markets, it now analyses the state of development of electric mobility in 33 countries: 31 European countries covering the EU-28, Norway, Switzerland and Iceland, to which USA and China were added in 2016.

Throught the HEMI and its country ranking, Hubject aims at simplifying the comparison of the 33 markets. The database is updated each year, the 2017 HEMI being based on 2017 full year data.

The index ranges from a minimum of 0 to a maximum of 5 points and is calculated for each country as a result of a mix of various indicators.

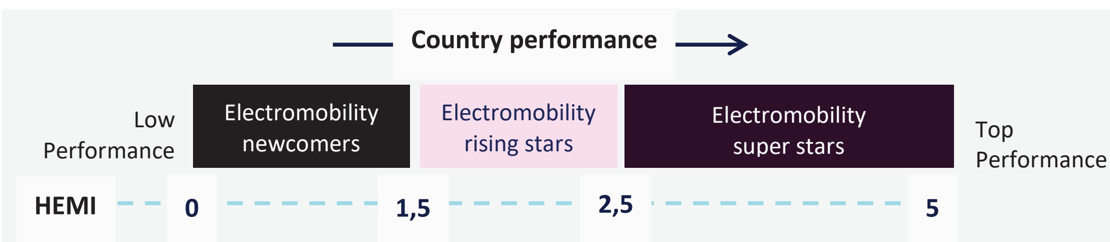

Figure 5-1: HEMI index

The higher its HEMI is, the more a country is attractive for the development of services in the field of electric mobility. On the contrary, the lower the HEMI, the lower the performance and the maturity of the market is, and the more difficult any market entry might be.

5.2 Selection criteria for data in the HEMI

- Relevance: The indicator tracks the electric vehicle (EV) environment in a manner that is applicable to countries under a wide range of circumstances.
- Data quality: The data represent the best measure available. All potential datasets are reviewed for quality and verifiability and the sources are reliable.
- Time series availability: The data have been measured at least since 2012, and there are ongoing efforts to continue consistent measurement in the future.
- Completeness: The dataset needs to have adequate geographical and temporal coverage to be considered.

5.3 The HEMI framework

The HEMI Score is constructed through the calculation and aggregation of 12 indicators reflecting national-level economic and environmental data (see Figure 5-2). These indicators are combined into four categories, weighted differently according to their impact on the development of electric mobility in the respective countries. The current status of EV deployment (Market demand), the general readiness of the market analyzed through the level of liberalization of the energy sector, the involvement of the automotive industry and the

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status of charge point deployment (Market environment) as well as the policies put in place to foster electric mobility (Policy) are granted the most importance, followed by the indicators of economic power and environmental awareness (Macroeconomic indicators).

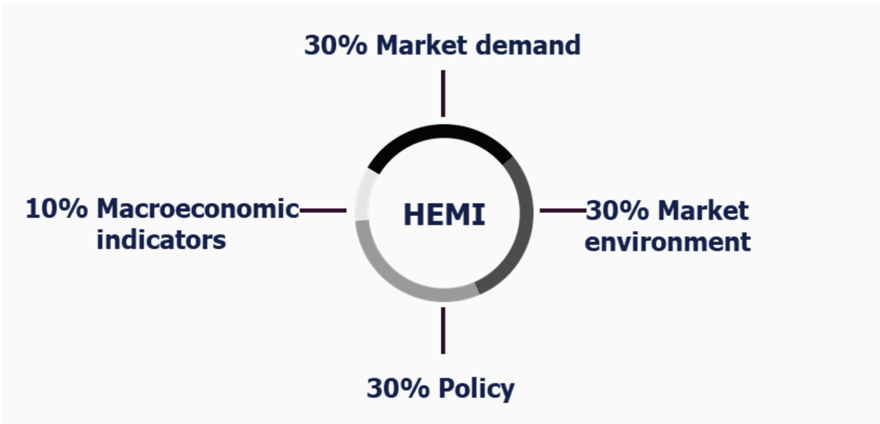

Figure 5-2: HEMI framework

Market demand : 30%

- Achievement level of EV deployment targets by 2020 (55%)
- EV Market share: Share of EVs in registered passenger cars in 2017 (45%)

Market environment : 30%

- Retail electricity market concentration (30%)
- Interconnection of charging stations (10%)
- Strength of automotive industry (number of car makers with production plants; EV/general) (30%)
- Achievement level of charge point deployment targets by 2020 (30%)

