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Deliverable 2.2 Energy services analysis, use cases, and CERF requirements

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KEYWORDS

Common European Reference Framework (CERF), High Level Use Case (HLUC), Use Case (UC), Work Package (WP), Demo-site, IEC 62559-2, Key performance Index (KPI), Electric Vehicle (EV), NILM (Non-Intrusive Load Monitoring), Application (APP), Distribution System Operator (DSO), Transmission System Operator (TSO), Photovoltaic (PV), Harmonised Electricity Market Role-Model (HEMRM).

EXECUTIVE SUMMARY

This document analyses the use case proposals and requirements that the ECLIPSE project partners will implement at the pilot sites during the field-testing phase, which will take place during the Work Package 5 tasks named “Demonstration Activities by Real Pilots” and “Simulations in Virtual Pilots”, between months 13th and 24th and between months 18th and 24th, respectively.

This study includes not only the use cases themselves. The scope also includes the analysis of:

- Which HLUC (High Level Use Case) is covered by the demo use case.
- The use cases categories which allow an easier study of them.
- Requirements of each demo site.
- A pilot site area description where each use case will take place.
- Key Performance Indicator (KPIs) so used to measure the success of each UC (Use Case).

A total of 56 use cases have been collected by using templates compliant with the IEC 62559-2 standard, clustered into six categories, and tested at 13 demo sites across 17 countries. Their distribution, both among categories and locations, is consistent to achieve the project's final objectives.
There are 5 HLUC that will be tested in the demo sites:

- HLUC 1 focuses on providing personalized messages to consumers and intermediaries based on economic benefits.

- HLUC 2 is similar to HLUC 1, but instead of economic benefits, it focuses on non-economic incentives.
- HLUC 3 involves providing personalized information to consumers about the potential for reducing or shifting their energy consumption through the adoption of specific technologies.
- HLUC 4 deals with general messages and alerts about extreme grid situations.
- HLUC 5 provides consumers with general tips and guidance on energy efficiency practices.

The previously defined HLUCs in the Grant Agreement encompass the classification established within the ECLIPSE Project. However, during the project, a second classification type (hereafter referred to as "category") has been created to address the characteristics of the use cases that have appeared throughout the project's duration. The use cases have been grouped into categories to facilitate the study. If a use case relates to more than one category, it has been incorporated to the most representative one. There are 6 categories:

- Energy invoice reduction for consumers: This category includes use cases focused on achieving an economic benefit for the customer by changing some habits of consumption.
- Carbon footprint reduction & customer awareness: This category embraces the use cases whose objective is to reduce the carbon footprint and contribute to fight against climate change.
- Enhancing quality of supply and grid resilience: These use cases will check how the quality supply can be improved thanks to minor behaviour customer changes avoiding the grid works outside its limits.
- Optimizing home energy use through energy assets control: Based on real-time and historical data, this category focuses on enhancing household energy efficiency by intelligently managing and coordinating energy assets such as solar panels, batteries, heat pumps, electric vehicle chargers, and smart appliances.
- Participation in flexibility energy markets: This category involves use cases which promote the implementation or growth of markets where the DSO flexibility needs can be traded.

- Smart charging in EVs: This category includes new EV charging strategies to fulfil customer preferences and DSO necessities.

A first version of the UC diagrams, following the HEMRM (Harmonised Electricity Market Role Model) methodology, has been presented that will help to define the architecture and information exchange of the CERF.

On the other hand, a list of requirements has been agreed among partners supported by the Volere tool linking which have an impact in the different project use cases.

A pilot site area description has been included in this document trying to provide an overview of the place where the tests will be carried out. The 13 pilot sites are the following: Austria, Bulgaria, Croatia, Cyprus, Czech Republic, France, Greece, Poland, Portugal, Romania, Slovenia, Spain and Sweden. An analysis of the HLUCs covered in the different demos has been made, comparing the proposal with the ones specified in the Grant Agreement (GA). The result is satisfactory because all the 5 HLUCs of the project´s Grant Agreement have been covered by the different use cases.

In addition, a proposal of KPIs for the use cases has been described as a preliminary approach for the consecutive Work Packages. The result is that the KPIs are representative enough in this stage but must be specified as part of WP6, based in WP5 data collected from pilot sites.

Finally, a set of recommendations have been included at the end of the document to improve the use cases proposal. The most important are the following:

- A set of preliminary KPIs has been proposed (after a presential workshop) with the information already available. Nevertheless, these KPIs must be confirmed or improved when the demo sites start testing the use cases.
- The requirements definition should be considered in the definition of the CERF APP, the Volere tool work done could be profitable.
- The conclusions among the different pilot sites (WP5) should be shared, so that the conclusions are homogeneous, and the UCs themselves become more complete.

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1. BACKGROUND.

1.1. WP2 AND DELIVERABLES.

The Work Package 2 (WP2) titled "CERF use cases, requirements and services", meaning CERF - Common European Reference Framework, has the main objective of involving all the project partners in the definition of the use cases and requirements, which will be the basis for the rest of the project activities. Furthermore, WP2 will enhance the user-experience and define the main motivators for consumers to be more environmentally active. The deliverables from this WP will be the following:

- D2.1 "Analysis of existing energy monitoring applications and services in the market and of the legal framework".
- D2.2 "Energy services analysis, use cases, and CERF requirements".

The purpose of the D2.1 (already submitted on 27th of February), is related with the task T2.1 "Analysis of the good practices from existing applications and services already available in the market", is to analyse the potential and best practices of energy monitoring applications and platforms, alongside the importance of an integrated legal and technological framework. These aspects will provide the basis for the development of the CERF, for their demonstration and evaluation in the project pilot sites.

On the other hand, the work done on tasks T2.2 "Co-creation of project use-cases and energy services in collaboration with all the relevant stakeholders" & T2.3 "Definition and consolidation of CERF requirements" is included in the present D2.2 document, in which the partners of the project have participated in the definition of the project scenarios and use cases. The use case description is based on the standard IEC 62559-2, and the information included contains mainly the scope and objectives pursued by each partner, as well as a detailed definition of the sequence of actions (by means of flowcharts) performed by each of the actors that are part of the use case, among other aspects. For this goal, the consortium partners involved on this task have also worked on the analysis of country-specific context and challenges, sustainability assessment of the proposed measures, or social acceptance aspects.

In the context of a European project, such as those funded by programs like Horizon Europe, a use case refers to a detailed description of how a technology, solution, or project outcome will be applied in a real-world setting to solve a specific problem or improve an existing process. Additionally, a requirement refers to a condition, need, or functionality that must be fulfilled or implemented for the project to achieve its objectives. Requirements guide the design, development, and evaluation of the proposed solutions. The detail on the requirement´s classification can be seen in detail in chapter 7.

As for task T2.3, partners have worked on the technical and operational requirements (user, system and data) that will be used to build ECLIPSE CERF. These requirements have been clearly defined and structured by specifying correlations, correspondence and interdependencies among them to provide a conceptual model for the design of the ECLIPSE CERF. Also, the requirements have been classified and prioritised based on the use cases defined by pilot-site partners. This process has been conducted using Volere, a tool proven successful in previous projects for the definition of requirements, which will be explained in detail later in section 7. An iterative process was followed, consisting in a validation phase, where requirements were reviewed and any objections, dependencies and conflicts among requirements were detected; and a revision phase, in which the previous identified issues were addressed and solved. The use of Volere has fostered the collaboration of all the partners involved in the project, that could provide their vision and inputs regarding the expected functionalities and outcomes of the project.

1.2. RELATION WITH OTHER WPS.

As shown in Figure 1, WP2 will be the basis for the following Work Packages:

- WP3 “Architecture of a scalable and interoperable European open-source CERF and data sets” (protocols, semantic models, blockchain, cybersecurity, trustful AI, interoperability, etc.) that will be used also as a basis for WP4.
- WP4 “Design and development of CERF and APIs” where the open-source CERF will be developed, with the applications based on machine learning tools and IA, demonstrated and verified into the WP5.

- WP5 "Preparation, coordination and monitoring of deployment and demonstration activities". The use cases defined will be the basis for the definition of the demonstration activities.
- WP6 "User satisfaction assessment and recommendations of the regulatory framework" will assess and demonstrate also the socioeconomic and environmental impact of ECLIPSE CERF when deployed at the selected real and virtual pilot sites.

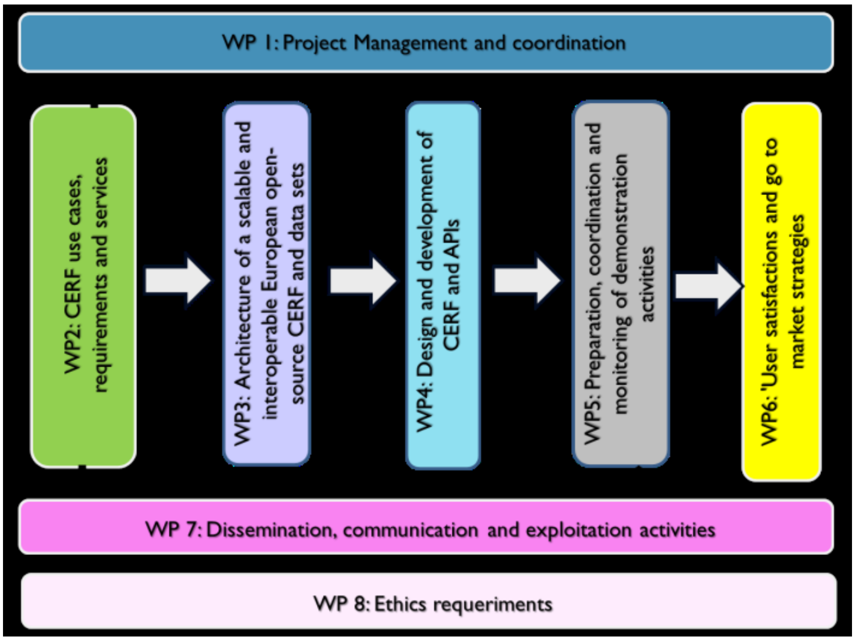


Figure 1. Work Packages sequence.

2. TIMELINE.

The following timetable shows the sequence of assignments over time for task T2.2, which has generated the deliverable D2.2. This task has lasted for 12 months (from September-2024 to August 2025).

The process starts with an informal description of the use case. This first definition has been analysed by partners and evolved to an IEC 62559-2 template for each use case. These use case documents have shaped the basis for a draft, which has been reviewed by all members (by conducting workshops), and internally, for achieving the expected detailed definition.

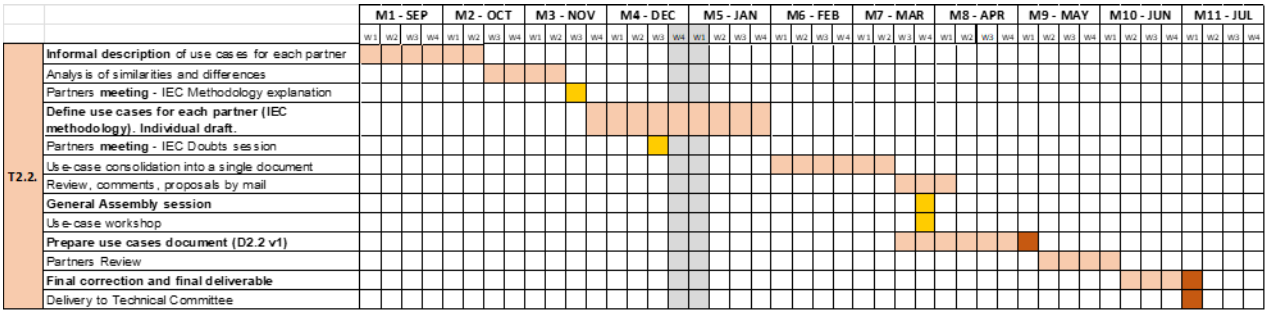


Table 1. Wokplan of task T2.2.

On the other hand, the requirements definition process began with the registration of project partners in the Volere tool. It was followed by a dedicated workshop aimed at introducing the format for submitting requirements using the Volere methodology, as well as outlining the iterative process to be followed. Each iteration comprised two key phases, validation and revision, each lasting approximately one and a half weeks. The original plan envisioned a total of four iterations, spanning roughly three months, to allow sufficient time for the progressive refinement of inputs and the development of a well-structured and finalised list of requirements.

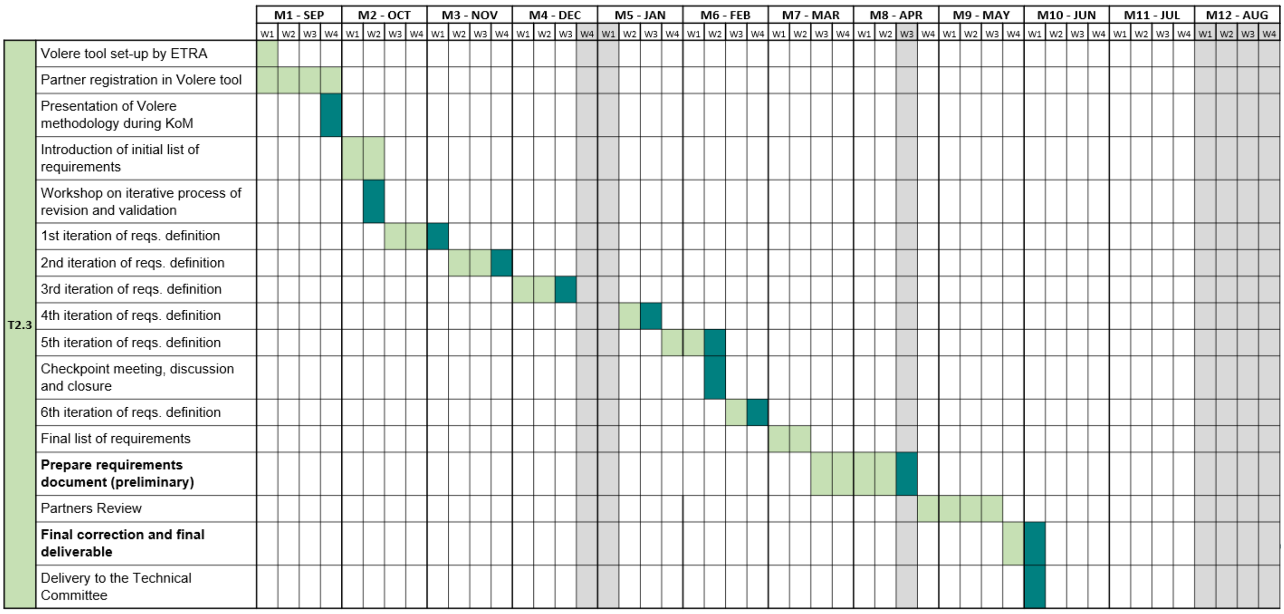


Table 2. Requirements workplan Gantt chart.

As the fourth iteration approached, it became evident that some partners had yet to contribute, and numerous outstanding issues remained unresolved within the existing requirements. These issues required further input and clarification from the respective requirement owners. Additionally, there was a noticeable imbalance in the distribution

of requirements across categories. To address these challenges and ensure a more comprehensive and balanced outcome, two additional iterations were introduced. This extension provided extra time for pending contributions and allowed for the resolution of open issues ahead of the final deadline for the definition process.
Following the completion of the sixth iteration, the compiled list of requirements from the Volere tool was exported and subjected to a thorough review by ETRA. This included filtering the content and correcting any missing or inaccurate information. The finalised requirements were then individually formatted into structured tables and appended to this document as annexes, representing their final validated form.

3. DELIVERABLE STRUCTURE.

This deliverable is composed of the following chapters:

- Description of the **use case methodology**, following standard IEC 62559-2.
- **Characterization of use cases** that are going to be performed by the partners, including information about:
    - Scope and objectives.
    - Narrative of the use case.
    - Diagram of the use case.
    - Actors of the use case.
    - Scenarios (main and exception path).
- Description of **requirements methodology**. In this chapter the different stages of the requirements task (definition, validation, revision, filtering) are specified, as well as the groups in which the requirements have been classified in the Volere tool.
- **Pilot site area description**. A brief description of the location where the use cases will take place.
- **Pilot sites vs HLUC and UC**. The relationship among the pilot sites, the HLUCs and the individual use cases.

- **KPIs for demos**. The representative KPIs proposed by the partners are presented, for measuring the success of the case, during the demonstration phase.

- **Requirements vs Use cases mapping**, i.e. which requirements specified through the Volere tool apply to each partner use case.

- **Conclusions and recommendations**. In this chapter, the main conclusions in relationship with the UC are exposed, as well as a few recommendations for future projects.

4. DESCRIPTION OF THE IEC 62559-2 STANDARD.

The IEC 62559-2 is an international standard that defines the structure of a template for the description of use cases, as well as lists of actors and requirements. It was developed to facilitate standardization and the development of systems projects. IEC 62559-2 is used in various domains to describe use cases in a standardized way. Here are some examples from the fields where it is applied:

- Smart Homes: for defining the requirements and actors involved in home automation, ensuring that systems are safe and efficient.
- Electric Mobility: applied in the development of charging infrastructure for electric vehicles, describing the processes and requirements necessary for its implementation.
- Smart Cities: facilitates the integration of different urban systems, such as traffic and energy management, to create more sustainable and efficient urban environments.

The main aspects included in the IEC templates for the ECLIPSE context are the following:

- **Use case description**: It provides an overview of the use case, including its purpose and scope.

- **Use case diagrams**: Includes diagrams that visually represent the use case and its interactions.
- **Technical details**: Describes the relevant technical aspects of the use case.
- **Step-by-step use case analysis**: Breaks down the use case into detailed steps.
- **Information exchanged**: Details the information that is exchanged among the Actors of the use case.
- **Requirements**: Lists the requirements necessary to implement the use case.
- **Common terms and definitions**: Defines the terms and concepts used in the use case.
- **Customization**: Allows the template to be adapted to specific needs.

These sections help ensure that use cases are described clearly and consistently, facilitating communication and collaboration between interested parties.

On the other hand, the standard provides a template to describe use cases, lists of actors and requirements, enabling better communication and understanding between developers and stakeholders. The main sections of the IEC standard considered are listed below:

- **Use case name** and **description** (around 150-300 words).
- **Actors/Roles** involved in the use case (following the Harmonized Electricity Market Role Model (HEMRM) methodology). The HEMRM is a model developed to simplify the dialogue among electricity market participants from different countries. This model assigns a unique name to each prevalent role and domain. The main objective is to standardize the terminology used in the development of information technologies related to the electricity market. This helps improve communication and interoperability among the different market players. In this project, a set of roles included in WP3 have been considered.
- **Products/Assets** involved, i.e. a functional building block or system within the energy ecosystem that contributes to the execution of specific tasks, services, or roles. These products/assets are defined in T3.2. The component list is outlined below:
  - Consumer-Facing Applications.
  - Consumer Management & Digital Twin.
  - Energy Management Tools.
  - Forecasting and Monitoring.

  - Real-Time & Near-Real-Time Streaming.
  - Data Catalogs & Models.
  - Market Data and Exchange.
  - Home and Grid Devices.
  - Renewable Energy and Storage.
  - Security & Compliance.
  - Data Exchange and Connectivity.
  - Analytics and AI-Based Support.
  - Market Interaction and Compliance.
  - Congestion and Balancing Management.
  - Energy Communities.

- **Triggering event**, i.e. the condition that starts the use case sequence.
- **Pre-condition and post-condition**: referred to the condition "sine qua non", without which the process will not take place.
- **Basic and exception paths**: in other words, the main or typical path and the alternative path (in case that there is a condition not reached).
- **Partners contribution & priority**. Distinguishing between main and contributing partners, as well as to the relevance of the use case.

5. DESCRIPTION OF THE FOLLOWED USE CASE METHODOLOGY.

This chapter shows a brief explanation of the process followed for defining the use cases, beginning from a general idea and, after a few steps, reaching its final definition. The steps followed were the following:

1. **Compilation of use cases in informal language**. First step is a preliminary definition of the use case. This will act as a first approach to the work, with a few questions to the partners for general description. These questions were the following:
    - Title of the use case.
    - General description.
    - System solution description.
    - Customer participation required in each use case.
    - Where should it be tested?
    - Expected challenges.
    - Social acceptance aspects.
    - Proposed KPIs.
    - Expected results.
    - Other details you consider that could be interesting.

    This information also helped to refine the information contained in later stages of the Work Package.

2. **Explanation of methodology** for defining use cases (**IEC 62559-2**). A series of internal meetings were held with partners to clarify the template and its application to the ECLIPSE use cases, as well as to solve doubts and questions regarding this matter.
3. **Definition of use cases by partner**. Each partner prepared the information about their use cases, including the information on the template which was specified in the previous chapter.

4. **Internal analysis**. Once the information from partners was received, a detailed analysis was performed, and the use cases were categorized into six "categories" depending on the objective of the use case. The objective of this categorization is to facilitate the study of the proposals and manage every category as a whole. In the cases in which a use-case could be included in more than one "category", the idea followed has been to include it in the most representative one, among the following:
    - Energy invoice reduction for consumers.
    - Carbon footprint reduction & customer awareness.
    - Enhancing quality of supply and grid resilience.
    - Optimizing home energy use through energy assets control.
    - Participation in flexibility energy markets.
    - Smart charging of EVs.
5. **Create review teams**. Discussion and feedback. Once the use cases were specified and categorized, the overall information was shared among partners to correct mistakes, refine information, and suggest additional ideas.
6. **Final document**. Comments, review and closure. As the final chapter of the process, a general detailed review of the document has been performed by the partners, producing the final version presented in this document.

6. USE CASES.

A total of 56 use cases has been specified by the project partners, which have been grouped as previously presented. The following chapter explains the scope of each “category” and details the use cases contained on each.

The table below presents the 13 demo sites across 17 countries where the ECLIPSE project use cases will be tested, indicating whether each will take place in a real or virtual test scenario.

The difference between real and virtual scenarios is that the former will take place in a demo site including consumers, assets, apps and communications among them, the latter will be tested by a software tool which is designed to replicate real situations and tries to test how different solutions respond to the same problem.

Acronym	Demo site	Demo partner/s involved	Real/Virtual Use Cases
AT	Austria	FHOOE	Real
BG	Bulgaria	ESO	Real
HR	Croatia	HOPS	Real
FR	France	Voltalis & Digital4Grids	Real (France, Finland) & Virtual (Belgium, Finland, Denmark and Estonia)
GR	Greece	HEDNO, Metlen (independent demos)	Real & Virtual
CY	Cyprus	TSOC & UBITECH ENERGY	Real
CZ	Czech Republic	ČEZ Distribuce	Real
RO	Romania	University Politehnica of Bucharest	Real
PL	Poland	TAURON	Real
PT	Portugal	E-REDES & R&D NESTER	Real
SI	Slovenia	Elektro Ljubljana	Real
ES	Spain	i-DE, AÉLEC	Real
SW	Sweden	CheckWatt	Real

Table 3. Demo site list, with country acronyms and real/virtual implementation.

The acronym of each use case follows this rule:

- The first two letters refer to the country standardized code, from the 13 demo sites.
- The first digit refers to the representative HLUC project number (1 to 5).
- The second digit refers to the sequence of use case inside the HLUC, (i.e. a pilot-site will just work on a single use case, this number will be only "1").

For example, "GR4.1", for a use case from Greece, is the first use case inside the HLUC4.

6.1. USE CASE CATEGORIES.

A use case refers to a demonstration conducted in a specific location. Its main objective is to test various solutions that could contribute to achieving a defined goal.

To facilitate analysis, the use cases are organized into six categories. The distinction between a HLUC and a category lies in their focus: the high-level use case defines what is to be achieved, while the category represents how it is proposed to be achieved.

The following schematic overview serves as a reference for the upcoming chapters:

- Table 4 shows the proportion of use cases on each created category, as well as a brief definition of it.
- Figure 2 represents a pie chart showing the percentage of use cases.
- Figure 3 specifies the bar chart for the number of use cases implemented on each pilot-site by country.

When a use case fits into more than one category, it has been assigned to the one that best represents its primary focus.

