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Interoperable solutions for implementing holistic **FLEXi**bility  
services in the distribution **GRID**

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## **Business Model Development – Month 24**

### **Deliverable 8.2**

### **WP8**

**Grant agreement: 864579**  
From 1<sup>st</sup> October 2019 to 30<sup>th</sup> September 2023

**Prepared by: CAPENERGIES**

**Date: 13 October 2021**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under service agreement No 864579

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## DELIVERABLE FACTSHEET

Deliverable no.	D8.2
Responsible Partner	CAPENERGIES
WP no. and title	WP8 Business cases and exploitation strategies
Version	V2
Version Date	10/13/2021

Dissemination level	
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## ABBREVIATIONS

**BESS:** Battery Energy Storage System  
**BMS:** Building management system  
**CAGR:** Compound annual growth rate  
**CAPEX:** Capital expenditures  
**CBRD:** Croatian Bank for Reconstruction and Development  
**CEER:** Council of European Energy Regulators  
**D:** Deliverable  
**DER:** Distributed energy resources  
**DSO:** Distribution system operator  
**EBRD:** European Bank for Reconstruction and Development  
**EIB:** European Investment Bank  
**EFSI:** European Fund for Strategic Investments  
**EPC:** Engineering, Procurement and Construction  
**ER:** Exploitable result  
**ESCo:** Energy service company  
**ESPC:** Energy service performance contract  
**ESIF:** European Structural and Investment Funds  
**EU:** European Union  
**EV:** Electric vehicles  
**FiT:** Feed-in-Tariff  
**GDP:** Gross domestic product  
**GHG:** Greenhouse gas  
**HV:** High voltage  
**ICT:** Information and communication technologies  
**IEA:** International Energy Agency  
**JRC:** Joint Research Centre  
**LV:** Low voltage  
**M2C:** Meter to customer  
**MV:** Medium voltage  
**NECP:** National Energy and Climate Plan  
**NRA:** National regulatory authority  
**O&M:** Operation and maintenance  
**OPEX:** Operating expenses  
**PR:** Public relations  
**PV:** Photovoltaic  
**R&D:** Research and development  
**R&I:** Research and innovation  
**RES:** Renewable energy sources  
**SAIDI:** System average interruption duration index  
**SAIFI:** System average interruption frequency index  
**SCADA:** Supervisory control and data acquisition  
**TEN-E:** Trans-European Networks for Energy



**TSO:** Transmission system operator

**UN:** United Nations

**UK:** United Kingdom

**VTES:** Virtual thermal energy storage

**WP:** Work package



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## EXECUTIVE SUMMARY

This Deliverable, intervening at the end of the second year of implementation of the FLEXIGRID project, continues the FLEXIGRID exploitable results' business model development process, building upon the market analysis, the value proposition of the FLEXIGRID approach and the exploratory business models for FLEXIGRID individual solutions presented in Deliverable 8.1.

While the Covid-19 pandemic and its consequences have had a significant impact on the short-term market conditions, more structural and long-term changes can also be expected, notably in line with the new climate and renewable energy targets defined by the European Union. This deliverable analyses these evolutions in the market outlook, as well as the opportunities and challenges that they create for stakeholders of the electricity value chain. It also proposes an in-depth analysis of the market context of two EU member States where FLEXIGRID demonstration activities are implemented, Croatia and Spain, articulated around the *"main factors affecting the number of projects and the level of investment"* in smart grid projects identified by the European Commission's Joint Research Centre.

In addition to this analysis of the market environment, which is key to prepare the deployment of the FLEXIGRID exploitable results on the market, this deliverable marks a second step in the development of business models for these results. Over the first twelve months of the FLEXIGRID project, exploratory business models have been designed for the nine individual FLEXIGRID solutions, based on a methodology resting on A. Osterwalder and Y. Pigneur's Business Model Canvas. During the second year of implementation of the project, these exploratory business models have been updated and refined using a complementary methodological framework. Besides, exploratory business models have been developed for other exploitable results of the project identified within the framework of the Exploitation Strategy, following the Canvas methodology. This deliverable presents the results of this business model creation process, in which all partners have been involved within the framework of working groups coordinated by each exploitable result's lead partner(s).

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## 1. INTRODUCTION

Throughout the implementation of the FLEXIGRID project, a reflection on the business models of the associated exploitable results and use cases is carried out within the framework of Task 8.1 of Work Package 8 (WP8), in order to pave the way towards their market deployment.

Intervening at the end of the first year of implementation of the project, Deliverable 8.1 (D8.1), “Business model development”, presented an analysis of key market trends and of the challenges that they create for different stakeholders of the electricity value chain, as well as the results of a first value proposition and business model design exercise conducted for the individual solutions constituting the FLEXIGRID approach. All the partners intervening in their development were involved in this interactive process, using a common methodological framework based on A. Osterwalder and Y. Pigneur’s Business Model Canvas (A. Osterwalder and Y. Pigneur, 2011). At these early stages of the business model development process, the choice had been made to focus more specifically on four of the Canvas’s building blocks: customer segments, value propositions, revenue streams and cost structure.

Deliverable 8.2 aims to take stock of the advances made in this reflection, which will lay the foundations for the definition of a business plan to support the deployment of the FLEXIGRID exploitable results (ERs) on the market. More precisely, it proposes:

- an update of the market analysis presented in D8.1, focusing on evolutions in the market environment and on the opportunities and challenges that they create for stakeholders of the electricity value chain;
- an in-depth analysis of the market context of two European Union (EU) member States where FLEXIGRID demonstration activities are implemented: Croatia and Spain;
- a refinement and update of the exploratory business models defined in D8.1 for nine ERs corresponding to the FLEXIGRID solutions;
- exploratory business models for other ERs identified over the course of the project implementation, notably within the framework of the definition of the Exploitation Strategy (Task 8.5).

In order to facilitate the update of the business models presented in D8.1, CAP proposed to the partners a methodology and template designed with two objectives:

- i) further refining the analysis on some of the Canvas’s key building blocks, notably by considering the interactions between them;
- ii) and preparing for the beginning of the implementation of the demonstration campaign (WP6) and of the cost-benefit analysis (Task 8.2), by focusing on the exploratory business models’ applicability.

Exploratory business models for other identified ERs have been designed using the methodology employed in D8.1 for the nine individual FLEXIGRID solutions, resting on the Business Model Canvas (presented in Appendix 1 of D8.1).

In both cases, the analysis was conducted within the framework of working groups gathering all the partners involved in the development of each ER, coordinated by one or several lead partner(s). The exploratory business models designed were then discussed and refined during progress meetings between CAP and the lead partner(s) of each working group.

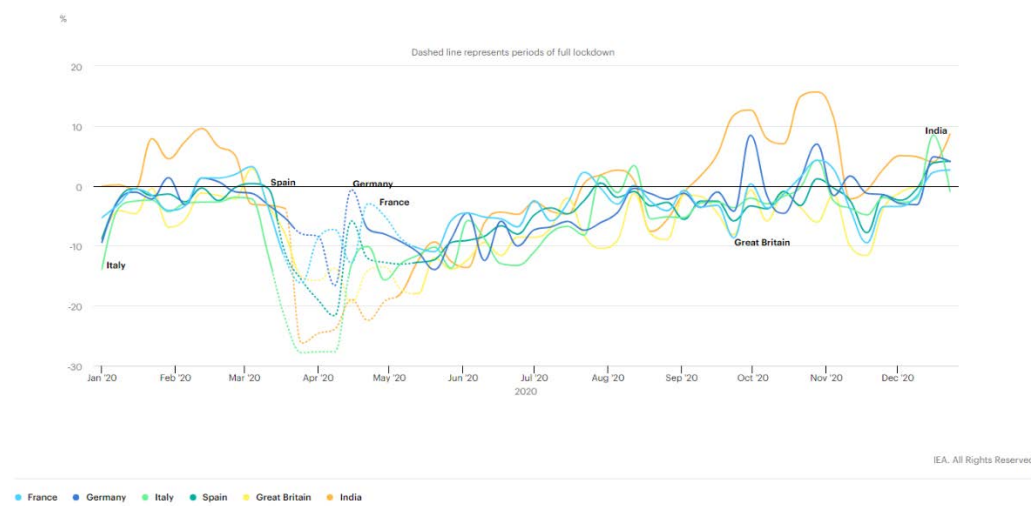
## 2. MARKET OUTLOOK – UPDATE

### 2.1. The Covid-19 pandemic: short- and longer-term impact on the market outlook

#### *A rise of uncertainty and challenges for the power system*

The Covid-19 pandemic and the measures taken to address it (lockdowns and/or other national or local restrictions) have had a direct impact on the energy system in many countries. In order to assess its consequences in Europe, the Council of European Energy Regulators (CEER) conducted a survey of national regulatory authorities (NRAs) in December 2020 (CEER, 2021). Most of them observed a significant decrease in electricity consumption in the first semester of 2020 (Figure 1), which was estimated at -7% in the European Union (EU) in comparison with the same period of 2019 (CEER, 2021). More generally, the International Energy Agency (IEA) notes that “countries in full lockdown [experienced] an average 25% drop in energy demand per week and countries in partial lockdown an average 18% decline”, and that “dramatic reductions in services and industry [were] only partially offset by higher residential use” (CEER, 2021; IEA, 2021c).

Figure 1. Year-on-year changes in weekly electricity demand, corrected for weather, in 2020



Source: IEA, 2021c

16 of the NRAs surveyed by the CEER also observed important decreases in wholesale electricity prices over the same period, due to the Covid-19 crisis' impact on energy demand and fuel prices, but also, in some cases, to other factors, including weather conditions (CEER, 2021). For instance, in April 2020, prices were inferior to their 2019 levels by 54% in Germany, Greece and Italy, and by 60% in Spain (CEER, 2021). In Austria, the “pure ‘COVID-19 effect’” on prices was estimated to EUR 9/MWh between March and May 2020 (CEER, 2021).

Changes in the electricity mix have also been noted: in the EU, the share of renewable energy sources (RES) (40%) reached higher levels than that of fossil fuels (33%) for the first time in the first semester of 2020, and record-high shares of variable RES were registered during lockdowns in Germany, Italy and Spain (CEER, 2021; IEA, 2021c).

The economic and social consequences of the Covid-19 pandemic had implications for energy stakeholders: in answer to the CEER's survey, *"several NRAs noted that suppliers reported increases in unpaid bills and that network operators expected loss in tariff revenue"* (CEER, 2021).

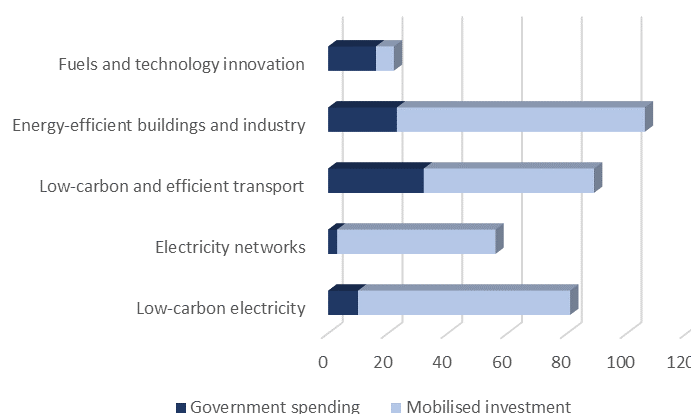
Measures have been taken to deal with the immediate consequences of the Covid-19 pandemic in the energy sector. In order to alleviate its impact on energy consumers, several European countries adopted specific provisions, in addition to social welfare measures and aids for businesses; they included adjusted payment conditions for energy bills, moratoriums on disconnection, and even contractual changes (CEER, 2021). In turn, in certain countries, energy suppliers were allowed to defer network tariff payments (CEER, 2021). Operational conditions also had to be adjusted, with the implementation of network operators' business continuity plans (CEER, 2021). The CEER notes that *"as a result, some countries report delays to network development and smart meter roll-out"* (CEER, 2021).

More long-term lessons have also been drawn from the experience of the energy sector during the Covid-19 pandemic, notably through the analysis of the factors that allowed its relative resilience (CEER, 2021). Among them, the CEER's survey highlights *"the importance of a swift and complete exchange of information with all stakeholders (government, network operators etc.) and the acceleration of digitalisation and remote operations in the energy sector to tackle the crisis"* (CEER, 2021). The latter dimension refers not only to remote working, which was common to many sectors during the Covid-19 crisis, but also, and more specifically, to *"technologies to monitor infrastructure remotely"* (CEER, 2021).

#### *Sustainable solutions for energy and end-use sectors at the heart of recovery packages*

In addition to the measures adopted to manage the Covid-19 pandemic, many governments have strived to address the economic crisis that it has triggered by adopting recovery packages. The IEA estimates that *"as of the second quarter of 2021, over USD 16 trillion has been mobilised in fiscal support aimed at stabilising and rebuilding economies around the world"* and, out of them, 2.3 trillion have been oriented towards *"economic recovery, defined as long-term projects and measures that boost growth"* (IEA, 2021b). Among the latter, c. 380 billion are dedicated to clean energy measures (IEA, 2021b). When taking into account the private investment that is expected to be leveraged through this spending, annual average expenditures in this field could register a USD 350 billion increase over the 2021-2023 period, among which 81 billion would be dedicated to low-carbon electricity and 56 billion to electricity networks (Figure 2) (IEA, 2021b).

Figure 2. Recovery packages – Annual investment by sector (annual average 2021-2023, USD billion/year)



Source: IEA, 2021b

In the EU, a Recovery and Resilience Facility was set up in February 2021 to contribute to member States' recovery reforms and investments financing until 2026, by means of grants and loans representing a total of EUR 672.5 billion (EC, n.d.). To benefit from it, member States have to define recovery and resilience plans detailing intended reforms and investments, which have to be dedicated notably to climate (at least 37% of expenditures) and to the digital transition (at least 20%) (EC, n.d.). *"Flagship areas"* have been suggested for these plans; among them, *"Power up (clean technologies and renewables)"*, *"Renovate (energy efficiency and buildings)"* and *"Recharge and refuel (sustainable transport and charging stations)"* can allow support for investments in energy and climate action (EC, n.d.; EC, 2020a). National plans are assessed by the European Commission (EC) and approved by the Council (EC, n.d.).

## 2.2. New climate and renewable energy targets

The year 2020 represented an important milestone in energy and climate policies, as it was the horizon at which the Climate and Energy Package enacted by the EU in 2009 had set objectives in terms of greenhouse gas (GHG) emission reduction, energy efficiency and RES. New objectives have been defined for 2030 and 2050.

### *The European Climate Law and the "Fit for 55" package*

The European Climate Law, approved in June 2021, sets the objective of reducing GHG emissions by 55% at the 2030 horizon (compared to 1990), before reaching climate neutrality by 2050 (EC, 2021a). In July 2021, the EC proposed a set of interconnected measures aiming at fostering progress towards these objectives: the *"Fit for 55"* package (EC, 2021a; EC, 2021b). It especially provides for a reinforcement and an extension of emission trading in some sectors (notably air, maritime and road transport and buildings), an enhancement of the Innovation and Modernisation Funds, and the creation of a Social Climate Fund aiming to *"help citizens finance investments in energy efficiency, new heating and cooling systems, and cleaner mobility"* (EC, 2021a; EC, 2021b). Besides, it includes an update of the Renewable Energy Directive which brings the targeted share of RES in gross final energy consumption from 32% to 40% by 2030, and must be complemented by indicative objectives at the level of member States (EC, 2021a; EC, 2021b).

### *Other evolutions in the regulatory framework*

A specific task of the FLEXIGRID project (task 7.3) will be dedicated to the analysis of the regulatory framework in Europe. However, some significant evolutions are mentioned here, insofar as they may have an impact on the market outlook. These include:

- the proposal for a revision of the Trans-European Networks for Energy (TEN-E) regulation adopted by the EC in December 2020: it especially contains *"upgraded rules to promote the uptake of smart electricity grids to facilitate rapid electrification and scale up renewable electricity generation"* (EC, 2020c);
- the action plan on the digitalisation of the energy sector, which will *"help develop a competitive market for digital energy services and digital energy infrastructure that are cyber-secure, efficient and sustainable"*, and *"support energy system integration, participation of 'prosumers' in the energy transition and ensure interoperability of energy data, platforms and services"*: the EC released a roadmap outlining it in July 2021 (EC, 2021c).



### 2.3. Challenges for distribution systems in Europe

Since the submission of D8.1, new studies have highlighted the challenges faced by distribution system operators (DSOs) in the context of the energy transition and the Clean Energy Package implementation.

#### *DSOs' readiness to take on the new role defined by the Clean Energy Package*

The EC's Joint Research Centre (JRC) released a third edition of its *Distribution System Operator Observatory*, which especially relies on a mapping, survey and data collection from 44 large DSOs in Europe (JRC, 2021). Its results show *"a clear potential"* for demand-side management and demand response programs: while only 38.5% of respondents already have such programs *"in place"*, more than half of the DSOs surveyed (56%) appear to consider them as *"non-wires alternatives [to network infrastructure investments]"* (JRC, 2021). 54% *"manage active consumers"*, even though in most cases they only do so *"in emergency situations"* and/or *"in pilot/demonstration projects"* (JRC, 2021). The JRC's study also provides insights regarding distributed energy resources (DER) (notably solar photovoltaic (PV), wind and hydro power) connected to some of the respondent DSOs' grids, as well as electric vehicles (EV) connection points (JRC, 2021).

Besides, the study sheds light on the tools used by the surveyed DSOs to monitor and control assets (JRC, 2021). 63% of respondent DSOs' metering points are equipped with smart meters, yet the share of installed smart meters varies strongly within the sample (JRC, 2021). While remote control capabilities are widespread for high/medium voltage (HV/MV) substations, they are less frequent for medium/low voltage (MV/LV) ones: *"75% of the respondents have less than 7.5% of their MV substations remotely controllable"* (JRC, 2021). Nearly all of the respondent DSOs (97%) *"have a SCADA [(Supervisory Control And Data Acquisition)] system or similar in place"* (JRC, 2021). Last but not least, the JRC's study also inquires about the use that DSOs make of certain *"advanced technologies"* such as *"power flow simulations"* (*"routinely run"* by 44% of the respondents), *"data analytics for asset planning and investment strategies"* (*"in place"* for 82% of the respondents), *"sensor technology for outage detection and prediction"* (*"in place"* for 74% of the respondents), *"advanced load and storage management skills"* (in development by 41% of the respondents, mostly within the framework of pilot projects), and *"DER visualisation and management tool"* (*"in place"* for 38% of the respondents) (JRC, 2021).

#### *Creation of the EU DSO Entity, allowing institutional representation and cooperation with TSOs*

The EU DSO Entity was launched in June 2021 and gathers more than 900 registered organisations (EU DSO Entity, n.d.). Its role includes:

- strengthening cooperation between European DSOs and representing them;
- facilitating coordination with Transmission System Operators (TSOs) on network planning and operation;
- contributing to the definition of network codes and guidelines (EU DSO Entity, n.d.; JRC, 2021).

Its agenda will also be articulated around the following missions:

- *"facilitating the integration in DSOs grid of renewable, distributed energy resources and storage"* and *"facilitating demand side flexibility and distribution grid users' access to markets"*;



- “contributing to the digitalisation of distribution systems” and “supporting the development of data management, cyber security and data protection” (EU DSO Entity, n.d.).

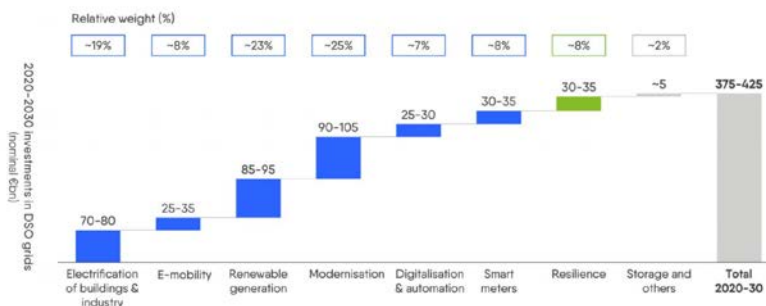
#### Investment needs in distribution networks

The survey conducted within the framework of the JRC’s *Distribution System Operator Observatory* indicates that 77% of the respondent DSOs are “preparing [a network] investment plan”, which according to the Centre “[provides] a very promising picture on the take up of long-term planning also at distribution level” (JRC, 2021).

Eurelectric and E.DSO conducted a study on investment needs in European distribution grids at the 2030 horizon, with the support of Monitor Deloitte and partners in 10 European countries (Monitor Deloitte, E.DSO and Eurelectric, 2021). According to this study, investments in distribution networks required in the EU and the United Kingdom (UK) would represent EUR 375-425 billion over the period 2020-2030<sup>1</sup> (Monitor Deloitte, E.DSO and Eurelectric, 2021). These investment needs are driven by several factors in the context of the energy transition (Figure 3), among which:

- electrification: final electricity demand would register a yearly increase of 1.8% in the EU and UK between 2017 and 2030, reaching 3,530 TWh; at this horizon, the number of EVs would reach 50-70 million, while 40-50 million heat pumps and 335 TWh of industrial and P2X loads would have been added to the grid;
- RES: their capacity would reach 940 GW in the EU and UK, thanks to the expected addition of 510 GW of new capacity; about 70% of the latter would be connected to distribution grids;
- and modernization: up to 55% of LV lines in the EU could be over 40 years-old at the 2030 horizon (Monitor Deloitte, E.DSO and Eurelectric, 2021).

Figure 3. Drivers of investment needs in distribution grids in the EU and the UK



Source: Monitor Deloitte, E.DSO, Eurelectric, 2021

The required investment effort (estimated by the study at EUR 34-39 billion per year) is 50 to 70% higher than historical trends (Monitor Deloitte, E.DSO, Eurelectric, 2021). However, these investments are projected to have a rather limited impact on the unit cost of electricity, representing a yearly increase of 1.5% (Monitor Deloitte, E.DSO, Eurelectric, 2021).

<sup>1</sup> This evaluation of investment needs has been realised on the basis of a GHG reduction target of 46% by 2030; additional investment needs associated with an increase of this target to 50-55% are estimated to EUR 25-30 billion (Monitor Deloitte, E.DSO, Eurelectric, 2021).

### 3. MARKET CONTEXT IN DEMO-SITE COUNTRIES: CROATIA AND SPAIN

The JRC's *Smart Grid Projects Outlook 2017* analyses the “main factors affecting the number of projects and the level of investment” in smart grid projects in given markets (Figure 4) (JRC, 2017). These factors reflect the main criteria to be taken into account in order to assess a given geographical market's potential in the field of smart grid development and will therefore be used as a reference to guide our analysis of the market context in the countries where the FLEXiGRID project's demonstration activities are implemented.

Figure 4. The JRC's framework of analysis of the “main factors affecting the number of projects and the level of investment” in smart grid projects (JRC, 2017)



Source: JRC, 2017

#### 3.1. Market context in Croatia

##### *General characteristics*

##### *Country's size, population and electricity consumption*

With an area of 56,594 square-kilometers, Croatia is considered as a “small yet highly geographically diverse [...] country” (Dijana Plestina et al., 2021). It especially comprises c. 1,100 islands and islets, which raises specific challenges for energy supply and also creates opportunities, notably in terms of self-supply and formation of energy communities (Dijana Plestina et al., 2021; MEE, 2019).

Croatia's population was 4.1 million in 2020 and is expected to decrease to 3.9 million by 2030 and 3.4 million by 2050 (UN, 2019). Population density is 72.9 persons per square kilometre, however the population is unevenly distributed across the country (MEE, 2019; UN, 2019). The

share of urban population is 57.9% and should reach 61.5% in 2030 and 71.3% in 2050, concentrating especially in large cities (UN, 2018; MEE, 2019).

Croatia's *Integrated National Energy and Climate Plan for the period 2021-2030* (NECP) proposes projections of the country's population and gross domestic product (GDP) in two scenarios: a "base productivity" scenario and a "convergence of productivity scenario" which "allows Croatia to reduce the gap in the level of development vis-à-vis other EU members to some degree" (Table 1) (MEE, 2019).

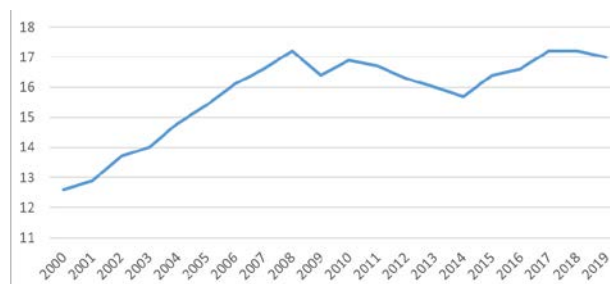
Table 1. Population and GDP projections in Croatia's NECP

	2020	2030	2040	2050
<b>Population (millions)</b>	3.984	3.755	3.532	3.295
<b>"Base productivity" scenario</b>				
<b>GDP (constant prices 2010, HRK billion)</b>	373.595	408.987	454.649	520.277
<b>"Convergence of productivity" scenario</b>				
<b>GDP (constant prices 2010, HRK billion)</b>	373.595	462.111	551.311	649.695

Source: MEE, 2019

Electricity consumption represented 17.0 TWh in 2019 (Figure 5) (IEA Data Services). Households account for 37.6% of the electricity sold to end consumers (Table 2) (HERA, 2020). The maximum load generally intervenes during the summer, notably due to air conditioning use (HERA, 2020).

Figure 5. Electricity consumption in Croatia (TWh)



Source: IEA Data Services

Table 2. Billing metering points and sales per consumption category in Croatia as of 2019

Consumption category	Number of billing metering points (BMP)	Sales (MW)	Sales per BMP (kWh)	Share in total sales (%)
<b>HV – 110 kV</b>	145	1,212,757.9	8,340,982	7.4
<b>MV</b>	2,324	4,304,283.6	1,851,955	26.1
<b>LV – non-household</b>	217,322	4,776,969.9	21,981	29.0
<b>LV – households</b>	2,209,224	6,201,954.2	2,807	37.6

Source: adapted from HERA, 2020

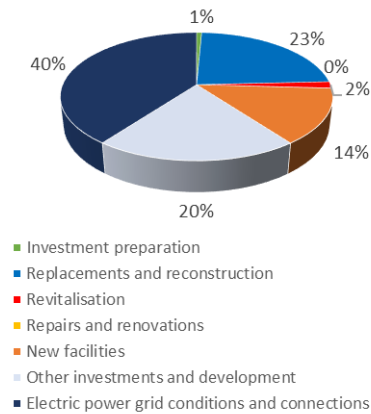
## State of the electricity grids

### ➤ Grid infrastructure

The Croatian Energy Regulatory Agency, HERA, has stated that "the national energy infrastructure is, in principle, satisfactorily developed, functioning at a level that allows for both operational security and the physical and commercial development of the market" (HERA, 2020). HERA's missions include the supervision of TSOs and DSOs and the approval of investment plans in energy systems, among which the transmission and distribution networks' ten-year development plans (HERA, 2020).

The length of the distribution network is 140,067 km as of 2019 (HERA, 2020). Investments in this network represented on average HRK 925 million per year between 2015 and 2019 (Figure 6) (HERA, 2020). The DSO HEP-ODS's ten-year development plan for 2020-2029, submitted to HERA in 2019, provides for investments of HRK 11.5 billion over this period (HERA, 2020).

Figure 6. Realised investments in the Croatian distribution network in 2019



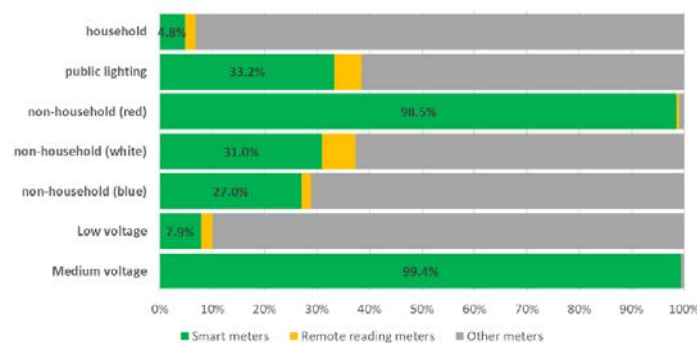
**Total: HRK 950.5 million**

Source: HEP-ODS, quoted by HERA, 2020

### ➤ Smart meter deployment

The *Cost-benefit analysis of smart meters and smart meter roll-out systems* conducted in 2017 by HERA yielded positive results (Eurelectric, 2020; HERA, 2020). Besides, HERA underlines that “the mass roll-out of smart metering would accelerate the development of the retail market and enable faster supplier switching and additional opportunities for end consumers to participate in the electricity market” (HERA, 2020). A plan for the large-scale roll-out of smart meters remains to be adopted by the Ministry of Environment and Energy (HERA, 2020). However, most of the meters installed in 2019 were smart meters (HERA, 2020). Overall, smart meter penetration has reached 14.3%, but its level varies across consumption categories (Figure 7) (Eurelectric, 2020; HERA, 2020).

Figure 7. Share of smart meters by consumption category in Croatia as of end-2019


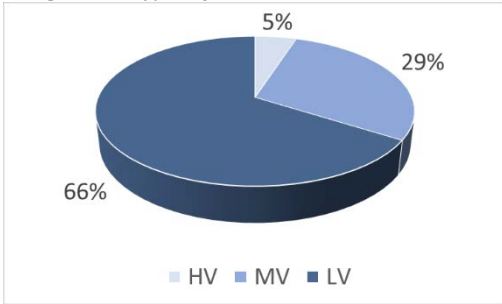


Source: HERA, 2020

### ➤ Quality of power supply

Eurelectric proposes three indicators to analyse the quality of power supply: continuity of supply, voltage quality and network losses (Eurelectric, 2020). The state of electricity grids in Croatia, in regard of these indicators, is described below (Table 3).

Table 3. Quality of power supply indicators in Croatia

Continuity of supply	<p>The continuity of supply is assessed by means of two indicators: the system average interruption frequency index (SAIFI) and the system average interruption duration index (SAIDI). HERA notes “an improving trend” of these two indexes in the Croatian distribution network, notably thanks to upgrades in the power outage monitoring system (HERA, 2020). It however calls for further improvements in specific areas (HERA, 2020).</p> <p>Figure 8. Evolution of SAIDI and SAIFI in Croatia (2015-2020)</p>  <table border="1"><thead><tr><th>Year</th><th>SAIDI</th><th>SAIFI</th></tr></thead><tbody><tr><td>2015</td><td>7</td><td>2</td></tr><tr><td>2016</td><td>5.8</td><td>1.9</td></tr><tr><td>2017</td><td>5</td><td>1.7</td></tr><tr><td>2018</td><td>5</td><td>1.7</td></tr><tr><td>2019</td><td>4.8</td><td>2.3</td></tr><tr><td>2020</td><td>3.3</td><td>1.6</td></tr></tbody></table> <p>Source: World Bank, DataBank, Doing Business</p>	Year	SAIDI	SAIFI	2015	7	2	2016	5.8	1.9	2017	5	1.7	2018	5	1.7	2019	4.8	2.3	2020	3.3	1.6																																																																											
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Voltage quality	<p>HERA defines voltage quality as “the variation of measured voltage characteristics at a supply terminal from the values listed in the Croatian standard HRN EN 50160”, and noted 144 related “written complaints” in 2019 for the distribution network (HERA, 2020).</p> <p>Figure 9. Voltage levels used in Croatia</p> <table border="1"><thead><tr><th colspan="10">LV</th><th colspan="10">MV</th><th colspan="10">HV</th></tr><tr><th>&gt;1kV</th><th>3kV</th><th>5kV</th><th>6kV</th><th>10kV</th><th>11kV</th><th>15kV</th><th>20kV</th><th>22kV</th><th>23kV</th><th>24kV</th><th>25kV</th><th>30kV</th><th>33kV</th><th>35kV</th><th>36kV</th><th>38kV</th><th>45kV</th><th>50kV</th><th>60kV</th><th>65kV</th><th>66kV</th><th>70kV</th><th>110kV</th><th>120kV</th><th>130kV</th><th>132kV</th><th>150kV</th><th>220kV</th></tr></thead><tbody><tr><td>▲</td><td></td><td></td><td></td><td>▲</td><td></td><td></td><td>▲</td><td></td><td></td><td></td><td></td><td>▲</td><td></td><td>▲</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> <p>Source: Eurelectric, 2020</p> <p>Figure 10. Types of distribution lines in Croatia</p>  <table border="1"><thead><tr><th>Type</th><th>Percentage</th></tr></thead><tbody><tr><td>LV</td><td>66%</td></tr><tr><td>MV</td><td>29%</td></tr><tr><td>HV</td><td>5%</td></tr></tbody></table> <p>Source: Eurelectric, 2020</p>	LV										MV										HV										>1kV	3kV	5kV	6kV	10kV	11kV	15kV	20kV	22kV	23kV	24kV	25kV	30kV	33kV	35kV	36kV	38kV	45kV	50kV	60kV	65kV	66kV	70kV	110kV	120kV	130kV	132kV	150kV	220kV	▲				▲			▲					▲		▲															Type	Percentage	LV	66%	MV	29%	HV	5%
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Network losses	<p>A reduction in transmission and distribution losses has been observed over the 2012-2017 period, at an average rate of 1.3% per year (MEE, 2019).</p> <p>Table 4. Distribution losses in Croatia (2019)</p> <table border="1"><thead><tr><th>Nominal:</th><th>Percentage:</th></tr></thead><tbody><tr><td>1,276 GWh</td><td>7.64%</td></tr></tbody></table> <p>Source: Eurelectric, 2020</p>	Nominal:	Percentage:	1,276 GWh	7.64%																																																																																												
Nominal:	Percentage:																																																																																																
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### Number and company culture of DSOs

Croatia is considered by Eurelectric as a country characterised by “very high concentration” regarding DSOs, as there is one DSO company: HEP-Operator distribucijskog sustava d.o.o. (HEP-ODS) (Eurelectric, 2020). HEP-ODS is a subsidiary of HEP d.d., but is “independent from [it] in

terms of its legal form, organisation, and structure, as well as from other companies within the HEP Group” (HERA, 2020). Electricity distribution is a regulated public service, and DSO ownership is “100% public” and national (Eurelectric, 2020; HERA, 2020).

### Regulatory framework

#### Favourable regulatory framework

The functioning of Croatia’s electricity markets is governed notably by the provisions of the Energy Act, the Electricity Market Act and the Act on the Regulation of Energy Activities (MEE, 2019).

#### ➤ Electricity markets framework and incentives given to network operators

Day-ahead and intraday trading takes place on the Croatian power exchange CROPEX (MEE, 2019). The TSO, HOPS, is in charge of managing system balancing and ancillary services (Table 5) (HERA, 2020; MEE, 2019). HERA observes that *“the positive consequences of the increased dynamics on the electricity market are already visible in the components of market balancing and the development of the ancillary services market”* (HERA, 2020). Nonetheless, Croatia’s NECP sets the goal of *“[developing] a competitive market for balancing and ancillary services”*, which could be achieved by *“[establishing] market mechanisms that will enable more market participants, as well as end consumers, to provide such services”* (MEE, 2019). It especially provides for evolutions in the regulatory framework, by 2022, to enable *“active participation of customers in the electricity market [...], in particular by introducing an aggregator as a market player and by facilitating the launch of ancillary service pilot projects”* (MEE, 2019). The NECP mentions as an example a research pilot project through which end customers can, by managing the consumption of certain devices, provide ancillary services – more specifically, active capacity reserve of tertiary control – to the TSO, and be compensated for them (MEE, 2019). The DSO does not procure ancillary and flexibility services from grid users yet, but this possibility is opened by the 2018 Distribution System Grid Code (MEE, 2019).

Table 5. Balancing and ancillary system services in Croatia

Frequency services	Frequency containment reserve (FCR) Automatic frequency restoration reserve (aFRR) Frequency restoration with manual activation (mFRR) Energy derived from them Imbalance netting (IN)
Non-frequency services	Compensation operation for the purpose of voltage and reactive power control Possibility of starting production units without external power supply Starting of production units without external power supply Availability of generating units for insular operation Delivered electricity in insular operation

Source: HERA, 2020

Regarding electricity network infrastructure, according to the provisions of the Energy Efficiency Act, HERA is responsible for ensuring that the potential for improvement of its energy efficiency is evaluated, and is also in charge of identifying measures and investments to achieve this improvement (MEE, 2019). Within this framework, the “Assessment of Potential for Increasing Energy Efficiency of the Electricity Infrastructure” has pointed out the provisions of HEP-ODS’s ten-year development plan regarding technical losses (MEE, 2019). Croatia’s NECP notes that *“when prerequisites for introducing advanced technologies such as load management are created, [HERA] will revise its assessment of potential for increasing energy efficiency of the electricity infrastructure and determine deadlines for the introduction of advanced measures”* (MEE, 2019).



### ➤ Electricity markets framework and incentives given to suppliers

Croatia's retail electricity market is fully open: end customers can choose their supplier, and prices are not regulated (HERA, 2020; MEE, 2019). As of 2019, while nine suppliers were present on this market, the market share of the three largest ones reached 99% for household end customers and 95% for non-household end customers (HERA, 2020). Besides, the supplier switching rate remains limited (3.51% in 2018 and 1.67% in 2019) (HERA, 2020). HERA observes that *"the retail electricity market in Croatia is stagnating"*, and Croatia's NECP plans to *"expand the choice of suppliers [...] and the number of products"* in order to strengthen this market's competitiveness (HERA, 2020; MEE, 2019).

Suppliers have to provide customers with information on their consumption, and notably with a comparison with the average or reference consumption of end customers within the same category (MEE, 2019).

Besides, the Energy Efficiency Act put in place an energy efficiency obligation system, which has been implemented progressively since 2019 (MEE, 2019). The Ministry of Construction and Physical Planning sets the energy savings' objective to be achieved for a given year and allocates it across suppliers (MEE, 2019). The latter can comply with this obligation by means of investments in energy efficiency improvements in consumption, contributions to the Environmental Protection and Energy Efficiency Fund, or through the purchase of savings from other suppliers (MEE, 2019).

### ➤ Provisions regarding emerging stakeholders

Aggregators are identified as actors that can intervene in the market procurement of balancing energy by the *Rules on System Balancing* (HERA, 2020). Suppliers as well as the relevant system operator(s) must be informed by network users of their willingness to resort to an aggregator's services (HERA, 2020). Croatia's NECP plans to further establish the role of these new actors by *"developing a regulatory framework for an independent aggregator"* by 2022 (MEE, 2019). More generally, it provides for the definition by 2022 of a *"regulatory framework for active participation of customers in the electricity market"*, which would especially involve *"[analysing] the potential to provide ancillary services and flexibility services with demand response"*, notably through pilot projects (MEE, 2019).

The notion of *"self-supply installation user"* was defined in 2018 by the Act on Amendments to the Renewable Energy Sources and High-Efficiency Cogeneration Act and applies to households generating electricity from connected RES installations, e.g. rooftop PV systems, which withdraw more electricity from the network in any given year than they inject into it (HERA, 2020). Croatia's NECP provides for a *"continued application of the surplus energy absorbing model from self-supply plants and self-producing end-customers with possible investment support and the supplier's obligation to absorb surplus energy"* (MEE, 2019).

146 self-supply installation users with a connection to the distribution grid were identified in 2019 (HERA, 2020). A 2020 study carried out at the initiative of HERA highlighted the strong potential for their development: according to its estimates, 63,321 PV systems could be installed by households (277 MW), to which 3,460 systems for non-household consumers (92 MW) could be added (HERA, 2020). Croatia's NECP also provides a forecast of the installed capacity of PV systems in buildings, which could reach 300 MW at the 2030 horizon (MEE, 2019). Such evolutions would have significant consequences for transmission and distribution system operators: *"considering current tariff amounts, this study estimates that each installed kW of*

photovoltaic systems in households will result in a reduction in HEP-ODS' revenues of HRK 279-331 yearly, and a reduction in HOPS' revenues from HRK 125-148 yearly" (HERA, 2020).

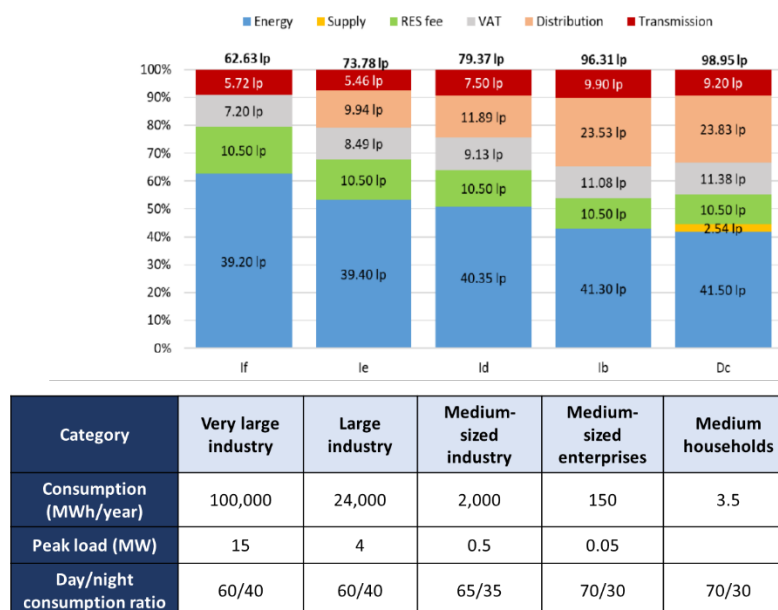
Croatia's NECP includes measures to promote energy communities and enact *"the regulatory framework necessary for their functioning"*, which may include an *"action plan"* for their development (MEE, 2019).

#### Specific regulatory funding for innovation projects

European DSOs mainly finance investments by means of tariffs, even though specific incentive mechanisms for innovation activities exist in certain countries (JRC, 2017). The JRC classifies the *"regulatory funding"* of DSOs as *"own/private financing"* (JRC, 2017). In Croatia, the private financing of investment in smart grid projects, as measured by the JRC's *Smart Grid Projects Outlook 2017*, represented EUR 2.9 million, i.e. 46.8% of total financing (JRC, 2017).

Tariffs, and especially distribution tariffs, are a component of the regulated part of the electricity price in Croatia (Figure 11) (MEE, 2019). They are not the only source for the DSO to recover its distribution costs: connection charges<sup>2</sup> and EU/national/local financing instruments are also mobilised (ACER, 2021). These sources cover the DSO's investments and operational expenditures; tariffs in Croatia also cover the costs of distribution losses, the costs of ancillary and/or flexibility services purchased by the DSO, and metering costs (ACER, 2021).

Figure 11. Electricity price structure in Croatia in 2019 by Eurostat consumption category (price for 1 kWh of electricity)



Source: adapted from MEE, 2019 and HERA, 2020

The tariff methodology is defined by HERA with a view to *"ensure the promotion of energy efficiency through tariffs"* (ACER, 2021; MEE, 2019). In this regard, HERA underlines that *"the calculation of peak load (maximum power used in the higher daily tariff period over a billing period) used as one of the tariff elements directly encourages end consumers to monitor and decide when and how they use their devices and how they use major energy consuming devices,*

<sup>2</sup> Connection charges can be defined as *"one-off charges covering the costs (or part of the costs) of connecting new users to the distribution system"* (ACER, 2021).

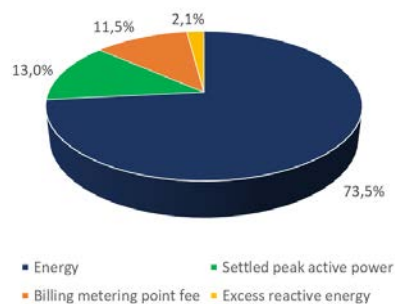


*thus indirectly controlling electricity consumption*” (HERA, 2020). The current tariff methodology has been defined in 2015, and no specific frequency has been set for its revision (ACER, 2021). Tariff values can be adjusted each year, depending on the *“realised difference between revenue and OPEX+CAPEX in previous regulatory year adjusted for inflation as well as planned OPEX+CAPEX and revenue for the future regulatory year”* (ACER, 2021).