Policy : 30%

- EV sales incentives: direct grants at purchase or tax benefits (50%)
- Subsidies for infrastructure and R&D and further promotion policies (50%)

Macroeconomic indicators : 10%

- Level of urbanization (20%)
- Purchasing Power per capita in € (55%)
- Environmental Performance Index - Air Quality (5%)
- Environmental Performance Index - Climate and Energy (20%)

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5.3.1 Example of presentation of the HEMI index

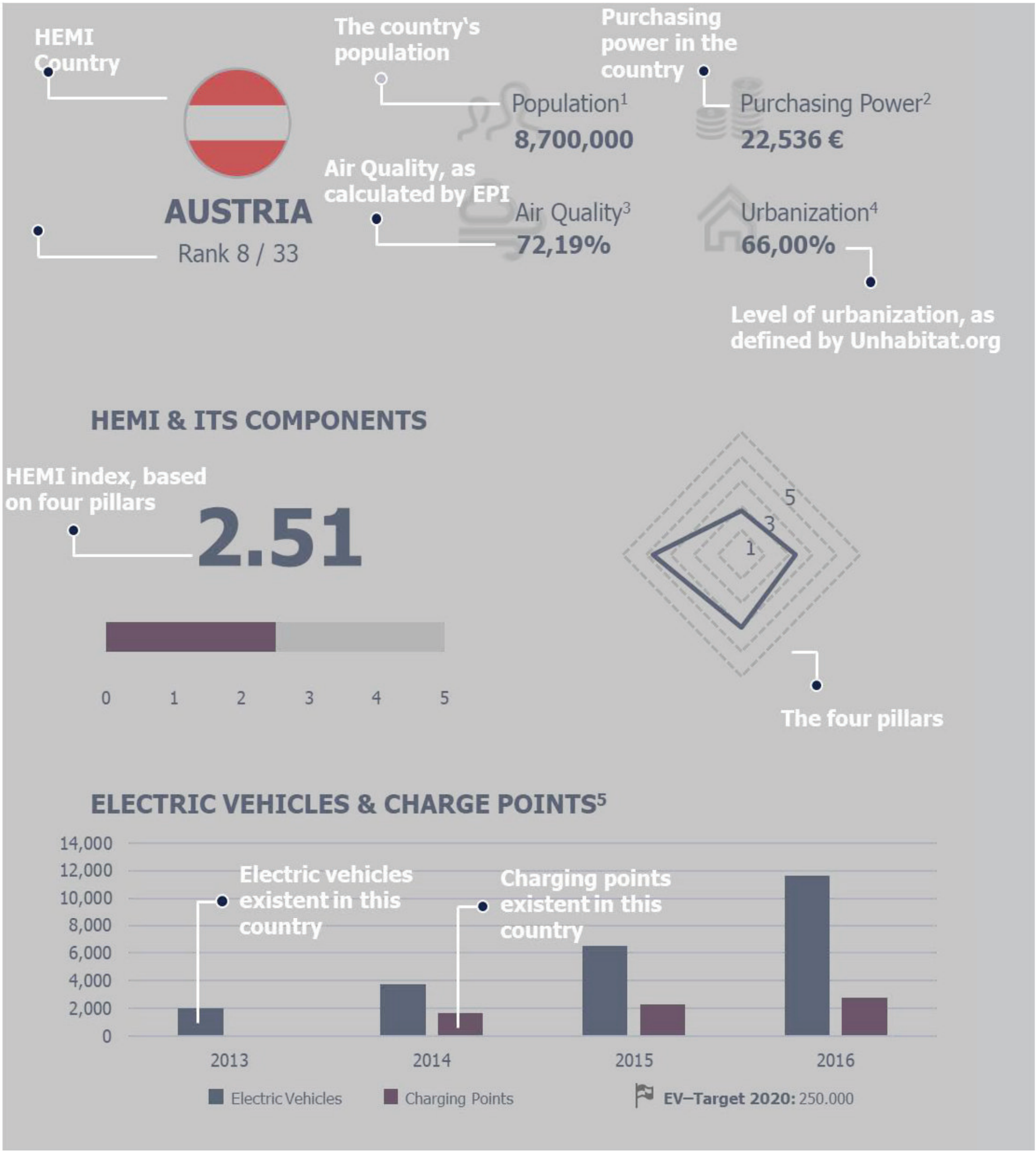

Figure 5-3: HEMI index Austria

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5.4 HEMI results at a glance