Categories	Use cases	Proportion [%]	Definition
Energy invoice reduction for consumers	8	14	Consumption optimization by adopting different rates or monitoring the pool market
Carbon footprint reduction & customer awareness	15	27	Those use cases that aim to increase environmental awareness through generic or personalized messages.
Enhancing quality of supply and grid resilience	14	25	When the network reaches or is expected to reach an operating state with values outside or close to the limit. A series of measures are proposed to avoid shedding or blackouts.
Optimizing home energy use through energy assets control	7	13	Based on real-time and historical data, this category focuses on enhancing household energy efficiency by intelligently managing and coordinating energy assets such as solar panels, batteries, heat pumps, electric vehicle chargers, and smart appliances.
Participation in flexibility energy markets	8	14	TSO and DSO send flexibility proposals to participate in customer flexibility markets that must previously identify which assets they could manage.
Smart charging of EVs for grid support	4	7	Those uses cases focused on managing the charging of EVs considering the state of the grid or the fleet itself

Table 4. UC category's summary.

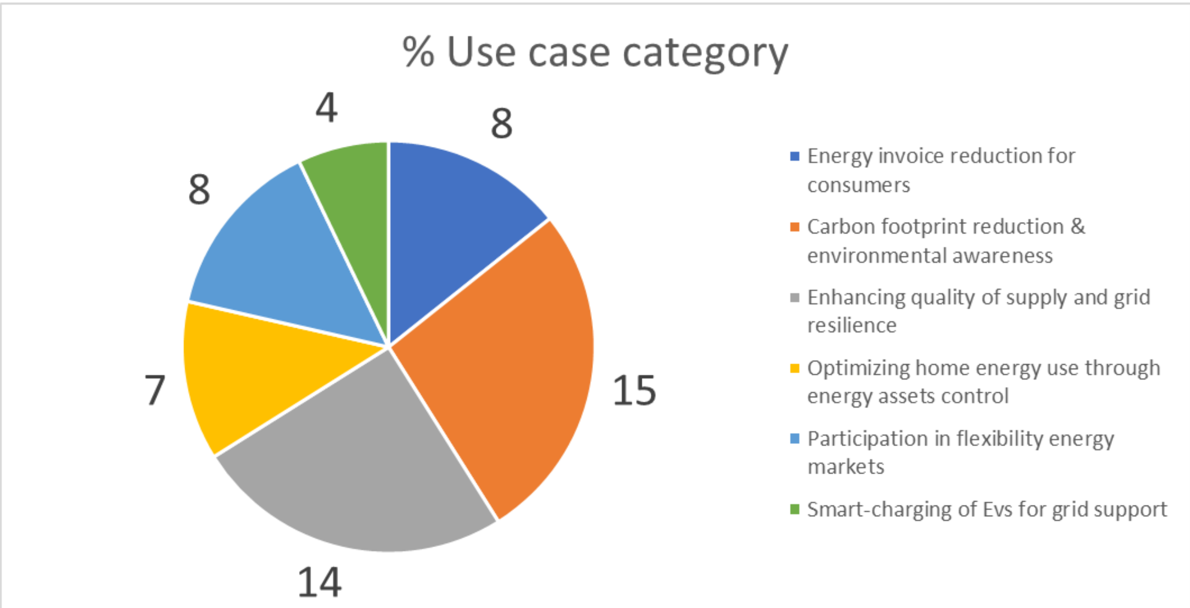


Figure 2. Percentage of use cases on each category.

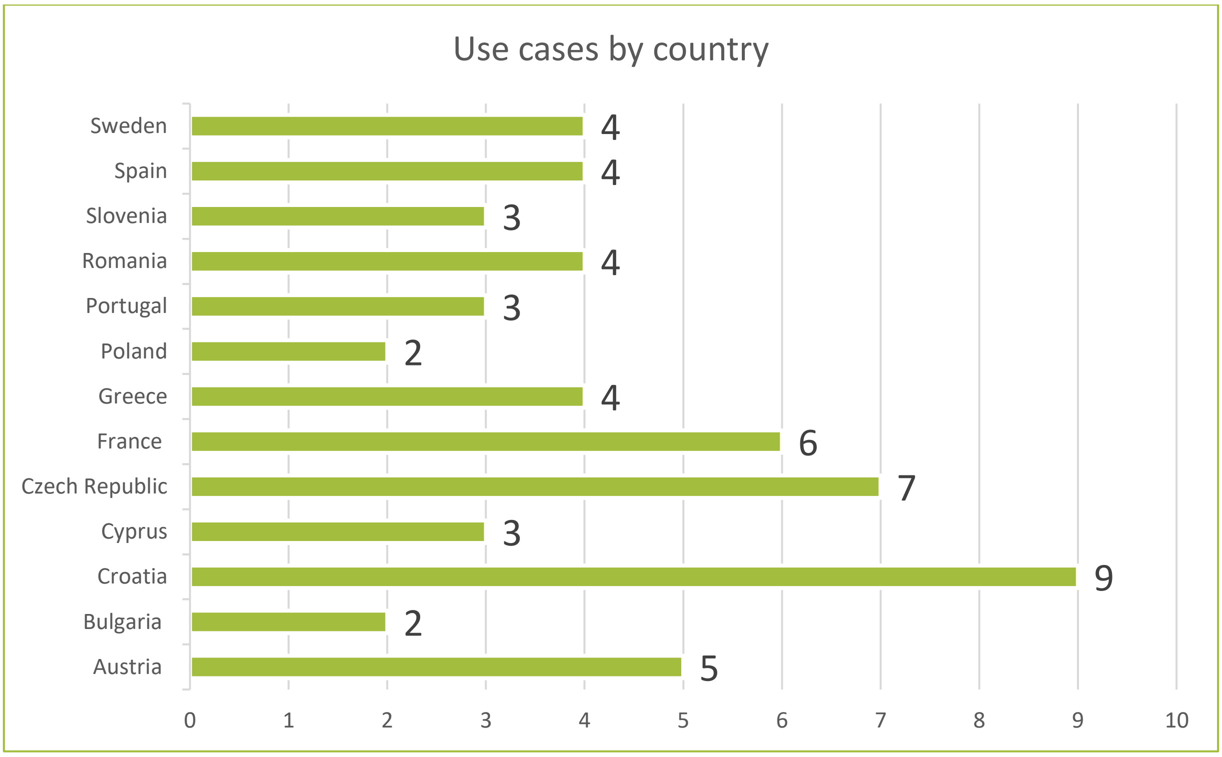


Figure 3. Number of use cases per country.

6.1.1. ENERGY INVOICE REDUCTION FOR CONSUMERS.

There are a total of 8 use cases from Austria, Bulgaria, Croatia, Cyprus, Czech Republic, France and Slovenia which represent 14% of the total.

Country	Use case	HLUC	Definition	Acronym	Category
Bulgaria	Energy consumption optimization tips – general.	3	The demo will provide consumers with a mobile application that delivers real-time information on current energy generation, consumption, pricing, estimated imbalance prices, and grid status. It will offer general advice to all users on how to optimize energy consumption based on price signals. Consumers with their own generation and/or energy storage systems (prosumers), as well as those with electric vehicles (EVs), may also receive personalized recommendations for charging and discharging.	BG3.1	Energy invoice reduction for consumers
Austria	Economic incentives	1	The use case uses EDDIE framework (European project that develops an open and standardized energy data infrastructure with the goal of facilitating access to and use of energy data to improve efficiency, innovation, and sustainability in the sector). For Historical	AT1.1	Energy invoice reduction for consumers

			Validated Data and AIIDA (open-source platform that automates and manages scientific workflows in computational simulations with the goal of ensuring traceability, reproducibility, and efficiency in materials science and computational physics research. for near real-time data access).		
Croatia	Tailored Notifications for Cost-Effective Energy Consumption	1	The system uses data from TSO to track energy pricing and grid conditions, offering consumers actionable insights to adjust their energy usage.	HR1.1	Energy invoice reduction for consumers
Croatia	Sandbox Tariff Program for Active Energy Engagement	1	This use case explores a regulatory sandbox aimed at incentivizing users to actively engage with energy-saving recommendations by offering them tailored tariff savings. The sandbox also serves as a testing ground for evaluating how dynamic tariffs can impact energy usage behaviour, shaping future regulatory decisions.	HR1.2	Energy invoice reduction for consumers
Cyprus	Consumer notifications for Cost-Effective Energy Consumption	1	This use case focuses on delivering real-time, personalized notifications to consumers based on economic factors, with the goal of optimizing energy consumption and reducing costs	CY1.1	Energy invoice reduction for consumers
Czech Republic	Personalised Tariff recommendation based on home appliances	1	This use-case determines which distribution tariff is the most suitable for the customer based on the appliances they reported through their connection agreement or via the form in the app, and which they actually use at home. The algorithm instantly selects the most advantageous distribution tariff based on the chosen appliances.	CZ1.1	Energy invoice reduction for consumers
Slovenia	Near real-time measurements with power limit notification	1	Users will have the option to configure a power limit notification. If the current power consumption exceeds the predefined threshold, the system will send an SMS or email alert, enabling users to take corrective action by reducing their power usage and thereby lowering their electricity costs	SI1.1	Energy invoice reduction for consumers
France	Near real-time measurements with power limit notification	3	Users are given real-time power consumption for their connected appliances, and general consumption. Users can schedule the consumption of their connected appliances, limiting consumption to when consumers need it. Users also have the option to configure a power limit notification. If the current power consumption exceeds the predefined threshold, the system will send an alert, enabling users to take corrective action by reducing their power usage Additionally, the DSR service can activate events on devices to reduce energy consumption, contributing to the balance of the electrical grid while generating savings for the user.	FR3.3	Energy invoice reduction for consumers

Table 5. Use cases in category "Energy invoice reduction for consumers".

Definition

This refers to increasing customer awareness of their energy usage patterns and the sources of their consumption. With this insight, customers can implement energy-saving measures, adopt more cost-effective tariffs, and monitor the energy market. By understanding when and how they consume energy, they are better equipped to reduce their bills by selecting optimal pricing schemes or responding to market signals.

Explanation

In this context, as in most customer-related matters, the economic aspect holds particular importance.

A common barrier to customer engagement is the lack of clarity regarding the financial benefits their actions can bring—both at an individual level and for the broader business or system. While social and environmental benefits are also significant, it is often the economic incentive that drives actual changes in consumer behavior. This is reflected in the first high-level use case: *"Personalized messages for consumer flexibility based on economic benefits"*, which specifically addresses this motivation.

When changes in consumption habits lead to noticeable reductions in electricity bills, it can serve as a catalyst for continued action. What begins as a new behavior can gradually become a lasting habit.

For this reason, business-oriented use cases have been included—to emphasize the economic dimension and assess how customers respond to opportunities for reducing their energy costs.

6.1.2. CARBON FOOTPRINT REDUCTION & CUSTOMER AWARENESS.

There are a total of 15 use cases from Austria, Croatia, Greece, Cyprus, Czech Republic, Romania, France and Slovenia which represent 27% of total use cases.

Country	Use case	HLUCs	Definition	Acronym	Category
Austria	Non-economic incentives	2	The use case uses EDDIE framework for Historical Validated Data and AIIDA for near real-time data access. The application facilitates consumption-related recommendations through integration with smart meters and home automation systems.	AT2.1	Carbon footprint reduction & customer awareness
Austria	Energy efficiency potential at aggregated level	3	The app generates personalized messages revealing individual and collective energy efficiency potential. By analysing aggregated consumption patterns from AIIDA and/or EDDIE, the	AT3.1	Carbon footprint reduction & customer awareness

			system/ESCO can provide targeted recommendations.		
Austria	Energy Awareness and Education	5	The app offers general tips and practical advice to help users improve their energy consumption habits. By leveraging AIIDA's near-real-time data and EDDIE's historical energy framework, the system delivers personalized, actionable recommendations for sustainable energy use.	AT5.1	Carbon footprint reduction & customer awareness
Croatia	RES Share Notification for Sustainable Energy Decisions	2	This use case involves notifying app users when the share of renewable energy generation exceeds a predefined threshold. Users can time their energy consumption to align with environmental sustainability goals. The app will provide users with personalized messages encouraging users to consume energy in a way that maximizes environmental benefits.	HR2.1	Carbon footprint reduction & customer awareness
Croatia	Environmental Awareness Notifications (General Information)	5	This use case delivers general, non-customized environmental information to users with a focus on the Croatian electricity grid and its renewable energy generation. The goal is to educate and engage users about sustainability in the context of Croatia's transmission network, promoting awareness of its energy sources and consumption patterns.	HR5.1	Carbon footprint reduction & customer awareness
Cyprus	Environmental awareness notifications for sustainable consumer behaviour	2	This use case delivers general, non-customized environmental information to users with the goal to educate and engage users about sustainable behaviour in the context of Cyprus's energy system,	CY2.1	Carbon footprint reduction & customer awareness
Cyprus	Customized energy efficiency tips for sustainable consumer behaviour	5	This use case focuses on delivering personalized energy efficiency tips to users. The system allows users to track their energy savings and adjust their behaviour for greater efficiency	CY5.1	Carbon footprint reduction & customer awareness
Czech Republic	Energy goals for sustainable energy use	2	This Use Case describes the implementation of a gamification feature within a mobile application designed to encourage users to adopt more sustainable energy consumption and production habits. The system provides users with various challenges.	CZ2.1	Carbon footprint reduction & customer awareness
Czech Republic	Energy tips for consumption reduction	5	This Use Case describes the implementation of a new section within a mobile application that provides users with simple and effective energy-saving tips. The system allows users to track their energy savings and adjust their behaviour for greater efficiency. Users can mark tips as completed and monitor their progress.	CZ5.2	Carbon footprint reduction & customer awareness
Romania	Follow_the_Sun	2	The use-case provides personalized messages to consumers regarding their potential CO2 footprint reduction by synchronizing shiftable loads with the high-RES production periods.	RO2.1	Carbon footprint reduction & customer awareness

Romania	Recommendation on Energy Management for Residential Buildings	5	Energy inefficiency can occur in student residences due to habits such as keeping unused appliances plugged in, heating systems used inefficiently, or leaving lights on in common areas. This use case aims to propose some useful tips and analyse the impact of their implementation on the power system. The tips will be addressed to both dormitory residents and building managers considering the identified behaviours and characteristics of consumption profiles over a longer period of time.	RO5.1	Carbon footprint reduction & customer awareness
Slovenia	Energy-Saving Tips	2	Based on the user's inputs, the new application will provide potential energy savings and personalized energy-saving tips.	SI2.1	Carbon footprint reduction & customer awareness
Greece	Tailored Energy Messages for Consumer Flexibility and Sustainability	3	This use case focuses on delivering personalized messages based on non-economic incentives. Using IoT data from residents' homes, the system generates customized messages that emphasize environmental impact, encouraging users to reduce energy consumption during peak times.	GR3.2	Carbon footprint reduction & customer awareness
France	Non-economic incentive	3	Consumers are being given the amount of C02 reduction that DSR events on their property has allowed them to provide to the power systems	FR3.4	Carbon footprint reduction & customer awareness
France	Energy Tips and goal	3	This feature integrates a section in the mobile application that combines personalized energy-saving tips with gamification elements. Users can set their energy consumption goals and visually track their progress through a system of green and red flags. The application provides practical and tailored advice to improve everyday energy efficiency, allowing users to measure the impact of their actions and adjust their behaviour based on the feedback received.	FR3.5	Carbon footprint reduction & customer awareness

Table 6. Use cases in the category "Carbon footprint reduction & customer awareness".

Definition

Use cases that aim to promote an ecological behaviour through generic or personalized messages that can drive to an eco-friendlier electricity utilization.

Explanation

The Environmental Awareness use case category encompasses scenarios where energy flexibility directly or indirectly contributes to environmental protection. This category highlights how the intelligent management of energy demand and supply can reduce the environmental impact of the energy system, promote more sustainable resource use, and support the integration of renewable energy sources.

Flexibility enables the adjustment of energy consumption to align with system conditions, shifting demand to periods when renewable generation (such as solar or wind) is abundant. This reduces reliance on fossil fuel-based generation, which is typically activated during peak demand or low renewable output. By minimizing the use of these polluting sources, greenhouse gas emissions and other air pollutants are significantly reduced, contributing to improved air quality and the achievement of European climate targets.

Moreover, flexibility can help avoid or defer investments in grid reinforcement infrastructure, which also has a positive environmental impact by reducing the ecological footprint associated with the construction and maintenance of new facilities. It also fosters greater public awareness and engagement in responsible energy use, empowering consumers to actively participate in the energy transition through informed consumption decisions.

In summary, the use cases grouped under the Environmental Awareness category demonstrate that flexibility is not only a technical tool for grid stability but also a key enabler of a cleaner, more resilient, and environmentally sustainable energy model.

6.1.3. ENHANCING QUALITY OF SUPPLY AND GRID RESILIENCE.

There are a total of 14 use cases from Austria, Bulgaria, Croatia, Greece, Czech Republic, Romania, Poland, France and Portugal which represent 25% of total use cases.

Country	Use case	HLUCs	Definition	Acronym	Category
Austria	Extreme Grid Situation Management	4	By leveraging AIIDA's near-real-time data access, the app provides immediate, actionable information during critical energy infrastructure scenarios, enabling rapid response and user awareness.	AT4.1	Enhancing quality of supply and grid resilience
Bulgaria	Energy consumption optimization tips - alert	4	The demo will provide the consumers with a mobile application (the same as UC BG 3.1), which will have separate sections (screen) informing them in real-time about the current grid status and appearance of contingencies, planned outages, and emergencies. Additionally, personalized alert notifications will be sent to certain consumers, who are in the areas with contingency, to support the grid by reducing their consumption.	BG4.1	Enhancing quality of supply and grid resilience

Croatia	Sandbox for Voluntary Participation in Energy Balancing Market	4	This use case focuses on a sandbox initiative enabling consumers and Balancing Service Providers (BSPs) to voluntarily participate in the energy balancing market. Participants can adjust their energy consumption in response to requests from the TSO during periods of grid imbalance. The system sends real-time alerts to consumers and BSPs.	HR4.1	Enhancing quality of supply and grid resilience
Croatia	Optimizing Energy Consumption for Grid Stability via Demand Response	4	This use case targets improving grid stability by encouraging consumers to adjust their energy usage, primarily through participation in demand response programs. The system monitors real-time grid data from TSO to assess grid conditions. When the grid is under stress, the app sends notifications to consumers.	HR4.2	Enhancing quality of supply and grid resilience
Croatia	Emergency Grid Overload Alerts	4	Provides real-time emergency alerts to consumers during instances of grid overload. By notifying users to decrease non-essential energy consumption during peak demand periods, the system helps balance the grid and avoids further strain on the infrastructure. The app uses real-time data from TSO and energy management platforms to send alerts to residential and commercial consumers. These alerts will include specific instructions.	HR4.3	Enhancing quality of supply and grid resilience
Croatia	Severe Weather and Emergency Response Alerts	4	This use case addresses severe weather conditions, such as heatwaves, storms, or snowstorms. The app provides real-time alerts to consumers, notifying them of the anticipated energy demand caused by severe weather and advising them to reduce energy usage or shift their consumption to help balance the grid.	HR4.4	Enhancing quality of supply and grid resilience
Croatia	Blackout and Critical Emergency Alerts	4	In this use case, the app provides alerts to consumers when the grid is at risk of a blackout or when a critical energy emergency occurs. This may involve turning off non-essential appliances, reducing heating or cooling use, or switching to backup power systems.	HR4.5	Enhancing quality of supply and grid resilience
Czech Republic	Notifications of power outages caused by natural disasters	4	This use-case will in case of extreme weather events notify customers about serious grid issues based on DSO/TSO information directly in the app via push notification. The user receives notifications about the occurrence, progress and termination of a fault at their point of consumption.	CZ4.1	Enhancing quality of supply and grid resilience
Romania	Help in preserving grid health (HGH)	4	Using input related to overload on transformer or general fuse and possible near-term disconnection to preserve grid against damage, users can voluntarily and temporarily reduce their consumption while further monitoring the evolution of the limitation means.	RO4.1	Enhancing quality of supply and grid resilience
Romania	Help in avoiding extreme grid situations (HAEGS)	4	Use Faculty of Energy Engineering to partially simulate in twin approach, extreme grid situations which are reported in the App to change user behaviour and potentially improve grid status based on DSO information.	RO4.2	Enhancing quality of supply and grid resilience
Poland	Demand side flexibility based on non-economic incentives in specific network situations	4	Standardized messages ('recommended use', 'normal use', 'recommended saving', and 'required curtailment') to specific zone customers to encourage them to reduce their consumption	PL4.1	Enhancing quality of supply and grid resilience

Greece	Risk Management and Operational Resilience in Distribution Systems	4	Implementing the demand-response mechanisms, designing effective incentives through feedback, and monitoring user response. The study also evaluates the short- and long-term impacts of this strategy on minimizing risks and improving network resilience.	GR4.1	Enhancing quality of supply and grid resilience
Portugal	Flexibility Services under Extreme Conditions	4	Upon an emergency request for participation, issued by a TSO, including expected power, time period of the need, deadline for participation and applicable geographical zone, consumers submit their response indicating the actions taken by them to adjust their consumption during the needed time period.	PT4.1	Enhancing quality of supply and grid resilience
France	Extreme Grids Situation Management	3	The App displays the French transmission system's daily constraints ('EcoWatt') forecast and alerts, as well as information on the ways to support the grid both at home and outside the home (at work, etc.)	FR3.6	Enhancing quality of supply and grid resilience

Table 7. Use cases in the category "Enhancing quality of supply and grid resilience."

Definition

Measures proposed to avoid shedding or blackouts in situations in which the network reaches, or is expected to reach, an operating state with values outside or close to the limit.

Explanation

Although the quality of supply is in general optimal, the present level should not be an excuse for not continuing to improve the service. Furthermore, with the electrification of the economy, the electric service will become a critical aspect for those activities that must be available 24 hours of every day of the year.

These business use cases will check how the quality can be improved thanks to minor behavioural customer changes. Customers will receive notifications when the grid approaches its operational limits, along with guidance on how their actions can contribute to maintaining grid stability.

6.1.4. OPTIMIZING HOME ENERGY USE THROUGH ENERGY ASSETS CONTROL.

There are a total of 7 use cases from Greece, Czech Republic, Poland and Slovenia which represent 13% of total use cases.

Country	Use case	HLUCs	Definition	Acronym	Category
Czech Republic	Consumption prediction	3	The app allows users to view energy consumption predictions based on historical data, meteorological conditions, and other relevant factors. Users can track consumption trends and optimize their energy needs. The system also includes notifications for unusual consumption fluctuations.	CZ3.1	Optimizing home energy use through energy assets control
Czech Republic	Advanced presentation of measured data	3	This use-case presents the consumption data, which will be comprehensive but easy to understand. Users will be able to track historical data, identify trends, which will help them better plan and optimize energy needs. For users with their own sources of energy production, it will enable monitoring of production and optimization of resources.	CZ3.2	Optimizing home energy use through energy assets control
Czech Republic	Consulting related to measured data	3	Implementation of an advisory system that provides customers with personalized energy-saving tips and predictions based on measured energy consumption and production data. The system delivers automated notifications, allowing users to optimize their energy consumption.	CZ3.3	Optimizing home energy use through energy assets control
Poland	Messages with general tips and guidance for energy efficiency and awareness rising	5	Predefined energy efficiency messages (PV, BESS, recommended inverter settings, obligation to report the increase in installation power capacity to the DSO, etc) to a specific group of customers.	PL5.1	Optimizing home energy use through energy assets control
Greece	Smart Energy Monitoring for Enhanced Consumer Control	1	This use case focuses on enabling residents to monitor and manage their energy consumption using the app. The solution integrates data from various energy loads, including PV production, HVAC systems, and Domestic Hot Water. It also supports personalized messaging based on economic benefits and energy efficiency guidance.	GR1.1	Optimizing home energy use through energy assets control
Greece	Personalized Energy Efficiency Tips for Homes with PV and Battery Systems	3	This use case aims to provide personalized messages to residents regarding energy efficiency, particularly for homes equipped with PV panels and domestic batteries. The system will generate tips on when to use stored energy, optimize self-consumption, and reduce dependency on the grid as well inform them of the energy that is already stored.	GR3.2	Optimizing home energy use through energy assets control
Slovenia	Advanced analytics of production and consumption data provision	3	The existing Moj Elektro portal currently provides electricity distribution grid users with information only about their past energy usage. To support users in managing their consumption more effectively, a new app will be introduced to view and export 15-min measurements, historical billing data and predicted consumption/generation.	SI3.1	Optimizing home energy use through energy assets control

Table 8. Use cases in the category "Management of consumption and generation".

