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[1] https://ev4eu.eu/

Executive Summary

The deliverable *Business models centred in the V2X value chain* aims to present new state-of-the-art business models developed within the EV4EU project. The study is centred on the countries of the EV4EU project members (Denmark, Greece, Portugal, and Slovenia), considering stakeholders and local specifics that influence the development and deployment of V2X services. However, most of the business models can be applied in other countries and regions.

The proposed Business Models focus on Vehicle-to-Everything (V2X) technology and propose and implement user-centric V2X management strategies following bottom-up approach. They provide benefits to the main stakeholders and investigate value to the entire V2X value chain to set the stage for the mass deployment of electric vehicles.

This document presents a description of the methodology used to develop the proposed Business Models, namely the Value Proposition Design that uses Business Model Canvas and Value Proposition Canvas as adopted due to its adequacy to represent business based on services. The process started with the five initial business models outlined in the project proposal. During the iterative business model development, twelve business models were created, namely TSO services for RES curtailment management, Sharing Charging Business Model, Electric Vehicle Fleet Management Services, Distribution System Operator Flexibility Services - Voltage Regulation via price signals, Virtual Power Plant Business Model, Flexibility Services operated by Distribution System Operator Business Model, Vehicle-to-Everything Stations Business Model, Distribution System Operators bound by Flexible Capacity Contract, Business Model for Charging Point Operators, Business Model for Cloud Platform Manager operating the Open V2X Management Platform, Business Model for Private Parking Lot Managers, and Business Model for Public Parking Lot Managers.

Furthermore, the deliverable *Business models centred in the V2X value chain* can be considered as a cornerstone for the next tasks of the project. The outcomes of this task will form the basis for the D1.5 V2X Use-cases repository, where business use cases will be developed considering the proposed business models. Furthermore, the Business Models also provide initial intuition for D10.3, Innovation Strategy, and the update D10.4. Overall, all technical solutions will also include a business component increasing possibilities of wider acceptance of electric vehicles. Proposed business models will be gradually developed and concretized over time. Outcomes will be incorporated in D10.5 Exploitation plan and the updated plan D10.6.

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Acronym

ADMS	Advanced Distribution Management System
BM	Business Model
BMC	Business Model Canvas
BUC	Business Use Case
B2B	Business-to-Business
CP	Charging Point
CPO	Charging Point Operator
CS	Charging Station
DR	Demand Response
DER	Distributed Energy Resources
DSO	Distribution System Operators
EMSP	E-Mobility Service Provider
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
EV4EU	Electric Vehicles Management for Carbon Neutrality in Europe
FFR	Fast Frequency Reserve
FFC	Fast Frequency Response
FCR	Frequency Containment Reserve
FRR	Frequency restoration Reserve
GHG	Greenhouse Gas
HV	High Voltage
ICE	Internal Combustion Engine
KPI	Key Performance Indicator
LV	Low Voltage
MV	Medium Voltage
NRA	National Regulatory Authority
O&M	Operation and Maintenance
OPEX	Operational Expenditure
PV	Photovoltaic
PMEA	Plan for Electric Mobility in Azores
DREn	Regional Energy Directorate
LREC	Regional Laboratory of Civil Engineering
SREA	Regional Statistical Service of Azores
RES	Renewable Energy Sources
ROI	Return on Investment
SoC	State of Charge
TSO	Transmission System Operators
V1G	Unidirectional Smart Charging
UC	Use Case
VP	Value Proposition
VPC	Value Proposition Canvas
V2B	Vehicle-to-Building
V2X	Vehicle-to-Everything

V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
VPP	Virtual Power Plants
WP	Work Package

1. Introduction

The EV4EU project is proposing and implementing bottom-up, user-centric Vehicle-to-Everything (V2X) management strategies that will set the stage for mass deployment of electric vehicles (EV). An important part to promote mass adoption of EVs is to develop and introduce novel business models (BM) that promote benefits to end users, as well as to integrate benefits of new demand response (DR) programs, market participation, and flexibility services, while considering benefits of the market. In the present deliverable several business models are explored considering the vision of different stakeholders such as system operators, virtual power plants, V2X managers and service providers. One of the main conclusions of this analysis is that new services can create new business opportunities, facilitating the operation of the distribution systems, the coordination of V2X with renewables and the reduction of charging invoice for the end users.

The proposed business models follow a value proposition design method where the gains and pains are identified for each stakeholder. After this identification, business model canvas are used to understand the main implications of the new products and services.

1.1 Scope and Objectives

This document collects information on the process of developing new BMs that create value for the entire V2X value chain. The proposed BMs will be explored, and field tested in the EV4EU project. The results will serve as an indicator of how the BMs can be further developed and adapted. The BMs described here should be considered as "work in progress" as they will be shaped by the input from the field tests.

The proposed BMs will serve as a basis for the development of business use cases (BUCs), which will be detailed in the deliverable D1.5 and tested in the four demonstrators. In addition, the Key Performance Indicators (KPIs) will be defined in D1.5 and further developed in the first tasks of the Work Packages (WP) of the specific demonstrators.

1.2 Structure

This document is divided into a general, theoretical section (Section 2) and a more practical section with specific BMs suitable for the demonstrators (Section 3). These sections are, in turn, divided into subsections. Section 2 describes the theoretical background of the concepts, key to a better understanding of the topic, the methodology, the process of developing new BMs used in this project, as well as the initial BMs proposed in the project proposal.

Section 3 collects information about the four demonstrators, with a brief description of the demonstrator, followed by the workshop outputs, and proposed BMs.

1.3 Relationship with other deliverables

Task 1.4 was carried out simultaneously with the identification of regulatory opportunities and barriers arising from the impact of the regulatory framework on BMs, available in **D1.3 Regulatory opportunities and barriers for V2X deployment in Europe**.

The BMs presented in this document are further developed into BUCs, which are detailed in **D1.5 V2X Use-cases repository**. D1.5 will also define related KPIs. Furthermore, D1.4. Is also related to the four demonstrators via **D6.3 Implementation plan for the Azores demo**, **D7.1 Detailed definition and**

implementation plan of Slovenian Demonstrator, **D8.1 Use case specifications and demonstrator deployment plan** and **D9.1 Use case specification, development, installation, commissioning, demonstration, and evaluation planning for the Danish demo**, where the KPIs for each demonstrator will be further developed to best suit the specific situations of the BMs and BUCs being tested in particular demonstrator.

Both deliverables D1.4 and D1.5 serve as a basis for identifying information exchange needs and barriers for the deliverable **D5.1 Information Exchange needs to enable different UCs,** which has already been completed**.** Considering the exploitation of results and business opportunities of the solutions proposed developed in the project, final outcomes will be included also in **D10.5 Exploitation plan** and the update **D10.6**.

2 Theoretical background and Methodology of Business models development

To accelerate EV use and the creation of favourable conditions for V2X, new services and BMs need to be developed considering all stakeholders, while providing incentives for EV users. The classic BMs for vehicles with internal combustion engines (ICE) cannot be simply transferred to e-mobility, and neither can we follow the already established BMs for EVs. Part of the V2X technologies, which makes EVs different from ICEs, is the so-called Vehicle-to-Grid (V2G) communication. V2G exploits two-way communication between the electricity grid and EVs, which could enable utilities and aggregators to better manage energy resources, as well as provide new roles to vehicle owners, ranging from private to public charging point operators (CPOs) (Zarazua de Rubens, Noel, Kester, & Sovacool, 2020).

By definition, a BM describes the basic principle of how an organization creates, delivers, and captures value (Osterwalde, Pigneur, Clark, & Smith, 2010). Following (Afuah, 2004), we use the definition: “A business model is the set of which activities a firm performs, how it performs them, and when it performs them as it uses its resources to perform activities, given its industry, to create superior customer value (low-cost or differentiated products) and put itself in a position to appropriate the value”.

A structured approach, which implicitly follows the above definition and includes a methodical approach, distinguishes BMs into three elements:

1. Value proposition (VP): Defines the promised value of a product that the manufacturer offers to the customer upfront.
2. Value chain configuration: Describes the potential ways in which the product offered can be configured regarding the various shareholders involved in a BM.
3. Revenue model: Defines the type of payment that the customer makes to the offering shareholder as part of the offer (Kley, Lerch, & Dallinger, 2011).

Another subdivision of BMs results from the two options available to the end-customer who can either buy the product, an EV in this case, or only the service, in the form of a taxi (Tukker, 2004). Between these two, there are numerous other options that offer mobility services to the end customer, as shown in Figure 1 (Kley, Lerch, & Dallinger, 2011).

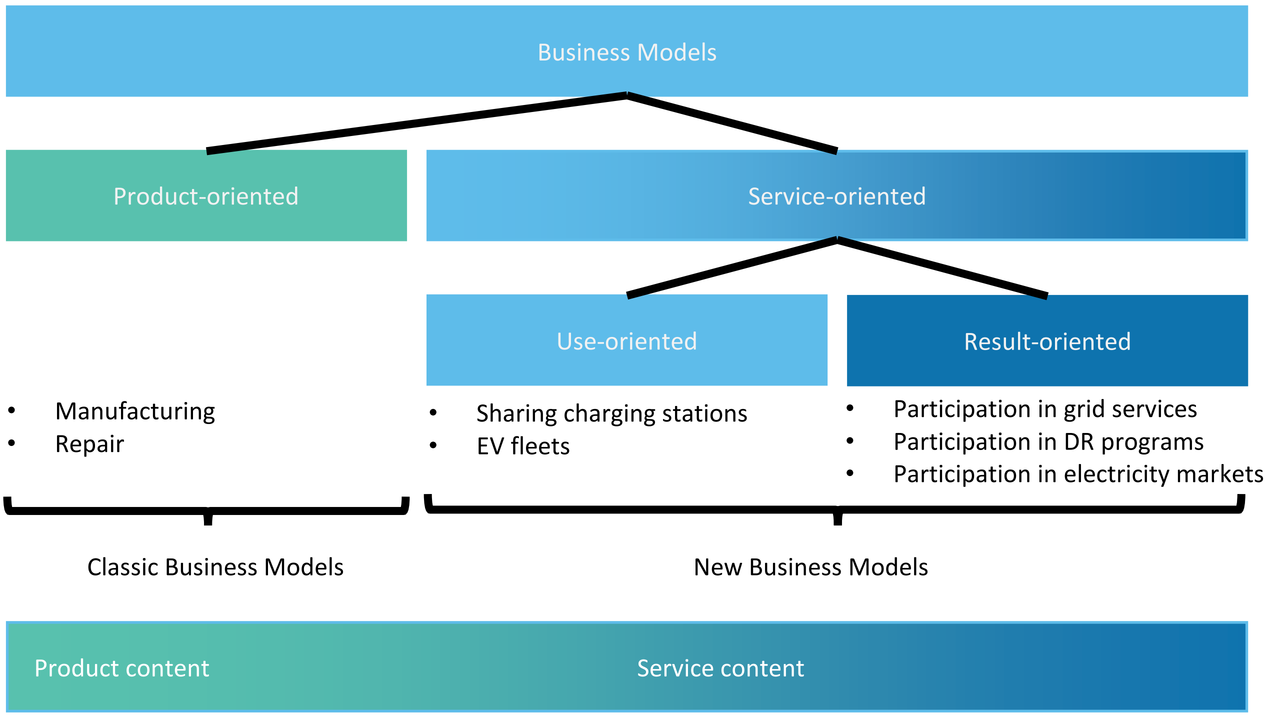

Figure 1: Business models structure for V2X (Based on Tukker's (Tukker, 2004) topology and business models for mobility concepts proposed by (Kley, Lerch, & Dallinger, 2011).

The first category, on the far left of the Figure 1, describes the "product-oriented business model" which follows the classic BM. These classic BMs do not include performance guarantees once the customer has purchased the product. Typical services offered in product-oriented BMs include financing, insurance, inspection, and repair services.

In contrast, "service-oriented business models" are applied during the service period of the vehicle. Service-oriented BM can be further divided into "use-oriented" and "result-oriented". In other words: the focus is no longer on the core product, but on a contractually guaranteed service even after delivery, which is provided with the help of the core product.

If we transfer this concept to mobility offers, this means for use-oriented BMs that a certain value is promised with the purchase of a vehicle. For result-oriented BMs, on the other hand, this means that the end customer can always get from A to B with the help of the mobility provider.

In (Kley, Lerch, & Dallinger, 2011), it is proposed a systematic classification of BMs for e-mobility, using a holistic approach considering a set of components that are influenced by battery-based e-mobility concepts. Among the identified influencing factors are:
- the vehicle along with the battery,
- the infrastructure system, and
- the system services that integrate EVs into the energy system.

How EVs can be integrated into the power grid as V2X and the resulting opportunity for providing services is the central aspect of the EV4EU project, for which innovative BMs need to be developed.

Baser (Baser, 2020) provides information about key components and key actors for sustainable V2G BMs and outlines the theoretical V2G framework. Different roles of consumers (EV drivers) in a V2G BM are identified where consumers can give importance to financial incentives, sustainability incentives, or have flexibility in choices whether and how to use EVs for V2G. The authors conclude that for the V2G BM definition, all stakeholders need to have an active contribution.

Sovacool et al. (Sovacool, Kester, Noel, & Zarazua de Rubens, 2020), motivated by the prospect of leveraging significant investment and financial flows along with private sector engagement to decarbonize passenger transport in Europe, they identify stakeholders (Figure 2), relevant business markets, and BMs. They observe that V2G BMs are temporally dynamic, structurally complex, and difficult to govern, as they involve multiple actors, disrupt traditional practices, may overlap with other BMs, and have variable costs and changing benefits.

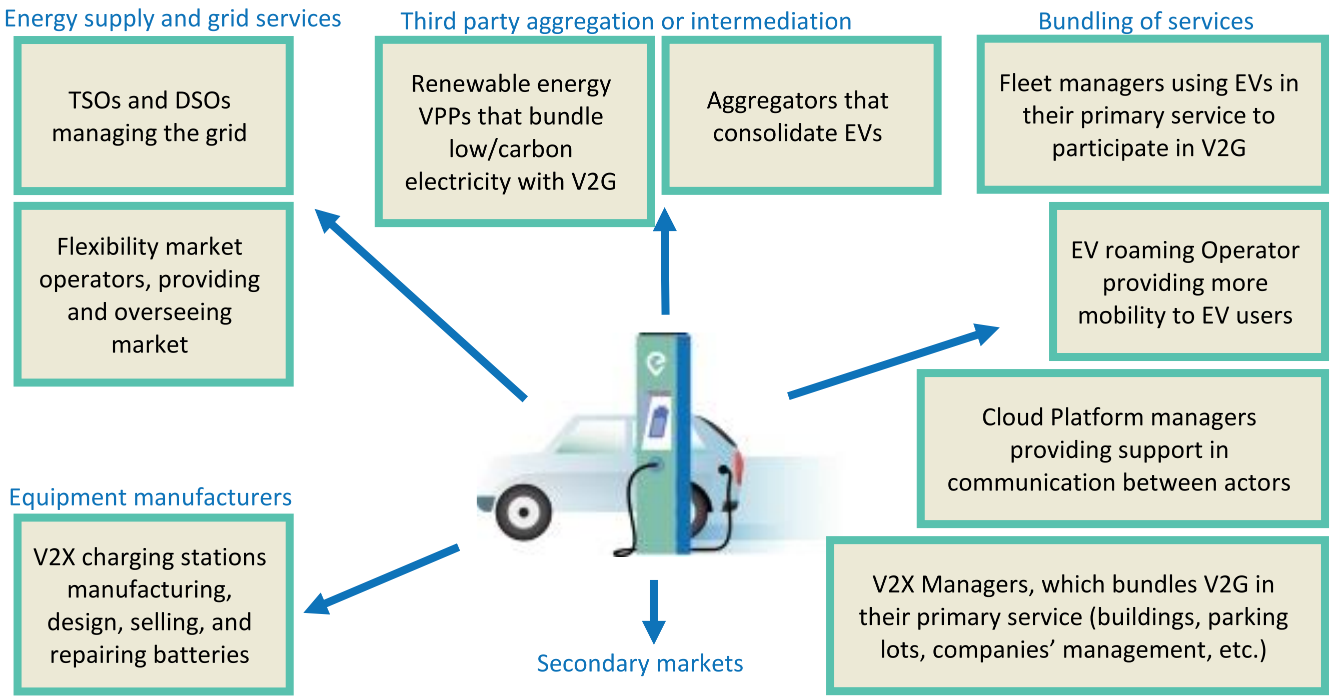

Figure 2: Stakeholders in V2X-based business model applicable for EV4EU project. Based on (Sovacool, Kester, Noel, & Zarazua de Rubens, 2020).

Figure 2 extends (Sovacool, Kester, Noel, & Zarazua de Rubens, 2020) for the EV4EU project providing groups of stakeholders. As it is possible to observe, in the EV4EU project all stakeholder groups are represented except secondary market stakeholders.

EV4EU stakeholders are presented in more detail with connections representing their relationship in Figure 3. These relationships vary from providing tangible products such as charging stations (CS) that support V2X as well as support services in the form of cloud platforms.

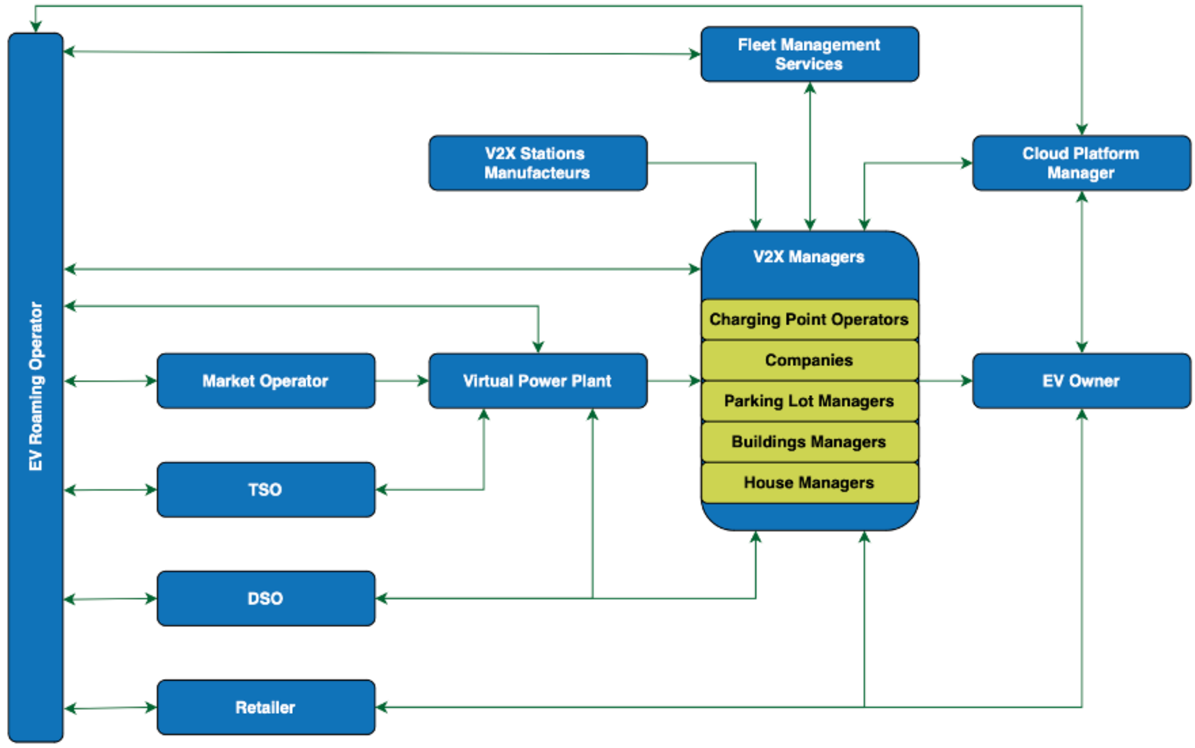

Figure 3: Stakeholders of the EV4EU project and their connections.