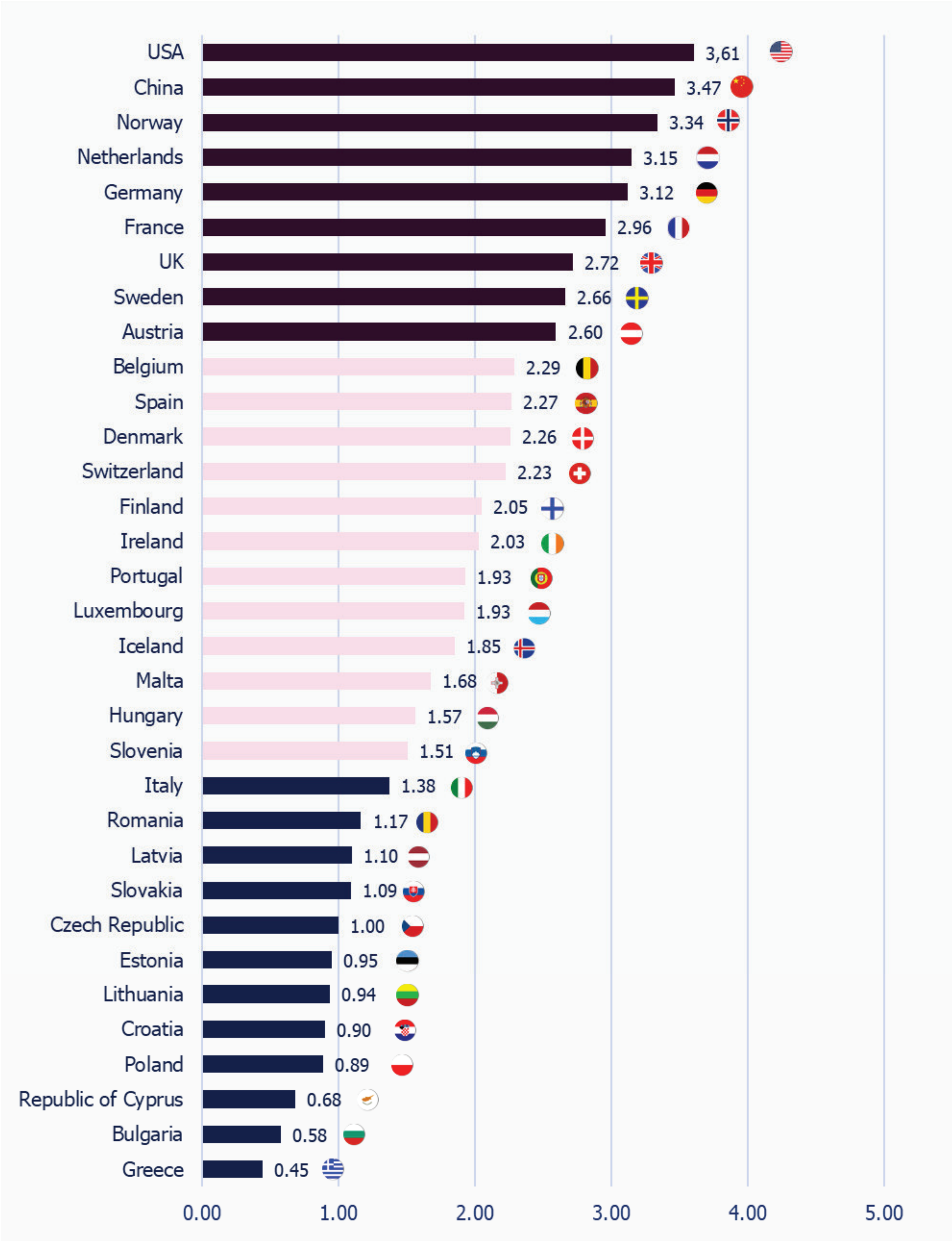

Figure 5-4: HEMI results European countries

5.5 Norway

5.5.1 HEMI index – Norway

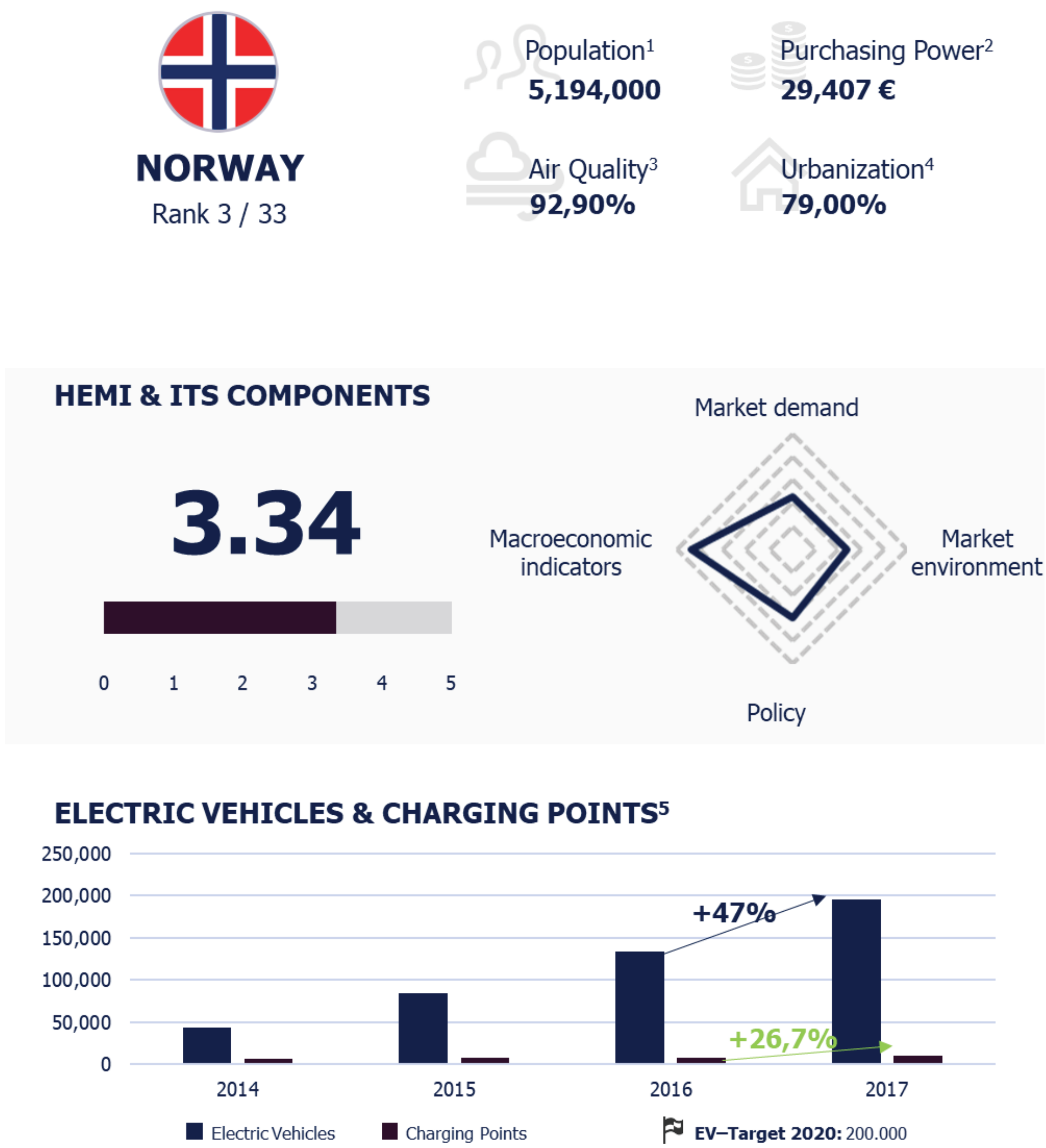

Figure 5-5: HEMI index Norway

5.5.2 Market & Policy – Norway

- Very strong incentives for EV purchase until 2015 including a grant of 25% of the purchase price. Grant reduced in 2016 as EV stock reached 50.000 units, but still very favorable.
- The incentive program will be revised and adjusted parallel with the market development in coming years. The tax incentives will stay in place to 2018 and then be revised. From 2017 the local governments will decide the incentives such as access to bus lanes and free municipal parking. Free

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toll roads will probably be replaced with a new system with differentiated prices depending on CO2 and NOx emissions.