The distribution tariff in Croatia does not include an injection charge, but consists in a withdrawal charge, which is both energy-based and power-based (ACER, 2021). The power-based part, which represents 15.2% of the withdrawal charge, applies in system peak periods (ACER, 2021). Besides, the tariff for withdrawal is time-differentiated: a high tariff applies during day time, while a low tariff applies during night time (from 10:00 pm to 8:00 am) (ACER, 2021). Distribution network charges in Croatia also include excess reactive energy and a billing metering point fee (Figure 12) (HERA, 2020).

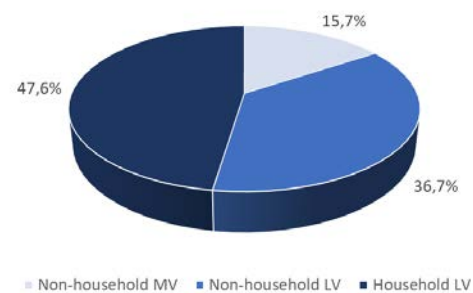
Household and non-household consumers, auxiliary services of generators and prosumers are subject to the tariff for withdrawal in Croatia, while pumped hydroelectric storage and other storage facilities are not (ACER, 2021). In the case of household prosumers withdrawing more from the grid than they inject into it, net-metering is applied (ACER, 2021). Figure 13 presents the share of the different consumption categories in HEP-ODS’s revenues from distribution network charges (HERA, 2020).

Figure 12. Share of the different tariff components in HEP-ODS’s revenues from distribution network charges in 2019



Source: HERA, 2020

Figure 13. Share of the different consumption categories in HEP-ODS’s revenues from distribution network charges in 2019

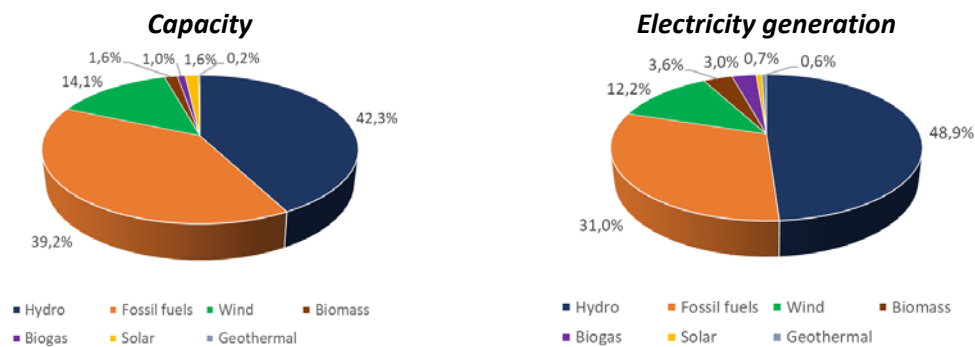


Source: HERA, 2020

### RES supporting mechanisms and policies

Croatia’s electricity mix (Figure 14) includes 19 hydroelectric power plants (2,127 MW), 10 thermal power plants (2,019 MW) and 18 wind power plants (671 MW) connected to the transmission network, to which must be added more than 2,000 power plants (394 MW) connected to the distribution grid (HERA, 2020). The share of installations connected to the distribution grid in the supply of electricity has been rising, to represent 7.4% (1,348 GWh) in 2019, most of which coming from RES (1,336 GWh) (HERA, 2020). Among them, 427 plants (63 MW) are consumers with own production and, more specifically, 146 are self-supply installation users with solar power installations (1 MW) (HERA, 2020).

Figure 14. Croatia's electricity mix as of end-2019



Source: HERA, 2020

Various mechanisms and policies have been implemented to foster the development of RES in Croatia. A Feed-in-Tariff (FIT) system for electricity production from RES was created in 2007 (MEE, 2019). The Act on Renewable Energy Sources and High-Efficiency Cogeneration of 2016 provided for a new system resting on market premiums allocated by means of public tenders: the selection of the lowest bidder paves the way for an agreement setting the guaranteed buy-off price (HERA, 2020; MEE, 2019). It however faced delays in implementation due to the necessary adoption of by-laws (HERA, 2020; MEE, 2019). One of these associated regulations, enacted in 2020, provides for the benefit of this new system to be granted to power plants representing a total capacity of 2,265 MW (HERA, 2020). HERA estimates that it is “*necessary to reconsider [these] quotas, especially given that the current incentives system already represents a significant burden on end consumers, and because the Quota Regulation provides for a manifold increase in this burden*” (HERA, 2020). As for individual facilities, the capacity limit to benefit from the incentive system was raised from 30 to 500 kW in 2018 (HERA, 2020).

1,347 power plants – especially wind power plants –, with a total capacity of 877 MW, benefited from the incentives system and produced c. 16% of the electricity consumed in Croatia in 2019 (HERA, 2020). A weighted average electricity price of HRK 0.93/kWh was associated with it in 2019 (HERA, 2020). In the same year, total liabilities represented HRK 2.7 billion, the majority of which (40.7%) concerned wind power (HERA, 2020).

The eligible electricity producer status, which is granted by HERA for 25 years, is necessary to benefit from these RES incentives by concluding a buy-off agreement with the Croatian energy market operator HROTE (HERA, 2020).

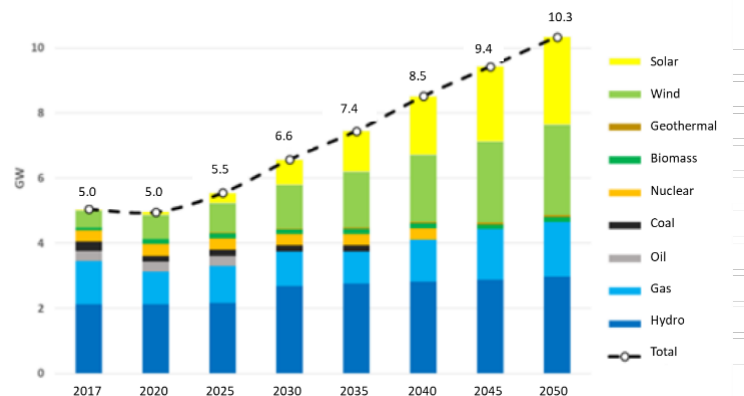
The EKO balance group, created in 2019, gathers eligible producers benefiting from the incentive system (HERA, 2020; MEE, 2019). Suppliers have to take up from HROTE a certain share of net electricity delivered by these producers (70% in 2019, 40% in 2020) (HERA, 2020). Since 2019, HROTE has also been selling part of the electricity from the EKO balance group on the electricity exchange CROPEX (HERA, 2020).

Producers whose electricity is sold on the market within this framework, as well as eligible producers which do not benefit from the incentive system can receive from HROTE guarantees of origin for the electricity generated and trade them on a dedicated market (HERA, 2020). Suppliers can use the guarantees of origin to design offers with a guaranteed share of given electricity sources for their customers (HERA, 2020).

In addition to these mechanisms, RES use is also promoted by means of different financing programs, notably from the Croatian Bank for Reconstruction and Development (CBRD) and the Environmental Protection and Energy Efficiency Fund (MEE, 2019).

Croatia's NECP, notified to the EC in 2019, as well as the *Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050* adopted in 2020 have defined new ambitions for the development of RES (EC, 2020a; MEE, 2019; HERA, 2020). The scenario called "S2" of a "moderate energy transition" is envisaged as a reference in the *Energy Development Strategy*, as well as in the NECP's contents regarding electricity production (HERA, 2020). The evolution of Croatia's electricity mix at the 2050 horizon according to this scenario is presented in Figure 15 (HERA, 2020). RES would account for 61% of generated electricity in 2030 and 83% in 2050 (HERA, 2020). Croatia's NECP sets the following targets at the 2030 horizon: a reduction of GHG emissions of at least 43% in the EU ETS sector and 7% in the non-EU ETS sectors (compared to 2005 levels); and a RES share of 36.4% in gross final energy consumption (up from 28.6% in 2020) and 63.8% in gross direct electricity consumption (up from 47.0% in 2020) (MEE, 2019). The EC deems Croatia's target of a 36.4% RES share to be "sufficiently ambitious as it is above the 32% resulting from the formula in Annex II of the Governance Regulation" (EC, 2020a).

Figure 15. Evolution of Croatia's electricity mix at the 2050 horizon according to Scenario S2 of the Energy Development Strategy



Source: HERA, 2020

In order to reach these RES targets, the NECP provides for several measures, including: i) "capacity building" for different actors, notably "active customers, renewable energy communities, energy suppliers, aggregators"; ii) incentives to promote RES use for electricity generation (notably the premium system "as a transition measure to full market integration of RES"); and iii) evolutions in the regulatory framework by 2022, notably regarding "active customers, aggregators, energy communities, renewable energy communities [...] and energy production for own needs", as well as the definition by HERA of "new methodologies for determining distribution grid charges that would take into account distributed generation by energy customers" (MEE, 2019). "Distributed power sources with a medium-voltage and low-voltage grid connection near the point of consumption" are also viewed in the NECP as a factor that would contribute to electricity supply security (MEE, 2019).

In view of the expected increase of the share of variable RES, Croatia's NECP "[anticipates] activities aimed at increasing the flexibility of the system", relying notably on hydro and gas

plants, battery systems, balancing market organisation and “*advanced grid systems and system management*” (MEE, 2019).

#### National context

##### National co-funding mechanisms

The JRC did not identify any national financing of investment in smart grid projects – coming from national or regional institutions – in Croatia in its 2017 *Smart Grid Projects Outlook* (JRC, 2017). Croatia’s NECP nonetheless provides for the “*co-financing [of] industrial research and experimental development projects aligned with the National Development Strategy*” over the 2021-2030 period (MEE, 2019). Besides, the plan proposes an estimation of investment needs for this period, at EUR 19 billion, 24% of which would be dedicated to electricity generation, transmission and distribution (EC, 2020a; MEE, 2019). The EC notes that “*further detail is needed on the private and public sources of financing (at national, regional, and EU level)*” (EC, 2020a). It also stresses that “*at least 37% of expenditure in Croatia’s recovery and resilience plan will have to be related to climate*” (EC, 2020a).

##### Adoption of Smart grid Action Plans/National priorities

Croatia’s NECP provides for several measures related to smart grids, notably the reduction of technical and non-technical losses in the distribution network and the “*introduction of smart grids*”, to be implemented between 2021 and 2030 (MEE, 2019). The Energy Development Strategy also refers to “*pilot projects for advanced grids [...], on the basis of which additional insights will be gained into the characteristics of grid users and possibilities of their active participation in the power system will be explored*” (MEE, 2019).

Linked with the objective of non-technical losses reduction, Croatia’s NECP provides for the “*introduction of advanced metering [devices and systems for their networking] and data management systems*” (MEE, 2019). It highlights the role of such systems in enabling a more active participation of end consumers in energy markets (MEE, 2019). The Energy Development Strategy also refers to the development of advanced metering systems, and sets the time horizon at 2025 (MEE, 2019).

The NECP underlines that these provisions will “*[entail] research and development by developing new and more energy-efficient technologies related to the distribution system (electricity equipment) and its management (information and communication technologies for advanced grids and advanced metering)*” (MEE, 2019).

#### European context

##### Accessibility to European co-funding mechanisms

European financing of investment in smart grid projects in Croatia was estimated at EUR 3.3 million – i.e. 53.2% of total financing – by the JRC in its 2017 *Smart Grid Projects Outlook* (JRC, 2017).

European Structural and Investment Funds (ESIF) have in particular contributed to a pilot project on the “*Introduction of smart grids in pilot areas*” implemented by HEP-ODS (HERA, 2020; MEE, 2019). Croatia’s NECP plans to capitalise on this experience and continue to resort to ESIF in this area during the 2021-2027 period (MEE, 2019). It also expects to mobilise funding from the Modernisation Fund for investments in “*energy storage and modernisation of energy grids*” (MEE, 2019). Other financing instruments intended to be used include the European Fund for Strategic Investments (EFSI), the Innovation Fund, funds from auctioning of EU-ETS emission

allowances, EU research and development (R&D) and competitiveness programs, as well as the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) (Table 6) (EC, 2020a; MEE, 2019).

Table 6. Potential sources of EU funding

Potential EU funding available to Croatia (2021-2027, EUR billion)		Potential EU funding available to all member States (2021-2027, EUR billion)	
Programme	Amount	Programme	Amount
Cohesion policy funds (ERDF, ESF+, Cohesion Fund)	8.7	Horizon Europe	91.0
Recovery and Resilience Facility	6.0	InvestEU	9.1
Modernisation Fund	0.2	Connecting Europe Facility - Energy	5.8
ETS auction revenue	0.5	Recovery and Resilience Facility	360.0
		Innovation Fund	7.0

Source: adapted from EC, 2020a

HEP-ODS forecasts that its investments in smart grid pilot projects, with EU co-financing, will reach HRK 233,745,000 between 2019 and 2028 (Table 7) (MEE, 2019).

Table 7. Investments in smart grid pilot projects forecasted by HEP-ODS, with EU co-financing

Total investment over the 2019-2028 period: HRK 233,745,000	
Advanced metering infrastructure	HRK 90,918,000
Development and optimisation of conventional network	HRK 40,618,000
Distribution grid automation	HRK 102,209,000

Source: MEE, 2019

#### Smart grids as priorities in the national or regional Smart Specialisation strategies

Smart specialisation strategies are adopted at the national or regional level in order to define priorities in the field of research and innovation (R&I) (JRC, 2017). Their adoption is a condition to gain access to ESIF (JRC, 2017). Member States were invited by the EC to consider the integration of smart grids into these plans for the 2014-2020 period (JRC, 2017).

The Smart Specialization Strategy defined by Croatia for 2016-2020 highlights the country's strengths in the domain of low-carbon technologies, among which:

- "Industrial capacities related to the electrical equipment for power system (e.g. voltage and distribution transformers, rotary machines, wind turbines, photovoltaic panels), [...]"
- The tradition and experience in the design and construction of power plants, transmission lines, substations and control systems with very good global export potential, [...]"
- A number of educational institutions and university programmes where students are educated in the area of production, engineering and maintenance,
- A certain number of public and private research organisations with proven capabilities in this area that can support and enhance the competitiveness of industry through research and development" (MEE, 2019).

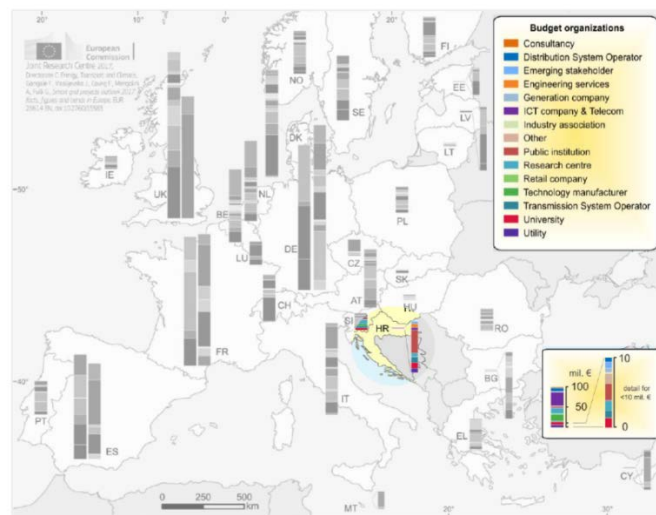
In order to capitalise on these strengths, the "sub-thematic priority areas" of "energy technology, systems and equipment" and "ecologically acceptable technologies, equipment and advanced materials" have been identified, and "advanced grids and smart systems" are one of the targeted research topics (MEE, 2019).

## Market environment

### Number and size of established market actors

The JRC's 2017 *Smart Grid Projects Outlook* provides estimates of investment in this domain by the different actors present in Croatia (Figure 16) (JRC, 2017). In particular, its database of smart grid projects counts 2 TSOs, 1 utility, 1 retail company, 1 engineering services company, 1 information and communication technologies (ICT)/telecom company, 2 universities, 1 research centre, 4 public institutions and 1 emerging stakeholder involved in the inventoried national and multinational projects (JRC, 2017).

Figure 16. Investment in smart grid projects by the different actors in Croatia



Source: JRC, 2017

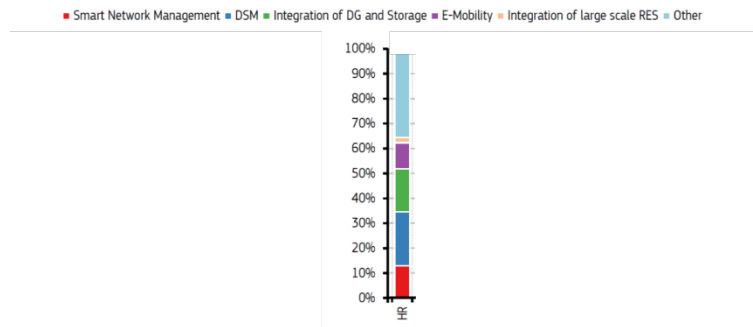
It also focuses on “*emerging stakeholders*”, defined as “*organisations that offer solutions and services related to energy generation, supply, distribution or other energy services (such as demand response and energy efficiency)*” and “*organisations that have more recently started to collaborate with traditional smart grid actors to implement smart solutions at local level, such as municipal utilities, housing associations, transport solution providers, energy cooperatives*” (JRC, 2017). Total investment by these actors in Croatia represents less than EUR 1 million (JRC, 2017).

### Existence of a national smart grid value chain

The JRC counted 9 R&D and 5 demonstration projects involving organisations based in Croatia in its 2017 *Smart Grid Projects Outlook* (JRC, 2017). The Centre estimates that this number “*can be considered as an indication of the intention to invest in smart grid solutions in each country*” (JRC, 2017). Among these projects, 2 are “*national projects*”, defined as “*projects carried out in one country with the exclusive participation of organisations from that country*” (JRC, 2017). The investment in smart grid projects whose partners are based in Croatia was estimated to EUR 3.8 million for R&D projects and EUR 2.4 million for demonstration projects (JRC, 2017). Investment in multinational projects (EUR 5.9 million) is higher than in national projects (EUR 0.4 million) (JRC, 2017). The projects cover the different smart grid domains (Figure 17) (JRC, 2017). The 3 demonstration implementation sites inventoried in the JRC’s database, within the framework of 2 multinational projects, are related with demand-side management and distributed generation and storage integration (JRC, 2017).



Figure 17. Investment in smart grid projects per domain in Croatia



Source: JRC, 2017

More specifically, Croatia's NECP identifies several "areas with most significant capacities of both industry and scientific community", among which:

- The "development of new and improvement of existing primary and secondary equipment for power system (primary equipment: [...] transformers, switches, [...] secondary energy equipment: control, measurement, protection, supervision, management),
- New technologies and improvements related to power plants, substations, components and systems related to renewable energy sources,
- [...] Systems for energy management and support to functioning of the energy market at the level of microgrids, advanced grids and smart cities,
- [...] [And the] application of advanced grids and complex energy systems" (MEE, 2019).

#### Overall climate for innovation

Croatia's R&D expenditures represented 0.86% of GDP in 2017, below the EU target of 3% (MEE, 2019). The NECP plans to increase them progressively to reach this threshold and provides for a set of measures in this domain (Table 8) (MEE, 2019). In addition to the Smart Specialisation Strategy, Croatia has adopted several roadmaps in the field of R&D&I, among which the Strategy of Education, Science and Technology (2014), the Research Infrastructure Development Plan (2016) and the Innovation Promotion Strategy (2014-2020) (MEE, 2019). Several institutions are in charge of supporting R&D&I programs and projects, notably the Croatian Science Foundation (HRZZ), the Croatian Agency for Small Business, Innovation and Investment (HAMAG-BICRO), the Croatian Chamber of Economy (HGK), the Croatian Chamber of Trades and Crafts (HOK) and the Croatian Employers' Association (CEA) (MEE, 2019). Besides, 13 competitiveness clusters dedicated to specific industries gather companies, public authorities and research institutions (MEE, 2019).

Table 8. Measures on R&amp;D&amp;I in Croatia's NECP

Measures	Implementation period
"Research, innovation and competitiveness status quo analysis and determining targets, indicators and monitoring system", notably through the definition of "a three-year action plan [...] relevant to the dimensions of the Energy Union"	2020-2022-2030
"Co-financing industrial research and experimental development projects aligned with the National Development Strategy"	2021-2030
"Supporting low carbon entrepreneurship development"	2021-2030
"Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies"	2021-2030
"Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy"	2020-2030

Source: MEE, 2019

### 3.2. Market context in Spain

#### General characteristics

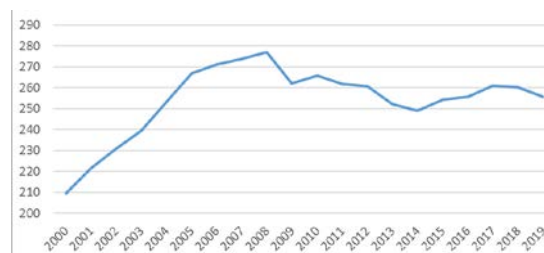
##### Country's size, population and electricity consumption

With an area of 505,000 square-kilometres, Spain presents a significant diversity in terms of geography and climate and a strong potential for renewable energies (IEA, 2021a; MITECO, 2020). In addition to the mainland, located in the Iberian Peninsula, it comprises the Canary and Balearic Islands, as well as two autonomous cities, Ceuta and Melilla (IEA, 2021a). Spain's governance is decentralised to a significant extent, and some competences in the field of energy – notably regarding electricity distribution networks – have been granted to the 17 autonomous communities (IEA, 2021a). Besides, specific regulations apply for electricity generation in non-peninsular territories, which represented c. 13,700 GWh in 2019 (IEA, 2021a).

Spain's population was 46.8 million in 2020, and is expected to decrease to 46.2 million by 2030 and 43.6 million by 2050 according to the United Nations' (UN) projections (UN, 2019). Nonetheless, Spain's National Energy and Climate Plan (NECP) makes the hypothesis of a 1% growth of the population between 2020 and 2030, to reach 47.2 million (MITECO, 2020). Population density is 93.7 persons per square kilometre, however it is relatively low in certain areas (MITECO, 2020; UN, 2019). The share of urban population is 80.8% and it should reach 83.3% in 2030 and 88.0% in 2050 (UN, 2018).

Electricity consumption represented 242 TWh in 2019 (Figure 18) (IEA, 2021). The services/other (including agriculture and forestry) sector represented the largest share of it (33.7%), while the industrial and residential sectors accounted for 31.4% and 30.1% respectively (IEA, 2021a). Table 9 presents a decomposition per category and share in electricity consumption of the 28.3 million consumers on Spain's retail market (IEA, 2021a).

Figure 18. Electricity consumption in Spain (TWh)



Source: IEA Data Services



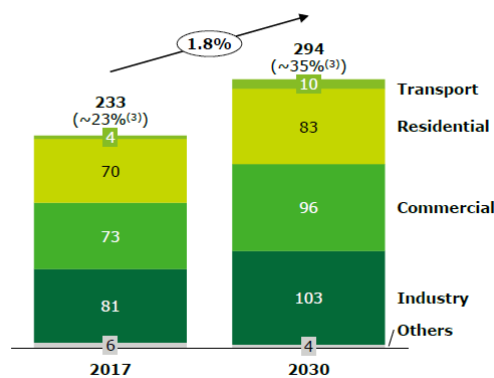
Table 9. Decomposition per category and share in electricity consumption of the 28.3 million consumers on Spain's retail market

Consumption category	Share in total consumers	Share in electricity consumption
Domestic consumers with power less than 10 kW	94%	27.5%
Domestic consumers with power more than 10 kW	6%	18.5%
SMEs		
Industry		54%

Source: IEA, 2021a

Various projections of the evolution of final electricity demand at the 2030 horizon have been proposed. It would reach 249 TWh according to the Spanish NECP's Target Scenario, down from 253 TWh in its Baseline Scenario, in which no additional policies would be enacted (MITECO, 2020). The scenario considered by Monitor Deloitte is even higher, with a projection at 294 TWh in 2030 and a yearly growth of c. 1.8% between 2017 and 2030 (Figure 19) (Monitor Deloitte, E.DSO, Eurelectric, 2021). There could especially be 4 million EVs at this horizon (Monitor Deloitte, E.DSO, Eurelectric, 2021).

Figure 19. Final electricity demand in Spain (TWh): projected evolution from 2017 to 2030



NB: the percentage between parentheses corresponds to the country's electrification rate

Source: Monitor Deloitte, E.DSO, Eurelectric, 2021

Peak demand could then increase by 8 GW between 2017 and 2030, to reach 49 GW (Monitor Deloitte, E.DSO, Eurelectric, 2021).

### State of the electricity grids

#### ➤ Grid infrastructure

Spain's NECP highlights the necessity to "[strengthen and expand]" the country's transmission and distribution infrastructure in the context of a rising share of RES (MITECO, 2020). Investment needs in networks and electrification are estimated to EUR 58.6 billion over the 2021-2030 period, accounting for 24% of the total investment needs associated to the Plan (MITECO, 2020). In the case of distribution grids, an estimation of investment needs over the 2020-2030 period has been proposed by Monitor Deloitte, at EUR 22 billion:

- 39% associated with electrification and increasing penetration of RES;
- 41% motivated by modernisation and resilience;
- and 20% for digitalisation and other drivers (Monitor Deloitte, E.DSO, Eurelectric, 2021).

DSOs have to define network investment plans for three-year periods (IEA, 2021a). The planning process is therefore not centralised: Spain's regulatory authority, the National Commission of Markets and Competition (CNMC), is only consulted on DSOs' plans, and a spending cap is applied to them (IEA, 2021a).

In 2020, a Royal Decree-Law (23/2020) was adopted to preserve and foster investments in electricity grids and their digitalisation in the specific context of the Covid-19 health crisis (IEA, 2021a).

Besides, Spain's NECP provides for several measures to “[adapt] electricity grids to integrate renewables”, notably an “adaptation of electricity transmission and distribution network planning”, and a “significant digitalisation process that will allow [the networks] to improve their monitoring, control and automation systems” and “to carry out effective demand management and to integrate new services for consumers such as smart charging systems, storage or demand aggregators” (MITECO, 2020).


#### ➤ Smart meter deployment

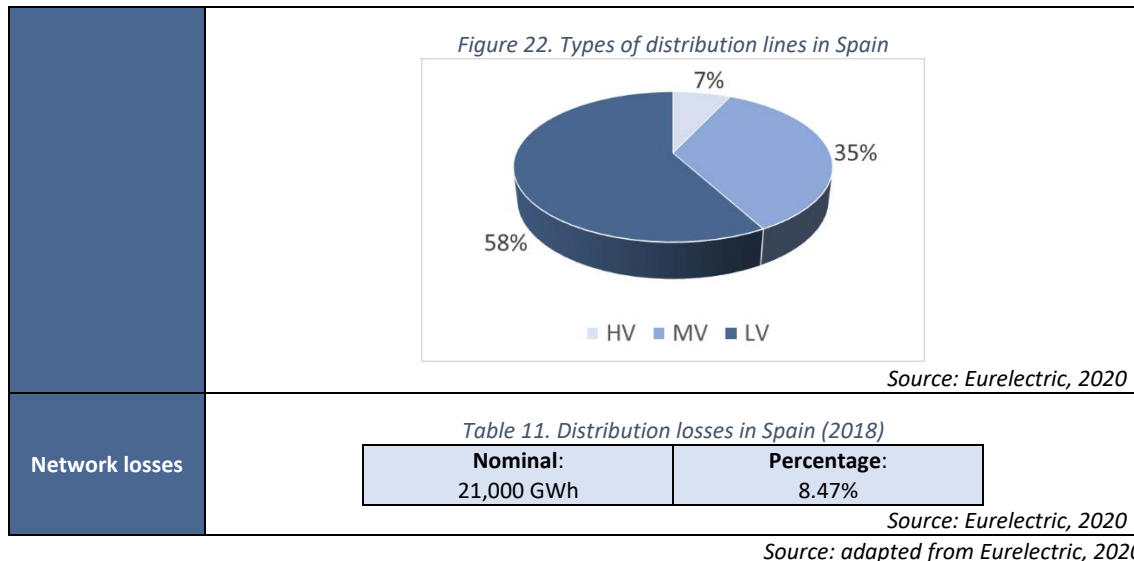
A large-scale deployment of smart meters has been achieved in Spain in 2018, ten years after the adoption of a dedicated plan (IEA, 2021a). Their penetration is very high, reaching 99.6% for consumers with a contracted power inferior to 15 kW and 75% for those between 15 and 50 kW (IEA, 2021a). Following the operating procedures approved in 2015, which allowed the issuance of bills resting on hourly data for customers with smart meters, the ones adopted in 2019 require the provision to consumers of hourly consumption measurements from these meters (CNMC, 2018; IEA, 2021a). Besides, a public consultation on the evolution of smart meters is planned (IEA, 2021a).

#### ➤ Quality of power supply

Eurelectric proposes three indicators to analyse the quality of power supply: continuity of supply, voltage quality, and network losses (Eurelectric, 2020). The state of electricity grids in Spain, in regard of these indicators, is described below (Table 10).

Table 10. Quality of power supply indicators in Spain

Continuity of supply	<p>Continuity of supply is assessed by means of two indicators: the system average interruption frequency index (SAIFI) and the system average interruption duration index (SAIDI).</p> <p><i>Figure 20. Evolution of SAIDI and SAIFI in Spain (2015-2020)</i></p>  <table border="1"><caption>Data for Figure 20: Evolution of SAIDI and SAIFI in Spain (2015-2020)</caption><thead><tr><th>Year</th><th>SAIFI</th><th>SAIDI</th></tr></thead><tbody><tr><td>2015</td><td>0.6</td><td>0.4</td></tr><tr><td>2016</td><td>0.6</td><td>0.4</td></tr><tr><td>2017</td><td>0.5</td><td>0.4</td></tr><tr><td>2018</td><td>0.9</td><td>0.7</td></tr><tr><td>2019</td><td>0.7</td><td>0.5</td></tr><tr><td>2020</td><td>0.7</td><td>0.5</td></tr></tbody></table> <p>Source: World Bank, DataBank, Doing Business</p>	Year	SAIFI	SAIDI	2015	0.6	0.4	2016	0.6	0.4	2017	0.5	0.4	2018	0.9	0.7	2019	0.7	0.5	2020	0.7	0.5																													
	Year	SAIFI	SAIDI																																																
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Voltage quality	<p><i>Figure 21. Voltage levels used and ranges in which DSOs operate in Spain</i></p> <table border="1"><thead><tr><th>LV</th><th colspan="10">MV</th><th colspan="10">HV</th></tr></thead><tbody><tr><td>(&gt;1kV)</td><td>3kV</td><td>5kV</td><td>6kV</td><td>10kV</td><td>11kV</td><td>15kV</td><td>20kV</td><td>22kV</td><td>23kV</td><td>24kV</td><td>25kV</td><td>30kV</td><td>33kV</td><td>35kV</td><td>36kV</td><td>38kV</td><td>45kV</td><td>50kV</td><td>60kV</td><td>65kV</td><td>66kV</td><td>70kV</td><td>110kV</td><td>120kV</td><td>130kV</td><td>132kV</td><td>150kV</td><td>220kV</td></tr></tbody></table> <p>Source: Eurelectric, 2020</p>	LV	MV										HV										(>1kV)	3kV	5kV	6kV	10kV	11kV	15kV	20kV	22kV	23kV	24kV	25kV	30kV	33kV	35kV	36kV	38kV	45kV	50kV	60kV	65kV	66kV	70kV	110kV	120kV	130kV	132kV	150kV	220kV
LV	MV										HV																																								
(>1kV)	3kV	5kV	6kV	10kV	11kV	15kV	20kV	22kV	23kV	24kV	25kV	30kV	33kV	35kV	36kV	38kV	45kV	50kV	60kV	65kV	66kV	70kV	110kV	120kV	130kV	132kV	150kV	220kV																							



### Number and company culture of DSOs

More than 330 DSOs are active in Spain; 5 of them are legally unbundled, which is required for DSOs having more than 100,000 customers (Eurelectric, 2020; IEA, 2021a). Spain is considered by Eurelectric as a country characterized by “*medium concentration*” regarding DSOs: it has “*a mix of DSOs, with the three largest accounting for more than 60% of distributed power*” and some smaller DSOs associated with local networks (Eurelectric, 2020; IEA, 2021a). DSO ownership is “*largely private*”, with a “*largely domestic*” shareholding (Eurelectric, 2020).

### Regulatory framework

#### Favourable regulatory framework

The functioning of Spain’s electricity markets is governed notably by the provisions of the Law 24/2013 on the electricity sector; the EU directives and regulations associated with the Clean Energy Package are being transposed into national law (IEA, 2021a).

#### ➤ Electricity markets framework and incentives given to network operators

Spain’s regulatory authority in charge of overseeing electricity markets is the CNMC (IEA, 2021a). The country’s wholesale market is part of the Iberian Electricity Market (MIBEL), which was launched in 2007 and is managed by two companies of the OMI Group: OMIE (day-ahead and intraday markets, with two price zones: Spain and Portugal) and OMIP (futures market) (IEA, 2021a). Ancillary services are managed by the Spanish and Portuguese TSOs, Red Eléctrica de España (REE) and Redes Energéticas Nacionais (REN) (IEA, 2021a). Table 12 presents the markets for system adjustment services managed by REE (IEA, 2021a).

Table 12. Markets for system adjustment services managed by REE

Solution of technical restrictions	
Balancing services	Secondary regulation (automatic reserve for frequency recovery) Tertiary regulation (manual reserve for frequency recovery) Deviation management (replacement reserves)

Source: adapted from IEA, 2021a

The CNMC estimates that “*the level of competition is higher in the day-ahead and intraday markets than in balancing and technical constraints markets*” (CNMC, 2018). Overall, the concentration of the Spanish electricity market, which is “*dominated*” by three large companies – Grupo Endesa, Iberdrola and Naturgy – representing half of consumption volumes, appears to

be decreasing with the rising penetration of RES (IEA, 2021a). The latter have been authorised to participate to markets for system adjustment services since 2016, and Spain's NECP plans to *"[increase] the contribution of renewable energies to adjustment and balancing services"*, as well as to *"[develop] the legal framework to enable and encourage distribution network operators to obtain flexibility and balancing services from distributed generation suppliers, demand response or energy storage, as a cost-efficient alternative to more conventional network management mechanisms"* (MITECO, 2020).

As regards electricity network infrastructure, Royal Decree 1048/2013 aimed at improving the quality of supply and energy efficiency, notably through incentives for losses and fraud reduction (CNMC, 2018; MITECO, 2020). The NECP evokes several measures in the same objective, namely: *"promoting design criteria based on efficiency, increasing line and cable sections, improving capacity factors and increasing voltage, upgrading substations, optimising the low-voltage network and the grid system, demand management, optimising the use of smart meters and reducing fraud"* (MITECO, 2020).

#### ➤ Electricity markets framework and incentives given to suppliers

Spain's retail market comprises a *"free market"* (63% of supply points in 2019), in which end consumers can choose their supplier, and a *"regulated market"* (37%) with eight reference suppliers, in which LV customers with power less than 10 kW can choose to benefit from a *"voluntary price for the small consumer"* (PVPC) – variable, based on wholesale market prices – or from a fixed price (CNMC, 2018; IEA, 2021a). There are also *"direct consumers"* purchasing energy to generators (IEA, 2021a).

The retail market is relatively concentrated, as the share of the five largest suppliers reached c. 86% of the household segment, 70% of the industrial segment, and 65% of SMEs in 2019 (IEA, 2021a). The supplier quarterly switching rate was of 2.1%, 6.2% and 4.6% respectively for these three segments (IEA, 2021a).

Several measures have been enacted to reinforce the information available to end customers and enable them to play an active role. The Electricity Act 24/2013 for instance sets a limit on the time required for supplier switching and contains provisions on consumers' access to information on energy costs and to their consumption data (CNMC, 2018). The CNMC proposes an online tool allowing LV customers to compare suppliers' commercial offers, and another one through which PVPC customers can analyse their electricity bill (CNMC, 2018). The NECP intends to go further in *"promoting the proactive role of citizens in decarbonisation"* (MITECO, 2020). It especially plans to foster *"citizen participation in demand management [...], through the necessary mechanisms to ensure that the structures of tariffs, tolls and electricity charges are designed to give a favourable signal both for active demand management and for consumption reduction"*, and to grant consumers with a *"full right [...] to have real-time access to their energy data at no additional cost and to transfer these data to third parties without any impediment"* (MITECO, 2020).

#### ➤ Provisions regarding emerging stakeholders

Spain's NECP *"[expects] that the diversity of stakeholders and the existence of participatory projects both in renewable energy generation and in the energy system as a whole will increase, as a result of own consumption, distributed generation, demand management and the promotion of local energy communities, as well as specific measures aimed at promoting the proactive role of citizens in decarbonisation"* (MITECO, 2020). The Royal-Decree Law 23/2020

went in this direction, paving the way for new actors like independent aggregators and renewable energy communities (IEA, 2021a).

The NECP provides for several measures to foster the development of demand management and the role of actors providing related services (among which aggregators), notably the definition of an appropriate regulatory and legislative framework, the provision of *“options and signals suitable for consumers”* (including *“dynamic pricing”*), the creation of a *“one-stop shop and [the] simplification of procedures”* (MITECO, 2020).

The NECP also puts emphasis on the *“development of own consumption using renewables and distributed generation”*, in line with Royal Decree-Law 15/2018 and Royal Decree 244/2019 which aimed at removing certain barriers, among which the *“sun tax”* applicable to certain installations, and paved the way for collective self-consumption and intervention of energy service providers (IEA, 2021a; MITECO, 2020). The Plan especially provides for the definition of a *“National Own Consumption Strategy”* which will define ambitious objectives while taking into account *“the required technical-economic sustainability of the electricity system”* (MITECO, 2020).

Own consumption schemes – especially collective ones – are considered as a *“starting point for local energy communities”*, which the NECP also intends to encourage, notably thanks to the definition of the relevant legislative framework, the creation of a one-stop shop, demonstration projects and capacity-building measures (MITECO, 2020).

#### Specific regulatory funding for innovation projects

DSOs mainly finance investments by means of tariffs, even though specific incentive mechanisms for innovation activities exist in certain countries (JRC, 2017). The JRC classifies the *“regulatory funding”* of DSOs as *“own/private financing”* (JRC, 2017). In Spain, the private financing of investments in smart grid projects, as measured by the JRC’s *Smart Grid Projects Outlook 2017*, represented EUR 236 million, i.e. 45.2% of their total financing (JRC, 2017). The JRC notes that *“private investment is [...] high”* in the country, *“particularly in the Basque region area”* (JRC, 2017).

Network access tariffs for both transmission and distribution are one component of electricity prices in Spain (MITECO, 2020). The CNMC has been in charge of defining the methodology for their calculation since 2020 (ACER, 2021; IEA, 2021a).

Distribution tariffs, which are the same for the different DSOs in the country, entirely cover distribution costs, including investments and operational expenditures, costs of distribution losses and metering costs (ACER, 2021). The tariff methodology is defined for 6-year periods (currently, 2020-2025), yet tariff values can be adjusted annually depending on *“the allowed revenues, energy and power forecasted demand for the tariff year and last available energy balances and load curves”* (ACER, 2021).

The distribution tariff in Spain does not include an injection charge, but consists in a withdrawal charge, which is both energy-based and power-based (ACER, 2021). The power-based charge represents 75% of the withdrawal charge, and a penalty also applies when actual power exceeds contracted power (ACER, 2021). Power- and energy-based charges are time-differentiated for all network users, with six periods – except in the case of households, for which there are two periods for the power-based charge and three for the energy-based charge (ACER, 2021). The

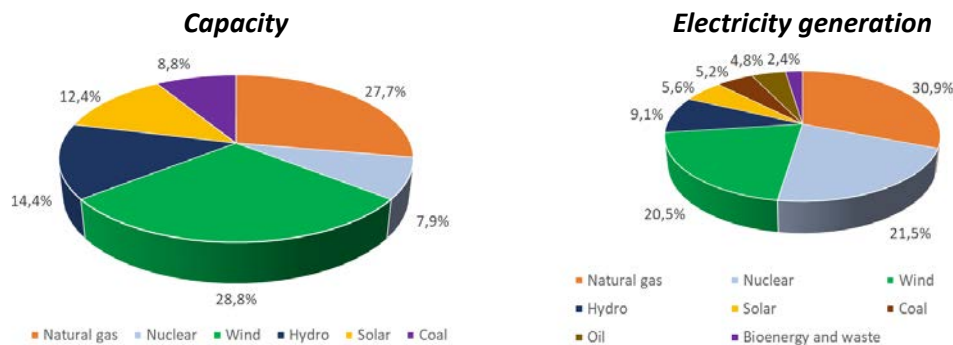
time differentiation is both daily (with a day/night, peak/off-peak, working day/week-end distinction) and seasonal (high, medium-high, medium and low) (ACER, 2021).

Household and non-household consumers, auxiliary services of generators, prosumers and self-consumers are subject to the tariff for withdrawal in Spain, while pumped hydroelectric storage and other storage facilities are not (ACER, 2021). Operators of publicly-accessible EV charging points can opt for a specific tariff, in which the energy-based charge has a more important weight (ACER, 2021).

#### RES supporting mechanisms and policies

Spain's electricity mix is characterised by a rising penetration of RES: their share in generation increased from 24% to 38% between 2009 and 2019 (IEA, 2021a). This increase was notably driven by wind energy, with an installed capacity growing from 2 GW in 2000 to 26 GW in 2019, and by solar PV, with an installed capacity rising from 476 MW in 2007 to c. 9 GW in 2019 (IEA, 2021a).

Figure 23. Spain's electricity mix as of 2019



Source: IEA, 2021a

Various mechanisms and policies have been enacted to foster the development of RES in Spain. A “Special Regime for the Promotion of Renewable Energy” was implemented from 1997 on, with a FiT scheme; complemented with specific provisions in Royal Decree 661/2007 (ensuring notably priority grid access), it led to a significant development of wind and solar energy until 2013, which saw evolutions in the remuneration framework and a slowdown in investments that lasted until 2018 (IEA, 2021a). A competitive tendering (auction) scheme has been introduced in 2014 and implemented from 2016 on (CNMC, 2018; IEA, 2021a; MITECO, 2020). Within its framework, RES may obtain support in addition to revenues from market participation (CNMC, 2018; IEA, 2021a).

The NECP points to significant changes in Spain's electricity mix by 2030, with a complete phase-out of coal generation, which is expected to no longer be competitive at this horizon, and a gradual closure of nuclear plants by 2035 (IEA, 2021a; MITECO, 2020). Ambitious objectives have been set for RES development over the same period: they should represent 42% of energy end-use and 74% of electricity generation at the 2030 horizon, contributing to a 23% reduction in GHG emissions from 1990 levels (IEA, 2021a; MITECO, 2020). Renewable electricity generation capacity would reach c. 123 GW in 2030, with 59 GW of capacity additions – of which 22 GW of wind capacity and 30 GW of solar PV capacity – by this horizon (IEA, 2021a; MITECO, 2020). However, a large share of the new capacity is expected to consist in large-size installations connected to the transmission network: only 20-30% of it could be connected to the distribution grid (Monitor Deloitte, E.DSO, Eurelectric, 2021).



In order to reach these objectives, Spain's NECP puts forward *“a three-pronged strategy: the promotion of large generation projects, the development of own consumption and distributed consumption, and measures to integrate renewables into the electricity system and market”* (MITECO, 2020). While the rising competitiveness of RES is expected to favour their development, auctions will continue to be held to grant support, with an updated framework (IEA, 2021a; MITECO, 2020). In addition, adapted public support mechanisms will foster the development of the *“technologies that have not reached technological maturity”* yet (e.g. offshore wind or marine energy), notably through specific tenders *“that will make it possible to accommodate demonstration or flagship projects”* (MITECO, 2020). According to the IEA, *“overall, the government plans to auction around 5 GW of renewables capacity annually, though additional capacity will be need to meet its targets, likely coming from corporate PPAs, utility bilateral contracts or self-consumption”* (IEA, 2021a). Table 13 provides an overview of other measures planned in the NECP to foster the development of RES (MITECO, 2020). Investment needs to reach the NECP's objectives in this field are estimated to represent c. EUR 92 billion between 2021 and 2030, i.e. 38% of the total (MITECO, 2020).