Definition

Based on historical data, these use cases provide a way of utilizing house assets to optimize energy consumption.

Explanation

Smart meters and IoT devices (e.g. Non-Intrusive Load Monitoring (NILM) devices) provide disaggregated information to understand the aggregated consumption of the customer and the use of each of the connected device's hour by hour. This can be used to extrapolate their behaviour in the past to different future periods, which allows planning and adapting consumption based on different parameters (temperature, weekends, etc.), respecting customer wishes. Minor changes (buying an intelligent socket or using the washing machine during off-peak hours) can contribute to an improved energy management. On the other hand, customers that have PV generation or their own batteries can manage the whole installation in a better way to extrapolate stored data.

6.1.5. PARTICIPATION IN FLEXIBILITY ENERGY MARKETS.

There are a total of 8 use cases from Portugal, France and Sweden which represent 14% of total use cases.

Country	Use case	HLUCs	Definition	Acronym	Category
France	Non-economically driven consumer flexibility participation in system services	3	Physical and simulated sues in France, Estonia, Finland, Denmark and Belgium are integrated into DSR programs and are rewarded through energy savings, which volumes are displayed on the App	FR3.1	Participation in flexibility energy markets
France	Increasing flexibility potential of buildings' distributed energy resources (DER) through explicit and implicit demand response	3	Increasing flexibility potential of buildings distributed energy resources (DER) through explicit and implicit demand response in selected France and Estonian sites: integration of residential energy management technologies combining explicit and implicit flexibility for either physical or simulated sites including electrification of transport, using Voltalis technology, the Voltalis cloud platform, Dcbel's Home Energy Station and the D'G insights platform.	FR3.2	Participation in flexibility energy markets

Portugal	Economically driven consumer flexibility participation in system services	1	TSO and DSO flexibility requests to grid customers to participate. Consumers submit their available flexibility in terms of power by selecting the household appliances they commit to disconnect during the needed time period. The data submitted by the consumer will be the following: provided power and required price	PT1.1	Participation in flexibility energy markets
Portugal	Non-economically driven consumer flexibility participation in system services	2	Clients submit flexibility bids, which are evaluated based on grid needs and specific criteria while receiving a given compensation for their contributions.	PT2.1	Participation in flexibility energy markets
Sweden	Extended flexibility services for households	1	This use case focuses on the household batteries aggregation service to offer balancing to the grid but also to DSO for local flexibility markets.	SW1.1	Participation in flexibility energy markets
Sweden	Service stacking	1	This use case is focused on providing two different types of flex services, DSO service such as local flex and TSO service. The combination of these services is also known as service stacking.	SW1.2	Participation in flexibility energy markets
Sweden	Introduce behind the meter services	3	This use case focuses on introducing behind the meter services such as Peak shaving, Energy Arbitrage and Self consumption to customers. Data will be shown to customer in a user-friendly way.	SW 3.1	Participation in flexibility energy markets
Sweden	Combine flex-services with behind the meter services	4	The objective with this use case is to combine all different type of services and present it to the user.	SW 4.1	Participation in flexibility energy markets

Table 9. Use cases in the category "Participation in flexibility energy markets".

Definition

Aggregators, TSO and DSO send flexibility proposals to participate in customer flexibility markets, that must previously identify which assets they could manage.

Explanation

In countries where flexibility is sufficiently widespread, well-understood competition, such as participating in markets for different DSO needs, can be a good option to optimize costs and encourage customer participation. The project will test different options to test customer response, contribution to grid stability and energy consumption optimization. The following topics will be covered:

- What tools will be used (APPs).
- What will be the data flow and what systems will be involved.
- What behavioural changes will the client have to make to provide the service.
- What will be the level of participation (engagement).

6.1.6. SMART CHARGING OF EVS.

There are a total of 4 use cases from Spain which represent 8% of total use cases.

Country	Use case	HLUCs	Definition	Acronym	Category
Spain	Smart EV Charging in Overdemand Grid Status	4	In this use case, the smart charging of electric vehicles is proposed in a station where the massive arrival of vehicles causes a specific problem in the electrical grid (either due to high load on the line or overvoltage)	ES4.1	Smart charging of EVs for grid support
Spain	Smart EV Residential Charging (I)	1	The use case consists of the residential smart charging of EVs due to an electrical congestion in a neighbourhood (either due to high load on the line or overvoltage).	ES1.1	Smart charging of EVs for grid support
Spain	Smart EV Residential Charging (II)	2	In this use case, the objective is to reduce the CO2 footprint from residential EV charging throughout the adoption of specific charging sessions that minimize CO2 emissions. This will consider the emissions of the national electricity system and propose the customer charges the electric vehicle according to a certain pattern without necessarily implying an economic benefit.	ES2.1	Smart charging of EVs for grid support
Spain	Smart EV Charging in Private Companies	4	The main differentiator of this case is how to handle the recharging of multiple company vehicles when the charging requests or needs exceed the capacity of the charging station	ES4.2	Smart charging of EVs for grid support

Table 10. Use cases in the category "Smart charging of EVs".

Definition

Use cases focused on managing the charge of electric vehicles considering the state of the grid and the type of EV customer (residential, on-route charging, private companies, etc.).

Explanation

The increased use of electric vehicles in our lives, far from being a challenge, has become an opportunity to improve the flexibility of the grid thanks to smart charging. Currently, apart from the differences between countries, new BEV or PHEV vehicles reached approximately 13% of total vehicle sales in Europe by 2024. Pure electric vehicles were the third most popular purchase option, while plug-in hybrids were in fifth place. Some strategies for smart charging can be reduce, delay or suspend the charge; charge the VE at a reduced power, V2G possibilities, etc. Due to the size of vehicle batteries, the reason for choosing this kind of vehicles is that they can be a great contributor to flexibility.

6.2. ENERGY INVOICE REDUCTION FOR CONSUMERS

BG 3.1. ENERGY EFFICIENCY POTENTIAL.

Scope and objectives

Residential and commercial (small business) consumers, looking to reduce energy costs.

TSO, seeking to balance the grid through consumer-side consumption optimization.

The Objectives are the following:

- Optimize Energy Consumption – Enable consumers to shift energy usage to lower-cost periods, reducing their overall electricity bills.
- Improve Consumer Awareness – Provide real-time insights that help users make informed decisions about their energy usage.

Narrative of the use case

The demo will provide for the consumers a mobile application, which will inform in real time for the current generation, load and prices of the energy and estimated imbalance prices and the status of the grid – contingencies, planned outages and emergencies. It will give general advice to all customers about energy consumption optimization, based on energy prices. The consumers who have their own generation and/or energy storage systems (prosumers) or EVs may receive personalized advice for charging and discharging.

Diagram of the use case

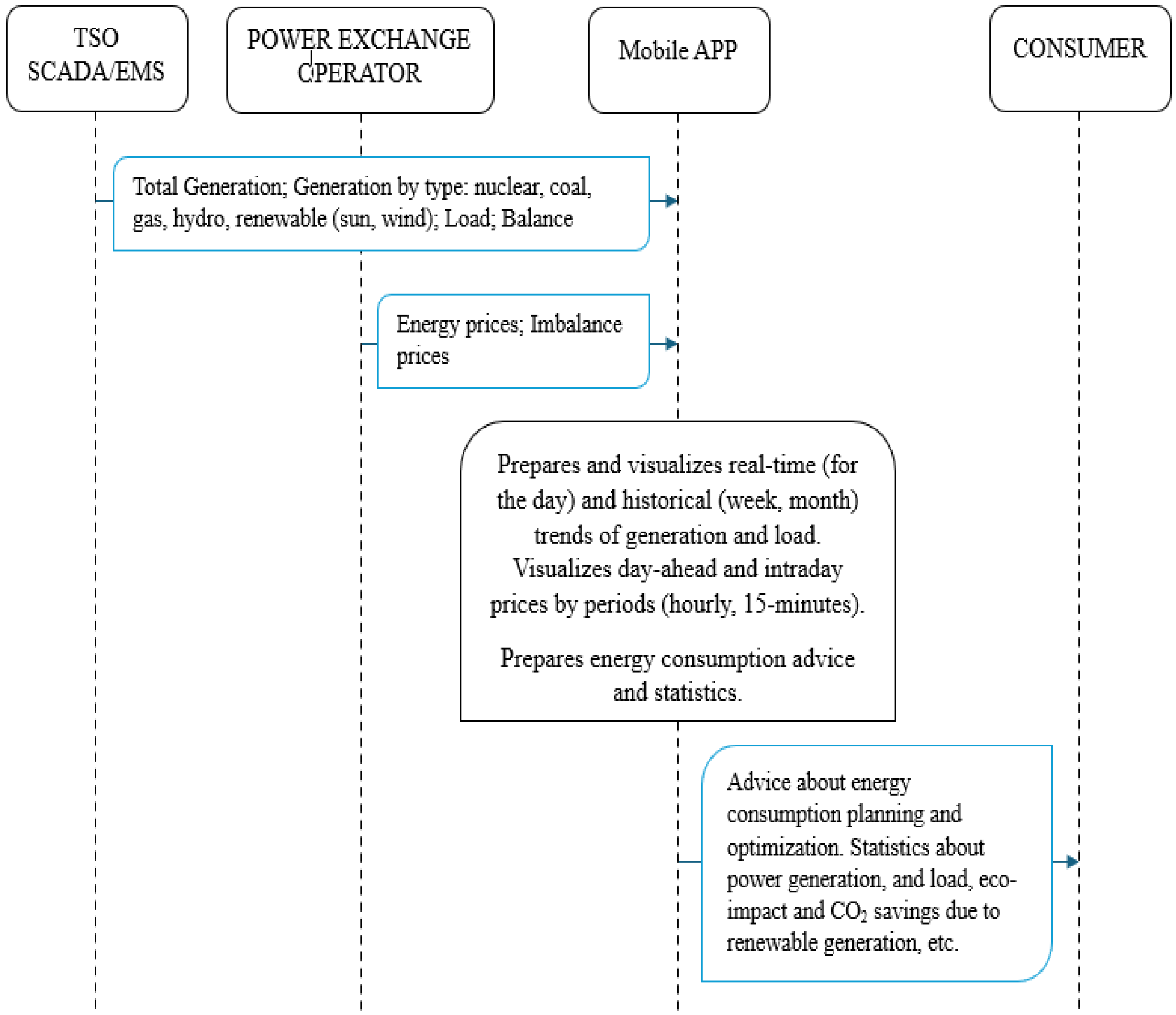


Figure 4. BG 3.1 diagram.

Actors of the use case

- Transmission system operator.
- Consumers.

Scenarios

Main path

Basic path					
Step no.	**Event**	**Description of process**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Consumer installs the energy app and registers his/her profile	Retrieve consumers personal data	Username, contact info, location across the country, consumer/prosumer, does he/she own/manage an electricity storage system, etc.	Consumers	Energy app
2	Normal daily operation: data input	TSO sends to the app data about energy and imbalance prices and generation by types	Electricity market: day-ahead and intraday prices for each trading period. Balancing market: prices of balancing energy for both directions (rise and lower) for each period of the day. Generation and load of the power system.	Market platforms and TSO.	Energy app
3	Normal daily operation: data output	Mobile energy app prepare visualizations and advices for the consumers, based on the input	Generation (total and by type) and load, eco-impact of the renewables. Energy and imbalance prices for all periods of the day. Advice for energy consumption according to the prices – best and worst periods, shifting strategies.	Energy app	Consumers

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Missing input data from TSO	The input data, sent to the mobile energy app is missing. The app indicates the missing data and gives links to the alternative sources – webpages of the market platfom or TSO.	Energy and imbalance prices, generation and load of the power system.	Market platforms, TSO	Energy app Consumers

AT 1.1. PERSONALISED MESSAGES FOR CONSUMER FLEXIBILITY BASED ON ECONOMIC BENEFITS

Scope and objectives

The scope is to encompass all stages through which the end-customer app (developed under the ECLIPSE project) collects historical and real-time data, generates cost-saving and load-shifting recommendations, and enables the user to accept or reject them. The objectives are the following:

- Provide financial advice to residential customers looking to reduce the cost of energy.
- Provide infrastructure to Energy Service Companies (ESCOs) which would like to perform a flexibility analysis and recommend economic opportunities.

Narrative of the use case

The End Customer App is designed to provide economic advantages to end users through optimized energy management. It leverages the EDDIE framework for Historical Validated Data and AIIDA for near real-time data access. The application facilitates consumption-related recommendations, allowing users to capitalize on off-peak electricity rates and reduce overall costs. Through integration with smart meters and home automation systems, the app empowers customers to make informed decisions and achieve financial savings.

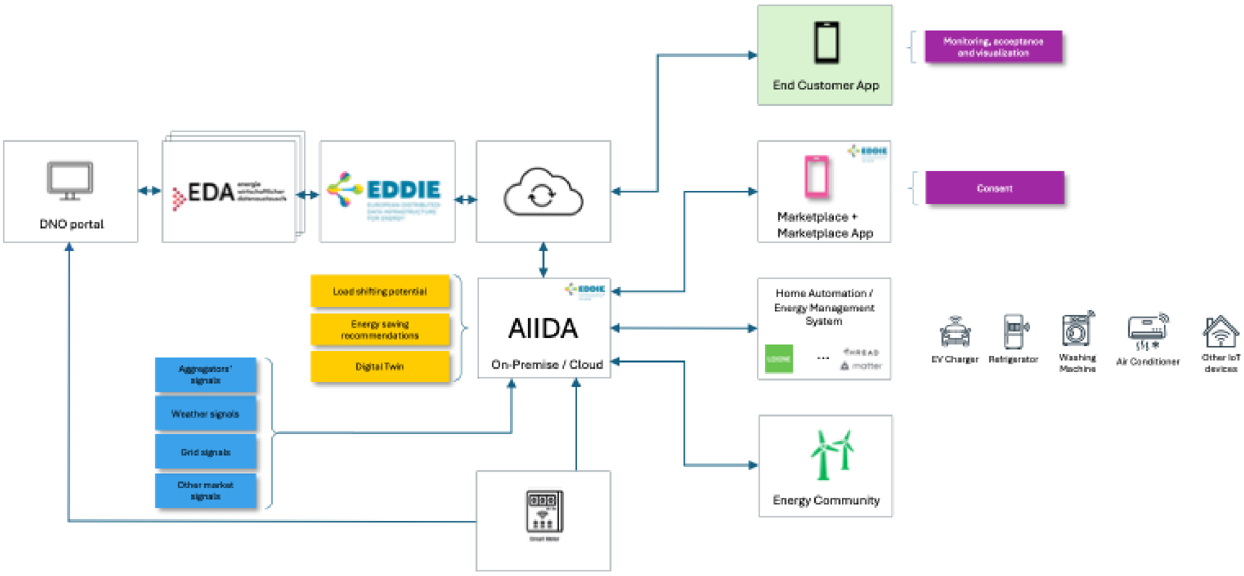


Figure 5. AT 1.1 diagram.

The End Customer App is a comprehensive energy management solution that integrates various data sources and smart home technologies. Its key features include:

- Visualization: Provides graphical representations of energy usage and other relevant data.
- Monitoring: Allows users to track their energy consumption in real-time.
- Acceptance: refers to user consent for data sharing or acceptance of recommendations.
- Load shifting potential: Suggests optimal times to use energy-intensive appliances.
- Energy saving recommendations: Offers personalized tips to reduce energy consumption.
- Digital twin: Creates a virtual model of the user's energy ecosystem for analysis and optimization.

Diagram of the use case

The app leverages both historical and real-time data, connecting to smart meters, home automation devices, and energy communities. It aims to empower end users with tools for more efficient energy management and conservation.

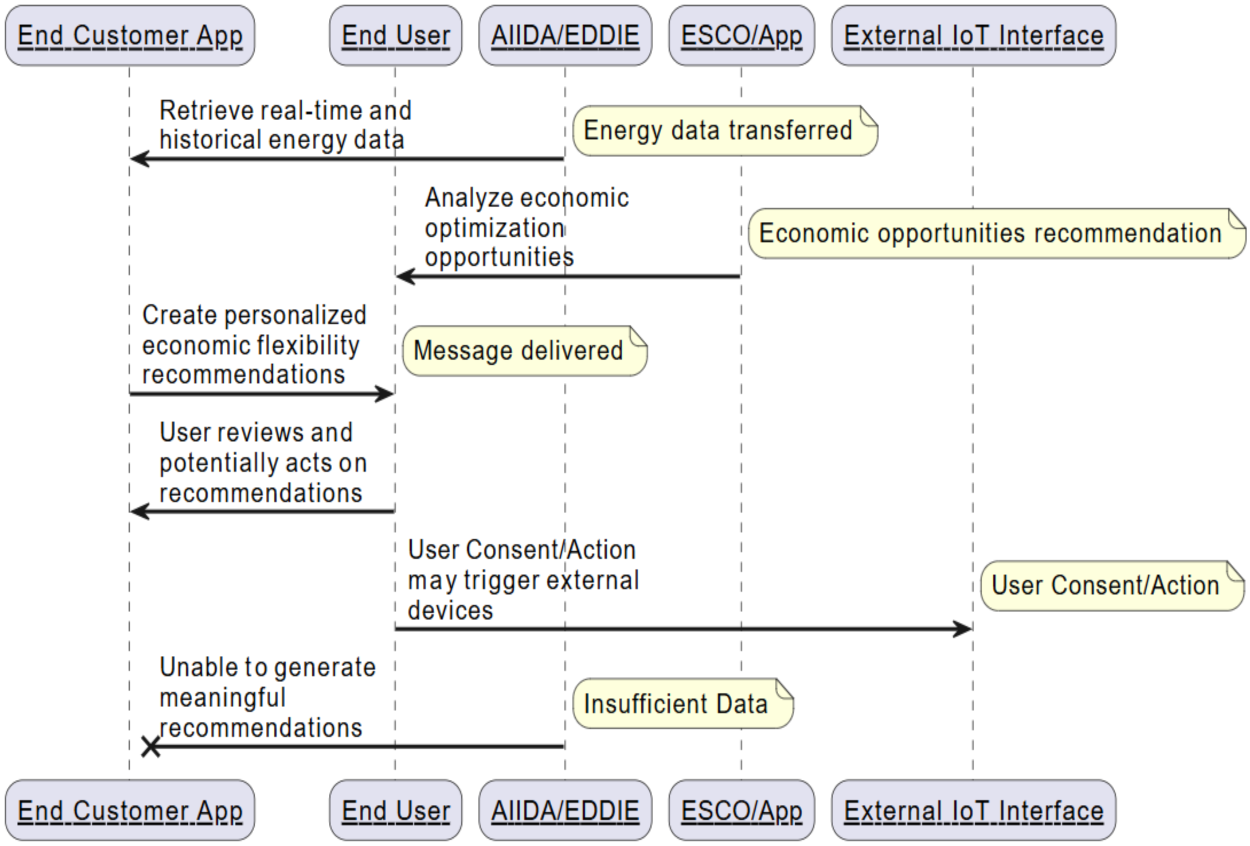


Figure 6. AT 1.1 diagram.

Actors of the use case

- Consumer: End users interacting with the application.
- EDDIE: Facilitates access to historical and real-time energy data.
- Energy Service Company (ESCO): Provides energy-saving insights.
- Aggregator: Manages energy resource optimization.
- DSO (Distribution System Operator): Ensures grid reliability and data exchange.
- MDA (Meter Data Administrator)/National Data Hub: Provides historical data to EDDIE.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data Collection	Retrieve real-time and historical energy data	Energy data	AIIDA, EDDIE	End Customer App
2	Flexibility Analysis	Analyze economic optimization opportunities	Economic opportunities recommendation	ESCO/App	End user
3	Message Generation	Create personalized economic flexibility recommendations	Message	End Customer App	End user
4	User Interaction	User reviews and potentially acts on recommendations	User Consent/Action	End User	End Customer App/ External IoT interface

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Insufficient Data	Unable to generate meaningful recommendations	-	-	-

HR 1.1. TAILORED NOTIFICATIONS FOR COST-EFFECTIVE ENERGY CONSUMPTION.

Scope and objectives

Scope:

- Residential and commercial consumers looking to reduce energy costs
- Energy managers and suppliers who optimize demand response strategies
- TSOs seeking to balance the grid through consumer-side adjustments

Objectives:

- Optimize Energy Consumption – Enable consumers to shift energy usage to lower-cost periods, reducing their overall electricity bills.
- Improve Consumer Awareness – Provide real-time insights that help users make informed decisions about their energy usage.
- Reduce energy consumption during price surges to promote efficiency and sustainability.
- Support Market Efficiency – Facilitate better energy management for suppliers and intermediaries, improving overall market operations.

Narrative of the use case

This use case focuses on delivering real-time, personalized notifications to consumers and intermediaries (such as energy managers or suppliers) based on economic factors, with the goal of optimizing energy consumption and reducing costs. The system uses data from the Transmission System Operator (TSO) to track energy pricing and grid conditions, offering consumers actionable insights to adjust their energy usage. For example, consumers may be notified to shift their energy consumption to off-peak hours when energy prices are lower, or they may receive alerts about upcoming price surges that encourage immediate reduction in energy usage. Economic interest for HOPS is balancing.

By delivering these tailored messages, the system empowers users to make informed decisions about when to use energy, contributing to overall cost savings. The use case's focus is on the economic interest of consumers, guiding them to reduce their energy bills while also helping the grid avoid overloading during peak demand periods. As a result, both residential and commercial consumers benefit from the insights provided, optimizing their energy behaviour and reducing unnecessary costs.

Diagram of the use case

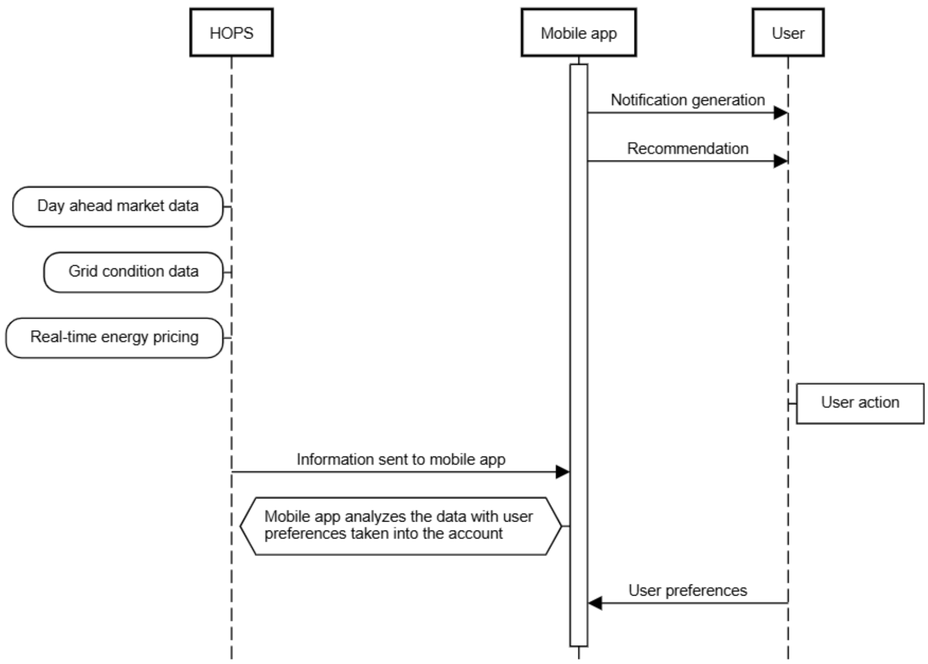


Figure 7. HR 1.1 diagram.

- The app integrates data from the TSO, such as real-time grid conditions and energy pricing.
- Data analysis in the context of user consumption patterns to generate personalized insights, focusing on when energy consumption is most cost-effective.
- Personalized messages with economic advice: "Shift usage to off-peak hours to save costs" or "Upcoming price surge, reduce energy use now." or "Provide voluntary bid for balancing".

Actors of the use case

- Consumers (Residential and Commercial Users).
- Transmission System Operator (TSO).
- Energy Suppliers.

