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HORIZON 2020: Mobility for Growth
MG-4.2-2017
Supporting Smart Electric Mobility in Cities
*Project Type:* Innovation Action

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# Final Business Model Designs

Authors:

Reinhard Scholten (EGEN), Bas Bosma (EGEN), Maurits Simons (EGEN), and Svein Hallsteinsen (SINTEF)

www.civitas.eu

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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

Project Coordinator: Jacqueline Floch, Jacqueline.Floch@sintef.no

Dissemination Manager: Reinhard Scholten, reinhard.scholten@egen.green

# Executive Summary

Traditional business models are pipelines, as shown in the stakeholder overview in Deliverable 3.1. Every link in the value chain adds value in a linear way. They do not scale very fast, because they are often asset heavy and must make a lot of marketing costs. They do not stimulate collaboration between all stakeholders, because the increased margin for one link in the chain goes at the cost of another. A pipeline business model does not maximise value for all stakeholders.

New collaborative business models of GreenCharge are multi-sided market places, which create an ecosystem of stakeholders connected by an orchestrator. The ecosystem can grow in an exponential way, because all stakeholders collaborate, make use of network effects, and maximize value. More customers will attract more producers of energy and the other way around. As a result, market place businesses can grow exponentially.

There are 5 design principles that refer to the most important elements of a business model concerning: what? (value proposition); for who? (customer segments); how? (key activities and network effects), and; at what costs and revenues?

A. Customer Segments: Solve a problem for the masses

B. Value Proposition: Information-based digital services

C. Key Activities: Ultra scalable processes, asset-light technologies and algorithms

D. Revenues and costs: capture of value in money terms

E. Market place: network effects

The future exponential business model of GreenCharge consists of a market place model, that connects producers and prosumers of renewable energy with customers and prosumers of renewable energy. The balancing of supply and demand for (green) electricity is done by the load balancing software and battery storage of the orchestrator. More producers of renewable energy will attract more customers of renewable energy to this business model and the other way around. In this way network effects will create economies of scale that generate a serious impact in reducing CO2 emissions. This future business model is an expansion and scale-up version of the combined GreenCharge demonstrators in Oslo.

The business model innovation process, that has been run together with PNO and the different stakeholders at the demonstrators, have resulted in the design of the initial, revised and final business models. PNO has identified several important learnings from this design process. The following most important lessons have been learned from the business model iterations:

1. One business model for all stakeholders per demo, not a business model per stakeholder
2. A multi-sided market place stimulates collaboration and maximizes value for all stakeholders
3. The concept of priority booking and flexible booking are interconnected
4. Keep business model test simple as to make demos feasible
5. Business KPIs need to be aligned with the criteria for exponential business models
6. Producers and customers of energy need to receive a fair price in an exponential business model
7. Business model measure tests should be organized in an Agile way

# Table of Contents

# Table of Figures



# List of Tables

# List of Abbreviations

**Table 1: List of abbreviations**

| Abbreviation | Explanation |
|---|---|
| BMI | Business Model Innovations |
| CPO | Charging Point Operators |
| CPs | Charging Points |
| DSO | Distribution System operator |
| EVs | Electric Vehicles |
| IoT | Internet of Things |
| kWh | Kilowatt Hour |
| LEV | Light Electric Vehicle |
| LRG | Local Reference Groups |
| NOK | Norwegian Krone |
| PV | Photovoltaic |
| RES | Renewable Energy Sources |
| TSO | Transmission System Operator |
| V2G | Vehicle to Grid |

# 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 aim to capture the project results and the main practical learnings from the business model innovation workshops in the form of a process description and the final set of business models. Besides this deliverable offers an explanation of useful tools for business model innovation and evaluation.

This deliverable forms the final version of a set of collaborative business model designs involving all relevant stakeholders.

## 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 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 or use the tools or process description in order to design their own innovative business models.

## 1.3 Structure

Chapter 2 of this deliverable comprises of a description of the relevant theory, objectives and methodology used for designing, describing and evaluating the business models for GreenCharge's demonstrators. Chapter 3 comprises a description of the 5 principles of exponential business models (section 3.1) and an overview of the final set of GreenCharge's business models (section 3.2). The business model tests used for evaluating the business models are described in detail in Chapter 4 and the corresponding business cases are described in Chapter 5. Subsequently, a brief overview of the market potential for the business models is presented in Chapter 6. In addition, this chapter describes two business model designs that were not implemented in practice in the project. But these theoretical business models pay attention to what cities can do to stimulate and facilitate viable business models for sustainable e-mobility in their cities.

# 2 Background, objectives, and methodology

This section covers the background information on business models, GreenCharge's objectives regarding business models and the methodology used for developing and evaluating GreenCharge's business models.

## 2.1 Background information on business models

### 2.1.1 What is a business model?

Before discussing the innovation of business models in Section 2.1.2, it is important to have a clear understanding of what should 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 have used the St. Gallen Business Model framework to develop the initial business models, because it describes the essential elements of a business model and comes with an easy to use canvas tool. This canvas tool focuses on the four most important elements of a business model: the Who, the What, the How, and the Value (How much). This model will provide a clear picture of the GreenCharge business model per demonstrator. A visualization of the St. Gallen business model concept can be seen in Figure 1.


**Figure 1: St. Gallen Business Model Concept**

The four dimensions which are combined to make up GreenCharge's business models 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.

### 2.1.2 Business model innovation

**What is business model innovation?**

The business model concept gained popularity during the dotcom boom of the 1990s 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 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.

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).

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 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).

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 model 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.

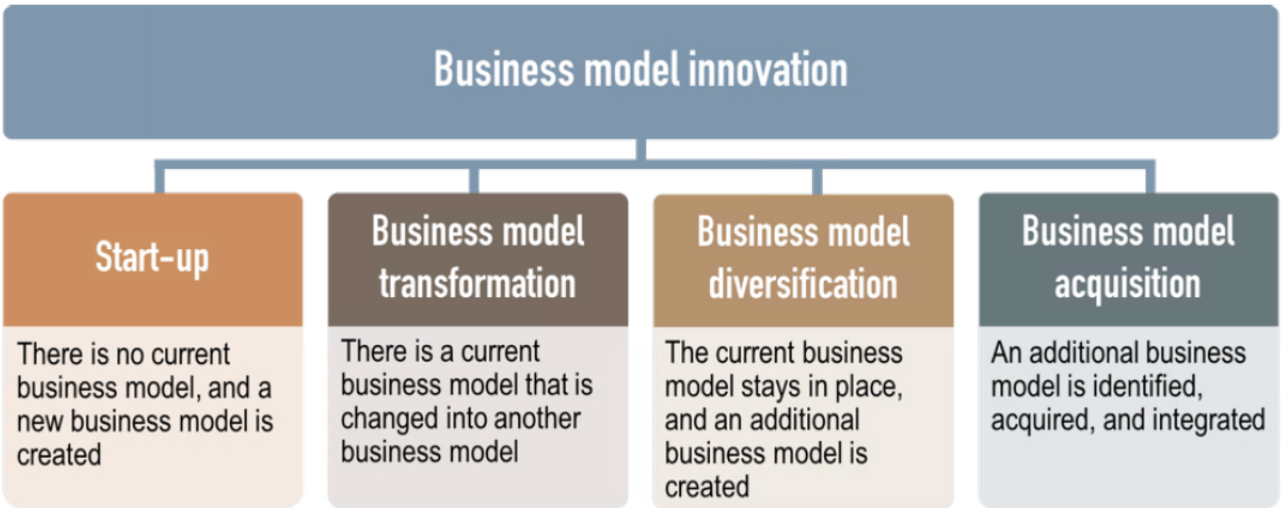


**Figure 2: Types of business model innovation (Geisdoerfer et al., 2018a)**

**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 theatrical 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). A business model canvas based on Osterwalder's business model canvas was used in workshops for designing GreenCharge's initial business models. To gain input for the business model innovation process the *Business Model Innovation (BMI) Game*[1] was played by stakeholders from each of the pilot cities. A detailed description of the BMI Game can be found in Section 2.3.1.

## 2.2 Objectives

Objectives 1 and 3 of GreenCharge's Grant Agreement aim at the design and testing of business models & cases for EV Charging of urban and sub-urban areas with renewable energy in various contexts, including:

- Prosumers of local renewable energy and shared use of local renewable energy sources,
- Shared use of charging infrastructure provided by different charging operators (public and private),
- Shared use of charging infrastructures between public EV fleets and private users, also including L-category and plugin hybrid vehicles,
- Priority charging for consumers, business people and visitors, and
- Reward flexibility and use of local Renewable Energy Sources.

These value propositions will be tested in GreenCharge's pilot cities: Oslo, Bremen and Barcelona. The methodology used for designing and testing of the business models is described in the next section.

## 2.3 Methodology

### 2.3.1 Developing innovative business models

**Business Model Innovation game**

As mentioned in 2.2.1, a Business Model Innovation (BMI) game was used for gaining input for designing the first set of business models for GreenCharge's demonstrators. The game was played in each pilot city with the local project partners and the local reference groups[2].

The participatory business model workshops, in which the BMI game was played, were the input for the initial business models that have been implemented at the pilot sites. The setting required for these workshops and for playing the BMI game is a group of around 9 to 12 mixed academic/industry participants and 1 or 2 moderators. The goal of the game is to provide insight in:

- Considerations of participants (LRG) for redesigning a business model;
- Opportunities and considerations of industrial experts;
- 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 and gain insight in considerations of stakeholders from the entire value chain, the players involved should be knowledgeable about specific parts of the value chain involved. A comprehensive description of the game and how to play the game can be read in the text box on the next page.

[1] This Business Model Innovation game was developed by PNO Consultants and TNO as part of the H2020 Inspire project.

[2] At each pilot site, Local Reference Groups (LRGs) were recruited among relevant stakeholders (citizens and business in EVs/ESN, city representatives, interest groups etc.). These LRGs were actively involved in the business model workshops to provide input for needs, requirements and more.

**Business Model Innovation game instructions**

The format of the BMI-game is a roleplay played by the participants and directed by the moderator (see Figure 20). 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 Assesees. 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.

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.

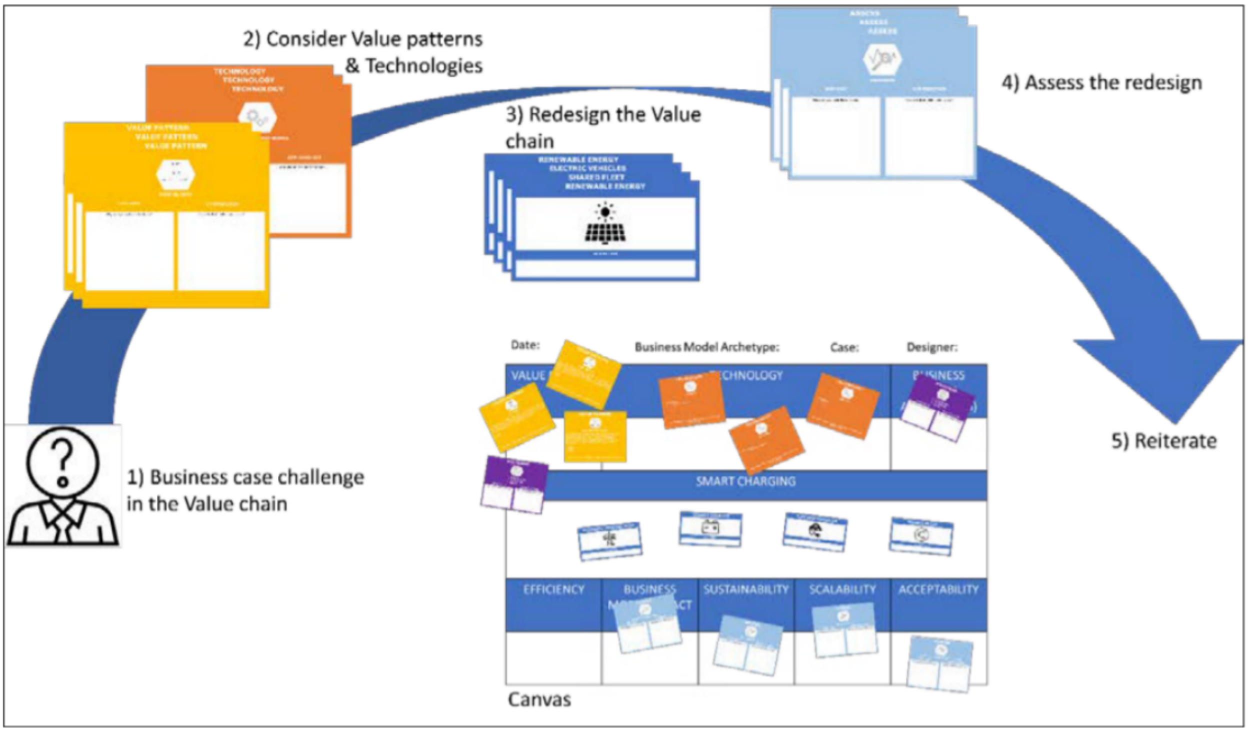


**Figure 3: Overview of the Business Model Innovation game**

**Business model workshops**

After defining and describing the initial set of business models based on the input from the BMI game, several workshops were held in order to further redesign the initial business models, define appropriate price levels, define evaluation methods and design innovative business models that cannot be implemented at the pilots for simulation purposes.

*Redesigning business models*

Due to Covid-19 related delays in implementing the business models in real life at GreenCharge's demonstrators, the initial business models were redesigned before actual implementation. In order to make the stakeholders involved and the relationship between these stakeholders more visible, and at the same time work on more scalable business models, the initial pipeline business models were translated into market place business models. By using the business model canvas for market places (further described in Section 2.3.2), the business model and its representation is more focused on the value chain as a whole instead focusing on separate parts without showing the relationships between the different stakeholders. The process of translating the initial pipeline business models into more innovative market place business models is done in close collaboration with the project partners involved in the various demonstrators.

*Defining price levels*

In order to develop financial viable business models, an appropriate price level for the value added must be defined. To be able to see and discuss what could be an appropriate price level several workshops were held. In these workshops, a price was determined on the basis of the business cases. The appropriate price level is not always geared towards obtaining the highest profit as possible. For example, in the Oslo demonstrators the housing cooperative acts as the orchestrator of the ecosystem. A housing cooperative has an interest in reducing its own costs (e.g. necessary grid investments if no smart energy management system is in place) and also in reducing the energy costs for residents. In addition, it is important that the costs incurred for this purpose are retrieved so that the rents for residents do not have to be increased to cover these investment costs. For this specific situation, the business case has to be break-even.

For commercial organisations, defining an appropriate price level depends on various elements. Companies can base their pricing on their costs, the competitors pricing or the perceived value. The housing cooperative, as a non-profit organisation, based its price level on the (investment and operating) costs made for offering the charging and energy management services. As it is a non-profit organisation, the pricing seems to be appropriate if the revenues cover the costs. A commercial organisation using this approach ensures that the difference between the price and the revenues is enough to make profit. However, in most cases there is an interdependency between the pricing of a service or product and the demand for this service or product.

In order to make sure that there is a balance between the actual price of a service or product and the price at which the service is valued by the user, the perceived value is an important element to be aware of. To investigate the perceived value of a product or service, a survey can be held. For some of GreenCharge's demonstrators a survey has been set up in which four main questions are of importance:

- At what price do you believe the service/product is cheap?
- At what price do you believe the service/product is so cheap that you will doubt the added value of the service/product?
- At what price do you believe the service/product is expensive?
- At what price do you believe the service/product is so expensive that you are no longer willing to pay that price?

By means of these four questions, four price levels can be identified:

- *Marginal cheapest point*: at this price level, the perception of a too cheap pricing flows over in an "expensive perception".
- *Optimal price level*: at this price level the fewest respondents believe that the price for the service is too high or too low. At this price level, the largest number of users can be expected.
- *Indifference point*: at this price level, the number of respondents that believe the service is cheap is the same as the number of respondents that believe the service is expensive. This pricing can be seen as a "normal" price level. The number of users will be lower than at the optimal price level, but the margins will be higher.

- *Marginal expensive point*: at this price level, the perception of a cheap pricing flows over in a "too expensive perception".