Table 13. Measures (beyond competitive tendering procedures) planned in the NECP to foster the development of RES

Measure 1.5. Incorporation of renewables in the industrial sector
Measure 1.6. Framework for the development of thermal renewable energies
Measure 1.10. Promotion of bilateral renewable electricity contracts
Measure 1.12. Unique projects and strategy for sustainable energy on the islands
Measure 1.16. Public procurement of renewable energy
Measure 1.17. Training professionals in the renewable energy sector
Measure 1.18. Revision and simplification of administrative procedures
Measure 1.19. Generating knowledge, outreach, awareness and training

Source: adapted from MITECO, 2020

The NECP underlines that *“the analyses performed by various models indicate that security of electricity supply would be guaranteed with the power generation mix presented in the Target Scenario”* (MITECO, 2020). To address the challenges raised by the rising share of variable RES, the Spanish electricity system is expected to rely on natural gas back-up capacity (a total of 27 GW in 2030), as well as flexibility provided by storage (with 6 GW of additional capacity) and demand management (IEA, 2021a; MITECO, 2020). Besides, the introduction of capacity mechanisms may be considered (IEA, 2021a; MITECO, 2020). The NECP specifies that they would be *“open to the participation of all resources that are in a position to provide the necessary capacity, including energy storage and demand management”* (MITECO, 2020).

Spain's NECP also defines objectives at the 2050 horizon, at which the country expects to reach climate neutrality, with an electricity entirely sourced from RES (IEA, 2021a).

Spain's targets related to RES development and GHG emissions reduction and neutrality are reaffirmed in the Climate Change and Energy Transition Law, adopted in May 2021, and in the Long-Term Strategy, approved in November 2020 (IEA, 2021a).

#### National context

##### National co-funding mechanisms

In Spain, the national (and regional) financing of investment in smart grid projects, as measured by the JRC's *Smart Grid Projects Outlook 2017*, represented EUR 104 million, i.e. 19.9% of total financing (JRC, 2017). The country, and notably the Basque region area, are identified as one of the *“important hotspots for national funding in Europe”* (JRC, 2017).

### Adoption of Smart grid Action Plans/National priorities

Spain's NECP provides for a change in paradigm in the country's power system, with a large penetration of RES and a reliance on flexibility, demand management and storage to ensure their smooth and secure integration: *"the paradigm of base and peak generation becomes a new one of variability versus flexibility"* (MITECO, 2020). The Plan therefore provides for several measures related to smart grids. The *"adaptation of electricity grids to integrate renewables"* (measure 1.3 of the NECP) is in particular expected to rest on *"a significant digitalisation process that will allow [the networks] to improve their monitoring, control and automation systems"* and *"to carry out effective demand management and to integrate new services for consumers such as smart charging systems, storage or demand aggregators"* (MITECO, 2020). The Plan underlines that *"one mechanism for promoting this is the remuneration schemes for regulated electricity distribution and transmission activities, which enable the necessary progress in digitalisation, encourage innovation and the application of alternative solutions to traditional investments that may entail savings for the system, and recognise the greater level of interaction between network operators and users"* (MITECO, 2020). More generally, within the framework of the *"Planning for safe operation of a decarbonised energy system"* (measure 3.6), the NECP notes that the *"challenges"* associated with RES development objectives cannot be met only through supply-side measures, and that in this regard, *"technological advances have enabled the existence of a series of technological solutions that have still not been fully explored in the electricity sector regulations, but [that] are required to play an important role in ensuring the continuity of electricity supplies: in particular, any of the optimisations that enable the intensive use of information and communication technologies in the energy system"* (MITECO, 2020).

In line with the NECP's provisions and projections, Spain's Recovery, Transformation and Resilience Plan, approved by the EC in June 2021, puts forth the smartening of electricity infrastructure: it calls for *"boosting the deployment and the technological update of electrical energy transmission and distribution networks with a view to the integration of renewable energies, demand management, the development of independent aggregators and distributed energy resources, and the progressive electrification of mobility and the construction sector"* (Presidency of the Government of Spain, 2020).

### Creation of Smart Grid Platforms

A smart grid platform has been created in Spain in 2005: the Spanish Technological Platform of Electrical Grids, FUTURED, which gathers DSOs, public organisations, companies and academic stakeholders, and whose stated mission is *"to foster the technological evolution of Spanish electricity transmission and distribution systems in order to promote the technological leadership, the sustainable development and an increased competitiveness"* (FUTURED, n.d.; JRC, 2017).

### European context

#### Accessibility to European co-funding mechanisms

European financing of investment in smart grid projects in Spain was estimated at EUR 182 million – i.e. 34.9% of total financing – by the JRC in its 2017 *Smart Grid Projects Outlook* (JRC, 2017). The country is ranked by the JRC as one of the *"hotspots for EU funding"* in Europe (JRC, 2017).

Spain plans to continue to resort to European funding mechanisms to accompany its energy transition. Investment needs to fulfil the NECP's objectives are estimated to EUR 241 billion over the 2021-2030 period; while private investment is expected to cover most of them, public



investment may account for 20%, and would come in part from European sources (MITECO, 2020). The EC's assessment of Spain's NECP proposes a list of potential EU funding sources that the country could mobilise (Table 14) (EC, 2020b).

Table 14. Potential sources of EU funding

Potential EU funding available to Spain (2021-2027, EUR billion)		Potential EU funding available to all member States (2021-2027, EUR billion)	
Programme	Amount	Programme	Amount
Cohesion policy funds (ERDF, ESF+, Cohesion Fund)	35.4	Horizon Europe	91.0
Recovery and Resilience Facility	59.2	InvestEU	9.1
Just Transition Fund	0.8	Connecting Europe Facility - Energy	5.8
ETS auction revenue	8.9	Recovery and Resilience Facility	360.0
		Technical Support Instrument	0.9
		Programme for Environment and Climate Action (LIFE)	5.4
		European Agricultural Fund for Rural Development	8.2
		Innovation Fund	7.0

Source: adapted from EC, 2020b

In particular, the NECP provides for a greater “*participation in European research and innovation funding programmes*” and for the mobilisation of “*European innovation financing mechanisms*”, notably the European Fund for Strategic Investments 2.0 and the Innovation Fund (MITECO, 2020).

#### Smart grids as priorities in the national and regional Smart Specialisation strategies

Spain has defined smart specialisation strategies at both the national and regional levels. Their framework is set by the Strategy for Science, Technology and Innovation 2013-2020, as well as the State plans for scientific and technical research and innovation (MITECO, 2020). Autonomous communities can rely on this basis to define R&I strategies for smart specialisation, which put forth priority areas for which EU cohesion funds could be mobilised (IEA, 2021a; MITECO, 2020). Smart grids are especially targeted in the S3-Energy “Intelligent Specialisation” platform (IEA, 2021a).

#### Participation in EU Working Groups and Platforms

Spain participates to European and international cooperation programs in the field of energy. At the international level, it takes part to 19 IEA technology collaboration programs and to the Clean Energy Ministerial's activities on RES, smart grids and flexibility in the power system (IEA, 2021a). At the European level, the IEA observes that “*Spanish institutions are a particularly active partner under the SET-Plan and Horizon 2020 activities*”, notably the European Energy Research Alliance, where Spain is represented by the Research Centre for Energy, Environment and Technology (CIEMAT) (IEA, 2021a). In this regard, the NECP notes that Spain is already “*the country with the fourth highest level of participation*” in Horizon 2020, “*the second most active country in the societal challenge ‘Climate action, environment, resource efficiency and raw materials’ and the third in Societal Challenge 3, ‘Secure, Clean and Efficient Energy’*” (MITECO, 2020). Within the framework of the SET Plan, Spain has especially been participating to working groups related to different RES and to smart energy systems (MITECO, 2020).

The NECP provides for a continuation of this active role, underlining that “*Spain is willing to participate in international consortia for research, innovation and industrial implementation. It will be particularly important to take part in future energy ERA-NET projects, in the SET Plan*”

implementation working groups (IWG), as well as in partnerships under Horizon Europe” (MITECO, 2020).

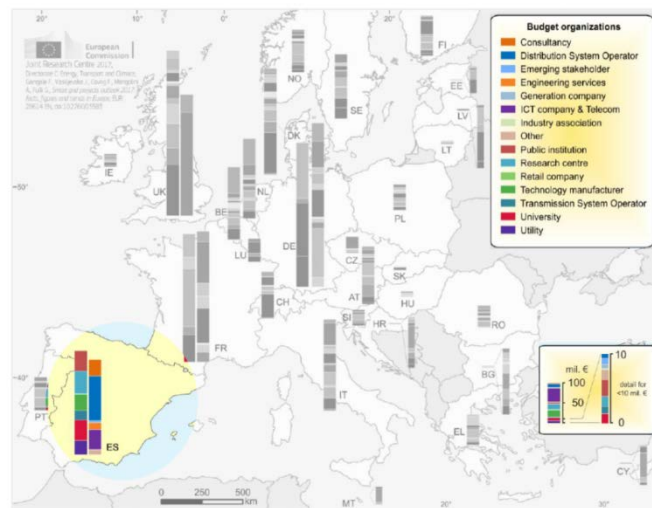
### Market environment

#### Number and size of established market actors

Spain counts leading actors in R&I and industry in the field of energy, as well as dedicated public organisations such as the CIEMAT and the CENER (National Renewable Energy Centre) (MITECO, 2020). The IEA underlines that the country “has a long-standing track record of incentivising clean energy deployment through market pull instruments [...]. Framework market conditions have helped position several Spanish utilities and energy equipment manufacturers in key sectors as European and global leaders, which in turn has increased the level of corporate R&D in these sectors and enhanced the incentives for innovators” (IEA, 2021a). The NECP announces the definition of an “Industrial Development Plan”, which will “carry out an exhaustive and systematic analysis of [Spain]’s potential in international renewable technology value chains, as well as [...] map existing technological, industrial and knowledge capacities” (MITECO, 2020).

The JRC’s 2017 *Smart Grid Projects Outlook* provides an estimate of the investment in this domain by the different actors present in Spain (Figure 24) (JRC, 2017). In particular, its database of smart grid projects counts 1 TSO, 6 DSOs, 3 utilities, 2 retail companies, 2 generation companies, 13 engineering services companies, 43 ICT/telecom companies, 30 technology manufacturers, 30 universities, 48 research centres, 34 public institutions, 23 consultancies, 4 industry associations and 8 emerging stakeholders involved in the inventoried national and multinational projects (JRC, 2017).

Figure 24. Investment in smart grid projects by the different actors in Spain



Source: JRC, 2017

Spanish DSOs are especially involved in smart network management projects (JRC, 2017). The JRC’s study also focuses on “emerging stakeholders”, defined as “organisations that offer solutions and services related to energy generation, supply, distribution or other energy services (such as demand response and energy efficiency)” and “organisations that have more recently started to collaborate with traditional smart grid actors to implement smart solutions at local level, such as municipal utilities, housing associations, transport solution providers, energy

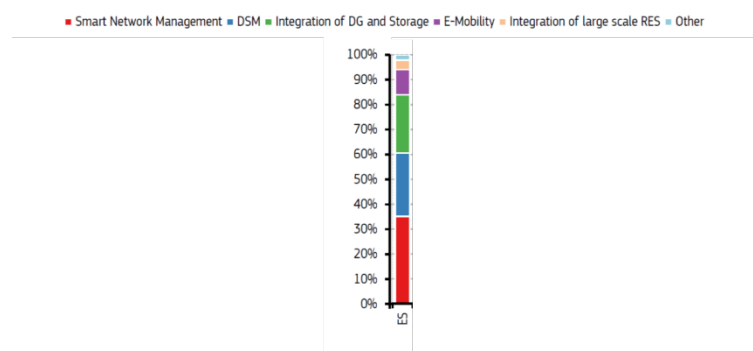
cooperatives” (JRC, 2017). Total investment by these actors in Spain represents about EUR 5 million (JRC, 2017).

#### Existence of a national smart grid value chain

The JRC counted 99 R&D and 79 demonstration projects involving organisations based in Spain in its 2017 *Smart Grid Projects Outlook*, which ranks Spain among the “countries with the highest number of initiatives” (JRC, 2017). The Centre estimates that this number “can be considered as an indication of the intention to invest in smart grid solutions in each country” (JRC, 2017). Among these projects, 19 are “national projects”, defined as “projects carried out in one country with the exclusive participation of organisations from that country” (JRC, 2017). Spain is also among the countries with the highest investments in this domain (JRC, 2017). The investment in smart grid projects whose partners are based in Spain was estimated to EUR 177 million for R&D projects and EUR 344 million for demonstration projects (JRC, 2017). Investment in multinational projects (EUR 277 million) is higher than in national projects (EUR 245 million) (JRC, 2017).

The projects cover the different smart grid domains (Figure 25), especially smart network management, and Spain is one of the countries with the “most implementation sites” (JRC, 2017).

Figure 25. Investment in smart grid projects per domain in Spain



Source: JRC, 2017

#### Overall climate for innovation

Spain has adopted several framework documents in the field of R&D&I, among which the Spanish Strategy for Science, Technology and Innovation 2013-2020 (EECTI) and the State Plans for scientific and technical research and innovation which have been defined for its implementation (MITECO, 2020). A “safe, sustainable and clean energy” is one of the eight key domains with significant potential put forth by the EECTI, and the State Plan for the 2017-2020 period identifies “the design of flexible and distributed networks and management systems” as a priority area (MITECO, 2020). A new Spanish Science, Technology and Innovation Strategy 2021-2027 was adopted in 2020, and is articulated around six pillars; “Climate, energy and mobility” is one of them, in line with the NECP which expected it to contain a “Strategic Action on Energy and Climate Change” (IEA, 2021a; MITECO, 2020).

In addition to the Ministry of Science and Innovation, several institutions are in charge of supporting R&D&I programs and projects, notably the State Research Agency (AEI) – with public-private technology platforms –, the Industrial and Technological Development Centre (CDTI) – which manages the venture capital organisation Innvierte –, the Spanish National Research

Council (CSIC), the CIEMAT and the Institute for Energy Diversification and Savings (IDEA) (IEA, 2021a; MITECO, 2020). Besides, a non-profit Alliance for Energy Research and Innovation (ALINNE) was launched in 2011 to coordinate public and private R&I stakeholders in the field of energy (IEA, 2021a; MITECO, 2020).

Spain's R&D expenditures represent 1.24% of GDP (IEA, 2021a). Its public R&D budget for energy represented EUR 103 million in 2018 and was especially focused on RES (63%) and other electricity and storage technologies (17%) (IEA, 2021a). According to the Spanish Science, Technology and Innovation Strategy 2021-2027, R&D spending should reach 2.12% by the end of the period (IEA, 2021a). Spain's NECP also provides for an increase in R&D&I investment in order to bring it to at least 2.5% of GDP and plans to dedicate *"a significant part"* of it to energy and climate (MITECO, 2020).

The NECP sets four *"priority objectives for energy and climate R&D in Spain"*; one of them is *"competitiveness to improve the effectiveness of the Spanish and European network through the development of a highly digitalised internal energy system and market"* (MITECO, 2020). In order to achieve them, it expects to focus on *"priority areas and technologies"*, among which:

- *"technologies that contribute to the flexibility and optimisation of the electricity system as a whole"*<sup>3</sup>;
- *"new services and technologies for consumers, cities and smart communities"*, notably *"smart solutions [...] that improve and enhance the citizen's status as an energy consumer"* (MITECO, 2020).

The NECP also announces *"new instruments to support research and innovation in energy and climate"*, in particular *"technology demonstrators"*, *"regulatory demonstration projects (sandbox)"*, and *"micro-missions"* (MITECO, 2020).

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<sup>3</sup> In this regard, the NECP notes that *"achieving a secure and resilient system in the context of the energy transition will require technological developments in digitisation, power electronics, storage, equipment and materials improvements, thus aiming to strengthen smart electricity grids, increasing asset flexibility, and the manageability of renewable energy (Action 4 of the SET Plan)"* (MITECO, 2020).

## 4. BUSINESS MODELS OF FLEXIGRID EXPLOITABLE RESULTS: UPDATES AND NEW DEVELOPMENTS

Over the first twelve months of the FLEXIGRID project, exploratory business models have been designed for the nine individual FLEXIGRID solutions. CAP defined and proposed to the partners a methodology resting on A. Osterwalder and Y. Pigneur's Business Model Canvas (presented in Appendix 1 of D8.1) and the corresponding template. At these early stages of the business model development process, the choice was made to focus more specifically on four of the Canvas's building blocks: customer segments, value propositions, revenue streams and cost structure.

During the second year of implementation of the FLEXIGRID project, CAP proposed to the partners a methodology (presented in Appendix 1) and template (presented in Appendix 2) to revisit these exploratory business models, with two objectives:

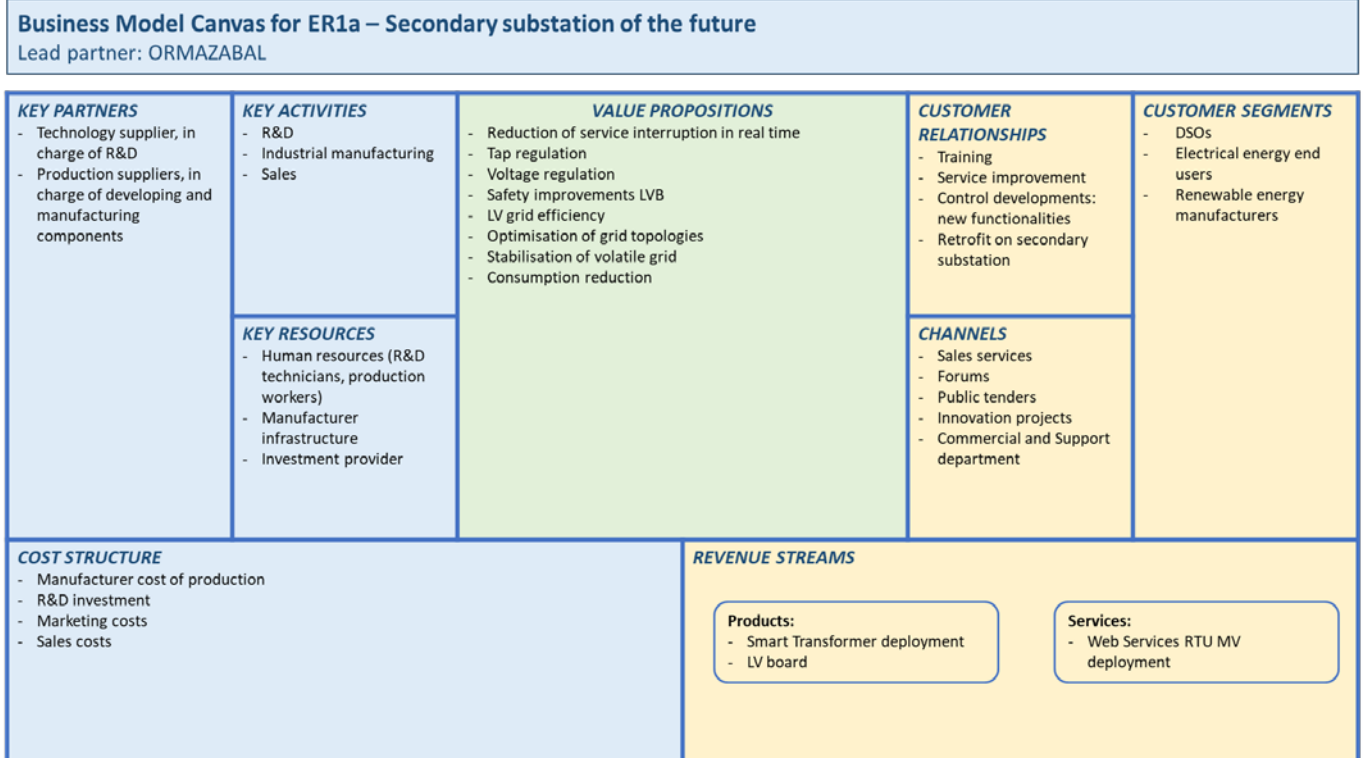
- i) further refining the analysis on some of the Canvas's key building blocks, notably by considering the interactions between them;
- ii) and preparing for the beginning of the demonstration campaign implementation and of the cost-benefit analysis, by focusing on the exploratory business models' applicability.

Besides, exploratory business models have been developed for other exploitable results of the FLEXIGRID project identified within the framework of the Exploitation Strategy (Task 8.5), using the Canvas methodology already applied for individual solutions.

The analysis was conducted within the framework of working groups gathering all the partners involved in the development of each ER, coordinated by one or several lead partner(s). The exploratory and updated business models designed were then discussed and refined during progress meetings between CAP and the lead partner(s) of each working group.

#### 4.1. ER 1a: Secondary substation of the future

##### *Refined and updated business model*



##### *Customer segment analysis*

Three potential customer segments have been identified for the secondary substation of the future, and are expected to be addressed with the following prioritisation: i) DSOs, ii) electrical energy end users, and iii) renewable energy manufacturers. Their analysis is presented in Table 15 to Table 17.

Table 15. Analysis of potential customer segment #1: DSOs

Potential segment #1: DSOs	
Relevant characteristics	Large DSOs, looking for: <ul style="list-style-type: none"> <li>- Service improvement;</li> <li>- Control developments: new functionalities;</li> <li>- Retrofit on secondary substation.</li> </ul>
Segment size	Target markets are national markets in Europe.
Hypothesised customer needs and aspirations	Distributed generation, decarbonisation and arrival of EVs
Hypotheses about segment purchasing behaviour and criteria	Functionality and price
Information and data required to verify these hypotheses	KPIs: SAIFI, CAIDI

Table 16. Analysis of potential customer segment #2: Electrical energy end users

Potential segment #2: Electrical energy end users	
Relevant characteristics	Small DSOs and industrial and commercial customers, looking for: <ul style="list-style-type: none"> <li>- Service improvement;</li> <li>- Control developments: new functionalities;</li> <li>- Retrofit on secondary substation.</li> </ul>
Segment size	Target markets are national markets in Europe and international markets.

Hypothesised customer needs and aspirations	Simplicity in Secondary substation control and automation
Hypotheses about segment purchasing behaviour and criteria	Functionality and price
Information and data required to verify these hypotheses	KPIs: SAIFI, CAIDI

Table 17. Analysis of potential customer segment #3: Renewable energy manufacturers

Potential segment #3: Renewable energy manufacturers	
Relevant characteristics	Renewable energy manufacturers (especially wind and solar power) are the targeted customer segment, yet final users are RES producers. This customer segment is looking for service improvement.
Segment size	Target markets are national markets in Europe and international markets.
Hypothesised customer needs and aspirations	Size of the engines and increase of electrical production
Hypotheses about segment purchasing behaviour and criteria	Functionality and price
Information and data required to verify these hypotheses	KPIs: SAIFI, CAIDI

### Customer journey analysis

An analysis of the customer journey has been performed for the different customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 26 to Figure 28.

Figure 26. Customer journey analysis for potential customer segment #1: DSOs

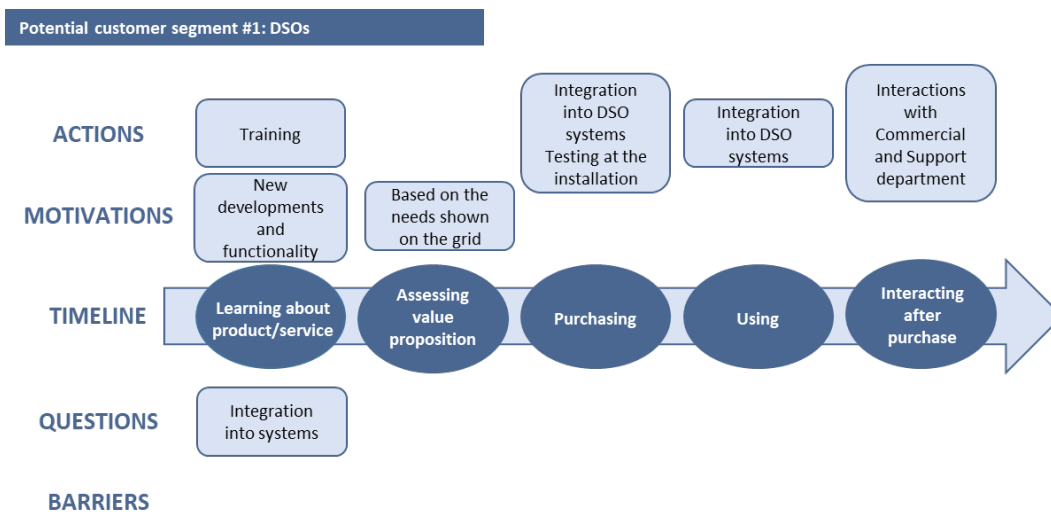




Figure 27. Customer journey analysis for potential customer segment #2: Electrical energy end users

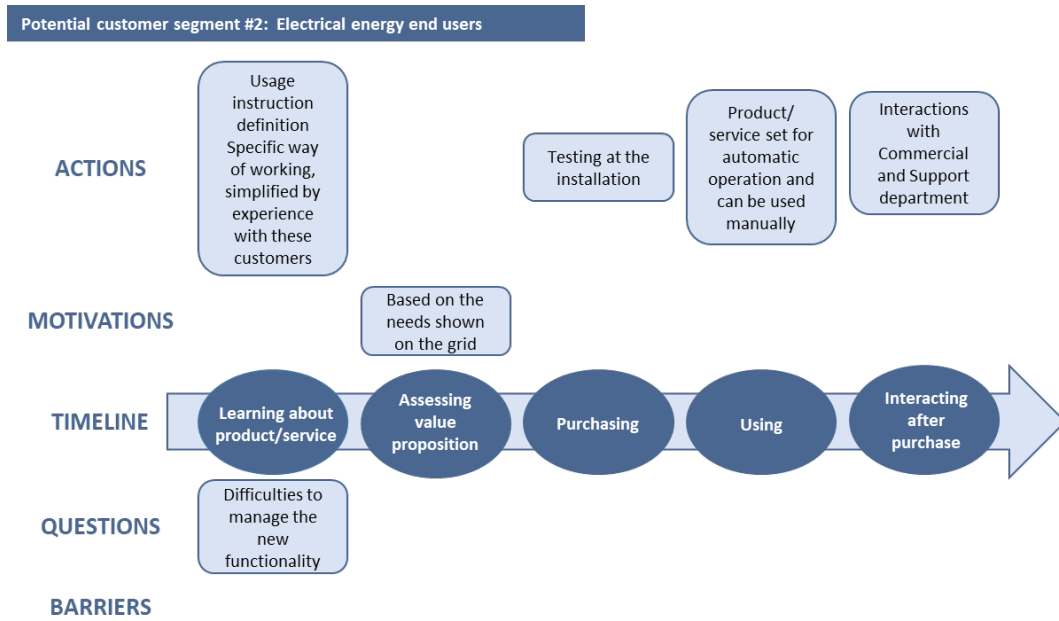
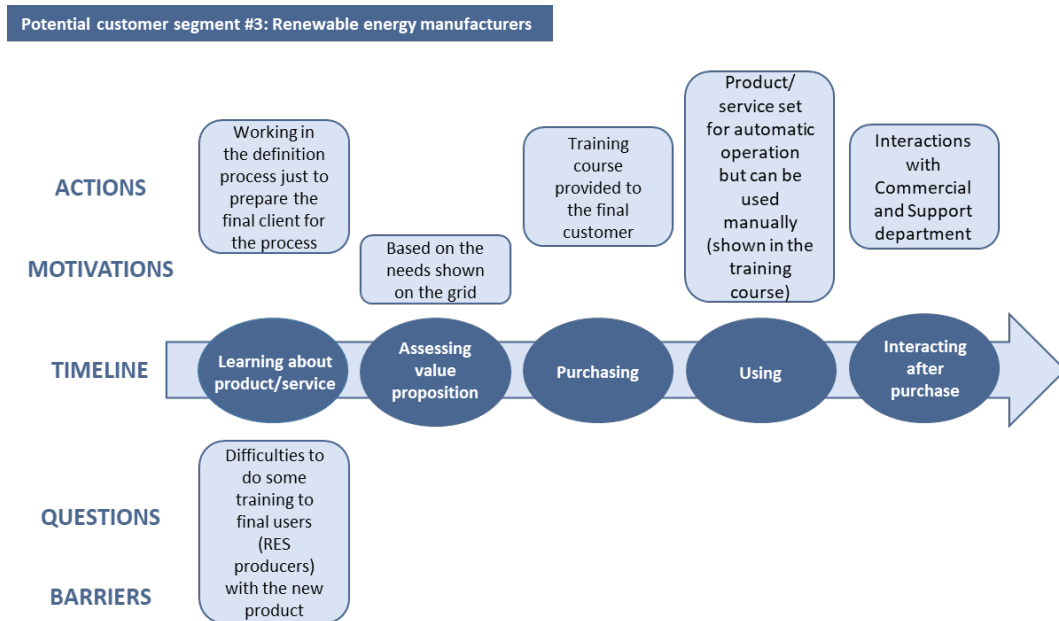


Figure 28. Customer journey analysis for potential customer segment #3: Renewable energy manufacturers



In relation with these customer journey maps, the solution provider's key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 18). As a result, the different activities presented in the "Key activities" building block of the business model canvas have been updated.

Table 18. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
R&D	Medium	Medium	High	New functionality
Industrial manufacturing	Medium	Medium	High	New products
Sales	Low	Low	Medium	Access to the market

### Market and competition analysis

A market and competition analysis has been performed in order to refine ER1a's value proposition (Table 19).

Table 19. Market and competition analysis for ER1a – Secondary substation of the future – in national markets in Europe

Current competitors
Electrical equipment manufacturers.
New entrants
<ul style="list-style-type: none"> <li>No expected new entrants.</li> <li>Barriers to entry: national technical regulations in each market.</li> </ul>
Substitutes
None.
Suppliers and other actors in the value chain
None (only internal suppliers).
Stakeholders
Actors that may have an impact on the activity or the competitive environment: public authorities, through national regulations.

Within this environment, the competitive advantages of the Secondary substation of the future are expected to rest notably on its advanced functionalities.

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER1a are evidenced in Table 20.

Table 20. Critical success factors for the business model considered for ER1a

Critical success factor	Data to be collected and sources
National regulations	Regulation documents
Training of customers	/
Automated control of the functionality	Manuals and instructions

### Documenting the revenue streams and cost structure

The analysis allowed to specify the variables which are likely to have the most significant impact on revenues and costs. Revenues associated with the Secondary substation of the future will depend on its market positioning and on the needs and trends observed in the market (e.g. decarbonation targets, development of EVs...) and on the product's functionalities. As for costs, items related to components and raw materials will play a significant role in their evolution.

#### 4.2. ER 1b: Secondary substation of the future specially designed for remote isolated areas

The Secondary substation of the future specially designed for remote isolated areas includes a smart set of electronic devices to be installed in order to implement a distributed control system for the electrical grid. The solution provides secure, fast and effective communication between the peripheral substations and the TSO/DSO centres. The communication architecture allows real-time bidirectional information exchange (e.g. measurements from the field and setpoints from the control centre). It permits the implementation of specific hierarchical algorithms studied for power flow management and MV voltage regulation.

### Exploratory business model canvas

#### Business Model Canvas for ER1b – Secondary substation of the future specially designed for remote isolated areas

Lead partner: SELTA

<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- SELTA</li> <li>- EDYNA</li> <li>- DSOs (partner role in new research pilot projects and field tests)</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Producing/manufacturing</li> <li>- Conducting further R&amp;D</li> <li>- Marketing campaigns</li> <li>- System engineering</li> <li>- Testing and reporting</li> <li>- Sales and distribution management</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Innovative equipment to monitor, control and manage the secondary substations of MV electrical grids</li> <li>- Specific communication system allowing real-time information exchange from control centre to peripheral resources and viceversa</li> <li>- Implementation of specific algorithms studied and tested</li> <li>- High level in terms of design, customisation, technical support and fitting of undesired problems</li> </ul> <p><b>DSOs:</b> Improved control and management of the electrical parameters related to MV grids, as well as voltage profiles, power congestions, black-out events and distributed generation penetration</p> <p><b>BSPs/Aggregators:</b> Possibility of real-time communication with aggregated energy resources, in order to provide the ancillary services requested by DSOs and TSOs</p> <p><b>RES producers and industrial customers:</b> Making their sources smarter and connected with the DSO, which can lead to multiple scenarios in the future of electrical grids operation:</p> <ul style="list-style-type: none"> <li>- For RES producers: being selected by DSOs in order to regulate the nodal voltages of the MV grid by controlling the generation of reactive power</li> <li>- For industrial customers: being selected by DSOs in order to regulate the power flow over MV lines by controlling the active power absorption of their modifiable loads</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> In general: acquisition by the customers	<b>CUSTOMER SEGMENTS</b> <p><b>Customer segments:</b></p> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- BSPs/Aggregators</li> <li>- RES producers</li> <li>- Industrial customers</li> </ul> <p><b>Other potential beneficiaries:</b></p> <ul style="list-style-type: none"> <li>- TSOs</li> </ul>
<b>COST STRUCTURE</b> <div> <div> <b>Variable costs:</b> <ul style="list-style-type: none"> <li>- Devices manufacturing and equipment supply</li> <li>- R&amp;D, engineering and service activities</li> </ul> </div> <div> <b>Fixed costs:</b> <ul style="list-style-type: none"> <li>- R&amp;D</li> <li>- Marketing</li> <li>- Sales and distribution management</li> </ul> </div> </div>		<b>REVENUE STREAMS</b> <div> <div> <b>Products:</b> Devices supply </div> <div> <b>Services:</b> Installation steps and field service </div> </div>		

### Customer segment analysis

The main customer segment for the Secondary substation of the future specially designed for remote isolated areas is expected to be DSOs in their quality of electrical MV grid managers. Aggregators and BSPs providing ancillary services to utilities may also be interested in it, as well as RES producers owning smart distributed generators and industrial customers owning flexible business equipment.

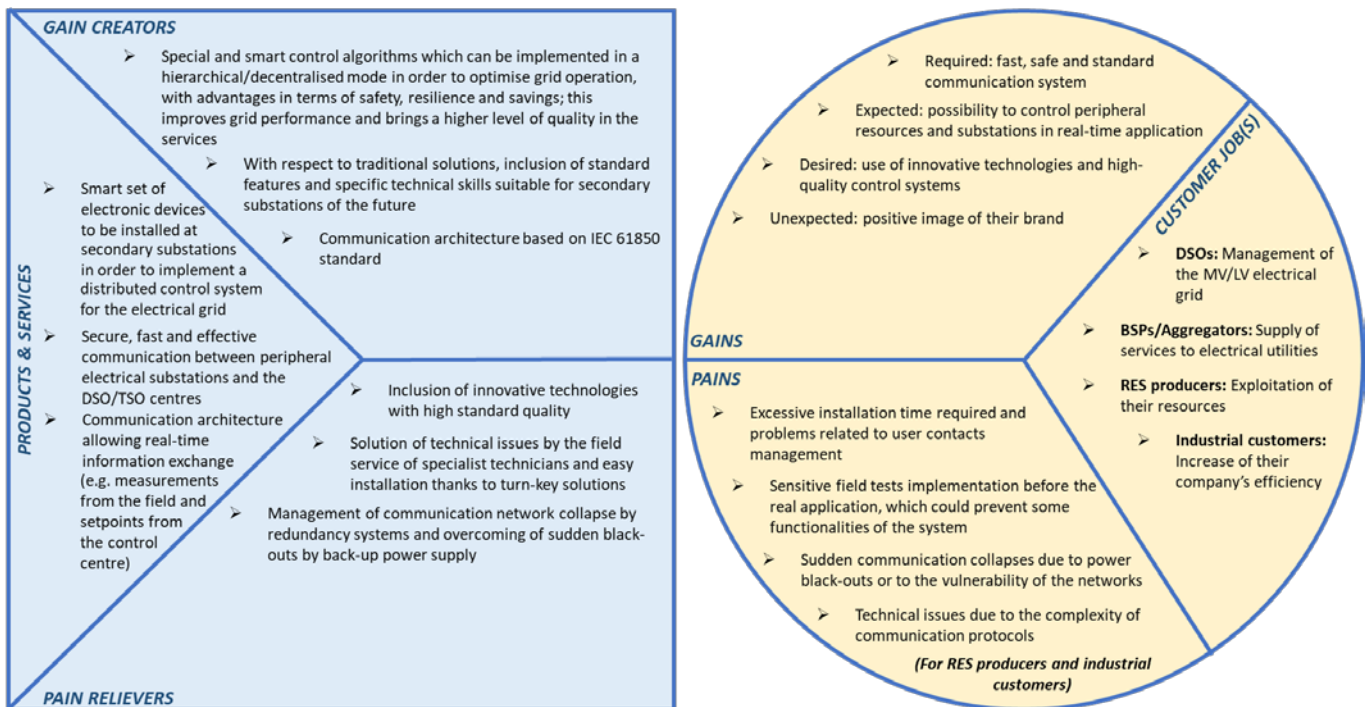
TSOs can be considered as potential beneficiaries of the distributed communication system.

In terms of geographical markets, the EU would be the main target.

### Value Proposition Canvas

#### Value proposition Canvas for ER1b – Secondary substation of the future specially designed for remote isolated areas

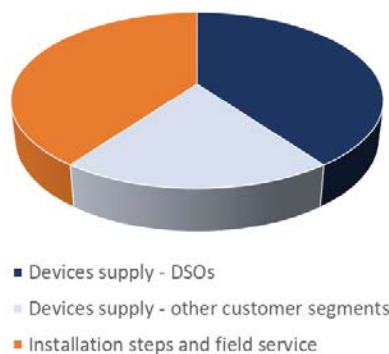
Lead partner: SELTA



The Value Proposition Canvas is very similar for the various customer segments, although they are performing different functions. DSOs aim to manage the MV/LV electrical grid, consisting in a large number of secondary substations. They need to involve large and small power plants in order to have the electrical parameters of the MV grid under control. Aggregators and BSPs' main activity is the supply of services to electrical utilities. They need to implement a reliable and innovative communication system in order to optimise control of the resources and to improve their business. RES producers' main task is the exploitation of their resources. They need to continuously improve their plants' technologies and to increase communication with DSOs. As for industrial customers, while the business of their venture is their main priority, they are constantly looking for new ways to increase their company's efficiency.

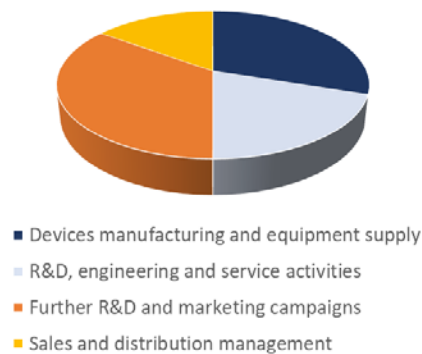
### Documenting the revenue streams and cost structure

Figure 29. ER1b – Secondary substation of the future specially designed for remote isolated areas – Revenue streams



The revenue streams associated with the Secondary substation of the future specially designed for remote isolated areas involve both products and services (Figure 29). For DSOs, the supply of the devices would rest on a recurring pricing mechanism related to the portions of the MV grid and the number of substations involved. For other customer segments, it may be recurring or one-off depending on the functionalities and features that they choose to implement. Installation steps and field service could also be the object of either one-off or recurring pricing mechanisms, depending on the customers' intentions.

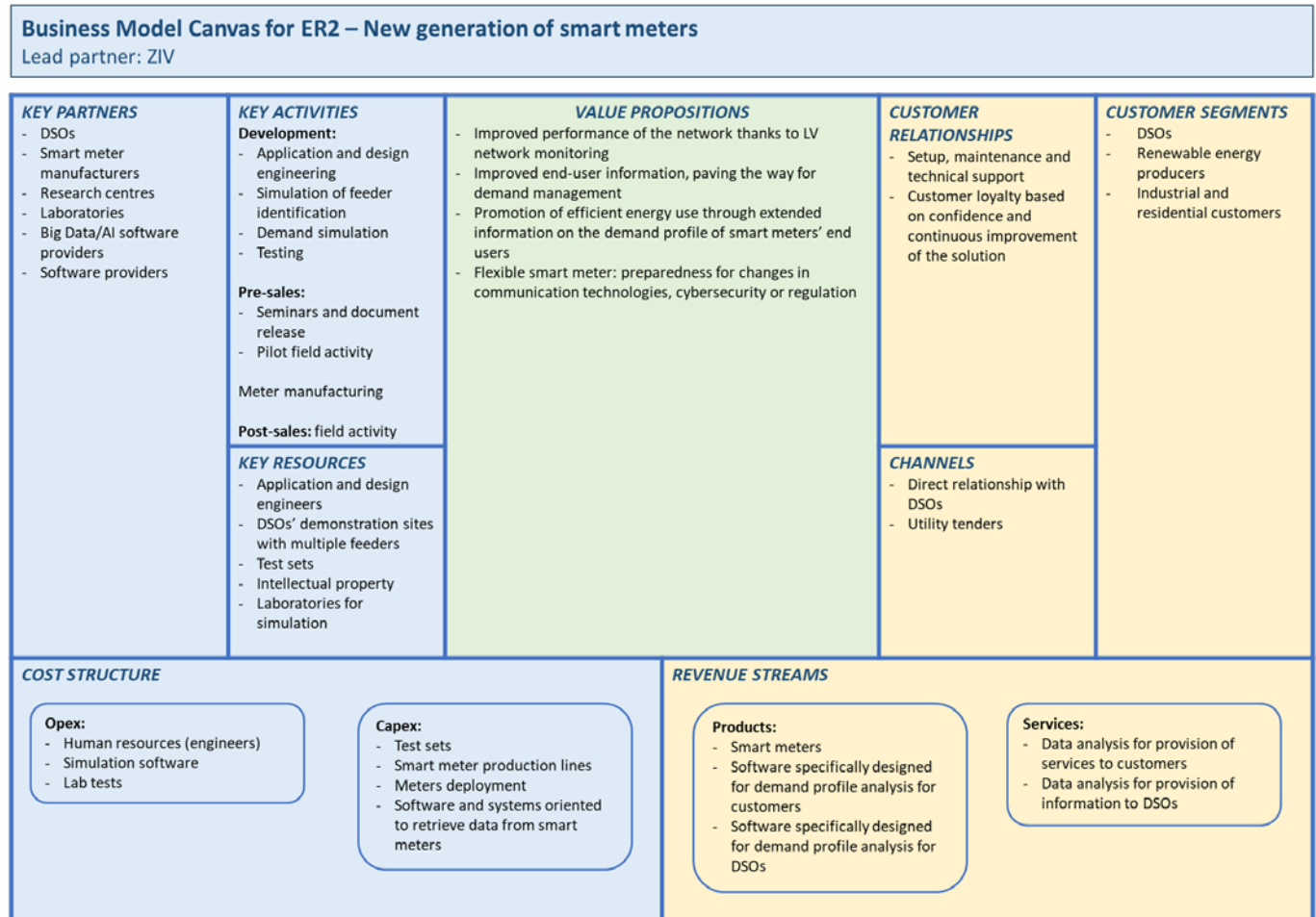
*Figure 30. ER1b – Secondary substation of the future specially designed for remote isolated areas – Cost structure*



The cost structure associated with this ER involves both variable and fixed costs (Figure 30). All of the variable costs – devices manufacturing and equipment supply (production and manufacturing, project management, purchasing department), as well as R&D, engineering and service activities (system engineering, testing and reporting costs and service activities) – are proportional to the number of requested devices. The costs related to R&D, engineering and service (especially for installation) activities will also be contingent upon the complexity of the use cases. Fixed costs will include the conduct of further R&D and marketing campaigns, depending on new products and services. Together with sales and distribution management, they will be continuous activities.