In the project preparation phase, twelve Use Cases (UC) have been defined for the four demonstrators and are presented in Table 1. UCs describe specific situations, and the way stakeholders interact with other stakeholders describing scenarios to be tested and evaluated.

During the project execution, some UCs were further adapted and modified to better fit the current situation, e.g., regulations, technology, etc. While the initial UCs are listed in Table 1, the current BUCs, in the testing phase, are listed in Chapter 3.

Table 1: Proposed initial Use Cases for the four demonstrators.
(PT: Portugal, DK: Denmark, SI: Slovenia and GR: Greece)

UC	Description	Demonstrator
1	Cost-Effective V2X station.	PT
2	Open V2X Management Platform.	GR
3	New Demand Response and Flexible capacity contracts.	DK, GR
4	V2X management in Houses.	PT
5	V2X management in Buildings.	PT, DK
6	V2X management in Companies.	PT
7	V2X management in parking lots.	DK
8	V2X management by CPO.	GR
9	V2X management by a VPP.	SI
10	Participation of V2X in electricity markets.	SI
11	Participation of V2X in Grid Services.	SI
12	Activation of V2X services by DSOs.	PT, DK, SI, GR

2.1 Methodology

By definition, a BM describes the basic principle of how an organization creates, delivers, and captures value (Osterwalde, Pigneur, Clark, & Smith, 2010). In the EV4EU project, the BM mainly aims to identify the value that the solutions proposed during the project implementation can provide to the stakeholders in the V2X management chain. Additionally, it must be simple, relevant, and understandable without oversimplifying the complexity of how businesses work.

To achieve the set goals, the BMs were developed using the VP design method (Osterwalder, Pigneur, Bernarda, Smith, & Papadakos, 2014), starting with the identification of the value created for EV users and ending with the value created for system operators, energy markets, and communities. The tools used to identify the elements of the BMs were Business Model Canvas (BMC) and Value Proposition Canvas (VPC), presented in Table 2 and Figure 4, respectively.

Table 2: Business Model Canvas with the description of the elements (Osterwalde, Pigneur, Clark, & Smith, 2010).

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationship</th><th>Customer</th></tr>
<tr><td rowspan="3">The network of suppliers and partners that makes the business model work.</td><td>The most important things a company must do to make its business model work.</td><td rowspan="3">Describes the bundle of products and services that create value for a particular customer segment.</td><td>Describes the types of relationships a company builds with specific customer segments.</td><td rowspan="3">The various groups of people or organizations that a company wants to reach and serve.</td></tr>
<tr><th>Key Resources</th><th>Channels</th></tr>
<tr><td>The key assets required to make a business model work.</td><td>How a company communicates with and reaches its customers to deliver a Value Proposition.</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Streams</th></tr>
<tr><td colspan="3">All the costs that are incurred to operate a business model.</td><td colspan="2">The cash a company generates from each customer segment.</td></tr>
</table>

The BMC consists of nine elements (Osterwalde, Pigneur, Clark, & Smith, 2010). It focuses on the aspect of value creation for the company. While the VPC, on the other hand, allows you to zoom into the details of how you create value for your customers (Osterwalder, Pigneur, Bernarda, Smith, & Papadakos, 2014). The VPC is a complement to the BMC.

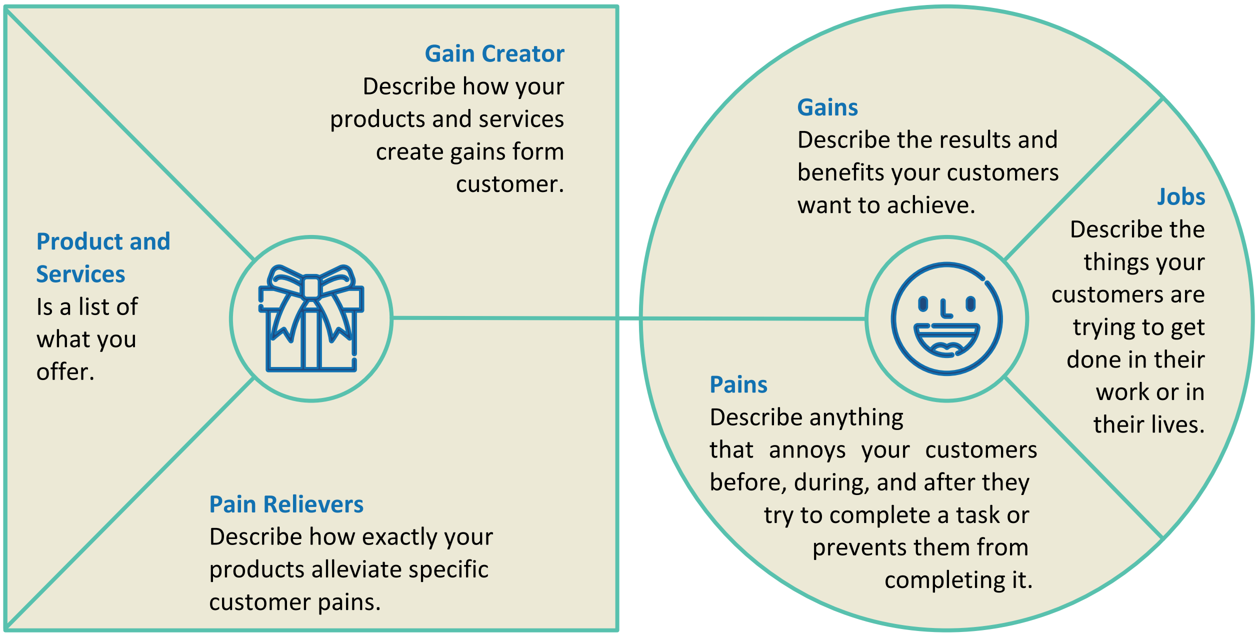

Figure 4: Value Proposition Canvas with the description of the elements (Osterwalder, Pigneur, Bernarda, Smith, & Papadakos, 2014).

In the initial step, BMC and VPC were selected as tools to develop EV4EU BMs. Activities of development of BMCs and VPCs were organized within the four demonstrators. Each group iteratively filled elements for individual UC. Along with developed BMCs and VPCs, related needs and obstacles were collected.

In the process of developing BMs, experiences from previous projects were taken into consideration. The GreenCharge project[2] developed BMs that use locally generated Renewable Energy Sources (RES) to charge private and shared EVs in cities. In their deliverable D3.4 (GreenCharge, 2022) the lessons learned in the GreenCharge project are presented. Other notable EU projects that also informed our work:

- ReDREAM[3], targeting to empower consumers to influence the use of energy significantly and sustainably (EU Project ReDREAM, 2021).
- DELTA[4], proposes a DR management platform that distributes parts of the Aggregator's intelligence into a novel architecture based on Virtual Power Plant (VPP) principles (EU Project DELTA, 2019).
- DECIDE[5], aims to gain a better understanding of how energy communities and energy efficiency services are established and managed (EU Project DECIDE, 2021).
- V2MARKET[6], is an innovative service to incorporate EV batteries into the electricity system as storage and flexibility capacity using V2G and Vehicle-to-Building (V2B) technologies (EU Project V2MARKET, 2022).

[2] https://www.greencharge2020.eu/
[3] https://redream-energy-network.eu/
[4] https://www.delta-h2020.eu/
[5] https://decide4energy.eu/
[6] https://v2market-project.eu/

2.2 Initial business models

In the next sub-sections, the initial BMs from the project proposal are shortly outlined, namely, Green Charging, Sharing Charging, Surge Pricing, Flexible capacity contracts, and Participation of V2X in services and markets. Each initial BM is briefly described, providing key elements of the BMC. These initial BMs are further developed into proposed BMs in Chapter 3.

2.2.1 Green Charging

V2X management offers the potential to improve the use of RES. Green Charging BM aims to achieve this through better coordination between V2X and RES at the distribution level. Distribution system operators (DSOs) identify abundant power generation from distributed RES and provide incentives for EVs to adjust their charging decisions to green energy use. These incentives are administered by DSOs in coordination with CPOs or VPPs. For example, EVs could be charged directly with locally produced curtailed wind energy. Another example of using green charging is to solve reversible load flow problems. One of the consequences of the high number of RES installations is reversible load flow from low voltage (LV) to medium voltage (MV) and MV to high voltage (HV). In such situations, based on the estimated values, the DSO could increase consumption in these areas.

From the description, we can conclude that the main actor is the DSO, whose main partners are CPO and aggregator of RES. The main objective of a DSO is to increase the use of RES and reduce the power outages. In this way, we can identify the environmental component of the VP. The identified elements of Green Charging to develop a BM are listed in Table 3.

2.2.2 Sharing Charging

Sharing Charging BM is suitable for companies, whose goal is to share the V2X infrastructure used for the EV fleet with employees, visitors, and other EV users. With this BM, we can better ensure that CS are always occupied, and that each CS is connected to an EV. To achieve this, benefits must be created for the end users. In turn, the company also has benefits. If the company is also an energy producer, it can charge the EVs with locally generated energy. As a result, it can reduce the energy bill by charging the EVs on its premises, it can participate in grid service markets by discharging the EVs' batteries, or discharge EVs for company energy needs.

From the description, we can conclude that the main actor for the Sharing Charging BM is a company that has CSs on its premises, while customers can be all kinds of EV users, from company's EV fleets to visitors, etc. To offer its services to customers, the company needs CS data from CPO and data from DSO about network demand. Elements of Sharing Charging that can be used to build BM are listed in Table 3.

2.2.3 Surge Pricing

CPOs manage the usage of V2X stations. To achieve a more balanced use of infrastructure and avoid operational problems in the network, different prices for V2X stations can be set. While Sharing Charging focuses on sharing CSs among different types of EV users, Surge Pricing focuses on differentiating between individual users of CSs. This approach attempts to solve grid problems by increasing or decreasing consumption locally through different prices for individual charging points (CP) rather than for the entire pool of CPs.

From the description, we can conclude that CPO can create a more stable network by differentiating each CP and thus each user. CPO participation in the network services creates value for the DSO by reducing costs for grid operation. Other identified elements of Surge Pricing are listed in Table 3.

2.2.4 Flexible capacity contracts

End-users' capacity represents a product in this BM, a commodity that can be purchased by the DSO to alleviate network problems. Such contracts compensate the user for temporarily restricted network access (or "loss" of available capacity), creating value for both DSOs and V2X infrastructure operators. Flexible capacity contracts are designed to reduce the cost of V2X connectivity to the distribution network. These contracts are set by the DSO and negotiated with aggregators or EV users. The goal of these contracts is to match generation and load in the long term and to efficiently use the resources of distributed energy resources (DER) (Villar, Bessa, & Matos, 2018). For example, The French transmission system operator RTE proposes long-term capacity contracts to meet increasing peak electricity demand and to encourage investment in generation and DR (RTE (Réseau de transport d'électricité), 2014). From July 2014, all markets are to be opened for participation by DR, with aggregators representing small consumers. Capacity certificates are to be traded in this capacity market so that suppliers' capacity obligations reflect their customers' contribution to reducing their consumption during peak periods. Consumers who have no consumption have no capacity obligation. Peak days are determined by RTE one day in advance, but peak periods occur at fixed times of the day (Villar, Bessa, & Matos, 2018).

The key partners in this BM are a DSO and an aggregator by signing a contract, while EVs are important resources for utilizing V2G. The additional identified elements of the Flexible Capacity Contract BM that can be used are listed in Table 3.

2.2.5 Participation of V2X in services and markets

Flexible capacity contracts and Participation in markets and services are difficult to reconcile. Flexible capacity contracts allow the aggregator to activate services when needed. Flexibility providers have a firm commitment to provide services and their participation is activated by the contractor. For example, power consumption can be curtailed throughout the year or at certain times of the year, once or many times. In another case flexibility providers participate in the market with their offers. They initiate processes and select the most suitable offer.

We can conclude that V2X flexibility is an added value that distinguishes this BM. And VPP, as the main player, uses flexibility with the intention of solving DSO problems and generating profits that can be shared between VPP and EV users. Other elements identified are listed in Table 3.

Table 3 lists the key elements of the initial BMs presented above, providing actors and channels, brief VP and resources needed.

Table 3: Elements of the initial BMs.

	Actors and Partners	Description value proposition, key activities and key resources	Customers
Green Charging	DSO, CPO, and VPP.	Better coordination between V2X and RES at the distributor level. DSOs should identify abundant distributed generation RES and incentivize EV users to adjust their charging decisions to use this green energy.	End users who charge with green energy.
Sharing Charging	Companies, CPO, and DSO.	The goal is to have companies share V2X infrastructure used for EV fleets with employers, visitors, and in some cases, other EV users.	EV users that can participate in V2X services at the company site.
Surge Price	CPO, and EV users.	This BM is managed by CPOs considering the usage and popularity of V2X stations. To achieve a more balanced use of the infrastructure, which can also avoid operational problems in the network, different prices for V2X stations can be set and communicated to users.	EV users that can participate in V2X services. DSO with less grid problems.
Flexible capacity contracts	DSO, and Aggregator.	This business model is a product that represents end-user capacity as a commodity that can be purchased by the DSO to alleviate network problems. Such contracts compensate users for temporarily restricted network access, creating value for both DSOs and V2X infrastructure operators. Flexible capacity contracts are designed to reduce the cost of V2X connectivity to the distribution network. These contracts are set by the DSO and negotiated with aggregators or EV users.	All grid users because stability and security of the grid is increased.
Participation of V2X	VPP, and EV users.	A VPP can operate V2X flexibilities and negotiate jointly with other RES in electricity markets and services. Benefits should be shared between the VPP and V2X owners.	All grid users because stability and security of the grid is increased.

3 Business models for Pilots

In this chapter, the developed BMs are introduced. The chapter is structured in such a way that first the demonstrators and the newly identified BUCs are described. The new BUCs were developed based on the initial UCs listed in Table 1 and have been updated to better fit the current situation, e.g. due to changes in the demonstrator's design, new regulations or technical advances. The new BUCs are listed in Table 4. These BUCs will be detailed in **D1.5 V2X Use-cases repository**.

Table 4: Business Use Cases for the four demonstrators.
(PT: Portugal, DK: Denmark, SI: Slovenia and GR: Greece)

BUC	Description	Demonstrator
1	Market participation Procurement and Activation.	SI
2	RES Curtailment Management Service Procurement and Activation.	PT
3	DR Services for Grid Congestion Management.	DK
4	DR Services for RES and EV coordination.	PT, GR
5	Dynamic V2X Capacity Contracts Procurement and Activation.	GR
6	DSO Flexibility Services Procurement and Activation.	SI
7	Frequency Control Services Procurement and Activation.	DK

Next, BMC and VPC elements identified at the workshops are presented. A summary of the Business Models is presented in Figure 5.

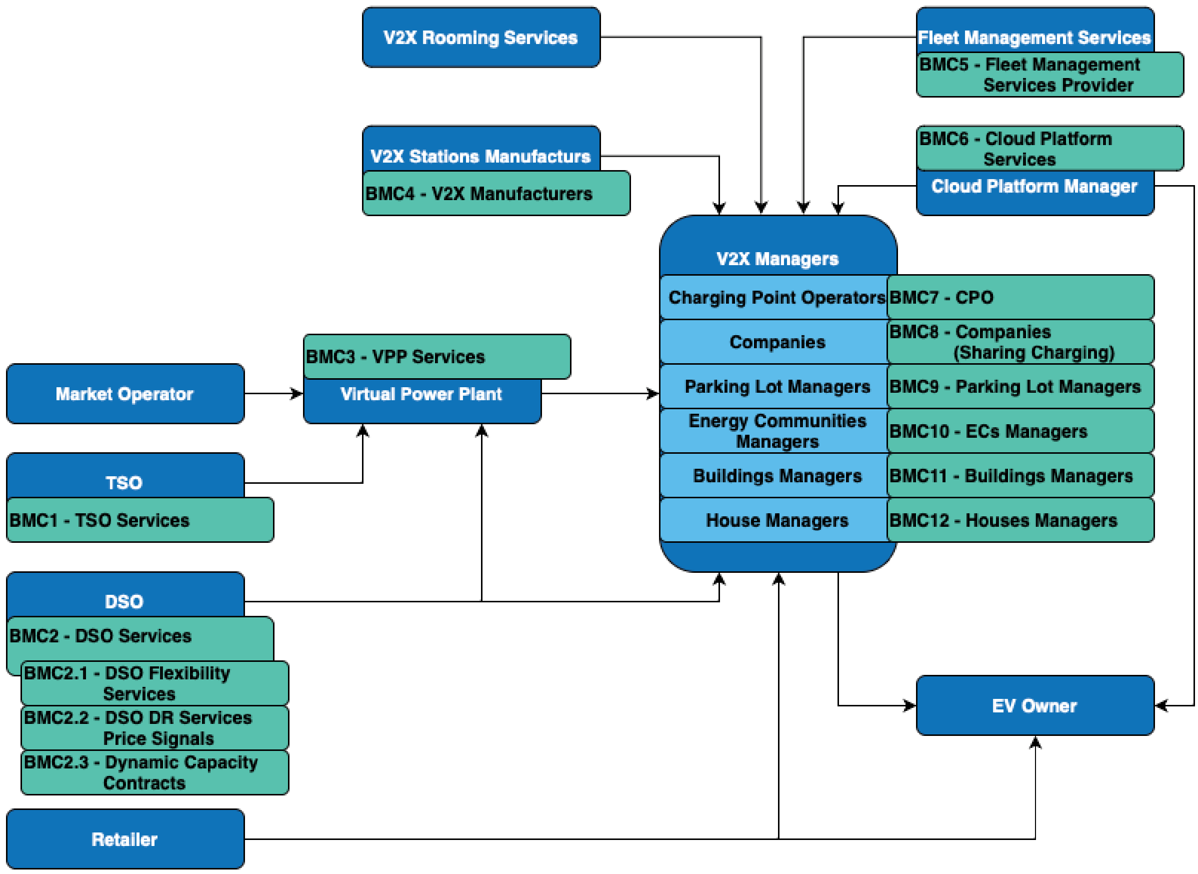

Figure 5: The proposed Business models.