- Funds for research into efficient and sustainable solutions for transport systems available through the Research Council of Norway and various programs and projects support environmentally friendly transport; including support for charging stations and pilot projects for batteries and how to introduce EVs in fleets.

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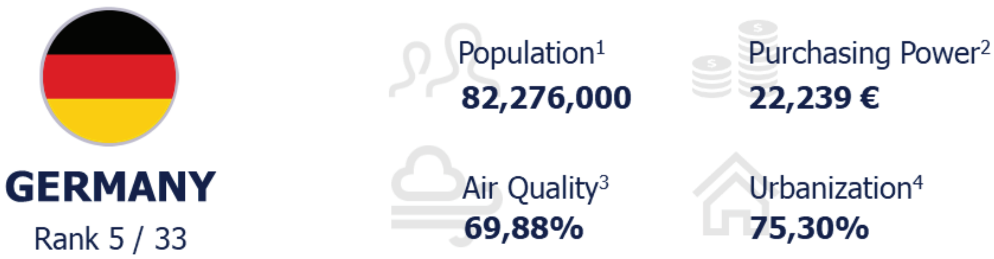
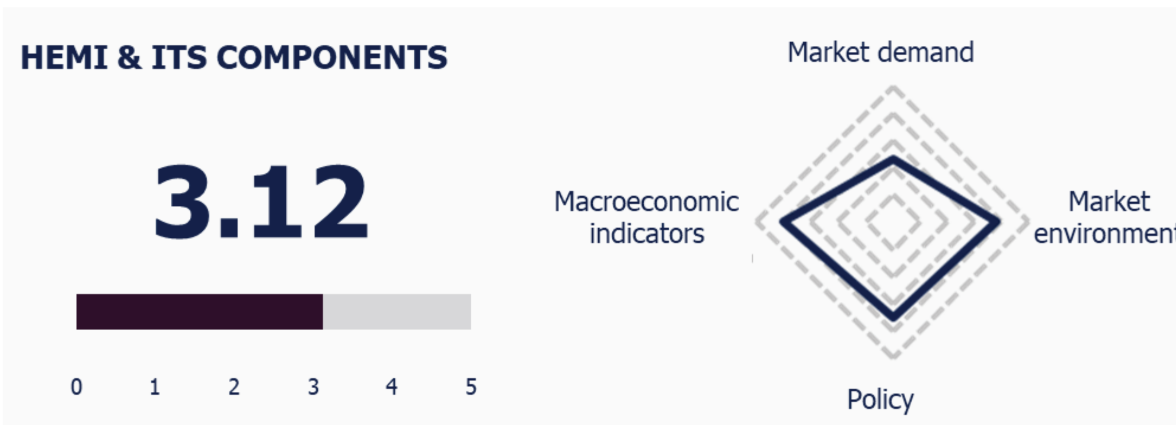
5.6 Germany

5.6.1 HEMI index – Germany





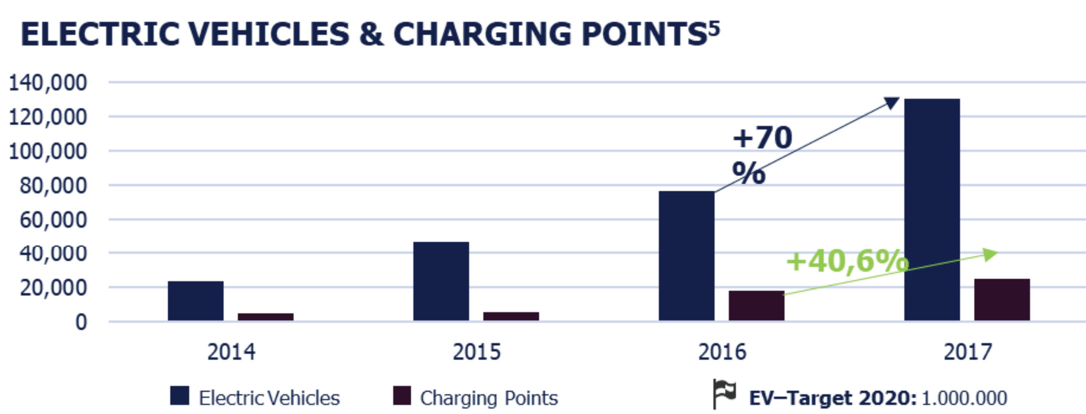


Figure 5-6: HEMI index Germany

5.6.2 Market & Policy – Germany

- After many years of low incentive levels, a new incentive scheme was introduced in 2016 including purchasing subsidies of 4,000€ for BEVs and 3,000€ for PHEVs. A maximum of 400,000 cars in total will be funded (overall funding of EUR 1.2 billion by public authorities & car makers).