### 4.3. ER2: New generation of smart meters

#### Refined and updated business model



#### Customer segment analysis

Three potential customer segments have been identified for the new generation of smart meters: i) DSOs, ii) renewable energy producers, and iii) industrial and residential customers. Their analysis is presented in Table 21 to Table 23. The market for ER2 will be driven by utilities (DSOs), which will be the customer segment with the highest priority. Industrial and residential customers will benefit from the new generation of smart meters' features once they are in place. Power generation owners will also follow DSOs' decisions and actions and might come up with specific needs based on the information that they require.

Table 21. Analysis of potential customer segment #1: DSOs

Potential segment #1: DSOs	
Segment size	There are more than 280 M electricity customers in Europe, with a penetration of smart meters estimated to reach c. 40% in 2020 (EC, 2019). Electricity demand is expected to grow at a 1.8% CAGR by 2030 (Monitor Deloitte, E.DSO and Eurelectric, 2021). EUR 30-35 billion are expected to be invested in smart meters up to 2030 (Monitor Deloitte, E.DSO and Eurelectric, 2021).
Hypothesised customer needs and aspirations	<ul style="list-style-type: none"> <li>- Enhancing grid monitoring, stability and control.</li> <li>- Fostering demand participation (through real-time monitoring) and the development of new flexibility services (e.g. smart charging, generation flexibility, EV batteries flexibility).</li> </ul>



	Smart meters are a key enabler to do so and will allow to identify the feeders for each customer.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	It is a regulated market. Smart meter deployments are realised through tenders. Some utilities will change to smart metering because there is a mandate from the government and, if not, they may do so based on a positive business case. The latter may come both from partial compensation with public funds and operations' efficiency enhancements.
<b>Information and data required to verify these hypotheses</b>	No data required (public information).

Table 22. Analysis of potential customer segment #2: Renewable energy producers

Potential segment #2: Renewable energy producers	
<b>Relevant characteristics</b>	This customer segment includes the energy generation facilities' owners, as well as some of the distributed energy resources' owners.
<b>Hypothesised customer needs and aspirations</b>	Typically, their needs should be similar to those of the DSOs. A power generation owner will need to control and monitor the energy that is being injected into the network.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Purchases will be opportunistic, based on the system that is being deployed and the metering needs that arise.
<b>Information and data required to verify these hypotheses</b>	No specific data.

Table 23. Analysis of potential customer segment #3: Industrial and residential customers

Potential segment #2: Industrial and residential customers	
<b>Relevant characteristics</b>	Industrial and residential customers are the DSOs' customers.
<b>Segment size</b>	Typically, these customers could be the c. 280 M electricity customers in Europe (EC, 2019).
<b>Hypothesised customer needs and aspirations</b>	LV customers need a real-time view of their demand to be able to take decisions and economically benefit from an efficient energy use.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Metering is a regulated market. Customers will typically conclude a contract with a retailer: the one offering the most convenient price, but also the one that can provide them with the means to achieve an efficient energy use.
<b>Information and data required to verify these hypotheses</b>	No specific data.

### Customer journey analysis

An analysis of the customer journey has been performed for potential customer segments in order to refine the "Channels" and "Key activities" buildings blocks of the business model canvas. Its results are presented in Figure 31 and Figure 32.

The problem faced by DSOs and renewable energy producers stems from the need to know the specific feeders of their end customers. For them to learn about the new generation of smart meters, the solution provider can organise seminars and/or trainings explaining the new algorithms implemented and the advantages of these new features. Papers, technical notes and the instruction book of the meters can be used as support documentation. For DSOs to assess the value proposition before the actual purchase, they could be provided with meters to prepare a pilot case and analyse the data that can be procured thanks to these new features. As for renewable energy producers, they will usually assess the value proposition through pilot experiences or different projects evidencing the potential of the product. Then, DSOs can purchase meters directly or through a tender specifying the required features. Renewable energy producers can also purchase meters directly or through a tender, or to an integrator providing the whole system. After their deployment, DSOs and renewable energy producers can



exploit the data generated by the meters and take decisions on this basis. Support is provided for the products sold, and trainings can also be organised.

In the case of industrial and residential customers, the problem addressed by ER2 is the need to know the real-time status of their demand and take decisions accordingly. These end-users can learn about the product from information provided by either DSOs or retailers. For them to assess its value proposition, simulations of the experience could be provided to leverage the benefit of the new features, especially for industrial customers, which are keener to procure their own meters. Then, customers can directly purchase the meters to a retailer, even though this would apply more to industrial customers than to residential customers. After deployment, these customers can analyse the data generated to take decisions on this basis. After the purchase, they would contact the retailer, and the latter may contact the smart meter provider if necessary.

Figure 31. Customer journey analysis for potential customer segment #1: DSOs and renewable energy producers

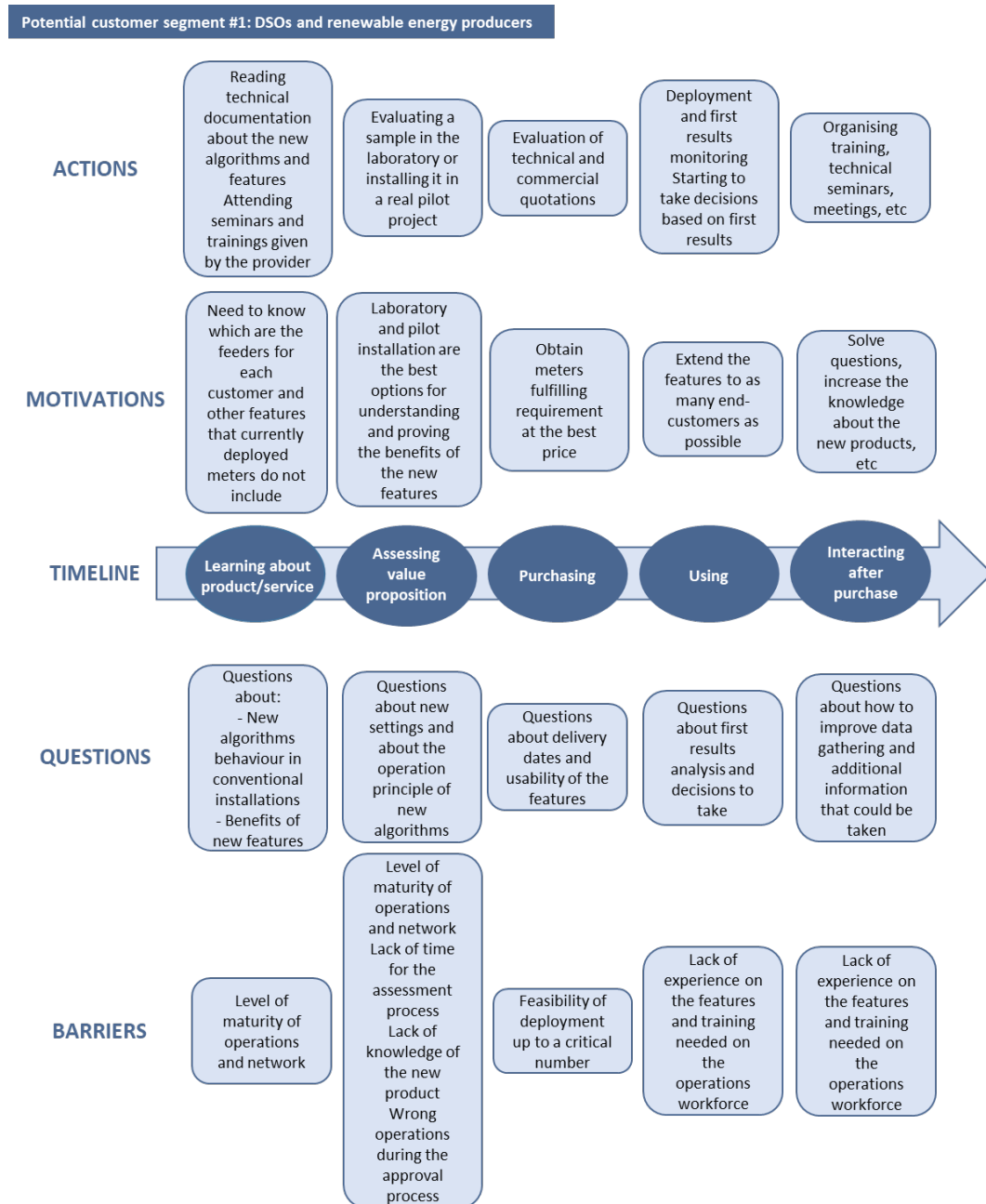
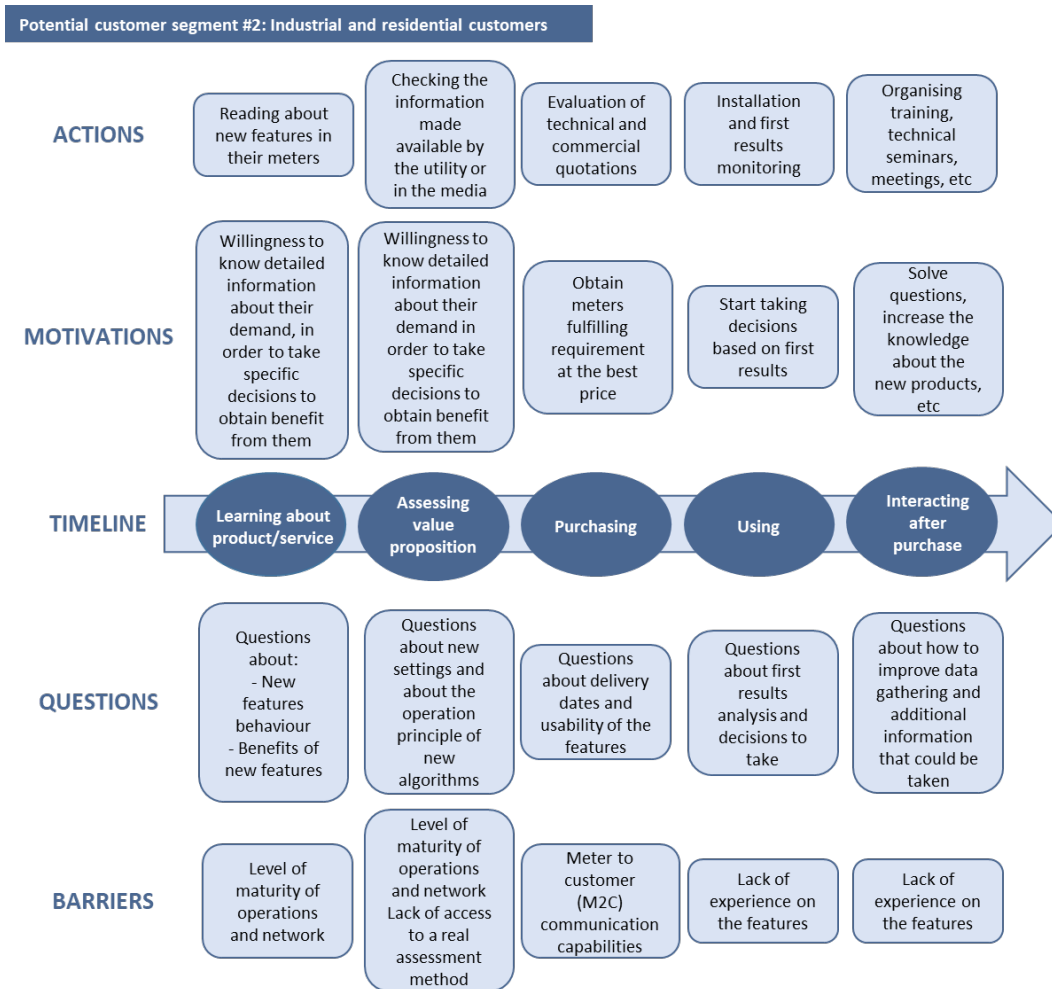


Figure 32. Customer journey analysis for potential customer segment #2: Industrial and residential customers



In relation with this customer journey map, the smart meters provider's key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 24). As a result, the scope of the activities retained in the "Key activities" building block of the business model canvas has been refined.

Table 24. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Development	Medium	High	High	Meter including all requested features
Pre-sales activity, making the new features known to the customers	Medium	High	Medium	DSOs' technical departments aware of the product and ready to test it
Pilot phase	Medium	Medium	High	Positive assessment of the new product by customers
Sales	High	High	High	Orders for the product
Manufacturing	High	High	High	Products shipped to customers
Post-sales activity, field support	Medium	High	High	Customers fully aware of deployed functionalities and benefiting from them

### Market and competition analysis

A market and competition analysis has been performed in order to refine ER2's value proposition (Table 25).

Table 25. Market and competition analysis for ER2 – New generation of smart meters – in Europe

Current competitors
Global meter manufacturers, which include new features in products once they are published in different tenders or by interacting with customers.
New entrants
Meter manufacturing does not have many new entrants: it is a highly competitive electronics manufacturing market based on volume. New entrants could come from small software providers offering different algorithms to be included in other meters.
Substitutes
No known substitutes, product- or service-wise.
Suppliers and other actors in the value chain
<ul style="list-style-type: none"> <li>- Electronic components manufacturers and distributors;</li> <li>- DSOs' technical departments (which prepare technical requirements in tenders).</li> </ul>
Stakeholders
Other actors that may have an impact on the activity or the competitive environment: regulatory authorities, governments and other similar stakeholders.

Within this environment, the competitive advantage of the new generation of smart meters will stem from the fact that their provider is a known meter manufacturing company, with a strong know-how on technical solutions and innovation. The solution will be tested within the pilots with DSOs, so the time-to-market, critical in such cases, will be reduced and the competitive advantage will be clear.

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER2 are evidenced in Table 26.

Table 26. Critical success factors for the business model considered for ER2

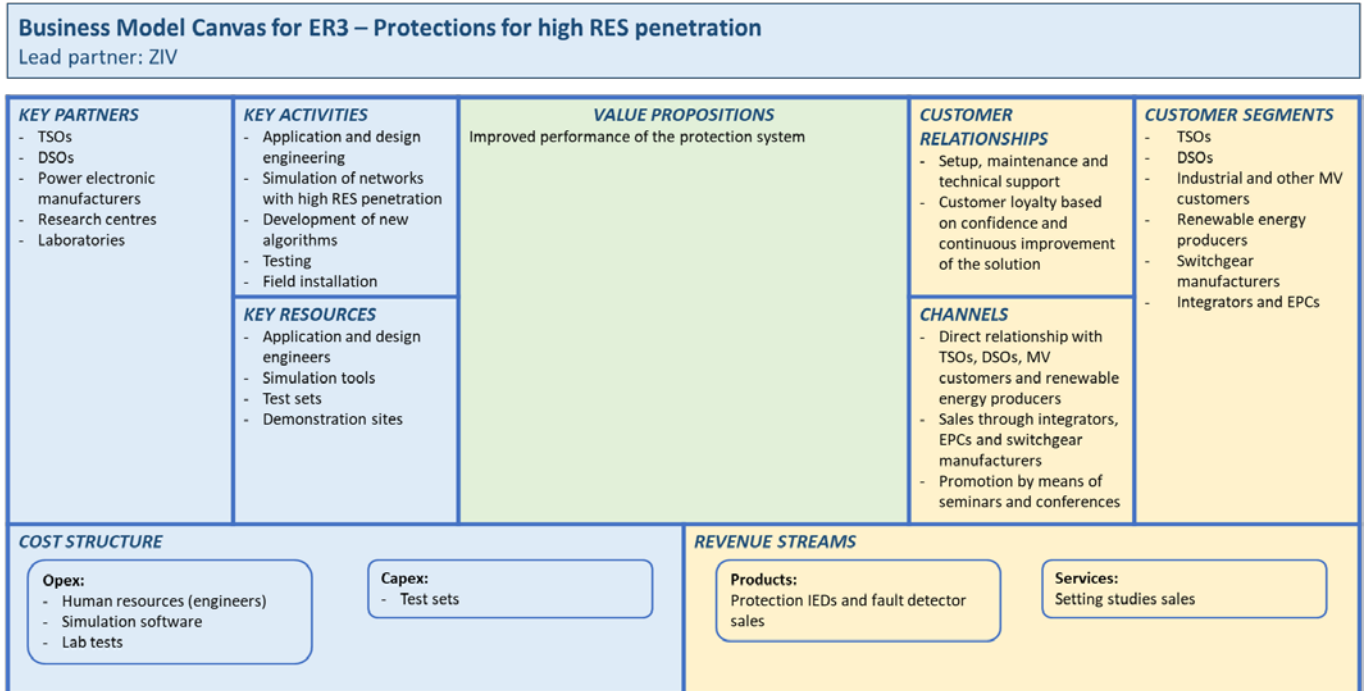
Critical success factor	Key metric	Data to be collected and sources
<b>Maturity of DSOs in a position to use the new features</b>	Number of tenders including these features	Public tenders
<b>Demand for data from feeders and demand</b>	Growth in the number of tenders including these features	Publications, public tenders

### Documenting the revenue streams and cost structure

The analysis allowed to specify the variables that are likely to have the most significant impact on revenues and costs. Revenues will especially depend on tenders including new features and on the tenders' volume, while product certifications and development will have the most significant impact on costs.

#### 4.4. ER3: Protections for high RES penetration

##### Refined and updated business model



##### Customer segment analysis

Six potential customer segments have been identified for the Protections for high RES penetration: i) DSOs, ii) TSOs, iii) industrial and other MV customers, iv) renewable energy producers, v) switchgear manufacturers and vi) integrators and Engineering, Procurement and Construction (EPCs). Their analysis is presented in Table 27 to Table 32. Utilities (TSOs and DSOs) are expected to drive this market, so they will be considered as customer segments with the highest priority. Other segments will have to comply with new network codes and utilities' requirements.

Table 27. Analysis of potential customer segment #1: DSOs

Potential segment #1: DSOs	
Segment size	As RES penetration is growing very fast, the implementation of the new algorithms could be a key differentiator to acquire more customers/enter new markets. A 10% business growth could be considered yearly.
Hypothesised customer needs and aspirations	DSOs require correct protection operation (no unwanted trips and no lack of trips), including in networks with high RES penetration.
Hypotheses about segment purchasing behaviour and criteria	DSOs will tend to buy complete automation packages, updating their functional specifications to this new scenario of high RES penetration.
Information and data required to verify these hypotheses	Contact with customers.

Table 28. Analysis of potential customer segment #2: TSOs

Potential segment #2: TSOs	
Segment size	As RES penetration is growing very fast, the implementation of the new algorithms could be a key differentiator to acquire more customers/enter new markets. A 10% business growth could be considered yearly.

<b>Hypothesised customer needs and aspirations</b>	TSOs require correct protection operation (no unwanted trips and no lack of trips), including in networks with high RES penetration.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	TSOs will tend to buy complete automation packages, updating their functional specifications to this new scenario of high RES penetration.
<b>Information and data required to verify these hypotheses</b>	Contact with customers.

Table 29. Analysis of potential customer segment #3: Industrial and other MV customers

<i>Potential segment #3: Industrial and other MV customers</i>	
<b>Segment size</b>	Growth is expected to be aligned with RES penetration in distribution networks. Hence, the same growth as for the utilities sector (10% yearly) may be considered.
<b>Hypothesised customer needs and aspirations</b>	MV customers will have to comply with network codes and DSOs' requirements.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	New MV customers will have to purchase their substations according to DSOs' specifications; the new algorithms will be necessary to comply with them.
<b>Information and data required to verify these hypotheses</b>	Experience and contact with customers.

Table 30. Analysis of potential customer segment #4: Renewable energy producers

<i>Potential segment #4: Renewable energy producers</i>	
<b>Segment size</b>	Growth is expected to be high as RES penetration is rising. Hence, a yearly growth of 25% can be considered.
<b>Hypothesised customer needs and aspirations</b>	Renewable energy producers will have to comply with network codes and utilities' requirements.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	New renewable energy producers will have to purchase their substations according to DSOs' specifications; the new algorithms will be necessary to comply with them.
<b>Information and data required to verify these hypotheses</b>	Experience and contact with customers.

Table 31. Analysis of potential customer segment #5: Switchgear manufacturers

<i>Potential segment #5: Switchgear manufacturers</i>	
<b>Segment size</b>	Growth is expected to be aligned with RES penetration in distribution networks. Hence, the same growth as for the utilities sector (10% yearly) may be considered.
<b>Hypothesised customer needs and aspirations</b>	Switchgear manufacturers will have to comply with network codes and DSOs' requirements.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Switchgear manufacturers will have to provide switchgears according to DSOs' specifications; the new algorithms will be necessary to comply with them.
<b>Information and data required to verify these hypotheses</b>	Experience and contact with customers.

Table 32. Analysis of potential customer segment #6: Integrators and EPCs

<i>Potential segment #6: Integrators and EPCs</i>	
<b>Segment size</b>	Growth is expected to be aligned with RES penetration in distribution networks. Hence, the same growth as for the utilities sector (10% yearly) may be considered.
<b>Hypothesised customer needs and aspirations</b>	Integrators and EPCs will have to comply with network codes and utilities' requirements.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Integrators and EPCs will have to provide their solutions (full package) according to DSOs' specifications; the new algorithms will be necessary to comply with them.
<b>Information and data required to verify these hypotheses</b>	Experience and contact with customers.

### *Customer journey analysis*

An analysis of the customer journey has been performed for potential customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 33 and Figure 34.

The problems faced by all customer segments stem from the fact that conventional protective relays do not operate correctly in networks with high RES penetration. For potential customers to learn about the ER, the protective relays provider can organise seminars and/or trainings to explain the new algorithms implemented and their advantages with regard to conventional algorithms. Papers, technical notes and the instruction book of the protective relays can be used as support documents. To assess the ER’s value proposition before the actual purchase, potential customers could be provided with some recordings with false operations of conventional algorithms and correct operations of new algorithms. The protection system provider could also propose a sample for customer evaluation: the customer could install it in a substation during a certain time to evaluate its behaviour, and support would be ensured during the evaluation process. Protective relays could then be purchased directly by potential customers, or through EPCs, system integrators, representatives of their provider, etc. The purchase will take place once the customer has approved the product. The relays will be installed in the customer’s network, and the end customer will normally operate them. Maintenance can be done by the customer or outsourced. Support will be provided for the products sold, and trainings can also be organised.



Figure 33. Customer journey analysis for potential customer segment #1: TSOs, DSOs, renewable energy producers and industrial and other MV customers

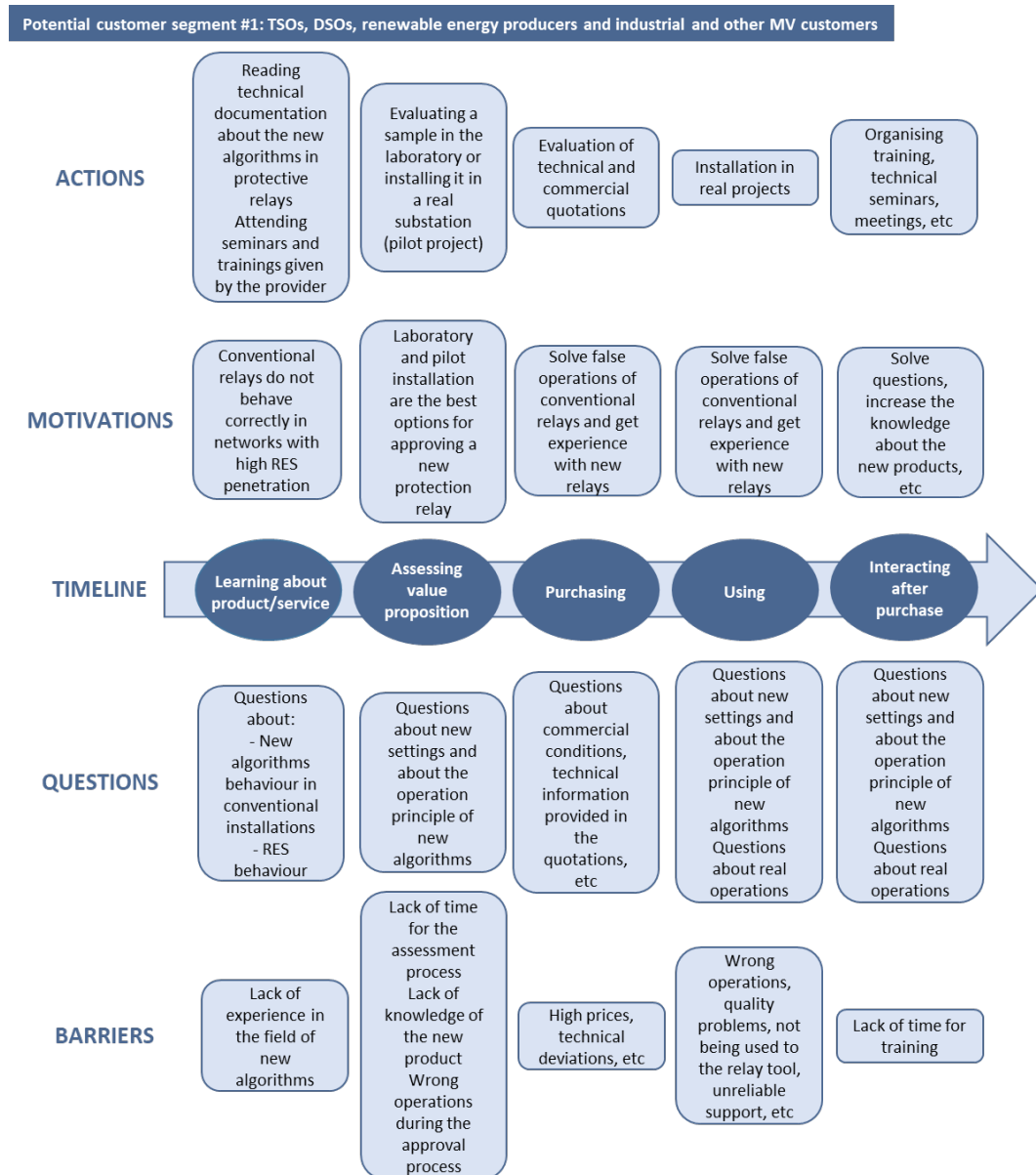
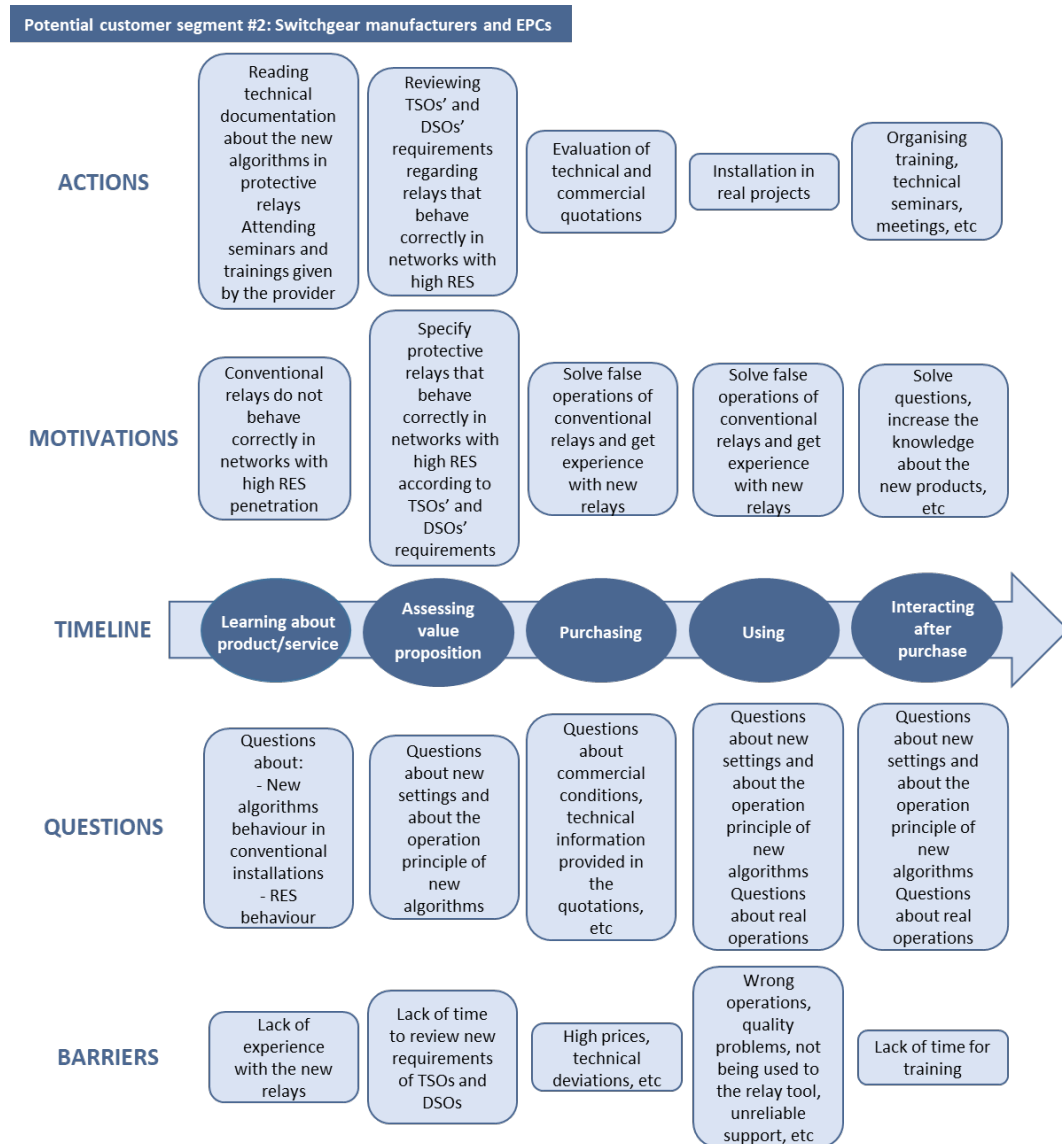


Figure 34. Customer journey analysis for potential customer segment #2: Switchgear manufacturers and EPCs



In relation with this customer journey map, the protection system provider's key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 33). As a result, the scope of the activities retained in the "Key activities" building block of the business model canvas has been refined.

Table 33. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Simulation of networks with high RES	High	Medium	High	Network and faults simulation files
Application and design engineering	Medium	High	High	Application and design specifications. Technical documentation for customers
Development of new algorithms	High	High	High	Deployable software modules, together with the software testing files and reports
Testing	High	High	High	Test plans and test reports
Field installation	Medium	Medium	Medium	Report about the performance and issues detected during normal operation

### Market and competition analysis

A market and competition analysis has been performed in order to refine ER3's value proposition (Table 34).

Table 34. Market and competition analysis for ER3 – Protections for high RES penetration – at the global level

Current competitors
<ul style="list-style-type: none"> <li>- <b>Siemens</b>: distance protection including some algorithms for better operation (improved phase selector).</li> <li>- <b>ABB</b>: conventional distance protection.</li> <li>- <b>SEL</b>: conventional distance protection.</li> <li>- <b>GE</b>: distance protection including some algorithms for better operation (improved phase selector).</li> <li>- <b>INGETEM</b>: conventional distance protection.</li> <li>- <b>Toshiba</b>: conventional distance protection.</li> </ul>
New entrants
<p>Potential new entrants: relay manufacturers selling in other countries and/or segments, trying to expand their business.</p> <p>Barriers to entry:</p> <ul style="list-style-type: none"> <li>- Lack of knowledge of their products;</li> <li>- Local support requirement.</li> </ul>
Substitutes
No known substitutes.
Suppliers and other actors in the value chain
EPCs and system integrators enter in the purchase process, so it is important that they are satisfied with the products.
Stakeholders
TSOs define grid codes that specify requirements for RES, which affects protective relay algorithms.

Within this environment, the competitive advantage of the Protections for high RES penetration will rest on the improved performance of the protection system, tested in the field in real environment.

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER3 are evidenced in Table 35.

Table 35. Critical success factors for the business model considered for ER3

Critical success factor	Key metric	Data to be collected and sources
Growth of RES penetration in electricity networks	Growth percentage of installed capacity of RES worldwide	Global reports evidencing new RES installed power
Adaptation of network codes	Number of countries with updated network codes	Countries' regulatory authorities

#### Documenting the revenue streams and cost structure

The analysis allowed to specify the variables that are likely to have the most significant impact on revenues and costs. Revenues will especially depend on sales of protection IEDs and fault detectors, while human resources (engineers) will have the most significant impact on costs.

#### 4.5. ER 4: Energy Box

##### Refined and updated business model

Business Model Canvas for ER4 – Energy Box				
Lead partner: CIRCE				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- FLEXIGRID partners and European Commission</li> <li>- Materials suppliers</li> <li>- Energy Box manufacturers</li> <li>- Commercial partner</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Solution testing (demonstration sites)</li> <li>- Market analysis</li> <li>- Dissemination, replication and exploitation</li> <li>- Installation at customer premises</li> <li>- Cooperation with other projects and networking</li> </ul>	<b>VALUE PROPOSITIONS</b> <p><b>Hardware and software solution to solve field-level communication and management:</b></p> <ul style="list-style-type: none"> <li>- High-level services and monitoring (performed remotely) and locally-processed services, improving service quality, security and efficiency</li> <li>- Autonomous real-time management</li> <li>- High interoperability when using standard protocols</li> <li>- Adaptability to each specific scenario for improving management</li> <li>- Debian-based computer operating system</li> <li>- Different physical communication interfaces (modules): Ethernet, ZigBee, WiFi</li> </ul> <p><b>Modern and compact design:</b></p> <ul style="list-style-type: none"> <li>- Reduced form factor, light weight</li> <li>- Quiet operation</li> <li>- Low power consumption</li> <li>- Competitive price</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"> <li>- Customer and maintenance services</li> <li>- Customer service call center</li> </ul>	<b>CUSTOMER SEGMENTS</b> <p><b>Primary:</b></p> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- Aggregators</li> <li>- Renewable energy producers</li> <li>- Industrial, commercial and residential customers</li> <li>- Energy communities</li> </ul> <p><b>Secondary:</b></p> <ul style="list-style-type: none"> <li>- Experts and actors of the refurbishment industry</li> <li>- Local authorities in charge of the management of social housing</li> </ul>
<b>COST STRUCTURE</b> <div> <b>Opex:</b> <ul style="list-style-type: none"> <li>- Human resources</li> <li>- Manufacturing</li> <li>- Hardware components costs</li> <li>- I&amp;D activities</li> <li>- Marketing costs</li> <li>- Sales costs</li> </ul> </div> <div> <b>Capex:</b> <ul style="list-style-type: none"> <li>- Aggregation and transmission hardware infrastructure</li> </ul> </div>		<b>REVENUE STREAMS</b> <ul style="list-style-type: none"> <li>- Direct sales and licences</li> <li>- Sales through intermediaries</li> <li>- Technology transfers</li> </ul>		

#### Customer segment analysis

Six potential customer segments have been identified for the Energy Box: i) DSOs, ii) aggregators, iii) renewable energy producers, iv) industrial, commercial and residential customers and energy communities, v) experts and actors of the refurbishment industry and vi) local authorities in charge of the management of social housing. The first four are considered as primary customer segments. Their analysis is presented in Table 36 to Table 39.

Table 36. Analysis of potential customer segment #1: DSOs

Potential segment #1: DSOs	
Relevant characteristics	DSOs which are managers or owners of energy distribution networks: they serve as simplifiers of the installation process for the energy distribution network and related devices, automate

	operation and increase their portfolio of customers (energy consumers).
<b>Segment size</b>	Target markets would include Spain, Greece, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.
<b>Hypothesised customer needs and aspirations</b>	<p>DSOs' mission throughout Europe is to operate and manage distribution networks in a safe and secure manner. They are also responsible for developing distribution grids to ensure the long-term ability of the system to deliver high-quality services to grid users and other stakeholders of the power system. DSOs are considered to have a "natural monopoly" on local grids and therefore play a crucial role in the effective roll-out of demand response in a given locality.</p> <p>DSOs are regulated players and provide their services in a strict regulatory framework that is traditionally focused on CAPEX-intensive investments for security of supply. Thus, DSOs have been mostly involved in maintenance and expansion of the grid infrastructure ("hardware"), whereas with a more forward-looking smart grid regulation DSOs would be incentivised to also invest in OPEX.</p> <p>In the coming years, several challenges for local distribution grids will accentuate:</p> <ul style="list-style-type: none"> <li>- electrification of transport, with EV charging patterns and electric heating patterns overlapping;</li> <li>- more distributed RES leading to bidirectional flows on the grid;</li> <li>- more flexible consumption patterns, with consumers reacting simultaneously to price signals (on the wholesale market) or curtailment instructions (for balancing services).</li> </ul> <p>Overall, there will be a growing uncertainty over the exact requirements and standards that the power grid will have to fulfil, making long-term investment cycles even more risky. Investments in monitoring and control functionalities, in order to manage demand side-flexibility on a local level (hence, rather the "software"), could represent a cost-effective alternative for DSOs.</p>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	If demand-side flexibility of end customers is used to reduce local network capacity issues and to limit capital-intensive infrastructure investments, DSOs will be ultimately responsible for designing and maintaining these programs. A multi-purpose concentrator for operation in various scenarios of advanced electrical networks and smart grids (the Energy Box) will facilitate decisions and responsibility and allow to obtain better results.
<b>Information and data required to verify these hypotheses</b>	<ul style="list-style-type: none"> <li>- Data that permits to know the limitations of the network that DSOs in the European electricity market will have to mitigate as RES penetration increases.</li> <li>- Studies or real cases of how much energy an installation/building is capable to offer to the flexibility market, to know if the needs can be covered with that energy.</li> <li>- Information on system costs, savings against new investments, etc.</li> </ul>

Table 37. Analysis of potential customer segment #2: Aggregators

Potential segment #2: Aggregators	
<b>Relevant characteristics</b>	Aggregators are entities that group the energy consumption and/or generation of various consumers/prosumers.
<b>Segment size</b>	Target markets would include Spain, Greece, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg, and other European countries.

<b>Hypothesised customer needs and aspirations</b>	Aggregators would expect functionalities able to make consumers' data accessible in real time to end customers via a web application, meaning an enhancement of the service platforms.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	With the purchase and installation of the Energy Box, aggregators will obtain a platform where end consumers could consult their electricity consumption and generate important data and use them to participate in the market. They would most likely exploit the data accessibility through the Energy Box by developing new business based on such data.
<b>Information and data required to verify these hypotheses</b>	The required data to verify these hypotheses will depend on the application of the Energy Box by the DSOs.

Table 38. Analysis of potential customer segment #3: Renewable energy producers

<i>Potential segment #3: Renewable energy producers</i>	
<b>Relevant characteristics</b>	<ul style="list-style-type: none"> <li>- Solar facilities or projects of different companies (big renewable projects).</li> <li>- Companies or different associations, even countries.</li> </ul>
<b>Segment size</b>	Target markets would include Spain, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.
<b>Hypothesised customer needs and aspirations</b>	This customer segment's main need is to reduce energy production costs, reduce costs to bring renewable energy to direct consumers, reduce installation and maintenance costs, as well as to reduce cyberattacks, obtain a better management of data and a new approach on wiring aesthetic.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Renewable energy production is currently in a phase of boom, growth and adaptation to market needs, because despite the fact that it is already known to all, there is still much to be implemented and improved. That said, producers are looking for actions, mainly technologies, that streamline the commercial process and provide greater understanding and better quality to customers.
<b>Information and data required to verify these hypotheses</b>	Producers' opinions and reactions towards the product and the solutions offered.

Table 39. Analysis of potential customer segment #4: Industrial, commercial and residential customers and energy communities

<i>Potential segment #4: Industrial, commercial and residential customers and energy communities</i>	
<b>Relevant characteristics</b>	<ul style="list-style-type: none"> <li>- Energy communities: residential houses, shopping centres, RESCoop initiatives.</li> <li>- People who own a grid infrastructure/microgrid.</li> <li>- Individual consumers.</li> </ul>
<b>Segment size</b>	Target markets would include Spain, Greece, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.
<b>Hypothesised customer needs and aspirations</b>	This customer segment is wishing to manage energy consumption in real time through a user-friendly, modern and compact design that can be adapted to a wide variety of facilities and business models and different types of housing, at a competitive price.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Many energy communities and some industries may benefit from providing energy consumers with valuable information to promote sustainable consumption and reduce unnecessary costs caused by spikes in energy prices. This tool would facilitate this function for this entire segment.
<b>Information and data required to verify these hypotheses</b>	Opinions and reactions towards the product and the solutions offered.

### *Customer journey analysis*

An analysis of the customer journey has been performed for primary customer segments<sup>4</sup> in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 35.

The problems faced by customers vary depending on the considered customer segment:

- DSOs need an enabler for advanced systems such as prediction and optimisation algorithms, since without an intelligent element in the field they are not able to perform calculated control.
- Aggregators need a controller able to manage energy intelligent devices in several environments to keep control of minimum communication requirements, reducing the number of ports and easy to manage in an industrial environment.
- Industrial, commercial and residential customers need to maintain control of energy consumption in their homes or companies through agile and easy-to-use systems and without the need to know in-depth data from the electrical network.

The ways in which customers can learn about the Energy Box also vary depending on the considered segment:

- This result will be approved and offered initially to the DSOs that are part of the FLEXIGRID project and to DSOs that are not part of the consortium but with whom the Energy Box provider has previously worked or already has commercial relationships.
- Aggregators can learn about the Energy Box through the EC, the FLEXIGRID website, events where the project and/or result is presented, the press and articles, business websites or list of clientele.
- Industrial, commercial and residential customers can learn about it through the company or FLEXIGRID website, the Energy Box provider’s list of clients, public relations (PR), social media and/or marketing.