3.1 Business models for WP6 – Portuguese demonstrator

The Portuguese demonstrator in São Miguel, Azores, will test and validate the feasibility of two main groups of V2X BMs. The first addresses RES-related issues: production curtailment (TSO scope) and LV networks' voltage level (DSO scope), corresponding to BMC1 and BMC2.2 of Figure 5, respectively. In Azores, the role of system operator at both scopes is performed by EDA. The other group deepens into facilities' and fleets' managers (Figure 5: BMC5, BMC8, BMC11 and BMC12), to take place at the building of the Regional Laboratory of Civil Engineering (LREC)[7] and counting with 10 EVs from EDA. The conceptual scheme of the demonstrator and the summary of partners and roles are in Figure 6 and Table 5, respectively.

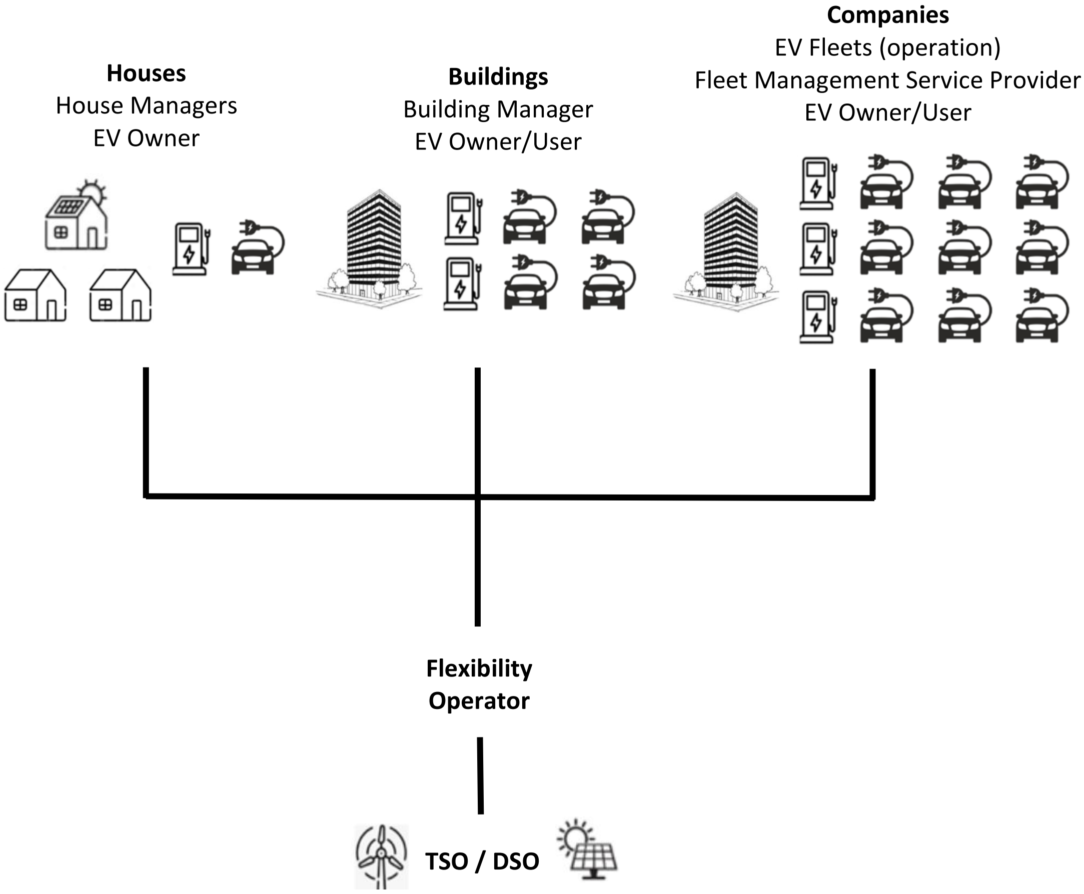

Figure 6: Layout of the Portuguese demonstrator.

[7] Linked to the Regional Energy Directorate (DREn).

Table 5: List of main actors in the Portuguese demonstrator.

Actor	Name	Role
TSO	EDA	Provision of renewable generation forecasts and grid technical information. Grid service procurement and activation.
DSO	EDA	Monitor or estimate the power flows in LV grids. Ensure the adequate operating conditions (*e.g.,* voltage level).
Flexibility Operator (VPP)	*EV4EU new actor*	Interface between system operators and V2X managers to enable V2X-based flexibility.
EVSE Supplier	Smart Energy Lab and others	Development, manufacturing (and at times installation) of V2X stations and corresponding integration modules.
Building Manager	LREC	Building energy management. Provision of energy consumption needs, preferences and planning.
EV Fleet Operator	EDA	Definition of EV fleet operational needs.
Fleet Management Service Provider	*EV4EU new actor*	Outsource and optimize mid to large EV fleets' operation.

3.1.1 TSO services for RES curtailment management

The main goal of the TSO services business model (formerly Green Charging) is the coordination between renewable energies and V2X. In the present case, the Azores has a non-neglectable amount of wind curtailment (mainly during the night), an issue that is also expected in other regions (Perez, Perez, Rábago, & Putnam, 2019) and (Dorsey-Palmateer, 2020). To realize such service, the key players and their dynamics are the following:

- Transmission System Operator (TSO): is the entity that has the responsibility to assure that the global system operates within the required quality of service. In the Azores, the TSO is the responsible for balancing production and consumption and, therefore, defining the unit commitment and wind generation curtailment. In the demonstration, EDA (as TSO) is the entity that triggers the service with a predefined time in advance. From this actor's point of view, the reduction of the wind curtailment reduces the GHG emissions and increases the incomes[8].

- Flexibility Operator (FO): the FO (or VPP) will be responsible for interfacing the TSO and V2X managers, coordinating the service operation. Upon request from the TSO, the FO will assess which EVs will be able to provide the service, engage them, and activate their charging to follow the renewable generation. The main remuneration stream should be a fee (regulated[9])

[8] Note that the remuneration of the energy should be lower compared to the regular value but will be higher than zero (energy curtailed).
[9] These TSO services aren't yet regulated in Portugal.

paid by the TSO in face of the value offered by the coordination of this service, which is addressed in detail in BMC3 (Slovenian demonstrator – WP7).

- Cloud Platform Manager (BPM): this is the entity responsible for managing the platform where the services will be coordinated. In some cases, the VPP may host its own platform, but as the development and maintenance of such asset is not a core-activity, this platform could be provided by a third-party entity in exchange for a regular fee (non-regulated). This service is detailed in BM6 (Greek demonstration – WP8).

- V2X managers: are the final beneficiaries of the TSO services. In most of the cases, they are the owners of the EVs, and the main value for them are the savings in the charging of their vehicles. In the Azores demonstrator, this service will engage Companies (BMC8), Buildings (BMC11) and Houses (BMC12) (BMC are shown on Figure 5). Nevertheless, the service may also introduce benefits for other V2X managers.

In Table 6: TSO services Business Model Canvas is drafted a BMC for this service, and Figure 7 the corresponding VPC. The BMC is built in the perspective of the FO/VPP so that, for compatibility-sake with the original BMC and considering the proposed payment flow, the TSO is put as customer, although in a regulated framework this is not the correct definition for its role or relationship with the FO. In the VPC, the provider is still the FO/VPP (left square), but the customer (right circle) are the beneficiaries of the service, *i.e.* the V2X managers, particularly the EV owners.

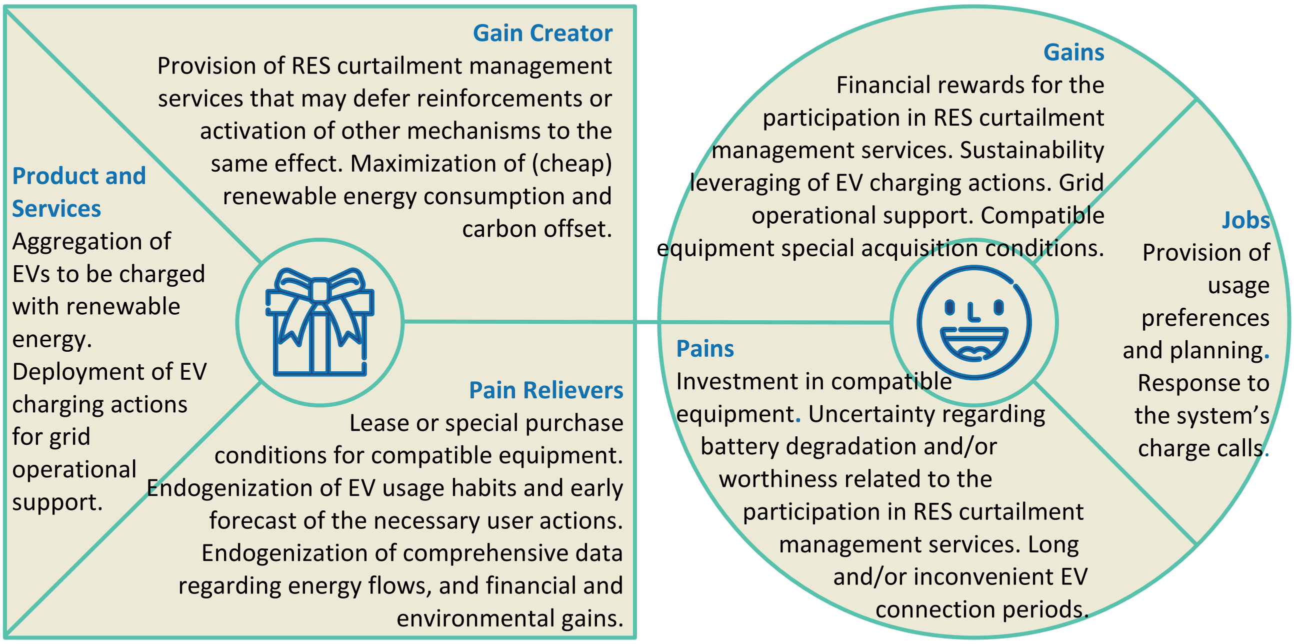

Figure 7: TSO Services Value Proposition Canvas.

Table 6: TSO services Business Model Canvas.

<table>
<tr><th rowspan="1">Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationship</th><th>Customer</th></tr>
<tr><td rowspan="3">- Cloud Platform Manager (BPM),
- V2X managers.</td><td>- Interface with the TSO for the acquisition of renewable energy generation forecasts and flexibility needs,
- Coordinate the service with the V2X managers.</td><td rowspan="3">- Increased consumption of renewable energy (financial and emissions benefits),
- Lower charging costs.</td><td>- Defined by regulation.</td><td rowspan="3">- TSO</td></tr>
<tr><th>Key Resources</th><th>Channels</th></tr>
<tr><td>- TSO and EV availability information,
- EV charging station with remote control and monitoring capability,
- Reliable communication links.</td><td>- Digital platform.</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="3">Revenue Streams</th></tr>
<tr><td colspan="2">- Maintenance and operation of tangible assets and of the digital platform (when applicable),
- Taxes concerning its regulated activity.</td><td colspan="3">- (Regulated) fee due to service coordination.</td></tr>
</table>

3.1.2 Sharing Charging

In this BM, the goal is to offer a solution that maximize the total number of EVs charging simultaneously while strategically conservating the power demand or, in other words, leveraging the local capacity and contracted demand to its maximum in a safe and cost-effective way. This BM virtually eliminates the burdens to a V2X manager of contracting extra power capacity – and pay corresponding demand charges – to supply EV chargers that could be idle several hours per day; or simply having no option to increase its power demand due to congestions on the local grid.

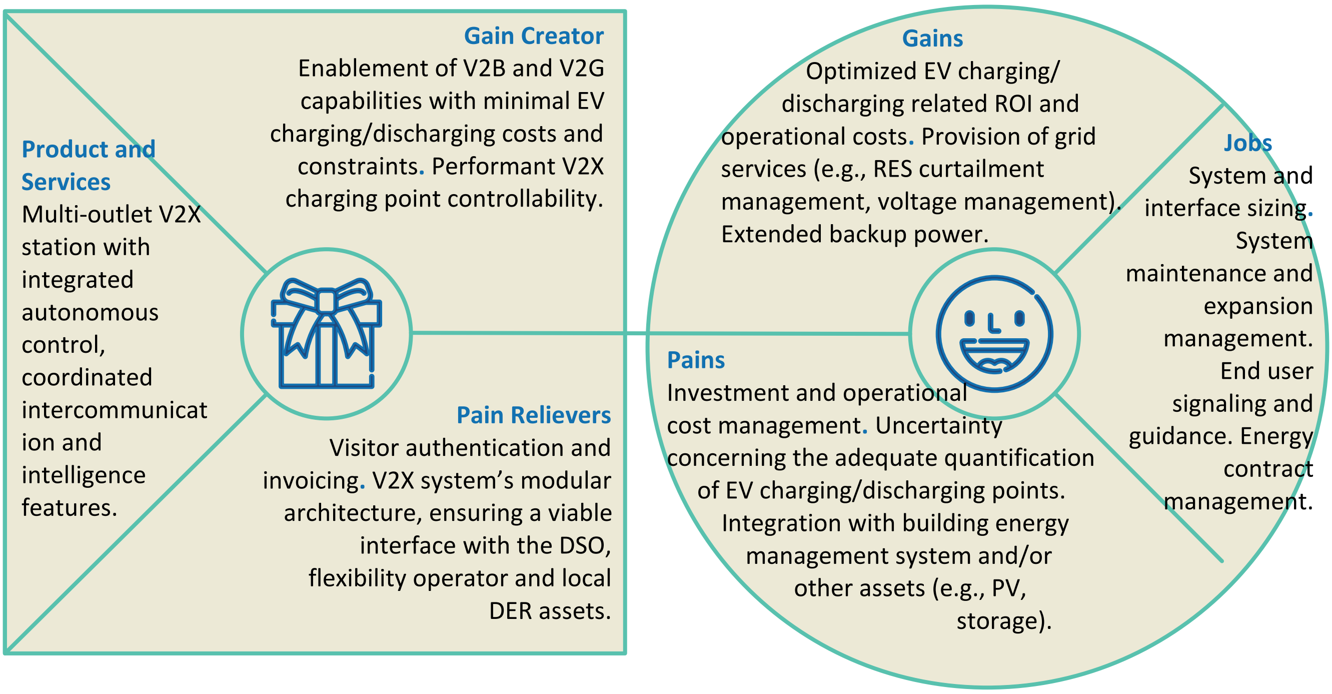

Figure 8: Sharing Charging Value Proposition Canvas.

The deployment of the proposed solution is a business opportunity for the entities that will develop, install, and maintain the V2X stations (V2X stations Manufacturers – BM4 in Figure 5). These services can be assured by a single entity or by multiple stakeholders specialized in each one of the processes (generically, subcontractors). The V2X station will be tested in the Azores demonstrator at a company and the following actors will be involved:

- V2X station manufacturer: provides the charging equipment and the services of operation and maintenance.

- Companies (or similar V2X managers): key players of this BM, the companies should define the rules (priorities) and price scheme for the use of V2X stations. The main advantages for them are the reduction of the investment costs, an optimized use of the charging capacity and the convenience offered to their beneficiaries.

To realize this service, the V2X stations shall feature interface with local energy management systems and/or communication link to the main counters, a user/admin interface to introduce and update rules and AI to manage the charging sessions. For the final user, this solution should work as close as possible to *plug-and-play*. In Figure 8, the VPC of this service is depicted, being the customer (right circle) the companies that acquire it. This service does not disrupt the business model of a standard EVSE manufacturer, it only addresses a novel issue by introducing specific features to the charging systems. For this reason, a custom BMC is not presented.

3.1.3 EV Fleet Management Services

This BM targets companies that rely on mid to large fleets to operate, regardless if the vehicles are deployed as the main asset (such as transport or logistics operators, for example) or instrumentally. When these fleets are turned electric, the operation management changes dramatically: a charging infrastructure must be put in place and follow (electrical installation) standards and procedures which could be unknown by the responsible team; fuel supply contracts are substituted by electricity contracts; charging time is extended compared to refueling, possibly affecting the logistics decisions. In sum, the "traditional" asset management and operations are replaced by novel conditions and idiosyncrasies, increasing the risk of inadequate investment and operational disruptions, delaying or even compromising the electrification decision. The solution proposed is that these companies outsource the EV fleet handling, which includes the sizing of both fleet and charging capacity, vehicles' and EVSE maintenance, power contracts' management and controlling (leveraging eventual incentives and including flexibility services when feasible), and operation scheduling. This third-party entity is the main actor in this BM and, despite targeting companies like the BM8, these can coexist – for example, a public transport operator outsources part of the e-buses' operational management and acquires a sharing charging solution for its offices' installations.

The EV fleet management services BMC (Table 7) and VPC (Figure 9) are in the following. The relationship between provider and customer is primarily contractual for a regular and custom service, that is, the provider has a core set of solutions, but must adapt them to each particular operation. In the Azorean demonstrator this service will be developed based on EDA's maintenance teams dislocations in duty.