Which price level works best for a company depends on the positioning of the company. The acceptable price range for a service is most of the times between the *marginal cheapest point* and the *marginal expensive point*. A price range between the *marginal cheapest point* and the *optimal price level* is focused on a low-end segment, while a price range between the *marginal expensive point* and the *indifference point* is focused on a high-end segment.

*Defining evaluation tests*

In order to be able to evaluate the business models and see whether the measures are achieving the desired effect, several workshops were held to define the evaluation tests per demonstrator. Based on the financial KPIs (as described in D5.6), it is possible to calculate the business cases for the demonstrators. However, besides the financial viability of the business models it is interesting to evaluate to which extend GreenCharge's business models stimulate the desired user behavior (e.g. stimulating sustainable driving or flexible charging).

The process for business model evaluation in GreenCharge (see also section 2.3.3) and the test cards per demonstrator were discussed during these workshops. The test cards defined for each demonstrator are further described in chapter 4.

*Defining innovative business models*

Unfortunately, it is not possible to implement all innovative technical features at GreenCharge's demonstrators. For this reason, simulation scenarios will be used in order to simulate innovative measures (e.g. V2G technology) and be able to evaluate what the consequences of further scaling up would be. A workshop was held to discuss innovative business models for ESNs. This workshop was mainly focused on a fair distribution of the gains of the ESN (higher contribution to ESN results in a larger share of the benefits). This is further described in section 6.3.

### 2.3.2 Describing business models

*From pipeline business models to market place business models*

The initial business models designed for GreenCharge's were displayed as pipeline business models based on the St. Gallen business model concept. Business models were designed for each stakeholder in each demonstrator. By using a pipeline approach, companies create value by controlling a linear series of activities: inputs at one end of the chain undergo a series of steps that transform them into an output with a higher value (Van Alstyne et al., 2016). Some examples of these initial business models are shown in Figure 4.

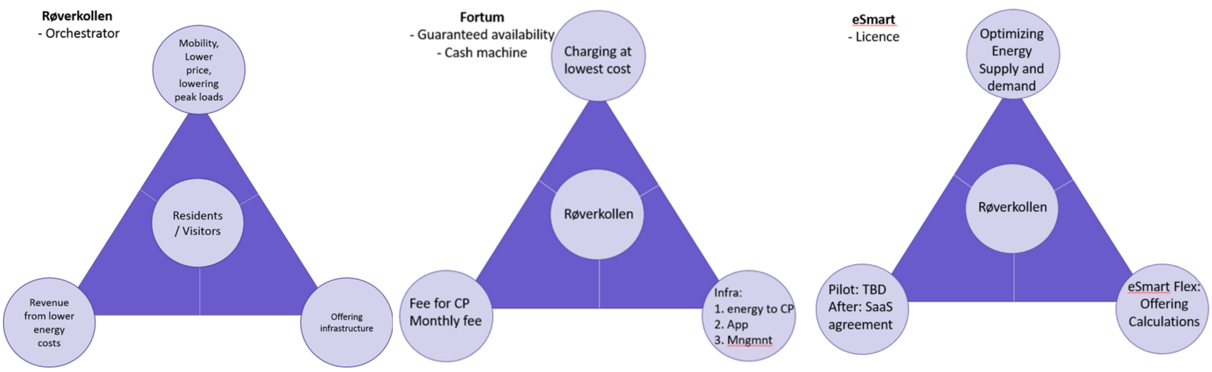


**Figure 4: Initial business models for the Oslo demonstrator**

By approaching GreenCharge's business models in a linear way, little attention is paid to the coherence between the different actors in the ecosystem and each stakeholder focuses only on its own interests. By approaching the business model as an ecosystem and identifying what each stakeholder contributes to the common interest, it becomes possible to create more value in a cost-efficient way. This market place or platform approach enables companies to make use of other companies physical infrastructure and assets. The platform provides the infrastructure and rules for a market place that brings together producers and consumers. In this ecosystem four roles can be distinguished (see also Figure 5):

- Owner (or *Orchestrator*): this is the controller of the platform IP and arbiter of who may participate and in what ways. As the controller, this stakeholder ensures that the necessary preconditions are defined and required assets are brought together to make the market place work. By using the expertise or products of other companies, it is possible for the Owner to be "asset light".
- Provider: this is (one of) the provider(s) of the required assets. This stakeholder provides the Owner with assets such as billing systems, mobile apps or physical infrastructure.
- Producers: these are producers of the platform's offerings. This stakeholder produces the offerings that can be sold through the Owner's platform. For example, in an ESN producers are the households or companies that produce local renewable energy and deliver this to the local grid.
- Consumers: these are the buyers or users of the offerings on the platform. Because the platform allows for cost-efficient operation, the terms and fees paid by consumers are often beneficial compared to more traditional (pipeline) businesses.

A more comprehensive description of these platform or market place business models and the scalability of these models can be read in Section 3.1.

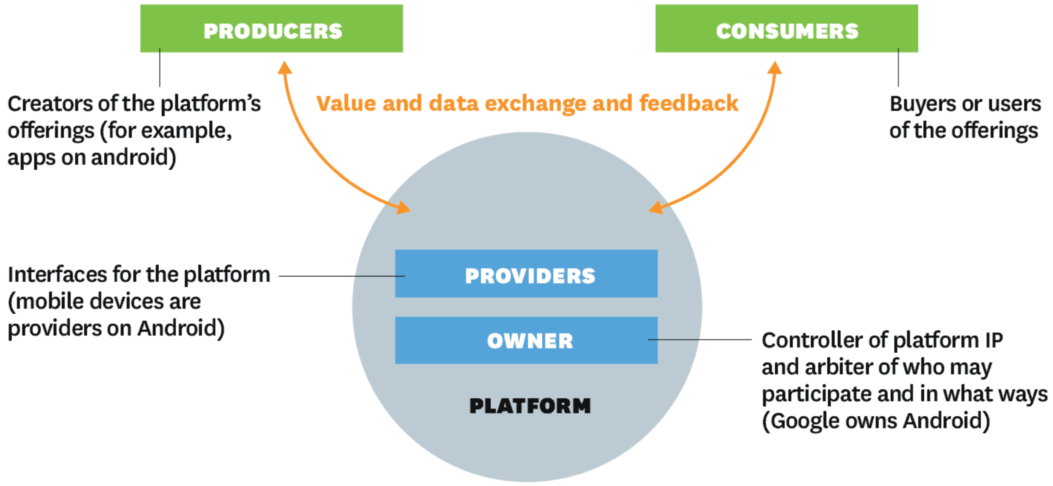


**Figure 5: Overview of a Platform Ecosystem (Van Alstyne et al., 2016)**

*Market place business models*

In order to transform GreenCharge's business models into market place business models and make the business models more scalable and exponential, we facilitated online workshops for the individual demonstrators. We used a different business model format to design these market place business models. This business model canvas for market places is displayed in Figure 6[3].

[3] This canvas for marketplace business models is created by Reinhard Scholten of EGEN.

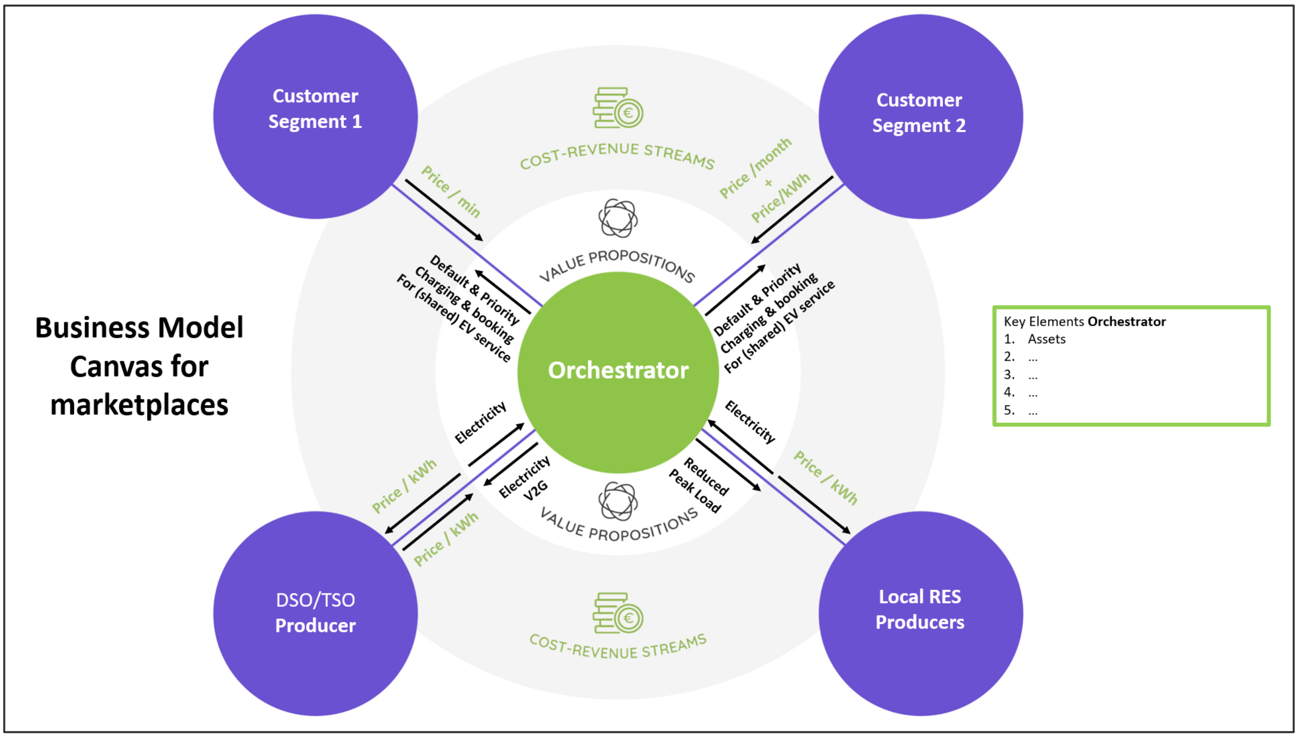


**Figure 6: Business model canvas for market place business models**

In this canvas, the different stakeholders that are part of the ecosystem are located in the corners of the canvas and the market place orchestrator (the *Owner*) is located in the middle. It shows the crucial elements of a business model: 1) customers segments (who?); 2) value propositions (what?); 3) key activities and assets (how?); 4) cost and revenues (how much?), and; 5) producer segments (who?).

Market place business models create cross-side network effects by connecting customers to producers of energy and/or mobility solutions. At a market place more customers of, for example, shared electric cars, will attract more electric car sharing providers and vice versa. The orchestrator connects all stakeholders in the eco-system and creates friction exchanges of information and/or energy. As a result, all stakeholders maximise the captured value. By means of the online business model workshops, we created separate business models for every single demonstrator. These revised business models are shown in section 3.2.

### 2.3.3 Business model evaluation

In order to evaluate the business models designed in GreenCharge, the GreenCharge business model evaluation framework has been set up. This business model evaluation process is an iterative process containing five steps and is displayed in Figure 7. Reinhard Scholten of EGEN has developed and designed this framework.

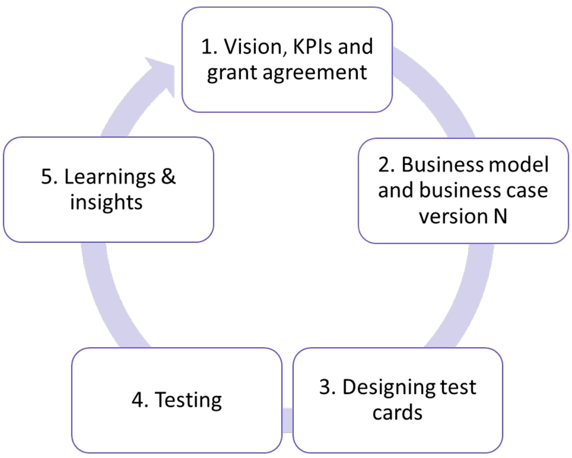


**Figure 7: Business model evaluation process**

The method for evaluation of the business models contains 5 steps:

1. *Vision, KPIs and Grant Agreement*

In the first step, the starting points of the business model design derived from GreenCharges's vision, the objectives from the Grant Agreement and the relevant KPIs have been listed. This forms the basis of each business model design and the tests that will be carried out by the 7 demonstrators.

2. *Business model and Business case version N*

In the second step, the initial business model designs have been made with the aid of workshops with relevant stakeholders in Oslo, Barcelona and Bremen. These designs are created with the aid of the business model game and described with the aid of the St. Gallen canvas. A second round of online workshops followed with the stakeholders of the separate demonstrators based on the learnings from a strengths and weaknesses analysis. The stakeholders designed revised business models with the aid of a market place canvas. The description of a revised business model per demonstrator can be found in Section 3.2.

3. *Designing test cards*

In cooperation with the partners involved in the demonstrators, we have designed test cards for the first testing phase, based on the Strategyzer Test Cards[4]. These test cards are based on the input from step 1 and are dependent on what can be tested in practice for each of the demonstrators[5]. The test cards as developed for the first testing phase are described in Section 4. An example of these test cards is displayed in Figure 8. By making use of these test cards, the demonstrators are forced to make their goals explicit. The following content is represented on the test cards:

1. What needs to be true for the business model to work? (hypothesis);
2. How are we going to test if this hypothesis is true or false?;
3. What are we going to measure in order to validate the hypothesis?
4. When is the test successful? What is the threshold for a positive result?

4. *Testing*

The business models, as described in Section 3.2, will be tested according to the test cards as designed in step 3 of the evaluation process. The demonstrators will deliver the data needed to analyse the results and perform the business model tests. Due to delays caused by COVID-19, no results of the tests are available at the time of writing this deliverable.

5. *Learnings & Insights*

The learnings and insights from the first testing phase were planned to be reported in this deliverable. The initial business models were already analysed and evaluated based on the 5 principles for design of exponential business models. Based on this analysis, revised business models are designed for each of the demonstrators.

The most important elements of these revised business models will be evaluated with the aid of test cards mentioned in step 4. Due to a delay in the start of the pilots because of the Corona pandemic, no results are

[4] https://www.strategyzer.com/

[5] For example, it was not possible to test V2G solutions in the demonstrators.

available at the time of writing this deliverable. However, GreenCharge's evaluation process will start in the coming month on the basis of the first data input.

| Test Card | | | |
|---|---|---|---|
| Test Name | *Barcelona – MOTIT RSD_2 + 3* | Deadline | |
| Assigned to | | Duration | |
| Step 1: Hypothesis<br>**We believe that** | | | |
| 'Rewarding sustainable driving'-option will reduce maintenance costs as well as electricity costs by 10% due to more efficient driving. | | | |
| Step 2: Test<br>**To verify that, we will** | | | |
| - Analyze the maintenance costs for the brakes over a period of 12 months and the correlation with the usage of 'Rewarding sustainable driving'-option.<br>- Analyze the energy costs over a period of 12 months and the correlation with the usage of 'Rewarding sustainable driving'-mode. | | | |
| Step 3: Metric<br>**And measure** | | | |
| - The maintenance costs for the brakes of the fleet.<br>- The costs for charging the batteries.<br>- The amount of time 'Rewarding sustainable driving'-mode is used in the fleet. | | | |
| Step 4: Criteria<br>**We are right if** | | | |
| There is the following trend: higher amount of time used in 'Rewarding sustainable driving'-mode corresponds to lower maintenance costs for brakes and lower electricity costs. | | | |
| **Requirements** | | | |
| We must be able to have insight in the amount of time 'Rewarding sustainable driving'-mode is used. | | | |
| **Comments** | | | |
| *Changed from scooter-specific to global fleet perspective.* | | | |

**Figure 8: Example of a business model test card**

### 2.3.4 Business cases

In order to see whether the business models designed for the demonstrators are also financial viable, the business case can be calculated. Although the environmental benefits of GreenCharge's measures are clear, it is also important that the business model is financially viable to maintain these benefits for the long term. Without a viable business case, (public) funding is needed to maintain or roll-out the service. A viable business case enables the company to (re)develop their product or service, improve their product or service and scale up or roll-out their product or service in other geographical areas.