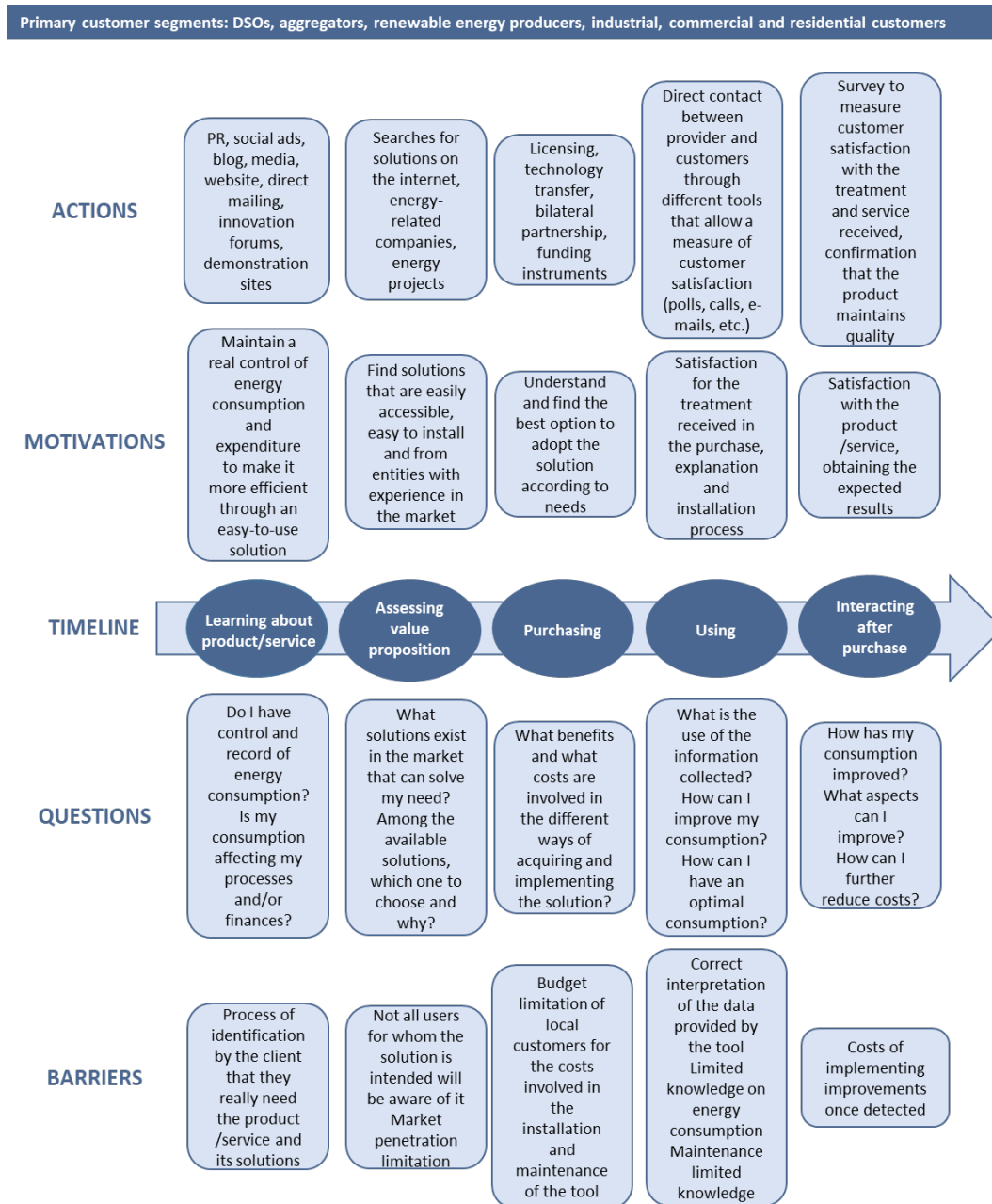
Customers can then assess the Energy Box’s value proposition before actually purchasing it by being shown the results obtained in the validations and tests on site (notably during the FLEXIGRID project’s lifetime). In the case of DSOs and aggregators, the purchase itself can take the form of licensing, sale or joint venture creation. In the case of industrial, commercial and residential customers, it can consist in licensing or sale, depending on whether the customer is a company or a direct user. Then, the Energy Box will be adopted in the customer’s facilities or home. After the purchase, there should be a user manual for initial configuration. For DSOs and aggregators, once data can be extracted, the algorithmic system can be updated and improved according to the user’s needs. Maintenance service for troubleshooting and software updates can be done remotely via Over The Air (OTA). In the case of industrial, commercial and residential customers, surveys will be conducted to measure satisfaction.

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<sup>4</sup> As far as renewable energy producers are concerned, the customer journey analysis will be refined at a later stage.



Figure 35. Customer journey analysis for primary customer segments



This customer journey map evidenced key interactions between the Energy Box provider and customer segments, which allowed to refine the analysis of the “Channels” building block of the business model canvas.

Besides, in relation with this customer journey map, the Energy Box provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 40). As a result, the scope of the activities retained in the “Key activities” building block of the business model canvas has been refined.

Table 40. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Testing the solution in demonstration sites	High	High	High	Confirm the correct adaptation and implementation of the solution before being brought to the market
Market analysis	Medium	High	High	Market assessment; learn about and further explore the different business outlets of the solution
Dissemination, replication and exploitation	Medium	Medium	High	Make the solution known in the markets already identified in the analysis and explore the different methods of exploitation and sale
Installation at customer premises	High	High	High	Deliver the product to the customer and carry out custom installation according to their needs
Cooperation with other projects and networking	Low	Medium	High	Constantly improve the Energy Box in each project Obtain commercial agreements and interact with interested partners

#### Market and competition analysis

A market and competition analysis has been performed in order to refine ER4's value proposition (Table 41).

Table 41. Market and competition analysis for ER4 – Energy Box – in the European market

Current competitors
<p>Due to differences in the regulatory framework among European countries, competition may vary from one market to another. The main competitors identified in the case of the Spanish market would be the following:</p> <ul style="list-style-type: none"> <li>- <b>Schweitzer Engineering Laboratories (SEL):</b> powerMAX for Mobile Microgrids system;</li> <li>- <b>Opus One Solutions:</b> GridOS™ smart grid system;</li> <li>- <b>S&amp;C Electric:</b> GridMaster Microgrid Control System;</li> <li>- <b>Other competitors:</b> ABB, Schneider Electric, Power Secure, Emerson, Clean Spark, OATI, General Electric, Eaton;</li> <li>- <b>Research centres and universities</b>, e.g. in Spain: IREC, CENER, TECNALIA, CARTIF, CIEMA.</li> </ul> <p>In international markets, the following solution may be mentioned for reference: <b>Revolution PI</b> (industrial PC based on Raspberry Pi).</p>
New entrants
<p>Communication protocols: 5G, LoRA.</p> <p>Barriers to entry:</p> <ul style="list-style-type: none"> <li>- Certifications;</li> <li>- Finding partners to commercialise the solution;</li> <li>- DSOs and aggregators market evolution (as these actors may produce their own solutions).</li> </ul>
Substitutes
<p><b>Merytronic:</b> Low Voltage Network Monitoring system</p> <p><b>Socomec:</b> services of protection, distribution, measuring and monitoring of LV electrical grids</p> <p><b>Embedded Monitoring System (EMSNI):</b> Sub.net-SLV product</p> <p>Since 2000, the national electric utility of Greece has installed and put in operation a modern <b>energy management system (EMS)</b> as a supervisory control and data acquisition (SCADA) system that could maybe substitute the Energy Box in the country.</p>

Suppliers and other actors in the value chain
<ul style="list-style-type: none"> <li>- AMMI Technologies: PCB maker;</li> <li>- LTP Atelier Plastique: all plastic components;</li> <li>- RS components: additional components (microSD memory, 3V battery, WIFI, etc).</li> </ul>

Stakeholders
<ul style="list-style-type: none"> <li>- Components manufacturers;</li> <li>- Installers;</li> <li>- Maintenance entity.</li> </ul>

The analysis allowed to identify the Energy Box's competitive advantages, which especially include:

- the monitoring of sensors, controllers and system analysers;
- the communication of the information collected by the control centre and the application of the orders received from it in physical devices;
- the implementation of relevant communication protocols in the IoT scope and measurement and energy control (ZigBee, MQTT, WiFi, Modbus);
- the real-time management of the associated physical system by following the general parameters established by the control centre;
- the implementation of local control algorithms for the system according to general parameters established by the control centre;
- the management and maintenance of a database for the treatment of system information.

#### *Critical success factors for the considered business model*

The critical success factors for the business model considered for ER4 are evidenced in Table 42.

*Table 42. Critical success factors for the business model considered for ER4*

Critical success factor	Key metric	Data to be collected and sources
Research	Marketing metrics	Market behaviour, competitors, possible sales, social sentiment
Anticipation of failures	Level of errors in implementation	Errors reported by customers and users
Teamwork/project team competence	Quality of final product	Personnel retention, quality of final product
Strong brand	Market valuation	Company's reputation
Success	Software as a Service metrics	Customer lifetime value, customer churn rate, monthly recurring revenue, customer retention rate

#### *Documenting the revenue streams and cost structure*

In order to meet the needs of new generations of smart grid control, demand management, DER or intelligent micro-networks, the Energy Box has been developed as a local management system capable of performing advanced monitoring and control, as well as processing large amounts of information, combining the most current technologies (IoT, optimisation algorithms, etc.). While leading companies in the sector (e.g. ABB, Schneider Electric...) have been mentioned in the market analysis as possible competitors, a possible alternative option has been identified: the Energy Box provider could also be placed in a position of seller and consider such companies as potential clients.

The analysis also allowed to specify the variables that are likely to have the most significant impact on revenues and costs. The elements that will have the greatest impact on revenues through the different selling processes are the components that provide the greatest added value to the final product, which are the compute module and the communication modules of

2G, WIFI and Bluetooth. Regarding costs, LV remote terminal units can be used for the digitalisation of the LV network in secondary substations.

#### 4.6. ER 5: Software module for fault location and self-healing

##### *Refined and updated business model*

Business Model Canvas for ER5 – Software module for fault location and self-healing				
Lead partner: CIRCE				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- TSOs</li> <li>- DSOs</li> <li>- Aggregators/ESCOs</li> <li>- Renewable energy producers</li> <li>- Industrial, commercial and residential partners</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Solution testing (demonstration sites)</li> <li>- Market analysis</li> <li>- Dissemination, replication and exploitation</li> <li>- Installation at customer premises</li> <li>- Cooperation with other projects and networking</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Hardware and software solution to solve the field-level communication and management</li> <li>- Provision of information and control on the MV network allowing to operate it in real time, ensuring the security of supply</li> <li>- Fault detection/location software and energy supply restoration through self-healing algorithms: <ul style="list-style-type: none"> <li>o Detection of faults in the distribution grid</li> <li>o Orders to open/close the relevant breakers to isolate the affected area in a milliseconds range</li> </ul> </li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"> <li>- Customer and maintenance services</li> <li>- Customer service call center</li> </ul>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- Energy communities</li> </ul>
<b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Developers and other human resources</li> <li>- Gathered data</li> <li>- Technical knowledge</li> <li>- Electricity market knowledge</li> <li>- Close knowledge of consumers and local markets</li> </ul>		<b>CHANNELS</b> <ul style="list-style-type: none"> <li>- Distribution at demonstration sites</li> <li>- Sales representatives</li> <li>- B2B and/or bilateral multiservice offerings using existing customer channels</li> <li>- Company website</li> <li>- Online and printed marketing tools</li> <li>- Active media relations</li> <li>- Social media</li> <li>- Conferences, workshops and events</li> <li>- PR, social ads, blog, media, direct mailing</li> </ul>		
<b>COST STRUCTURE</b> <ul style="list-style-type: none"> <li>- Human resources</li> <li>- Testing lab</li> <li>- Marketing costs</li> <li>- Sales costs</li> </ul>		<b>REVENUE STREAMS</b> <ul style="list-style-type: none"> <li>- Licenses</li> <li>- Technology transfers</li> </ul>		

##### *Customer segment analysis*

Two potential customer segments have been identified for the software module for fault location and self-healing: while DSOs would be the main customer segment, energy communities facing some specific issues within their energy supply grids may also be interested in this result. The customer segment analysis is presented in Table 43 and Table 44.

Table 43. Analysis of potential customer segment #1: DSOs

Potential segment #1: DSOs	
<b>Relevant characteristics</b>	DSOs which are managers or owners of energy distribution networks: they serve as simplifiers of the installation process for the energy distribution network and related devices, automate operation and increase their portfolio of customers (energy consumers).
<b>Segment size</b>	Target markets would include Spain, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.
<b>Hypothesised customer needs and aspirations</b>	<p>DSOs' mission throughout Europe is to operate and manage distribution networks in a safe and secure manner. They are also responsible for developing distribution grids to ensure the long-term ability of the system to deliver high-quality services to grid users and other stakeholders of the power system. DSOs are considered to have a "natural monopoly" on local grids and therefore play a crucial role in the effective roll-out of demand-response in a given locality.</p> <p>DSOs are regulated players and provide their services in a strict regulatory framework that is traditionally focused on CAPEX-intensive investments for security of supply. Thus, DSOs have been</p>

	<p>mostly involved in maintenance and expansion of the grid infrastructure (“hardware”), whereas with a more forward-looking smart grid regulation DSOs would be incentivised to also invest in OPEX.</p> <p>In the coming years, several challenges for local distribution grids will accentuate:</p> <ul style="list-style-type: none"> <li>- electrification of transport, with EV charging patterns and electric heating patterns overlapping;</li> <li>- more distributed RES leading to bidirectional flows on the grid;</li> <li>- more flexible consumption patterns, with consumers reacting simultaneously to price signals (on the wholesale market) or curtailment instructions (for balancing services).</li> </ul> <p>Overall, there will be a growing uncertainty over the exact requirements and standards that the power grid will have to fulfil, making long-term investment cycles even more risky. Investments in monitoring and control functionalities in order to manage demand-side flexibility on a local level (hence, rather the “software”) could represent a cost-effective alternative for DSOs.</p>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Improved detection and identification time of the faulty network section allows for reduced response times and thus minimised outage time.
<b>Information and data required to verify these hypotheses</b>	Data that permits to know the limitations of the network that DSOs in the European electricity market will have to mitigate as RES penetration increases.

Table 44. Analysis of potential customer segment #2: Energy communities

<i>Potential segment #2: Energy communities</i>	
<b>Relevant characteristics</b>	Energy community refers to a wide range of collective energy actions that involve citizens’ participation in the energy system.
<b>Segment size</b>	Target markets would include Spain, Greece, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.
<b>Hypothesised customer needs and aspirations</b>	Energy communities can promote social and solidarity-based economy and innovation in the energy sector, tackling energy poverty, promoting energy sustainability and innovation, ensuring production, storage, self-consumption, distribution and/or supply of energy as well as improving local acceptance of RES and energy efficiency in end-use at the local and regional level.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Energy communities, in order to mitigate the lack of access to energy and to improve energy systems throughout the population, will be interested in technological solutions that allow the minimisation of failures (reducing interruption time) in electrical networks and guarantee stability to consumers.
<b>Information and data required to verify these hypotheses</b>	<ul style="list-style-type: none"> <li>- Range that energy communities cover;</li> <li>- Number of points to which they supply energy;</li> <li>- Frequency of failures in their networks;</li> <li>- Time to resolve these failures;</li> <li>- Specific network data.</li> </ul>

### Customer journey analysis

An analysis of the customer journey has been performed for both customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 36.

The problems faced by customers vary depending on the considered customer segment:

- DSOs need an enabler for advanced systems such as prediction and optimisation algorithms: without an intelligent element in the field, they would not be able to perform calculated control.

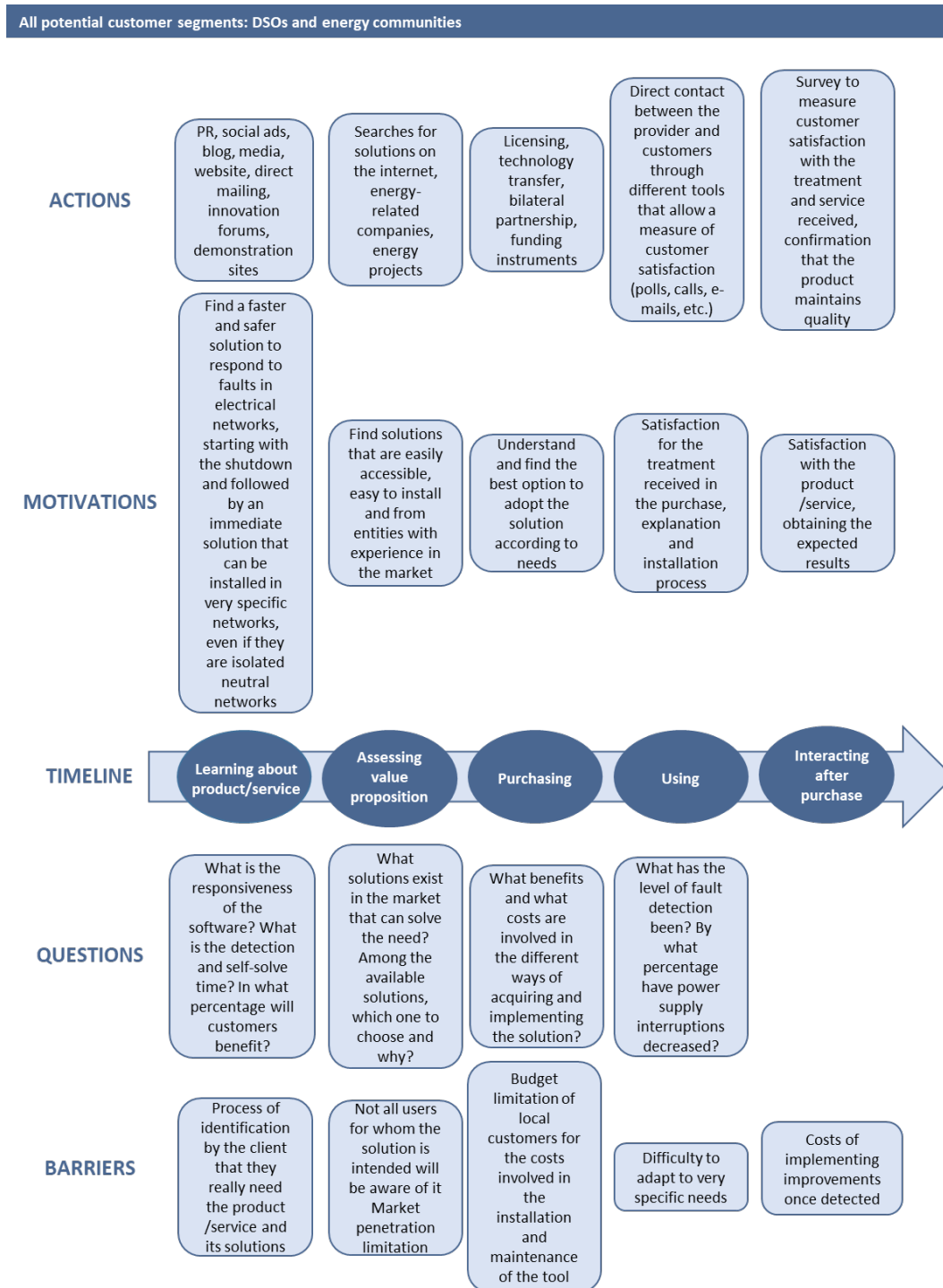
- Energy communities aim to make energy more accessible to consumers within the community. Because of their funding limitations, networks may face failures that affect supply.

The ways in which customers can learn about the software module also vary depending on the considered segment:

- This result will be approved and offered initially to the DSOs that are part of the FLEXIGRID project and to DSOs that are not part of the consortium but with whom the software module provider has previously worked or already has commercial relationships.
- Energy communities can learn about the software module through the EC, the FLEXIGRID website, events where the project and/or result is presented, the press and articles, business websites or list of clientele.

To assess the software module's value proposition before the actual purchase, potential customers will be shown the results obtained in the validations and on-site tests (notably during the FLEXIGRID project's lifetime). The purchase itself can consist in licensing, selling or creating a joint venture. DSOs can then adopt the solution through the software module provider's servers, while energy communities will adopt it in their facilities.

Figure 36. Customer journey analysis for all potential customer segments



This customer journey map evidenced key interactions between the software module provider and customer segments, which allowed to refine the analysis of the “Channels” building block of the business model canvas.

Besides, in relation with this customer journey map, the software module provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 45). As a result, the scope of the activities retained in the “Key activities” building block of the business model canvas has been refined.



Table 45. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Testing the solution in demonstration sites	High	High	High	Confirmation of the correct adaptation and implementation of the solution before being brought to the market
Market analysis	Medium	High	High	Market assessment. Learning about and further exploring the different business outlets of the solution
Dissemination, replication and exploitation	Medium	Medium	High	Making the solution known in the markets already identified in the analysis and exploring the different methods of exploitation and sale
Installation at customer premises	High	High	High	Delivering the product to customers and carrying out custom installation according to their needs
Cooperation with other projects and networking	Low	Medium	High	Constant improvement of the algorithm once needs are identified after launch in user/client facilities

#### Market and competition analysis

A market and competition analysis has been performed in order to refine ER5's value proposition (Table 46).

Table 46. Market and competition analysis for ER5 – Software module for fault location and self-healing – in the European market

Current competitors
<p>The main competitors identified for the ER are the following:</p> <ul style="list-style-type: none"> <li>- technology manufacturers for the energy sector;</li> <li>- manufacturers of protection technologies and network analysis.</li> </ul> <p>Examples include Siemens and Schneider, as well as technological centres that develop solutions for the energy market.</p>
New entrants
<p>Barriers to entry:</p> <ul style="list-style-type: none"> <li>- Certification to penetrate the market;</li> <li>- Adaptation of solutions to different customer needs;</li> <li>- Necessity to know very specific network data to be able to demonstrate the functionality of the algorithms to potential customers.</li> </ul>
Substitutes
<p>At the moment, no identical solution for isolated neutral networks, mostly owned by DSOs, was found on the market.</p>
Suppliers and other actors in the value chain
<p>The main supplier needed for production is the commercial hardware that is needed to create own hardware and run the software itself.</p>
Stakeholders
<ul style="list-style-type: none"> <li>- Components manufacturers;</li> <li>- Installers;</li> <li>- Maintenance entity.</li> </ul>

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER5 are evidenced in Table 47.

Table 47. Critical success factors for the business model considered for ER5

Critical success factor	Key metric	Data to be collected and sources
Research	Marketing metrics	Market behaviour, competitors, possible sales, social sentiment
Anticipation of failures	Level of errors in implementation	Errors reported by customers and users
Teamwork/project team competence	Quality of final product	Personnel retention, quality of final product
Strong brand	Market valuation	Company's reputation
Success	Software as a Service metrics	Customer lifetime value, customer churn rate, monthly recurring revenue, customer retention rate

### Documenting the revenue streams and cost structure

The analysis allowed to specify the variables which are likely to have the most significant impact on revenues and costs. The variable that will have the greatest impact on revenues is expected to be the precision of the software to detect faults and solve them, while the commercial hardware that needs to be purchased to run the software is the expense that will have the most significant impact on costs.

## 4.7. ER 6: Software module for forecasting and grid operation

### Refined and updated business model

Business Model Canvas for ER6 – Software module for forecasting and grid operation				
Lead partner: VERD				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- TSOs</li> <li>- DSOs</li> <li>- Aggregators/ESCOs</li> <li>- Energy retailers</li> <li>- Renewable energy producers</li> <li>- Commercial and industrial customers</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Market analysis</li> <li>- Identification, assessment and comparison of the technological solutions for monitoring and control systems in the distribution network and in the customer premises</li> <li>- Testing of algorithms (simulation, small scale demonstration)</li> <li>- Performance test of the developed applications in a real grid</li> <li>- Cooperation with other projects and networking</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Forecasting algorithms to accurately predict energy generation, demand and electricity price</li> <li>- Optimisation algorithm taking advantage of the forecasting results and suggesting grid operation orders</li> <li>- Provision of optimal settings for network controllable assets, prevention of network congestion</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> <p>For all customer segments: Sales representatives</p> <p>For network operators and renewable energy producers: Workshops, conferences and events</p> <p>For aggregators, ESCOs, energy retailers and commercial and industrial customers: Company website and dedicated website giving access to non-IP sensitive results</p> <p>For commercial and industrial customers: Local support</p>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- Network operators (TSOs, DSOs)</li> <li>- Aggregators/ESCOs</li> <li>- Energy retailers</li> <li>- Renewable energy producers</li> <li>- Commercial and industrial customers</li> </ul>
<b>COST STRUCTURE</b> <ul style="list-style-type: none"> <li>- Human resources</li> <li>- Testing and simulation</li> <li>- Licence for a specific software</li> <li>- Marketing costs</li> <li>- Sales costs</li> </ul>	<b>REVENUE STREAMS</b> <ul style="list-style-type: none"> <li>- Direct sales</li> <li>- Licence purchases (monthly/yearly fee)</li> </ul>			

### Customer segment analysis

Four potential customer segments have been identified for the software module for forecasting and grid operation: i) network operators (TSOs, DSOs), ii) aggregators/energy service companies (ESCos) and energy retailers, iii) renewable energy producers, and iv) commercial and industrial customers. Their analysis is presented in Table 48 to Table 51.

Table 48. Analysis of potential customer segment #1: Network operators (TSOs, DSOs)

Potential segment #1: Network operators (TSOs, DSOs)	
Relevant characteristics	Network operators are responsible for the management of electricity grids, hence load and generation forecasting services could allow them to optimise their operations.
Segment size	Around 2,500 network operators are currently operating in Europe (JRC, 2017a). Assuming a penetration rate of 0.1%, the potential market volume in this area would be of 2 customers.
Hypothesised customer needs and aspirations	<ul style="list-style-type: none"> <li>- Optimisation of the performance of networks.</li> <li>- Overall efficiency improvement in forecasting processes.</li> </ul>
Hypotheses about segment purchasing behaviour and criteria	<ul style="list-style-type: none"> <li>- The sector is changing at a much slower pace than other markets/clients, hence a fast-purchasing behaviour is not expected from network operators' side.</li> <li>- Clients would require high quality and low prices as normally they would pass on the cost to their customers and are typically heavily regulated and monitored regarding operational expenditure.</li> </ul>
Information and data required to verify these hypotheses	<ul style="list-style-type: none"> <li>- Actual spending on generation and demand forecasting for flexibility markets and demand response markets.</li> <li>- Practical requirements and specifications of forecasting processes required.</li> </ul>

Table 49. Analysis of potential customer segment #2: Aggregators/ESCos and energy retailers

Potential segment #2: Aggregators/ESCos and energy retailers	
Relevant characteristics	Aggregators and ESCos are responsible for managing energy resources on behalf of their customers, hence generation forecasting services would allow them to offer improved services to their customers. The ER will target specifically aggregators with solar assets, which is the technology currently covered by it.
Segment size	There are currently around 5,000 licenced aggregators/ESCos in Europe (JRC, 2017a). Assuming a penetration rate of 0.75%, the potential market volume in this area would be of 37 customers. In Europe, the market for demand response aggregators is projected to represent USD 3.5 billion by 2025 (Nicolas Nhede, 2018).
Hypothesised customer needs and aspirations	<ul style="list-style-type: none"> <li>- Optimisation of energy charges for their customers.</li> <li>- Optimisation of flexibility estimation associated with prosumers' forecasted consumption profile.</li> <li>- Improvement of bidding/trading operations in energy markets.</li> </ul>
Hypotheses about segment purchasing behaviour and criteria	Energy forecasting services would allow aggregators/ESCos to minimise their OPEX by introducing automated processes in their businesses.
Information and data required to verify these hypotheses	Actual spending on generation and demand forecasting for participation in energy trading market and flexibility markets.

Table 50. Analysis of potential customer segment #3: Renewable energy producers

Potential segment #3: Renewable energy producers	
Relevant characteristics	RES producers are managing and operating renewable energy resources. They are benefitting from selling the electricity either to aggregators/ESCos or directly to the energy market. PV producers in particular would benefit from the forecasting solutions, as the

	latter would enable them to better understand the production patterns of their assets.
<b>Segment size</b>	At the global scale, the renewable energy market was estimated at USD 928 billion in 2017 and would represent more than USD 1,500 billion by 2025 (Allied Market Research). More specifically, in Europe, this market's growth would register a highest compound annual growth rate (CAGR) of 6.7% between 2018 and 2025 (Allied Market Research).
<b>Hypothesised customer needs and aspirations</b>	<ul style="list-style-type: none"> <li>- Accurate forecasting of the electricity produced by their assets.</li> <li>- Ability to understand potential future generation in order to be able to calculate future revenues.</li> <li>- Creation of robust business cases for new RES installations based on accurate forecasting of future revenues.</li> </ul>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Only interested in PV energy forecasting for potential market self-participation.
<b>Information and data required to verify these hypotheses</b>	Information on current spending for PV energy generation forecasting.

Table 51. Analysis of potential customer segment #4: Commercial and industrial customers

Potential segment #4: Commercial and industrial customers	
<b>Relevant characteristics</b>	Commercial and industrial customers are looking to maximise RES uptake on their sites in order to reduce their energy costs. More specifically, facility managers and building owners with PV systems installed in their premises would benefit from a forecasting solution which would allow them to better understand the production capacity of their assets.
<b>Segment size</b>	Commercial and industrial customers typically represent 50% of the total energy use (Eurostat, 2020). The total electricity production in Europe reached a net 2,800 TWh in 2018, which at an average electricity unit cost of 7.7 cents/kWh represents a total market worth c. EUR 108 billion (Eurostat, 2020; Eurostat, 2021a).
<b>Hypothesised customer needs and aspirations</b>	<ul style="list-style-type: none"> <li>- Emissions reduction by deploying RES and EVs.</li> <li>- Taking advantage of the forecasting results aiming at maximising the integration of RES generation without compromising business-as-usual operation.</li> <li>- Reduced operating expenses.</li> </ul>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	<ul style="list-style-type: none"> <li>- Customers would need a stable and profitable business model in order to invest in the software.</li> <li>- Customers would probably be looking for a payback period lower than 5 years in order to invest.</li> </ul>
<b>Information and data required to verify these hypotheses</b>	Current strategies and energy forecasting/optimisation actions as well as energy costs relevant for the offered solution.

This knowledge about customer segments was used to refine the analysis of customer relationships in the corresponding building block of the business model canvas.

### Customer journey analysis

An analysis of the customer journey has been performed for the different customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 37 to Figure 39.

The problems faced by customers vary depending on the considered segment:

- Network operators (TSOs, DSOs) want to be able to optimise their operation efficiency while at the same time increasing the hosting capacity of RES in the grid. Without the ability to accurately match RES generation and load at any given time, grid security and resilience could be compromised.

- Aggregators, ESCos and energy retailers trade electricity in the energy market. Dealing with interruptible and non-predictable RES, they need to rely on accurate forecasting services to be able to make informed decisions regarding their trades on the market.
- Renewable energy producers own and operate renewable energy assets and sell their electricity either to aggregators or directly to the energy market. The unpredictability of energy generation from these sources may pose a significant challenge when negotiating prices since an accurate forecast of the energy produced needs to be in place to allow making informed trades.
- Commercial and industrial customers often install RES on their premises in order to reduce their energy bill while benefiting from a given level of energy services. At the same time, they need to satisfy their building occupants' level of comfort and their businesses' specific energy needs. This implies a high level of complexity in their operations, introducing the need for accurate load and energy generation forecasting from their assets.

These different customer segments could learn about the software module through dissemination activities such as articles, conferences and events or by looking at their competitors' activities and replicating strategies. To enable them to assess the software module and its capabilities, a trial version could be available for a specific period of time (e.g. 3 months) before purchasing it. Then, they could purchase the module either by being given access to it using a licence (with a monthly/yearly fee) or purchasing it from the developer through a one-off payment.

The use of the software module will be tailored to each customer segment's specific needs:

- Network operators can use the load and generation forecasting module to better understand demand and generation participation in flexibility and demand response markets.
- Aggregators can use it to produce hourly and daily forecasts of the energy production of their assets in order to be able to participate in the energy market.
- Renewable energy producers would use it mainly for long-term forecasts if they are selling to aggregators or for shorter-term forecasts if they are participating in the energy trading market.
- Commercial and industrial customers can use it to accurately predict their energy demand and RES generation on a daily basis. Buildings' facility managers could this way have a very good overview of their energy needs and adjust operations accordingly, aiming at reducing their energy costs.

Then, for all customer segments, interaction with the software module provider post-purchase could be done through emails in order to ensure that support is provided for any technical issue that may arise. An operation and maintenance (O&M) contract could also be provided to customers.

Figure 37. Customer journey analysis for potential customer segment #1: Network operators (TSOs, DSOs)

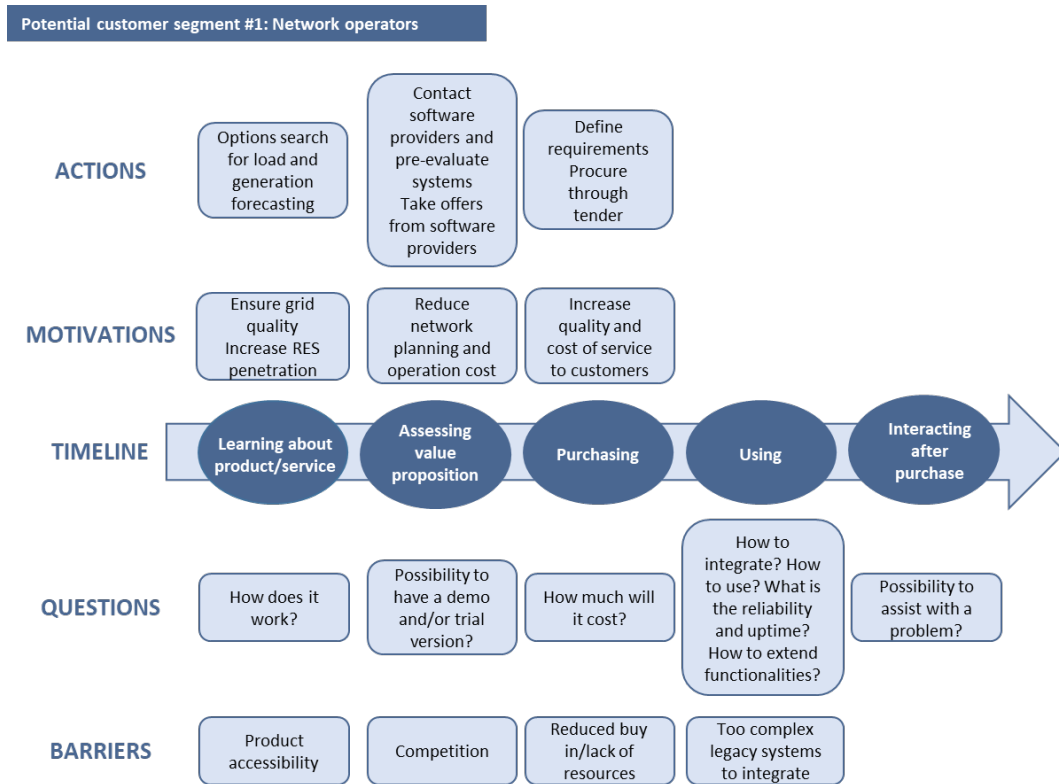


Figure 38. Customer journey analysis for potential customer segments #2 and 3: Aggregators/ESCOs, energy retailers and renewable energy producers

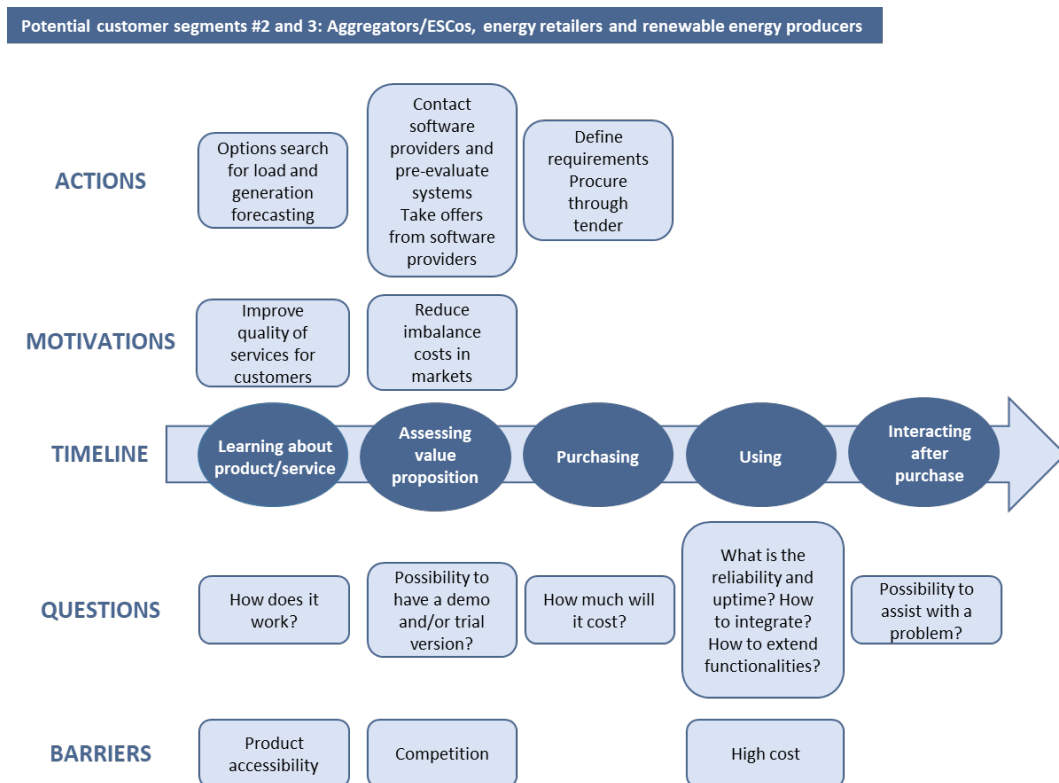
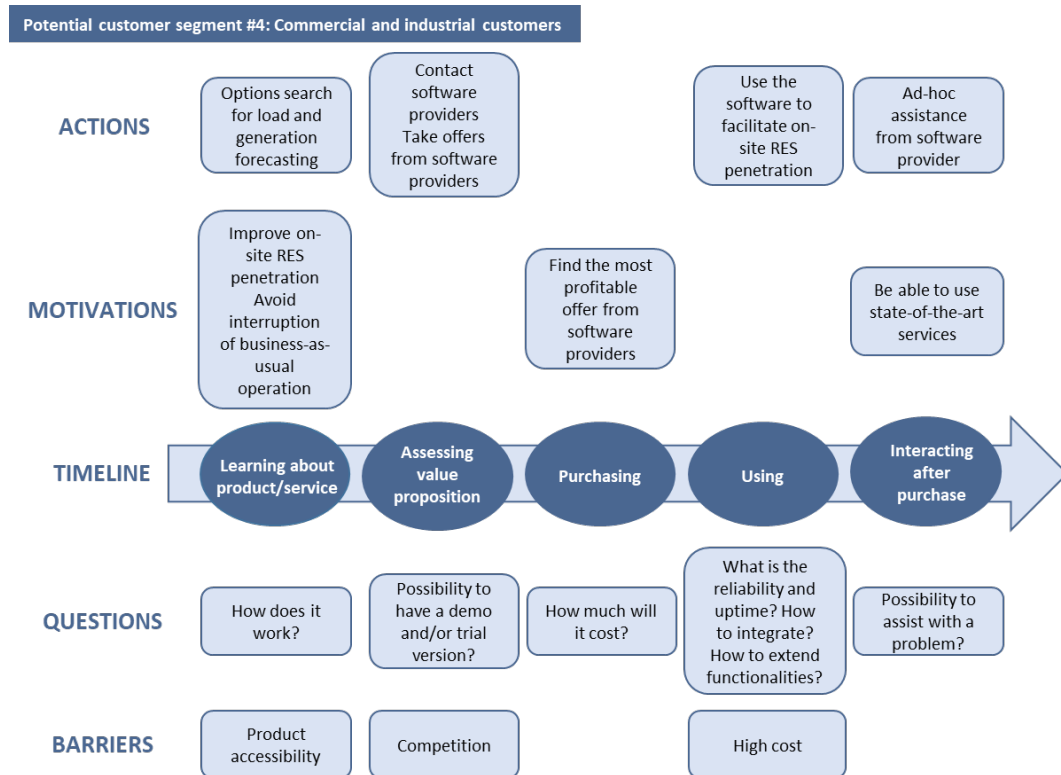


Figure 39. Customer journey analysis for potential customer segment #4: Commercial and industrial customers



These customer journey maps evidenced key interactions between the software module provider and customer segments, which allowed to refine the analysis of the “Channels” building block of the business model canvas.

Besides, in relation with these customer journey maps, the software module provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 52). As a result, the scope of the activities retained in the “Key activities” building block of the business model canvas has been refined.

Table 52. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Market analysis	High	High	Medium	Understanding of competition and target markets
Identification, assessment and comparison of the technological solutions for monitoring and control systems in the distribution network and in customer premises	Medium	Low	High	Understanding of competition and potential gaps in existing markets
Testing of algorithms (simulation, small scale demonstration)	High	Medium	Medium	Product testing and refinement
Performance test of the developed applications in a real grid	High	High	High	Final product refinement and customisation to specific customer needs
Cooperation with other projects and networking	High	Medium	Low	Development of new ideas, potential overcoming of obstacles, creation of new market opportunities



### Market and competition analysis

A market and competition analysis has been performed in order to refine ER6's value proposition (Table 53).

Table 53. Market and competition analysis for ER 6 – Software module for forecasting and grid operation – in the European market

Current competitors
<p><b>Meteologica:</b> forecasting services</p> <p><b>EDF store and forecast:</b> PVSCOPE™, SKYSCOPE™, EOLSCOPE™ and CONSOSCOPE™</p> <p><b>Enfor:</b> forecasting tools and services</p> <p><b>Energymeteo:</b> customised forecasting services</p> <p><b>NextKraft Werke:</b> NEMCOS live monitoring, forecasting and nowcasting solution</p> <p><b>AleaSoft:</b> forecasting services</p>
New entrants
<p>Barriers to entry:</p> <ul style="list-style-type: none"> <li>- High competition in the field of forecasting services;</li> <li>- Software companies create dedicated products;</li> <li>- RES developers and aggregators often use in-house products, thus they do not need specific services from third parties.</li> </ul>
Substitutes
<p>Products/services that can act as substitutes:</p> <ul style="list-style-type: none"> <li>- In-house software: companies may build their own forecasting algorithms/software in order to avoid going out to the market and seeking a customised solution to their needs;</li> <li>- A forecasting module included in a wide purpose software (e.g. VPP software).</li> </ul>
Suppliers and other actors in the value chain
<ul style="list-style-type: none"> <li>- Weather forecast companies;</li> <li>- IT companies;</li> <li>- RES producers which could use their sites to validate the developed solutions;</li> <li>- Facility managers;</li> <li>- Network operators.</li> </ul>
Stakeholders
<p>Other actors that may have an impact on the activity or the competitive environment:</p> <ul style="list-style-type: none"> <li>- Public authorities;</li> <li>- Regulators;</li> <li>- Utilities;</li> <li>- Facility management consultants;</li> <li>- Energy experts.</li> </ul>

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER6 are evidenced in Table 54.

Table 54. Critical success factors for the business model considered for ER6

Critical success factor	Key metric	Data to be collected and sources
<b>Forecast accuracy</b>	%error	PV production and load demand from demonstration site in Greece
<b>Reliability/Uptime</b>	%time	PV production and load demand from demonstration site in Greece
<b>Cost to run and maintain</b>	Hardware/software resources and personnel	Resources used in FUSE (data storage, user interface) and average time to maintain after demonstration in the demonstration site in Greece

### Documenting the revenue streams and cost structure

A possible alternative option has been identified: marketing the software module as a bundle with ER7 to provide a holistic forecasting and scheduling service.

The analysis also allowed to specify the variables that are likely to have the most significant impact on revenues and costs. Revenues will be contingent upon the number of customers and the number of sites, as well as customer maintenance, which is linked with persisting product quality (stable and satisfactory forecast accuracy). As for costs, they will depend mainly on integration costs with the customer, the training and support required, maintenance costs, and customisation/upgrade costs.