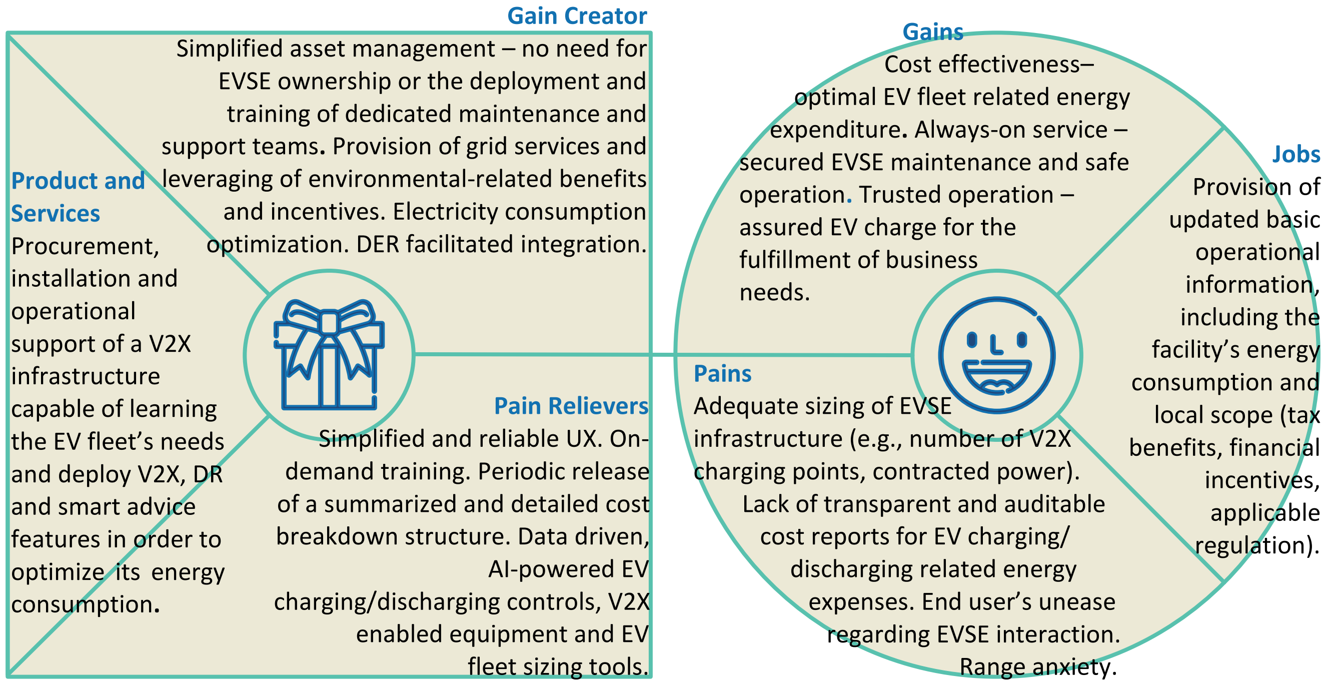

Figure 9: EV Fleet Management Services Value Proposition Canvas.

Table 7: EV Fleet Management Services Business Model Canvas

Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer
- Equipment suppliers.	- Sizing optimal fleets and charging capacity, - Development and customization of EV fleets operational schedule, - Power contracts management, - Vehicles and charging infrastructure maintenance.	- Always-on operation due to an optimized asset management strategy, involving regular technical maintenance and a quick incident response, - Reduce or eliminate risks of inadequate investment (stranded assets), operational flaws and penalties for non-compliance, - Transparent and auditable EV charging/discharging related cost reporting.	- Contract.	- Companies operating mid to large EV fleets.
	Key Resources		**Channels**	
	- Operational management intelligence.		- Standard B2B sales channels, - Operation: web UI, - Customer support: hotline, web.	
Cost Structure		**Revenue Streams**		
- Personnel, - Variable costs due to mismatches between subcontractors' payments and income.		- Regular service fee.		

3.1.4 DSO Flexibility Services – Voltage regulation via price signals

This service BM, alike the BM1, addresses a RES-related issue, but is designed for low voltage (LV), local networks' operation with an increasing penetration of PV and EVs, which can lead to over and undervoltage, respectively. The solution to test here is that the DSO manipulates the EV charging demand in critical networks by applying grid use prices tuned with the operating voltage levels. This BM would rely on a similar Flexibility Operator (VPP) as the BM1, a Cloud Platform Manager (BPM), the V2X Managers and the DSO, which should monitor or estimate the power flows in the LV grids and change the grid use process accordingly – for example, by deploying a dead-band function to define the dynamic price.

Following, the Voltage regulation BMC (Table 8) and VPC (Figure 10) are presented. Again, such service should be regulated prior to entering into force, and upon that the DSO wouldn't be a customer in a strict sense, but for compatibility with the standard canvases, this is the role assigned.

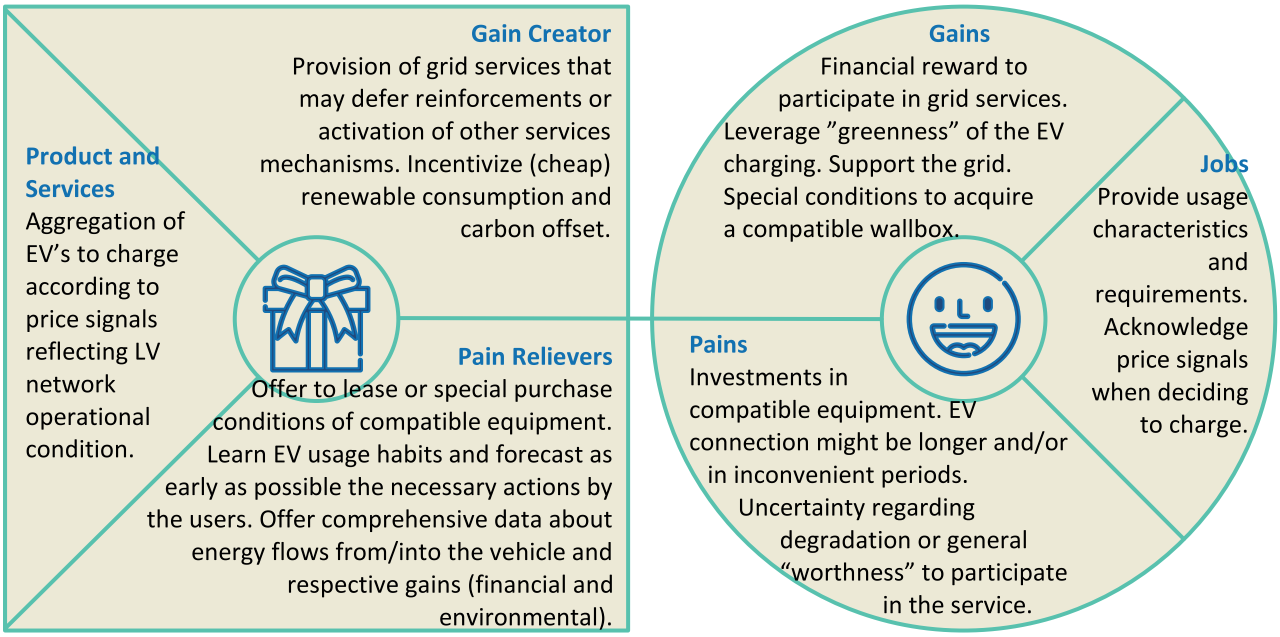

Figure 10: DSO Flexibility Services – Voltage Regulation Value Proposition Canvas.

Table 8: DSO Flexibility Services – Voltage Regulation Business Model Canvas

Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer
- Cloud Platform Manager, - V2X Managers.	- Interface with the DSO for price signalling, - Coordinate the service with the V2X managers.	- Maintaining the grid stability.	- Defined by regulation.	- DSO.
	Key Resources		**Channels**	
	- TSO and EV availability information, - EV charging station with remote control and monitoring capability, - Reliable communication links.		- Digital platform.	

Cost Structure	Revenue Streams
- Maintenance and operation of tangible assets and of the digital platform (when applicable), - Taxes concerning its regulated activity.	- (Regulated) fee due to service coordination.

3.2 Business models for WP7 – Slovenian demonstrator

In Slovenia, the practical demonstration will take place at two locations where the impact of V2X on the power grid will be analyzed. The first location is the office building of GEN-I in Krško, where some of the equipment needed for the practical demonstration is already integrated. The office building in Krško has PV systems on the roof of the building with a capacity of 100 kW. This facility is already part of the VPP portfolio operated by GEN-I. For purpose of the project, it will be equipped with additional 5 CSs provided by the manufacturer ABB. These CSs support V2X technology and have 2 sockets that can provide up to 22 kW and are autonomously controlled to provide behind the meter services.

The second location is targeted at existing GEN-I customers in the area served by DSO Elektro Celje. These households are not located in the same substation. They will be equipped with V2X CSs. The main objective is to analyze the impact of domestic V2X management on the grid and the required capacity as well as on the VPP portfolio.

The stakeholders of the Slovenian demonstrator are listed in Table 9. For better illustration, the actors and their connections are presented in Figure 11.

Table 9: Actors in Slovenian demonstrator.

Actor	Name	Role
Aggregator	GEN-I	Is participating in the demonstration project with its VPP, which includes an office building in Krško.
DSO	Elektro Celje	The participating households are located within its distribution area and is actively involved in the demonstration.
CPO	GEN-I	Operates charging stations for the demonstration.
V2X station manufacturer	ABB	Will develop charging stations that provide the required V2X services.
Market operator	ELES / Elektro Celje	In Slovenia, the market is supervised at the national level by the Slovenian TSO, ELES. At the local level, markets are overseen by DSOs, which in the case of the demonstrator is Elektro Celje.
EV users	To be specified	They participate in the services through V2X technology with their EV as a mobile battery.

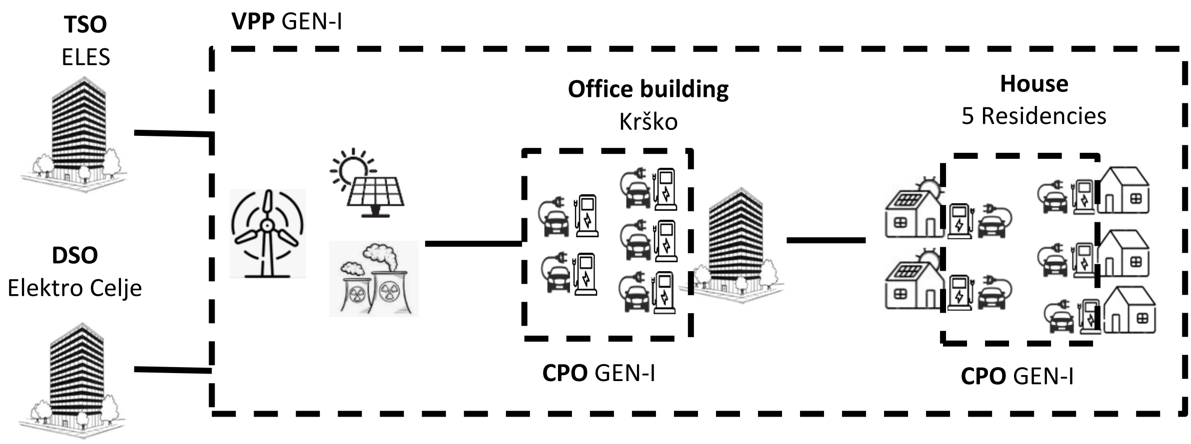

Figure 11: Layout of the Slovenian demonstrator.

In the practical demonstration, the management of V2X by a VPP, i.e., the aggregator GEN-I, is tested. The goal is to test the algorithms developed in the project that best suits for managing V2X aggregation with other flexibility sources. These algorithms consider aggregation considering participation in multiple services and markets.

Two main services will be tested, namely:

- Market participation Procurement and Activation (BUC 1): This service is managed by the VPP and intends the negotiation of EVs energy needs and flexibilities in electricity markets. The participation in ancillary service markets is also included in this service. This service is presented in Figure 5 as the BMC3.

- DSO Flexibility Services Procurement and Activation: This service is activated by the DSO with the goal of solving grid problems (congestion and voltage constraints). The participation of the EVs in this service should be coordinated by the VPP. This service is presented in Figure 5 as BMC2.1.

The management of V2X by the VPPs will be offered in markets at the national and local level. The national flexibility market in Slovenia is overseen by the TSO, ELES. At the local level, the market is supervised by DSOs, Elektro Celje in the case of the Slovenian demonstrator. The flexibility market is not yet fully established in Slovenia, but the current legislation regulates very strictly and precisely a similar solution, namely the request for flexibility from multiple actors. In cases where only one provider of flexibility is available, we will rely on a contractual agreement for the demonstration (Electricity Supply Act (original title Zakon o oskrbi z električno energijo, ZOEE, UL RS št. 172/21)).

With V2X, aggregated with other resources, and participation in electricity markets, we aim to solve problems on the grid caused by an instantaneous high increase in production or an instantaneous high load. Here, the Frequency Containment Reserve (FCR) and Fast Frequency Response (FFC) compensate for fluctuations in the power system within seconds to keep the grid stable and secure. The goal of this portion of the demonstration is to understand the benefits of V2X participation for users in these markets and the impact that mass V2X participation can have in these markets.

At the local level, we will demonstrate and evaluate the contribution of V2X to solving problems in distribution systems, such as managing grid congestion and voltage regulation. The goal of testing V2X in grid services is to evaluate the benefits to users and DSOs. In addition, a comparison between V2G and V1G will be made, and the main conclusions will be reported.

On one side, VPP will aggregate V2X with other resources, manage them, and procure or contract them in the market to solve grid problems. On the other hand, DSOs should be able to activate the services provided by VPP. The activation will be done in the DSO's Advanced Distribution Management System (ADMS) in real time. The first phase will integrate and verify communications between VPPs and ADMS, which is critical for service activation. In this phase, the V2X assets in ADMS must be modeled appropriately so that the advanced functions can use V2X data. In the second phase, the activation is triggered by the VPP operator. The decision is on the aggregator side. This is used to evaluate the activation of VPPs for the ADMS system, which can model EVs in different ways. In a third phase, activation is triggered by the ADMS operator, decision is on the DSO side, taking into account market outcomes and distribution system operating conditions. This UC is a general case that includes the UCs described in the previous paragraphs.

From the description of the demonstrator and the tests planned, it is possible to conclude that the main actors of the Slovenian demonstrator are GEN-I, the aggregator managing the VPP, and Elektro Celje, the DSO on whose territory the test facilities are located. From their point of view, new BMs have been developed.

Considering that the VPP presents a key role in both services that will be tested in Slovenia, a single BMC is presented in Table 10 and Figure 12. However, some detailed information considering the perspectives of VPP (BMC3), DSO (BMC2.1) and V2X station manufacturer (BMC4) are presented in sub-sections 3.2.1, 3.2.2 and 3.2.3, respectively.

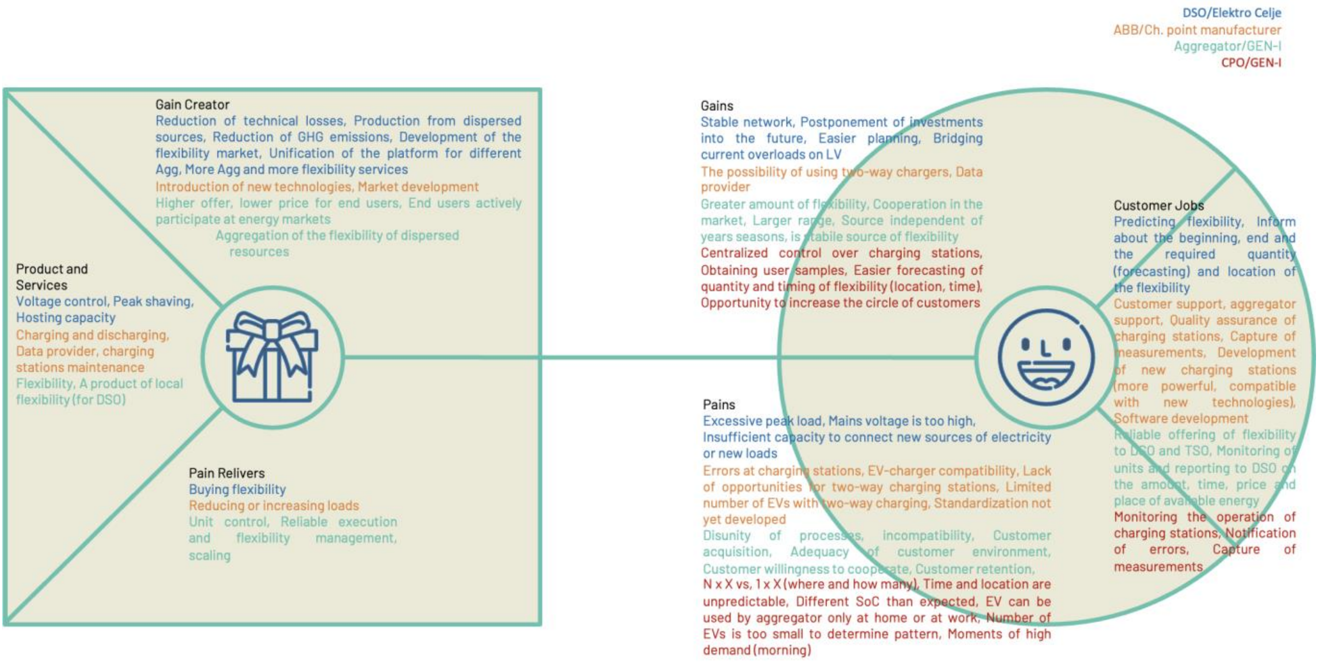

Figure 12: Value Proposition Canvas with elements identified for use case 12 from individual actor's perspective: DSOs' (blue), V2X charging station manufacturers' (orange), aggregators' (green) and CPOs' (red).

Table 10: Business Model Canvas - Slovenian Demonstrator

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationship</th><th>Customer</th></tr>
<tr><td rowspan="3">- TSO,
- DSO,
- Platform Manager,
- V2X Managers (CPO, Houses)</td><td>- Participation on Ancillary services (Frequency management, FCR, FFR).
- Participation in Electricity markets
- Grid services (voltage control, congestion management, peak shaving)
- DERs management including distributed generation, energy storage systems and active consumers.
- Contribute to increase the hosting capacity of the grids.</td><td rowspan="3">- Flexibility of V2X,
- Provide optimal offers to energy markets,
- Optimal management of energy resources of costumers (adjusting consumption of households and with charging and discharging of EVs),
- Provide grid services (grid stability, voltage and congestion management),
- Ensure stable energy supply.</td><td>- Regularly informing end user about cheaper and cleaner energy,
- Exchange data with DSO about capacity, needs,
- Provide fast response to meet market demands.</td><td rowspan="3">- Market participants,
- DSO,
- V2X managers.</td></tr>
<tr><th>Key Resources</th><th>Channels</th></tr>
<tr><td>- V2X stations
- V2X management platforms
- ADMS (DSO)
- Information exchange platform</td><td>- APPs
- Digital V2X management platforms,
- Smart meter.</td></tr>
</table>

<table>
<tr><th>Cost Structure</th><th>Revenue Streams</th></tr>
<tr><td>- Charging stations with V2X possibility,
- App that provides real-time data about EVs,
- Maintenance of V2X stations, digital platforms,
- Investment into building of V2X network.</td><td>- Flexibility to sell at higher profits and store energy when prices are low,
- A better (stable and secure) grid offers opportunity for bigger aggregation of EVs.</td></tr>
</table>

The greatest input for the creation of new BMs came from the workshops whose methods were described in Chapter 2. The value that stood out most in these workshops was a stable and secure power grid. This is the motivation of DSOs to minimize the impact of negative events on the grid. The motivation of the aggregators, on the other hand, is to stay ahead of the curve and offer something new to the market by integrating V2X, i.e., EV batteries, into their VPP, and with it they help DSOs achieve a stable and secure power grid.