Dedicated business model workshops were held in order to identify and list the most important elements of each demonstrator's business case. In simple terms, these are the elements that either make or cost money. Some of these elements are dependent on future developments in the field of the transition to zero emission mobility (e.g. number of EVs in a certain area, usage of charging points, etc.). At the moment of writing this deliverable, no (complete) data set is provided by the demonstrators. Therefore it is only possible to calculate the business case for the demonstrator based on assumptions instead of real data.

On the basis of these business case elements, it is also possible to calculate the business case for similar projects. For example, this makes it possible to determine the number of EVs needed for the project to become profitable. Table 2 shows the most important elements of the business case for Oslo D2. An overview of the most important elements per demonstrator is shown in Annex A.

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 2: Business case elements for Oslo D2**

| *Oslo* | *Unit* |
|---|---|
| | |
| *Number of charge points* | Number |
| *Sales default price per kWh to visitors* | NOK/kWh |
| *Average load per charge point* | kWh |
| *Sales price electricity to CPO* | NOK/kWh |
| *Average load* | kWh |
| | |
| *Purchase price electricity from Retailer* | NOK/kWh |
| *Average load* | kWh |
| | |
| *Revenues* | NOK |
| *Costs of goods sold* | NOK |
| *Gross Margin* | NOK |
| *Fixed costs* | NOK |
| *Interest* | NOK |
| *Tax* | NOK |
| *Depreciation* | NOK |
| *Earnings* | NOK |
| *NPV* | NOK |

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.

# 3 Business models of demonstrators

## 3.1 Principles of exponential business models

An exponential business model looks at the same key areas as a traditional business model—but it has radically different goals. Most business models are linear, designed to increase profits or decrease costs by 10 percent. With an exponential business model, we think in terms of changes that are 10 times greater or lesser than today's value—the common shorthand for this goal is simply "10X". Taking your business model from 10 percent to 10X is not simply about scaling.

Often it requires a completely new way of looking at your business and the market it serves. Exponential business models require exponential imagination. Further, to 10X your business model, you must create value by leveraging technology in at least one key building block, such as the value proposition, channels, or key resources. Amazon, Facebook, Airbnb, Snap, Alibaba and Slack are just a handful of the companies that have successfully done so. Airbnb, for example, built a software platform to connect those in need of lodging to those who had it. By combining existing tech with an alternative value proposition, they liberated a huge, underused resource and created 10X value without owning a single room.

There are 5 design principles that refer to the most important elements of a business model concerning: what? (value proposition); for who? (customer segments); how? (key activities and network effects), and; at what costs and revenues?[6]

*A. Customer Segments: Solve a problem for the masses*

Technology is enabling organisations to reach entirely new markets in massive and viral ways. As the world's population approaches 7.5 billion, companies and organizations with exponential business models can help close the gap between our growing population and the resources they need. Many companies start with one core offering to customers to serve one need—like Uber and personal transportation—then expand their services to meet other needs, like UberEATS or UberHEALTH.

*B. Value Proposition: Information-based digital services*

As companies digitise their products and services, they are not just creating new versions of their traditional offerings, they are creating entirely new market places. Airbnb's platform re-imagines short-term accommodations; Slack digitises collaboration and knowledge sharing; the consumer genetics firm 23andMe offers affordable DNA sequencing to anyone. Every business, regardless of industry, should be exploring how and what to digitise in their existing value proposition to not only serve existing customers better, but to potentially open up foundationally new exchanges of value.

*C. Key Activities: Ultra scalable processes, asset-light technologies and algorithms*

Google is one of the best examples of a company built on an algorithm (to rank websites), that is then augmented by machine learning. StichFix, one of the fastest-growing on-demand retail companies, has a team of over 65 data scientists and uses algorithms to drive nearly every part of its business. It even has a well-respected public blog on data science. Amazon Web Services (AWS)—rented access to computing infrastructure—was launched in 2006. Ten years on, it contributed 56 percent of Amazon's growth and is on target to be a $100 billion business in less than five years.

[6] These 5 principles are defined by Reinhard Scholten from EGEN.

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.

*D. Revenues and costs: capture of value in money terms*

A business model describes how a company delivers and captures value from customers. Without revenues no income for the company. Value can on the other hand also be created in non-monetary terms. In that case we speak of an organisation or non-profit model, instead of a business model.

*E. Market place: network effects*

Traditional business models are pipelines, as shown in the stakeholder overview in Deliverable 3.1. Every link in the value chain adds value in a linear way. They do not scale very fast, because they are often asset heavy and must make a lot of marketing costs. They do not stimulate collaboration between all stakeholders, because the increased margin for one link in the chain goes at the cost of another. A pipeline business model does not maximise value for all stakeholders.

New collaborative business models of GreenCharge are multi-sided market places, which create an ecosystem of stakeholders connected by an orchestrator. The ecosystem can grow in an exponential way, because all stakeholders collaborate, make use of network effects, and maximize value. More customers will attract more producers of energy and the other way around. As a result, market place businesses can grow exponentially.

GreenCharge KPIs from the evaluation framework as described in D5.1-D6.1, which refer to these 5 design principles of exponential business models can be seen in Table 3 below. These KPIs will be used in order to evaluate GreenCharge's business models and business cases. An exponential business model solves a problem for the masses, which can be measured by the number of EVs and the number of CPs, that are used by a demonstrator. An exponential business model delivers information-based digital services, which can be measured by the Ratio of Capital investment costs and Average operating revenue. For traditional pipeline business models this ratio is high (around 30%), because they often own the assets of (energy) production. For exponential business models this ratio is low (around 10%), because they do not own the (energy) assets. They only connect (energy) customers with (energy) producers with information-based services. An exponential business model has ultra-scalable processes and algorithms, which is measured by the Ratio of Average operating revenues and costs. The more a business model produces, the higher its gross margin, because the use of algorithms mainly leads to fixed costs and not to variable costs.

An exponential business model captures its value creation for customers by revenues and costs, which is measured by earnings. Earnings is the resulting cash flow from the business model. For the calculation of earnings we refer to the business case format mentioned in section 2.3.4. An exponential business model generates network effects, which can be measured by savings per customer (and per producer) as a result of joining an exponential business model instead of a pipeline business model. These network effects create lower costs for customers (using energy) from an exponential business model in comparison to a pipeline business model, because they do not pay for the marketing. In an exponential business model marketing is done by customers themselves, because they recommend the use of the business model to other customers. The exponential business model gives an incentive to customers to attract other customers, which in turn attract more producers. The more producers and customers, the lower the costs of the service per customer and the higher the revenue of the service per producer (of energy).

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 3: Link between exponential business model design principles and KPIs**

| Design principles of exponential business models | KPI | KPI number |
|---|---|---|
| **1. Customer segment: Solve a problem for the masses** | Number of EVs<br>Number of CPs | GC 5.1<br>GC 5.2 |
| **2. Value proposition: information-based digital services** | Ratio Capital investment cost and Average Operating revenue (%) | GC5.7 and 5.8 |
| **3. Key activities: ultra-scalable processes and algorithms** | Ratio of Average Operating Revenue and Costs (%) | GC 5.6 and 5.8 |
| **4. Revenues and costs: capture of value with money** | Earnings and Net Present Value | GC 5.15 |
| **5. Market place: network effects** | Cost savings per Customer and per Producer | GC 5.6 and 5.8 |

## 3.2 GreenCharge's business models

This sections shows the final set of business models that is developed in Work Package 3 - Business Model Design and Prototyping. Each of the following sub-sections shows a figure and a description of the individual business model per demonstrator.

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.

### 3.2.1 Oslo Demonstrator 1 – Housing Cooperative (residents)

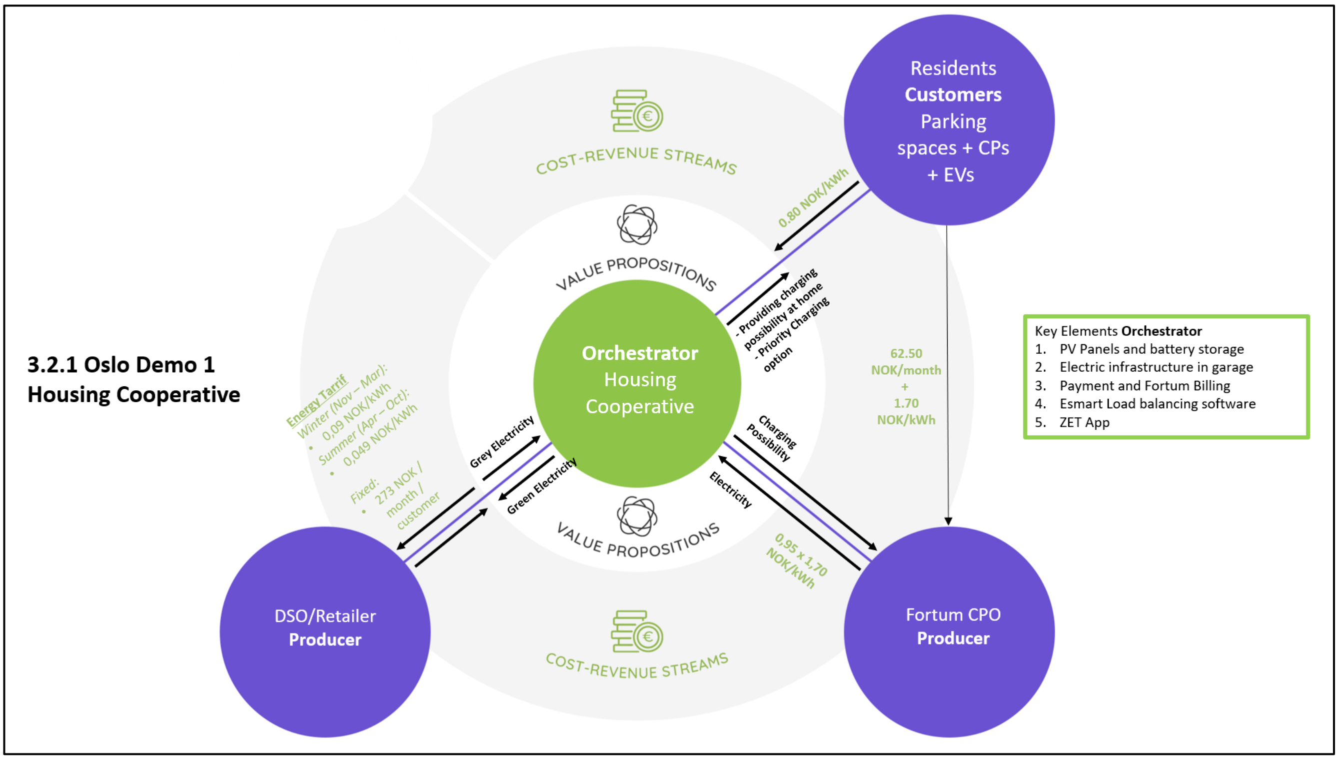


**Figure 9: GreenCharge Business Model for Oslo Demonstrator 1 – Housing cooperative**

**Orchestrator: Housing Cooperative (Røverkollen)**

The orchestrator of Oslo Demonstrator 1 operates in the smart charging market for housing cooperatives and its residents/visitors. In addition to the standard activities of a housing cooperative, Røverkollen provides smart charging solutions powered by local renewable energy to its residents. The demonstrator is located in Oslo at an apartment block with its own parking garage for residents. In order to regulate and reduce the peak load in energy demand, Roverkollen offers its residents smart charging solutions. This way, no further grid investments are needed to enable the transition to zero-emission vehicles.

As an orchestrator, the housing cooperative connects all stakeholders in the ecosystem and exchanges information, energy and cost & revenue streams. Within Oslo Demonstrator 1, the orchestrator bundles the following key elements and assets:

1. Photovoltaic panels and battery storage: for producing and storing PV energy
2. Charging infrastructure and grid connection in the garage: required for distribution of energy within the garage and to charging points
3. Payment and billing system: ensuring a user-friendly and secure payment and billing process
4. Energy management system: ensuring an efficiently distribution of the mix of grid energy and local renewable energy and enabling smart charging solutions
5. ZET.Charge App: developed in the GreenCharge project and enables users to charge based on their individual energy demand and flexibility, resulting in higher tariffs for faster priority charging in comparison with the default charging mode.

All of these elements are interlinked and each individual element adds value to the ecosystem as a whole. As a result, the captured value can be maximised by making the best use of local renewable energy. The text below outlines each stakeholder's value and corresponding cost-revenue streams for Oslo Demonstrator 1.

**Producer: DSO/Retailer**

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 Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy from the generation sources to the final consumers. This entails all energy distributed to the final consumers, which are the residents that park in the garage and live in the apartment blocks. Roverkollen, as the orchestrator, pays for the energy used by the apartment block as a whole. This energy tariff consists of a fixed tariff per month and a tariff per kWh (differs between summer and winter period).

**Producer: Charge Point Operator (Fortum)**

Charge point operators (CPOs) are responsible for the implementation and operation of EV charging stations. This means that CPOs install hardware from a variety of electric vehicle supply appliances vendors, and guarantee optimal ongoing EV charging operations. In this case, Fortum is the CPO and is responsible for the charging availability and distribution of electricity towards the residents' EVs.

Housing Cooperative pays the CPO for the charging service, consisting of a fixed tariff per month and a tariff per kWh. However, since the CPO does not pay for the energy used for charging, the CPO transfers 95% of its revenues to the orchestrator. The remaining 5% is the fee for providing the charging service. In case residents want to make use of the priority charging mode instead of the default and flexible charging mode, the residents have to pay an additional fee to the orchestrator.

**Customers: Residents**

The customers at Oslo Demonstrator 1 are the residents living at the apartment block. Especially the residents who drive an EV and make use of the charging infrastructure inside the parking garage. These residents make use of the charging infrastructure provided by the orchestrator so that they have a charging points with guaranteed availability at their own parking place in the garage.

Residents can choose between two charging modes: the default flexible charging mode or the priority charging mode. By opting for the default charging mode, residents can indicate when they want to make use of their EV again (and what should be the state of charge of the battery). The energy management system ensures that, based on this information, the EV will be charged as much as possible with renewable energy (and at times the overall energy demand is low). By opting for the priority charging mode, the residents indicate that they want to have their EV's battery fully charged as soon as possible, not taking into account the availability of renewable energy or peak energy demands.

As already mentioned before, residents have to pay to the CPO for the charging service (fixed fee per month and fee per kWh) when making use of the default charging mode. When using the priority charging mode, on top of the payment to the CPO, residents have to pay an additional fee per kWh to the orchestrator.

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.