- Data Analysts.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Real-time grid data collection	The Transmission System Operator (TSO) collects and shares real-time energy pricing and grid condition data.	Real-time grid data (pricing, demand, grid status)	TSO	App Backend
2	Data analysis	The app backend analyses the grid data along with user preferences and consumption patterns to determine optimal usage times.	Analysed data (pricing trends, user behaviour insights)	App Backend	App Backend
3	Notification generation	Personalized notifications are created based on the analysed data, detailing recommendations for cost-effective energy usage.	Tailored notification (e.g., pricing changes, consumption advice)	App Backend	Mobile App (User)
4	Notification received	Consumers receive the notifications on their devices, guiding them to take action to optimize energy consumption.	Notification message, pricing updates, usage suggestions	Mobile App (User)	User (End User)
5	Consumer action	Users act on the notifications, such as shifting energy	Modified energy	User (End User)	App Backend

		usage to off-peak hours or reducing energy-intensive tasks.	consumption behaviour		
6	Outcome observed	The app tracks the results, such as reduced peak demand and user cost savings, and reports data back to the system.	Energy consumption data, cost reduction data	App Backend	TSO, Energy Suppliers

Exception path

Exception paths					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Grid data failure or inaccuracy	The grid data provided by the TSO is delayed, missing, or inaccurate, affecting analysis quality.	Error message, incomplete or incorrect data	TSO	App Backend
2	User disengagement	Some users do not engage with the notifications, choosing not to act on the recommendations provided by the app.	Notification ignored or dismissed	User (End User)	App Backend
3	Ineffective recommendations	Due to data inaccuracies or misanalysis, the notifications fail to produce significant	Feedback or lack of desired action	User (End User)	App Backend

		cost savings or behaviour changes.			
4	Privacy concerns raised	Users may opt out of the system due to concerns about sharing their consumption data or personal preferences.	User opt-out data	User (End User)	App Backend
5	Reduced effectiveness	Without user engagement or accurate data, the system cannot achieve its goals of optimizing grid balance or reducing costs.	Feedback or reduced adoption metrics	App Backend	TSO, Energy Suppliers

HR 1.2. SANDBOX TARIFF PROGRAM FOR ACTIVE ENERGY ENGAGEMENT.

Scope and objectives

Scope:

- Regulatory sandbox for testing dynamic energy tariffs that incentivize users to optimize their consumption.
- Real-time energy usage recommendations delivered via mobile and web applications, based on grid and pricing data.
- User participation in tariff experiments, such as time-of-use pricing and rebate programs, to evaluate demand-side flexibility.

Objectives:

- Encourage user engagement in energy-saving strategies through financial incentives.

- Optimize grid stability by shifting consumption away from peak demand periods.
- Evaluate the effectiveness of dynamic tariffs in shaping consumer behaviour.
- Reduce overall energy costs for users by aligning consumption with lower-priced periods.
- Provide data-driven insights for future regulatory policies on flexible energy pricing.

Narrative of the use case

This use case explores a regulatory sandbox aimed at incentivizing users to actively engage with energy-saving recommendations by offering them tailored tariff savings. Users are notified through a mobile or web app about optimal times for energy usage, leveraging real-time grid and pricing data.

The sandbox initiative rewards participants who modify their energy behaviour based on recommendations with dynamic tariffs, such as time-of-use pricing models or rebate programs. These participants can test innovative tariff structures designed to promote grid stability and energy efficiency while reducing their bills. The goal is to encourage demand-side flexibility by fostering user engagement in grid optimization strategies.

Participants' consumption patterns, grid demand, and energy pricing are analysed to generate actionable insights. By acting on these insights, users reduce energy costs while contributing to smoother grid operations. The sandbox also serves as a testing ground for evaluating how dynamic tariffs can impact energy usage behaviour, shaping future regulatory decisions.

Diagram of the use case

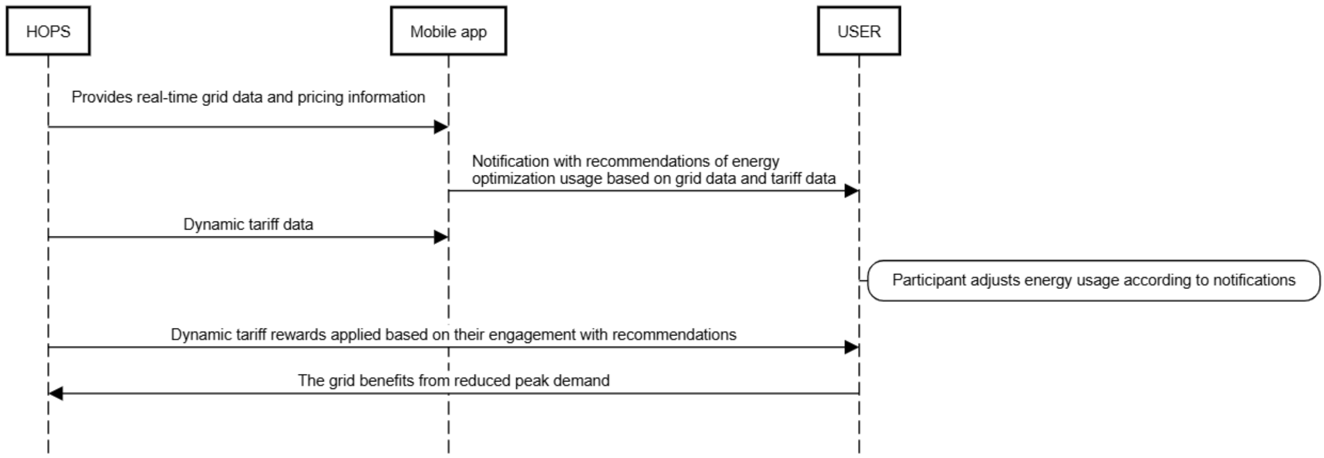


Figure 8. HR 1.2 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- Transmission System Operator (TSO).
- Energy Suppliers.
- Regulatory Authorities.
- Data Analysts.
- App Developers.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Real-time grid data provided	The Transmission System Operator (TSO) provides real-time grid data, including pricing, demand, and	Real-time grid data (pricing, demand, renewables share)	TSO	App Backend

		renewable energy availability.			
2	Data analysis performed	The app backend analyses the grid data and participant consumption patterns to generate actionable recommendations.	Consumption patterns, pricing trends, and recommendations	App Backend	App Backend
3	Notification generated	Personalized notifications are sent to participants with recommendations on when to optimize energy use and potential tariff savings.	Notification message with time-specific advice	App Backend	Mobile/Web App
4	User engagement	Participants adjust energy usage according to the notifications (e.g., delaying high-energy tasks to off-peak times).	Modified consumption behaviour	User (Participant)	App Backend
5	Tariff savings applied	The system tracks user behaviour and applies dynamic tariff rewards based on their engagement with recommendations.	Reward and cost adjustment data	App Backend	TSO, Energy Suppliers
6	Outcome observed	The grid benefits from reduced peak demand, participants save on energy costs, and the sandbox collects data to evaluate tariff effectiveness.	Post-engagement data (grid demand, user savings)	App Backend	TSO, Regulatory Authorities

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Data delay or inaccuracy	The TSO provides delayed or inaccurate grid data, leading to suboptimal recommendations.	Error message or incomplete grid data	TSO	App Backend
2	User disengagement	Participants may ignore notifications or fail to adjust their energy usage as recommended.	Notification dismissed	User (Participant)	App Backend
3	Limited behaviour change	User behaviour remains unchanged, resulting in missed tariff savings and limited grid optimization.	Lack of behavioural data	User (Participant)	App Backend
4	Privacy concerns raised	Some participants opt out of the sandbox due to concerns over sharing consumption or preference data.	User opt-out data	User (Participant)	App Backend
5	Reduced sandbox effectiveness	With limited participation or engagement, the sandbox program cannot fully evaluate the impact of dynamic tariffs.	Reduced engagement and adoption metrics	App Backend	Regulatory Authorities, TSO

CY 1.1. CONSUMER NOTIFICATIONS FOR COST-EFFECTIVE ENERGY CONSUMPTION.

Scope and objectives

- Residential and commercial consumers optimize their energy behaviour based on the insights provided.
- Consumers to reduce their energy bills during peak demand/high price periods by adjusting accordingly their consumption.

Narrative of the use case

The selected pilot site region is the wider Nicosia Region. The area has mainly residential and commercial loads, and to a lesser extent industrial loads. The demand of the area is ~ 35-40% of total demand of Cyprus.

This use case focuses on delivering real-time, personalized notifications to consumers based on economic factors, with the goal of optimizing energy consumption and reducing costs. The system uses data from the Transmission System Operator (TSO) to track energy pricing and grid conditions, offering consumers actionable insights to adjust their energy usage. In Cyprus, there is not a fully deployed electricity market, so electricity tariffs are flat for one month/two months period.

By delivering these tailored messages, the system empowers users to make informed decisions about when to use energy, contributing to overall cost savings. The use case's focus is on the economic interest of consumers, guiding them to reduce their energy bills during peak demand/high price periods, and negative/low price periods, adjusting accordingly their consumption. As a result, both residential and commercial consumers benefit from the insights provided, optimizing their energy behaviour and reducing unnecessary costs.

Diagram of the use case

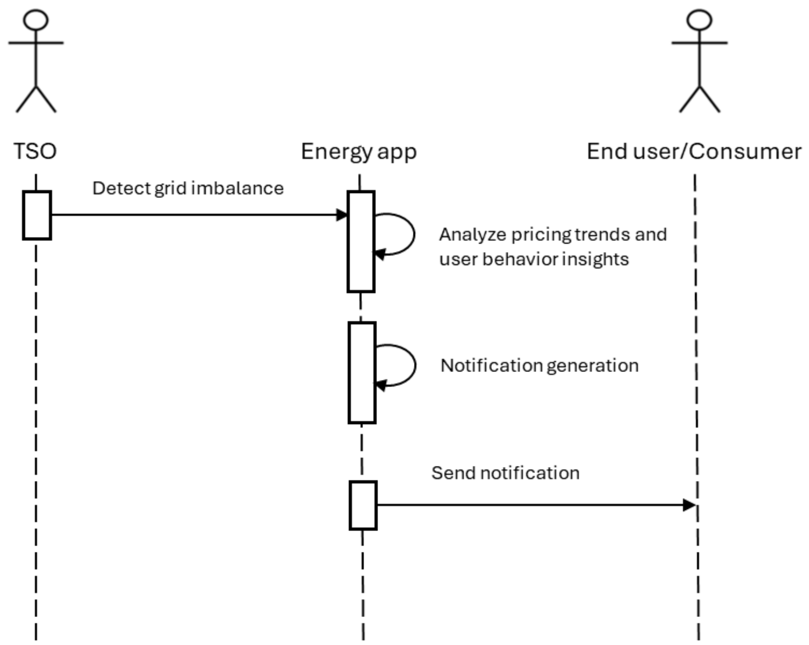


Figure 9. CY 1.1 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- Transmission System Operator (TSO).
- Energy Suppliers.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid problem detected	A change in energy pricing is detected by the TSO.	grid data	TSO	Energy supplier
2	Data analysis	The app backend analyzes the grid and market data along with user preferences and consumption patterns to determine optimal usage times.	Analyzed data (pricing trends, user behavior insights)	App Backend	App Backend
3	Notification generation	Personalized notifications are created based on the analyzed data, detailing recommendations for cost-effective energy usage.	Notification	App Backend	Mobile App (User)
4	Notification received	Personalized notifications are sent to consumers.	Notification	Mobile App (User)	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Grid data failure or inaccuracy	The grid data provided by the TSO and/or market is delayed, missing, or inaccurate, affecting analysis quality.	Error message, incomplete or incorrect data	TSO	App Backend
2	User disengagement	Some users do not engage with the notifications, choosing not to act on the recommendations provided by the app.	Notification ignored or dismissed	User (End User)	App Backend
3	Ineffective recommendations	Due to data inaccuracies or misanalysis, the notifications fail to produce significant cost savings or behavior changes.	Feedback or lack of desired action	User (End User)	App Backend
4	Privacy concerns raised	Users may opt out of the system due to concerns about sharing their consumption data or personal preferences.	User opt-out data	User (End User)	App Backend

CZ 1.1. PERSONALISED TARIFF RECOMMENDATION BASED ON HOME APPLIANCES.

Scope and objectives

The scope is to determine the best fitting distribution tariff (out from many options) based on home appliances and additional information from the user.
The objective is to provide customers with instructive form which will be easy to complete and instantly propose the best option.

Narrative of the use case

Current Customer mobile app called “Proud” (Czech word for electric current) contains multiple functionalities (www.cezdistribuce.cz/cs/proud) such as visualization of consumption data, outages and failures, self-readings of the meter, notifications, reporting, contacts, generator connection online check. The goal of all UCs is to bring new features based on CERF which would visualize metering data and help customers to monitor their electricity consumption.

This use-case determines which distribution tariff is most suitable for the customer based on the appliances they reported through their connection agreement or via the form in the app, and which they use at home. A user-friendly interface for selecting the appliances that users have at home. The algorithm instantly selects the most advantageous distribution tariff based on the chosen appliances. The user will be notified of the option to change their distribution tariff, along with information about potential savings. Functionality would enable customers to easily add, change, update information about electricity devices behind the supply point (heating, generator, EV, electronics, white goods, air conditioning, heat recovery ventilation, pool technology etc.). Also, basic dimensions, size, type of the apartment, house, etc. could be filled in. The user is prompted to update their appliances regularly (e.g. every 3 years).

Diagram of the use case

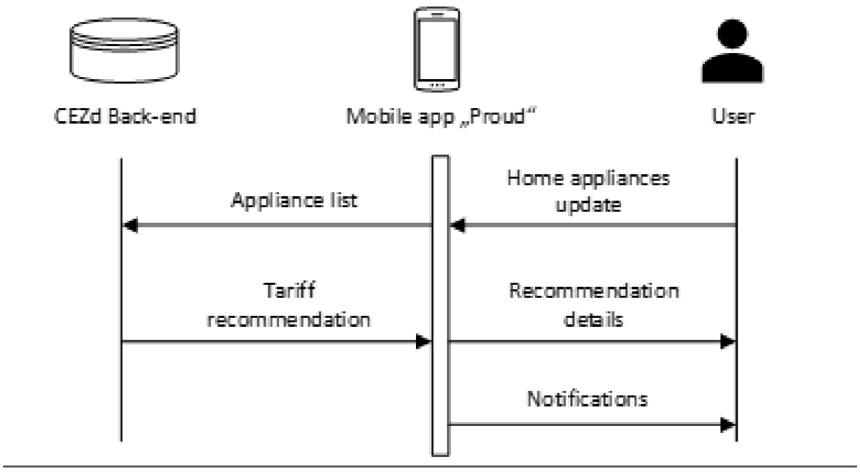


Figure 10. CZ 1.1 diagram.

Actors of the use case

- Mobile application user.
- Energy data provider (DSO)
- System administrator.
- Tariff recommendation functionality.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App opened	The user opens the mobile application and navigates to the appliance section	User request	User	Mobile application
2	List displayed	The system displays the current list of selected appliances and available options	Appliance data	Mobile application	User
3	Appliance modified	The user selects or modifies their appliances	Updated appliance selection	User	Mobile application
4	Optimal tariff calculation	The system calculates the optimal tariff based on the selected appliances	Tariff calculation results	Tariff recommendation system	Mobile application
5	Optimal tariff displayed	The system displays the recommended tariff and potential savings	Recommendation details	Mobile application	User
6	Details displayed	The user can view more details and instructions for applying the tariff	Tariff application steps	Mobile application	User
7	Reminder notification	The system reminds the user to review their appliance selection periodically	Notification alert	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Data unavailable	If tariff data is unavailable, the system notifies the user	Error message	Mobile application	User
2	Tariff optimal	If the user already has the optimal tariff, a notification is displayed	Information message	Mobile application	User
3	Calculation failed	If calculation fails, the system provides default advisory insights	Default advisory insights	Tariff recommendation system	Mobile application

SI 1.1. NEAR REAL-TIME MEASUREMENTS WITH POWER LIMIT NOTIFICATION.

Scope and objectives

The existing Moj Elektro portal currently provides electricity distribution grid users with information about their past energy usage at 15-minute intervals, available for the previous day (day -1).

The newly developed application will be capable of displaying 1-minute interval measurements in near real-time (reflecting the previous minute), provided that the meter supports the transmission of 1-minute data.

Users will have the option to configure a power limit notification. If the current power consumption exceeds the predefined threshold, the system will send an SMS or email alert, enabling users to take corrective action by reducing their power usage and thereby lowering their electricity costs.

Narrative of the use case

Modern smart meters have the capability to transmit measurements in near real-time, meaning the meter sends data for the previous minute every 60 seconds. This functionality enables users to configure power limit notifications within the newly developed application.

As of October 2024, a new network usage tariff scheme has been introduced, featuring five distinct daily tariff periods. This revised scheme also includes monthly peak power measurements. If a user's actual peak power exceeds the declared value, a penalty is applied for the difference. The newly developed application allows users to simulate and recalculate network usage costs based on changes to peak power across different tariffs or shifts in energy consumption within those tariffs.

Users can configure power limit notifications, whereby they receive an SMS or email alert if the current power exceeds a predefined limit. If the 1-minute active power measurement surpasses this threshold, the application will send an immediate notification. In this way, users receive near real-time information about increased power usage. Since the billing period for power is 15 minutes, the consumer still has time to reduce their power usage before the end of the current interval, potentially resulting in savings on their electricity bill.

Diagram of the use case

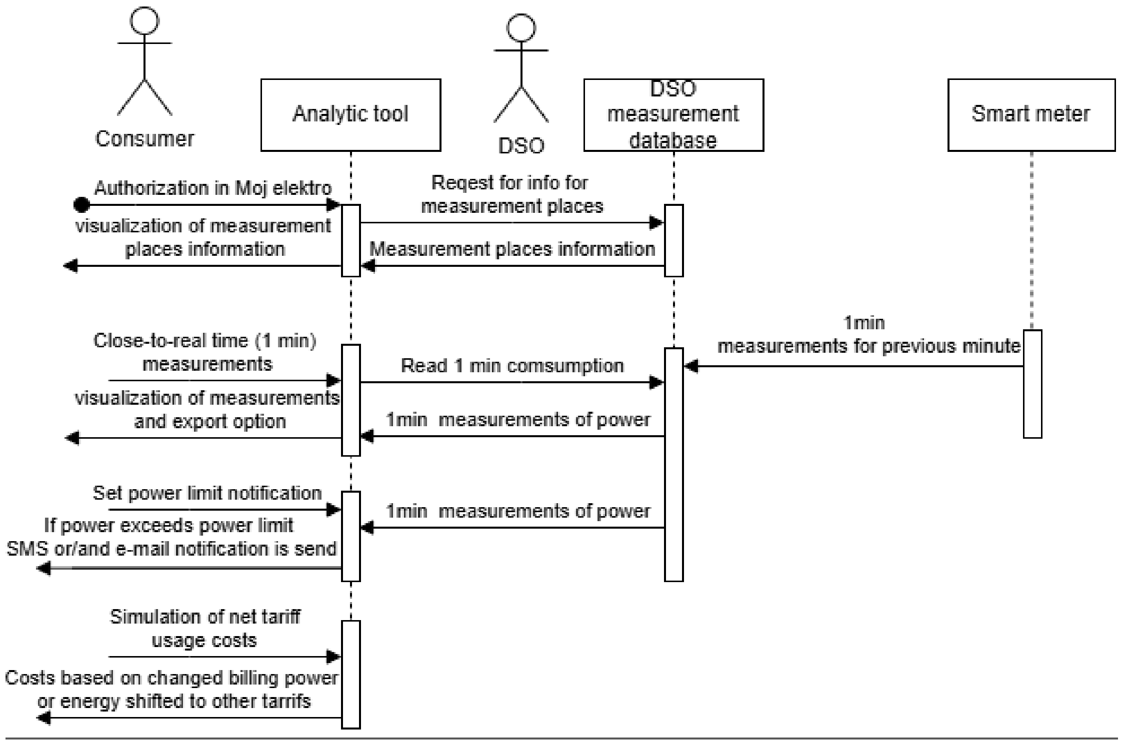


Figure 11. SI 1.1 diagram.

The user logs into the Moj Elektro portal using two-step verification of their electronic identity and unified registration and authentication via the Rekono application. The system also facilitates autonomous management of authorizations and user rights and is composed of several key components.

Once logged in, the user selects a measurement point. Within the newly developed application, the user can then view near real-time measurements. Every minute, the smart meter transmits data to the DSO's measurement database. The application retrieves this data from the database and visualizes the 1-minute measurements for the user. Users are also able to set a power limit. If the real-time measurement surpasses the defined limit, the application sends an SMS or email notification.

The newly developed application also enables the simulation of network tariff usage costs. The user can input arbitrary quantities of energy and power across different tariffs, and the application will return updated calculations. This allows the user to observe the impact on their electricity bill when consumption patterns are adjusted.

Actors of the use case

- Mobile application user.
- Energy data provider (DSO).
- System administrator.

Scenarios

Main path

Grid users are invited to start using the application by signing in at MOJ ELEKTRO. To a signed user one or more metering points or grid connection points can be addressed. The main provider of all information and data is the local electricity distribution company, DSO. The main source of the close to real time and historical grid user consumption data is the DSO's metering values database. This data will be processed by the analytic tool, offering grid users a complete data provision and analytics service.

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Logging to Moj elektro portal	User logs to Moj elektro portal and opens new developed application	User's credentials with two-step verification	User	Moj elektro and new developed app
2	Data Collection	Retrieve real-time 1-minute measurements	Energy data	DSO	App
3	Message generation	User receives an information, as an awareness, that there is a possibly, that the declared peak power will be exceeded	Real time data	DSO	App
4	Net usage costs analysis	Declared Peak power optimization	Change of the peak power, existing peak power	DSO	App

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Smart meter is not capable to provide the data	Unable to generate complete information			

FR 3.3 NEAR REAL-TIME MEASUREMENTS WITH THRESHOLD NOTIFICATION

Scope and objectives

Residential consumers looking to monitor and reduce their energy consumption in real-time. The objectives are the following:

- Provide Near Real-Time Monitoring – Give users real-time power consumption data for their connected appliances and general consumption.
- Enable Power Consumption Management – Allow users to schedule the consumption of their connected appliances to limit usage to when it's needed.
- Implement Power Limit Notifications – Configure alerts that notify users when their current power consumption exceeds predefined thresholds.
- Display Energy Savings – Show users the energy savings realized on surface heating and cooling appliances through DSR events activation within the mobile application.
- Visualize Financial Benefits – Allow users to view savings in both Energy (kWh) and money saved (EUR) based on their indicated energy tariff.

Narrative of the use case

The system will provide consumers with real-time measurements of their power consumption across all connected appliances. Users can configure power limit notifications that will send alerts when consumption exceeds their predefined thresholds, enabling them to take immediate corrective action by reducing their power usage. This functionality allows consumers to schedule their appliance usage more efficiently, limiting consumption to necessary periods, which ultimately leads to energy invoice reduction. This use case also describes the display of energy savings realised on surface heating and cooling appliances by activation of DSR events within a mobile application. The system allows users to visualise these savings in Energy (kWh) and money saved (EUR) if users indicated their energy tariff.