Table 11: Elements from business model canvas and value proposition canvas for Slovenian demonstrator for each use case.

	UC1	UC6
Actor	The main actor in the Slovenian demonstrator is the VPP.	
Product and services	- Management of V2X, generation and storage of energy, - Participation in Ancillary Services (FCR, FFR, and frequency adjustment management).	- Voltage control, and congestion management, - Peak shaving, flexibility, also production of local flexibility for DSO.
Key Partners	TSO, DSO, CPO, Market, and V2X Managers.	
Customer	TSO, DSO, V2X Managers.	
Customers jobs	- DSO has to forecast flexibility needs, inform about its start, end, required amount and location of flexibility, - V2X managers must agree to the services and the EVs should be connected to the V2X stations even if they are not charging.	
Pains	- Environmental impacts, - High off-peak energy costs, - Excessive peak load creating congestion and voltage problems in the distribution grids, - Insufficient capacity to connect new power sources or new loads.	
Pains Relievers	- Coordination with RES, - Use of energy at off-peak times from storage resulting in lower off-peak prices, - Flexibility acquisition, control, reliable execution, flexibility management and scaling.	
Gains	- Lower energy bills for the costumers, - Reducing GHG emissions, - Increase power systems stability, - Deferring investments into the future, bridging current congestion at LV grids.	
Gains Creator	- Increase the use of RES and their coordination with EVs needs. This intends to reduce the energy bills and, at the same time, the GHG emissions, - Coordination between VPP and DSO will provide the necessary tools to increase the grid stability and reduce the constraints in the networks related with lines congestion and bus voltages, - Better grids planning to consider new flexibility services and contracts.	
Cost structure	- Developing better charging stations with V2X capability and digital platforms. Investing in building a network of charging stations with V2X capability, - Marketing, control, and maintenance of V2X stations and digital platforms.	
Revenue Streams	- A better, stable, and secure electricity grid provides the opportunity for greater aggregation of EVs, - Participation of V2X in the electricity and ancillary services markets (Selling Flexibility).	
Customer Relationships	- Regular data exchange between aggregator and DSO on capacity and demand is required. - Signing of contracts between EV users and aggregator, between aggregator and DSO, and between aggregator and CPO or charging station owners or manufacturers.	
Channels	Digital platforms, V2X Charging Station, and smart meter.	

The next chapters present the BM for aggregators, for DSOs and for V2X CSs manufacturers. These chapters start with the general description, with insights from other authors, and then refer to the Slovenian demonstrator.

3.2.1 Virtual Power Plant Business Model

The Virtual Power Plant (VPP), or aggregators in general, is a stakeholder with the main aim of managing DERs and their flexibility. In the EV4EU, the main aim is to include V2X operation in their portfolio of resources. Aggregators can operate locally in coordination with the DSO, and at national level to provide reserves or flexibility on electricity markets or in coordination with the TSOs. Different key actors are needed, and different customers are targeted, depending on the type of services and markets where the aggregator develops their activities. The regulatory framework can also impose constraints on the activities of these entities.

In the case of electric mobility, the aggregator should collaborate with several entities but mainly with CPOs and other V2X managers (EV users). The BM handled in this section is centred on VPP activities and, therefore, does not involve interaction with other stakeholders. This task is related to managing the VPP portfolio. The goal is to minimize the cost of the global imbalance by reducing individual imbalances. To this end, the power demand and production of the aggregated resources are adjusted using updated forecast data closer to real time (van der Veen, 2012). The aggregated resources are rewarded for allowing the aggregator to manage their power demand of its assets (Okur, Heijnen, & Lukszo, 2021).

When VPP actions are focused on the local level, the main aim is to solve grid congestion or, in some few cases, voltage problems. The term congestion in the distribution grid refers to a situation where the energy exceeds the transmission capacity of the grid. Congestion management refers to the prevention, relieving or elimination of congestion in the distribution grid. Typically, congestion is managed by DSOs and TSOs by reinforcing the grid, i.e., increasing the capacity of cables, transformers, etc. (Biegel, et al., 2014), or by re-dispatching, i.e., changing power plant dispatch to eliminate congestion (Linnemann, Echternacht, Breuer, & Moser, 2011).

Additionally, flexibility can be used as an alternative. The aggregator aims to help the distribution grid avoid congestion by applying three scenarios (Okur, Heijnen, & Lukszo, 2021):

- Consumers operating on the principle of peak shaving. The aggregator offers consumers time-varying financial rewards if they reduce their electricity consumption during peak hours.
- Aggregators operate on the peak-shaving principle. The aggregator is given permission to control consumers' electricity consumption and operate them on the peak-shaving principle.
- Aggregators operating with DSO in frames of the market mechanisms.

In participation in the flexibility market and in the reserve market at the national level, aggregator can offer reserves on the market in exchange for payment to eliminate the imbalance in the system. The operating decisions of the plants become bids in the balancing markets. The aggregator offers consumers a financial reward for agreeing to participate with their EVs. In this part of the BM, the consumer's assets are operated by the aggregator because the activation of reserve power must occur quickly. The goal is to increase the aggregator's profit by participating in the FCR, Fast Frequency Reserve (FFR), and Frequency restoration Reserve (FRR) markets (Okur, Heijnen, & Lukszo, 2021).

In this description it is already implied who are the customers of the aggregator in this new BM. They are the EV users when it works internally, the DSO at local level and the TSO at national level. GEN-I, the aggregator in Slovenian demonstrator, will provide services to Elektro Celje, the DSO participating in Slovenian demonstrator, and will procure them on the markets at the national level, overseen by

ELES, the Slovenian TSO. A more detailed overview of the elements identified in the workshops can be found in the next Table 12 and Figure 13, followed by the description of the newly developed BM.

Table 12: At the workshops identified elements for the Virtual Power Plant Business Model.

	Description
Actor	Aggregator GEN-I.
Product and services	- Management of V2X, generation and storage of energy, - FCR, FFR, and frequency adjustment management, - Grid services including voltage control and congestion management, - Peak shaving and other flexibility services to the DSO.
Key Partners	TSO, DSO, CPO, market participants, and V2X managers.
Customer	TSO, DSO, V2X managers, costumers.
Customers jobs	- DSO/TSO must forecast flexibility, inform about its start, end, required amount and location of flexibility, - EV users must agree to the services and connect EVs even when not charging.
Pains	- Environmental impacts, high off-peak energy costs, excessive peak load, excessive grid voltage. Insufficient capacity to connect new power sources or new loads.
Pain Relievers	- Coordination with RES, - Use of energy at peak times from storage systems and EVs resulting in lower peak prices, - Flexibility acquisition, control and management and scaling.
Gains	- Lower energy bills for the customers, - Reducing GHG emissions, - Increase power systems stability, - Deferring investments into the future, bridging current congestion at LV grids.
Gains Creator	- Increase the use of RES and their coordination with EVs needs. This intends to reduce the energy bills and, at the same time, the GHG emissions, - Coordination between VPP and DSO will provide the necessary tools to increase the grid stability and reduce the constraints in the networks related with lines congestion and bus voltages, - Better grids planning to consider new flexibility services and contracts.
Cost structure	- Investing in building a network of charging stations with V2X capability.
Revenue Streams	- A better, stable, and secure electricity grid provides the opportunity for greater aggregation of EVs, - Participation of V2X in the electricity and ancillary services markets.
Customer Relationships	Signing of contracts between EV users and aggregator, between aggregator and DSO, and between aggregator and CPO or charging station owners or manufacturers.
Channels	Digital platforms, V2X Charging Station, and Smart meter.

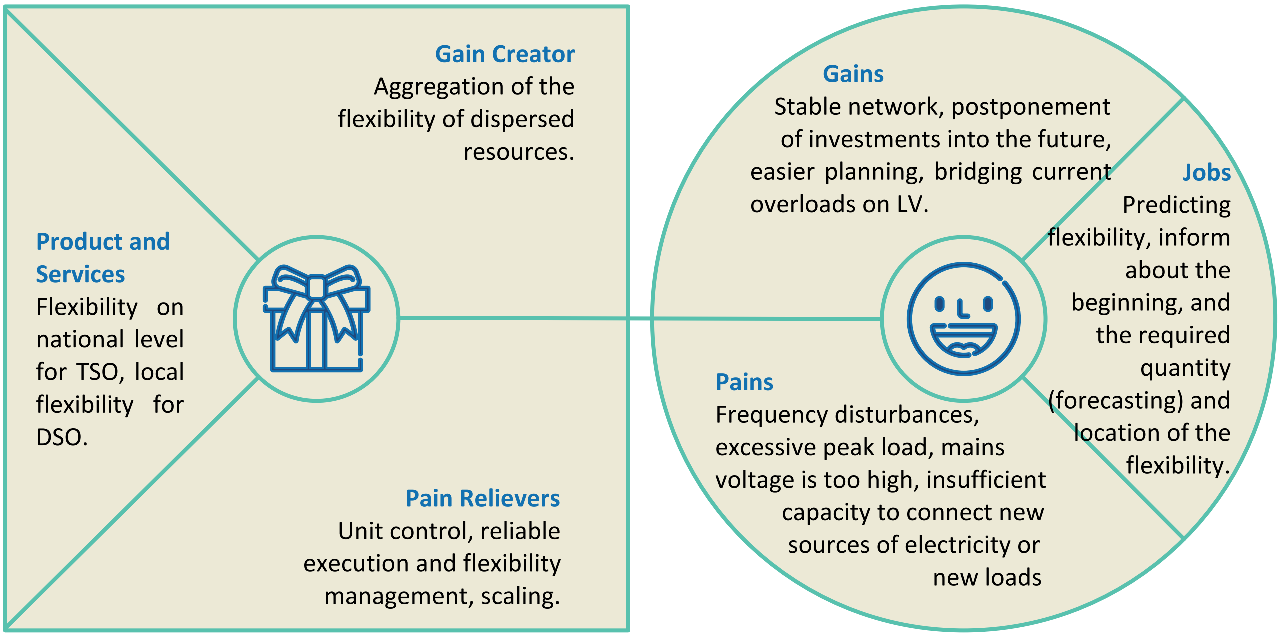

Figure 13: Value Proposition Canvas for Virtual Power Plant Business Model, with Aggregator as an actor and DSO/TSO as it's a customer.

GEN-I will procure V2X flexibility on a market, and in certain cases they will be provided to Elektro Celje based on a contract. GEN-I will also receive flexibility from EV users based on the contractual relationship.

The Flexibility Contracts proposed in the BM give the aggregator the ability to enable V2X services but leave it up to EV users to decide whether they want to participate in V2X services. For example, GEN-I can activate services when needed by Elektro Celje based on the EV user's predetermined profile, but the EV user still has the option to decline them within a certain time window. To enable this, a digital platform should be established as a communication channel.

What amenities should EV users have to participate in the services, what is the optimal time window, should the number of rejections be limited, and so on - these are all questions that can be tested in the demonstrator.

In today's fast-paced world, real-time data is critical to successful operations. So, too, in this case. GEN-I will have to make its decisions based on data provided by ELES, Elektro Celje, the markets, and by CPO. In this model, V2X stations are also part of the cost structure. Additional costs come from investments in building a V2X network, marketing it, and maintaining V2X stations. Further costs arise from the development and maintenance of the digital platform.

GEN-I gains a new value through the integration of V2X, namely mobile batteries. This optimization of the network infrastructure at another level allows GEN-I to offer Elektro Celje better services, different from those of other market players. To make more advantages, Elektro Celje has to share data with GEN-I. The DSO should inform the aggregator about the start, the end, the location and amount of flexibility needed or predicted. In return, GEN-I will contribute to mitigate some of Elektro Celje problems with flexibility metering, unit control, reliable execution, flexibility management, and scaling. Specifically, problems such as excessive peak load, excessive grid voltage, and insufficient capacity to connect new power sources or new loads. GEN-I will do this by managing V2X, offering ancillary services, participating in FCR and FFR markets, and grid services such as voltage control and congestion management. Not only locally, but also nationally, GEN-I will bid on the ELES overseen balancing market for FFR and FCR.

Selling V2X related flexibilities and services on the market or according to the contract is the main source of revenue for aggregators in this BM. But not only financial gains are sought, but all end users, all customers, benefit as the grid is more stable and secure. Since EVs are mobile and can be connected in places where other forms of electricity generation or energy storage systems are unattractive. This gives the aggregator an advantage over other market players and, consequently, higher revenues. Of course, part of the profit should be shared with participating V2X managers. This should increase the willingness of EV users to participate in V2X services, to agree to the services, and to connect EVs even when they are not charging.

3.2.2 Flexibility Services operated by Distribution System Operators Business Model

Flexibility services BM is developed from DSO perspective and will be tested in the Slovenian demonstrator. DSO is responsible for operating, maintaining, and developing the distribution network in its area of responsibility. The main aim of the DSO is to assure the required quality of service of the distribution system, the supply of energy to the consumers and more recently the availability of the network for the producers.

The technological shift implied by the energy transition and consequent electrification of the end-use, requires an increase in electricity generation and better management of the existing networks. While increased electricity generation is manageable for the grid on a large scale, localised issues will arise. EVs present unique challenges to the electricity grid due to their flexibility in the charging process. As stated by (Fleetcarma, 2017), considering a study conducted in US and Canada, the clustered charging of multiple EVs in one area poses a risk to local infrastructure. In Europe, where the average power grid is more efficient and stable than in the US, the need for replacement would probably be lower, but will still exist (EU Project eVolution2Grid, 2019).

On the other hand, according to Sovacool et. at. in (Sovacool, Kester, Noel, & Zarazua de Rubens, 2020), TSOs and DSOs must handle a large volume of system and grid services and are therefore well positioned to benefit from V2X integration. Some of these services are peak shaving, valley filling, load shifting, energy conservation and load growth. Current resources to handle these services include flywheels, pumped hydro, flow batteries and compressed air storage, all of which are used for very short or temporary storage.

V2X can compete with or complement these resources that DSOs use to mitigate grid constraints. The benefits of V2X for distribution systems have been confirmed and modelled in several studies, all of which show that V2X can improve the optimisation of electric utilities' transmission and distribution assets (Sovacool, Kester, Noel, & Zarazua de Rubens, 2020).

As utilities, DSOs do not make a profit in the traditional sense. For the DSOs, the benefits come from reducing operating costs, improving the operation of the distribution network in its area, deferring investments, managing congestion, and avoiding network constraints in densely and sparsely populated areas, minimising network expansion, etc. Against this background, a new BM needs to be created for DSOs that obtain flexibility services from V2X aggregation. In this way, the elements listed in the next Table 13 and Figure 14 in were identified in the workshops.

Table 13: At the workshops identified elements of the Flexibility Services operated by Distribution System Operators Business Model.

	Description
Actor	DSO.
Product and services	Congestion management, Voltage control, peak shaving, hosting capacity.
Key Partners	VPPs and Aggregators.
Customer	Electricity end users.
Customers jobs	Operate the distribution system.
Pains	Grid congestion, bus voltages, lack of hosting capacity.
Pain Relievers	Buying/contracting flexibility to solve grid problems.
Gains	Secure and stable network.
Gains Creator	- Reduction of technical losses, - Production from distributed energy resources, - Reduction of GHG emissions, - Development of the flexibility market, - Unification of the platform for different aggregators, - More flexibility services.
Cost structure	Payments for the flexibility provided.
Revenue Streams	- Reducing operating costs, - Deferring investments.
Customer Relationships	Signing of contracts between aggregator and DSO.
Channels	Digital platforms.

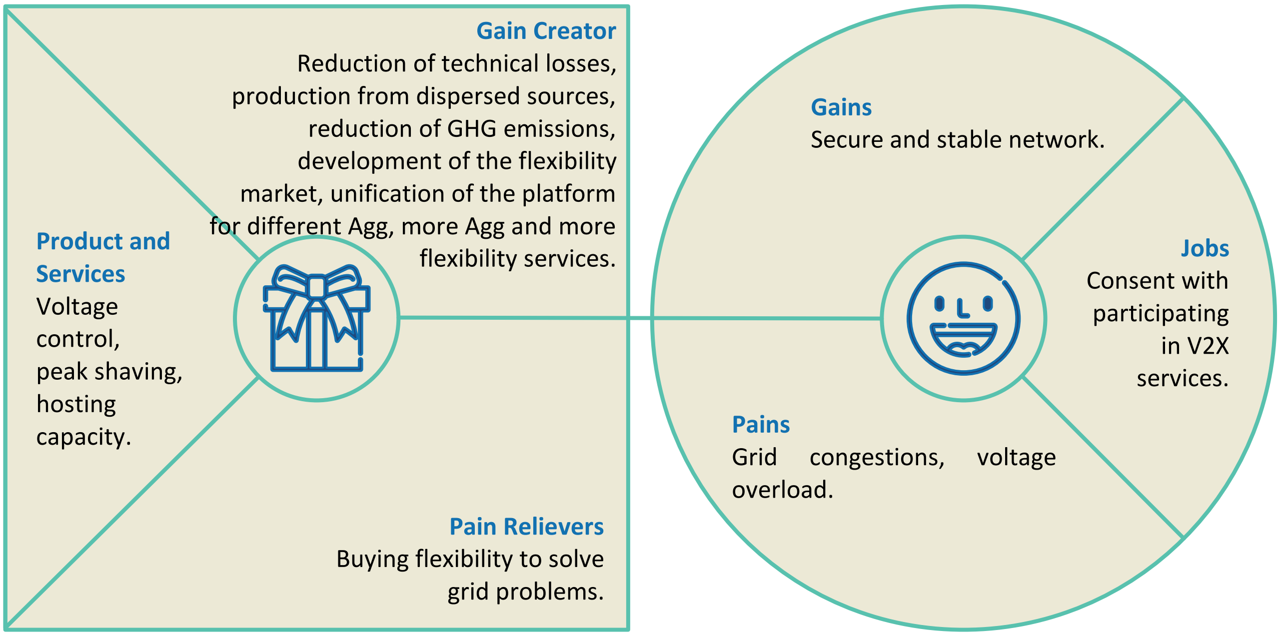

Figure 14: Value Proposition Canvas for Flexibility Services operated by Distribution System Operators Business Model, with DSO as an actor and end users as its customer.