## 4.8. ER 7: Software module for congestion management

### Refined and updated business model

Business Model Canvas for ER7 – Software module for congestion management				
Lead partner: VERD				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- Utilities</li> <li>- Aggregators/ESCos</li> <li>- Commercial, industrial and residential customers</li> <li>- Facility management consultants</li> <li>- Energy experts</li> <li>- Regulators</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Business development and marketing</li> <li>- Development of a turn-key solution</li> <li>- Adaptation and customisation of the turn-key solution</li> <li>- Continuous updating to comply with market rules and tariff structure</li> </ul>	<b>VALUE PROPOSITIONS</b> <p><b>Aggregators:</b> One-stop solution for setting up, developing and exploiting flexible energy provisioning from the customer to the DSO</p> <p><b>Commercial and industrial customers:</b> Harvesting the full potential of their energy assets in order to reduce network and energy charges while potentially providing services to the grid</p>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"> <li>- Customer acquisition, audits and contracts</li> <li>- Integration, technical operation and maintenance</li> <li>- Account management (contract, support, loyalty schemes, billings/settlements)</li> </ul>	<b>CUSTOMER SEGMENTS</b> <p><b>Primary:</b></p> <ul style="list-style-type: none"> <li>- Aggregators/ESCos</li> </ul> <p><b>Secondary:</b></p> <ul style="list-style-type: none"> <li>- Commercial and industrial customers</li> <li>- Residential customers</li> </ul>
	<b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Historical consumption and generation data to feed the forecasting algorithm that will facilitate the scheduling</li> </ul> <p><b>Technology provider's assets:</b></p> <ul style="list-style-type: none"> <li>- Expertise in energy management</li> <li>- Software engineering personnel</li> </ul> <p><b>Aggregators' asset:</b></p> <ul style="list-style-type: none"> <li>- Communications Smart Box</li> </ul> <p><b>Commercial and industrial customers' assets:</b></p> <ul style="list-style-type: none"> <li>- PV infrastructure</li> <li>- Batteries</li> <li>- EV chargers</li> <li>- Communications local backbone infrastructure</li> <li>- Local energy and communications O&amp;M personnel</li> </ul>		<b>CHANNELS</b> <ul style="list-style-type: none"> <li>- Awareness raised by government and regulations promoting new policies and market schemes</li> <li>- Workshops conducted by network operators on new markets' design and operation</li> <li>- Direct customer support to aggregators</li> </ul>	
<b>COST STRUCTURE</b> <div> <b>Opex:</b> <ul style="list-style-type: none"> <li>- Hardware and software infrastructure maintenance</li> <li>- Human resources</li> </ul> </div> <div> <b>Capex:</b> <ul style="list-style-type: none"> <li>- Hardware and software infrastructure development and integration</li> </ul> </div>		<b>REVENUE STREAMS</b> <ul style="list-style-type: none"> <li>- Licencing</li> <li>- Payments for level of support</li> </ul>		

### Customer segment analysis

Three potential customer segments have been identified for the software module for congestion management: i) aggregators/ESCos, ii) commercial and industrial customers, and iii) residential customers. Their analysis is presented in Table 55 to Table 57.

Table 55. Analysis of potential customer segment #1: Aggregators/ESCOs

Potential segment #1: Aggregators/ESCOs	
Relevant characteristics	Aggregators/ESCOs trade electricity in the energy market. Dealing with interruptible and non-predictable RES, they need to use customised congestion management tools in order to be able to benefit from the flexible energy resources of their customers.
Segment size	There are currently around 5,000 licenced aggregators/ESCOs in Europe (JRC, 2017a). Assuming a penetration rate of 0.75%, the potential market volume in this area would be of 37 customers. In Europe, the market for demand response aggregators is projected to represent USD 3.5 billion by 2025 (Nicolas Nhede, 2018).
Hypothesised customer needs and aspirations	The software module would help aggregators and ESCOs to undertake a comprehensive one-stop solution to set up, develop and exploit flexible energy provisioning from customers to DSOs. It would also allow them to drive decarbonation and minimise their customers' burdens in monetising flexibility.
Hypotheses about segment purchasing behaviour and criteria	The software services would enable aggregators/ESCOs to minimise their OPEX by introducing automated processes in their businesses.
Information and data required to verify these hypotheses	Current spending and strategy for congestion management.

Table 56. Analysis of potential customer segment #2: Commercial and industrial customers

Potential segment #2: Commercial and industrial customers	
Relevant characteristics	Commercial customers often install RES on their premises in order to reduce their energy bill while benefitting from a given level of energy services. At the same time, they need to satisfy their building occupants' level of comfort and their businesses' specific energy needs. This implies a high level of complexity in their operations, introducing the need for accurate monitoring and operation of their equipment.
Segment size	Commercial and industrial customers typically represent 50% of the total energy use (Eurostat, 2021a). The total electricity production in Europe reached a net 2,800 TWh in 2018, which at an average electricity unit cost of 7.7 cents/kWh represents a total market worth c. EUR 108 billion (Eurostat, 2020; Eurostat, 2021a).
Hypothesised customer needs and aspirations	The software could be leveraged by commercial facility owners which do not fully exploit their energy assets (RES, batteries, EV charging points, etc.) and face high energy costs. It would enable them to benefit from the full potential of their equipment's capabilities in order to reduce network and energy charges, while potentially providing services to the grid.
Hypotheses about segment purchasing behaviour and criteria	Commercial facility owners would probably like to see a detailed business case with the potential benefits of the purchase/use of the software before making an investment as they typically invest in low-risk projects.
Information and data required to verify these hypotheses	<ul style="list-style-type: none"> <li>- Current spending and strategy for congestion management, if any;</li> <li>- Identification of individual issues for specific sub-segments of this customer segment.</li> </ul>

Table 57. Analysis of potential customer segment #3: Residential customers

Potential segment #3: Residential customers	
Relevant characteristics	Residential customers would need to increase self-consumption rates from their RES. Optimisation and scheduling algorithms would allow for optimisation of energy use in residential premises.
Segment size	Energy consumption in households represents a steady contribution of c. 25% of the total energy consumption in Europe (Eurostat, 2021b). Electricity production in Europe reached 2,800 TWh in 2018 (Eurostat, 2020). The average price paid by EU

	households with an annual consumption superior to 2,500 kWh was 21.13 cents per kWh in 2018, representing a total spending on electricity for residential customers of around EUR 147 billion (Statista, 2020).
<b>Hypothesised customer needs and aspirations</b>	<ul style="list-style-type: none"> <li>- Improved reliability of supply;</li> <li>- Reduced energy costs;</li> <li>- Reduced environmental footprint;</li> <li>- Introduction of new technologies in the household (e.g. small storage systems).</li> </ul>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	Residential customers are not expected to be very eager to purchase these services as there is currently no strong motivation for them to manage their loads.
<b>Information and data required to verify these hypotheses</b>	Potential issues with reliability of supply, energy bills and/or potential opportunities for reduced energy costs depending on the country of reference might help to verify the need for congestion management at a residential level.

This analysis suggests that congestion management is more likely to be useful to aggregators and ESCos in the near future, as congestion issues will need to be resolved primarily at the network level. At a later stage the need might arise for congestion management at a smaller scale (i.e. smaller network), which will then open the market for such software services to commercial, industrial and residential customers.

#### *Customer journey analysis*

An analysis of the customer journey has been performed for the different customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results for the primary customer segment, i.e. aggregators/ESCos, are presented in Figure 40.

The problems faced by customers vary depending on the considered segment:

- Aggregators and ESCos want to be in position to offer complete energy management solutions (bundled services) to their customers on top of their traditional roles, satisfying their need for complete energy management that will safeguard both financial profitability and local network and equipment resilience.
- Commercial and industrial customers may want to reduce their environmental footprint by introducing RES into their systems. However, complex control technologies might be needed to effectively manage those resources and increase their potential, leaving room for the deployment of a congestion management software in their facilities.
- Residential customers want to optimise their energy use.

The channels through which potential customers could learn about the software also vary depending on the considered segment:

- For aggregators/ESCos, the software module provider could conduct workshops to promote it.
- Commercial, industrial and residential customers could learn about the software module through direct customer support channels (web portal, social media, etc.). Awareness raised by government and regulation could also help to promote the need for congestion management services.

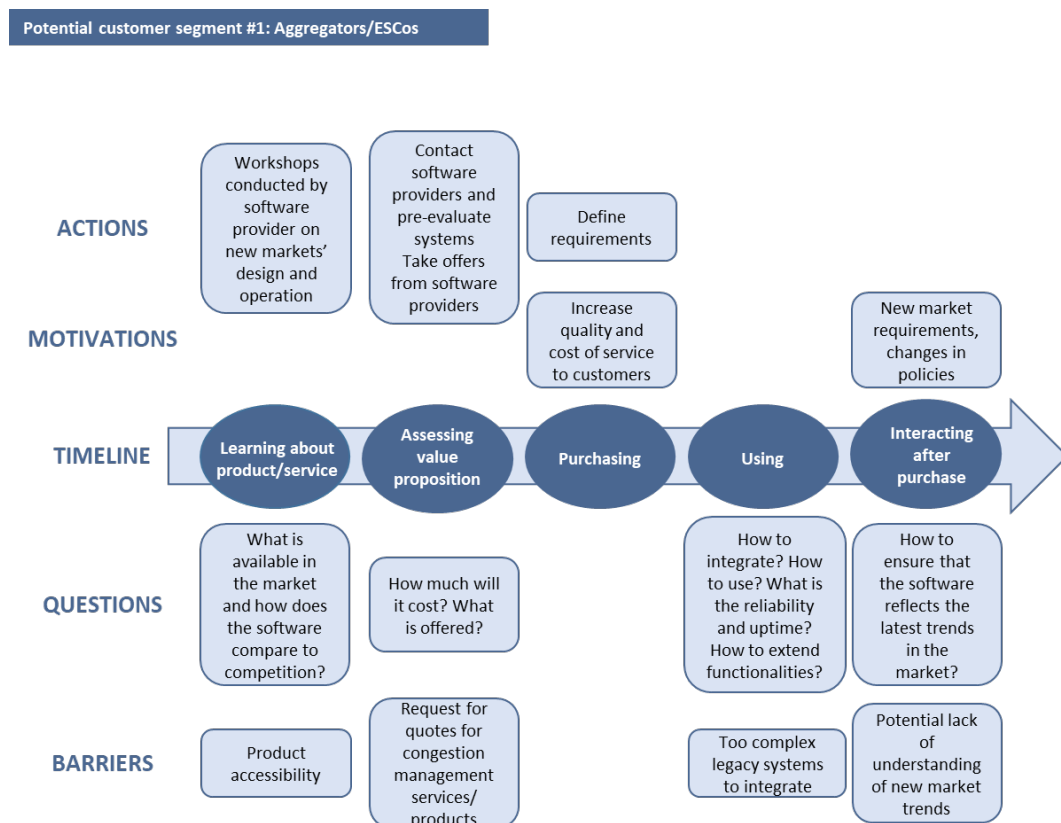
Potential customers could assess the software before purchasing it by requesting a free trial period in the form of a personalised report based on simulation. They could then purchase a fixed-term licence for using the product (e.g. a one-year licence), or agree with the software provider on specific payments depending on the level of support.

The use of the software module will be tailored to each customer segment’s specific needs:

- For aggregators/ESCOs, the service could be a one-stop solution for setting up, developing and exploiting flexible energy provisioning from their customers to the DSO.
- Commercial and industrial customers can harvest the full potential of their energy assets by using the service in order to reduce network and energy charges while potentially providing services to the grid.
- Residential customers can either set up the relevant SaaS to be functioning in an automated preconfigured way or interact in real time with the application’s suggestions to accept or not a congestion mitigation or an energy management optimisation action.

After the purchase, customers will need to interact with the software services supplier at the beginning for training purposes. Aggregators/ESCOs and commercial and industrial customers will also need to interact with the provider on a regular basis during the time that they use the service for questions and issues that may arise and/or for updates or adjustments needed to the software in order to customise it to specifically address their needs. As for residential customers, they will need to interact with the provider during an active licence period for support purposes. The interaction will be realised through the available communication channels defined in the relevant contractual agreement (e.g. e-mail, phone, dedicated support platform).

Figure 40. Customer journey analysis for potential customer segment #1: Aggregators/ESCOs



This analysis of the customer journey evidenced key interactions between the software module provider and customer segments, which allowed to refine the contents of the “Channels” building block of the business model canvas.

Besides, in relation with this analysis, the software module provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 58).

As a result, the scope of the activities retained in the “Key activities” building block of the business model canvas has been refined.

Table 58. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Business development and marketing	High	High	Low	Identification of target market and clients
Development of a turn-key solution	High	High	High	Product development
Adaptation and customisation of the turn-key solution	High	High	High	Customised product to fit the specific needs of particular clients
Continuous updating to comply with market rules and tariff structure	Medium	Medium	Low	A product remaining state-of-the-art at any point

#### Market and competition analysis

A market and competition analysis has been performed in order to refine ER7’s value proposition (Table 59).

Table 59. Market and competition analysis for ER7 – Software module for congestion management – in Europe

Current competitors
There are currently no known competitors in the market selling congestion management software. At the moment, congestion management is performed at a network or utility level using internal tools built by TSOs and DSOs. Besides, scheduling and monitoring is performed at device level (e.g. batteries’ inverters).
Substitutes
On-site equipment might be equipped with basic congestion management algorithms.
Suppliers and other actors in the value chain
<ul style="list-style-type: none"> <li>- RES and technology providers (e.g. PV and battery suppliers);</li> <li>- Facility managers;</li> <li>- Communications hardware suppliers (e.g. gateways).</li> </ul>
Stakeholders
Other actors that may have an impact on the activity or the competitive environment: <ul style="list-style-type: none"> <li>- Network operators;</li> <li>- Aggregators;</li> <li>- Public authorities;</li> <li>- Policymakers.</li> </ul>

This analysis helped to refine the value proposition of the software module, notably for aggregators: it provides them with a one-stop solution for setting up, developing and exploiting flexible energy provisioning from the customer to the DSO.

#### Critical success factors for the considered business model

The critical success factors for the business model considered for ER7 are evidenced in Table 60.

Table 60. Critical success factors for the business model considered for ER7

Critical success factor	Key metric	Data to be collected and sources
Cost to run and maintain	Hardware/software resources and personnel	Resources used in FUSE (data storage, interface) and average time to maintain after the demonstration in the demonstration site in Greece
In the case of commercial and industrial customers: availability of data on the evolution of electricity and CO <sub>2</sub> costs, reliability indices	Number of sales of battery systems, electricity and carbon prices	Average electricity cost

#### Documenting the revenue streams and cost structure

A possible alternative option has been identified: marketing the software module as a bundle with ER6 to provide a holistic forecasting and scheduling service.

The analysis also allowed to specify the variables which are likely to have the most significant impact on revenues and costs. Revenues will be contingent upon the number of customers and the number of sites, as well as customer maintenance, which is linked with persisting product quality (stable and satisfactory forecast accuracy). As for costs, they will depend mainly on integration costs with the customer, the training and support required, maintenance costs, and customisation/upgrade costs.



#### 4.9. ER 8: Virtual Thermal Energy Storage Module

##### *Refined and updated business model*

Business Model Canvas for ER8 – Virtual Thermal Energy Storage Module				
Lead partner: HYPER				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- European TSOs/DSOs</li> <li>- Energy retailers/suppliers</li> <li>- Aggregators</li> <li>- ESCOs / ESPCs</li> <li>- Microgrid operators</li> <li>- Energy communities</li> <li>- Certified installers</li> <li>- Smart home solutions / BMS providers</li> <li>- Cloud computing service providers</li> <li>- IoT devices / platforms providers</li> <li>- FLEXIGRID project partners</li> <li>- Open source initiative</li> <li>- Website developers</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Marketing of the solution</li> <li>- Training of installers /commissioners (B2B scenario)</li> <li>- Installation /commissioning (B2C scenario)</li> <li>- Creation of necessary documentation to address issues and concerns of users</li> <li>- Measurement of customer satisfaction</li> <li>- Website and online shop development</li> <li>- Development of commercial product and service offerings</li> <li>- Development of consumer /end-customer interfaces</li> <li>- Networking activities /customer engagement</li> <li>- Provision of technical support</li> </ul> <b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Development team</li> <li>- Databases and collected data</li> <li>- Cloud hosting space</li> <li>- Developed algorithms / software</li> <li>- Controllable devices</li> <li>- User App</li> <li>- Smart Box</li> <li>- Website</li> <li>- Marketing and sales team and marketing material</li> <li>- Technical support team</li> <li>- IT infrastructure</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Comfort-based flexibility offering</li> <li>- Data-driven thermal comfort profiling</li> <li>- Participation in explicit demand response programs</li> <li>- Delivery of dynamic energy tariffs (implicit demand response)</li> <li>- Monitoring, programming and configuration of smart energy appliances</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"> <li>- Training of certified installers and commissioners</li> <li>- Product self-learning</li> <li>- Troubleshooting manual</li> <li>- Customer support team</li> <li>- Web platform and customer app</li> <li>- Social media</li> </ul> <b>CHANNELS</b> <ul style="list-style-type: none"> <li>- Stakeholder ecosystem</li> <li>- B2B collaboration (especially with actors seeking to offer demand response smart services, certified installers, ESCOs and energy product retailers)</li> <li>- Targeted communication with existing clients</li> <li>- Website (with online shopping platform) / social media</li> <li>- Marketing and dissemination activities</li> <li>- Cooperative / networking events</li> <li>- Co-creation activities for product improvement (following up on user feedback)</li> <li>- Documentation covering user concerns and issues (such as privacy policies, troubleshooting guides, etc.)</li> </ul>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- Energy retailers</li> <li>- Aggregators</li> <li>- ESCOs / ESPCs</li> <li>- BMS providers</li> <li>- Residential customers</li> <li>- Energy communities</li> <li>- Local authorities</li> </ul>
<b>COST STRUCTURE</b> <div> <b>Opex:</b> <ul style="list-style-type: none"> <li>- Human resources (development team, marketing and sales team, operations team, technical support team)</li> <li>- Cloud hosting fees</li> <li>- Website service party licences</li> <li>- Purchase of components for product development</li> </ul> </div> <div> <b>Capex:</b> <ul style="list-style-type: none"> <li>- IT infrastructure (hardware, software, licences)</li> </ul> </div>		<b>REVENUE STREAMS</b> <div> <b>Option 1:</b> <ul style="list-style-type: none"> <li>- Smart Box purchases</li> <li>- Licences for software products</li> </ul> </div> <div> <b>Option 2:</b> <ul style="list-style-type: none"> <li>- Software-as-a-Service</li> </ul> </div> <div> <b>Common to both options:</b> <ul style="list-style-type: none"> <li>- Personalisation/customisation of product/platform</li> <li>- Sales of additional energy services</li> <li>- Technical support, training and installation</li> </ul> </div>		

##### *Customer segment analysis*

Seven potential customer segments have been identified for the virtual thermal energy storage (VTES) module: i) energy retailers, ii) aggregators, iii) ESCOs / energy service performance contracts (ESPCs), iv) building management system (BMS) providers, v) residential customers, vi) energy communities, and vii) local authorities. Their analysis is presented in Table 61 to Table 67. They can be prioritised according to the following criteria:

- How well ER8 meets the purchasing criteria and satisfies the needs of each customer segment (i.e. how likely it is for the customer segment to purchase the product);
- The current size and expected growth of each segment in Europe;

- iii) The size of the client portfolio of each segment (e.g. an aggregator may have 50 clients to whom they can sell the solution, while a retailer may have 1,000 customers).

Following these criteria, the prioritisation of customer segments would be the following: i) energy retailers, ii) ESCos / ESPCs, iii) energy communities, iv) BMS providers, v) aggregators, vi) local authorities, and vii) residential customers. The latter, although they are in size the largest segment, are more difficult to approach at an individual level, so targeting them through retailers, ESCos etc. seems to be a more reasonable approach. Therefore, the VTES module provider will follow primarily a B2B approach, whereby a smaller pool of customers (retailers, ESCos, BMS providers, etc.) are targeted in the first instance and can resell the products to their customers under a different commercial arrangement.

Table 61. Analysis of potential customer segment #1: Energy retailers

Potential segment #1: Energy retailers	
Relevant characteristics	Energy retailers in Europe that want to expand their product offerings towards demand response services, in markets where this is feasible.
Segment size	As of 2018, there were c. 1500 electricity suppliers across Europe (including Great Britain) (CEER, 2019). An increasing trend was observed in most European countries between 2017 and 2018 (CEER, 2019). A similar growth rate may continue for countries which still have a relatively low supplier/consumer ratio.
Hypothesised customer needs and aspirations	Energy retailers will need to expand their offerings' portfolio to attract more customers. Their aspiration is to increase their market share nationally, but also internationally if possible.
Hypotheses about segment purchasing behaviour and criteria	<ul style="list-style-type: none"> <li>- Any low-cost solution that could be combined with existing offerings or help to create new offerings for electricity customers.</li> <li>- Potentially, disruptive technologies that could provide a market advantage to early adopters and providers.</li> </ul>
Information and data required to verify these hypotheses	Feedback on the hypotheses.

Table 62. Analysis of potential customer segment #2: Aggregators

Potential segment #2: Aggregators	
Relevant characteristics	All aggregators active in explicit demand response markets where Direct Load Control (DLC) is needed. The solution may also be useful for the implementation of implicit demand response and recommendation services.
Segment size	There were c. 60 aggregators in the EU in 2019 (including the UK) (K. Poplavska and L. de Vries, 2020). One can assume that by 2025, their number will have reached 100 in the EU (excluding the UK).
Hypothesised customer needs and aspirations	Aggregation gives relatively low returns; therefore, aggregators aim at increasing their market share and portfolio size to achieve viability and profitability (K. Poplavska and L. de Vries, 2020).
Hypotheses about segment purchasing behaviour and criteria	<ul style="list-style-type: none"> <li>- Solutions that may open up new value streams to aggregators.</li> <li>- Solutions that could add more assets to aggregators' portfolios.</li> <li>- Solutions that reduce energy transaction costs and minimise risks for the prosumers/customers within aggregators' portfolios.</li> </ul>
Information and data required to verify these hypotheses	Feedback on the hypotheses.

Table 63. Analysis of potential customer segment #3: ESCOs / ESPCs

Potential segment #3: ESCOs / ESPCs	
Relevant characteristics	ESCos that want to augment their traditional products with human-centric demand-side management offerings.
Segment size	There were up to 1,500 ESCOs/ESPCs in Europe in 2013 (excluding the UK) (B. Boza-Kiss, P. Bertoldi et al., 2015). They represented a EUR 8.5 billion market in the EU in 2013 (JRC, 2017a). The market change has been slow in most EU countries from 2013 to 2016 (JRC, 2017a). One may assume that growth will continue to be quite slow until 2025 (JRC, 2017a).
Hypothesised customer needs and aspirations	<ul style="list-style-type: none"> <li>- Improve their public image by demonstrating ways of promoting energy efficiency;</li> <li>- Offer ways to improve the comfort of building occupants;</li> <li>- Find ways to increase the loyalty of current customers, but also to expand their client portfolios;</li> <li>- Achieve financial gains for both their clients and themselves.</li> </ul>
Hypotheses about segment purchasing behaviour and criteria	Any low cost, non-intrusive technologies/solutions that could achieve any or several of the aforementioned aspirations and needs of ESCOs and ESPCs.
Information and data required to verify these hypotheses	Feedback on the hypotheses.

Table 64. Analysis of potential customer segment #4: BMS providers

Potential segment #4: BMS providers	
Relevant characteristics	BMS providers that want to include human-centric modelling and optimisation routines to their management systems.
Segment size	There are approximately 8-10 top market players owning the majority of the BMS market share (Markets and Markets, 2017). The market of BMS is expected to grow until 2025 with a CAGR of approximately 3%-7.5% (Mordor Intelligence, n.d.; Research and Markets, 2019). This is partly due to legislation pushing for greater energy performance in buildings and energy efficiency.
Hypothesised customer needs and aspirations	<ul style="list-style-type: none"> <li>- Increase market share and profits by expanding solutions' portfolio;</li> <li>- Solutions that can be used in both commercial and residential buildings, as these two building types are expected to make use of BMSs the most;</li> <li>- Solutions that require low implementation costs.</li> </ul>
Hypotheses about segment purchasing behaviour and criteria	<ul style="list-style-type: none"> <li>- Solutions that could offer significant cost savings to end-users;</li> <li>- Automated solutions that could simplify daily operations and improve the energy performance of buildings;</li> <li>- Non-intrusive, low-cost solutions to manage the energy consumption and generation of a building without compromising user comfort.</li> </ul>
Information and data required to verify these hypotheses	Feedback on the hypotheses.

Table 65. Analysis of potential customer segment #5: Residential customers

Potential segment #5: Residential customers	
Relevant characteristics	Small energy consumers that want to become active energy market players through an aggregator or are interested in energy automation for efficiency and comfort.
Segment size	There are more than 200 million households in the EU (Statista, 2021). However, only a small proportion of them is likely to be interested in smart home and BMS solutions. More than 8 million units of smart lights, thermostats and monitoring devices for domestic premises were sold in 2020 across Europe (IDC, 2021). At the same time, between 2018 and 2019, there was a c. 43% increase in the number of households in the EU using building energy management systems (from 35,000 to 50,000 households)

	(Mordor Intelligence, n.d.). Those trends, in combination with the push towards a more energy efficient management of residential buildings, leads to the assumption that the number of potential residential customers for the VTES solution will increase in the future.
<b>Hypothesised customer needs and aspirations</b>	<ul style="list-style-type: none"> <li>- Achieve cost savings on energy bills;</li> <li>- Achieve higher energy efficiency at home;</li> <li>- Have remote control over specific domestic loads.</li> </ul>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	<ul style="list-style-type: none"> <li>- Low-cost, automated solutions that could help to achieve energy, and hence energy bill, savings;</li> <li>- Solutions that are plug-and-play (easy to install and operate);</li> <li>- Non-intrusive solutions that do not compromise the comfort of customers;</li> <li>- Solutions that allow the visualisation of energy consumption and offer remote control capabilities for specific residential loads.</li> </ul>
<b>Information and data required to verify these hypotheses</b>	The validation of the solution through the relevant project KPIs, such as customer satisfaction, energy savings achieved per customer and thermal discomfort, could help verify most of the aforementioned hypotheses.

Table 66. Analysis of potential customer segment #6: Energy communities

Potential segment #6: Energy communities	
<b>Relevant characteristics</b>	The term “energy community” is used here to describe any collective action that enables the active participation of citizens to the energy transition. Energy communities may act as retailers, aggregators and/or ESCos; as such, the relevant characteristics mentioned in the tables above are valid here according to the case at hand.
<b>Segment size</b>	In Europe, in 2020, around 3,500 energy cooperatives were identified (including approximately 500 cooperatives in the UK) (JRC, 2020). Due to lack of relevant data on expected growth, one may assume that the number of energy communities in Europe is going to remain stable in the next five years.
<b>Hypothesised customer needs and aspirations</b>	<ul style="list-style-type: none"> <li>- Achieve improvements in energy efficiency at community level;</li> <li>- Increase community-level self-consumption;</li> <li>- Achieve energy cost savings at community level;</li> <li>- Facilitate the participation of the community as a whole, as well as of members of the community as individuals, in the energy market (local energy market, local flexibility market, wholesale market, etc.);</li> <li>- Explore new revenue streams for the community.</li> </ul>
<b>Hypotheses about segment purchasing behaviour and criteria</b>	<ul style="list-style-type: none"> <li>- Solutions that offer opportunities for revenue stacking for the community as a whole and open up ways to new revenue streams;</li> <li>- Solutions with high acceptability potential by members of the community.</li> </ul>
<b>Information and data required to verify these hypotheses</b>	Feedback on the hypotheses.

Table 67. Analysis of potential customer segment #7: Local authorities

Potential segment #7: Local authorities	
<b>Relevant characteristics</b>	Local authorities interested in or required to participate in green energy initiatives and decarbonation activities.
<b>Segment size</b>	There are approximately 88,000 local authorities in the EU (CEMR, 2016). One may assume that the number of local authorities will not significantly change over the next five years in the EU.
<b>Hypothesised customer needs and aspirations</b>	Local authorities have a key role in promoting the agenda of and achieving the commitments made by EU member States and the EC

	with regards to the decarbonation, decentralisation and digitalisation of the energy sector. They especially implement key energy and cost efficiency measures in municipality buildings.
<b>Hypotheses about segment purchasing behaviour and criteria</b>	<ul style="list-style-type: none"> <li>- Solutions that are low-cost, non-intrusive, ideally plug-and-play, and that help to achieve energy and cost savings in public buildings without compromising occupant comfort;</li> <li>- Solutions that help to raise energy awareness (e.g. through the visualisation of energy consumption and generation in public buildings).</li> </ul>
<b>Information and data required to verify these hypotheses</b>	Feedback on the hypotheses.

This knowledge about customer segments was used to refine the analysis of customer relationships in the corresponding building block of the business model canvas.

### *Customer journey analysis*

An analysis of the customer journey has been performed for the different customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 41 to Figure 44.

The problems faced by customers vary depending on the considered segment:

- Energy retailers face difficulties in gaining market advantage over competition and want to increase their client portfolio.
- Aggregators are willing to diversify their portfolio of flexible assets, increase liquidity (i.e. increase the number of contracted demand-response providers) at lower voltage levels to offer services to DSOs, and increase customer buy-in for participation in demand-response schemes.
- ESCos and ESPCs are seeking ways to increase the loyalty of current customers, but also to expand their client portfolios. They strive to offer customisable services to their clients.
- BMS providers are willing to expand their market share in commercial and residential buildings with solutions that do not require high implementation costs.
- Residential customers want to increase their energy efficiency and save on energy bills with solutions that are user-friendly, non-intrusive and do not compromise their comfort and energy needs.
- Energy communities wish to increase participation in collective actions that can offer additional revenue streams to the community and its members. They may have a limited understanding of revenue stacking opportunities within the energy flexibility landscape.
- Local authorities aim to increase energy efficiency and energy cost savings in public buildings.

All customer segments may learn about the software module through the provider’s network of existing clients, through targeted commercialisation activities (including marketing campaigns), and through demonstration campaigns in specific pilot sites, where they may be involved. Residential customers and energy communities may also learn about it by word of mouth (through other customers that have previous, positive experience of the products/services), and, in the case of residential customers, from their energy retailers, ESCos, aggregators or their community if they are part of an energy community. Energy communities and local authorities may also learn about the solution through social media.

Customers can assess the module’s value proposition before the actual purchase through different means:

- Participation in demonstration campaigns at pilot sites;
- Evidence from the validation activities and demonstration campaigns carried out in EU-funded projects;
- Potentially, the use of Net Promoter Score;
- Potentially, a free trial of the module for a limited amount of time.

For energy retailers, aggregators, ESCos and ESPCs and BMS providers, the purchase of the module can be made over-the-counter or through an online shop. In the case of residential customers, energy communities and local authorities, the products and services will be sold mainly through a network of energy retailers, ESCos / ESPCs, aggregators, etc. (B2B scenario); in a B2C scenario, products and services could also be sold directly to customers, mainly through an online shop.

The use of the module will vary depending on the customer segment:

- The products/services provided to energy retailers and BMS providers will be resold to interested end customers (mainly residential and commercial customers). In the case of energy retailers, they can be sold as standalone items or as parts of existing or new/innovative service offerings. For BMS providers, they can be sold, after appropriate integration, as part of existing or new/innovative service offerings.
- Aggregators are expected to resell the products and services to their clients. An interfacing between the VTES module and existing aggregator tools may be required, in which case the service sold to the aggregator will include the development and testing of such interfaces.
- ESCos and ESPCs may resell the products and services to their clients as part of more holistic energy service offerings.
- For residential customers, the necessary kit will be installed at home or in the building. A Customer App (as part of a certain type of offering) will enable customers to use the smart box remotely, through their mobile phone (with a user-friendly interface).
- For energy communities, the necessary solution equipment will be distributed to members that are keen to use the relevant technology and service. Customers can realise energy efficiency improvements and energy cost savings, while the community can also participate in demand-response schemes for additional revenue streams.
- In the case of local authorities, the solution will be deployed in the buildings that they own to improve energy efficiency and achieve energy cost savings.

After the purchase, depending on the commercial agreement between the module provider and energy retailers, aggregators, ESCos/ESPCs and BMS providers, interactions can involve ongoing technical and troubleshooting support, training of certified installers, continuous feedback loops for product and service improvements, personalisation and customisation of product/service offerings, etc. In the case of residential customers, energy communities and local authorities, in a B2B scenario (in which the customer purchases the module through a BMS provider, retailer, etc.), interaction only involves the customer and the product seller; in a B2C scenario, interactions between the module provider and customers can range from ongoing technical and troubleshooting support to continuous feedback loops for product and service improvements, etc.



Figure 41. Customer journey analysis for potential segment #1: Energy retailers, aggregators, ESCos / ESPCs, BMS providers

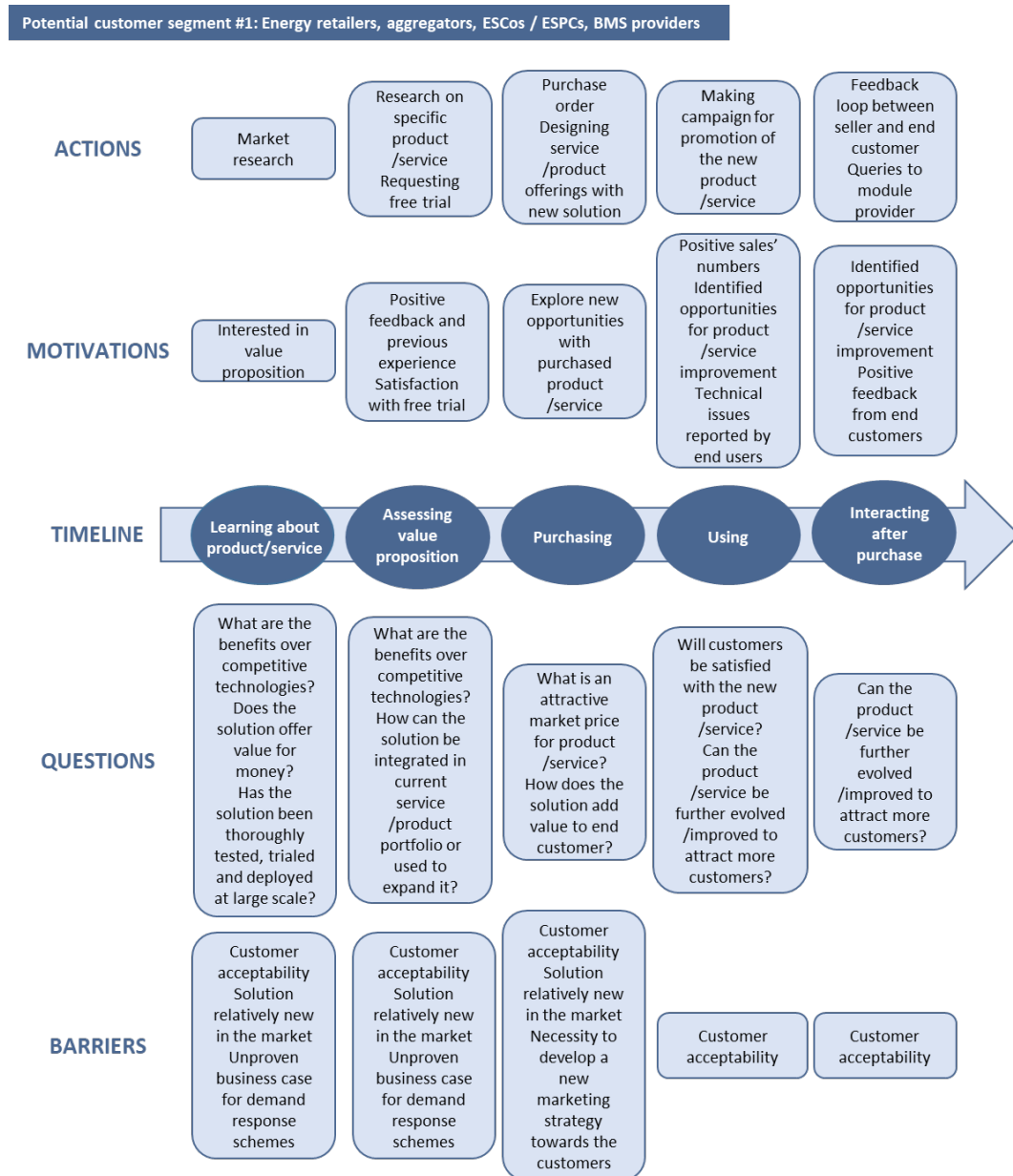




Figure 42. Customer journey analysis for potential segment #2: Residential customers

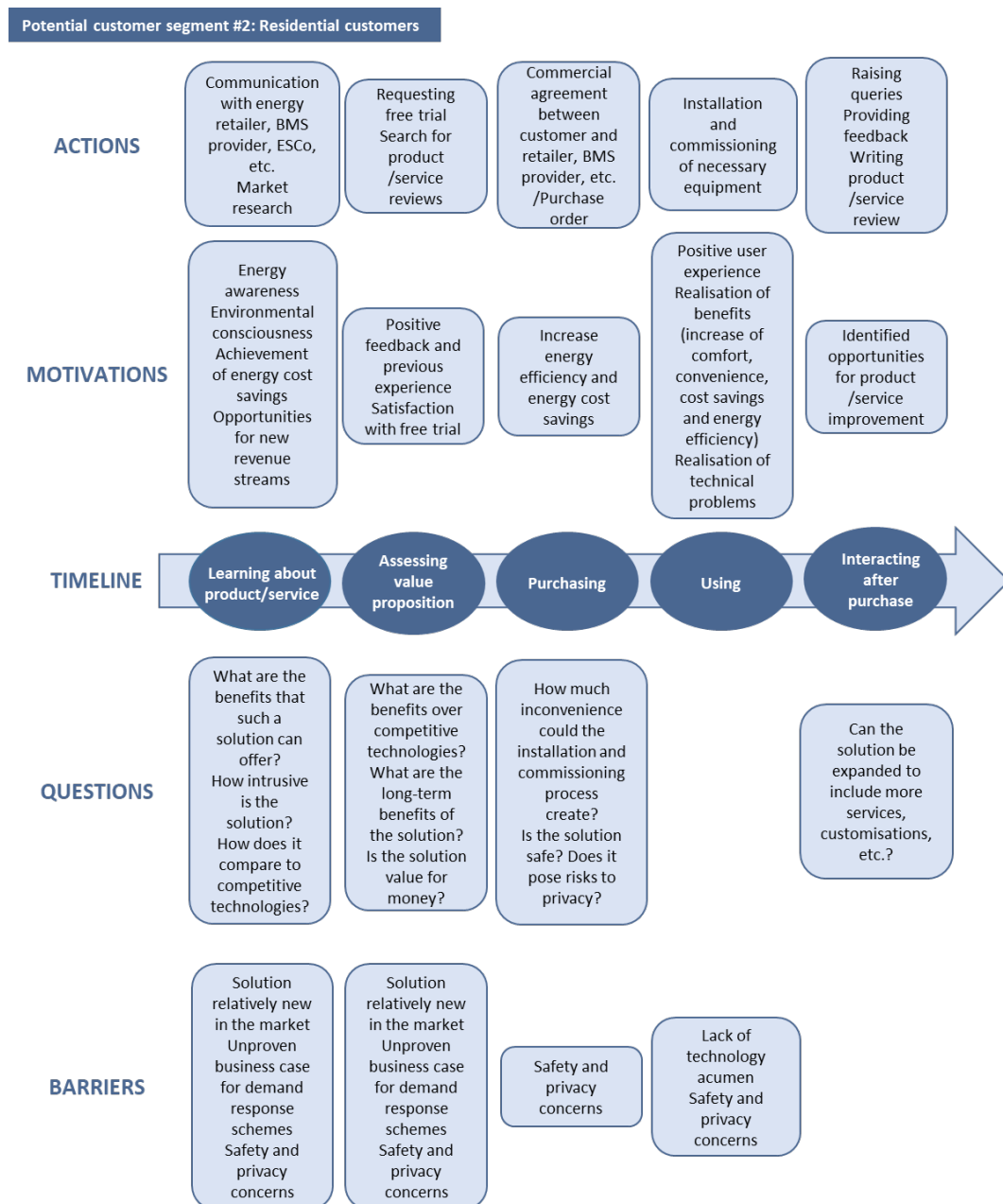


Figure 43. Customer journey analysis for potential segment #3: Energy communities

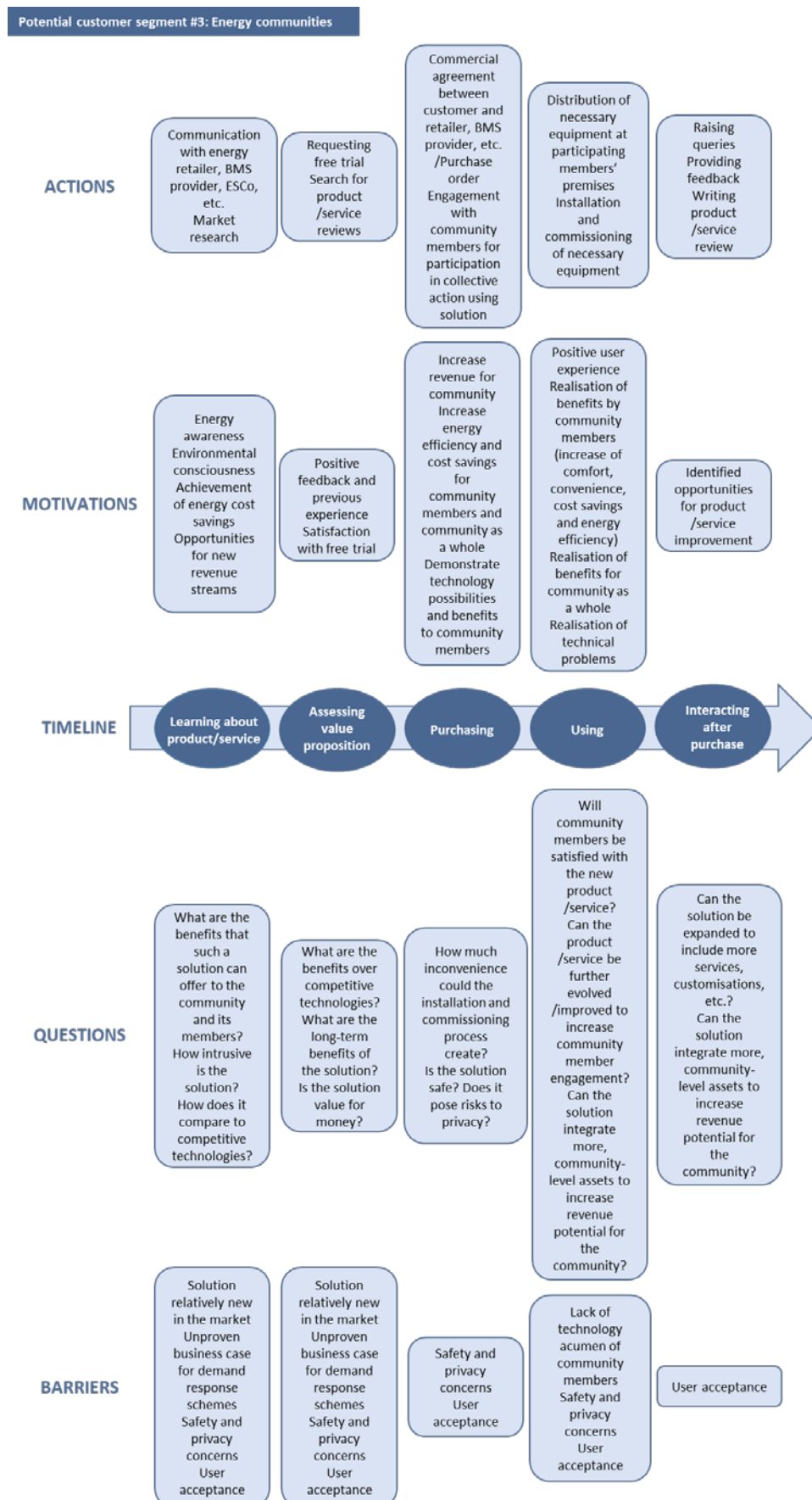
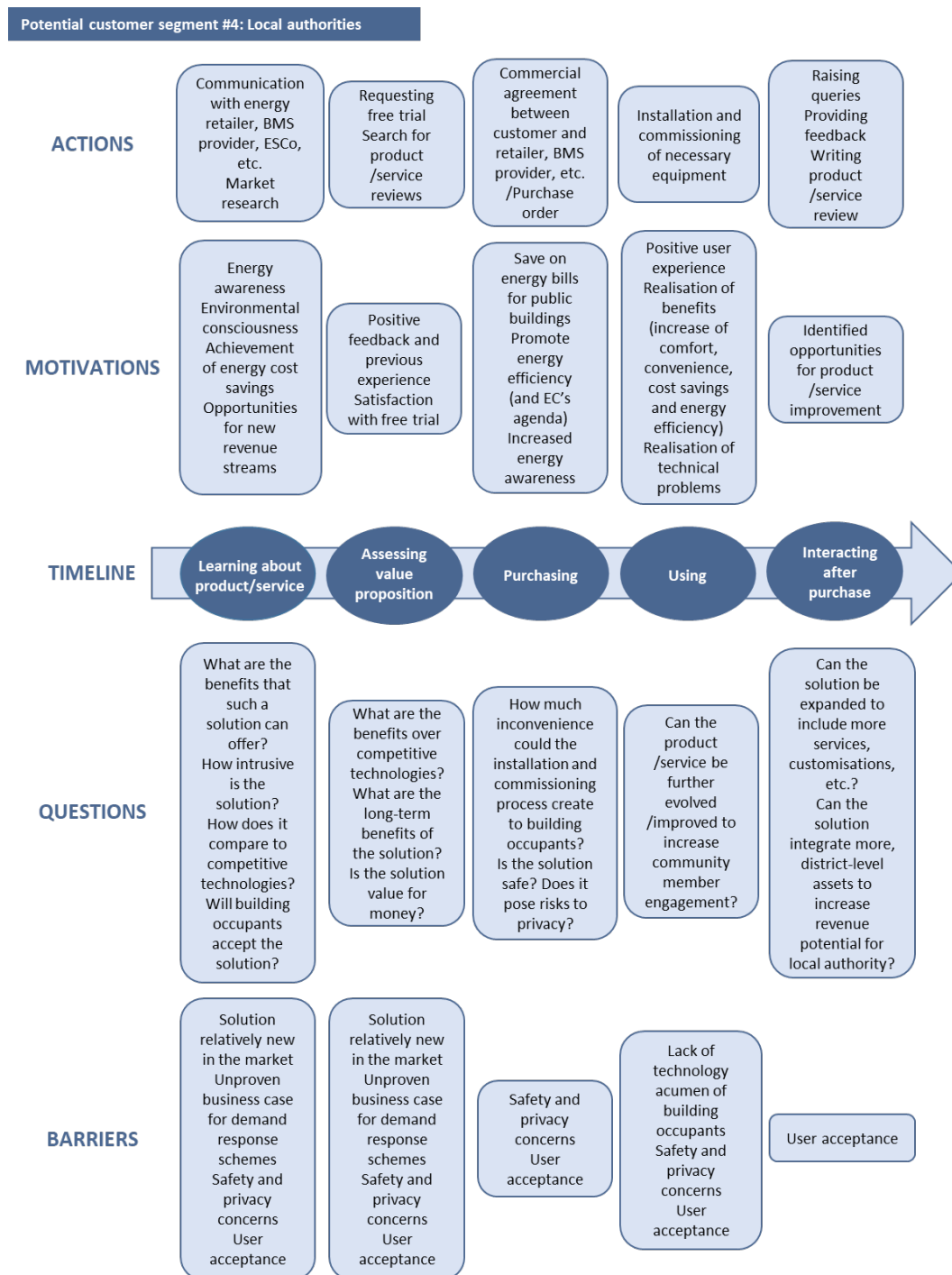


Figure 44. Analysis of customer journey for potential segment #4: Local authorities



This analysis of the customer journey evidenced key interactions between the VTES module provider and customer segments, which allowed to refine the contents of the “Channels” building block of the business model canvas.