Diagram of the use case

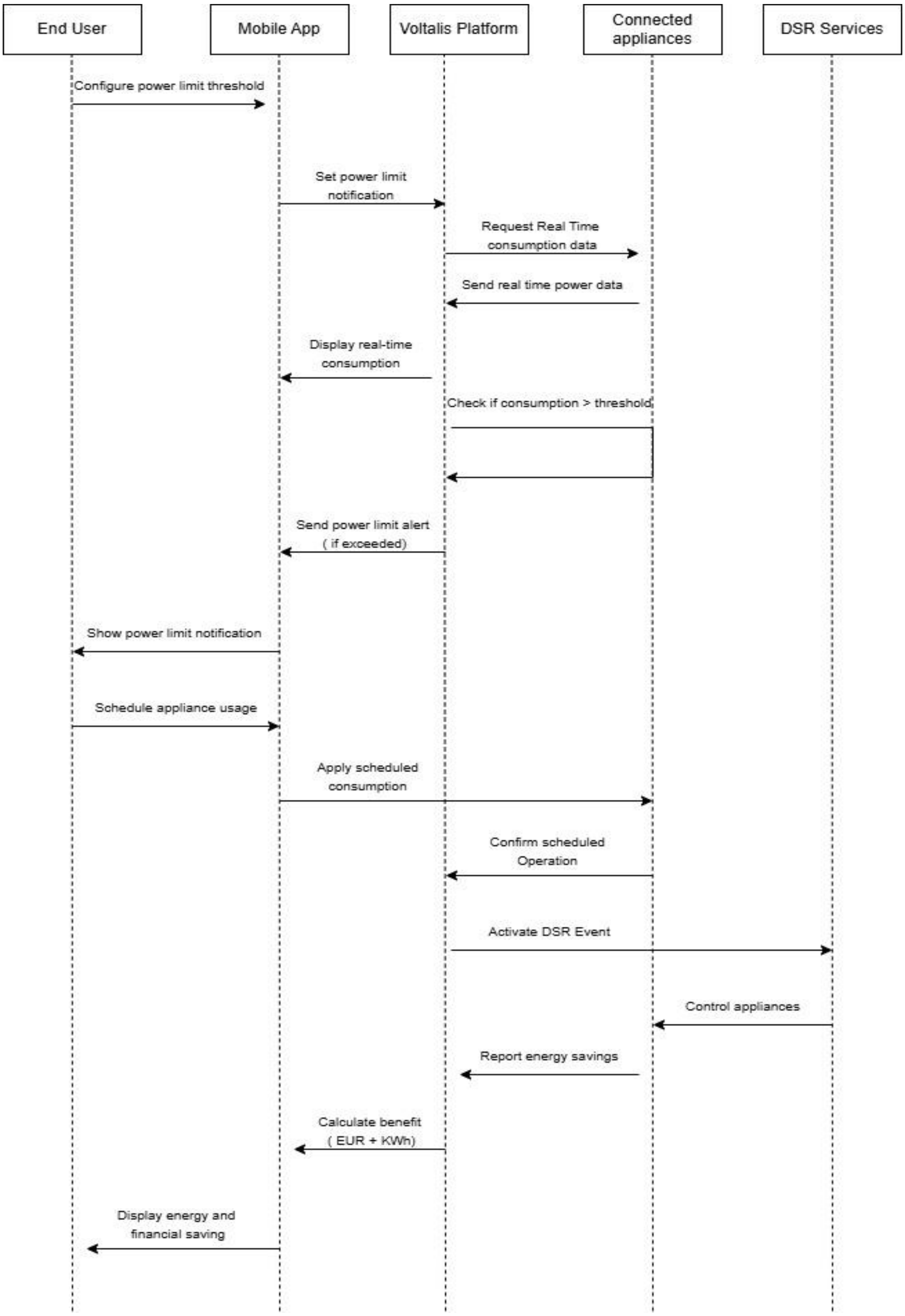


Figure 12. FR 3.3 diagram

Scenarios

Main path

End users are invited to start using the application by configuring consumption thresholds. The system monitors real-time consumption data from connected appliances and sends alerts when thresholds are exceeded. Users can schedule appliance usage to optimize consumption. The DSR service activates events on heating and cooling devices to reduce energy use. The application calculates and displays both energy (kWh) and financial (EUR) savings, offering users a complete energy management solution.

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Power threshold configuration	The user configures the power limit notification threshold	Power threshold parameters	End User	Mobile App
2	Real-time monitoring	The system collects and displays real-time consumption data from connected appliances	Energy consumption data	Energy consumption data	Connected Appliances
3	Message generation	The user receives a notification when consumption exceeds the predefined threshold	Power limit alert	Platform	End user
4	DSR events activation	The system activates demand response events on appliances	DSR commands	DSR services	Connected Appliances
5	Savings visualization	The application calculates and displays energy savings (kWh) and financial savings (EUR)	Savings data	Platform	End User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Smart meter is not capable to provide the data	Unable to generate complete information			

2	DSR events activation failure	If the DSR service fails to communicate with connected appliances to reduce energy consumption during peak periods.

6.3. CARBON FOOTPRINT REDUCTION & CUSTOMER AWARENESS

AT 2.1. PERSONALISED MESSAGES FOCUSING ON NON-ECONOMIC INCENTIVES FOR BENEFITS OF THE SYSTEM

Scope and objectives

The scope is to cover all steps by which the end-customer app (being developed under ECLIPSE) fetches historical and real-time data, generates environmental-saving and load-shifting recommendations, and the user accepts or rejects them.

The objectives are the following:

- Provide non-financial advice to residential customers looking to reduce their carbon footprint.
- Provide infrastructure to ESCOs which would like to perform a flexibility analysis and recommend non-economic opportunities.

Narrative of the use case

The End Customer Application is designed to provide non-economic advantages to end users through optimized energy management. It leverages the EDDIE framework for Historical Validated Data and/or AIIDA for near real-time data access. The application facilitates consumption-related recommendations, allowing users to capitalize on off-peak electricity rates and reduce overall costs. Through integration with smart meters and home automation systems, the app empowers customers to make informed decisions and achieve financial savings.

Diagram of the use case

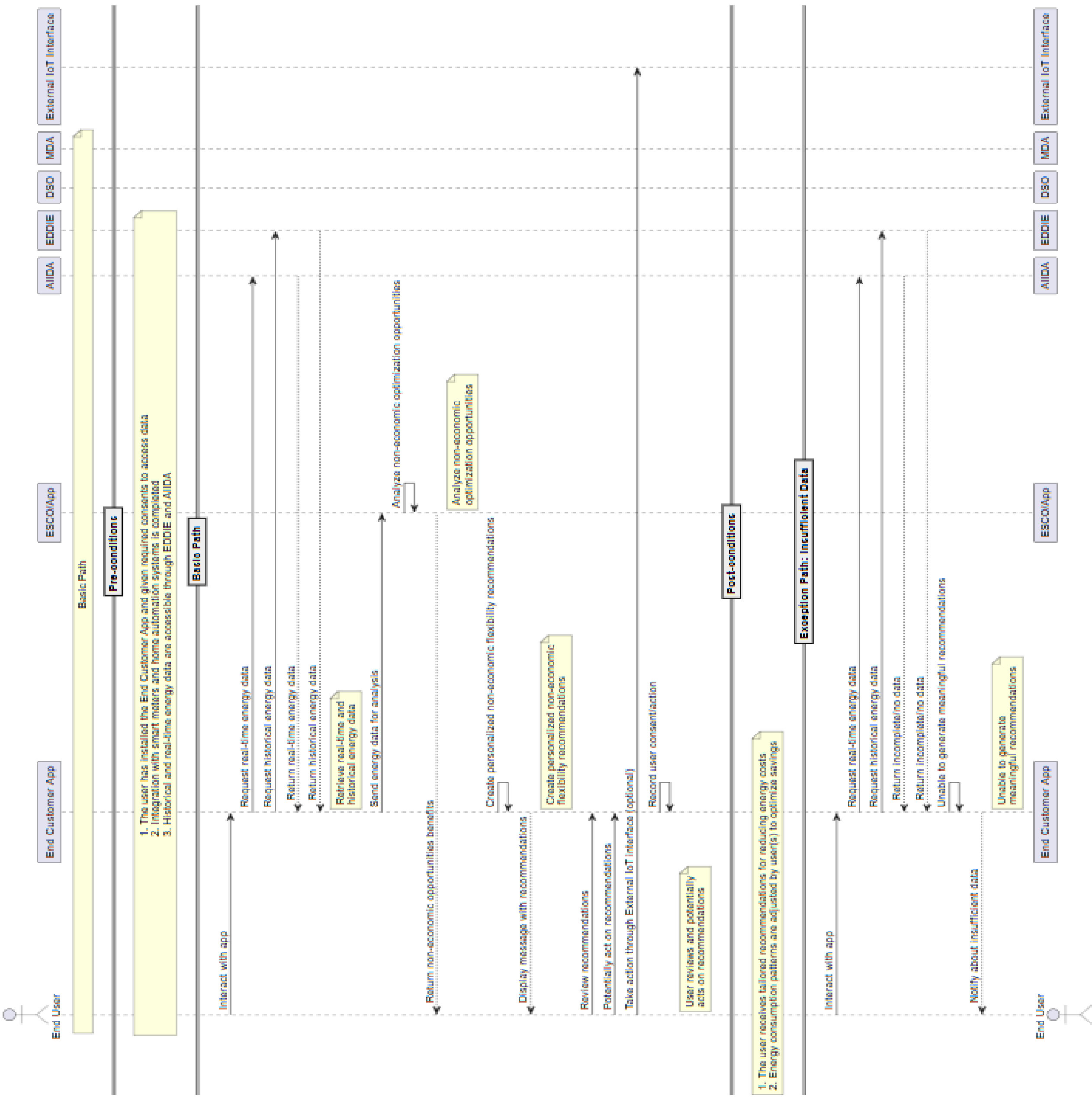


Figure 13. AT 2.1 diagram.

Actors of the use case

- Consumer: End users interacting with the application.
- EDDIE: Facilitates access to historical and real-time energy data.
- Energy Service Company (ESCO): Provides energy-saving insights.
- Aggregator: Manages energy resource optimization.

- DSO (Distribution System Operator): Ensures grid reliability and data exchange.
- MDA (Meter Data Administrator)/ National Data Hub: Provides historical data to EDDIE.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data Collection	Retrieve real-time and historical energy data	Energy data	AIIDA, EDDIE	End Customer App
2	Flexibility Analysis	Analyze non-economic optimization opportunities	Non-economic opportunities benefits	ESCO/App	End user
3	Message Generation	Create personalized non-economic flexibility recommendations	Message	End Customer App	End user
4	User Interaction	User reviews and potentially acts on recommendations	User Consent/Action	End User	End Customer App/ External IoT interface

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Insufficient Data	Unable to generate meaningful recommendations	-	-	-

AT 3.1. ENERGY EFFICIENCY POTENTIAL AT AGGREGATED LEVEL.

Scope and objectives

The scope is to encompass analytics and recommendations aimed purely at lowering overall energy consumption at an aggregated level, irrespective of cost or emissions.

The objectives are the following:

- Aggregate the energy profiles of individual customers.
- Generate the recommendations aiming at reducing the overall energy at an aggregated level.

Narrative of the use case

Focused on aggregated-level energy savings, the app generates personalized messages revealing individual and collective energy efficiency potential. By analysing aggregated consumption patterns from AIIDA and/or EDDIE, the system/ESCO can provide targeted recommendations that highlight specific energy-saving opportunities within regional contexts.

Diagram of the use case

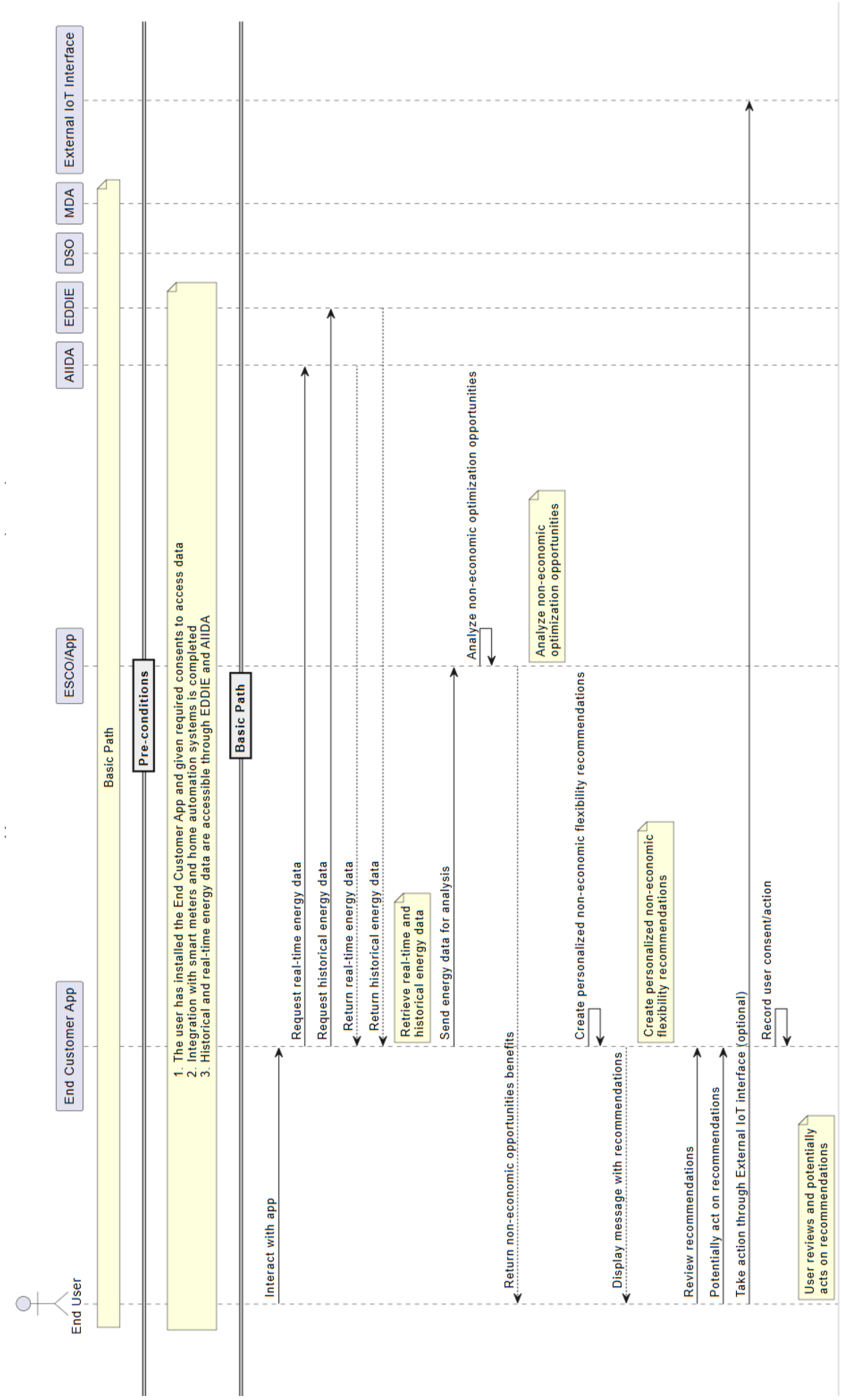


Figure 14. AT 3.1 Diagram (I)

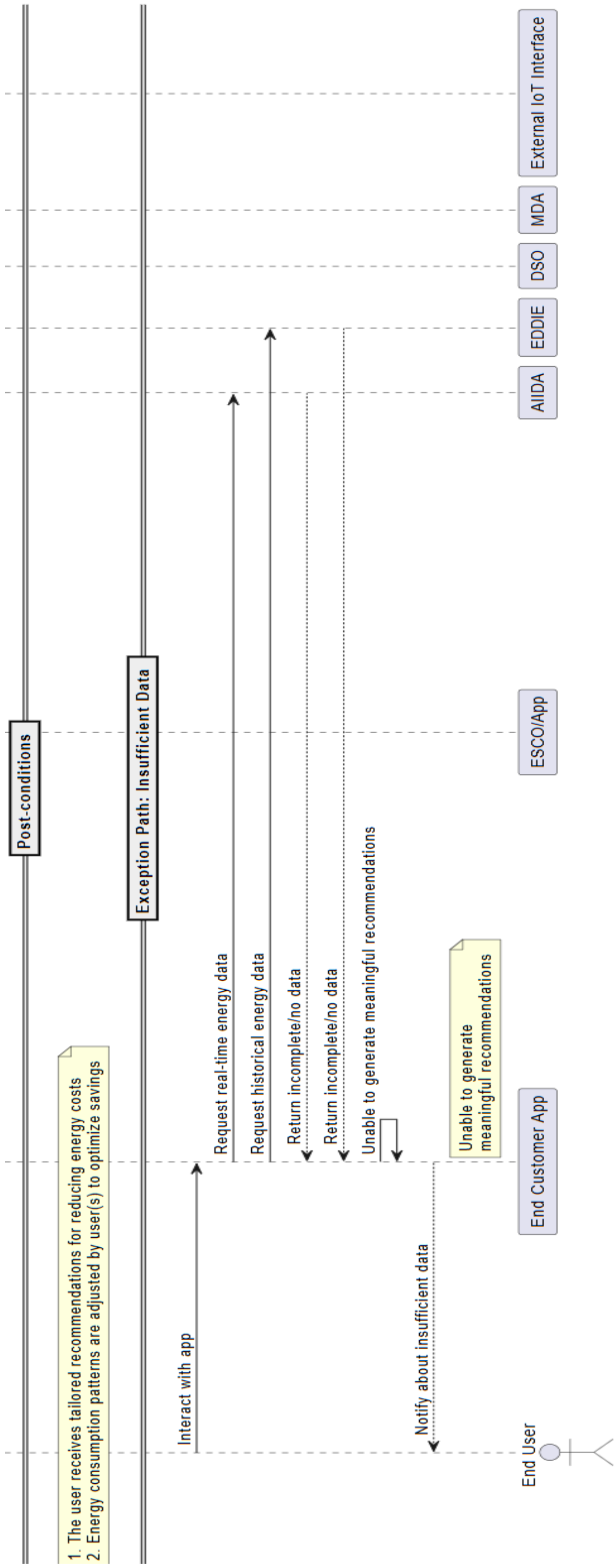


Figure 15. AT 3.1 Diagram (II)

Actors of the use case

- End Users.
- Energy Efficiency Experts.
- DSO (optional).
- Community Energy Planners.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data Integration	Aggregate historical and real-time energy data	Aggregated-level Consumption Patterns	AIIDA, EDDIE	End Customer App
2	Efficiency Analysis	Based on the aggregation consents, identification of energy savings potential	Recommendation(s) good for community	End Customer App	End user
3	Localized Recommendation	Generate community-specific energy saving messages	Efficiency Advice	End Customer App	End user

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Insufficient Aggregated Data	Limited community-specific information due to less/no users	No (or low confidence) aggregation	End Customer App	End user
2	Limited consents	Not many users have provided the consent for their data aggregation	No (or low confidence) aggregation	End Customer App	End user

AT 5.1. ENERGY AWARENESS AND EDUCATION.

Scope and objectives

The scope is to encompass push notifications, tutorials, and community marketplace features to educate users on best practices, upcoming features, and peer benchmarks. Includes “Did you know?” tips and community energy-sharing options to increase general awareness.

The objectives are the following:

- Send push notifications to the users about awareness campaigns.
- Inform users about the community energy-sharing opportunities.
- Spread energy literacy through personalized messages.

Narrative of the use case

The app provides comprehensive, user-friendly energy efficiency guidance, offering general tips and practical advice to help users improve their energy consumption habits. By leveraging AIIDA's near-real-time data and EDDIE's historical energy framework, the system delivers personalized, actionable recommendations for sustainable energy use.

Diagram of the use case

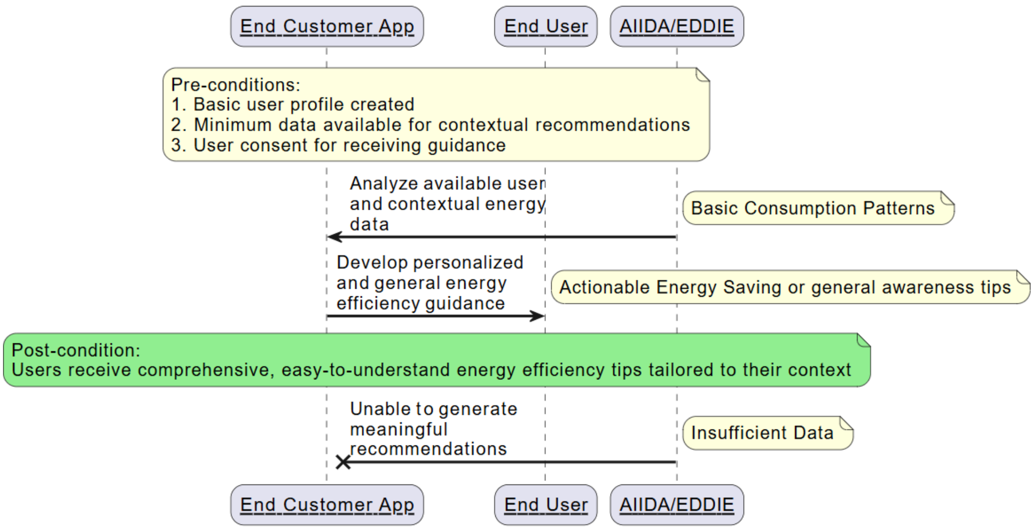


Figure 16. AT 5.1 diagram.

Actors of the use case

- End Users.
- Energy Efficiency Experts (optional).
- Local Energy Advisory Services (optional).
- Environmental Education Organizations (optional).
- Sustainability Consultants (optional).

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Initial Assessment	Analyze available user and contextual energy data	Basic Consumption Patterns	AIIDA, EDDIE	End Customer App
2	Tip Generation	Develop personalized and general energy efficiency guidance	Actionable Energy Saving or general awareness Tips	End Customer App	End user

Exception path

N/A.

HR 2.1. RES SHARE NOTIFICATION FOR SUSTAINABLE ENERGY DECISIONS.

Scope and objectives

Scope:

- Real-time notifications to app users when renewable energy generation exceeds a set threshold.
- Personalized insights on the share of clean energy in the grid to guide consumption decisions.
- Encouraging environmentally conscious energy usage by aligning consumption with periods of high renewable energy availability.

Objectives:

- Promote sustainable energy consumption by informing users when renewable energy is abundant.
- Encourage demand shifting to maximize the use of clean energy sources.
- Enhance user awareness of renewable energy contributions in the power grid.
- Support grid efficiency by balancing energy demand with green energy supply.
- Foster environmental engagement through personalized, actionable recommendations.

Narrative of the use case

This use case involves notifying app users when the share of renewable energy generation exceeds a predefined threshold. The notification is designed to inform users about the proportion of electricity being generated from renewable sources at a given time, helping them make informed energy usage decisions. By understanding when clean energy is abundant in the grid, users can time their energy consumption to align with environmental sustainability goals. The app will provide users with personalized messages, such as "Good news! X% of the electricity used today comes from renewable sources" encouraging users to consume energy in a way that maximizes environmental benefits.

Diagram of the use case

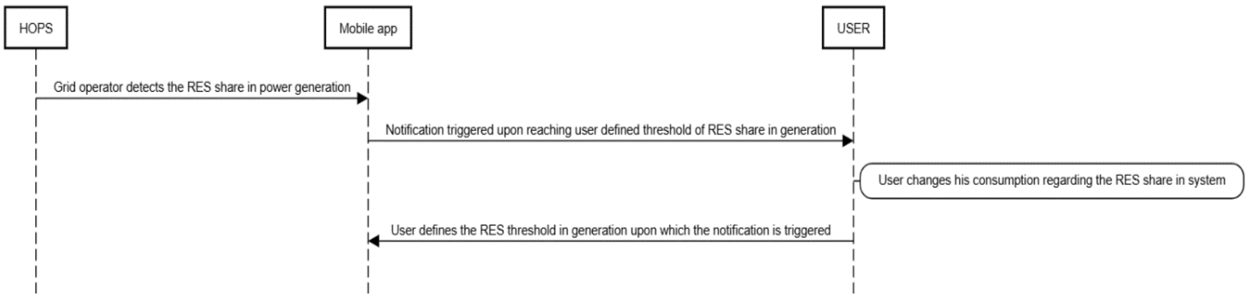


Figure 17. HR 2.1 diagram.

Actors of the use case

- End Users (Consumers): Individuals or organizations using the app to make energy-related decisions.
- Energy Suppliers/Producers: Entities responsible for generating and distributing electricity, including renewable energy producers.
- Grid Operator: The organization responsible for overseeing grid stability and managing the balance between energy supply and demand.
- Notification System (App Backend): The system that monitors RES generation levels and triggers notifications.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	RES share exceeds threshold	The grid operator detects that the share of renewable energy generation has exceeded the predefined threshold.	Real-time RES share data	Grid Operator	App Backend
2	Notification triggered	The app backend identifies that the RES threshold has	RES share percentage and	App Backend	Notification System

		been surpassed and triggers a notification.	notification details		
3	Notification sent	The app sends a personalized notification to users informing them about the high share of renewable energy.	Notification content	Notification System	Users (Consumers)
4	User receives notification	Users receive the notification and can choose to adjust their energy consumption behaviour based on the information.	Notification delivery confirmation	Notification System	Users (Consumers)
5	Historical data updated	The app updates user records with historical RES data for tracking and sustainability insights.	User-specific energy and RES data	App Backend	Users (Consumers)

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	RES share does not exceed threshold	The grid operator reports that the RES share remains below the predefined threshold.	Real-time RES share data	Grid Operator	App Backend
2	No notification triggered	The app backend determines that no	RES share percentage	App Backend	Notification System

		notification needs to be sent.			
3	Data delay or system failure	There is a delay or failure in receiving real-time RES data from the grid operator, causing a disruption in notification.	Error details	Grid Operator	App Backend
4	Users opt out of notifications	Users who have not opted in or have disabled notifications do not receive any messages.	User preferences	Users (Consumers)	App Backend
5	Notification error	A technical error in the app backend prevents notifications from being sent to eligible users.	Error report	App Backend	Notification System

HR 5.1. ENVIRONMENTAL AWARENESS NOTIFICATIONS (GENERAL INFORMATION).