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- Some local incentives available, such as free/reduced parking fees or reserved parking spots. EV bus lane use exempt from annual circulation tax for a period of five years.
- Governmental R&D funding for OEMs and suppliers, e.g. for lithium-ion batteries as well as PHEVs and BEVs.

5.7 Spain

5.7.1 HEMI index – Spain

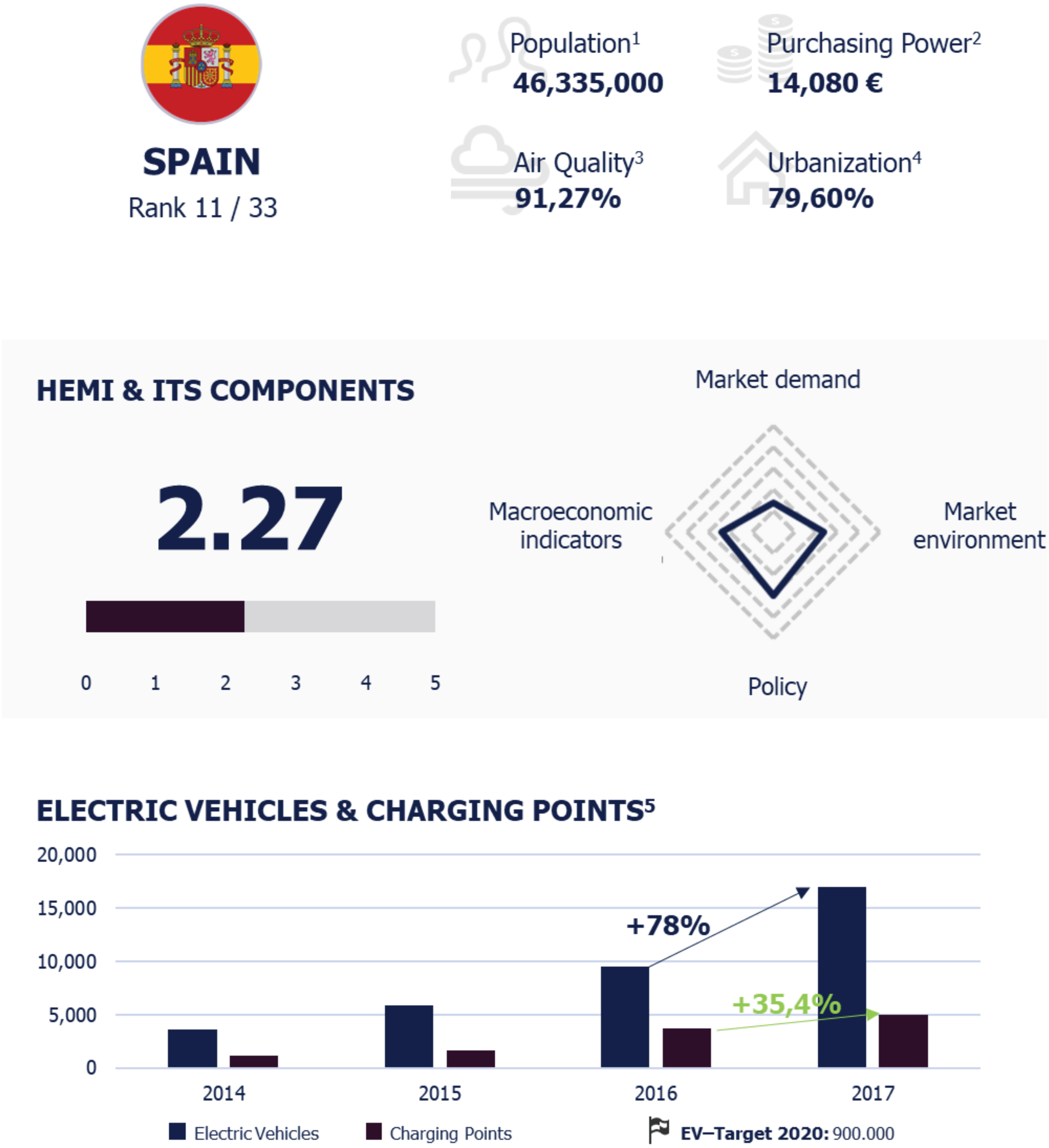

Figure 5-7: HEMI index Spain

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5.7.2 Market & Policy – Spain