Besides, in relation with this analysis, the VTES module provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 68). As a result, the scope of the activities retained in the “Key activities” building block of the business model canvas has been refined.

Table 68. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Marketing of solution	Medium	High	Medium	Marketing campaign
Training of installers/commissioners (B2B scenario)	Medium	High	High	Trained personnel
Installation/commissioning (B2C scenario)	Medium	High	High	Deployed and fully functional solution
Creation of necessary documentation to address issues and concerns of users	Medium	High	Medium	Privacy policy Installation guide Troubleshooting manual
Customer satisfaction measurement	High	Medium	Medium	Net Promoter Score Customer feedback and reviews
Website and online shop development	High	High	High	Website Online shop
Development of commercial product and service offerings	High	High	High	Commercial product Fully developed service offerings
Consumer/end-customer interfaces development	High	High	High	App Web-based platform
Networking activities/customer engagement	Low	High	Medium	Increased number of clients
Technical support provision	Medium	High	High	Lower number of remaining troubleshooting tickets

### Market and competition analysis

A market and competition analysis has been performed in order to refine ER8's value proposition (Table 69).

Table 69. Market and competition analysis for ER8 – VTES module – in Europe

Current competitors
<p><b>Demand-side management providers</b> like Enel X (formerly EnerCON) offer customised solutions to commercial, institutional and industrial businesses that want to participate in demand-side management programs, including energy efficiency and demand response, without affecting business operations, comfort or product quality.</p> <p>As for consumers' data aggregation, <b>WattDepot</b> is an open-source software system available in the market for collecting and storing data from electricity meters in a smart grid.</p> <p>Regarding demand-response simulation strategies, <b>Spa Hub®</b> is a diagnostics application that uses data to simulate demand control actions and provides them on an energy dashboard.</p> <p>The <b>Power Matcher</b> technology uses virtual power plants that collect and cluster numerous distributed generators, responsive loads and electricity storage systems in a single operational unit.</p> <p>Defining automated or price-based demand-response strategies and dispatching signals to consumer cluster is a function implemented in <b>Siemens DRMS</b>, which creates an automated, integrated and flexible demand-response dispatching system.</p> <p>In addition, <b>AutoGrid DROMS</b> is a tool that includes customer enrolment, program management, load-shed forecasting, portfolio optimisation, customer notification, automated signals and post-event reporting.</p>
New entrants
<p>Potential new entrants: most of the aforementioned competitors are relatively new in the market or their products/services are relatively new.</p> <p>Barriers to entry:</p> <ul style="list-style-type: none"> <li>- Large market share of few dominant energy entities;</li> <li>- Low user buy-in/acceptability;</li> <li>- Unproven business case of demand-response schemes;</li> <li>- Lack of regulatory frameworks for demand-response;</li> </ul>

- Lack of incentives for participation in demand-response schemes.

#### Substitutes

From the point of view of electricity network operators looking to resolve grid constraints using demand-response schemes which rely on the virtual energy storage of buildings and thermal loads, alternatives could be the following:

- Network upgrades to resolve constraints. This alternative may not be the most cost-efficient option. It is also very time consuming.
- Deployment of other flexible assets, such as distributed generation or storage (both stationary and mobile).

The latter is also an alternative for product users, such as aggregators, ESCos/ESPCs and energy communities.

Electricity customers can participate in demand-response schemes using other building-level flexible assets:

- Storage assets (mobile and/or stationary) at building-level;
- Smart appliances (white appliances for example that are smart-enabled).

From the point of view of energy retailers and BMS providers, commercially available smart home solutions could be an alternative.

It should be noted, however, that none of the abovementioned alternatives offer the same exact services as the VTES module.

#### Suppliers and other actors in the value chain

##### Commercialisation of the product:

The VTES module will be mainly commercialised following a B2B approach (the B2C scenario is not discarded; it is however second in priority), whereby energy retailers, aggregators, BMS providers, ESCos/ESPCs are targeted in the first instance, as they serve a large pool of customers.

##### Product evaluation:

End users are key to the business model viability. They will be evaluating the solution and providing useful feedback and evidence to prove the business case for demand response in residential and commercial buildings.

#### Stakeholders

**Energy regulators:** The lack of appropriate demand-response regulatory frameworks is a barrier to the large-scale deployment of demand-response solutions. Regulatory authorities should be actively engaged and provided with evidence of the business cases developed for demand-response schemes in order for relevant frameworks to be pushed high in the implementation agenda. Regulatory authorities may also be able to provide certain incentives to network operators for a higher uptake of demand-response schemes (as an alternative to costly and time-consuming network upgrades).

This analysis helped to refine the value proposition of the module, notably by specifying its competitive advantage. Commercially available demand-response solutions are mainly targeting larger customers, such as large producers and consumers, industrial and commercial entities, etc. These solutions are, to a large extent, non-customisable, standardised and generic to accommodate for most of users' requirements; however, they do not easily account for specificities and variations in customer systems and needs and they lack the intelligence and flexibility to cope with smaller energy consumers/prosumers (such as residential customers). The latter group of users require systems that are non-intrusive, easy to install (almost plug-and-play), with demand-response models and strategies that do not compromise the comfort of the users and offer them tangible benefits (e.g. economic gains from greater energy efficiency, participation in demand-response schemes, etc.). The adaptability of current systems to such requirements is very low and this represents a key advantage of the FLEXIGRID VTES solution (including the comfort-based flexibility profiling engine). As the project progresses and the VTES module will be deployed and trialled at the Croatian pilot sites, more of its competitive advantages will be realised. Therefore, this section can be further refined based on the outcomes of these trials.

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER8 are evidenced in Table 70.

Table 70. Critical success factors for the business model considered for ER8

Critical success factor	Key metric	Data to be collected and sources
Proven positive demand-response business case	Positive cost-benefit analysis for main customer segments of the solution	KPIs from demonstration activities, end-user feedback
End-user buy-in	Increased customer acceptability for the solution	Net Promoter Score, product sales, market share / value

### Documenting the revenue streams and cost structure

Two main options are being explored with regards to revenue streams : option 1 rests on software-as-a-service, while option 2 involves a combination of smart box purchases and licences for software products (Table 71).

Table 71. Options for ER8 revenue streams

Options	Advantages	Disadvantages
<b>Option 1: Software-as-a-Service (SaaS)</b>	<ul style="list-style-type: none"> <li>- This approach does not require any intermediary party for its deployment: the software component is centrally hosted and can be deployed (e.g. over a web browser) easily within seconds (it does not require any specialised knowledge from the end user).</li> <li>- Customers pay a subscription for the use of the software (e.g. on a monthly basis), therefore they do not need to pay a high upfront cost, making this approach attractive to a wider set of customers. Opportunities exist for charging customers (especially in the case of retailers, ESCos, etc.) on a per-user basis (i.e. a subscription fee is paid for every client of the retailer, ESCo, etc.).</li> <li>- This option provides the capability of developing a configuration /customisation self-service interface, which allows customers to personalise their application.</li> <li>- Updates to the software are more easily implemented as it is centrally hosted and there is only one version that needs to be updated and maintained (i.e. the latest installed version on the central server/system).</li> </ul>	<ul style="list-style-type: none"> <li>- As the software and hence customer data are hosted centrally, security and privacy become a top priority issue.</li> <li>- Due to inherent latency of response (as the software is centrally hosted), the SaaS approach is not appropriate for fast-response demand-response scheme applications (which may require a response within a few milliseconds).</li> <li>- Ongoing operating costs (for the maintenance, update and support required for the software) may be higher for the module provider.</li> </ul>
<b>Option 2: Smart box purchases and licences for software products</b>	<ul style="list-style-type: none"> <li>- Security measures are only implemented at the component development stage, using far less resources (both financial and human).</li> <li>- The local deployment nature of this approach makes it suitable for demand-response schemes that require a fast response (within milliseconds).</li> </ul>	<ul style="list-style-type: none"> <li>- For B2B scenarios, where the customer (usually an aggregator, retailer, etc.) buys the product to deploy it in its portfolio, this option may have a significant overhead in terms of CAPEX and OPEX. In these cases, option 1 should probably be preferred.</li> <li>- Updates and maintenance of software versions become a time-consuming and cumbersome task, as</li> </ul>



	- Lower operating costs for the module provider.	there may be many versions of the product available on customer systems.
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The analysis also allowed to specify the variables that are likely to have the most significant impact on revenues and costs. Revenues will be contingent upon:

- The solution acceptability by customer segments and customer buy-in;
- The strength of demand-response schemes' business case;
- The development (where not already existent) of the regulatory framework for the provision of demand-response services to interested parties;
- The market size and the share of customers interested in the solution.

As for costs, they will depend mainly on user requirements for the solution (especially in cases where a personalisation/customisation of the solution is requested).

#### 4.10. ER 9: FUSE platform

##### *Refined and updated business model*

Upon internal discussion, the lead partner for ER9, ATOS, considers that it does not make sense to present an adaptor as an ER, since it is quite specific and cannot be exploited on its own and sold as a separate item. The business model development process will therefore focus on the FUSE platform.

Business Model Canvas for ER9 – FUSE platform				
Lead partner: ATOS				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"><li>- Traditional energy stakeholders: TSOs, DSOs, retailers, large generators</li><li>- New energy stakeholders: aggregators, traders, ESCos</li></ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"><li>- Digitalisation of energy assets</li><li>- Data processing</li><li>- Monitoring</li><li>- Data analytics</li><li>- Forecasting</li><li>- Harmonisation</li></ul>	<b>VALUE PROPOSITIONS</b> <p>Open source framework that enables the integration of devices at the edge by fully exploiting the available data from local and distributed energy resources to build value-added services for the different user profiles</p>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"><li>- Enhancing the portfolio of solutions already offered to large utilities</li><li>- Reaching new customers for new energy stakeholders</li></ul>	<b>CUSTOMER SEGMENTS</b> <p><b>Medium complexity:</b></p> <ul style="list-style-type: none"><li>- Energy communities</li><li>- Aggregators</li><li>- Building operators</li></ul> <p><b>High complexity:</b></p> <ul style="list-style-type: none"><li>- Large utilities (TSOs, DSOs, retailers)</li></ul>
	<b>KEY RESOURCES</b> <ul style="list-style-type: none"><li>- FUSE maintenance and technical manager</li><li>- IT support team</li></ul>		<b>CHANNELS</b> <p>Business personnel in charge of establishing the commercial relationship with customers</p>	
<b>COST STRUCTURE</b> <ul style="list-style-type: none"><li>- Technical development and maturity</li><li>- Marketing and promotional</li><li>- Commercial actions</li><li>- Customer support</li></ul>			<b>REVENUE STREAMS</b> <ul style="list-style-type: none"><li>- To be commercialised as a product license and its maintenance</li><li>- According to specific offerings: ad hoc services, adaptations, tenders, etc</li></ul>	

##### *Customer segment analysis*

Two potential customer segments have been identified for the FUSE platform: i) energy utilities and ii) energy communities, building managers and aggregators. These segments are notably differentiated by the expected complexity in convincing them to opt for this new solution: energy utilities are characterised by high complexity, as they may already have deployed similar systems, while energy communities, building managers and aggregators would only be medium-complexity. Special efforts are on-going to provide solutions based on the FUSE platform and services to the growing number of energy communities and associations focused on interoperability. The analysis of the two potential customer segments is presented in Table 72 and Table 73.



Table 72. Analysis of potential customer segment #1: Energy utilities

Potential segment #1: Energy utilities	
Relevant characteristics	The energy and utilities industry globally covers electric generation: transmission, distribution and retailing of energy.
Segment size	The main customers would be DSOs and so far, the targeted geographical market is Europe.
Hypothesised customer needs and aspirations	Specific and highly innovative modules answering particular identified new business needs, to be integrated in the (most likely already in place) data gathering platform that customers are using.
Hypotheses about segment purchasing behaviour and criteria	<ul style="list-style-type: none"> <li>- Initial reluctance to incorporate new functionalities into their already consolidated systems.</li> <li>- Possibility to receive requests for customised designs.</li> </ul>
Information and data required to verify these hypotheses	Interviews with representatives of energy utilities.

Table 73. Analysis of potential customer segment #2: Energy communities, building managers and aggregators

Potential segment #2: Energy communities, building managers and aggregators	
Relevant characteristics	Energy communities and large buildings put together aggregate, resident-driven energy activities that add to making ready towards energy transition, while carrying citizens to the cutting edge. They contribute to expand public acknowledgment of RES projects and to align private interests with this energy change. Simultaneously, they can possibly give direct advantages to citizens by fostering energy productivity and reducing power bills (COME-RES, n.d.). Aggregators are another kind of energy specialist co-op that can increment or moderate the power utilisation of a gathering of customers dependent on the absolute power demand on the network.
Segment size	Current European policies are empowering the advancement of energy communities. At this beginning phase of development, EU member States are relied upon to configure instruments for their support (free specialised and legal guidance or endowments to employ specialised help; market access rules and grid usage guidelines for energy communities). Communities dealing with their own electricity networks can coordinate the inclusion of more RES in neighbourhoods, allowing them to act as an aggregator and offer flexibility services to the regional or national grid. Energy communities are generally restricted to not-revenue-driven status and they may face issues in terms of access to subsidising and funding (EC, 2021c).
Hypothesised customer needs and aspirations	As new actors on the value chain, these potential customers are most likely not to have yet their own digital tool for data acquisition and valorisation. Therefore, FUSE can pose as an end-to-end value proposition for them to enter digital energy.
Hypotheses about segment purchasing behaviour and criteria	FUSE can be used (1) as a data management platform for the control and supervision of the whole community/set of users and (2) bundled as an additional service to be used individually by community users or aggregator customers to manage their own premises.
Information and data required to verify these hypotheses	Contact and discussions with representatives from these sectors.

### Customer journey analysis

An analysis of the customer journey has been performed for the different customer segments in order to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Figure 45 and Figure 46.

The problems faced by customers vary depending on the considered segment:

- For energy utilities, the specific service provided by the FUSE platform is not available in their current deployed solutions.
- Energy communities and aggregators lack a digital tool to gather and valorise data.

Both customer segments can learn about the FUSE platform through dissemination activities conducted within the framework of the FLEXIGRID project. They can assess its value proposition before the actual purchase by accessing the results of real-life demonstrations carried out in environments such as the ones posed by FLEXIGRID use cases. The purchase itself then takes the form of licensing through the channels established by the solution provider. The platform is used by self-operation with technical assistance from the solution provider, after successful integration into the customers' systems. Interactions with the solution provider after the purchase take place through an open channel to act upon potential issues and provide support.

Figure 45. Customer journey analysis for potential segment #1: Energy utilities

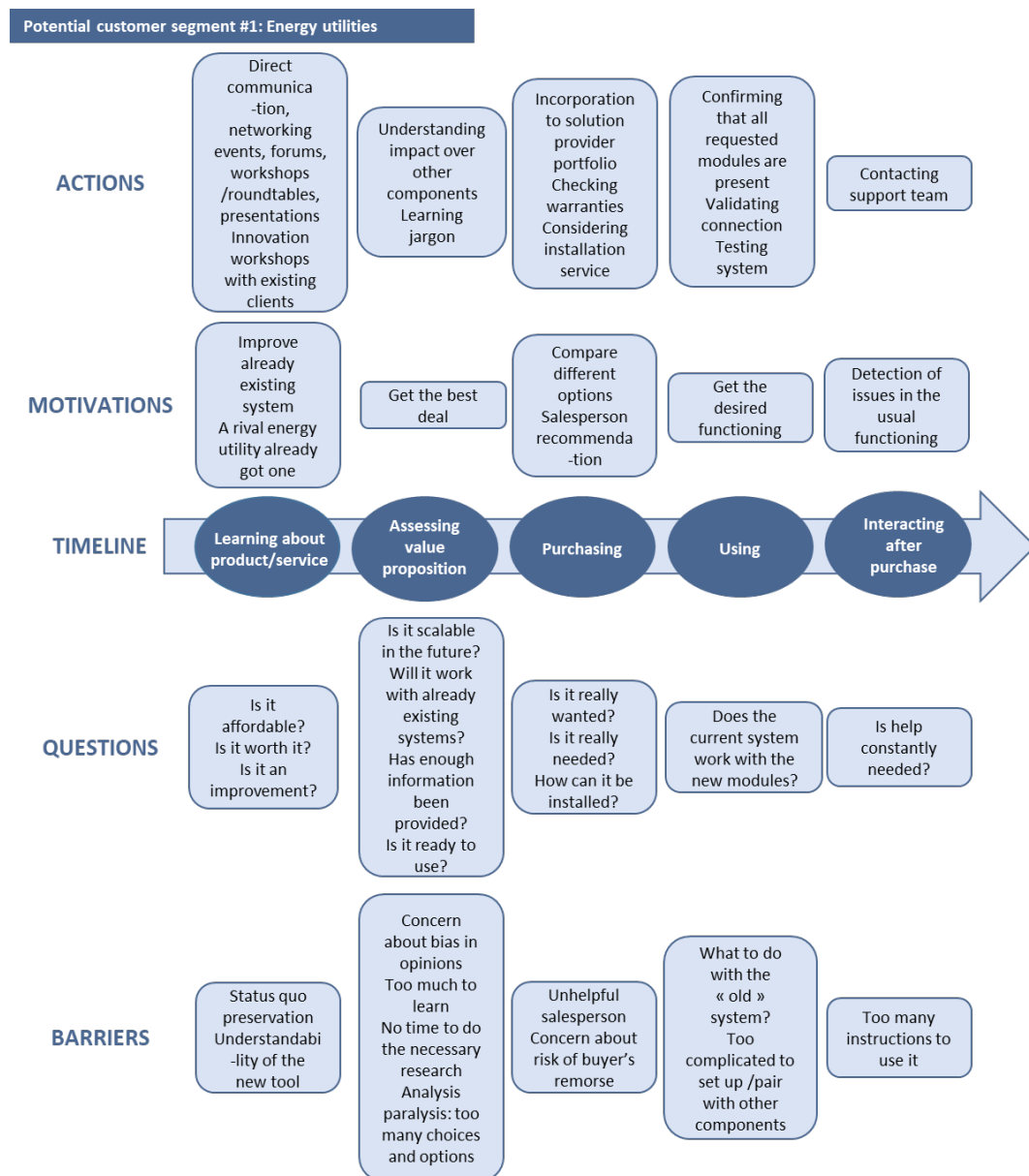
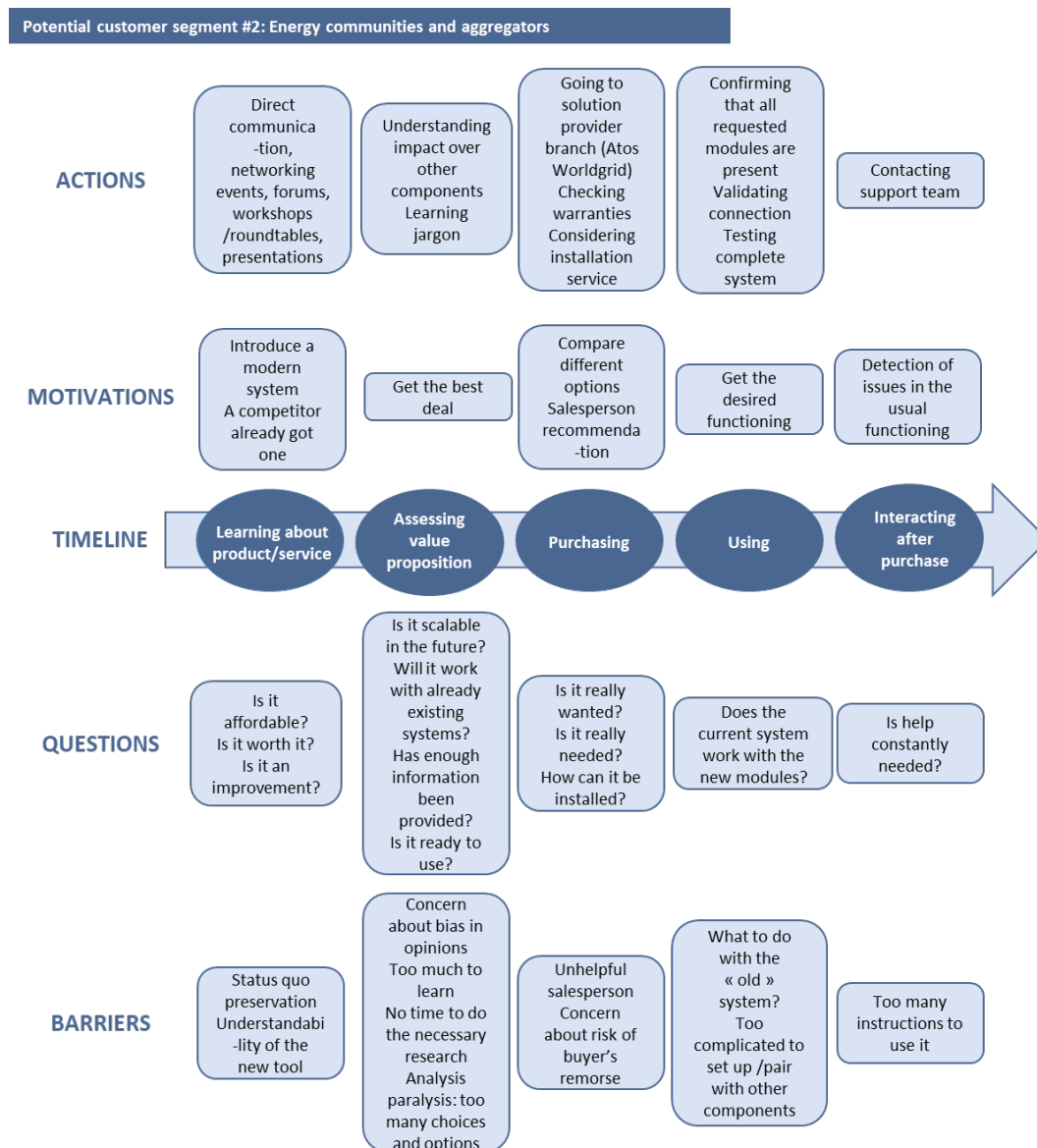


Figure 46. Customer journey analysis for potential segment #2: Energy communities and aggregators



In relation with the customer journey analysis, the FUSE platform provider's key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 74).

Table 74. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Digitalisation of energy assets	High	Medium	Medium	Digital version of every asset
Data processing	Medium	High	High	Data adapted to a Common Information Model
Monitoring	High	Medium	Medium	Keeping continuous track of data flow
Data analytics	High	Medium	Medium	Extracting valuable insight that drives decision-making
Forecasting	Medium	Medium	Medium	Ability to prevent the occurrence of problems
Harmonisation	Low	Medium	Low	Sharing a common methodology

### Market and competition analysis

A market and competition analysis has been performed in order to refine ER9's value proposition (Table 75).

Table 75. Market and competition analysis for the FUSE platform in the EU

Current competitors
<b>EcoStruxure ADMS</b> (Schneider Electric)  <b>C3.ai</b>  <b>IBM Solution Architecture for Energy and Utilities Framework</b>
New entrants
<b>Sogno – GridHound DMS</b> on a research grade (state estimation, fault location isolation and restoration, generation and load prediction, power quality evaluation)
Substitutes
<b>Dynamic Demand 2.0:</b> open-source IoT data-driven platform from Open Energi, which is already market-ready (frequency regulation, energy trading, capacity services, peak price management, constraint management, energy efficiency, energy scheduling).  <b>Monet</b> (Siemens): IoT data-driven platform, energy management system, offered under a proprietary license and ready for validation (EV manager, assets manager, distributed generation forecast, demand-response functionalities).
Suppliers and other actors in the value chain
The focus for scalability is oriented towards new market applications where the involvement of a great number of small players could originate huge volumes of transactions. FLEXIGRID's solution will establish and scale up new value chains in Europe involving utilities, service providers and charging infrastructure providers.
Stakeholders
<ul style="list-style-type: none"> <li>- ESCos/electricity suppliers/utilities: they may undertake the administration of the networks of energy generation stations, as well as RES micro-generation;</li> <li>- Local and regional authorities (and their associated organisations/companies): they will provide the necessary approvals, space for the stations' installations, and may well procure the installation and operation of client/server networks;</li> <li>- Smart grid stakeholders (ESCos/electricity suppliers): for the provision of relevant energy services (demand response, ancillary services, etc.) through public-private partnerships/multi-annual contracts.</li> </ul>

### Critical success factors for the considered business model

The critical success factors for the business model considered for ER9 are evidenced in Table 76.

Table 76. Critical success factors for the business model considered for ER9

Critical success factor	Key metric	Data to be collected and sources
<b>Recognition of real value served by the solution</b>	Acceptance surveys	User feedback about usability and results
<b>Income streams</b>	Licensing fees	
<b>Technology infrastructure</b>		
<b>Proven scalability</b>	Number of new modules integrated Replication in different countries and/or use cases	

### Documenting the revenue streams and cost structure

In order to map potential revenue streams, a matrix has been proposed, facing frequency (of interactions with the key customer) vs. ownership (of these interactions) (Table 77).

Table 77. Frequency vs. ownership matrix of revenue streams

<b>FREQUENCY</b> ↑ High              Low ↓	Recurring indirect revenue model (via recurring contractor) Indirect Specific offerings: ad hoc services, adaptations, tenders, etc.	Recurring direct revenue model Direct Commercialised as a product license and its maintenance
	No	Yes
<b>OWNERSHIP</b> →		

Besides, a possible alternative option has been identified: that of indirect benefit, with an aggregator-to-system operator. In this model, the FUSE platform would be provided to aggregators, which would then leverage their network of contacts to offer it to system operators (for congestion management on the distribution network through coordinated load shifting/peak shaving and reactive power support/voltage control).

The analysis also allowed to specify the variables that are likely to have the most significant impact on revenues and costs. Revenues will be contingent upon the appearance of tenders where the solution fits, the recurring contractor's willingness to keep on hiring the solution, and the number of modules that raise interest in potential and already existing customers. As for costs, they will depend mainly on the detection of functioning issues that require to devote effort to solve them, and the development of specific middleware and/or adaptors to integrate the solution with some tools owned by customers.

#### 4.11. ER 10: Software module for sizing and siting of the battery storage system

This ER will consist in a software or web service relying on novel algorithms which allow to model electricity networks and their constraints, and then to optimize the sizing (capacity and power) and placement (installation node within the network) of Battery Energy Storage Systems (BESSs). It takes into account the trade-offs between their potential impact on the electricity system and the costs associated with their deployment, with a view to maximize the technical and economic benefits of such investments.

##### Exploratory business model canvas

Business Model Canvas for ER10 – Software module for sizing and siting of the battery storage system				
Lead partner: LINKS				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- TSOs</li> <li>- DSOs</li> <li>- Aggregators/ESCos</li> <li>- Energy retailers</li> <li>- Ancillary services providers</li> <li>- Microgrid operators</li> <li>- Energy communities</li> <li>- Research institutions</li> </ul>	<b>KEY ACTIVITIES</b> Algorithm development for optimisation of the size and location of the battery storage system in the electricity system and development of back-end  <b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Development team</li> <li>- Webservice and computation capacity provider</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Maximising economic benefit from storage system investment</li> <li>- Opening space for more RES hosting in the energy system</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> Introduction and instructions for the interested parties  <b>CHANNELS</b> <ul style="list-style-type: none"> <li>- Stakeholders</li> <li>- Project partners</li> <li>- Direct contacts with potential targets</li> <li>- Website, social media</li> <li>- Public repository</li> <li>- Dissemination activities</li> </ul>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- Aggregators/ESCos</li> <li>- Ancillary services providers</li> <li>- Energy communities</li> <li>- Research entities</li> </ul>
<b>COST STRUCTURE</b> Development team			<b>REVENUE STREAMS</b> None: the software will be exposed as an open-source tool	

Many actors in the energy system, notably DSOs and aggregators/ESCos, are resorting to batteries to fulfil several functions (e.g. quality correction), which makes them a promising

product for flexibility provision. However, their use is costly. The software module for sizing and siting of the battery storage system provides these actors with a tool to optimise investment as well as technical KPIs.

#### Customer segment analysis

The software module for sizing and siting of the battery storage system is intended to be exposed as an open-source tool on a public repository (GitHub). Therefore, in its case, “customer segments” should be understood as potential target users. This open-source status will enable research entities to provide feedback on the first versions of the software.

In line with its above-mentioned functionalities, the software module could interest DSOs looking for alternative solutions to grid upgrade or reinforcement. Aggregators and ESCos offering services to grid operators (e.g. power quality, voltage and frequency stability) could also leverage it to help ensure revenue streams by a wise investment. Other potential users include ancillary services providers and energy communities.

Regarding the geographical scope to be retained for exploitation, the software is potentially applicable worldwide, as it is intended to be published on a public repository as an open-source tool.

#### ➤ Customer journey analysis

An analysis of the customer journey has been performed for the different customer segments and allowed to refine the “Channels” and “Key activities” buildings blocks of the business model canvas. Its results are presented in Table 78.

Table 78. Customer journey analysis for potential customer segments

<b>Problem</b> faced by the customer	<p><b>DSOs:</b> The changing centralised energy generation paradigm to a distributed and active distribution system with a high penetration of RES and EVs requires an upgrade of the distribution system, with considerable costs.</p> <p><b>Aggregators/ESCos and energy communities:</b> These users might optimise investments with wise decisions.</p> <p><b>Research entities:</b> A wide range of use cases for hosting more RES in the electricity system can be considered.</p>
How the customer can <b>learn</b> about the product or service	Potential users can learn about the software through dissemination activities and presentations in project events.
How the customer can <b>assess</b> the product or service’s value proposition before the actual purchase	The software can be accessed and used freely.
How the customer can <b>purchase</b> the product or service	Users will get the software from a public repository: no transaction is required.
How the customer can <b>use</b> the product or service	The software will be standalone and necessary usage instructions will be released on the public repository.
How the customer <b>interacts</b> with the provider after the purchase	Interactions can be done by email to the author of the software, or by creating a new issue on GitHub.

In relation with this customer journey analysis, the software module provider’s key activities, their output and the extent to which they are assessable, critical and timely have been specified (Table 79).

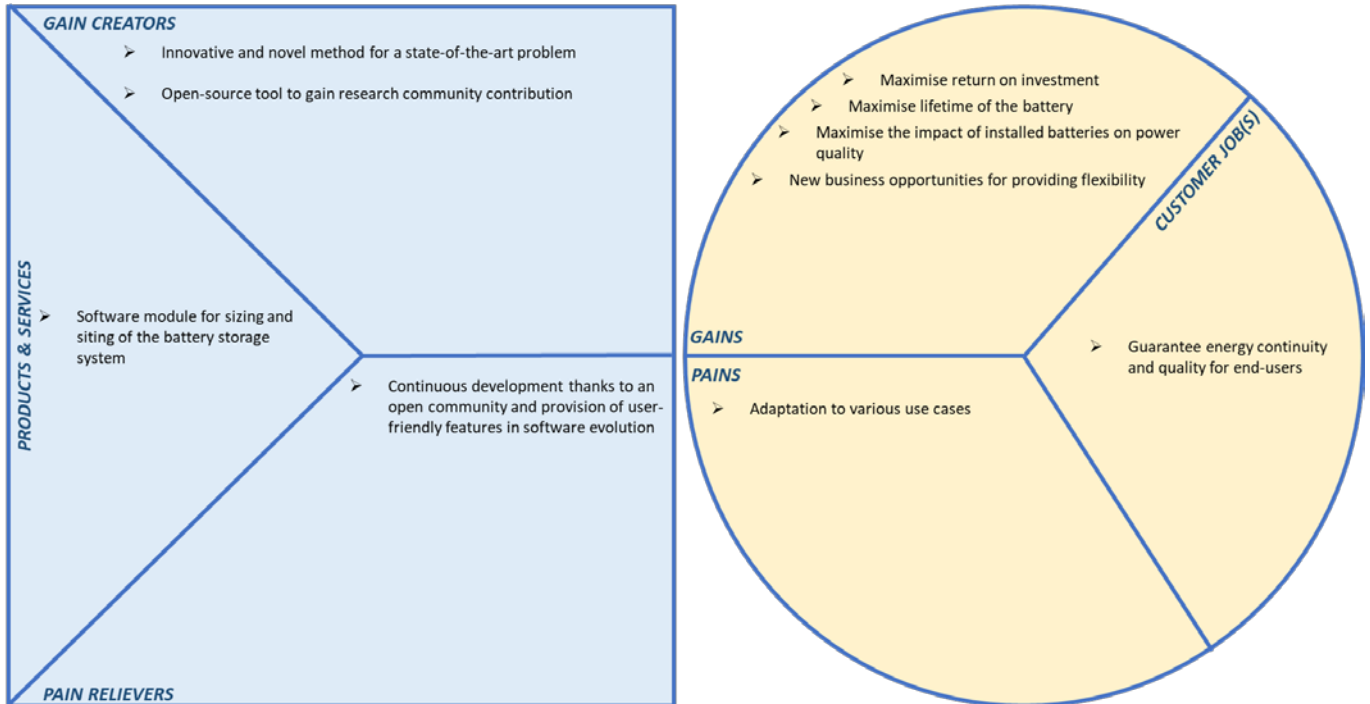
Table 79. Analysis of key activities

Activity	Assessable?	Critical?	Timely?	Output of the activity
Development	Medium	Low	Medium	Deployable software module

### Value Proposition Canvas

#### Value proposition Canvas for ER10 – Software module for sizing and siting of the battery storage system

Lead partner: LINKS



The value proposition of this software rests on its optimisation features, which allow to maximise the investment's benefits and expected impact and/or to minimise investment costs. The algorithms cover major objective functions and, from a practical point of view, require a lower time to calculate. The software can therefore enable grid operators to avoid network reinforcement and expansion expenses and service providers to maximise their expected income.

### Documenting the revenue streams and cost structure

No revenue stream is expected, as the software will be released as an open-source tool.

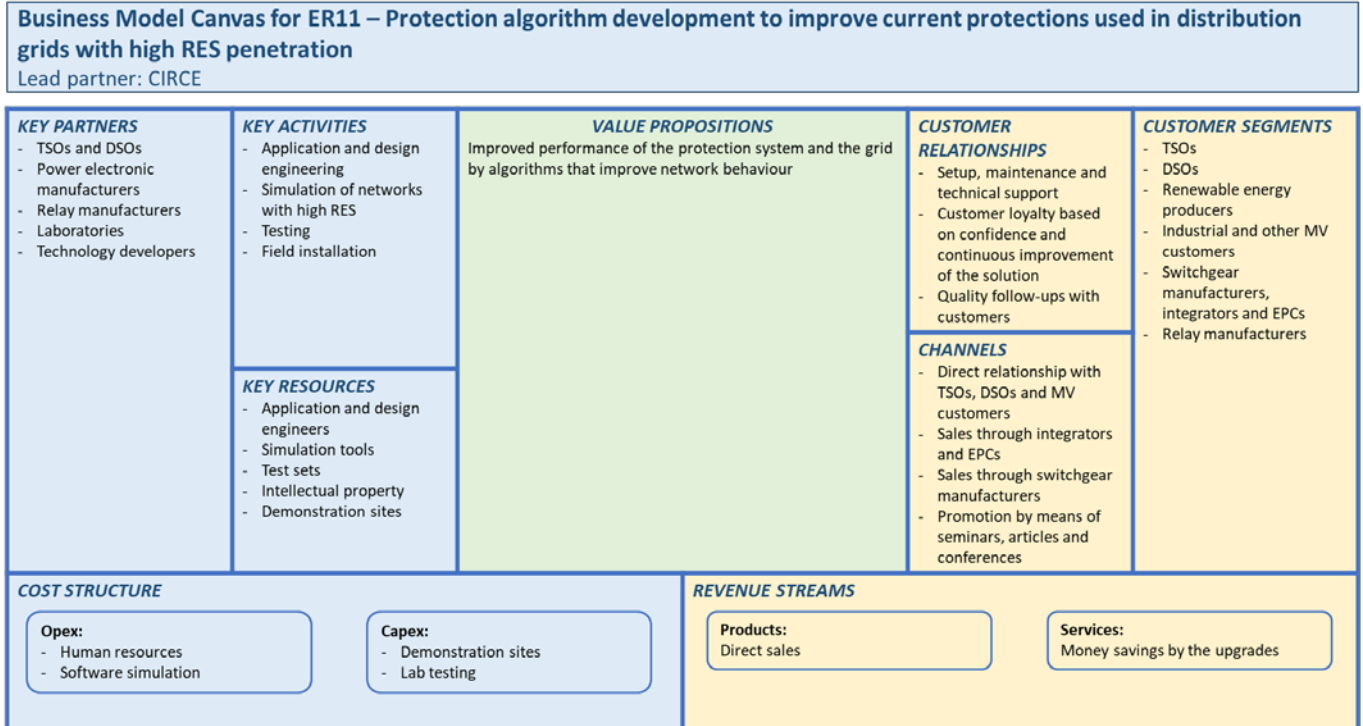
The cost structure would essentially involve operating expenses associated with the development team, i.e. human resources.

#### 4.12. ER 11: Protection algorithm development to improve current protections used in distribution grids with high RES penetration

ER 11 consists in a new system for protection of the MV grid, composed by software algorithms improving current protection relay behaviour in distribution grids.



### Exploratory business model canvas



### Customer segment analysis

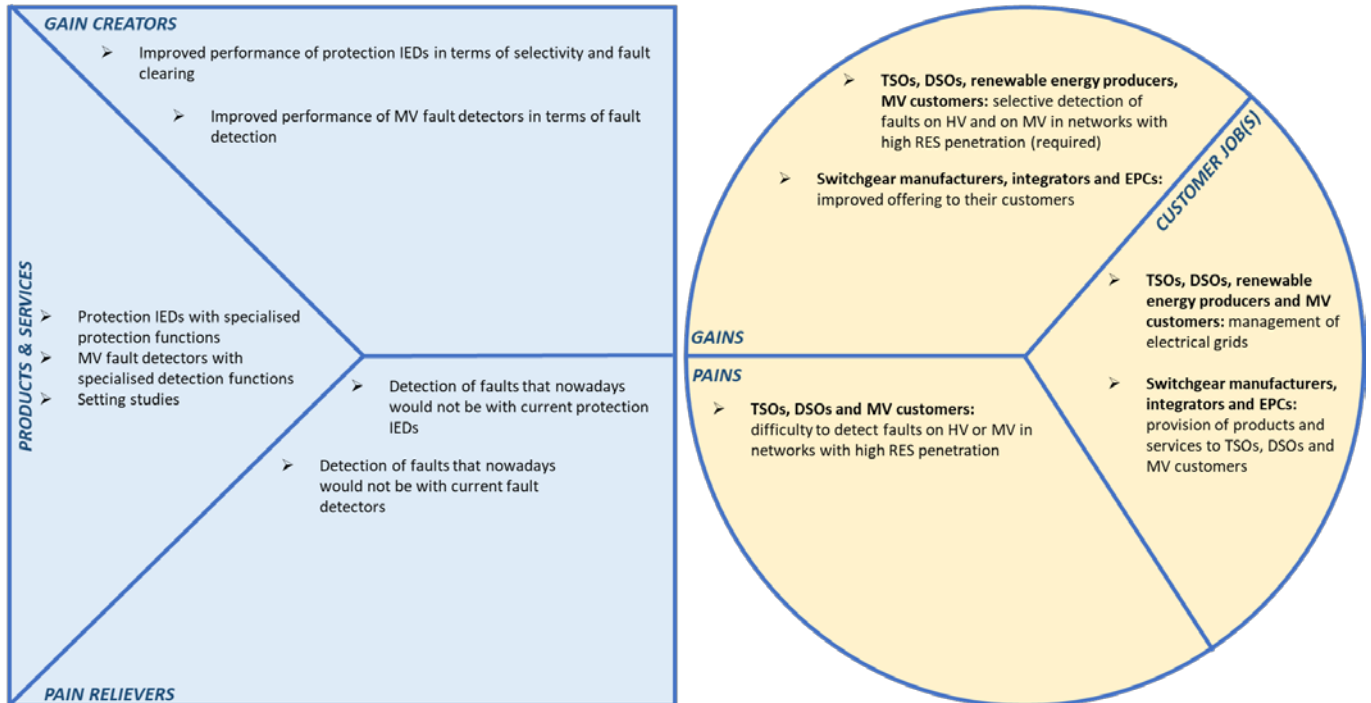
Customer segments for ER11 would include TSOs and DSOs, as well as owners of renewable energy-based generators and MV customers (especially industrial customers) owning their own grid or microgrid infrastructure. Besides, this ER could also be sold through switchgear manufacturers (i.e. manufacturers of HV and MV breakers, load break switches and reclosers) and integrators and EPCs (i.e. integrators of sub-systems and project providers). Relay manufacturers would be another customer segment.

In terms of geographical markets, target markets would include Spain, Greece, France, Switzerland, Austria and Slovenia, Italy, the UK, Germany, Denmark, the Netherlands, Switzerland, Sweden, Luxembourg and other European countries.