3.2.3 Vehicle-to-Everything Stations Business Model

This BM is product-oriented BM, in contrast to BM for the aggregator and BM for the DSO, which are service-oriented BMs (Figure 1, reference to product- and service-oriented BMs). From this point of view, it could be seen as a classic BM. The V2X station manufacturer responds to market pains due to lack of charging stations and demand for V2X technologies. The manufacturer gives the aggregators and V2X managers an advantage to stay ahead of the competition. Their relationship is regulated through the trade channels.

The sale of V2X stations and the associated services are revenues generated by the CS manufacturer. To differentiate itself from the competition, it must provide reliable V2X stations that comply with standards, are compatible with a wide range of V2X managers' needs and support new technologies such as 5G/6G. Manufacturing, maintenance, and development of new V2X stations are the key activities of manufacturers and the most important elements of the cost structure.

In Slovenian demonstrator, ABB have the role of V2X stations manufacturer. As mentioned before, it will provide V2X stations for the demonstration site at the office building of GEN -I in Krško and for the participating households. A detailed overview of the elements of a new BM for V2X manufacturer, identified in the workshops, can be found in the next Table 14 and Figure 15.

Table 14: At the workshops identified elements for the Vehicle-to-Everything Stations Business Model.

	Description
Actor	V2X stations manufacturer.
Product and services	Manufacturing, maintenance and development of new charging stations.
Key Partners	N/A
Customer	Aggregator, V2X managers (CPO in the case of Slovenian demonstrator).
Customers jobs	Reliable offering of flexibility to DSO and TSO, monitoring of units and reporting to DSO on the amount, time, price, and place of available energy.
Pains	Disunity of processes, incompatibility, customer acquisition, adequacy of customer environment, customer willingness to cooperate, customer retention.
Pain Relievers	New user-friendly technology.
Gains	Greater amount of flexibility, cooperation in the market, larger range, source independent of years seasons, stable source of flexibility.
Gains Creator	Introduction of new technologies, market development.
Cost structure	Manufacturing, maintenance and development of new charging stations.
Revenue Streams	Income from selling charging stations.
Customer Relationships	Contracts.
Channels	B2B channels.

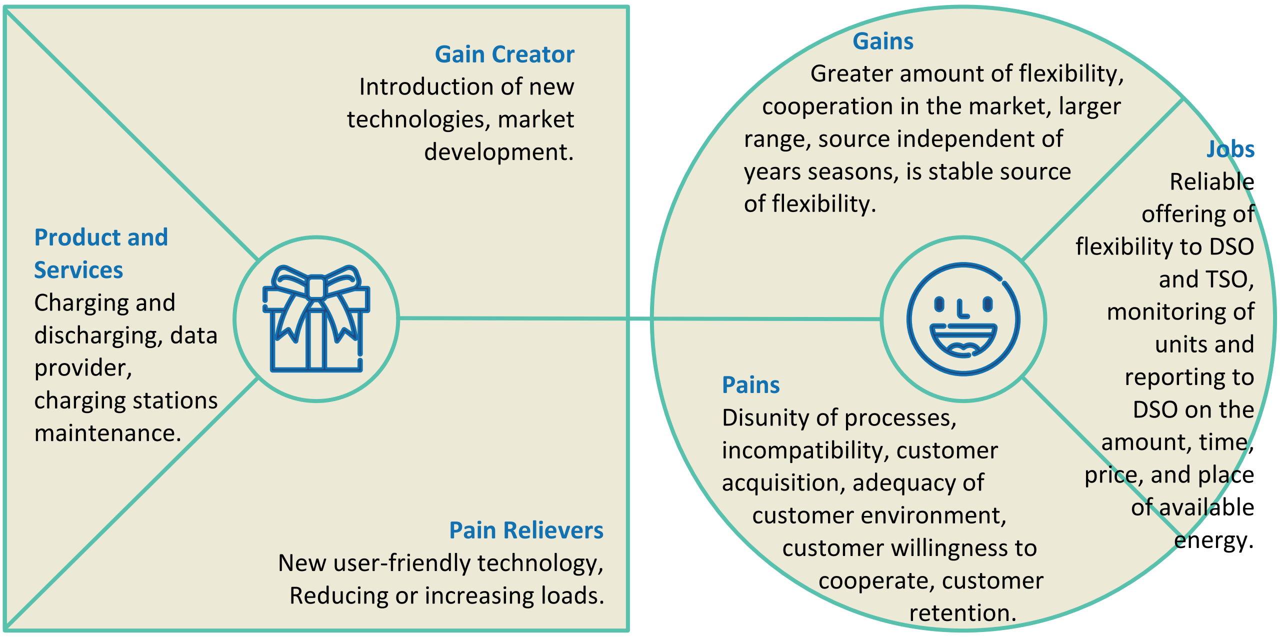

Figure 15: Value Proposition Canvas for Vehicle-to-Everything Stations Business Model, with V2X charging station manufacturer as an actor and Aggregator as its customer.

The Slovenian demonstrator focuses on the integration of V2X in the problem solving of the electricity grid. In this sense, the optimal equipment will be provided by ABB and this BM will not be tested.

3.3 Business models for WP8 – Greek demonstrator

The Greek demonstrator will take place largely in the Mesogia area in the Attica region of central Greece, which is thus on the outskirts of the metropolis of Athens. The Mesogia area includes the municipalities of Koropi, Lavrio, N. Makri and the interconnected islands of Kea, Andros and Tinos. It has been the demonstration site for several European Horizon 2020 projects, including Coordinet[10], Platone[11] and now EV4EU. It is a semi-rural area that has around 225.000 customers on its LV and MV networks, ranging from households to small, medium and large industrial companies. The area benefits from the installation of various forms of RES, such as wind turbines and PV systems. One of the sections, the Markopoulo distribution network, consists of several voltage feeders (20 kV) connected to three HV/MV transformers with a capacity of 50 MVA. In terms of RES penetration, 27,0 MW PV plants are connected to the distribution network. In addition, 20,7 MW PV plants are in the approval phase for connection to the distribution grid. No wind turbines are connected to the distribution grid in the demonstration area.

The high-level structure of the Greek demonstrator and the list of main stakeholders can be seen in the Figure 17 and Table 15, below.

[10] https://coordinet-project.eu/
[11] https://www.platone-h2020.eu/

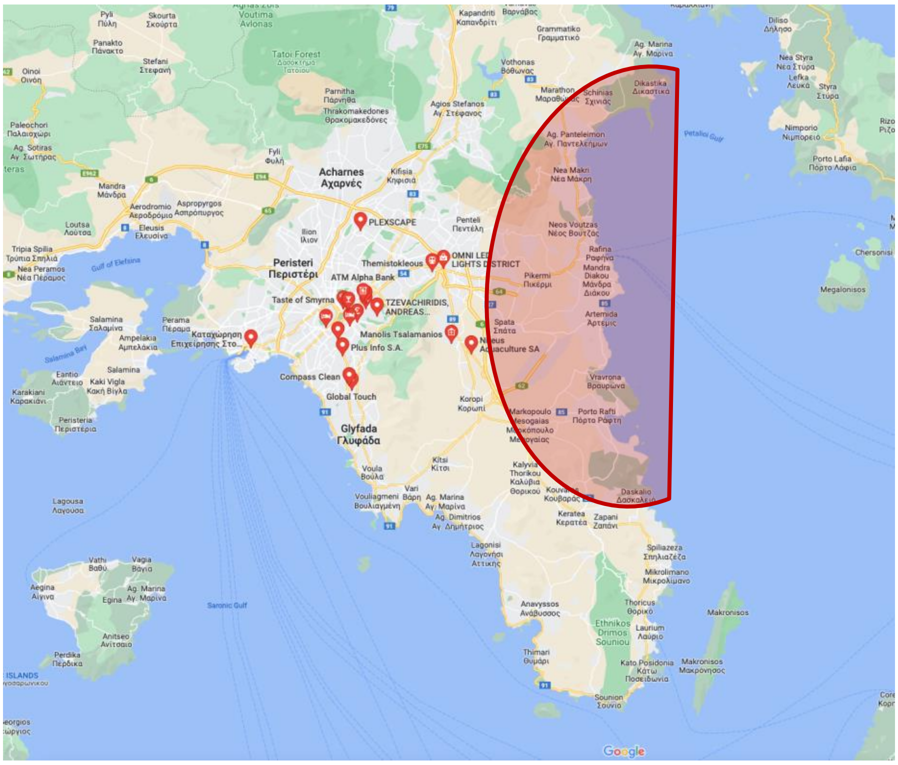

Figure 16: Area of the demonstration in Greece.

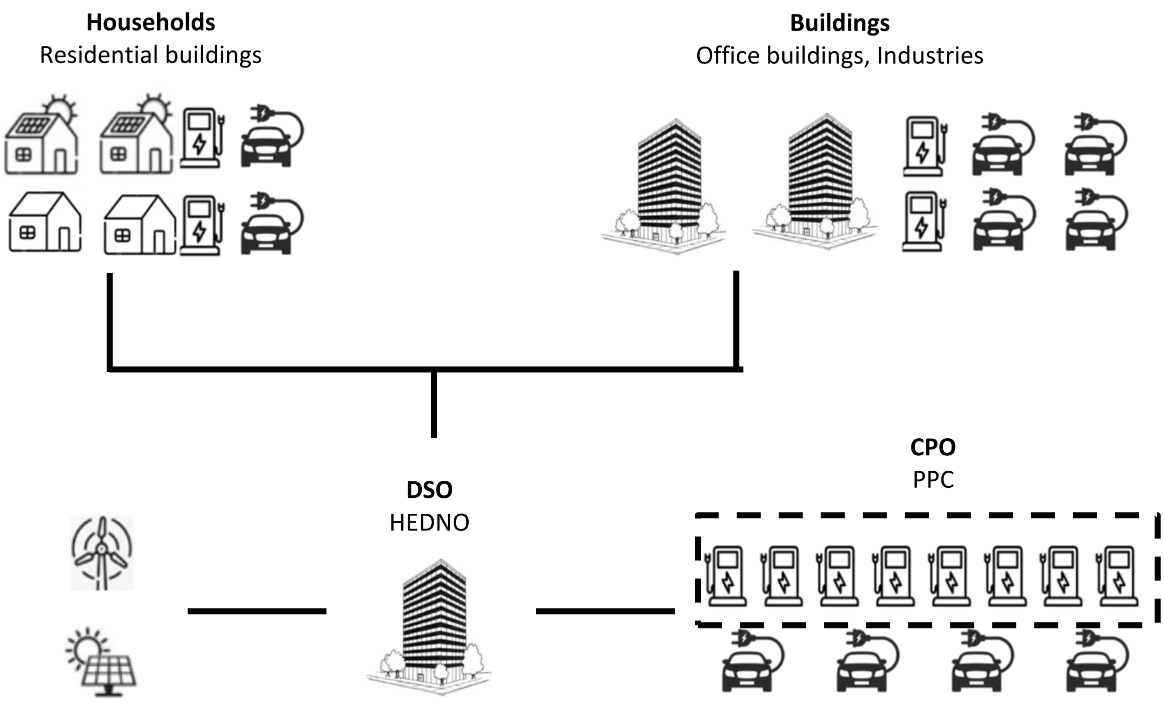

Figure 17: Layout of the Greek demonstrator.

Table 15: Actors in Greek demonstrator.

Actor	Name	Role
DSO	HEDNO	Own the distribution network, services all customers, is responsible for keeping the network within physical limits, investment decisions, procuring and activating flexibility.
CPO (Aggregator)	PPC	Operate the charging stations, interacts with EV users selling them charging capacity and energy, aggregates EV resources.
EV manufacturer	CITROEN	Responsible for providing guidelines and feedback from the perspective of a vehicle manufacturer.
Market Operator	Simulated	Responsible for the smooth operation of flexibility transactions.
EV users		They use charging infrastructure.
Consumer	Simulated	Regular distribution network customers.
Platform manager	PPC	Open V2X platform owner.

The main aspects of the Greek demonstrator are the deployment and testing of the Open V2X management platform for public CSs developed by PPC, the integration and testing of the flexibility algorithms for local and system-wide grid services developed by DTU and INESC-ID, and the study of utilisation and commercialisation strategies for the proposed solutions with the participation of CITROËN.

The demonstrator can be considered as a multi-phase test. It starts with testing the platform as a software tool, intelligent methods, and impact on the network and public CSs, the platform and integration with users and end user devices, and finally the full integration and interoperability of the platform and DSO.

In the first phase, the Open V2X Management Platform, developed in WP5 under the leadership of PPC, will be finalised and tested. These tests include new methods for integrating EVs, which require platform inclusion, interoperability, and communication with end devices such as CS, as well as the user interface. PPC has an R&D campus near Mesogia (Kantza, Athens), the Innovation Hub, where proof-of-concept scenarios of the V2X platform will be conducted. This platform will be operated by a Cloud Platform Manager corresponding to BMC6 in Figure 5.

Next, the Greek demonstrator will validate EV integration methods, such as DR (BMC2.2), Flexible Capacity Contracts (BMC2.3), market services, green charging, surge pricing, etc. The main aim is to evaluate the impacts on the distribution network, on the public electricity utilities and the feasibility of implementing this method in collaboration with the Open V2X management platform.

In addition, the interoperation of the platform with end-users and end-user devices will be tested. These tests aim to identify efficient mechanisms for charging and discharging EVs, which is also related to the actual final scope of the demonstrator. These mechanisms are closely related to the standardisation activities of the Open Charge Alliance (OCA), such as the Open Charge Point Protocol (OCPP). Finally, in this phase, the integrated functionalities of the V2X platform will be tested in the field. KPIs collected during these tests include interoperability and communication metrics, activation success and user responsiveness.

The final phase of the demonstrator is the integration of the platform with the DSO systems and operation at actual demonstration scale in a realistic validation environment. The objective is to evaluate the proposed solution across the entire operational chain, i.e., interoperability issues, including with the DSO systems, user responsiveness, impact on the safe operation of the distribution network, contribution to DSO flexibility management.

3.3.1 Distribution System Operators bound by Flexible Capacity Contract

This BM presents the DSO´s perspective on flexibility contracts. As mentioned in the Slovenian demonstrator description, the DSO is generally responsible for operating, maintaining, and developing the distribution network within its jurisdiction, for interconnections with other networks and for ensuring the long-term capacity of the network to meet adequate demand for electricity distribution, and not for profit making in the classical sense. All this is also true for Greece. The task of the DSO is to serve all customers equally while ensuring that the distribution system functions safely and within technical limits (current and voltage). It is not allowed to trade energy or directly control DERs. The DSO's main remaining options are implicit DER control (tariffs, etc.) and buying/using/requesting flexibility. In the Greek demonstrator, HEDNO is a DSO participating in the tests. The main instruments of its BMs are dynamic network tariffs and flexible capacity. These are a mix of BMs developed for DSOs and presented in the Portuguese and Slovenian demonstrators' chapters. The first instrument is Green Charging, the second is the case of Flexible Capacity Contracts.

Table 16: Elements from business model canvas and value proposition canvas for Greek demonstrator per each use case for the DSO.

	UC4	UC5
Actor	DSO.	
Product and services	Green Charging.	Flexible Capacity.
Key Partners	V2X Managers (CPO in the case of Greek demonstrator), market Operator.	
Customer	Consumer, EV user, CPO.	
Customers jobs	Act rationally and lawfully, take care of your own equipment.	
Pains	- Network congestion and/or voltage issues, - Inverse power flows.	
Pain Relievers	- Flexible capacity contracts, - Green charging, - Demand Response.	
Gains	- Reduction of technical losses, - Generation from distributed sources (DER), - Reduction of GHG emissions, - Controlled Grid investments.	
Gains Creator	Better resource allocation.	
Cost structure	Methodology rollout, infrastructure integration to new methodologies, distribution network capabilities increase.	
Revenue Streams	- Network tariffs, - Rationalization of grid investment.	
Customer Relationships	- Reliable service, - Simple and intelligible tariffs schemes, - Safe network operation.	
Channels	Smart meters (AMI), service teams, retailers.	

In the case of Green Charging, the DSO is the optimiser of social welfare. As the actor responsible for promoting the integration of RES, the DSO tries to reduce reverse flows and RES curtailment as much as possible. The means for this process are dynamic grid tariffs that promote real-time demand shifting to facilitate local consumption in places with strong presence of DERs. The objective of optimising social welfare can be promoted in DSOs through appropriate regulation, monitored by the National Regulatory Authority (NRA) and implemented through penalty/reward systems, similar to SAIDI/SAIFI (Putynkowski, et al., 2016).

In the case of Flexible Capacity Contracts, the DSO acts as a monopsonist for flexibility providers. The value of the DSO is created through the optimal acquisition of flexible capacity, which in turn reduces the costs incurred (usually investment costs). The DSO acquires flexibility in various medium-term periods that are definitely longer than day-ahead, i.e., weeks, months or years.

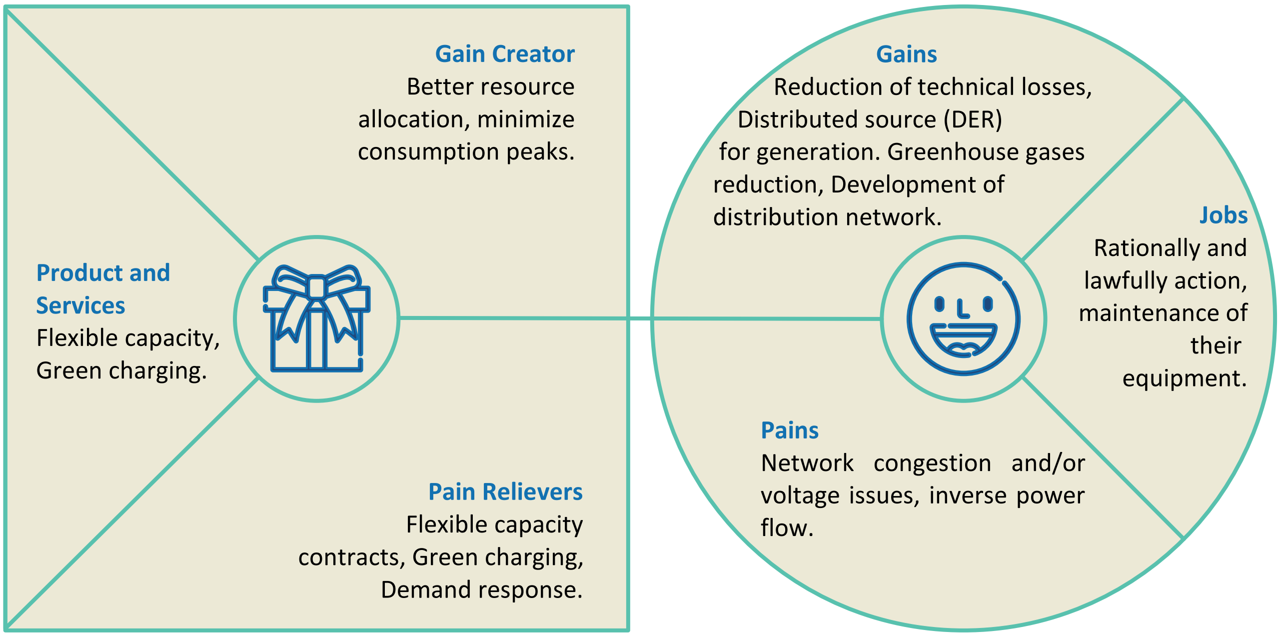

Figure 18: Value Proposition Canvas for Distribution System Operators bound by Flexible Capacity Contract.