### 3.2.2 Oslo Demonstrator 2 – Housing Cooperative (visitors)

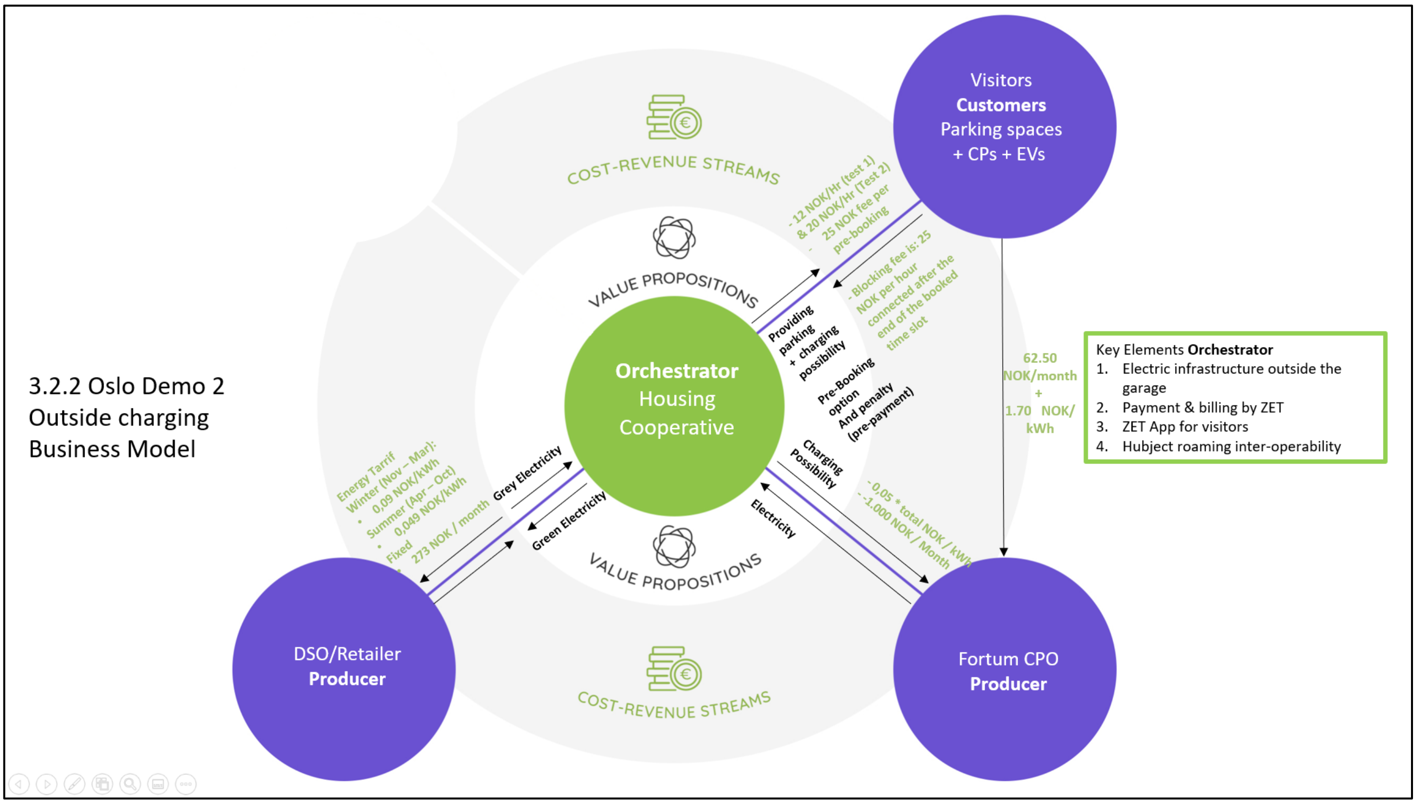


**Figure 10: GreenCharge Business Model for Oslo Demonstrator 2 – Housing cooperative**

**Orchestrator: Housing Cooperative**

The Oslo demonstrators operate in the smart charging market for housing cooperative and its residents/visitors. In addition to the standard activities of a housing cooperative, Røverkollen provides charging solutions to its visitors. The demonstrator is located in Oslo at an apartment block with its own parking garage for residents. Visitors have to park their EV outside, where they can book their own charging point in advance.

As an orchestrator, the housing cooperative connects all stakeholders in the ecosystem and exchanges information, energy and cost & revenue streams. Within Oslo Demonstrator 2, the orchestrator bundles the following key elements and assets:

1. Charging infrastructure outside the garage
2. Payment and billing system: ensuring a user-friendly and secure payment and billing process
3. ZET.Charge App for visitors: developed in the GreenCharge project and enables visitors to book their charging point in advance.
4. Roaming interoperability: by making use of Hubject's eRoaming network, it is possible to offer a seamless charging experience to visitors. Visitors can plug in and charge up instantly using automatic EV-to-charging station authentication technology, without apps or RFID cards needed.

All of these elements are interlinked and each individual element adds value to the ecosystem as a whole. As a result, the captured value can be maximised by maximising the utilisation of the charging points through offering real-time availability information and booking options. The text below outlines each stakeholder's value and corresponding cost-revenue streams for Oslo Demonstrator 2.

**Producer: DSO/Retailer**

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 Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy from the generation sources to the final consumers. This entails all energy distributed to the final consumers, which are the visitors that charge their EV outside the parking garage. Roverkollen, as the orchestrator, pays for the energy used by the visitors for charging their EV. This energy tariff consists of a fixed tariff per month and a tariff per kWh (differs between summer and winter period).

**Producer: Charge Point Operator (Fortum)**

Charge point operators (CPOs) are responsible for the implementation and operation of EV charging stations. This means that CPO install hardware from a variety of electric vehicle supply appliances vendors, and guarantee optimal ongoing EV charging operations. For this demonstrator, In this case, Fortum is the CPO and is responsible for the charging availability and distribution of electricity towards the visitors' EVs.

Housing Cooperative pays the CPO for the charging service, consisting of a fixed tariff per month and a tariff per kWh. However, since the CPO does not pay for the energy used for charging, the CPO transfers 95% of its revenues to the orchestrator. The remaining 5% is the fee for providing the charging service. In case visitors want to make use of the booking service via the ZET app, they must pay an additional fee to the orchestrator through the app.

**Customers: Visitors**

The customers at Oslo Demonstrator 2 are the people who visit the residents. In Oslo Demonstrator 2 the visitors are the people who have an EV and use the outside charging points at the housing corporative. They are able to pre-book a parking space via the ZET app. Pre-booking is used to solve an important problem faced by EV drivers: they can only see if there are any CPs at a specific location, but cannot see whether or not these CPs are already in use. Opposed to the pre-booking functionality there is also a blocking penalty: if an EV driver unnecessary blocks a charging point (already fully charged or exceeding the pre-booked period), the driver has to pay an additional blocking fee to the orchestrator.

### 3.2.3 Bremen Demonstrator 1 – GC@Work

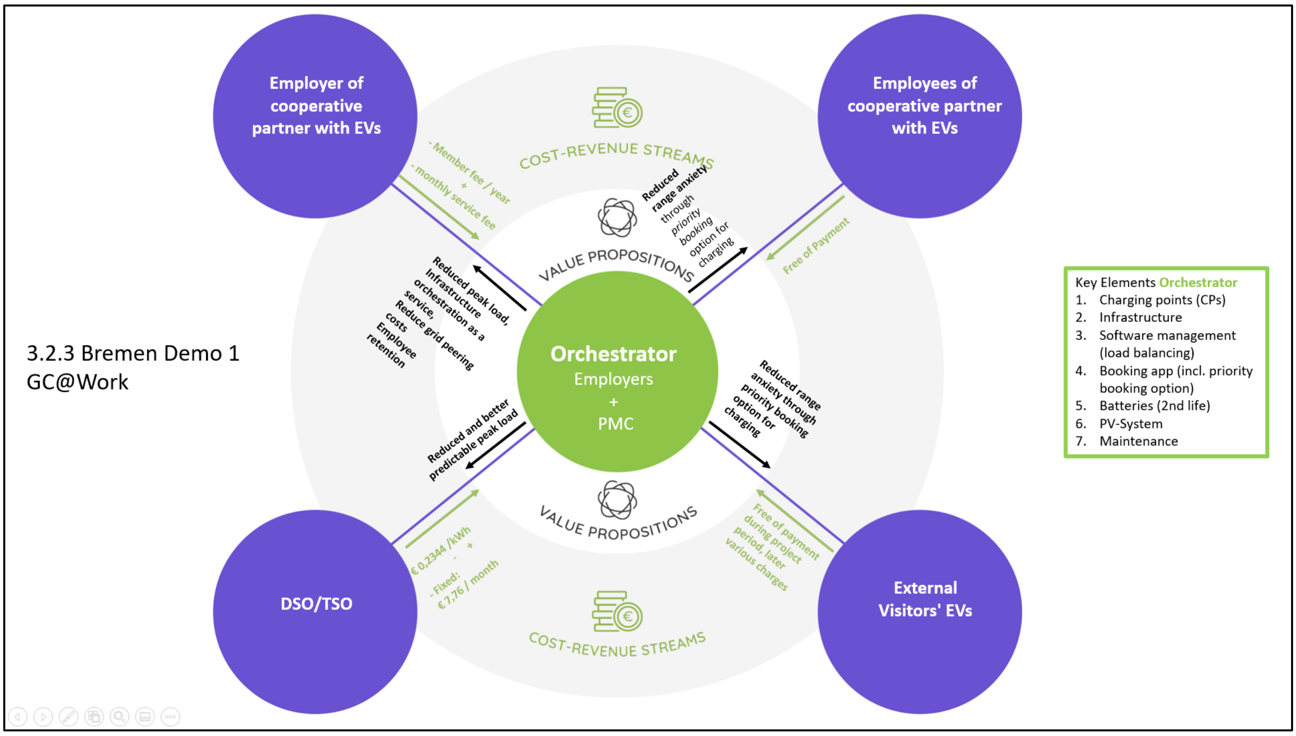


**Figure 11: GreenCharge Business Model for Bremen Demonstrator 1 – GC@Work**

**Orchestrator: Employers + PMC**

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.

Bremen Demonstrator 1 is about providing smart charging solutions to employers with parking spaces and a need for (smart) charging facilities. PMC, as the orchestrator, connects all stakeholders in the ecosystem and exchanges information, energy and cost & revenue streams. As a result, the value is maximised for all stakeholders. Within Demonstrator 1 in Bremen, the orchestrator bundles the following key elements and assets:

1. Charging points: located at PMC's and PMC members' premises
2. Grid infrastructure: necessary to distribute the energy from renewable energy sources to the charging points and storage system within the demonstrator
3. Energy management system: this software is used for load balancing and ensures that demand and supply of (renewable) energy is well managed.
4. Booking application: PMC members' employees and visitors can book a charging point through this application
5. Batteries (2$^{nd}$ life): used for storage of renewable energy produced by the PV panels
6. PV-System: for on-site renewable energy production
7. Maintenance: necessary to ensure the availability of the charging infrastructure.

The text below outlines each stakeholder's value and corresponding cost-revenue streams for Bremen Demonstrator 1.

**Producer: DSO/Retailer**

The Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy from the generation sources to the final consumers. This entails all energy distributed to the final consumers, which are the employees (or visitors) that charge their EV at the PMC premises or PMC members' premises. PMC, as the orchestrator, pays for the energy used for charging the EVs. This energy tariff consists of a fixed tariff per month and a tariff per kWh.

**Customers: Employer of cooperative partner with EVs**

Employers have the responsibility over their employee which have to travel to their workplace. This is the largest user group bringing typically their own EV (if not leased) or are using business EVs. The employer pays a member fee per year and a monthly service fee. The value gained from the orchestrator are: Reduced peak load, infrastructure as a service, reduced grid peering costs and employee retention. The latter one is crucial to the employer existence of their knowledge base.

**Customers: Employee of cooperative partner with EVs**

Employees have to travel to their workplace. This is the largest user group bringing typically their own EV (if not leased) or are using business EVs. The employee does not pay a member fee per year, nor it pays a monthly service fee. The reason for this is that the employer pays for this. The value gained from the orchestrator is: reduced range anxiety. This is due to the functionality priority booking option which gives the employee the option to pre-book a charging spot at the campus.

**Customers: External visitors' EV**

Visitors would come along occasionally using a private/business EV and are able to pre-book a charging space in advance of their meeting at the campus. Hereby, visitors' range anxiety will be reduced, due to the fact that visitors are able to charge their vehicle during the day. There will be no cost stream at the start of the project, however, GreenCharge cannot guarantee that this will not be the case at a later stage.

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.

### 3.2.4 Bremen Demonstrator 2 – ZET

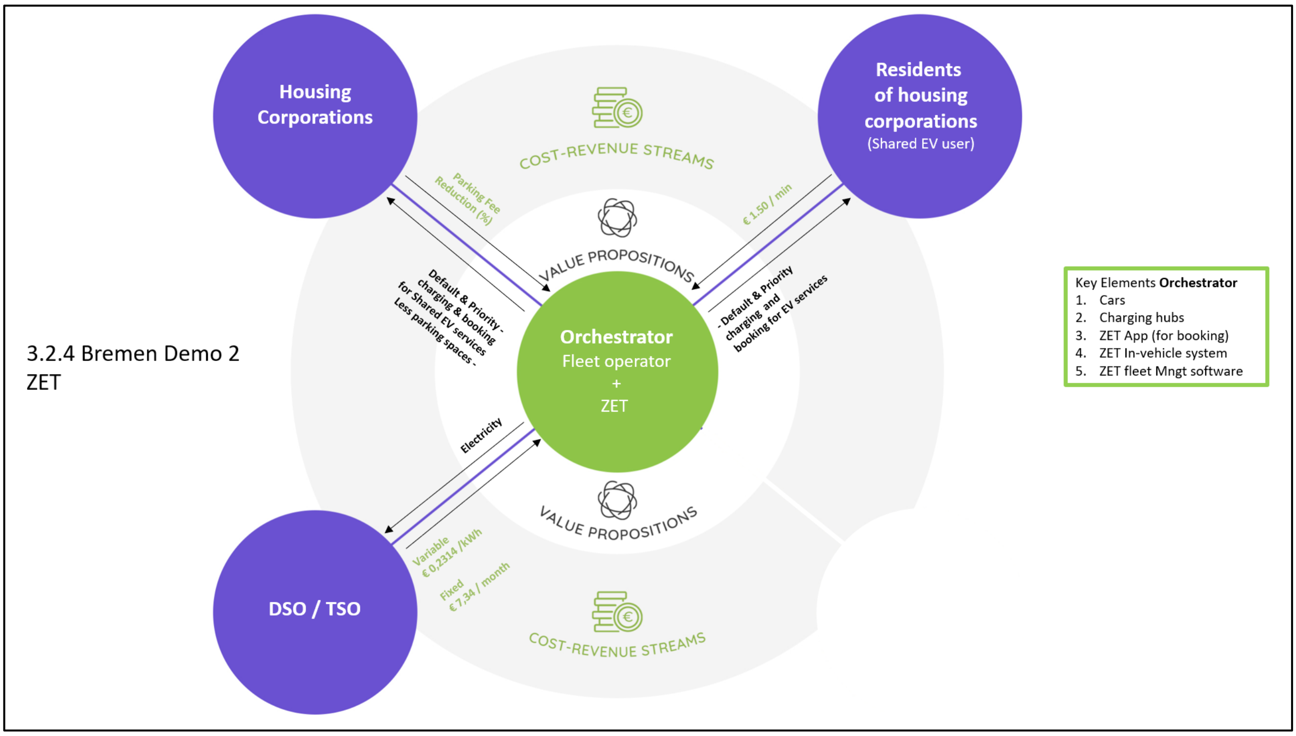


**Figure 12: GreenCharge Business Model for Bremen Demonstrator 2 – ZET**

**Orchestrator: Fleet operator + ZET**

Demonstrator 2 in Bremen operates in the shared car market for housing corporations and its residents/visitors. ZET and Fleet operators (orchestrator) both connect the stakeholders in the ecosystem and exchanges information, energy and cost & revenue streams. As a result, all stakeholders maximise the captured value.

Within Demonstrator 2 in Bremen, the orchestrator bundles the following key elements and assets:

1. Cars: the shared EVs that are available for end-users
2. Charging hubs: the charging points at housing corporations that are available for shared EVs
3. ZET CarSharing application: required for booking and using a shared EV
4. ZET In-vehicle system: tracks state of charge, geolocation, driving-patterns and charging times
5. ZET Fleet management software: provides user information, booking overview, car availabilities and locations and access to data tracked by the in-vehicle system

The text below outlines each stakeholder's value and corresponding cost-revenue streams for Bremen Demonstrator 2.

**Producer: DSO/TSO**

Distribution System Operators (DSO) is the entity which is responsible for distribution and management of energy within the demonstrator of Bremen ZET. This entails alle electricity necessary for consumers, which are the residents of the housing corporations. ZET only pays for the electricity used for charging the shared EVs. The cost streams consists of a combination of fixed fee per month and fixed fee per kWh.

**Customers: Housing corporations**

ZET provides a sustainable shared mobility solution to the housing corporation by offering shared EVs to its residents. The City of Bremen sets requirements for the minimum number of parking spaces per number of built apartments. If these housing corporations or property developers are not willing to or not able to provide the required parking spaces, they need to pay a replacement to the City of Bremen (depending on the city zone of the new planned building). Instead of paying this fee to the City, housing corporations may also pay this amount to a shared mobility provider that can provide shared mobility services at their apartments.