### Value Proposition Canvas<sup>5</sup>

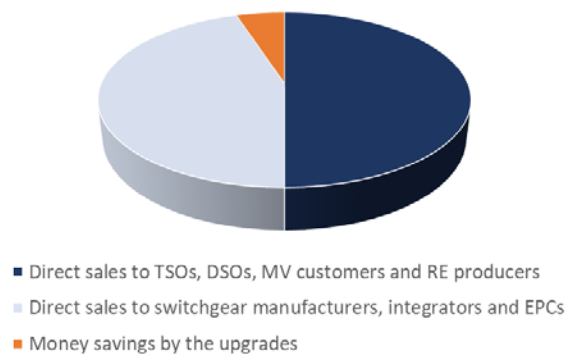
#### Value proposition Canvas for ER11 – Protection algorithm development to improve current protections used in distribution grids with high RES penetration

Lead partner: CIRCE



### Documenting the revenue streams and cost structure

Figure 47. ER 11 – Protection algorithm development to improve current protections used in distribution grids with high RES penetration – Revenue streams



Revenue streams from ER11 would include both products and services (Figure 47). The software algorithm would be sold directly to the different customer segments.<sup>6</sup> Besides, revenue streams more akin to services would include a monthly fee based on the money savings permitted by the upgrades.

<sup>5</sup> As far as relay manufacturers are concerned, the Value Proposition Canvas will be refined at a later stage.

<sup>6</sup> As far as relay manufacturers are concerned, the analysis of potential revenue streams will be refined at a later stage.

Figure 48. ER 11 – Protection algorithm development to improve current protections used in distribution grids with high RES penetration – Cost structure: OPEX

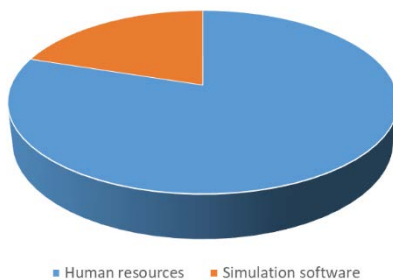
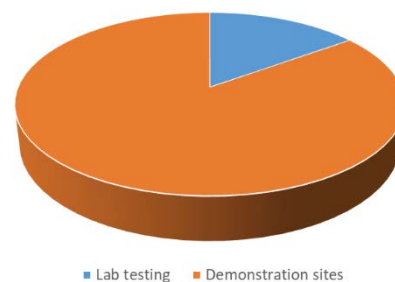


Figure 49. ER 11 – Protection algorithm development to improve current protections used in distribution grids with high RES penetration – Cost structure: CAPEX



The costs related to ER11 would include both OPEX (Figure 48) and CAPEX (Figure 49). Along with human resources, OPEX would be associated with the simulation software used for validation. CAPEX would consist in lab testing, as well as in demonstration sites that could be arranged after the FLEXIGRID project implementation.

#### 4.13. ER 12: Software module for flexibility assets emergency operation

ER 12 will consist in machine learning algorithms for a one-minute forecast combined with a discriminator of the status of the network (with or without network issues like over/under voltage problems or overloaded lines). This will allow to send specific setpoints to avoid the issues previously anticipated through a flexibility assets operation algorithm (also developed by CIRCE).

#### Exploratory business model canvas

Business Model Canvas for ER12 – Software module for flexibility assets emergency operation				
Lead partner: CIRCE				
<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- European Commission</li> <li>- Universities</li> <li>- Technology providers</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Development of machine learning algorithms</li> <li>- Identification, assessment and comparison of technological options for forecasting and control systems in the distribution network</li> <li>- On-site validations</li> <li>- Market analysis</li> <li>- Cooperation with other projects and networking</li> <li>- Testing of algorithms at simulation level or small-scale demonstrations at first</li> <li>- Testing by Atos</li> </ul>	<b>VALUE PROPOSITIONS</b> <p>Machine learning algorithms for a one-minute forecast combined with a discriminator of the network status (with or without network issues like over/under voltage problems or overloaded lines), allowing sending specific setpoints to avoid the issues previously anticipated through a flexibility assets operation algorithm</p>	<b>CUSTOMER RELATIONSHIPS</b> <p>B2B demonstrations and bilateral multiservice offerings to new and existing customers</p>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- Aggregators</li> </ul>
<b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Researchers and developers</li> <li>- Gathered data</li> <li>- Technical knowledge</li> <li>- Local and international market knowledge</li> <li>- Presence in the electricity market</li> </ul>		<b>CHANNELS</b> <ul style="list-style-type: none"> <li>- Sales representatives / market developers</li> <li>- Company website, social media, PR and a dedicated website to demonstrate non-IP sensitive information and results</li> <li>- Media and workshops, scientific journals, etc.</li> <li>- Other marketing tools</li> </ul>		
<b>COST STRUCTURE</b> <ul style="list-style-type: none"> <li>- Human resources</li> <li>- Tests, simulations and software licences</li> <li>- Marketing costs</li> <li>- Sales costs</li> </ul>		<b>REVENUE STREAMS</b> <div> <b>Products:</b> Direct sales and licences </div> <div> <b>Services:</b> Optimised participation in energy markets </div>		

### Customer segment analysis

DSOs may be interested in the software module for flexibility assets emergency operation. Aggregators may also use it to expand their activities on the consumption and production sides.

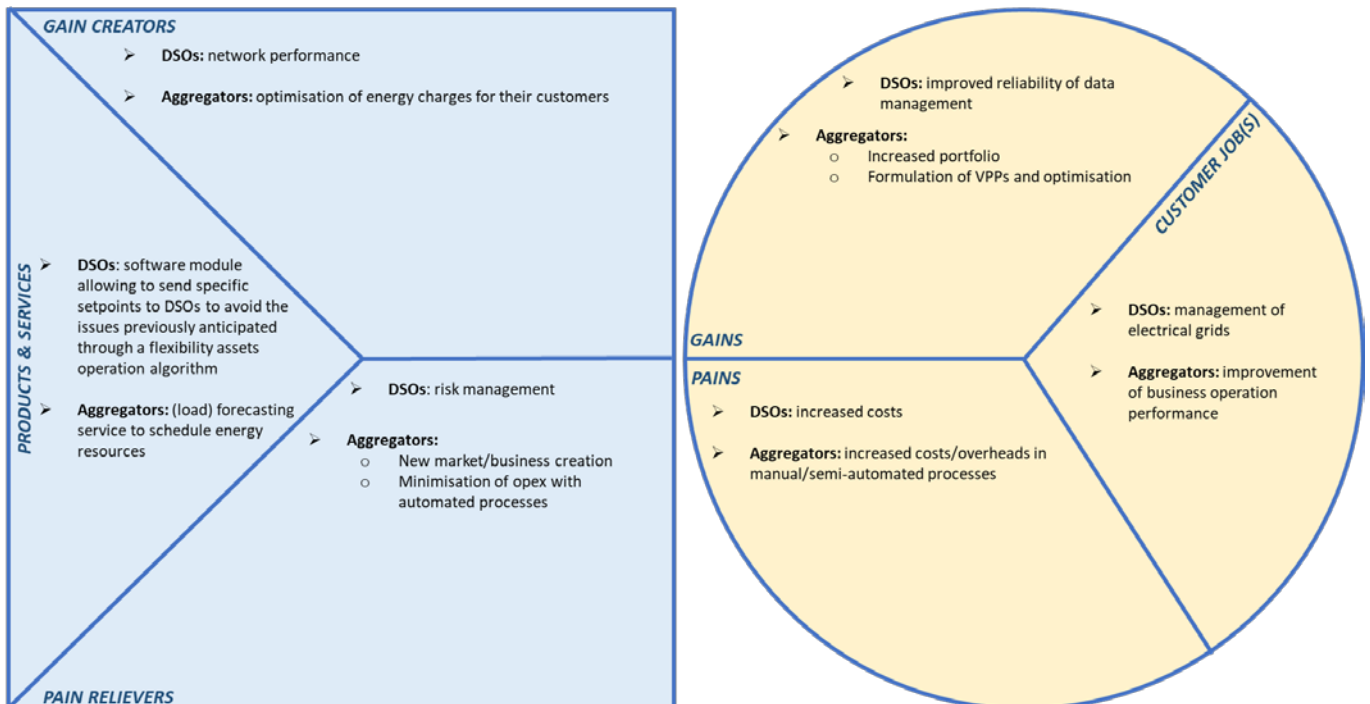
Other potential beneficiaries would include renewable energy producers, technology providers and associations, as the ER will allow large RES penetration in the grid and may therefore open market opportunities for them in case of a wide application. Besides, TSOs, energy retailers, ESCOs, industrial, commercial and residential customers and actors of the refurbishment industry (including PV installation companies) may benefit from improvements of their quality of service thanks to the ER.

In terms of geographical markets, specific European markets – namely France, Switzerland, Austria and Slovenia, Northern Italy, the UK, Germany, Greece and Spain – would be the main targets.

### Value Proposition Canvas

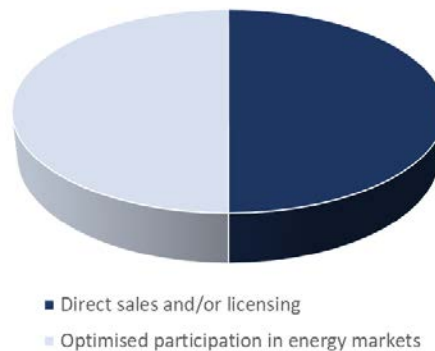
#### Value proposition Canvas for ER12 – Software module for flexibility assets emergency operation

Lead partner: CIRCE



## Documenting the revenue streams and cost structure

Figure 50. ER 12 – Software module for flexibility assets emergency operation – Revenue streams



Revenue streams from ER12 will consist in direct sales or licencing to DSOs. Besides, for aggregators, the software module will allow an optimised participation in energy markets and help them to reach energy communities and other potential customers.

Figure 51. ER 12 – Software module for flexibility assets emergency operation – Cost structure



The costs related to the software module will include human resources (for software module and interfaces operation, billing and invoicing, training and customer support), testing, simulations and software licencing, as well as sales and marketing costs.

### 4.14. ER 13: Fault location TDR prototype

The fault location prototype will estimate a distance between the fault point and the place where the locator is installed, using a special approach of time domain reflectometry technique. This prototype and the location algorithm (ER 5) will be upgraded in order to fix previously detected problems regarding range and accuracy.

### Exploratory business model canvas

#### Business Model Canvas for ER13 – Fault location TDR prototype

Lead partner: CIRCE

<b>KEY PARTNERS</b> <ul style="list-style-type: none"> <li>- DSOs</li> <li>- Technology providers</li> <li>- RTOs</li> </ul>	<b>KEY ACTIVITIES</b> <ul style="list-style-type: none"> <li>- Strengthening the algorithms and the prototype</li> <li>- Testing and simulations of the algorithms and the prototype</li> <li>- Performance test on a real grid</li> <li>- Market analysis for the sale of the development and for possible cooperation with projects</li> <li>- Identification, assessment and comparison of the technological options for monitoring and control systems in the distribution network</li> </ul> <b>KEY RESOURCES</b> <ul style="list-style-type: none"> <li>- Developers and other staff</li> <li>- Technical knowledge</li> <li>- Electricity market knowledge</li> <li>- Close knowledge of consumers and local markets</li> <li>- Gathered data</li> </ul>	<b>VALUE PROPOSITIONS</b> <ul style="list-style-type: none"> <li>- Estimation of a distance between the fault point and the place where the locator is installed, using a special approach of time domain reflectometry technique</li> <li>- Upgrade of this prototype, as well as the location algorithm (ER5), in order to fix previously detected problems regarding range and accuracy</li> </ul>	<b>CUSTOMER RELATIONSHIPS</b> <ul style="list-style-type: none"> <li>- Customer and maintenance services</li> <li>- Inclusion in promotional activities and customer relations of ER5 (software module for fault location and self-healing)</li> </ul> <b>CHANNELS</b> <ul style="list-style-type: none"> <li>- B2B and/or bilateral multiservice offerings using existing clientele channels</li> <li>- Sales representatives</li> <li>- Scientific magazines</li> <li>- Company websites</li> <li>- Active media relations</li> <li>- Conferences, workshops and events to promote the solution</li> </ul>	<b>CUSTOMER SEGMENTS</b> <ul style="list-style-type: none"> <li>- TSOs</li> <li>- DSOs</li> <li>- Aggregators</li> <li>- Renewable energy producers</li> <li>- Other energy actors (electricity retailers and utilities)</li> <li>- Industrial and other MV customers</li> <li>- Software module for fault location (ER5) customers</li> </ul>
<b>COST STRUCTURE</b> <ul style="list-style-type: none"> <li>- Human resources</li> <li>- Testing and in-site demonstrations</li> <li>- Marketing costs</li> <li>- Sales costs</li> </ul>		<b>REVENUE STREAMS</b> <div data-bbox="821 1019 1109 1075"> <b>Products:</b> <ul style="list-style-type: none"> <li>- Direct sales</li> </ul> </div> <div data-bbox="1165 1019 1452 1131"> <b>Services:</b> <p>Technology services such as the estimation of the distance between the fault point and the locator of the algorithm</p> </div>		

### Customer segment analysis

DSOs are likely to be interested by the fault location TDR prototype, as it will provide them with the range between the locator and the fault. Other customer segments would include TSOs, renewable energy producers (as well as related technology providers and associations), aggregators, other energy actors (electricity retailers, utilities) and MV customers (especially industrial customers) owning grid or microgrid infrastructure. Customers of the software module for fault location and self-healing (ER5) may also be interested in this ER, as both ERs are complementary, even though they can operate separately. They may be sold together.

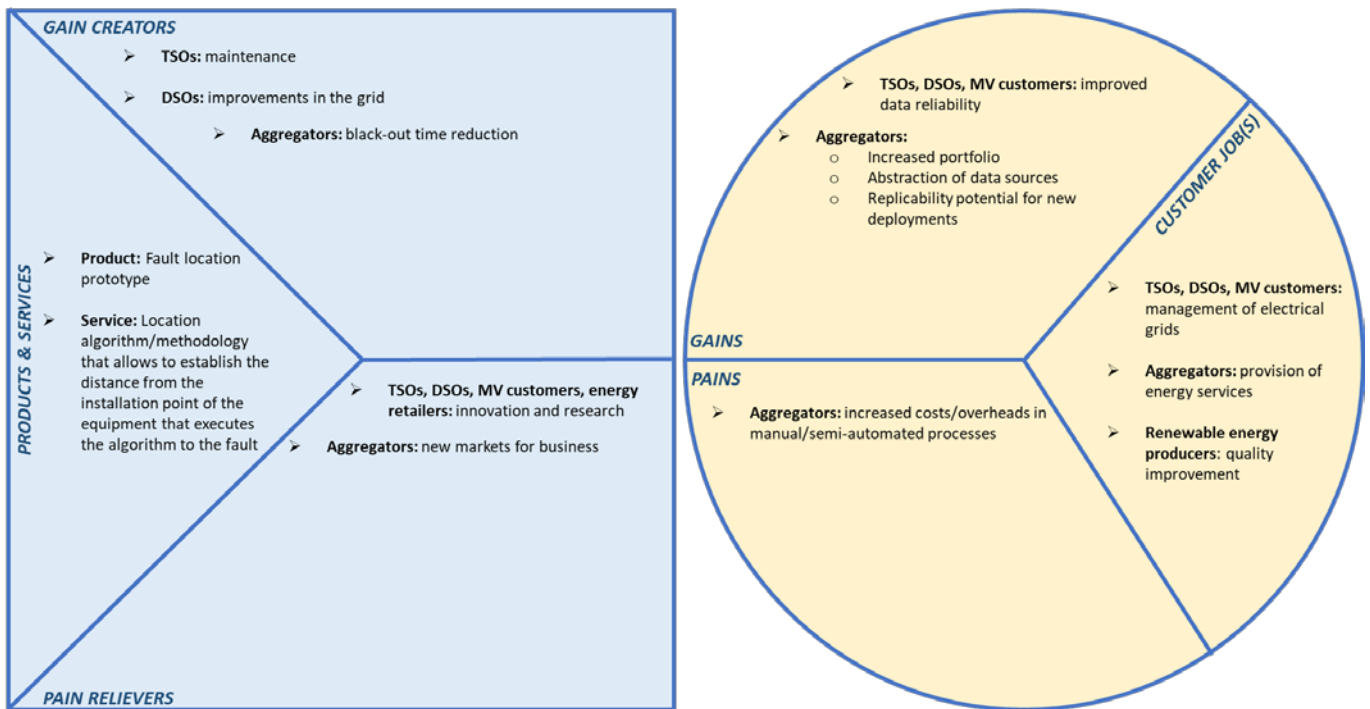
In terms of geographical markets, target markets would be mostly European in the case of TSOs, DSOs and aggregators. They would especially include France, Spain, Switzerland, Austria, Slovenia, Italy, Germany and the UK. As for other customer segments, international markets could also be targeted.



### Value Proposition Canvas

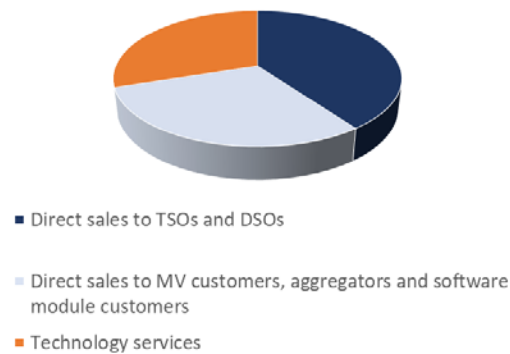
#### Value proposition Canvas for ER13 – Fault location TDR prototype

Lead partner: CIRCE



### Documenting the revenue streams and cost structure

Figure 52. ER 13 – Fault location TDR prototype – Revenue streams



Revenue streams from ER13 would include both products and services. Direct sales would be proposed to TSOs, DSOs, MV customers, aggregators and software module for fault location (ER5) customers. Besides, technology services such as the estimation of the distance between the fault point and the locator of the algorithm could be provided to other energy actors (electricity retailers and utilities) and to renewable energy producers.



Figure 53. ER 13 – Fault location TDR prototype – Cost structure



The costs related to the fault location TDR prototype will include human resources, testing and in-site demonstrations, as well as sales and marketing costs.

## 5. CONCLUSION

### A new step in the business model development process

This deliverable constitutes the second of four yearly reports over the course of the FLEXIGRID project dedicated to the FLEXIGRID exploitable results' business model development.

The market environment has registered significant evolutions in this second year of implementation of the project, marked by the short-term impact of the Covid-19 pandemic on the energy sector, but also by the more long-term perspectives emerging from the new targets set by the EU within the framework of the European Climate Law and the Fit for 55 package.

Croatia and Spain, two EU member States where FLEXIGRID demonstration activities are implemented, have also defined specific objectives in terms of GHG emission reduction and RES development, which have important implications for energy stakeholders in both countries. This deliverable proposes an in-depth analysis of the market context in these two countries, focusing notably on the distribution network level and on the perspectives of development of smart grid and flexibility solutions.

Besides, this deliverable presents the results of the reflection carried out within the framework of working groups for both the refinement and update of the business models designed for the nine FLEXIGRID solutions and the definition of exploratory business models for four other ERs identified within the framework of the development of the Exploitation Strategy.

### Implications for next steps

In the next steps of the business model development process, the market outlook analysis will have to be updated, taking into account possible context and policy evolutions. An in-depth study will also have to be carried out to analyse the market context of the two other EU member States where FLEXIGRID demonstration activities are implemented: Greece and Italy.

In addition, the business models designed for FLEXIGRID exploitable results will have to be updated, taking into account advances in their development and demonstration, and complemented by a reflection at the level of the use cases.

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## APPENDIX

### Appendix 1: Methodology to refine the exploratory business models designed in D8.1

Over the first twelve months of the FLEXIGRID project, exploratory business models have been designed for the nine individual FLEXIGRID solutions. CAP defined and proposed to the partners a methodology resting on A. Osterwalder and Y. Pigneur's Business Model Canvas and the corresponding template. At these early stages of the business model development process, the choice was made to focus more specifically on four of the Canvas's building blocks: customer segments, value propositions, revenue streams and cost structure. The analysis was conducted within the framework of working groups gathering all the partners involved in the development of each solution, coordinated by one or several lead partner(s). The exploratory business models designed were then discussed and refined during progress meetings between CAP and the lead partner(s) of each working group.

The present note proposes a methodology and template to revisit these exploratory business models, with two objectives:

- i) further refining the analysis on some of the Canvas's key building blocks, notably by considering the interactions between them;
- ii) and preparing for the beginning of the demonstration campaign implementation and of the cost-benefit analysis, by focusing on the exploratory business models' applicability.

The proposed steps are the following:

#### *Reviewing the exploratory business models designed in D8.1*

- ✓ Checking that the exploratory business model designed for each exploitable result (ER) in D8.1 can be considered as an up-to-date starting point

In light of the advances in the development of solutions which have intervened since the finalisation of D8.1, working group members may wish to modify and/or update some elements presented in the exploratory Business Model Canvas. Business model definition should indeed be viewed as a dynamic, evolving process, throughout – and beyond – the ER's development.

- ✓ Considering alternative business models for each ER

The first step of the business model development process consisted in the definition of an exploratory business model for each ER, which was presented in D8.1. Some of these exploratory business models include various possible options, especially regarding potential revenue streams. The approach consisting in considering multiple potential business models – possibly distinct from the ones retained for other products/services already provided by the partners – should be systematised. A. Osterwalder indeed underlines that *"exploring the possibilities is critical to finding a successful business model. Settling on first ideas risks the possibility of missing potential that can only be discovered by prototyping and testing different alternatives"* (A. Osterwalder, quoted by A. J. Bock and G. George, 2018). Working groups may therefore brainstorm and come up with several options to be explored further.

- ⇒ This review will ensure to have an up-to-date starting point for the next steps, which aim at refining specific blocks of the Business Model Canvas.



### Refining the analysis of CUSTOMER SEGMENTS and RELATIONSHIPS

#### ✓ Specifying customer segmentation (CUSTOMER SEGMENTS block)

Potential customer segments for each ER have been identified in the dedicated block of the Business Model Canvas. To specify them, two elements have to be considered:

- the profile and characteristics of these customers;
- and the value for which they are willing to pay.

This analysis can be realised with the support of the template presented in Table 80, adapted from A. J. Bock and G. George (n.d.).

Table 80. Template for customer segment analysis

Potential segment #1: [Name of the segment]	
<b>Relevant characteristics<sup>7</sup></b>	
Segment <b>size</b> (current size and expected growth)	
Hypothesised customer <b>needs and aspirations</b>	
Hypotheses about segment <b>purchasing behaviour and criteria</b>	
<b>Information and data required</b> to verify these hypotheses	

Source: adapted from A. J. Bock and G. George (n.d.)

This step allows to deepen knowledge about customer segments (characteristics, size) and to shed light on the key assumptions made about their needs, aspirations and behaviour.<sup>8</sup> It can also help to specify the information and data that needs to be collected (possibly within the framework of the demonstration campaign) in order to verify these assumptions.

This analysis, and especially the estimates regarding customer segments' size and purchasing behaviour, is key to determine which potential customer segments are the most important and should be addressed first (A. J. Bock and G. George, 2018).

This step also lays the groundwork for the identification of the risks associated to this specific section of the Business Model Canvas, which will be useful for the evaluation of the considered business model(s) (to be performed at a later stage).

#### ✓ Leveraging this knowledge about customer segments to refine the analysis of CUSTOMER RELATIONSHIPS

The knowledge about customer segments can be used to specify the type of relationship(s) that should be favoured for each of them. A. J. Bock and G. George suggest considering requirements on two dimensions to characterise it:

- "*proximity*", which "*refers to how close or direct the relationship is*";
- and "*engagement*", which "*refers broadly to the level of interaction and contribution to the relationship*" (A. J. Bock and G. George, 2018).

<sup>7</sup> Examples of relevant characteristics may include, in the case of business customers, their size, location, and/or industry/sector; however, A. J. Bock and G. George underline that "*the critical determinant of whether two customers are in the same segment is whether, for a given situation, they make the same purchasing decision*" (A. J. Bock and G. George, n.d.).

<sup>8</sup> The literature review and survey realised within the framework of Deliverable 2.3 (*Stakeholders' Common Requirements Report*) provide insights on these issues.

Another question that needs to be addressed is whether these relationships will vary from one customer segment to another (A. J. Bock and G. George, 2018).

### *Studying the customer journey to refine the analysis of CHANNELS and KEY ACTIVITIES*

#### ✓ Designing a customer journey map

A customer journey map is a tool which depicts and allows to visualise customers' interactions with the solution provider within the framework of the purchase and use of its products or services (A. J. Bock and G. George, n.d.). In order to build it, the following methodology, inspired by A. J. Bock and G. George (n.d.), can be followed:

- i) Answering the questions in Table 81, by adopting the customer's viewpoint:

*Table 81. Template for customer journey map design (step 1)*

<i>Potential customer segment #1: [Name of the segment]</i>	
<b>Problem</b> faced by the customer	
How the customer can <b>learn</b> about the product or service	
How the customer can <b>assess</b> the product or service's value proposition before the actual purchase	
How the customer can <b>purchase</b> the product or service	
How the customer can <b>use</b> the product or service	
How the customer <b>interacts</b> with the company after the purchase	

*Source: adapted from A. J. Bock and G. George (n.d.)*

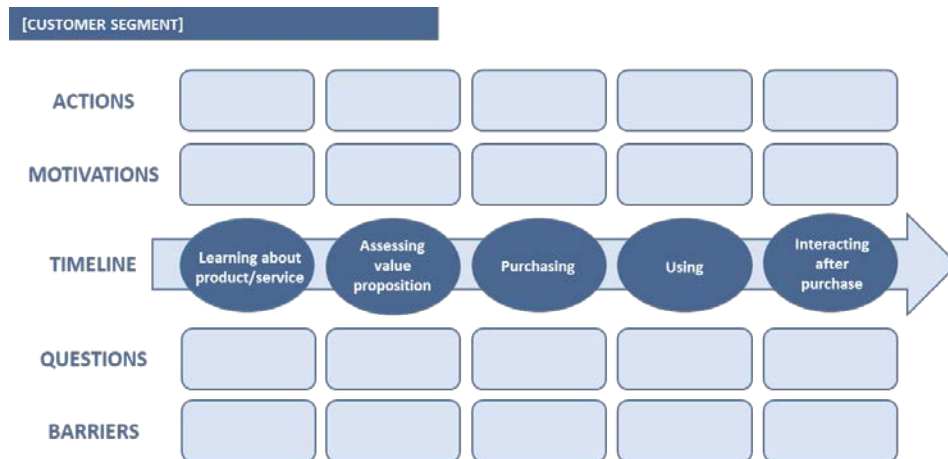
- ii) Drawing a customer journey map encompassing all of these steps

The customer journey map should highlight, in a visual, clear and simple way, the “*key moments, events, information, or interactions in the process*” (A. J. Bock and G. George, n.d.). To design it, A. Richardson proposes a framework articulated around the “*timeline*”, which covers the different steps followed by the customer (corresponding to Table 81 above) and, for each of these steps, the analysis of:

- “*actions*” undertaken by the customer;
- “*motivations*”, defined as the customer's “*emotions*” at this stage and her “*[reasons] to keep going to the next stage*”;
- “*questions*”, which are “*the uncertainties [...] or other issues preventing the customer from moving to the next stage*”;
- and “*barriers*”, which may especially be “*structural, process, cost, implementation*” (A. Richardson, 2010).

The proposed template (Figure 54) may of course be adapted depending on the ER and on customer segments' specificities. In particular, the step concerning the use of the product/service can be broken down into several stages.

Figure 54. Template for customer journey map design (step 2)



Source: adapted from A. Richardson (2010)

- ✓ Focusing on the key interactions evidenced by the map to refine the analysis of CHANNELS

The customer journey map can be used to evidence key interaction points between the solution provider and the customer. This analysis can help to refine the definition of the channel(s) that should be mobilised by the solution provider at each of these points.

Besides, the design of the customer journey map invites the solution provider to consider customer needs and anticipate the questions that customers may have and the issues and barriers that they may face at each step. It should therefore facilitate the identification of the stages at which service can be improved to ease or enhance customer experience and trigger a reflection on how to do so.

- ✓ Leveraging the customer journey map to refine the analysis of KEY ACTIVITIES

In order to point out the solution provider's activities which are key to the considered business model, A. J. Bock and G. George propose to use three criteria: these activities should be "assessable, critical and timely" (A. J. Bock and G. George, 2018). The customer journey map can be used to identify them. It indeed evidences key steps, processes and interactions throughout the product or service's lifecycle, which should be covered by one or several key activity(ies) of the solution provider (A. J. Bock and G. George, 2018). Then, in order to evaluate each activity's contribution to the business model, A. J. Bock and G. George suggest using the template presented in Table 82 (A. J. Bock and G. George, n.d.).

Table 82. Template for the analysis of key activities

Activity	Assessable? (High/Medium/Low)	Critical? (High/Medium/Low)	Timely? (High/Medium/Low)	Output of the activity

Source: adapted from A. J. Bock and G. George (n.d.)

### Carrying out a market and competition analysis to specify the VALUE PROPOSITION

According to A. J. Bock and G. George, the definition of a product or service's value proposition is a process which entails:

- *"Identifying the pain or gain.*
- *Demonstrating that the product/service addresses the customer need.*
- *Linking the value proposition to the competitive advantage."* (A. J. Bock and G. George, 2018).

The analysis carried out for each ER in D8.1, with the support of the Value Proposition Canvas, has initiated a reflection on the first two steps of this process. The proposed market and competition analysis aims to focus on the third step and is also useful to prepare for the identification of the strengths, weaknesses, opportunities and threats associated to the considered business model(s), which will be part of their evaluation (to be performed at a later stage).

In order to analyse the competitive environment, A. Osterwalder and Y. Pigneur propose a framework which includes the study of the *"sector forces"* (Table 83) (A. Osterwalder and Y. Pigneur, 2011). The elements that it suggests considering are reminiscent of M. Porter's model of the *"five competitive forces that shape strategy"* (M. E. Porter, 2008). These forces - namely the *"rivalry among existing competitors"*, the *"threat of entry"*, the *"power of suppliers"* and that of *"buyers"*, and the *"threat of substitutes"* - and their relative strength are characteristic features of a given industry's structure (M. E. Porter, 2008). The latter, in turn, *"determines the industry's long-run profit potential because it determines how the economic value created by the industry is divided"* (M. E. Porter, 2008). M. Porter underlines that this analysis should be realised with a dynamic approach, taking into account recent and expected changes and trends that may influence each force (M. E. Porter, 2008).

Table 83. Template for market and competition analysis

MARKET AND COMPETITION ANALYSIS FOR [Exploitable Result] IN [Country/Region/At the global scale]
<b>Current competitors</b> <i>Identification of key competitors and analysis of their positioning (products and/or services offered, value proposition, targeted customer segments...)</i>
<b>New entrants</b> <ul style="list-style-type: none"> <li><i>Identification of (potential) new entrants and analysis of their positioning (products and/or services offered, value proposition, targeted customer segments...)</i></li> <li><i>Identification of barriers to entry</i></li> </ul>
<b>Substitutes</b> <ul style="list-style-type: none"> <li><i>Identification of products and/or services that could act as substitutes<sup>9</sup></i></li> </ul>

<sup>9</sup> According to M. Porter's definition, *"a substitute performs the same or a similar function as an industry's product by a different means"* (M. E. Porter, 2008).

- *Analysis of their value proposition, their advantages and drawbacks (notably in terms of performance and price) and of the factors that may motivate (or dissuade) customers to resort to them*

#### Suppliers and other actors in the value chain

*Identification of key suppliers and other actors in the value chain and of their importance for the business model*

#### Stakeholders

*Identification of other actors that may have an impact on the activity or the competitive environment (e.g. public authorities)*

*Source: adapted from A. Osterwalder and Y. Pigneur (2011)*

Once this analysis has been carried out, its results can help to identify the specificities which differentiate the ER from rival solutions or potential substitutes and constitute its competitive advantage(s). A. J. Bock and G. George define “an ‘unfair advantage’ [as] something that competitors cannot easily copy, acquire or otherwise execute”; the examples that they provide involve protected intellectual property, specific expertise or experience, or long-term contractual relationships with key partners, among others (A. J. Bock and G. George, 2018). This competitive advantage may exist from the onset; however, it may also be acquired only at a later stage and/or built over time (A. J. Bock and G. George, 2018). In both cases, “the business model needs to guide the firm towards sustainable competitive advantage” (A. J. Bock and G. George, 2018).

The competitive advantage, either existing or to be developed, should be highlighted in the ER’s value proposition, as it participates in its differentiation. The other building blocks of the Business Model Canvas can also be re-examined in light of it, in order to make sure that they capitalise on this advantage or, conversely, that they contribute to its development and its sustainability (A. J. Bock and G. George, n.d.).<sup>10</sup>

#### *Identifying the critical success factors for the considered business model(s)*

The market analysis and the Business Model Canvases realised within the framework of D8.1, as well as their refinement by means of the above-mentioned steps, should be leveraged to identify the critical success factors (CSFs) that will condition the viability and sustainability of the business model(s) considered for each ER. Identifying these CSFs can be useful for the preparation of the demonstration campaign, as well as for the evaluation, at a later stage, of the considered business model(s) and the analysis of the risks associated to them.

A. J. Bock and G. George propose a template (Table 84) in order to identify the CSFs and specify them by defining related key metrics and required data (A. J. Bock and G. George, 2018).

<sup>10</sup> The exploitation strategy (developed within the framework of task 8.5) and IPR management (task 8.3) can play a key role to achieve this objective.

Table 84. Template for the identification of critical success factors

Critical success factor	Key metric	Data to be collected and sources
1.		
2.		
3.		
4.		
5.		

Source: adapted from A. J. Bock and G. George (n.d.)

The CSFs may be related to:

- the opportunity itself: in this case, they may especially be linked to the analysis of the market context and trends and of the competitive environment, and to the “customer segments” block of the Business Model Canvas;
- the way in which the solution provider is addressing it: in this case, the CSFs may notably be linked to the “value propositions”, “key resources” and “key activities” blocks (A. J. Bock and G. George, 2018).

Key metrics should be associated with each of the CSFs. They consist in quantifiable indicators allowing to test whether the conditions are fulfilled (A. J. Bock and G. George, 2018). The data required to validate or invalidate these hypotheses should be identified and the sources for its collection should be specified. The demonstration campaign can be one of these sources.

#### Documenting the REVENUE STREAMS and COST STRUCTURE

The business models presented in D8.1 include an exploratory analysis of potential revenue streams and of the main expected cost items associated with each ER. This last step aims at refining this analysis.

- ✓ Considering alternative options

“Revenue streams” and, to a lesser extent, “cost structure” are building blocks for which it is particularly important to consider various possibilities and analyse the advantages and drawbacks of alternative options before retaining a given business model. Ideas on the hypotheses that may be contemplated could especially be drawn from:

- the knowledge about customer segments that has been gathered, which should have highlighted the value for which they are willing to pay, and may also help to specify how they want to pay for it;
- the market and competition analysis, which may have evidenced the practices of competitors (or even providers of substitutes) in terms of pricing, their revenues and their cost structure.

This does not imply that the choices made for the ER should be aligned with competitors’. However, the solution provider should be aware of the similarities and differences between the considered business model(s) and the ones existing in the industry and of the reasons justifying them.

- ✓ Building a spreadsheet detailing the elements necessary to build estimates of the main revenue streams and cost items

Once the options to be considered are selected, the next step is to create a matrix on a spreadsheet identifying the main revenue streams and the most significant cost items and decomposing them into underlying variables which are necessary to compute them (examples

of the elements to be considered in the case of revenue streams are provided in Table 85). This analysis should help to:

- identify the variables which will have the most significant impact on either costs or revenues;
- specify the data necessary to build estimates and identify potential sources (specific research, benchmarks, demonstration campaign...).

*Table 85. Elements to be taken into account to decompose revenue streams into underlying variables*

For each revenue stream:

- The targeted customer segments, their potential size, and hypotheses regarding customer acquisition (e.g. market share and its evolution over time)
- The time frame, which depends on the nature of the revenue stream:
  - If it is one-time: when will it intervene?
  - If it is recurring: at which frequency will it be charged?
- The pricing mechanism which will be used for the revenue stream's computation: on which elements will it depend?
  - If it is fixed: on the solution's features or options? the customer segment?
  - If it dynamic: on a negotiation? an auction? a market?

This step is a key prerequisite to:

- identify underlying hypotheses and specify how they can be tested within the framework of the demonstrations;
- build estimates, which will in turn be used to assess the profitability of the considered business model(s).



## Appendix 2: Template to refine the exploratory business models designed in D8.1

This template is intended to be used in conjunction with the methodology, which provides the guidelines and references corresponding to each proposed activity. It only aims at facilitating the gathering of inputs within the framework of the working groups.

Exploitable Result #[Number of the ER]: [Name of the ER]	
Lead partner	
Working group members	

### Reviewing the exploratory business model designed in D8.1

- ✓ **Checking that the exploratory business model designed for the ER in D8.1 can be considered as an up-to-date starting point**

[Please use the template below to update the exploratory business model presented in D8.1, if necessary]

### Business Model Canvas for ER #[Number of the ER] – [Name of the ER] Lead partner: [Name]

KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITIONS	CUSTOMER RELATIONSHIPS	CUSTOMER SEGMENTS
	KEY RESOURCES		CHANNELS	
COST STRUCTURE			REVENUE STREAMS	

- ✓ **Considering alternative business models for the ER**

[If relevant, please reuse the template above to state different options to be explored further and present them here]

### Refining the analysis of CUSTOMER SEGMENTS and RELATIONSHIPS

#### ✓ Specifying customer segmentation (**CUSTOMER SEGMENTS** block)

Template for customer segment analysis (to be completed for each customer segment):

<i>Potential segment #1: [Name of the segment]</i>	
<b>Relevant characteristics</b>	
<b>Segment size</b> (current size and expected growth)	<i>[Size in relevant geographical markets: the European Union / other potential target markets]</i>
<b>Hypothesised customer needs and aspirations</b>	
<b>Hypotheses about segment purchasing behaviour and criteria</b>	
<b>Information and data required to verify these hypotheses</b>	

<i>Potential segment #2: [Name of the segment]</i>	
<b>Relevant characteristics</b>	
<b>Segment size</b> (current size and expected growth)	<i>[Size in relevant geographical markets: the European Union / other potential target markets]</i>
<b>Hypothesised customer needs and aspirations</b>	
<b>Hypotheses about segment purchasing behaviour and criteria</b>	
<b>Information and data required to verify these hypotheses</b>	

<i>Potential segment #3: [Name of the segment]</i>	
<b>Relevant characteristics</b>	
<b>Segment size</b> (current size and expected growth)	<i>[Size in relevant geographical markets: the European Union / other potential target markets]</i>
<b>Hypothesised customer needs and aspirations</b>	
<b>Hypotheses about segment purchasing behaviour and criteria</b>	
<b>Information and data required to verify these hypotheses</b>	

*Comments/conclusions regarding the prioritisation of potential customer segments:*

✓ **Leveraging knowledge about customer segments to refine the analysis of CUSTOMER RELATIONSHIPS**

*[Please insert here the update of the “Customer Relationships” block, considering requirements in terms of proximity and engagement, as well as the potential differentiation of relationships between customer segments]*

*Studying the customer journey to refine the analysis of CHANNELS and KEY ACTIVITIES*

✓ **Designing a customer journey map**

iii) Answering the questions in the table below, by adopting the customer’s viewpoint:

<i>Potential customer segment #1: [Name of the segment]</i>	
<b>Problem</b> faced by the customer	
How the customer can <b>learn</b> about the product or service	
How the customer can <b>assess</b> the product or service’s value proposition before the actual purchase	
How the customer can <b>purchase</b> the product or service	
How the customer can <b>use</b> the product or service	
How the customer <b>interacts</b> with the company after the purchase	

<i>Potential customer segment #2: [Name of the segment]</i>	
<b>Problem</b> faced by the customer	
How the customer can <b>learn</b> about the product or service	
How the customer can <b>assess</b> the product or service’s value proposition before the actual purchase	
How the customer can <b>purchase</b> the product or service	
How the customer can <b>use</b> the product or service	
How the customer <b>interacts</b> with the company after the purchase	

Potential customer segment #3: [Name of the segment]	
Problem faced by the customer	
How the customer can <b>learn</b> about the product or service	
How the customer can <b>assess</b> the product or service's value proposition before the actual purchase	
How the customer can <b>purchase</b> the product or service	
How the customer can <b>use</b> the product or service	
How the customer <b>interacts</b> with the company after the purchase	

iv) Drawing a customer journey map encompassing all of these steps

[Please draw the customer journey map using the proposed template - possibly adapting it depending on the ER and on the customer segment's specificities, and breaking down the step concerning the use of the product/service into several stages]

[CUSTOMER SEGMENT]					
ACTIONS  MOTIVATIONS  TIMELINE  QUESTIONS  BARRIERS					
	Learning about product/service	Assessing value proposition	Purchasing	Using	Interacting after purchase

- ✓ **Focusing on the key interactions evidenced by the map to refine the analysis of CHANNELS**

*[Please insert here the update of the “Channels” block, building on key interaction points between the solution provider and customers evidenced by the customer journey map]*

- ✓ **Leveraging the customer journey map to refine the analysis of KEY ACTIVITIES**

Template for the analysis of the solution provider’s key activities, to be identified using the customer journey map:

Activity	Assessable?	Critical?	Timely?	Output of the activity
	<i>High/Medium/Low</i>	<i>High/Medium/Low</i>	<i>High/Medium/Low</i>	

*[Please insert here the update of the “Key Activities” block, retaining the ones which fulfil the “assessable / critical / timely” criteria]*

*Carrying out a market and competition analysis to specify the VALUE PROPOSITION*

Template for market and competition analysis:

MARKET AND COMPETITION ANALYSIS FOR [Exploitable Result] IN [Relevant geographical market: Country/Region/At the global scale]
--

Current competitors
<i>Identification of key competitors and analysis of their positioning (products and/or services offered, value proposition, targeted customer segments...)</i>

New entrants
<ul style="list-style-type: none"> <li><i>Identification of (potential) new entrants and analysis of their positioning (products and/or services offered, value proposition, targeted customer segments...)</i></li> <li><i>Identification of barriers to entry</i></li> </ul>

Substitutes
<ul style="list-style-type: none"> <li><i>Identification of products and/or services that could act as substitutes</i></li> <li><i>Analysis of their value proposition, their advantages and drawbacks (notably in terms of performance and price) and of the factors that may motivate (or dissuade) customers to resort to them</i></li> </ul>

Suppliers and other actors in the value chain
---

*Identification of key suppliers and other actors in the value chain and of their importance for the business model*

#### Stakeholders

*Identification of other actors that may have an impact on the activity or the competitive environment (e.g. public authorities)*

*Identification of the ER's competitive advantage(s), relying on the above analysis:*

*[Please insert here the update of the "Value Propositions" block, highlighting this (these) competitive advantage(s)]*

*Identifying the critical success factors for the considered business model(s)*

Template for the identification of critical success factors:

Critical success factor	Key metric	Data to be collected and sources
1.		
2.		
3.		
4.		
5.		

*Documenting REVENUE STREAMS and COST STRUCTURE*

#### ✓ Considering alternative options

*Analysis of different options that may be explored further and of their respective advantages and drawbacks*

#### ✓ Building a spreadsheet detailing the elements necessary to build estimates of the main revenue streams and cost items

*[Please insert here the matrix identifying the main revenue streams and the most significant cost items and decomposing them into underlying variables which are necessary to compute them]*

*Identification of the variables that will have the most significant impact on revenues:*

*Identification of the variables that will have the most significant impact on costs:*

*Recap of the data necessary to build estimates and potential sources:*