Scope and objectives

Scope:

- General, non-customized environmental notifications focused on Croatia's electricity grid and renewable energy generation.
- Educational content about Croatia's energy mix, grid stability, and sustainability efforts.
- Opt-in/opt-out functionality allowing users to control their participation.

Objectives:

- Raise public awareness about Croatia’s renewable energy efforts and electricity grid.
- Educate users on the environmental impact of energy consumption and conservation.
- Promote sustainability by sharing key facts and milestones related to the Croatian grid.
- Encourage engagement with energy efficiency practices in a non-intrusive way.
- Support informed decision-making regarding energy use and its environmental effects.

Narrative of the use case

This use case delivers general, non-customized environmental information to users with a focus on the Croatian electricity grid and its renewable energy generation. The goal is to educate and engage users about sustainability in the context of Croatia's transmission network, promoting awareness of its energy sources and consumption patterns. Users can opt in or out of receiving these messages at any time.

The notifications will primarily highlight facts about the Croatian electricity generation mix, grid stability, and renewable energy efforts, giving users a clearer understanding of their local energy ecosystem. Additionally, users will be informed about major milestones, environmental statistics, and the benefits of energy conservation specifically related to the Croatian grid.

Examples of such notifications include:

- "Did you know? Over 50% of Croatia’s electricity is generated from renewable sources, including hydro and wind energy."
- "Fact: Croatia is a leader in solar energy adoption in the region, with significant capacity added to the grid each year."
- "In 2020, Croatia achieved a major milestone by reducing its carbon emissions by 20% compared to 1990 levels, thanks to renewable energy investments."
- "Croatia's electricity grid has integrated advanced technologies to improve grid stability, ensuring reliable power even during high demand."

- "Did you know? By adjusting your energy use during peak times, you help the Croatian grid stay balanced and reduce the need for fossil-fuel-based power plants."

These messages are designed to raise awareness without requiring user-specific data, focusing on universal truths and impactful stories.

Diagram of the use case

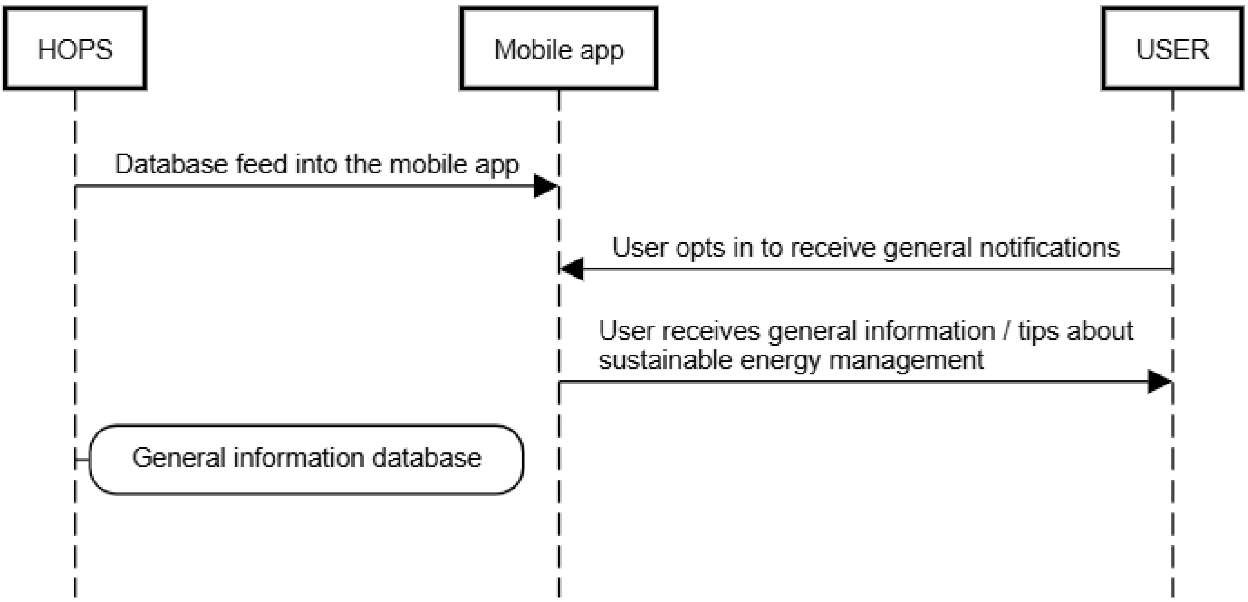


Figure 18. HR 5.1 diagram.

Actors of the use case

- End Users (Consumers): Individuals opting to receive environmental notifications.
- App Backend: Responsible for managing user preferences and delivering general notifications.
- Sustainability Experts: Provide verified content and historical facts.
- Regulatory Authorities (Optional): Ensure compliance with rules for disseminating public information

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User opts in	Users enable the option to receive general environmental awareness notifications.	Opt-in request	User	App Backend
2	Content selected	The app backend selects a relevant general fact or historic milestone from its database.	Environmental fact or insight	App Backend	Notification System
3	Notification sent	A general informational notification is sent to the user's device.	Notification message	Notification System	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User opts out	User disables notifications in the app settings.	Opt-out request	User	App Backend
2	Database error	The app cannot access the environmental facts database due to a technical issue.	Error logs	App Backend	Admin Team
3	Notification delivery fails	Notification fails to reach the user due to device or network issues.	Error report	Notification System	App Backend

CY 2.1. ENVIRONMENTAL AWARENESS NOTIFICATIONS FOR SUSTAINABLE CONSUMER BEHAVIOUR.

Scope and objectives

Educate and engage users about sustainable behaviour in the context of Cyprus's energy system, promoting awareness of its energy sources and consumption patterns.

Narrative of the use case

The selected pilot site region is the wider Nicosia Region. The area has mainly residential and commercial loads, and to a lesser extent industrial loads. The demand of the area is ~ 35-40% of total demand of Cyprus.

This use case delivers general, non-customized environmental information to users with a focus on the Cypriot electricity grid and its renewable energy generation. The goal is to educate and engage users about sustainable behaviours in the context of Cyprus's energy system, promoting awareness of its energy sources and consumption patterns. Users can opt in or out of receiving these messages at any time.

The notifications will primarily highlight facts about the Cyprus electricity generation mix, grid stability, and renewable energy efforts, giving users a clearer understanding of their local energy ecosystem.

Diagram of the use case

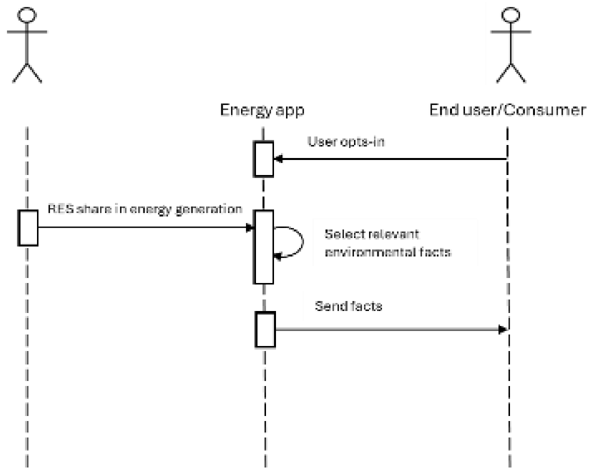


Figure 19. CY 2.1 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- Transmission System Operator (TSO).

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User opts in	Users enable the option to receive general environmental awareness notifications.	Opt-in request	User	App Backend
2	Content selected	The app backend selects a relevant general fact or historic milestone from its database.	Environmental facts or insight	App Backend	Notification System
3	Notification sent	Notification sent	Notification System	Notification System	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User opts out	User disables notifications in the app settings.	Opt-out request	User	App Backend
2	Database error	The app cannot access the environmental facts database due to a technical issue.	Error logs	App Backend	Admin Team

CY 5.1. CUSTOMIZED ENERGY EFFICIENCY TIPS FOR SUSTAINABLE CONSUMER BEHAVIOUR.

Scope and objectives

- Deliver personalized energy efficiency tips to users.
- Educate and guide users towards adopting energy efficient behaviour.

Narrative of the use case

This use case focuses on delivering personalized energy efficiency tips to users. The goal is to educate and guide users towards adopting an energy efficient behaviour. The system allows users to track their energy savings and adjust their behaviour for greater efficiency.

Both domestic and commercial consumers will participate in the pilot. For commercial users, operational details such as working hours and active weekdays will be considered to ensure that the recommendations are aligned with actual business routines.

In addition, the system will integrate information related to renewable energy schemes available in Cyprus, including net metering and net billing. This will allow users, particularly those with or considering rooftop photovoltaic installations, to better understand how to optimize their participation in such programs and maximize their energy and cost benefits.

Diagram of the use case

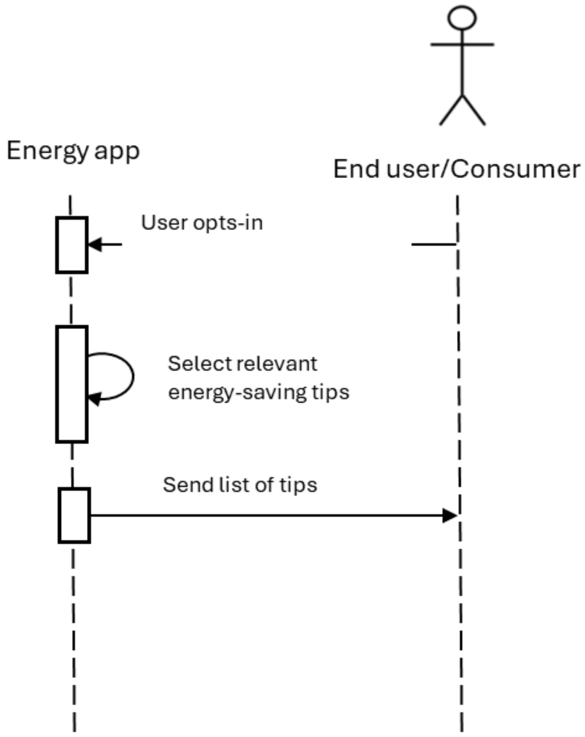


Figure 20. CY 5.1 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- Transmission System Operator (TSO).

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User opts in	Users enable the option to receive customized energy efficiency tips.	Opt-in request	Mobile App (User)	App Backend
2	Content selected	The app backend selects relevant energy-saving tips from the predefined lists based on user's consumption patterns and loads.	Energy-efficiency tips	App Backend	App Backend
3	List of tips	The system displays the list of available energy-efficiency tips.	Energy-efficiency tips	App Backend	Mobile App (User)

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User opts out	User disables notifications in the app settings.	Opt-out request	User	App Backend
2	Data unavailable	The app cannot access the predefined energy-efficiency database due to a technical issue.	Error message	App Backend	Mobile App (User)

CZ 2.1. ENERGY GOALS FOR SUSTAINABLE ENERGY USE.

Scope and objectives

- Enabling consumers to receive timely and relevant advice from the DSO aimed at improving their energy efficiency.
- Encouraging behaviour change through gamified challenges to make energy savings engaging and rewarding.
- Supporting voluntary participation, where users opt into programs that promote load shifting, reduced, consumption during peak times and overall sustainable usage patterns

Narrative of the use case

This Use Case describes the implementation of a gamification feature within the mobile application designed to encourage users to adopt more sustainable energy consumption and production habits. The system provides users with various challenges that promote energy efficiency, increased renewable energy production, and more frequent application usage for monitoring and optimization.

Diagram of the use case

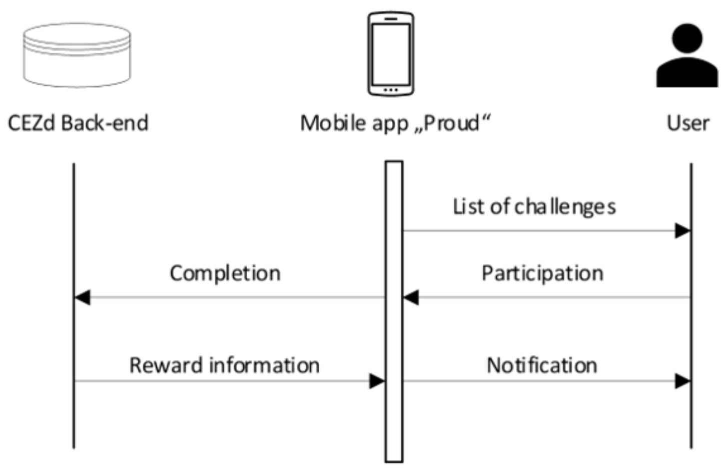


Figure 21. CZ 2.1 diagram.

Actors of the use case

- Customer (mobile application user).
- Energy data provider (DSO).
- System administrator.
- Challenge management functionality.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App opened	The user opens the mobile application and navigates to the challenge section	User request	User	Mobile application
2	Challenges displayed	The system displays the list of available challenges and user progress	Challenge data	Mobile application	User
3	Challenge accepted	The user selects and starts a challenge	Challenge participation	User	Mobile application
4	Progress tracked	The system tracks the user's progress in the challenge	Progress data	Challenge management system	Mobile application
5	Challenge completed	The user completes the challenge conditions	Completion confirmation	Mobile application	Challenge management system
6	Reward received	The system rewards the user with badges or virtual incentives	Reward information	Challenge management system	Mobile application
7	New challenge notification	The system notifies the user about new available challenges	Notification alert	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Data unavailable	If challenge data is unavailable, the system notifies the user	Error message	Mobile application	User
2	Challenge tracking unavailable	If the system fails to track progress, a default completion mechanism is used	Default progress update	Challenge management system	Mobile application

CZ 5.2. ENERGY TIPS FOR CONSUMPTION REDUCTION.

Scope and objectives

- The scope is a consumption reduction based on voluntary changes in behaviour of the user and his home.
- The objective is to motivate user to change consumption behaviour based on energy tips.

Narrative of the use case

This Use Case describes the implementation of a new section within the mobile application that provides users with simple and effective energy-saving tips. The system allows users to track their energy savings and adjust their behaviour for greater efficiency. Users can mark tips as completed and monitor their progress.

Diagram of the use case

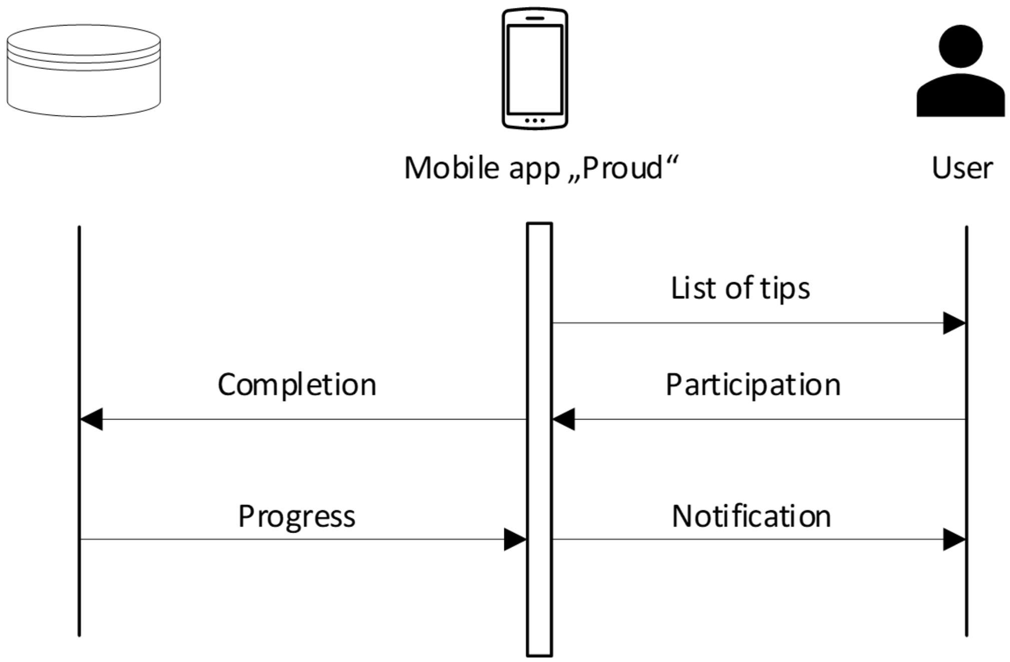


Figure 22. CZ 5.2 diagram.

Actors of the use case

- Customer (mobile application user).
- Energy data provider (DSO).
- System administrator.
- Content management system.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App open	The user opens the mobile application and navigates to the tips section	User request	User	Mobile application
2	List of tips	The system displays the list of available energy-saving tips	Tips data	Mobile application	User
3	Tips completed	The user reviews tips and marks them as completed	Tip completion status	User	Mobile application
4	Tips progress	The system tracks the user's progress in completing tips	Progress data	Content management system	Mobile application
5	New Tips	The system notifies the user about new available tips	Notification alert	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Data unavailable	If Tips data is unavailable, the system notifies the user	Error message	Mobile application	User

RO 2.1. FOLLOW_THE_SUN.

Scope and objectives

The "Follow the Sun" use-case provides personalized messages to consumers regarding their potential CO_2 footprint reduction by synchronizing shiftable loads with the high-RES production periods. The UC name suggests that it is advised that needed consumption is increased during rich renewable energy production, thus avoiding grid overload and high storage need. This, metaphorically speaking, the UC name suggests pairing between RES production and consumption, like being in a "follow the Sun" situation.

Narrative of the use case

Consumption and production of renewable energy are often in different timeframes, such that the power system need to use flexibility means to both satisfy consumption when needed and absorb production when it occurs. BESS are new means to cope with this situation, but their price is still high, and the investment is not affordable in all use cases. One way to reduce the need of BESS is to synchronize shiftable loads to be used with higher priority during periods of abundant RES production. However, the user is not always aware of the moments when a high share of RES is locally or at national level produced. The use-case is collecting data regarding the local PV production and highlights periods of favourable ratios of RES/consumption periods, by giving personalized messages to consumers to increase mandatory consumption during these periods, thus reducing the CO2 footprint. Where appropriate, NILM will be used to enhance the advice content.

Diagram of the use case

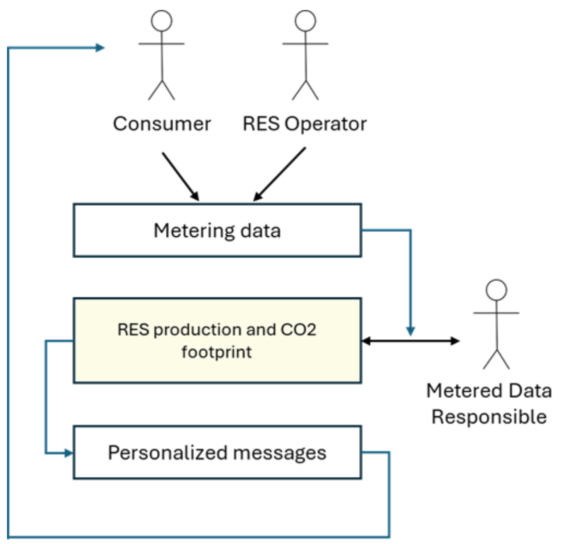


Figure 23. RO 2.1 diagram.

Actors of the use case

- Consumer.
- Metered Data Responsible (AMR system operator).
- RES Operator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	High RES	RES production is monitored in FEE and thresholds are detected	RES average power, timeframe	Metered Data Responsible	App
2	Send advice	Send info which points that shiftable load can be used in order to synchronize it with RES production	Message	App	Consumer
3	Check consumption in the current/next timeframe	Use individual or aggregated meter data to see change of consumption	Message	Metered Data Responsible, App	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Rejection of advice due to some circumstances	Due to some circumstances, the end user does not want to implement the advice	Notification	Customer	App
2	Advice cannot be implemented	IF the customer is not in the consumption area, he might not be able to implement the advice	Lack of reaction	Customer	App

RO 5.1. RECOMMENDATION ON ENERGY MANAGEMENT FOR RESIDENTIAL BUILDINGS.

Scope and objectives

Energy consumption can be reduced by ensuring that unused appliances are either unplugged or switched off after fulfilling their intended purpose. Awareness of potentially abnormal consumption compared with other groups of consumption points might give a hint to local consumers to look on their active consumption portfolio and to take measures towards an efficient use of energy. The scope of the use-case is to bring awareness about higher consumption comparing with other anonymous groups and to trigger the possibility to decrease un-necessary consumption. Where appropriate, NILM will be used to enhance awareness.

Narrative of the use case

Energy inefficiency can occur in student residences due to habits such as keeping unused appliances plugged in, heating systems used inefficiently, or leaving lights on in common areas. These not only impact on the cost of electricity but also contribute to increased carbon footprints and even higher losses through the electricity grids. This use case aims to propose some useful tips and analyse the impact of their implementation on the power system. The tips will be addressed to both dormitory residents and building managers considering the identified behaviours and characteristics of consumption profiles over a longer period of time including study periods, exam session or holiday periods. The advice will be based on data collected from households, aggregated at different levels - individual rooms, shared spaces and whole buildings.

A challenge will be residents' agreement and willingness to get involved in monitoring their electricity consumption and implementing the advice given so that the impact on the system becomes meaningful. Thus, their proactive behaviour can contribute not only to reducing costs, but also to maintain grid stability and efficiency, especially during peak demand or extreme situations in terms of electricity consumption/production.

Diagram of the use case

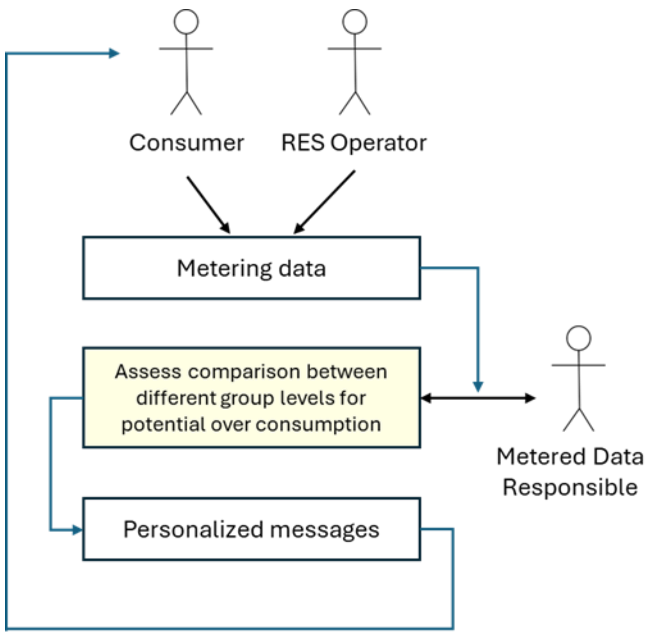


Figure 24. RO 5.1 diagram.

Actors of the use case

- Consumer.
- Metered Data Responsible.
- Grid Operator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Violated limit	The power has exceeded a predefined limit either imposed by network conditions (over/under load, increased generation) or by the user (a pre-allocated budget for the electricity bill)	Power, timeframe	Consumer	Metered Data Responsible
2	Send tip	Mention in the message that it is possible for to experience outage the bill will increase with a percent of the increased power if it continues to apply the same consumption pattern.	Message	Metered Data Responsible	Consumer
3	Check network operation	Compare energy consumption before and after the recommendation	Power, timeframe	Consumer	System Operator

Exception path

N/A.

GR 3.1. TAILORED ENERGY MESSAGES FOR CONSUMER FLEXIBILITY AND SUSTAINABILITY.

Scope and objectives

This use case delivers personalized, sustainability-focused messages to encourage residents to shift their energy usage during peak periods. The goal is to both reduce stress on the grid (flexibility) and promote environmentally responsible behaviour, leading to more conscious energy use.

Narrative of the use case

This use case focuses on delivering personalized messages based on non-economic incentives. Using IoT data from residents' homes, such as controlling devices for ACs and boiler, environmental sensors for air quality, customized messages that emphasize environmental impact will be generated, encouraging users to reduce energy consumption during peak times.