3.3.2 Business Model for Charging Point Operators

The CPO is responsible for the O&M of the charging stations infrastructure. This actor interacts with EV users who want to use the infrastructure to charge their vehicles and with the DSO who wants to buy flexibility from CPO and dynamically define its grid tariffs (price signals) or dynamic contracts. In addition, CPO interacts with the platform manager that provides the open V2X platform infrastructure that coordinates EV users, CPO and DSO. PPC assumes both roles, in the Greek demonstrator, that of CPO and the platform manager. HEDNO is the participating as a DSO.

The CPO offers a range of products and services. To clearly define the roles, regardless of who fills them, CPO is defined as the sole owner of the CSs. Roles that may be associated with the role of CPO and are filled by the same entity in Greece include platform manager, aggregator, and energy retailer. In other countries such as Portugal and Slovenia, the role of CPO is different. In the Greek demonstrator, PPC holds all these roles. In addition, in the Greek demonstrator, CPO is also an aggregator in the overall BM description of this delivery. The role of the platform manager is analysed separately.

In its main role, CPO provides charging infrastructure to EV users. In addition, CPO provides flexibility to the DSO and green charging to EV users. Its main partners include the platform manager and the DSO. Its customers are the EV users and, in the case of flexible capacity contracts, the DSO. CPO tries as much as possible to avoid missing opportunities due to insufficient charging infrastructure and its under-utilisation due to network constraints. This is achieved using the open V2X platform and proposed methodologies that enable several objectives such as better services to customers, societal benefits and increased revenues. Afterwards, a surge pricing strategy can be implemented by the CPO with the goal to balance the use of different charging stations operated by the CPO (BMC7).

Table 17: Elements from business model canvas and value proposition canvas for Greek demonstrator per each use case for the CPO.

	UC4	UC5
Actor	PPC (CPO).	
Product and services	- Management of public charging infrastructure, - V2X Management - Green Charging.	- Management of public charging infrastructure. - V2X Management - Flexible capacity contracts
Key Partners	DSO, and Platform manager.	
Customer	DSO, and EV user.	
Customers jobs	- EV user has to request a charging session, - DSO requests flexibility according to RES generation.	- EV user must request a charging session, - DSO requests flexibility.
Pains	- Limited charging infrastructure capabilities. - Reverse power flows and voltage constraints	- Interrupted operation of charging station due to network problems.
Pain Relievers	- Platform allowing the coordination with the distribution network, - Better resource allocation, - Surge pricing.	- Flexible capacity contracts, - Green charging.
Gains	- Better and more reliable service to EV users, - reduction of GHG emissions, - Lower Power losses.	- Better charging infrastructure management.
Gains Creator	- Platform automation and analytics, - Better resource allocation.	
Cost structure	- Platform implementation and maintenance, - Methodology rollout, infrastructure integration to new methodologies, opportunity cost due to capacity limitations.	
Revenue Streams	More utilization of charging stations.	
Customer Relationships	- Regular data, request and information exchange between CPO and DSO is required. - Interaction of customers with the platform front end.	
Channels	Digital platform.	Flexibility provision framework, digital platform.

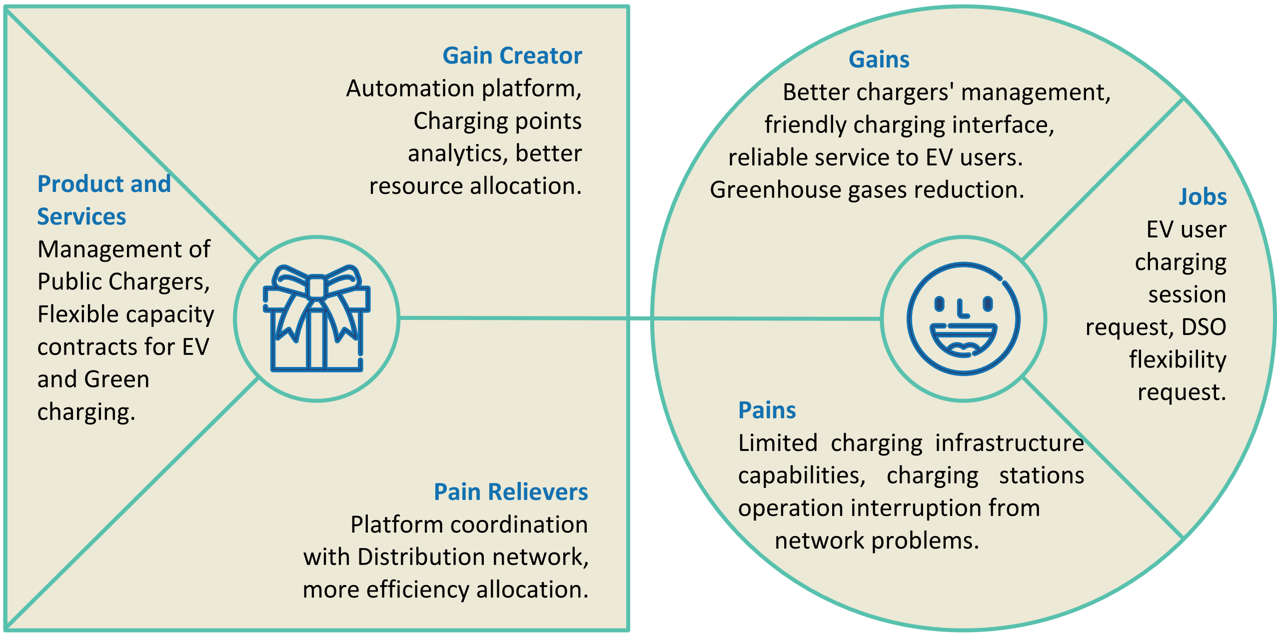

Figure 19: Value Proposition Canvas for Business Model for Charging Point Operators.

3.3.3 Business Model for Cloud Platform Manager operating the Open V2X Management Platform

This BM focuses on a company that develops and supports the Open V2X Management Platform that manages the public charging network. The platform manager is the same as the CPO in the Greek demonstrator. In the Greek demonstrator, PPC (CPO) builds and operates the Open V2X Management Platform with the aim of extending and optimising the services offered by its public charging network. At the same time, the platform must be compatible with and support the methods proposed by the EV4EU project to exploit the flexibility of EVs, such as Flexible Capacity Contracts and Green Charging. It is important to notice that this platform will be also used in the Portuguese demonstrator as described in the Section 3.1.

The most important partner and at the same time customer in this BM is the CPO. The CPO uses the platform, so it is a customer, but it is also responsible for maintaining the interoperability of the charging network with the platform, as it has contributed to its design. The problems the platform is trying to solve are the poor management of the public charging network due to a fragmented backend landscape, the hindrance of flexibility opportunities for EVs and the technical unreliability of the charging network. Afterwards, the platform should allow V2X services. This can be achieved through a unified platform that is compatible with the most common charging types, supports new features and can handle the expected load. If built on a solid foundation, such a platform can lead to better management of CSs, greater acceptance in the market and wider use of the flexibility of EVs in power grid management.

Table 18: Elements from business model canvas and value proposition canvas for Greek demonstrator for the Platform manager.

	UC2, UC4 and UC5
Actor	Cloud Platform Manager (PPC).
Product and services	Platform support for public charging infrastructure.
Key Partners	- CPO and other V2X managers, - VPPs and Flexibility Operators.
Customer	CPO.
Customers jobs	Maintain and integrate its public charging infrastructure so that interoperability with the open V2X platform is smooth.
Pains	- Public charging infrastructure is not managed by a unified system that can support critical (both for EV user and the DSO) features, - Public charging infrastructure interoperability is not reliable, - Lack of interoperability between V2X managers and Aggregators.
Pain Relievers	- Platform design with the entire framework (EV flexibility, etc.) taken into account, - Platform can support all public charger types and, in Portuguese case, the private ones, - Platform is built to handle the expected load and problems.
Gains	- Better charging infrastructure management, - Wider use of the platform, - EV flexibility features, - V2X services.
Gains Creator	Open V2X platform built on sound principles.
Cost structure	- Platform build, - Research on platform architecture.
Revenue Streams	- CPOs and other V2X managers using the platform, - Aggregators using the platform
Customer Relationships	CPOs buy/use the platform on their public chargers' network.
Channels	B2B cooperation.

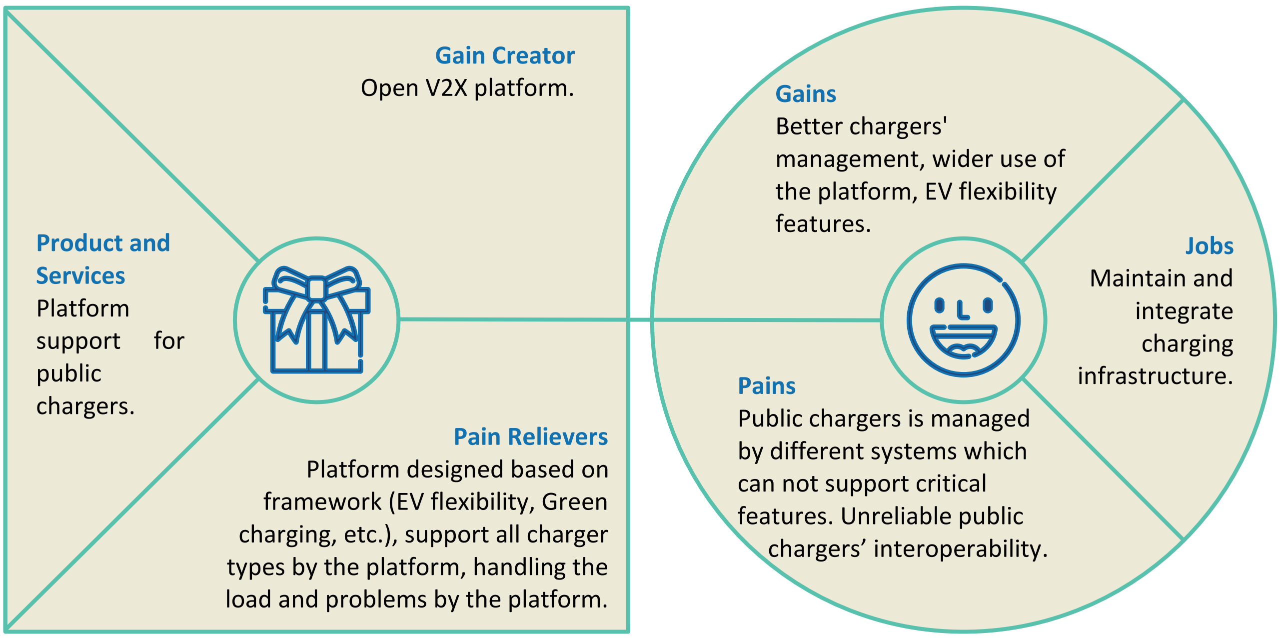

Figure 20: Value Proposition Canvas for Business Model for Cloud Platform Manager operating the Open V2X Management Platform.

3.4 Business models for WP9-Danish demonstrator

In Denmark, demonstration activities will take place in two locations. The first location (Risø) is part of the world-class facility SYSLAB, already successfully used in multiple EU and Danish research projects. As part of the Danish-funded ACDC Project[12], the facility has been equipped with 8 controllable chargers (each charger has 2 outlets capable of supplying up to 11+11 kW), which can be autonomously controlled to provide behind-the-meter services such as limitation of consumption at the point of common coupling or maximization of the consumption of locally produced RES from PV plants and wind turbines. The second location is at Campus Bornholm (Rønne, Bornholm Island). Campus Bornholm has a 180kW rooftop PV plant, its own 10/0.4 kV transformer station, 124 parking lots at Minervavej, and 372 car arrivals per day. As part of the EV4EU project, 6 chargers (each charger has 2 outlets) of a similar technology installed at Risø will be installed in Campus Bornholm.

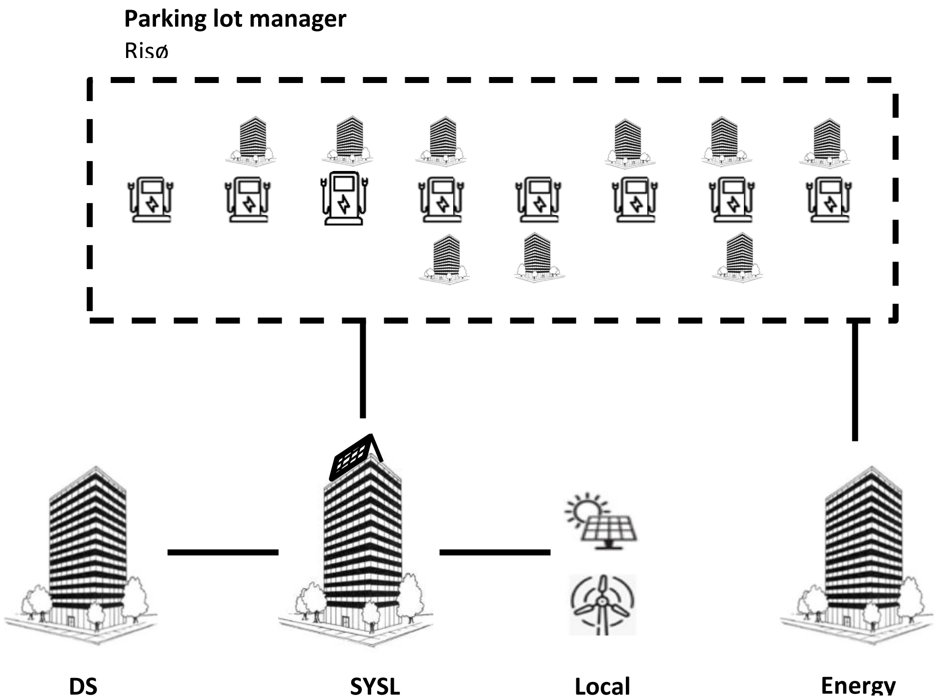

Figure 21: Layout of the Danish demonstrator at the Risø location.

Both locations will host a practical demonstration of parking lots participating in DR. The main objective of this integration is to meet the EV demand of the users while also lowering energy consumption during peak hours (BUC3). A two-way communication system between the parking lot manager and the utility company is required for the integration of the parking lots (BMC9) with the DR program (BMC2.2). The utility company may ask the parking lot manager to reduce energy use during times of high electricity demand. In response, the manager of the parking lot has the option of delaying or slowing down the rate at which the EVs are charged at the CSs. By doing this, the parking lot can lessen energy use during peak hours while also assisting in the grid's balancing. The goal of the practical demonstration of DR participation in parking lots is to illustrate how well the strategy works to meet the EV users' demand while also advancing a more sustainable and effective energy system. The demonstration will assist in determining whether integrating parking lots with the DR program is

[12] https://www.acdc-bornholm.eu/

technically feasible and evaluate the strategy's overall effects on energy use, DR, and customer satisfaction.

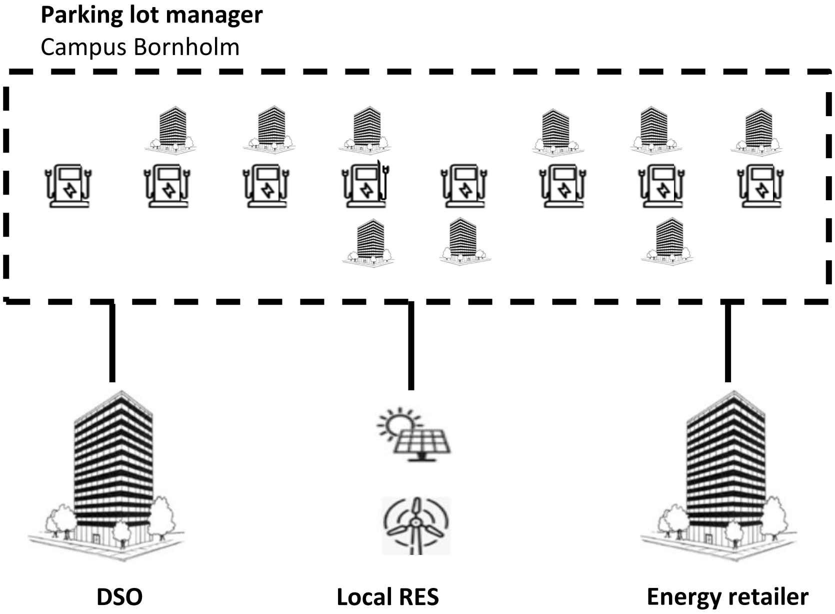

Figure 22: Layout of the Danish demonstrator at the Bornholm setup.

Table 19: Actors in Danish demonstrator.

Actor	Name	Role
Electricity producer	BEOF	Provides electricity and therefore handles electricity payment.
DSO	TREFOR	Handles access to grid.
CPO	Circle Consult	Supplies EV chargers, payment system and grid integration.
TSO	Energinet	Handles electricity production on a larger scale.
Owner		The owner of the parking lot manager can change and configure the system to the wanted functionality.
EV users		They use the charging stations and input their EV specifications and choose their charging strategies if applicable.

The FCR practical demonstration will take place in both locations, with the main goal of meeting customer EV demand while also providing frequency regulation services to the grid. The parking lot manager will be integrated with the FCR market for the FCR demonstration. In this integration, a contract will be signed with the TSO, and the parking lot manager will measure the frequency and, if necessary, take action (BUC7). To balance the supply and demand for electricity, the parking lot manager will use advanced software to monitor the CSs in the parking lot and manage the charging cycles of EVs. The parking lot manager can tweak the charging cycles of EVs in the parking lot by temporarily reducing, increasing, or stopping the charging process to balance the grid when there is frequency instability. The demonstration of FCR participation in parking lots is intended to demonstrate the technical feasibility of integrating parking lots with the FCR market, as well as the potential for parking lot managers to generate additional revenue streams by providing FCR services. The FCR demonstration will also aid in testing the overall impact of this integration on power system stability and efficiency, customer satisfaction, and the environment.