**Customers: Residents of housing corporations (Shared EV user)**

The customers at Bremen demonstrator 2 are the residents that live in the corporation's apartments. In this demonstrator, the residents are the people who make use of shared EVs at the parking spaces of the housing corporation. The residents have to pay a fee per minute for the use of a shared EV.

### 3.2.5 Barcelona Demonstrator 1 – MOTIT

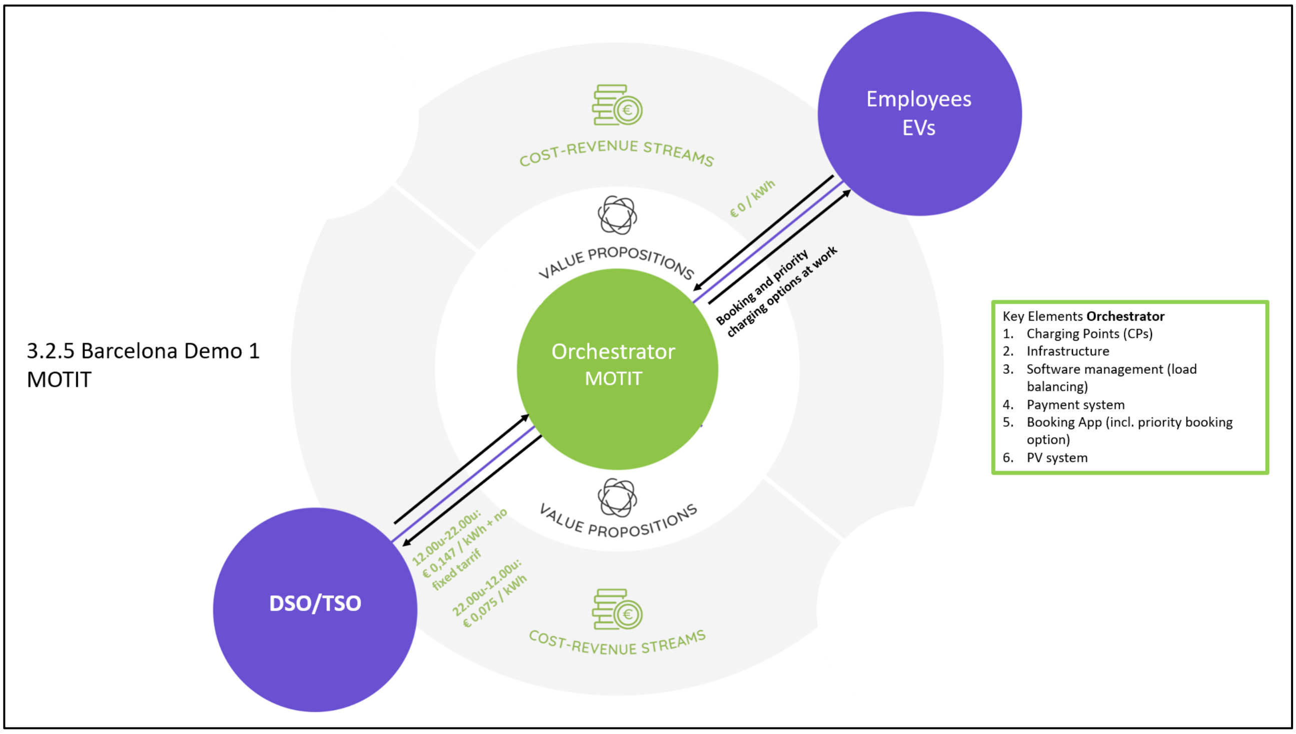


**Figure 13: GreenCharge Business Model for Barcelona Demonstrator 1 – MOTIT**

**Orchestrator: MOTIT**

Barcelona Demonstrator 1 operates in the shared LEV market and offers a shared e-scooter service. Users of this service benefit from this flexible and sustainable mobility solution.

Within Demonstrator 1 in Barcelona, the orchestrator bundles the following key elements and assets:

1. E-Scooters (+ IoT): the shared LEVs that are available for end-users
2. Battery hubs: the locations where the swappable batteries are charged.
3. Booking application: required for booking and using a shared LEV
4. Software (back-end): this is the shared services fleet management system

The text below outlines each stakeholder's value and corresponding cost-revenue streams for Barcelona Demonstrator 1.

**Producer: DSO/TSO**

Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy within Barcelona Demonstrator 1. This entails alle electricity necessary for charging the batteries. MOTIT pays for the electricity used for charging the shared LEVs. The cost streams consists of a variable fee per kWh (differs between day and night).

**Customers: Shared LEV users**

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 customers at Barcelona Demonstrator 1 are the people that use the shared e-scooters. These users have to pay a fee per minute for the use of a shared LEV. In case they opt for the eco-driving mode, the users can benefit from a 15-20% discount. MOTIT can reduce energy usage (and corresponding emissions) and save costs on maintenance if many users opt for the eco-driving mode.

### 3.2.6 Barcelona Demonstrator 2 – EURECAT

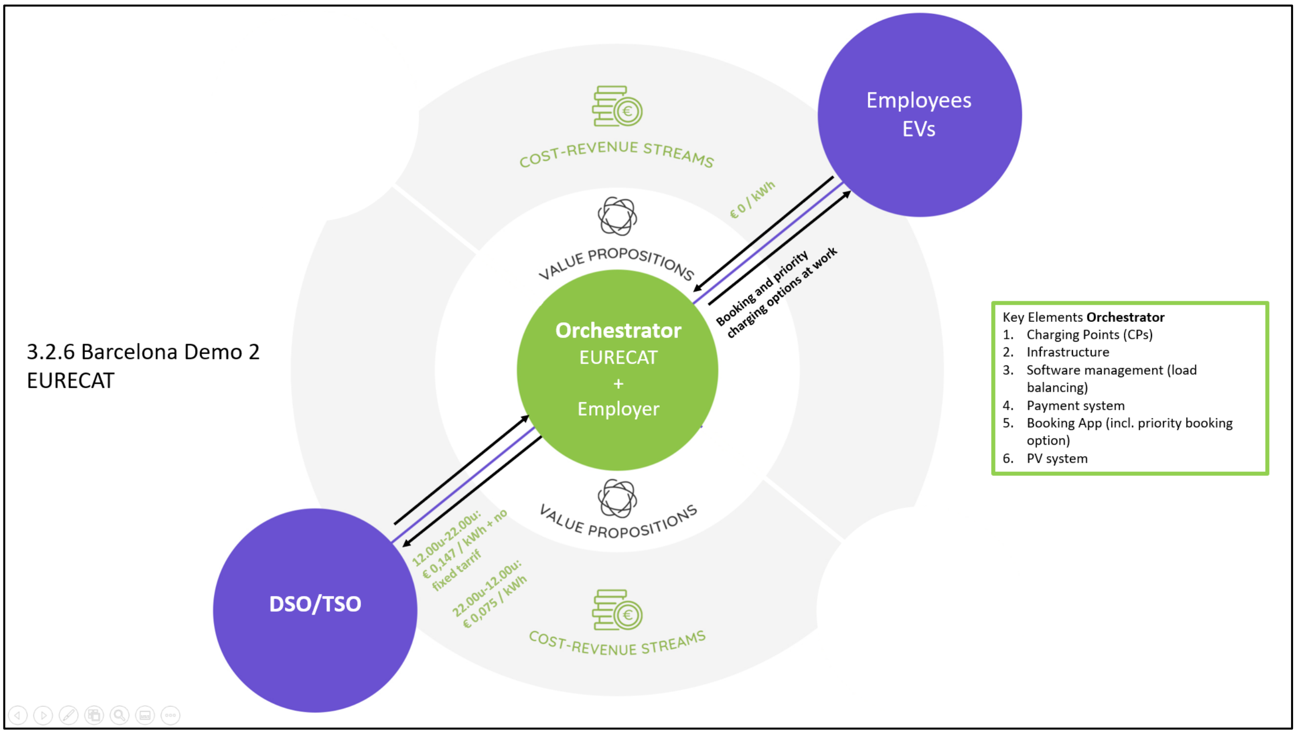


**Figure 14: GreenCharge Business Model for Barcelona Demonstrator 2 – EURECAT**

**Orchestrator: Eurecat**

The EURECAT demo in Barcelona operates in the smart charging market for employers with parking spaces and its employees/visitors with EVs.

Within Demonstrator 2 in Barcelona, the orchestrator bundles the following key elements and assets:

1. Charging points and grid infrastructure: the charging points and required grid connections at Eurecat premises
2. Energy management system: this software is used for load balancing and ensures that demand and supply of (renewable) energy is well managed
3. Payment system: users pay for their charging session through this payment system[7]
4. Booking app: this application enables EV drivers to book the charging point in advance
5. PV-system: the PV panels produce renewable energy to be used at Eurecat's premises

The text below outlines each stakeholder's value and corresponding cost-revenue streams for Barcelona Demonstrator 2.

**Producer: DSO/TSO**

Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy within Barcelona Demonstrator 2. This entails alle electricity necessary for charging the EVs. Eurecat

[7] Currently, no payment system is used at Barcelona Demonstrator 2. However, in the future users will be charged for charging their EV and have to pay through a payment system.

pays for the electricity used for charging the shared EVs. The cost streams consists of a variable fee per kWh (differs between day and night).

**Customers: Employees/visitors**

The customers at Eurecat are its employees and visitors of Eurecat's premises. These users can book their charging point in advance in order to ensure a guaranteed availability. In the current situation, these users do not have to pay a fee for charging their car at Eurecat's premises.

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.

### 3.2.7 Barcelona Demonstrator 3 – St. Quirze

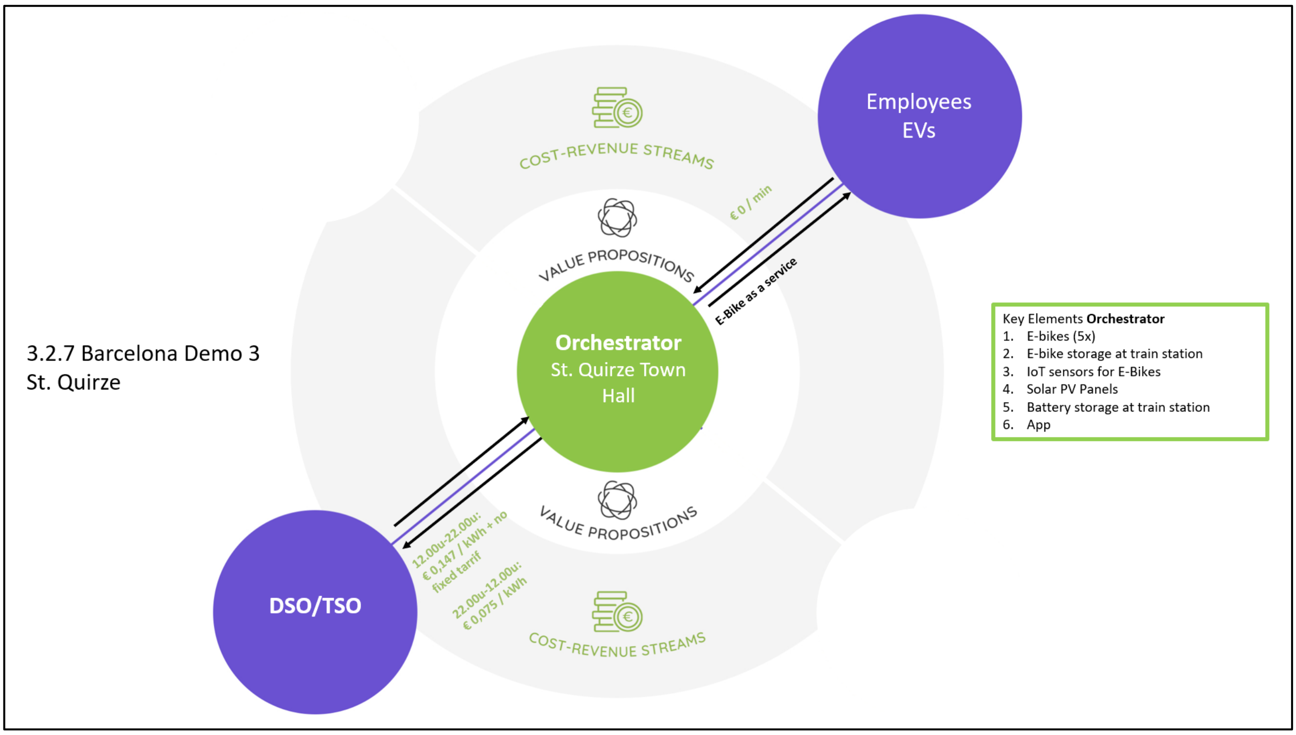


**Figure 15: GreenCharge Business Model for Barcelona Demonstrator 3 – St. Quirze**

**Orchestrator: St. Quirze Town Hall**

The St. Quirze demo operates in the shared or rental bike market at train stations.

Within Demonstrator 3 in Barcelona, the orchestrator bundles the following key elements and assets:

1. E-bikes: the shared e-bikes that can be used by commuters for their trip from the station to their company site
2. E-bike storage at train station: the storage where the e-bikes are charged
3. IoT sensors for e-bikes: used for, among others, geo-positioning and reading SoC
4. Battery storage at train station: a surplus in renewable energy produced by the PV panels is stored in the battery storage system
5. PV-system: the PV panels produce renewable energy to be used for charging the e-bikes
6. Atlantis Fleet app: this is the user interface with the e-bike sharing service and can be used for finding an e-bike, read the SoC, get route history and get directions to the charging station

The text below outlines each stakeholder's value and corresponding cost-revenue streams for Barcelona Demonstrator 3.

**Producer: DSO/TSO**

Distribution System Operator (DSO) is the entity which is responsible for distribution and management of energy within Barcelona Demonstrator 3. This entails alle electricity necessary for charging the EVs. St. Quirze Town Hall pays for the electricity used for charging the shared e-bikes. The cost streams consists of a variable fee per kWh (differs between day and night).

**Customers: Employees**

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.

Employees commuting to their work and travelling by train can make use of the shared e-bikes offered by the St. Quirze Town Hall. Employers at the nearby business park can arrange that their employees can make use of these shared e-bikes for a certain period. At the moment, no fee is charged for using the shared e-bikes.

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 Business model measure tests at demonstrators

In this chapter the test cards for the final set of business models are described per demonstrator. These test cards are based on the Strategyzer method as described in section 2.3.3. Since there is no complete data set available when writing this deliverable, we unfortunately cannot present any business model evaluation results yet.

## 4.1 Oslo Demonstrator 1 – Housing Cooperative

**What will be tested?**

We believe that residents are willing to pay more for priority charging in comparison with default charging. In this way, the resident's range anxiety decreases and a sufficient state of charge is guaranteed. In order to lower the peak energy demand and avoid grid investments, the price for priority charging must be so high that residents do not choose this option just to be on the safe side. For this reason, the flexible charging mode has also been chosen as the default option instead of the priority mode.

**How is the hypothesis tested?**

To verify the above hypothesis, we will take a look at the charging behaviour of the residents. At first, we will count the number of charging sessions in the default situation where no priority charging options are available for residents. In the following months, the priority charging option becomes available. To verify if the residents are really willing to pay (and how much) for this additional service, the additional price in comparison to the default charging option will increase. In the first month of this test the price for priority charging will be 25% higher than for default charging, in the second month this difference will be 50%, in the third month of this test the price for priority charging will be twice as high as the price for default charging. By analysing the distribution between default and priority charging sessions it will be possible to verify or reject the hypothesis.

**How is this measured?**

The number of default and priority charging sessions is based on data from the charging app that is used in this demonstrator. With the aid of the collected data the impact on ZET's and eSmart's earnings (GC KPI 5.11) can be calculated. We can also see whether or not the peak energy demand remains within the limit so no further grid investments are needed.

**We are right if?**

The hypothesis can be verified if 30% of the charging sessions is a priority charging session. By analysing this hypothesis for different price levels, we can make an estimation of what would be a fair price for this added service. This should also take into account the peak demand for energy: if this exceeds the limitations of the grid capacity the share of priority charging sessions has to be lowered (for example by increasing the additional fee for priority charging).

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating the impact of GreenCharge's measures on the business KPIs.