Diagram of the use case

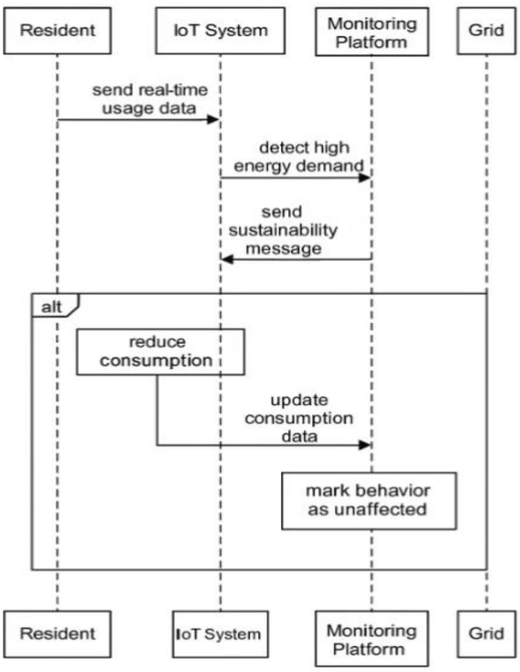


Figure 25. GR 3.1 diagram.

Actors of the use case

- Residents.
- Energy service providers.
- IoT system operators.
- Smart grid operators.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	System identifies peak demand	IoT devices detect high energy usage in the network	Peak load data	IoT system	Monitoring app
2	Message sent	System sends an environmental impact message to residents	Sustainability advice	Monitoring app	Resident
3	User response	Resident adjusts energy use based on guidance	Energy-saving actions	Resident	System
4	User response	Resident adjusts consumption	Action confirmation	Resident	System
5	Monitoring	System records change in energy use	Adjusted consumption data	System	Energy providers

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User does not engage	No response to notifications	No action taken	Resident	System
2	IoT device failure	One or more devices fail to send data	Incomplete monitoring data	IoT system	Monitoring app
3	System failure	Temporary unavailability of app	No messages sent	Monitoring app	Resident

SI 2.1. ENERGY-SAVING TIPS.

Scope and objectives

Based on the user's inputs, the new application will provide potential energy savings and personalized energy-saving tips.

Narrative of the use case

The application will provide energy-saving tips to help users reduce their consumption. The application will prompt users to select from predefined answer options provided within the app. This information will relate to the user's lifestyle, including the type of property, number of residents, and social status. Additionally, the user will be asked to select the appliances they use and provide details about their heating and cooling systems.

Based on this information and the user's historical daily energy consumption, the application will calculate, assess the user's possible energy savings (in kWh) and generate a list of personalized energy-saving tips, categorized by appliance. This service is not using smart meter load profile data and will not split the load profile in different appliances load profiles.

Diagram of the use case

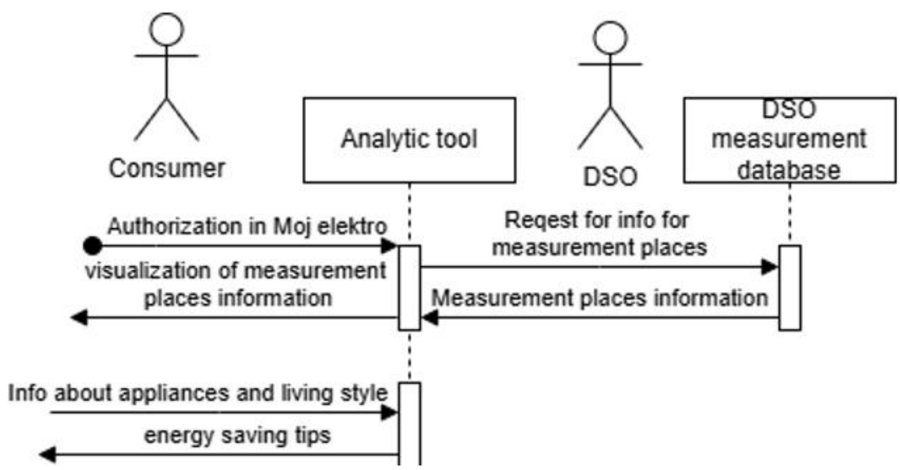


Figure 26. SI 2.1 diagram.

The user signs in to the Moj Elektro portal using two-step verification of their electronic identity, with unified registration and authentication through the Rekono application. After logging in, the user selects a measurement point. In the newly developed application, the user enters information about their appliances and lifestyle. Based on this input, the application calculates potential energy savings and provides personalized energy-saving tips.

Actors of the use case

- Mobile application user.
- DSO as the data provider and APP developer.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Logging on Moj elektro portal	User logs on Moj elektro portal and opens new developed application	User's credentials with two-step verification	User	Moj elektro and new developed app
2	Tip Generation	Develop personalized and general energy efficiency guidance	Actionable Energy Saving or general awareness Tips	End Customer App	End user

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Lack of data	Unable to generate messages			

FR 3.4 NON-ECONOMIC INCENTIVE

Scope and objectives

The mobile application will provide users with information about the amount of CO2 they have helped reduce through Demand Side Response (DSR) events activated on their properties, allowing them to visualize their positive environmental impact on the electrical system.

Narrative of the use case

The application will calculate and display the amount of CO2 avoided thanks to users' participation in DSR events. After each DSR event activated on users' heating and cooling devices, the system will analyse consumption reduction data and convert it into equivalent CO2 not emitted.

Users will be able to visualize this information in a dedicated section of the application, with graphical representations showing the evolution of their environmental contribution over time.

Diagram of the use case

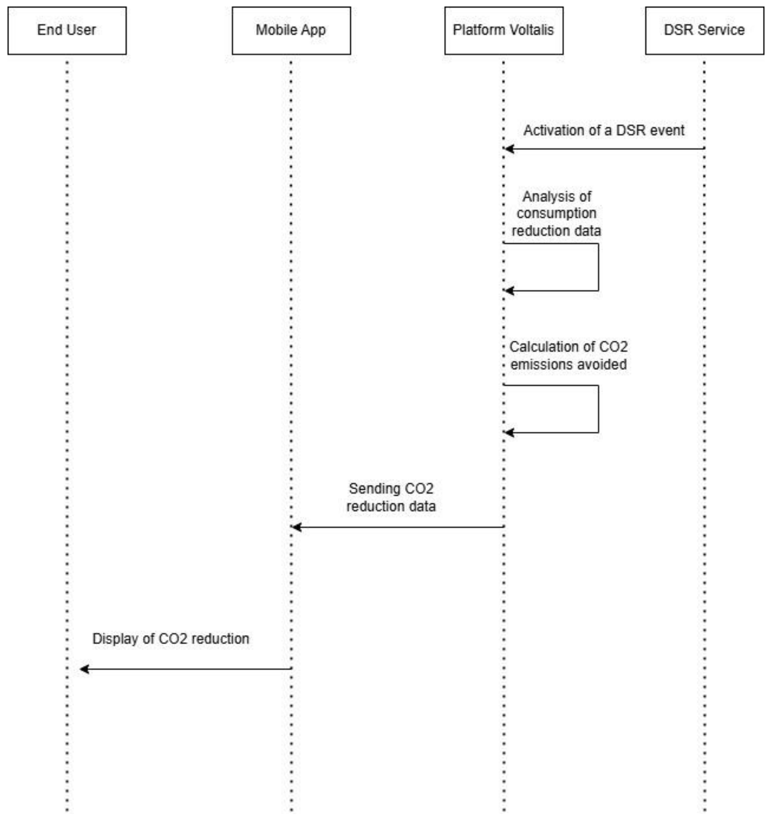


Figure 27. FR3.4 diagram

Actors of the use case

- End user
- Application My V
- Platform Voltalis
- DSR Services

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	DSR event activation	The system activates demand response events on appliances	DSR commands	DSR Service	Connected Appliances
2	CO2 reduction calculation	System analyses consumption reduction data and calculates CO2 emissions avoided	CO2 reduction data	Voltalis Platform	Mobile App
3	CO2 reduction visualization	The application displays CO2 reduction information with graphical representations	Environmental impact metrics	Mobile App	End User

Exception path

N/A

FR 3.5 ENERGY TIPS AND GOAL

Scope and objectives

Based on the user's inputs, the application will provide potential energy savings and personalized energy-saving tips.

Narrative of the use case

The application will provide energy-saving tips to help users reduce their consumption. The application will prompt users to select from predefined answer options provided within the app. This information will relate to the user's lifestyle, including the type of property, number of residents, and social status. Additionally, the user will be asked to select the appliances they use and provide details about their heating and cooling systems.

Based on this information and the user's historical daily energy consumption, the application will calculate the user's potential energy savings (in kWh) and generate a predefined list of personalized energy-saving tips, categorized by appliance.

Diagram of the use case

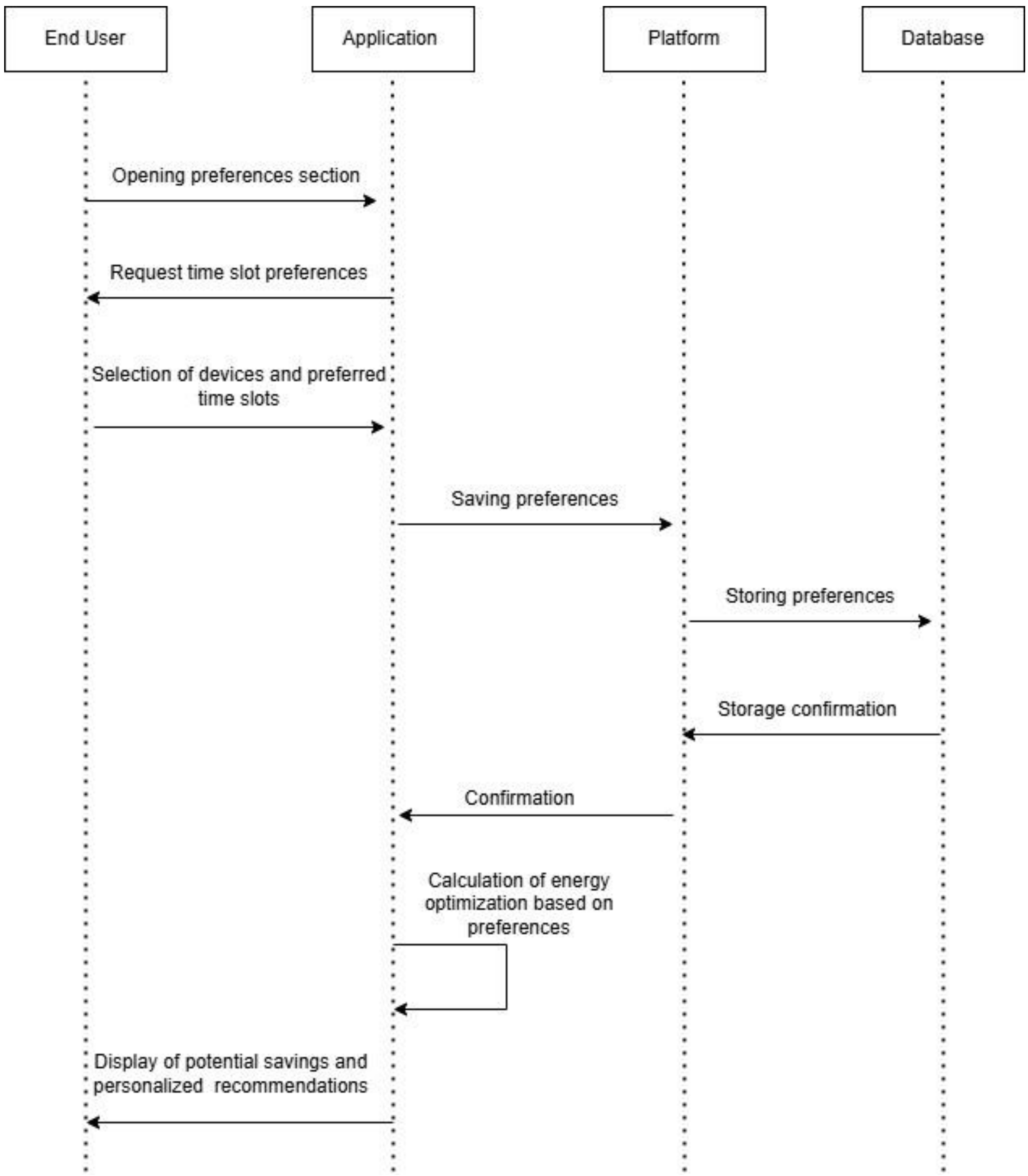


Figure 28. FR3.5 diagram

Actors of the use case

- End user
- Application My V
- Voltalis Platform
- Database

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User input collection	The application prompts user to provide information about lifestyle, property type, number of residents, social status, and appliances used	DSR commands	DSR Service	Application
2	Energy savings calculation	System analyses user inputs and historical consumption data to calculate potential energy savings	Energy consumption data, savings potential (kWh)	Voltalis Platform	Application
3	Personalized tips generation	The application generates and displays personalized energy-saving tips categorized by appliance	Energy-saving recommendations	Application	End User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Incomplete user information	The user hasn't provided all necessary information about their housing or appliances			

6.4. ENHANCING QUALITY OF SUPPLY AND GRID RESILIENCE.

AT 4.1. EXTREME GRID SITUATION MANAGEMENT.

Scope and objectives

The scope is to cover notification of grid stress events (e.g. peak load, voltage or frequency alerts) via DSO integration. The app warns users in advance based on the signal received from the DSOs and suggests temporary curtailments or load shifts to relieve grid stress, if applicable.

The objectives are the following:

- Integrate with DSOs to receive grid-status external signals.
- Notify users in the regions which might be affected.
- Provide user specific actions, if applicable.

Narrative of the use case

The system generates critical messages and alerts about extreme grid situations based on external data signals. By leveraging AIIDA's near-real-time data access, the app provides immediate, actionable information during critical energy infrastructure scenarios, enabling rapid response and user awareness.

Diagram of the use case

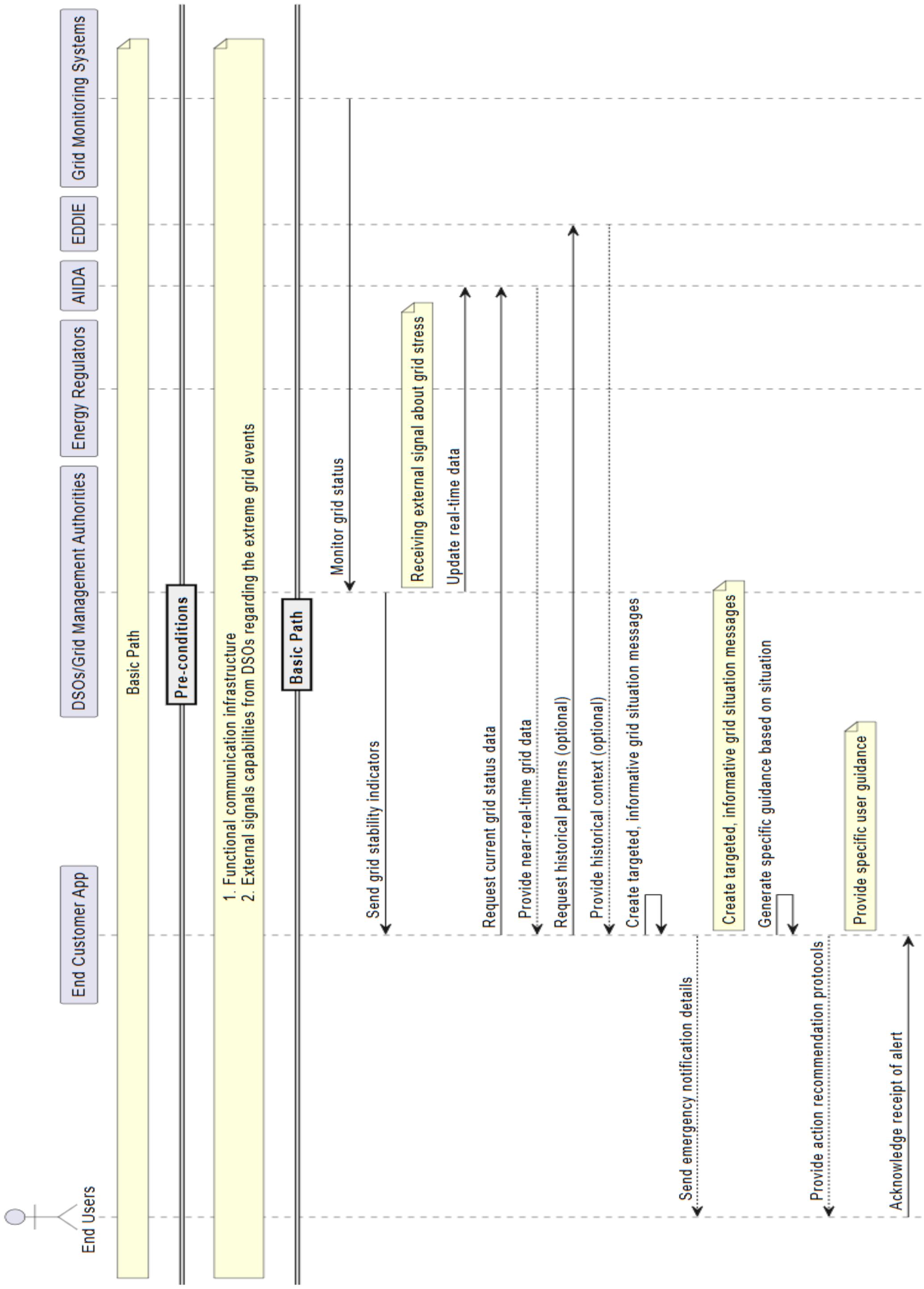


Figure 29. AT 4.1 diagram (I).

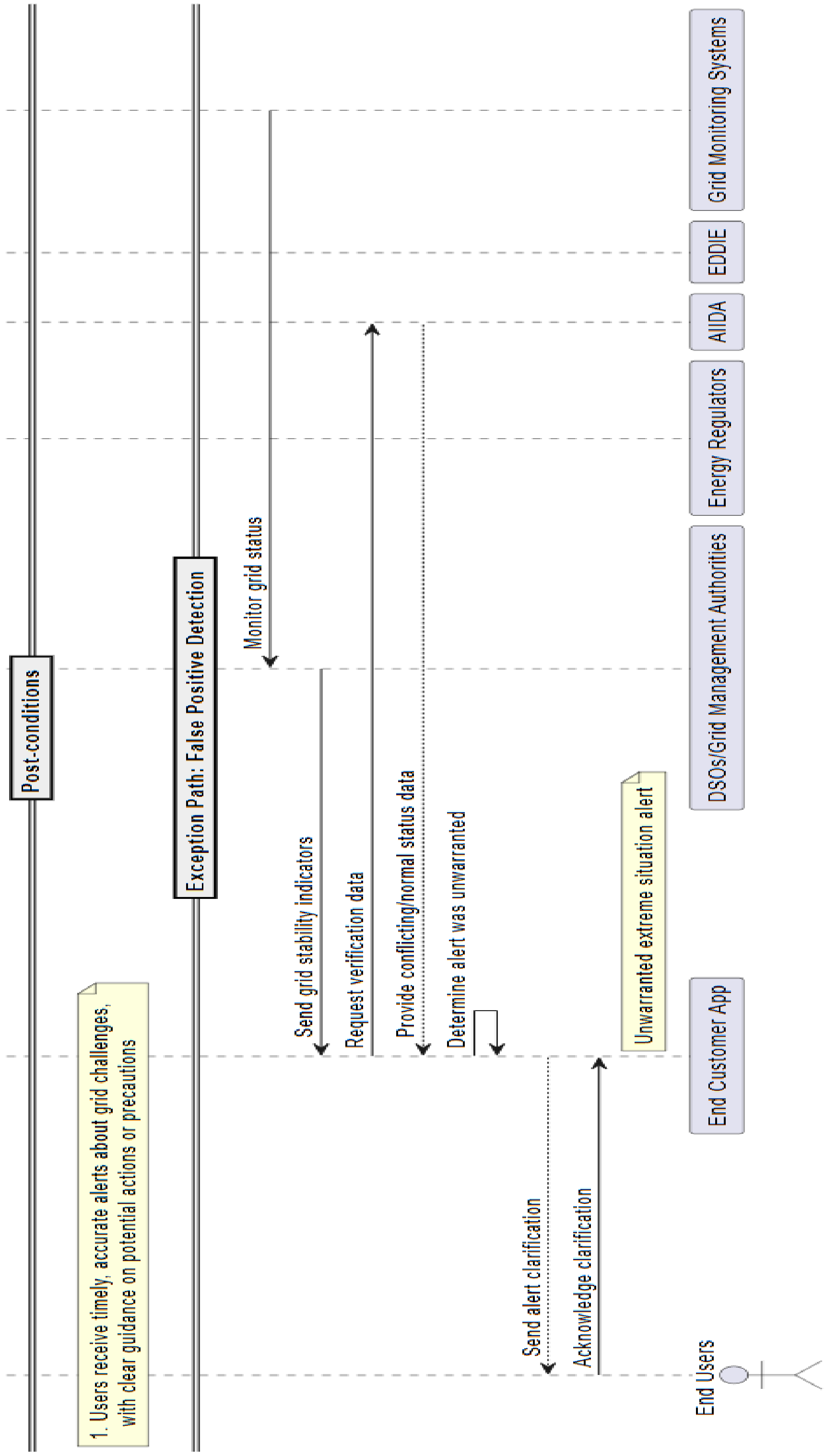


Figure 30. AT 4.1 diagram (II).

Actors of the use case

- End Users.
- Distribution System Operators (DSOs) / Grid Management Authorities.
- Energy Regulators (optional).

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Signal Detection	Receiving external signal about grid stress	Grid Stability Indicators	DSOs, Grid Monitoring Systems	End Customer App
2	Alert Generation	Create targeted, informative grid situation messages	Emergency Notification Details	End Customer App	End user
3	Recommended Actions	Provide specific user guidance	Action Recommendation Protocols	End Customer App	End user

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	False Positive Detection	Unwarranted extreme situation alert	Alert Clarification	End Customer App	End user

BG 4.1. ENERGY CONSUMPTION OPTIMIZATION TIPS – ALERT.

Scope and objectives

Residential and commercial (small business) consumers receive information about the grid conditions and notifications in case of outages.

TSO provides an additional channel of communication to keep consumers aware of the reasons for the power outages and ask them to support the grid in emergency situations.

Objectives:

Improve Consumer Awareness – Keep consumers informed about the grid condition and appearance of contingencies, outages, and emergencies.

Narrative of the use case

The demo will provide the consumers with a mobile application (the same as UC BG 3.1), which will have separate sections (screen) informing them in real-time about the current grid status and appearance of contingencies, planned outages, and emergencies. Additionally, personalized alert notifications will be sent to certain consumers, who are in the areas with contingency, to support the grid by reducing their consumption.

Diagram of the use case

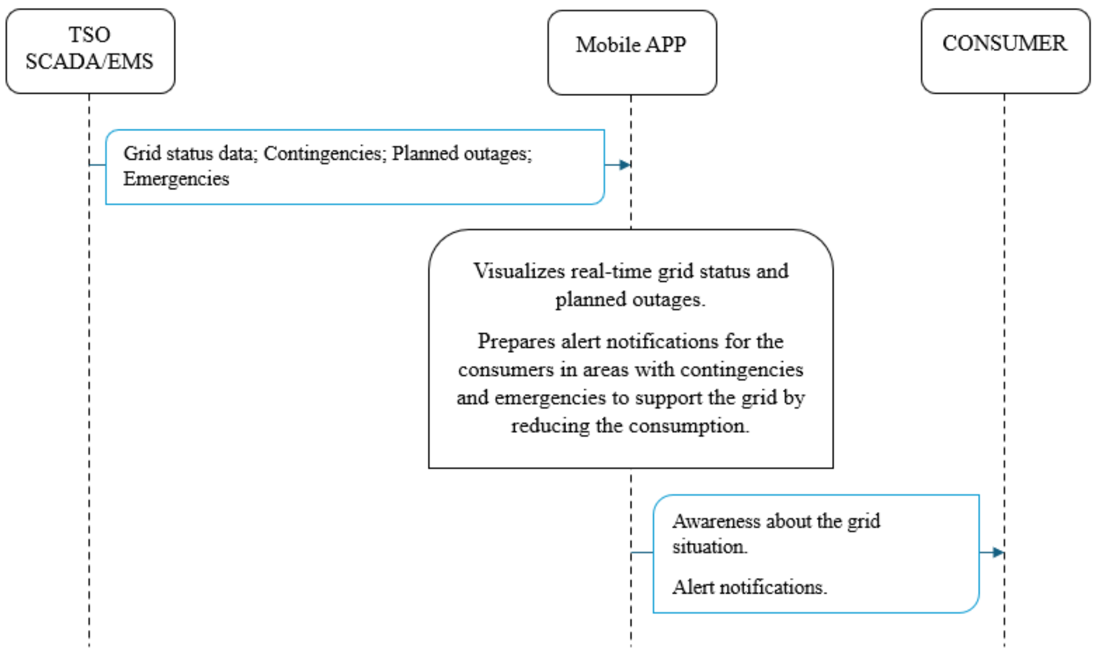


Figure 31. BG 4.1 diagram.