Table 20: Elements from business model canvas and value proposition canvas for Danish demonstrator per each use case

	DR service (BM2.2)	FCR service (BM1)	Energy prices (BM9)	RES coordination (BM9)
Actor	The main actor in the Danish demonstrator is the V2X manager in that case, the Parking Lot manager.			
Product and services	Participate in Demand Response (DR) programs considering other services priorities.	Participate in Frequency Control services, and coordination with local RES while frequency is stable and user needs are in priority.	Schedule EVs based on day-ahead energy prices while user needs are in priority.	Coordination with local RES generation, with user needs in priority.
Key Partners	DSO, TSO, CPO, V2X managers, market, Cloud Platform Manager, and V2X users.			
Customer	EV users, and V2X managers.			
Customers jobs	- Familiarity with app / interface, - EV owners should know their EV battery capacity and charging type, and understand and learn how to use the app.			
Pains	- Need for user data input, - RES intermittency, - High peak energy costs.			
Pain Relievers	Lower need for grid upgrades, charging schedule estimations, greener energy usage, coordination with RES, use of energy at off-peak hours.			
Gains	Prediction of charging current, options to have lower prices, charging fulfilment, cheaper charging plans available, faster charging plans available, greener charging plans available, lower energy bills, participation in reducing GHG emissions, stable grid.			
Gains Creator	- Reliable and safe EV charging service, - EV demand fulfilment, - Pricing schemes, - Reduction of GHG emission.			
Cost structure	- EV charging hardware, firmware for EV chargers, internet connection, - Cloud aggregator, cloud setup, data security, cloud uptime, - DSO/TSO/Electricity provider portal integration, - On-/offsite technical support.			
Revenue Streams	- Electricity per kWh payment, - A fee from DSO/Electricity provider to maintain grid services.			
Customer Relationships	- Customers can create an account, - Customers can have an app on their phone, - Customers can connect and charge, - Customers can stop charging anytime in the app, - Customers can change charging strategy in the app.			
Channels	Contacting and selling charging stations to building owners which notify EV owners of charging stations, QR codes on EV charging stations to download the app to use a charging station, digital platform.			

The energy prices obtained from the energy retailer are used in the scheduling of the EVs in the context of managing EV charging in parking lots with the aim of minimizing the cost of charging while also ensuring that the EVs are charged and ready for use by their owners when they return to the parking lot. The energy management system of the parking lot manager will gather the energy prices from the energy retailer and incorporate them into the EV charging schedule during the practical demonstration at both locations. This integration involves scheduling EVs based on energy prices, accounting for their charging requirements, and when they will leave the parking lot. Where the charging requirements and time until departure are inputs from the EV users. The primary goal will be to ensure that the EVs are charged and ready for use when their owners return to the parking lot. This means that the charging schedule must consider the EVs' charging requirements and prioritize their charging based on their expected usage. The secondary goal of this system is to reduce the cost of charging for the parking lot manager's users. The system can charge the EVs when energy prices are low and avoid charging them when prices are high by incorporating energy prices into the charging schedule. This helps to reduce the overall cost of charging for the parking lot manager's users.

Both locations will host a practical demonstration of RES coordination with the parking lot manager. The main goal of this demonstration is to ensure that EV users' demand is met while utilizing RES. This coordination entails incorporating RES into the EV charging procedure, such as solar panels or wind turbines (UC5). It is possible to streamline the charging process so that it uses RES during periods of peak production and switches to conventional energy sources when RES aren't available. The parking lot manager can keep an eye on the availability of RES and use this data to optimize the charging procedure to make the most of RES. This can lower the overall cost of EV charging in addition to assisting in the reduction of carbon emissions. In a parking lot setting, the practical demonstration will show how the integration of RES and EV charging can be successfully implemented to reduce carbon footprint and lower overall EV charging costs.

After several iterations to complete the BMC and VPC, the following key elements emerged, as shown in Table 20. Elements presented in Table 20 were the basis for developing new BMs to be tested in the Danish demonstration project.

3.4.1 Business Model for Public Parking Lot Managers

The public parking lot manager will operate the chargers locally, which allows them to manage the connected EVs more effectively and with greater control as it is operating on a local basis. Operating locally gives the public parking lot manager direct control over the electricity load, and the scheduled charging power, which enables them to address any problems or concerns faster and more proficiently. This enables the parking lot manager to make sure that the charging infrastructure is used effectively and sustainably while also optimizing pricing strategies to meet the needs of their customers. The parking lot manager can gain better data and insights into the charging habits and requirements of the EV drivers by operating locally. With the help of this data, marketing strategies, CS design, and relationships with EV customers can all be improved. For instance, the public parking lot manager may decide to provide incentives or loyalty programs to regular users of the CSs, or it may advise equipment suppliers on features or enhancements that would better serve their clients. Finally, operating locally gives the parking lot manager better security and privacy over the information gathered from the connected EVs and the charging infrastructure. This guarantees that the EV drivers' personal information and data are handled with the utmost confidentiality and security. Overall, by conducting business locally, the parking lot manager can better manage the connected EVs and offer a higher level of service to their clients, which will increase use of the CSs and generate more revenue.

The owner can increase revenue and support a more sustainable energy grid by setting up the parking lot manager to take part in frequency control and DR programs. By balancing the electricity supply and demand, frequency control services aid in the stabilization of the grid's frequency. By reducing or increasing the load on CSs, it is possible to adjust the electricity load to match the generation. The parking lot manager can receive compensation from the grid operator for adjusting the electricity load as needed by taking part in a frequency control program. When there is a high demand for electricity or when the grid is under stress, DR programs involve reducing the electricity load. By temporarily limiting the number of CSs available during rush hours or lowering the charging rate for EV drivers, the parking lot manager can take part in these programs. As a result, the grid is less stressed, and the owner may receive payments. The parking lot manager can increase their income and help create a more sustainable energy grid by taking part in these programs. To set up and manage these programs and make sure they meet the needs of EV drivers as well as the overall operation of the parking lot, the owner can work with the TSO. Additionally, by taking part in these programs, the parking lot manager can gain more visibility and respect as a sustainable company. This may help to increase the number of EV drivers and establish a good reputation within the community. Additionally, the parking lot manager can aid in lowering GHG emissions and advancing a cleaner environment by contributing to a more sustainable energy grid. Overall, enabling the manager of the parking lot to take part in frequency control and DR programs can increase revenue, help create a more sustainable energy grid, and be advantageous to both the owner of the parking lot manager and the EV customers.

By basing the energy prices on day-ahead energy prices, the parking lot manager can, among other things, provide better rates for EV charging. The parking lot manager can provide more predictable and stable rates for EV charging and can take advantage of opportunities to offer lower prices when energy is anticipated to be more affordable by using day-ahead energy prices. For instance, the parking lot manager can change the charging fees to encourage customers to charge their EVs during off-peak hours if the forecast for the following day indicates that energy prices will be lower then. This can give consumers more affordable and flexible charging options while also easing the load on the energy grid during peak hours. The parking lot manager can change the charging rates to reflect higher costs, however, if the forecast for the following day indicates that energy prices will be higher during peak hours. This can support the CS's profitability while also offering customers a just and open pricing structure. By encouraging customers to charge their EVs off-peak, when the demand on the energy grid is lower, the parking lot manager can also support energy efficiency and sustainability by basing energy prices on day-ahead energy prices. This may aid in lowering EV charging's carbon footprint and overall energy prices. Overall, the parking lot manager can offer more competitive and alluring pricing for customers while also maximizing the effectiveness and profitability of the CS by using day-ahead energy prices to adjust the charging rates for EVs.

A crucial component of a successful CS management system is the ability of customers to choose their charging strategies. Customers can select the charging strategy that best suits their unique needs and preferences, whether it be faster, more affordable, or environmentally friendly charging, by providing a variety of charging options. Although faster charging options may cost more, they can offer the convenience of a quicker charging time, allowing EV customers to easily recharge their cars and resume driving. Customers with busy schedules or those who need to travel farther distances might favor this option. For customers who are willing to wait for a longer charging time in exchange for lower costs, slower, less expensive charging options may offer a more practical alternative. Customers who are trying to reduce their charging costs might favor this option. To lessen the carbon footprint of EV charging, greener charging options may prioritize the use of RES, like solar or wind power. Drivers who are concerned about the environment and want to lessen their impact on it might favor this option. The parking lot manager can modify the cost and charging duration for these charging options to best serve the needs of the users and the overall performance of the CS. To encourage customers to use less expensive or environmentally friendly options, for instance, prices for faster charging options may be raised during times of high demand. By providing a variety of charging options, the parking lot manager can give the customers a more specialized and personalized experience, enhancing their general satisfaction and raising the likelihood that they will return. The CS can also be made more effective and profitable by considering the pricing and charging time for EVs, which will benefit both the customers and the parking lot manager.

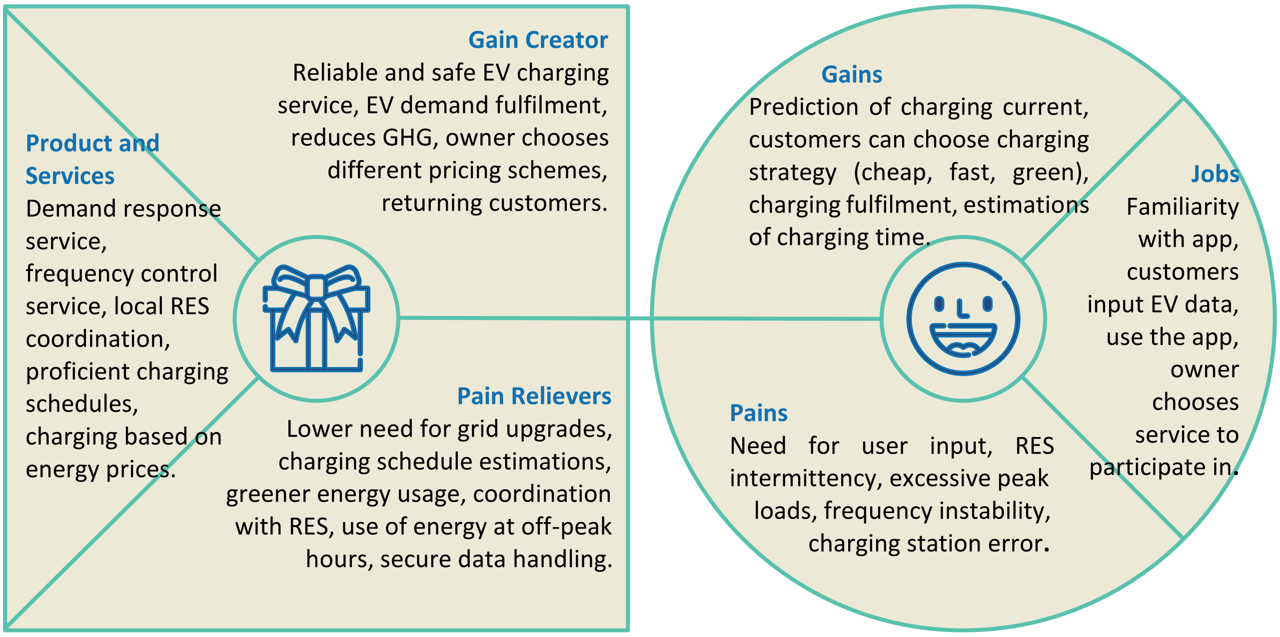

Figure 23: Value Proposition Canvas for Public parking lot manager, with elements identified from Public parking lot manager owners perspective.

3.4.2 Business Model for private Parking Lot Managers

In this case, the EV stations shall be rendered as a service by the private parking lot manager for the convenience of its users. Such an arrangement confers upon the parking lot manager an added degree of control over the charging infrastructure, considering that the users of the parking facility are expected to remain parked for extended durations, primarily due to work or study-related engagements. This provision of charging services by the parking lot manager therefore enables greater control over the charging infrastructure and affords increased flexibility in its operations. The local management of chargers by the private parking lot manager enables effective and efficient control over connected EVs, including prioritization, load, and scheduled power. This ensures prompt and efficient handling of issues and inquiries.

The parking lot manager can also exert more control over the CS pricing and revenue-sharing models by running its business locally between CSs. This enables the parking lot manager to make sure that the charging infrastructure is used effectively and sustainably while also optimizing pricing strategies to meet the needs of their users. The parking lot manager can gain better data and insights into the charging habits and requirements of the EV drivers by operating locally. With the help of this data, marketing strategies, CS design, and relationships with users can all be improved. For instance, the local parking lot manager may decide to provide incentives or loyalty programs to regular users of the CSs, or it may advise equipment suppliers on features or enhancements that would better serve their clients. Finally, operating locally gives the parking lot manager better security and privacy over the information gathered from the connected EVs and the charging infrastructure. This guarantees that the EV drivers' personal information and data are handled with the utmost confidentiality and security. Overall, by conducting business locally, the parking lot manager can better manage the connected EVs and offer a higher level of service to their clients, which will increase use of the CSs and generate more revenue.

To boost revenue and promote sustainable energy, the parking lot owner can enroll their manager in frequency control and DR initiatives. These services help stabilize the grid's frequency by balancing electricity supply and demand. Private lot managers can benefit from greater flexibility and longer connection times to participate in these programs. Since EVs in private lots tend to have longer dwell times, aggregators can optimize their charging cycles to provide grid services. This involves managing CS loads to adjust the electricity load to generation. By joining a frequency control program, parking lot managers can earn compensation from the grid operator for adjusting the electricity load as needed. When there is a high demand for electricity or when the grid is under stress, DR programs involve reducing the electricity load. By temporarily limiting the number of CSs available during rush hours or lowering the charging rate for EV drivers, the parking lot manager can take part in these programs. As a result, the grid is less stressed, and the owner may receive payments. The parking lot manager can increase their income and help create a more sustainable energy grid by taking part in these programs. Additionally, by taking part in these programs, the parking lot manager can gain more visibility and respect as a sustainable company. This may help to increase the number of EV drivers and establish a good reputation within the neighborhood.

Equally so for the private parking lot manager, he can take advantage of basing the charging schedule on energy prices, by using the day ahead market, as described in chapter 3.4.1 Public parking lot manager.

The owner of the private parking lot manager can select from three different charging strategies: cheap, fast, or green charging, and choose whether they should be optional or mandatory. For instance, in certain periods or for certain chargers they may need to have higher priority for service vehicles where power should be available at all times, whereas the users' private vehicles may have lower priority or a different charging profile.

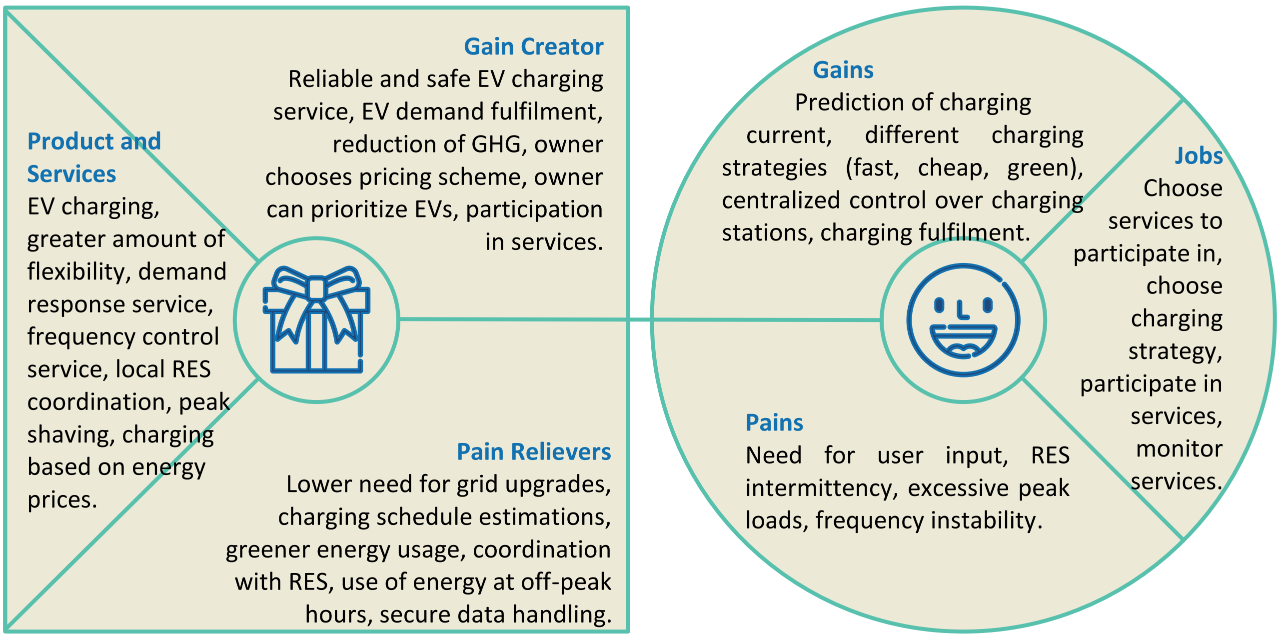

Figure 24: Value Proposition Canvas for Private parking lot manager, with elements identified from Private parking lot manager owners' perspective.

4 Conclusion

This deliverable presents Business models focused on the V2X value chain for the selected Use Cases that will be developed in the EV4EU project members countries (Denmark, Greece, Portugal, and Slovenia). The proposed Business Models are based on initial UCs, considering specifics of the four countries, yet general enough to be transferable.

EVs are creating new business opportunities mainly driven by the high flexibility that can be provided. Afterwards the charging (and discharging) of the EVs can be managed at different locations and consequently, by different entities (V2X managers). Several V2X managers are described in this document namely, charging point operators, companies, parking lots, energy communities, buildings and houses. From the mentioned V2X managers, only the energy communities will not be tested in the EV4EU. Beyond the internal management of their V2X stations in coordination with the other resources, V2X managers can interact with system operators (TSO and DSO) and aggregators (VPPs and FOs) creating additional advantages. In that case, the V2X managers can take advantage of the services proposed by these entities and described in the seven use cases mentioned in D5.1 and D1.5. Beyond the description of the business models related with different stakeholders and services, the perspective of V2X stations manufacturers, cloud platform managers and fleet management entities are described.

In this document, we have first identified the stakeholders involved in the V2X value chain, presented in Figure 3. Using BMC and VPC we have iteratively developed 12 BMCs presented in Figure 5 and described in Chapter 3. For service-oriented UCs, additional SBMC methodology was used to consider their key characteristics, such as service exchange and value co-creation in business networks.

Focusing on the four demonstrators and selected Use Cases, the proposed BMs together with defined actors present valuable information for further development of services and information platforms. For example, the document collects actor activities taking into account local specifics that will be valuable for the development of V2X Business Use Cases. The developed and presented BMs will be evaluated and further evolved during the project.

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