## 4.2 Oslo Demonstrator 2 – Housing Cooperative

**What will be tested?**

For the visitors at the Røverkollen demonstrator, we will test the booking feature. We believe that visitors are willing to pay more for an additional booking service. In this way, the visitor's range anxiety decreases and a sufficient state of charge is guaranteed.

**How is the hypothesis tested?**

To verify the above hypothesis, we will take a look at the charging behaviour of the visitors. At first, we will count the number of charging sessions in the default situation where no booking options are available for

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.

visitors. In the following months, the booking option becomes available. To verify if the visitors are really willing to pay (and how much) for this additional service, the additional price in comparison to the default charging option (without booking a charging point) will increase. In the first month of this test the price for booking and charging will be 25% higher than for default charging, in the second month this difference will be 50%, in the third month of this test the price for booking and charging will be twice as high as the price for default charging. By analysing the distribution between default and booked charging sessions it will be possible to verify or reject the hypothesis.

**How is this measured?**

The number of default and booked charging sessions is based on data from the charging app that is used in this demonstrator. With the aid of the collected data the impact on ZET's and Hubject's earnings (GC KPI 5.11) can be calculated.

**We are right if?**

The hypothesis is verified if 30% of the charging sessions is a booked charging session. By analysing this hypothesis for different price levels, we can make an estimation of what would be a fair price for this added service.

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs.

## 4.3 Bremen Demonstrator 1 – GC@Work

**What will be tested?**

We believe that companies are willing to pay a higher monthly fee for charging services including smart energy management than for default charging services. In this demonstrator PMC, as a cooperation, offers charging services for its shareholders in two ways: default charging services or charging services including smart energy management. We will test if companies are willing to pay a higher monthly fee for smart charging services and at which price difference (in comparison to default charging) they will opt for these added services.

**How is the hypothesis tested?**

A survey will be conducted in order to test the above hypothesis. At first, PMC's members will be asked if they are willing to make use of the smart charging services if they were available for the same price as the default charging service. Also members of PMC will be asked about their willingness to pay for this added service. In addition to this, we will ask PMC's members what would be a fair price for this service. To investigate what would be a fair pricing for the services, we have formulated four questions: a. At what price do you believe this service is cheap? b. At what price do you believe this service is so cheap that you will doubt the added value of the service? c. At what price do you believe this service is expensive? d. At what price do you believe this service is so expensive that you are no longer willing to pay this price? By means of these questions, four price levels can be identified.

**How is this measured?**

The data needed for testing the hypothesis for this demonstrator will be derived from the survey. And the resulting effect on extra earnings for PMC and other Cooperative Partners is calculated based on these data.

**We are right if?**

More than 50% of the respondents indicate that they are willing to pay a higher monthly fee for charging services including smart energy management than for default charging services and this results in extra earnings for PMC and other Cooperative Partners (GC5.11).

***Business case***

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.

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs

## 4.4 Bremen Demonstrator 2 ZET

**What will be tested?**

The business model of ZET is geared towards Housing cooperatives. They are charged a fee for the offer of shared services to their end-customers and local residents in the neighbourhood. At the same time the Housing cooperatives save money by paying less parking space fees to the municipality of Bremen. For this demonstrator the willingness of the Housing cooperatives to pay a recurring fee will be tested. In addition to this, an assessment of a fair price level for this service will be executed.

**How is the hypothesis tested?**

Ask Housing cooperatives about their willingness to pay a recurring fee and the maximum height of this fee to ZET for offering Car Sharing Services to their end-customers and residents with the aid of a survey. In addition to this, we will ask Housing cooperatives what would be a fair price for this service. To investigate what would be a fair pricing for the services, we have formulated four questions: a. At what price do you believe this service is cheap? b. At what price do you believe this service is so cheap that you will doubt the added value of the service? c. At what price do you believe this service is expensive? d. At what price do you believe this service is so expensive that you are no longer willing to pay this price? By means of these questions, four price levels can be identified.

**How is this measured?**

The data needed for testing the hypothesis for this demonstrator will be derived from the survey. The price and revenue difference between a one-time fee versus a recurring fee for Housing cooperatives and the resulting effect on extra earnings for ZET will be calculated based on these data.

**We are right if?**

At least 20% of the Housing cooperatives indicate that they are willing to pay a recurring fee for car sharing service offered by ZET and this results in extra earnings for ZET (GC5.11).

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs.

## 4.5 Barcelona Demonstrator 1 – MOTIT

**What will be tested?**

We believe that the "Rewarding sustainable driving" option will improve customer loyalty. By using this option, users will be rewarded with free minutes when driving more sustainable. In addition to this, we believe that making this option available will reduce the maintenance and electricity costs for MOTIT.

**How is the hypothesis tested?**

The hypothesis will be tested by analysing the data on energy usage, driving profiles and fleet maintenance costs.

**How is this measured?**

The data needed for evaluation MOTIT's business model will be derived from the users' app and the "Internet of Things" device on the e-scooter. The resulting effect on extra earnings (due to savings on maintenance and electricity costs) for MOTIT is calculated based on these data.

**We are right if?**

With regard to the customer loyalty, we are right if 30% of total (new and current) users choose for the new "Sustainable driving" option. With regard to the maintenance and electricity costs, we are right if a larger share of the total ride time driven in the sustainable driving mode corresponds with a decrease in MOTIT's maintenance and electricity costs and as a result extra earnings for MOTIT (GC5.11).

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs.

## 4.6 Barcelona Demonstrator 2 – EURECAT

**What will be tested?**

We believe that employees are willing to pay a fee for added charging services such as priority charging and booking of charging points. In the current situation, employees do not have to pay a fee for charging their car at one of the Eurecat premises. We will test if employees are willing to pay a fee for smart charging services and at which price level they will opt for these added services.

**How is the hypothesis tested?**

A survey will be conducted in order to test the above hypothesis. At first, Eurecat's employees will be asked if they are willing to make use of the added charging services if they were available for the same price as the default charging service. Also Eurecat's employees will be asked about their willingness to pay for this added service. In addition to this, we will ask Eurecat's employees what price would be fair for this service. To investigate what would be a fair pricing for the services, we have formulated four questions: a. At what price do you believe this service is cheap? b. At what price do you believe this service is so cheap that you will doubt the added value of the service? c. At what price do you believe this service is expensive? d. At what price do you believe this service is so expensive that you are no longer willing to pay this price? By means of these questions, four price levels can be identified.

**How is this measured?**

The data needed for testing the hypothesis for this demonstrator will be derived from the survey. The resulting effect on extra earnings for EURECAT is calculated based on these data.

**We are right if?**

More than 50% of the respondents indicate that they are willing to pay a fee for added charging services such as priority charging and booking of charging points. This will result in extra (potential) earnings for EURECAT (GC5.11).

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs

## 4.7 Barcelona Demonstrator 3 St. Quirze

**What will be tested?**

We believe that employers are willing to pay a fee to provide St Quirze's e-bike sharing service to their employees. In the current situation, employers do not have to pay a fee for making use of the e-bike sharing service. We will test if employers are willing to pay a fee to provide St Quirze's e-bike sharing service and at which price level they will opt for this service.

**How is the hypothesis tested?**

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.

A survey will be conducted in order to test the above hypothesis. At first, employers in St Quirze will be asked if they are willing to make use of this service if this service is available for free. Also St Quirze's employers will be asked about their willingness to pay for the e-bike service. In addition to this, we will ask the employers what would be a fair price for this service. To investigate what would be a fair pricing for the services, we have formulated four questions: a. At what price do you believe this service is cheap? b. At what price do you believe this service is so cheap that you will doubt the added value of the service? c. At what price do you believe this service is expensive? d. At what price do you believe this service is so expensive that you are no longer willing to pay this price? By means of these questions, four price levels can be identified.

**How is this measured?**

The data needed for testing the hypothesis for this demonstrator will be derived from the survey. The resulting effect on extra earnings for St. Quirze is calculated based on these data.

**We are right if?**

More than 50% of the respondents indicate that they are willing to pay a fee to provide St Quirze's e-bike sharing service to their employees. This will result in extra (potential) earnings for St. Quirze (GC5.11).

***Business case***

Besides the business model tests, the impact of GreenCharge's measures on the demonstrator's business case will be evaluated. This will be done by evaluating by evaluating the impact of the measures on GreenCharge's business KPIs.

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.

# 5 Business cases of demonstrators

In this section the business cases for the demonstrators are described. Since there are little or no results from the demonstrators we will focus on the most important elements that have to be included in the business case per demonstrator. The business case calculation was intended as part of the business model measure evaluation. With this information, readers who are planning to set up a similar business can use this as an input to calculate their own business case.

A short overview of the business cases was already available in section 3.3 in D3.3. In this separate chapter we will give a more comprehensive description of the most important business case elements for the final set of business models. The business case format for the Demonstrators is based on their respective Profit & Loss Accounts. The Bottom-Line or Earnings after Interest Tax Depreciation, and Amortization should be calculated on a monthly basis. These monthly earnings are then compared with a "baseline scenario" per demonstrator, whereby Electric Vehicles are charged in the traditional way. In doing so the business case effect of a business model measure in 3 months' time can be calculated. In the end the NPV of the investment to realise a certain business model measure can be subtracted from the discounted earnings in 3 months' time to calculate its Net Present Value. Most business model measures in GreenCharge are related to price level options and the pricing option with the highest NPV will be the preferred price level from a financial point of view.

The elements of the business case for the Oslo Demo 1 Housing Cooperative demonstrator are as follows:

| ***Oslo Demonstrator 1*** | ***Unit*** |
|---|---|
| Number of charge points | Number |
| Sales default price per kWh to Residents | NOK/kWh |
| Average load per charge point | kWh |
| Sales price electricity to CPO | NOK/kWh |
| Average load | kWh |
| | |
| Purchase price electricity from Retailer | NOK/kWh |
| Average load | kWh |
| | |
| Sales priority price per kWh to Residents | NOK/kWh |
| Average priority load per charge point | kWh |
| | |
| Revenues | NOK |
| Costs of goods sold | NOK |
| Gross Margin | NOK |
| Fixed costs | NOK |
| Interest | NOK |
| Tax | NOK |
| Depreciation | NOK |
| Earnings | NOK |
| NPV | NOK |

The business case formats for the other demonstrators are shown in Appendix A.

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.

# 6 European roll-out

In this section the opportunities for a further European roll-out of GreenCharge's business models will be described. This chapter will cover the potential European market size for the demonstrator orchestrators, as was already present in section 4.3 of D3.3. Section 6.2, 6.3 and 6.4 are completely new and are based on the business model workshops held last year.

## 6.1 European market size for demo orchestrators

The potential market size for GreenCharge's demonstrator orchestrators will be described in this section, focusing on the different markets that are targeted by GreenCharge's diverse electric mobility solutions.

To determine the market size potential of every single demo you can use a combined local, national and European approach, which cover the consecutive growth phases of the demonstrators. The GreenCharge demonstrators operate in different markets, because they all target different customer and producer segments. They all operate in different market segments across Europe. As a result, the calculation of the potential market size of the different demonstrators differs too.

The Oslo demonstrators operate in the smart charging market for housing cooperative and its residents/visitors. The ZET demonstrator in Bremen operates in the shared car market for Housing cooperatives and its residents/visitors. The PMC demonstrator in Bremen operates in the smart charging market for employers with parking spaces and its employees/visitors with EVs. The MOTIT demo in Barcelona operates in the shared scooter market. The EURECAT demo in Barcelona operates in the smart charging market for employers with parking spaces and its employees/visitors with EVs. The St. Quirze demo operates in the shared or rental bike market at train stations.

Based on the local, national and European numbers, every demonstrator can determine what market share it can gain at their 3 consecutive growth phases. In order to facilitate the demonstrators, we have created a template for them to fill in. They can use actual numbers for the years from 2015 until 2019. For 2020 until 2025 they can use estimated numbers based on growth in past years. By taking a market share % from these numbers that is expected to grow, every demo can calculate its market size potential.

The expected growth per city, and country within Europe differs considerably, because of the different policies of the government to stimulate the uptake of electric vehicles and its use of local renewable energy. The recent ICCT report on Analysing Policies to grow the electric vehicle marketing in European cities of February 2020 confirms these differences across Europe. With a few exceptions the cities with a higher density of charging infrastructure have a higher-than-average electric vehicle market share. This can be seen in Figure 16, which shows higher EV sales in metropolitan areas with a higher density of charging points (for example in north-western Europe)[8]. The same can be seen in Figure 17, which shows the number of public charging points (per million population) relative to the EV sales market share. However, when comparing for example the region of Oslo to the regions of Rotterdam-The Hague and Amsterdam it is clear that a higher density of charging infrastructure is not the only accelerator of EV sales. The difference in EV market share between these regions can be explained largely by governmental incentives for EV drivers.

[8] European Alternative Fuels Observatory – Charging infrastructure statistics

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.