- Some incentives and support for the EV market, relatively strong industry cooperation.
- National subsidy of up to 5.500€ for light EVs, road tax exemption / reduction depending on local policies. High occupancy traffic lanes reserved for drivers of BEVs.
- Subsidies for private and public charging points.
- 2016-2019: PIRVEC project in Catalonia including all of the market players foresees the installation of 100 quick CP, 400 rapid CP, and 25.000 slow charging points.
- 2016: the national CIRVE project aims at installing 40 quick charging stations alongside strategic highways to build a corridor between France and Portugal.

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6 Future work

This document describes the initial version of the business models for the different pilots in Oslo, Bremen and Barcelona. For the next deliverable 3.3 revised business models will be, developed, implemented and tested. These are, for example, more collaborative business models, such as digital platform or marketplace business models. In these business models the traditional energy value chain or pipeline business model is replaced by a platform business model with an orchestrator in the middle.

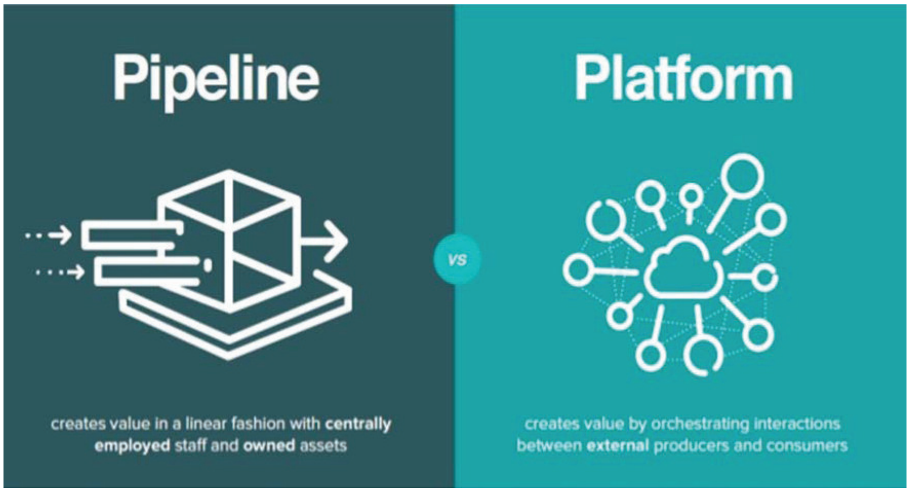

Figure 6-1: From pipeline to platform business model

Platform businesses have already existed for a very long time in the form of traditional village marketplaces to modern shopping malls. As a result of new IT technologies digital platforms have sprung up and scaled globally. They bring together producers and consumers in high-value and frictionless exchanges. Their chief assets are information, data and interactions (Source: HBR Article about Pipelines, Platforms and The New Rules of Strategy of April 2016).

Two-sided digital platforms are taking over and disrupting the pipeline business model of the established product, service and software companies. For example, the digital platform business model of Wikipedia has disrupted the pipeline businesses model of the Encyclopedia Britannica in no time. Pipeline businesses create value by controlling the classic value-chain. Value is added in different steps of the chain from raw material to finished end-product. Their most important assets are mostly physical.

The customer segments, value proposition and core interaction, as well as the producer segments, value proposition and same core interaction should be aligned. These are the most important elements of my platform canvas. These aspects need to be in line with the other aspects of the platform. I will discuss these later in another post.

Currently many of the most valued unicorns, like Didi Chuxing, AirBnB and Stripe, are two-sided (or more) digital platforms according to CB Insights. These platforms make use of both same-side network and cross-side network effects. Same-side effects result from producers attracting more producers and customers attracting more customers. Cross-side effects come from producers attracting more customers and the other way around. As a result, the number of (potential) core interactions between customers and producers grow exponentially. And, the valuation of these platforms skyrocket.

For the following deliverables we are planning to iterate the business models based on feedback from stakeholders until the value for every stakeholder of a demonstrator is maximized. This is a continuous improvement, testing and learning process.

The research leading to these results has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation (H2020) under grant agreement n° 769016.

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