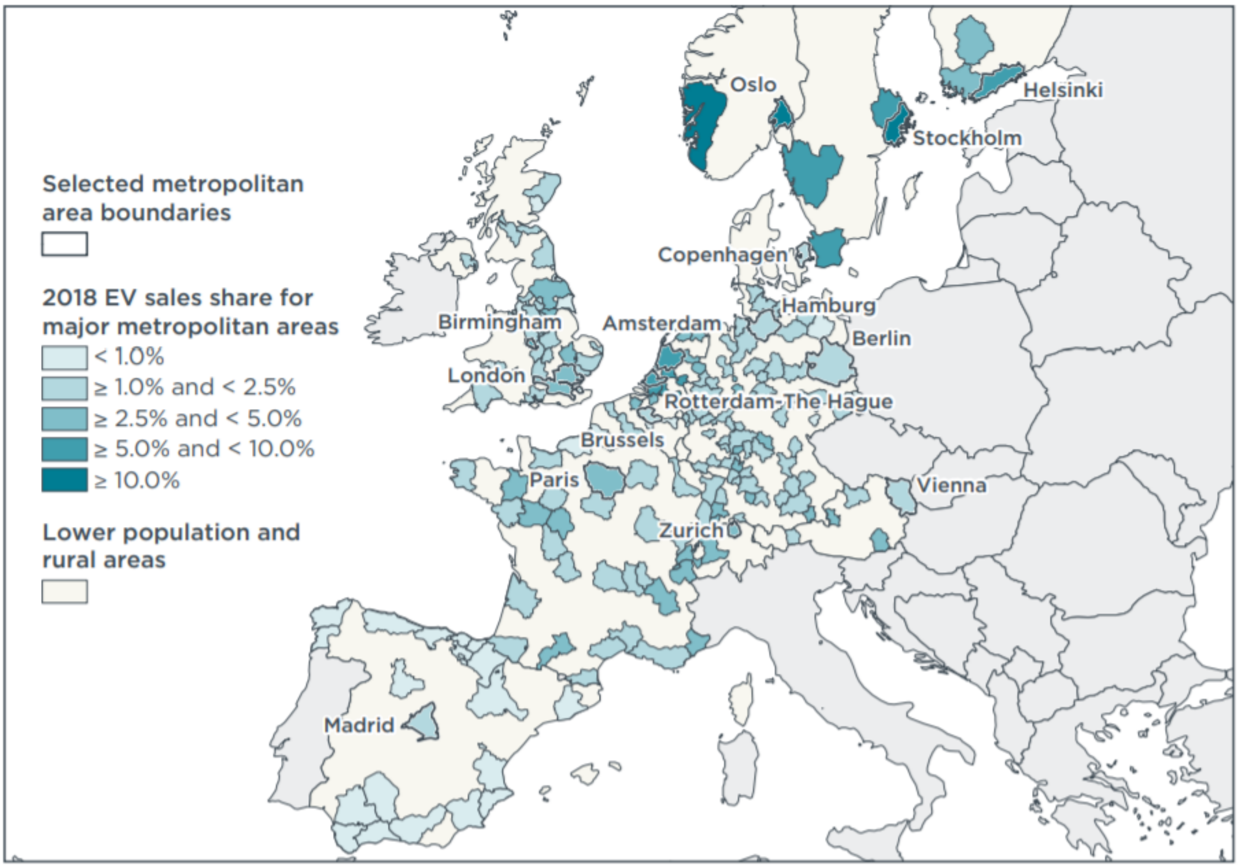


**Figure 16: Electric vehicle share of new registrations in major European metropolitan areas (Source: ICCT, 2020)**

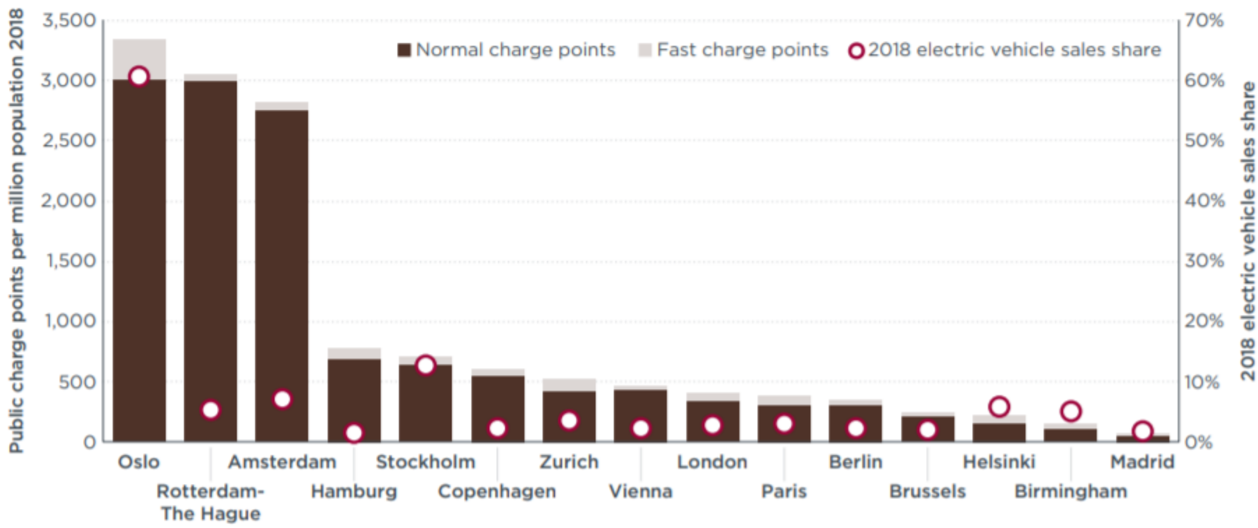


**Figure 17: Electric vehicle sales share and public charging points (Source: ICCT, 2020)**

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 overall number of Electric Vehicles in numbers and its market share in all vehicles driving round in Europe can be derived from Figure 18, as depicted in the EV Outlook 2020 of the IEA. As can be seen, the number of EVs as well as the market share of EVs has increased rapidly in the last five years.

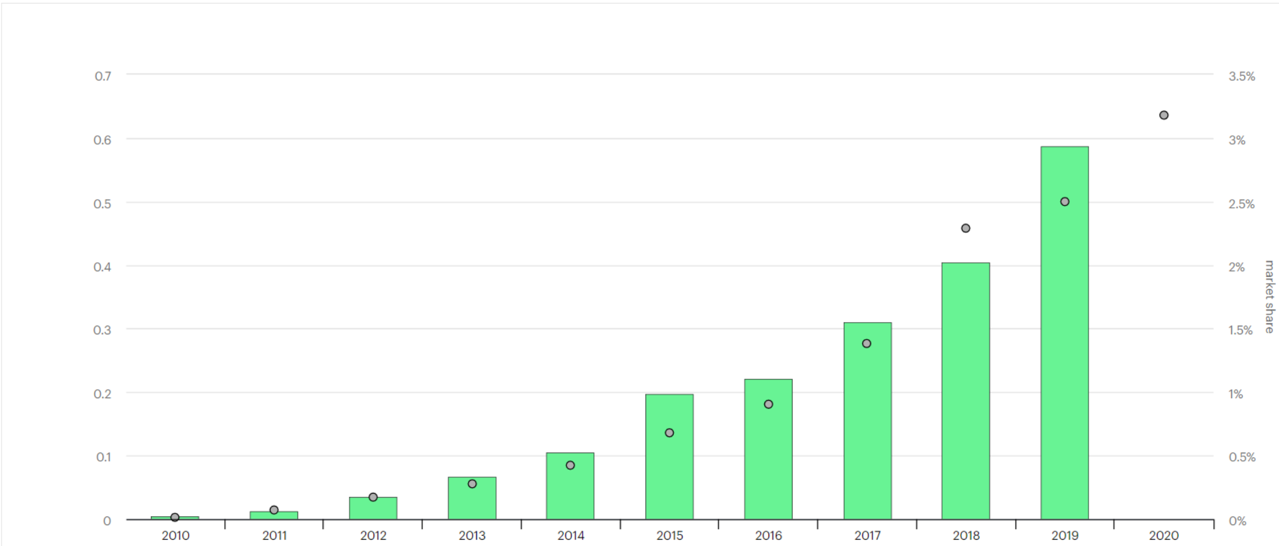


**Figure 18: Number of electric vehicles and its market share in Europe (Source: IEA, EV Outlook 2020)**

A minimum scenario calculation of the market size potential is based on the assumption that all demonstrators stick to their current value proposition and will grow by extending their market reach to all other countries in Europe. The maximum scenario calculation is based on the assumption that all demonstrators will copy each other's value propositions and extend their market reach over all countries in Europe at the same time. In the coming year EGEN intends to facilitate a workshop with every demonstrator, so that they can calculate themselves their own respective market size potential with the aid of the Excel format in Figure 19.

| Market size | INPUT FROM | 2015 | 2016 | 2017 | 2018 | 2019 | 2020E | 2021E | 2022E | 2023E | 2024E | 2025E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| **Europe** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Number of housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of parking places at housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of charge points at housing cooperatives | SINTEF | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Number of business premises | PMC | | | | | | | | | | | |
| Number of parking places at business premises | PMC | | | | | | | | | | | |
| Number of charge points at business premises | PMC | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Number of (shared) scooters rented per year | MOTIT | | | | | | | | | | | |
| Number of (shared) electric scooters rented per year | MOTIT | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Number of (shared) bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |
| Number of (shared) electric bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **National** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Norway** | | | | | | | | | | | | |
| Number of housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of parking places at housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of charge points at housing cooperatives | SINTEF | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Germany** | | | | | | | | | | | | |
| Number of housing cooperatives | ZET | | | | | | | | | | | |
| Number of business premises | PMC | | | | | | | | | | | |
| Number of parking places at business premises | PMC | | | | | | | | | | | |
| Number of charge points at business premises | PMC | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Spain** | | | | | | | | | | | | |
| Number of business premises | EURECAT | | | | | | | | | | | |
| Number of parking places at business premises | EURECAT | | | | | | | | | | | |
| Number of charge points at business premises | EURECAT | | | | | | | | | | | |
| Number of (shared) scooters rented per year | MOTIT | | | | | | | | | | | |
| Number of (shared) electric scooters rented per year | MOTIT | | | | | | | | | | | |
| Number of (shared) bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |
| Number of (shared) electric bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Local** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Oslo** | | | | | | | | | | | | |
| Number of housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of parking places at housing cooperatives | SINTEF | | | | | | | | | | | |
| Number of charge points at housing cooperatives | SINTEF | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Bremen** | | | | | | | | | | | | |
| Number of housing cooperatives | ZET | | | | | | | | | | | |
| Number of business premises | PMC | | | | | | | | | | | |
| Number of parking places at business premises | PMC | | | | | | | | | | | |
| Number of charge points at business premises | PMC | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Barcelona** | | | | | | | | | | | | |
| Number of business premises | EURECAT | | | | | | | | | | | |
| Number of parking places at business premises | EURECAT | | | | | | | | | | | |
| Number of charge points at business premises | EURECAT | | | | | | | | | | | |
| Number of (shared) scooters rented per year | MOTIT | | | | | | | | | | | |
| Number of (shared) electric scooters rented per year | MOTIT | | | | | | | | | | | |
| Number of (shared) bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |
| Number of (shared) electric bikes rented at train stations per year | ATLANTIS | | | | | | | | | | | |

**Figure 19: Excel format for predicting market size potential**

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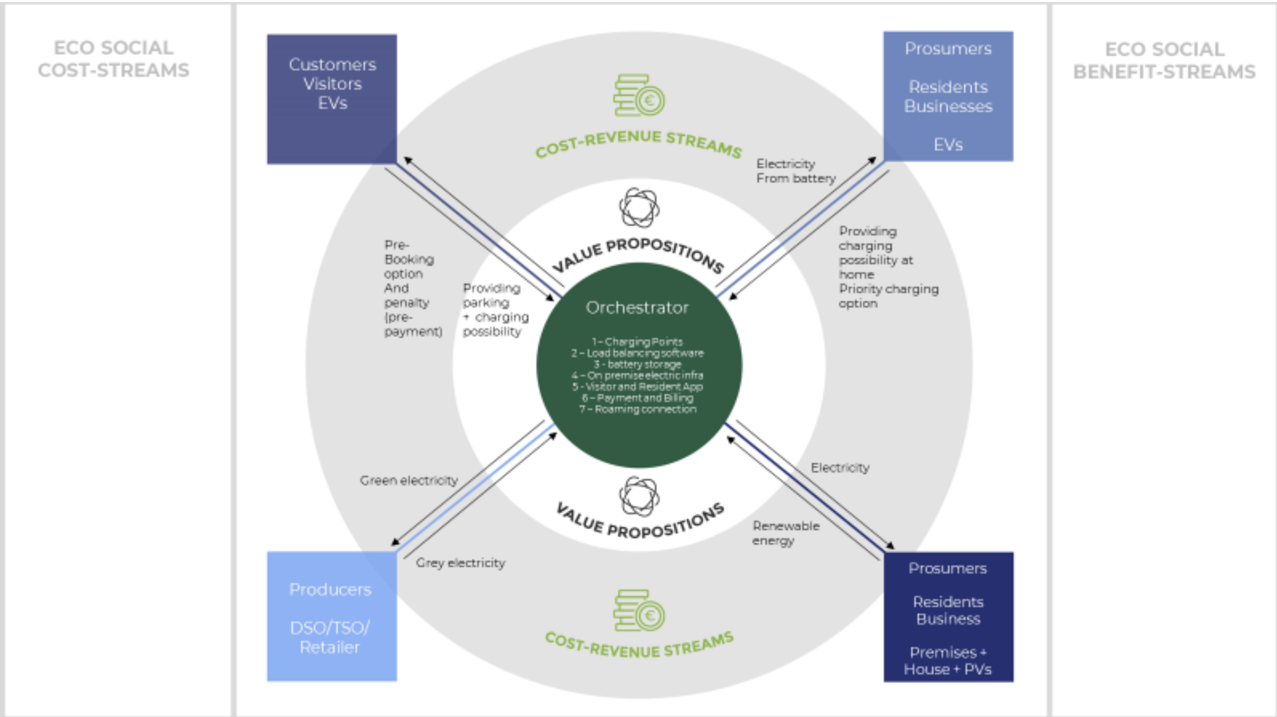
As you can read in the above Excel format every demonstrator is responsible for his/her own calculation of market size potential by assuming a market share (%) in the coming years.

## 6.2 Future Exponential Business Model of GreenCharge

The future exponential business model of GreenCharge consists of a market place model, that connects producers and prosumers of renewable energy with customers and prosumers of renewable energy. The balancing of supply and demand for (green) electricity is done by the load balancing software and battery storage of the orchestrator. More producers of renewable energy will attract more customers of renewable energy to this business model and the other way around. In this way network effects will create economies of scale that generate a serious impact in reducing CO2 emissions. This future business model is an expansion and scale-up version of the combined GreenCharge demonstrators in Oslo.

This exponential business model has the potential to seize the full market. The future exponential business model can be depicted as follows:




Residents in a housing cooperative or business premises, which own their own Solar PV Panels, and EVs (electric Vehicles) are both producers and customers of green electricity and form an Energy Smart Neighbourhood of Prosumers in this way. This future business model is called the Green Electric Vehicle Charging Service, because all electricity is used for Electric Vehicles. These vehicles can be e-cars, e-bikes, or e-scooters.

## 6.3 Future GreenCharge Business Models and Energy Smart Neighbourhoods

A future business model, that can be used for Energy Smart Neighbourhoods (ESN), focussing on the interaction between prosumers (V2G, local renewable energy) and electricity providers can be based on game theory. This theory can help to computate the optimal price levels for energy from prosumers and electricity providers in order to maximize value creation for all stakeholders of a Market Place Business Model.

We understand an ESN as a sharing-oriented community where members contribute “resources” to be managed to the benefit of the common good and are rewarded according to the value of their contribution. The common

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good is reduced energy cost. Many may also consider reduced carbon footprint and reduced burden on the public grid, but we will assume that grid tariffs are designed to reward that. The contributed resources are:

- local RES, e.g. local solar plants
- local storage, e.g. stationary battery or V2G
- flexibility of electric energy demand, e.g. flexible charging
- prediction of electric energy demand, e.g. booked charging

The challenge is to find a fair distribution of the common good among the members that reward them appropriately relative to their contributions, and thus create an incentive to create ESNs and share their DER and knowledge about own electric energy demand. A possible approach is to consider the ESN as a coalitional game and distribute the gain according to the Shapley value.

The Shapley value

In game theory a coalitional game is a game with a set N (of n players) and a function v that maps subsets of players to real numbers. The function v is called the characteristic function and if S is a subset of N then v(S) represents the gain if the players in S form a coalition and collaborates.

The Shapley value is one way to distribute the total gains to the players, assuming that they all collaborate. It is a "fair" distribution in the sense that it is the only distribution with a given set of properties defining fairness. The Shapley value1, is given by the following formula:

$$\emptyset(i) = \sum_{i \in S \subseteq N} \frac{(n - |S|)!\ (|S| - 1)!}{n!} (v(S) - v(S - \{i\})$$

To illustrate how it works consider the following simple example. The ESN has three members P,C and B. P has a PV plant with capacity 2 kWp, C has an AC charge point with max charging power 3 kW, and B has a stationary battery with storage capacity 6 kWh and max (dis)charging power 2kW. We consider a sunny day with sunrise at 6 am and sunset is at 6 p.m., giving a production profile as shown Figure 1. The grid price is constant at 1, the feed-in price is 0, and the battery cannot be charged from the grid. The EV connects at noon, requests 12 kWh, and expects to leave at 9 p.m.

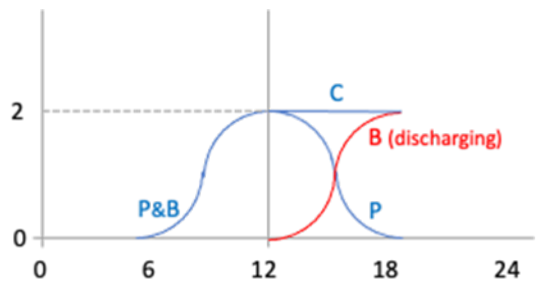


Figure 1 Energy production and consumption profiles

The optimal schedule found and executed by the energy management system is as follows:

- from 6 am to noon the PV plant of P charges the battery of B with 6 kWh
- from noon to 6 pm the battery of B and the PV plant of P charges the EV of C with 6 kWh each.

The characteristic function of the coalition game in this case would be defined as follows:

v ({B C P}) = 12

v ({C P}) = 6

v ({B P}) = 6

v = 0 otherwise

If we compute the Shapley values using the defining formula above, we get

Ø(P) = 2/6*(12-0) + 1/6*(6-0) + 1/6*(6-0) = 6,

Ø(B) = 2/6*(12-6) + 1/6*(6-0) = 3,

Ø(C)= 2/6*(12-6) + 1/6*(6-0) = 3,

which looks reasonable.

Computational complexity

Unfortunately, computing the Shapley values in this way is computationally intractable in real life ESNs. However, if the characteristic function satisfies a certain constraint, there is a simpler way to do the computation. The constraint is that the value of the characteristic function of a coalition is the sum of the values of the characteristic function for all pairs of members of the coalition. In this case the characteristic function can be represented as an undirected weighted graph where the nodes represent the players and the weights on the edges represent the values of the characteristic function of the sub-coalition consisting of the players represented by the nodes they connect, and the Shapley value of a player can be computed as half the sum of the weights of all the edges connected to the node representing it, i.e.:

$$\emptyset(i) = \frac{1}{2}\sum_{j \neq i} v(i,j)$$

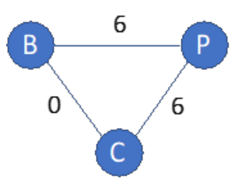


Figure 2 Graph representation of the characteristic function of the example game

The characteristic function of the example game obviously satisfies this constraint, and the graph representation is shown in Figure 2. Applying the simplified calculation gives



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∅(P) = ½*(6+6) = 6,

∅(B) = ½*(6+0) = 3,

∅(C) = ½*(6+0) = 3,

i.e., the same result as above.

As stated in the introduction, we define the gain of the coalitional game as the cost reduction caused by replacing consumption of energy imported from the grid by locally produced energy, we can model the ESN as a coalitional game with a characteristic function satisfying the constraint enabling this simplified calculation of the Shapley value.

Fortunately, we do not need to construct the characteristic function and its graph representation, because the sum in the formula corresponds to the value of the energy flow into or out of a household minus the household's share of the flow into or out of the neighbourhood, which we can compute from the log of the main meters of the member households, and the grid tariffs. Since all this vary over time, we have to integrate over the time period for which we want to compute the Shapley values.

Thus, the calculation of the sharing of the gain among the members of an ESN with n households labeled 1:n can be expressed as follows:

Let p(t) represent the grid price, fN(t) represent the energy exchange between the ESN and the public grid, and fi (t) the exchange of energy over the main meter of household i.

At a given point in time both the neighbourhood as a whole and each of the member households will either be a net consumer (f(t) > 0) or a net producer (f(t) < 0). The sum of energy consumed by the net consumers is

$$f_N^c(t) = \sum_{i=1:n, f_i(t)>0} f_i(t)$$

and for the net producers

$$f_N^p(t) = \sum_{i=1:n, f_i(t)<0} f_i(t)$$

Then the shapley value for the net consumers can be expressed as follows

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$$\phi_i(t) = \left(f_i(t) - \frac{f_i(t)}{f_N^c(t)} f_N(t)\right) * p(t) \text{ when } f_i(t) > 0 \text{ and } f_N(t) > 0,$$

$$\phi_i(t) = \left(f_i(t) - \frac{f_i(t)}{f_N^p(t)} f_N(t)\right) * p(t) \text{ when } f_i(t) < 0 \text{ and } f_N(t) < 0,$$

$$\phi_i(t) = f_i(t) * p(t) \text{ otherwise.}$$

Finally, the Shapley values for a given period of time can be found by integrating over the time period

$$\int_{t_0}^{t_0+\Delta t} \phi_i(t)\, dt$$

where t0 is the start of the period and Δt.

Conclusion

The Shapley value is proved to be fair according to certain fairness principles and the given characteristic function. So the fairness depends on the fairness of the characteristic function.

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# 7 Conclusions

The business model innovation process, that has been run together with PNO and the different stakeholders at the demonstrators, have resulted in the design of the initial and revised business models. PNO has identified several important learnings from this design process. The following most important lessons have been learned from the business model iterations so far:

1. <u>One business model for all stakeholders per demo, not a business model per stakeholder</u>

The initial business models were described as traditional pipeline business models based on the St. Gallen business model concept. They used three canvasses to describe one business model for one demonstrator. We have simplified this and reduced the number of business models to one per demonstrator.

2. <u>Multi-sided market place stimulates collaboration and maximizes value for all stakeholders</u>

A traditional pipeline business model contains a margin trade-off between the different links of the chain. A multi-sided market place where all customers and producers are owners of the orchestrator is characterised by fair margin division between these stakeholders. In this way, incentives are aligned and collaboration is optimised.

3. <u>The concept of priority booking and flexible booking are interconnected</u>

Previously the concepts of priority booking and flexible booking were described as two separate value propositions. However, these two concepts are highly interconnected: offering priority booking services means that users who do not opt for this added service could be considered as users that offer flexibility. Without specifically opting for a more flexible charging strategy, these users are put in second place. The same applies to the opposite, where users who do not offer flexibility as an added service take automatically precedence over the users who have opted for the flexibility service.

4. <u>Keep business model test simple as to make demos feasible</u>

We have focused the business model tests on its core element: the value proposition in combination with the cost and revenue streams. As a result, the learnings of the tests will be clear and useful to the demonstrator leaders.

5. <u>Business KPIs need to be aligned with the criteria for exponential business models</u>

The assessment of business models should be done by applying the criteria for exponential business models. These criteria form business requirements for the demonstrators. We learned that these business requirements match with the business KPIs from the CIVITAS Network, except for GC5.15 (earnings).

6. <u>Producers and customers of energy need to receive a fair price in an exponential business model</u>

An important aspect of the 5$^{th}$ element of exponential business models is that stakeholders receive a fair price for their added value to the market place. As long as their cost savings of joining a market place business model, instead of a pipeline one, are in line with their added value to the market place, they will continue to be part of it. As a result the network effects will keep working. If an orchestrator claims a larger part of the profits than its fair share based on its added value to the market place, than the network effects will slow down.

7. <u>Business model measure tests should be organized in an Agile way</u>

Business model (measure) tests for energy market places should be organised in an Agile way instead of a linear one from the start onwards, because the outcomes are highly uncertain and give room for flexibility and adaptation. As a result business models can easily be adapted to unforeseen events, like the COVID pandemic.

At the start of the GreenCharge project it was expected that the first results of the business model evaluation tests would be presented. These test results are unfortunately still lacking due to a delay in the start of the pilots and the Corona pandemic. Nevertheless, the extra time for business model design has given the demonstrators the chance to revise their initial pipeline business models to more effective market place business models; and incorporate the learnings mentioned above.

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A common concern about market place business models is, that the orchestrators take all profits. This drawback can be overcome by proper EU competitive regulation of the market and/or shared cooperative ownership of the orchestrator. The GreenCharge@Work demo shows how cooperative ownership can play out in practise.

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# A Business case elements per demonstrator

## A.1 Oslo Demonstrator 1

**Table 4: Business case elements for Oslo Demonstrator 1**

| *Oslo Demonstrator 1* | *Unit* |
|---|---|
| Number of charge points | Number |
| Sales default price per kWh to Residents | NOK/kWh |
| Average load per charge point | kWh |
| Sales price electricity to CPO | NOK/kWh |
| Average load | kWh |
| | |
| Purchase price electricity from Retailer | NOK/kWh |
| Average load | kWh |
| | |
| Sales priority price per kWh to Residents | NOK/kWh |
| Average priority load per charge point | kWh |
| | |
| Revenues | NOK |
| Costs of goods sold | NOK |
| Gross Margin | NOK |
| Fixed costs | NOK |
| Interest | NOK |
| Tax | NOK |
| Depreciation | NOK |
| Earnings | NOK |
| NPV | NOK |

## A.2 Oslo Demonstrator 2

**Table 5: Business case elements for Oslo Demonstrator 2**

| *Oslo Demonstrator 2* | *Unit* |
|---|---|
| Number of charge points | Number |
| Sales default price per kWh to visitors | NOK/kWh |
| Average load per charge point | kWh |
| Sales price electricity to CPO | NOK/kWh |
| Average load | kWh |
| | |
| Purchase price electricity from Retailer | NOK/kWh |
| Average load | kWh |
| | |
| Revenues | NOK |
| Costs of goods sold | NOK |
| Gross Margin | NOK |
| Fixed costs | NOK |
| Interest | NOK |
| Tax | NOK |
| Depreciation | NOK |
| Earnings | NOK |
| NPV | NOK |

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## A.3 Bremen Demonstrator 1

### Table 6: Business case elements for Bremen Demonstrator 1

| *Bremen Demonstrator 1* | *Unit* |
|---|---|
| Fee for Housing cooperative | EURO |
| Number of shared cars | Number |
| Sales price of using shared cars by residents or visitors | EURO/min |
| Average number of trips per shared car | Number |
| Average length of trip | Minutes |
| Marketing | EURO |
| Purchase price of electricity | EURO/kWh |
| Average load of electricity per shared car | kWh |
| Maintenance | EURO |
| | |
| Number of cars per customer | Number |
| Number of cars per resident in the area | Number |
| | |
| Costs of goods sold | EURO |
| Gross Margin | EURO |
| Fixed costs | EURO |
| Interest | EURO |
| Taks | EURO |
| Depreciation | EURO |
| Earnings | EURO |
| NPV | EURO |

## A.4 Bremen Demonstrator 2

### Table 7: Business case elements for Bremen Demonstrator 2

| *Bremen Demonstrator 2* | *Unit* |
|---|---|
| Number of large cooperative partners | Number |
| Price of large cooperative partnership | EURO |
| Number of small cooperative partners | Number |
| Price of small cooperative partnership | EURO |
| Number of members | Number |
| Price of membership | EURO |
| Sales price of electricity | EURO |
| Average load per charging point per CP | kWh |
| Purchase price of electricity | EURO |
| Maintenance | EURO |
| Marketing | EURO |
| | |
| Sales price of smart charging | EURO |
| Average load of smart charging per CP | kWh |
| | |
| Revenues | EURO |
| Costs of goods sold | EURO |
| Gross Margin | EURO |

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.

| | |
|---|---|
| Fixed costs | EURO |
| Interest | EURO |
| Tax | EURO |
| Depreciation | EURO |
| Earnings | EURO |
| NPV | EURO |

## A.5 Barcelona Demonstrator 1

**Table 8: Business case elements for Barcelona Demonstrator 1**

| ***Barcelona Demonstrator 1*** | ***Unit*** |
|---|---|
| Number of scooters | Number |
| Available scooters | % |
| Sales price per minute | EURO |
| Average number of trips per available scooters | Number |
| Average length of trip per available scooter | Minutes |
| Price of electricity | EURO |
| Average load of electricity per trip | kWh |
| | |
| Sales price per minute sustainable driving | EURO |
| Sustainable driving | Minutes |
| | |
| Revenues | EURO |
| Costs of goods sold | EURO |
| Gross Margin | EURO |
| Fixed costs | EURO |
| Interest | EURO |
| Tax | EURO |
| Depreciation | EURO |
| Earnings | EURO |
| NPV | EURO |

## A.6 Barcelona Demonstrator 2

**Table 9: Business case elements for Barcelona Demonstrator 2**

| ***Barcelona Demonstrator 2*** | ***Unit*** |
|---|---|
| Number of employees with EV | Number |
| Sales default price of electricity | EURO/kWh |
| Average load of electricity per employee | kWh |
| Purchase price of electricity | EURO/kWh |
| | |
| Sales priority price of electricity | EURO/kWh |
| Average priority load of electricity per employee | kWh |
| | |
| Revenues | EURO |
| Costs of goods sold | EURO |
| Gross Margin | EURO |
| Fixed costs | EURO |
| Interest | EURO |
| Tax | EURO |
| Depreciation | EURO |

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.

| | |
|---|---|
| Earnings | EURO |
| NPV | EURO |

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## A.7 Barcelona Demonstrator 3

**Table 10: Business case elements for Barcelona Demonstrator 3**

| ***Barcelona Demonstrator 3*** | ***Unit*** |
|---|---|
| Number of shared e-bikes | Number |
| Sales price per day | EURO |
| Purchase price of electricity | EURO |
| Average load electricity per e-bike per day | kWh |
| | |
| Number of trips per month | Number |
| Average length of trip | Minutes |
| Sales price per minute | EURO |
| | |
| Average length of trip | KMs |
| Sales price per km | EURO |
| | |
| Revenues | EURO |
| Costs of goods sold | EURO |
| Gross Margin | EURO |
| Fixed costs | EURO |
| Interest | EURO |
| Tax | EURO |
| Depreciation | EURO |
| Earnings | EURO |
| NPV | EURO |

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# Members of the GreenCharge consortium

| | | |
|---|---|---|
| | SINTEF AS (SINTEF)<br>NO-7465 Trondheim<br>Norway<br>www.sintef.com | **Project Coordinator:**<br>Jacqueline Floch,<br>Jacqueline.Floch@sintef.no<br>**Technical Manager:**<br>Shanshan Jiang<br>Shanshan.Jiang@sintef.no |
| | eSmart Systems AS (ESMART)<br>NO-1783 Halden<br>Norway<br>www.esmartsystems.com | **Contact:**<br>Susann Kjellin Eriksen<br>susann.kjellin.eriksen@esmartsystems.com |
| | Hubject GmbH (HUBJ)<br>DE-10829 Berlin<br>Germany<br>www.hubject.com | **Contact:**<br>Jürgen Werneke<br>juergen.werneke@hubject.com |
| | Fundacio Eurecat (EUT)<br>ES-08290 Barcelona<br>Spain<br>www.eurecat.org | **Contact:** Regina Enrich<br>regina.enrich@eurecat.org |
| | Atlantis IT S.L.U. (ATLAN)<br>ES-08013 Barcelona<br>Spain<br>http://www.atlantisit.eu/ | **Contact:** Ricard Soler<br>rsoler@atlantis-technology.com |
| | Millor Energy Solutions SL (ENCH)<br>ES-08223 Terrassa<br>Spain<br>www.millorbattery.com | **Contact:** Baltasar López<br>blopez@enchufing.com |
| | Motit World SL (MOTIT)<br>ES-28037 Madrid<br>Spain<br>www.motitworld.com | **Contact:** Valentin Porta<br>valentin.porta@goinggreen.es |
| | Freie Hansestadt Bremen (BREMEN)<br>DE-28195 Bremen<br>Germany | **Contact:** Michael Glotz-Richter<br>michael.glotz-richter@umwelt.bremen.de |
| | ZET GmbH (MOVA)<br>DE-28209 Bremen<br>Germany<br>www.zet.technology | **Contact:** Dennis Look<br>dennis@zet.technology |

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| | | |
|---|---|---|
| pmc personal mobility center | Personal Mobility Center Nordwest eG (PMC)<br>DE-28359 Bremen<br>Germany<br>www.pmc-nordwest.de | **Contact:** Bernd Günther<br>b.guenther@pmc-nordwest.de |
| Oslo | Oslo kommune (OSLO)<br>NO-0037 Oslo<br>Norway<br>www.oslo.kommune.no | **Contact:** Patrycjusz Bubilek<br>patrycjusz.bubilek@bym.oslo.kommune.no |
| fortum | Fortum OYJ (FORTUM)<br>FI-02150 Espoo<br>Finland<br>www.fortum.com | **Contact:** Jan Ihle<br>jan.haugen@fortum.com |
| PNO Connecting Ambitions | PNO Consultants BV (PNO)<br>NL.2289 DC Rijswijk<br>Netherlands<br>www.pnoconsultants.com | **Contact:** Francesca Boscolo Bibi<br>Francesca.boscolo@pnoconsultants.com |
| V: Università degli Studi della Campania Luigi Vanvitelli<br>Scuola Politecnica e delle Scienze di Base<br>Dipartimento di Ingegneria Industriale e dell'Informazione | Universita Deglo Studi Della Campania Luigi Vanvitelli (SUN)<br>IT-81100 Caserta<br>Italy<br>www.unicampania.it | **Contact:** Salvatore Venticinque<br>salvatore.venticinque@unicampania.it |
| UiO : Universitetet i Oslo | University of Oslo (UiO)<br>NO-0313 Oslo<br>Norway<br>www.uio.no | **Contact:** Geir Horn<br>geir.horn@mn.uio.no |
| ICLEI Local Governments for Sustainability EUROPE | ICLEI European Secretariat GmbH (ICLEI)<br>DE-79098 Freiburg<br>Germany<br>www.iclei-europe.org | **Contact:** Stefan Kuhn<br>stefan.kuhn@iclei.org<br>**Innovation Manager:** Reggie Tricker<br>reggie.tricker@iclei.org |
| EGEN Part of PNO Group | EGEN B.V.<br>NL.2289 DC Rijswijk<br>Netherlands<br>www.egen.green | **Contact:** Simone Zwijnenberg<br>Simone.zwijnenberg@egen.green |


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