Actors of the use case

- Transmission system operator.
- Mobile APP.
- Consumers.

Scenarios

Main path

Basic path					
Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Consumer installs the energy app and registers his/her profile	Retrieve consumers personal data	Username, contact info, location across the country, consumer/prosumer, does he/she own/manage an electricity storage system, etc.	Consumers	Energy app
2	Normal daily operation: data input	TSO sends data about the status of the grid. The areas (regions) with contingencies, planned outages or emergencies are declared.	Grid data: contingencies, outages, emergencies.	TSO	Energy app
3	Normal daily operation: data output	Mobile energy app prepares visualization of the grid status, based on the input. The areas with abnormal conditions are shown in different color, with additional text description. Personalized alert notifications are sent to the consumers in the areas with contingencies, outages and emergencies.	Grid data: contingencies, outages, emergencies. Personalized alert notifications.	Energy app	Consumers

Exception path

Exception paths					
Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Missing input data from TSO	The input data, sent to the mobile energy app is missing. The app indicates the missing data and gives links to the alternative sources – web site of the TSO.	Grid data: contingencies, outages, emergencies	TSO	Energy app Consumers

HR 4.1. SANDBOX FOR VOLUNTARY PARTICIPATION IN ENERGY BALANCING MARKET.

Scope and objectives

Scope:

- Sandbox initiative for testing voluntary participation in the energy balancing market.
- Real-time alerts to consumers and Balancing Service Providers (BSPs) for adjusting energy consumption during grid imbalances.
- Financial incentives for participants who modify their consumption to support grid stability.

Objectives:

- Evaluate the feasibility of voluntary participation in energy balancing.
- Enhance grid stability by encouraging demand-side flexibility.
- Test real-time alert effectiveness in influencing energy consumption behaviour.
- Assess financial incentive models for consumers and BSPs.
- Provide insights into future regulatory frameworks and broader market adoption.

Narrative of the use case

This use case focuses on a sandbox initiative enabling consumers and Balancing Service Providers (BSPs) to voluntarily participate in the energy balancing market. Participants can adjust their energy consumption in response to requests from the Transmission System Operator (TSO) during periods of grid imbalance caused by high demand or insufficient supply.

The system sends real-time alerts to consumers and BSPs, encouraging them to modify their consumption habits to alleviate stress on the grid. This voluntary participation provides dual benefits: consumers and BSPs can receive financial incentives for their contributions, while the TSO achieves a more stable and cost-efficient grid operation. Being part of a sandbox program, this use case is still in its developmental stages and aims to test the feasibility of broader implementation. The sandbox serves as an experimental environment to assess how voluntary participation, real-time alerts, and incentive mechanisms can be refined to create an effective energy balancing system. Insights gained will shape future deployments and regulatory frameworks for the energy balancing market. Possibility of including Non-intrusive Load monitoring for this sandbox use case.

Diagram of the use case

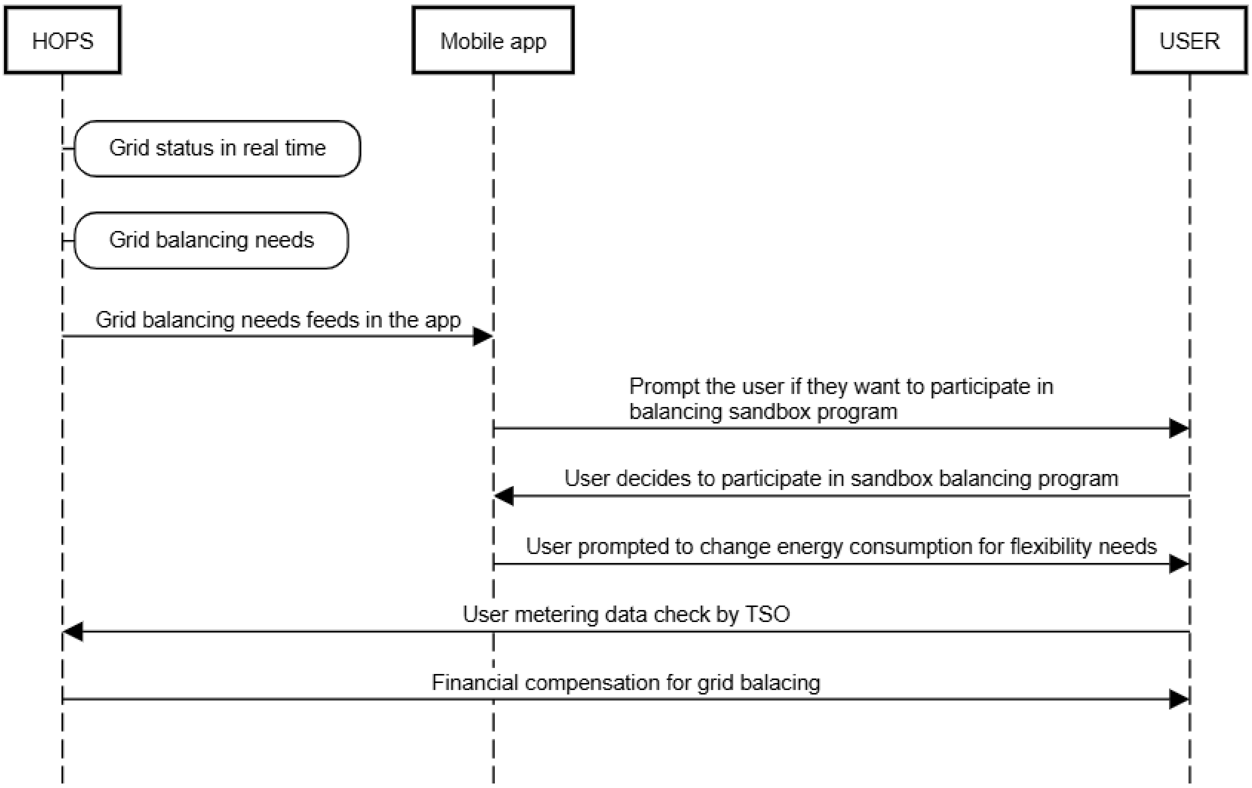


Figure 32. HR 4.1 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- Balancing Service Providers (BSPs).
- Transmission System Operator (TSO).
- Regulatory Authorities.
- App Developers.
- Data Analysts.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid imbalance detected	The TSO identifies a significant grid imbalance caused by high demand or insufficient supply.	Real-time grid imbalance data	TSO	App Backend
2	Request generated	The TSO sends a request for voluntary load adjustment to consumers and BSPs.	Request for load reduction	TSO	App Backend
3	Notification sent	The app sends real-time notifications to enrolled participants, encouraging them to adjust their energy consumption.	Notification message with action suggestions	App Backend	Consumers, BSPs
4	Participant action	Consumers and BSPs voluntarily adjust their energy usage as per the recommendation (e.g., delaying energy-intensive activities).	Adjusted energy consumption data	Consumers, BSPs	App Backend
5	Incentive applied	Incentives (e.g., financial rewards) are calculated and applied for participants based on their level of engagement.	Incentive and consumption data	App Backend	TSO, Regulatory Authorities
6	Grid balance achieved	The grid stabilizes, reducing the impact of the imbalance. Data from the sandbox program is collected for future improvements.	Post-action grid data and participant insights	App Backend	TSO, Regulatory Authorities

Exception path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data delay or inaccuracy	The TSO provides delayed or inaccurate grid data, leading to delayed or incorrect requests to participants.	Incomplete or inaccurate grid data	TSO	App Backend
2	Participant disengagement	Consumers or BSPs ignore the notifications or fail to act due to lack of incentives or unclear messaging.	Notification dismissed	Consumers, BSPs	App Backend
3	Privacy or engagement concerns	Participants withdraw from the sandbox due to concerns about data sharing or low perceived benefits.	User opt-out data	Consumers, BSPs	App Backend
4	Insufficient response	Limited participation results in inadequate load reduction, leaving grid imbalances unresolved.	Insufficient response data	Consumers, BSPs	App Backend
5	Incentive structure failure	If the incentive mechanisms are unclear, delayed, or insufficient, participants may lose trust or interest in the program.	Feedback or complaint data	Participants	App Backend
6	Sandbox limitations	The sandbox collects limited or unreliable data due to insufficient engagement or technical issues, reducing its effectiveness for future developments.	Participation and performance metrics	App Backend	Regulatory Authorities, TSO

HR 4.2. OPTIMIZING ENERGY CONSUMPTION FOR GRID STABILITY VIA DEMAND RESPONSE.

Scope and objectives

Scope:

- Real-time monitoring of grid conditions (energy demand spikes, overload risks) through data from the Transmission System Operator (TSO).
- Notifications to consumers (residential and commercial) urging them to adjust energy consumption during periods of grid stress.
- Participation in demand response programs, encouraging actions like reducing high-energy device usage or shifting usage to off-peak hours.
- Focus on grid stability rather than direct financial savings for consumers, though incentivization is provided through the knowledge of contributing to system health.

Objectives:

- Improve grid stability by reducing the risk of overloads or blackouts during high demand periods.
- Encourage user participation in demand response programs to shift energy consumption patterns.
- Optimize energy consumption across residential and commercial users to reduce grid stress.
- Increase consumer awareness of their role in contributing to grid stability.
- Test and refine demand response processes for greater efficiency in managing grid load.

Narrative of the use case

This use case targets improving grid stability by encouraging consumers to adjust their energy usage during times of high demand or grid stress, primarily through participation in demand response programs. The system monitors real-time grid data from the Transmission System Operator (TSO) to assess grid conditions, such as energy demand spikes or potential overloads. When the grid is under stress, the app sends notifications to consumers, urging them to reduce or shift their energy consumption to stabilize the grid. These notifications are aimed at residential and commercial users who can participate in demand response actions, such as reducing the use of high-energy devices or shifting usage to off-peak periods. The goal is to reduce the likelihood of grid failures or blackouts by preventing the grid from becoming overloaded. The system relies on real-time communication to inform users about when and how to adjust their consumption. By participating in such programs, users contribute to a more stable and resilient energy grid. While the benefits to the individual user are more aligned with grid stability rather than direct financial savings, consumers are incentivized by the knowledge that their actions are contributing to the overall health of the energy system. This use case not only focuses on the reliability of energy delivery but also on optimizing the demand response processes for more efficient energy consumption across the board.

Diagram of the use case

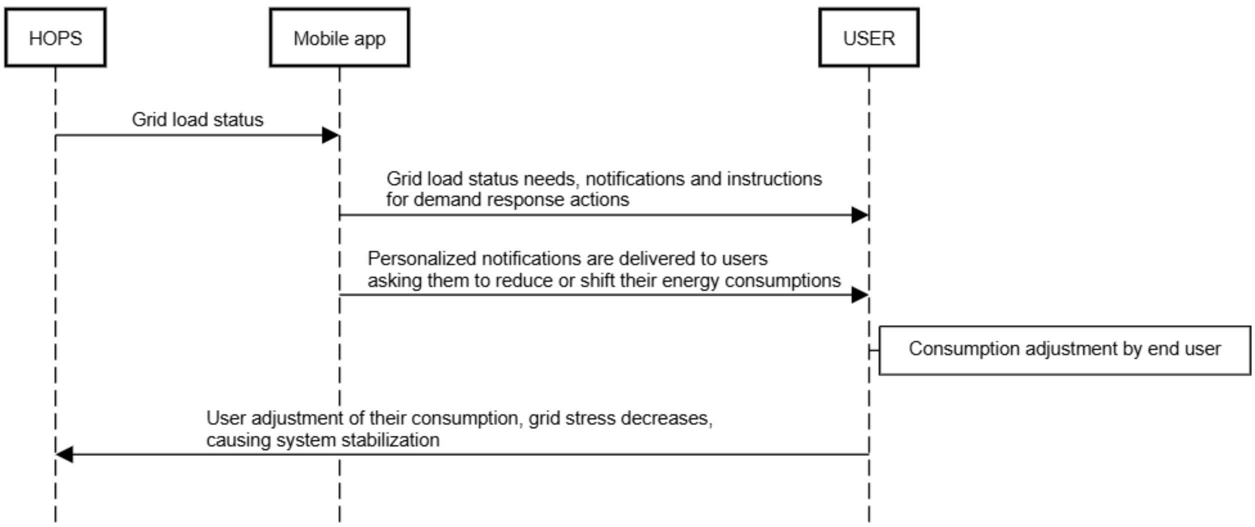


Figure 33. HR 4.2 diagram.

Actors of the use case

- Consumers (Residential and Commercial Users).
- TSO.
- Balancing Service Providers (BSPs).
- Energy Suppliers.
- Regulatory Authorities.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid stress detected	The TSO identifies stress or high demand on the grid and sends data to the app.	Real-time grid stress data	TSO	App Backend
2	Notification triggered	The app backend processes the grid stress data and triggers a notification to encourage demand response actions.	Notification content	App Backend	Notification System
3	Notification sent	Personalized notifications are delivered to users, asking them to reduce or shift their energy consumption.	Notifications	Notification System	Consumers (Users)
4	User action	Users adjust their energy usage based on the recommendations in the notification (e.g., reduce device usage).	User response (action or feedback)	Consumers (Users)	Grid Stability System (TSO)
5	Grid stability improved	As users adjust their consumption, grid stress decreases, and the system stabilizes.	Demand reduction data	Consumers (Users)	TSO

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Users fail to comply	Users do not adjust their energy consumption as recommended in the notification.	Lack of user engagement	Consumers (Users)	TSO
2	Communication delays	Delays in receiving grid stress data from the TSO lead to late notifications, reducing the effectiveness of demand response.	Delayed grid stress data	TSO	App Backend
3	Inaccurate grid data	Errors in grid stress data result in inappropriate or irrelevant notifications being sent to users.	Faulty grid data	TSO	App Backend
4	Notification delivery failure	Technical issues prevent notifications from reaching users in time or at all.	Error logs	App Backend	Notification System
5	Users opt out of demand response	Some users may choose to opt out of the program, reducing overall demand response participation.	Opt-out preferences	Consumers (Users)	App Backend

HR 4.3. EMERGENCY GRID OVERLOAD ALERTS.

Scope and objectives

Scope:

- Real-time emergency alerts to consumers during grid overload events caused by extreme weather, high demand, or system failures.
- Notifications with specific instructions for consumers (residential and commercial) to reduce energy usage and prevent grid overload.
- Integration with real-time data from the Transmission System Operator (TSO) and energy management platforms to trigger alerts and guide user actions.

Objectives:

- Prevent grid overloads and potential blackouts by notifying consumers to reduce energy consumption during critical times.
- Promote quick, actionable responses from consumers to help balance the grid and prevent further strain.
- Provide clear instructions on how consumers can adjust energy usage, such as turning off high-energy appliances or switching to low-power modes.
- Enhance grid stability by enabling consumers to play an active role in protecting infrastructure during emergencies.
- Test and improve emergency response systems to ensure effective real-time communication during grid overloads.

Narrative of the use case

This use case focuses on providing real-time emergency alerts to consumers during instances of grid overload. Grid overloads can occur during extreme weather, unexpected surges in demand, or system failures. The goal is to quickly inform consumers to take immediate actions, such as reducing energy usage, to prevent a full system overload or blackout. By notifying users to decrease non-essential energy consumption during peak demand periods, the system helps balance the grid and avoids further strain on the infrastructure. The app uses real-time data from the Transmission System Operator (TSO) and energy management platforms to send alerts to residential and commercial consumers. These alerts will include specific instructions such as turning off high-energy appliances or switching to low-power modes, all with the aim to stabilize the grid and maintain overall system integrity.

Diagram of the use case

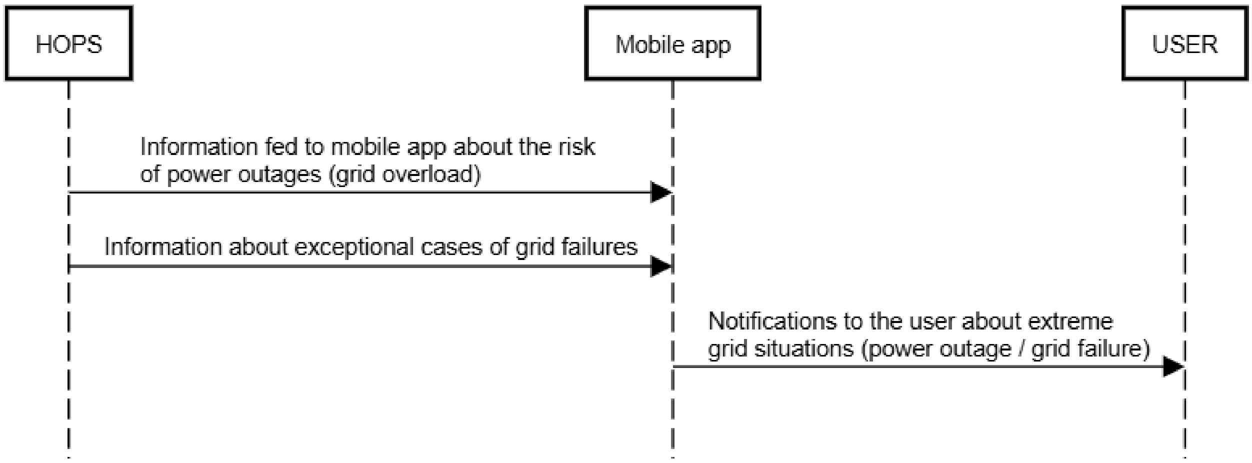


Figure 34. HR 4.3 diagram.

- The app integrates emergency data from the TSO regarding grid capacity, energy shortages, or unexpected events.
- General alerts are sent to users during these extreme situations, instructing them to take immediate action, such as reducing energy usage or switching to backup power.
- Messages may be sent through push notifications, SMS, or emails, depending on the severity.

Actors of the use case

- Consumers (Residential/Commercial Users): Respond to the emergency alerts and modify their energy usage accordingly.
- Utility Companies (Electricity Distribution System Operators): Monitor grid health and send overload signals to the app.
- Transmission System Operator (TSO): Provides real-time grid data related to overload conditions.
- Energy Suppliers: Work with grid operators to manage electricity distribution during overloads.
- Regulatory Bodies: Ensure that grid overload notifications and responses comply with energy regulations.
- Emergency Service Providers: Assist in managing grid issues during critical overloads.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid overload detected	TSO detects an overload situation caused by a spike in demand or extreme weather.	Overload signal data	TSO	Energy management platform
2	Alert sent to consumers	The app delivers a real-time alert to users, asking them to reduce energy usage.	Notification with action instructions	Energy management platform	Consumers (Residential/Commercial)
3	Consumers take action	Users adjust their energy consumption (turn off high-energy appliances, etc.).	Reduced energy usage data	Consumers	Energy management platform
4	Grid demand is reduced	Reduced energy consumption helps lower overall grid demand, stabilizing the grid.	Updated grid demand status	Energy management platform	Grid management infrastructure

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Alert delivery failure	The alert delivery system fails due to network or system issues.	Backup communication (SMS, email)	App/System	Consumers (Residential/Commercial)
2	No response from consumers	Consumers fail to take action within the given time frame.	Alert status and missed response data	Consumers	Energy management platform
3	Fallback mechanism initiated	The system initiates a fallback action, such as rolling blackouts or temporary service reductions.	System warning about power cuts	Energy management platform	Grid operators, consumers

HR 4.4. SEVERE WEATHER AND EMERGENCY RESPONSE ALERTS.

Scope and objectives

Scope:

- Real-time alerts to consumers during severe weather events (heatwaves, storms, snowstorms) that could impact energy grid stability.
- Notifications advising consumers to reduce energy usage or shift consumption to off-peak hours to help balance grid load.
- Integration of weather prediction systems and data from the Transmission System Operator (TSO) to anticipate energy demand surges or supply reductions.
- Suggestions for specific actions such as turning off high-energy appliances or reducing heating/cooling usage during extreme weather.

Objectives:

- Prevent energy shortages and maintain grid stability during severe weather events.
- Encourage consumer participation in demand reduction by providing actionable insights for energy-saving actions.
- Improve grid resilience by reducing the risk of overloads caused by extreme weather conditions.
- Enhance forecasting and coordination by using weather prediction systems and TSO data to anticipate and manage energy demand.
- Optimize energy consumption during high-demand periods to prevent strain on the grid and ensure continuous service.

Narrative of the use case

This use case addresses severe weather conditions, such as heatwaves, storms, or snowstorms, that can strain energy grid capacity. During such events, the demand for energy increases or supply decreases, leading to potential grid instability. The app provides real-time alerts to consumers, notifying them of the anticipated energy demand caused by severe weather and advising them to reduce energy usage or shift their consumption to help balance the grid. These alerts could include suggestions to turn off high-energy appliances or reduce heating/cooling usage. The goal is to prevent energy shortages and ensure grid stability during extreme weather conditions, with the help of advanced weather prediction systems and data from the TSO.

Diagram of the use case

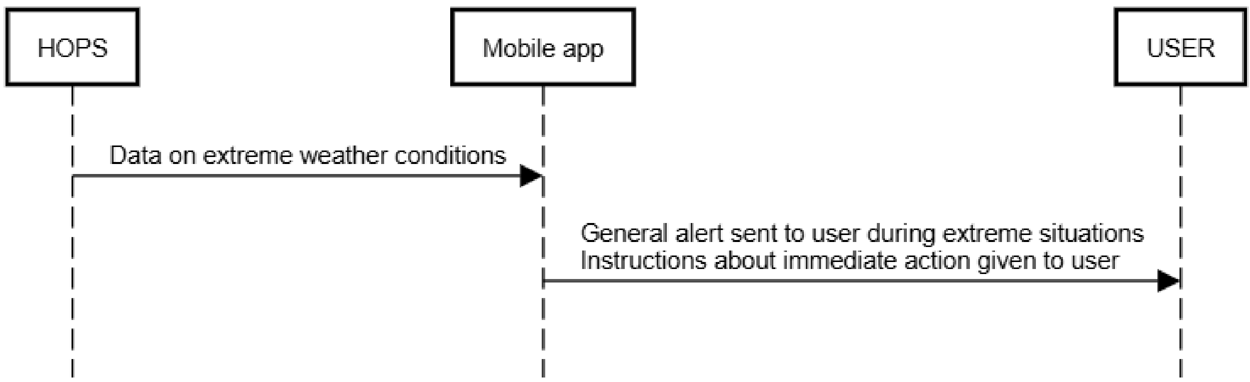


Figure 35. HR 4.4 diagram.

- The app integrates emergency data from the TSO regarding grid capacity, energy shortages, or unexpected events.
- General alerts are sent to users during these extreme situations, instructing them to take immediate action, such as reducing energy usage or switching to backup power.
- Messages may be sent through push notifications, SMS, or emails, depending on the severity.

Actors of the use case

- Consumers (Residential/Commercial Users): Respond to weather-related alerts by adjusting their energy consumption.
- Energy Suppliers: Coordinate with grid operators to ensure that sufficient energy is available during severe weather events.
- Transmission System Operator (TSO): Provides real-time weather-related data and potential risks to the grid.
- Smart Meter Manufacturers: Provide the necessary infrastructure for energy tracking.
- Regulatory Bodies: Ensure that weather-related grid demand management practices are following regulations.
- Emergency Service Providers: Work in coordination with grid operators during severe weather events to prevent outages.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Severe weather detected	The TSO receives data on an impending weather event that may impact the grid.	Weather data and expected grid impact	TSO	Energy management platform
2	Weather impact analyzed	The energy management platform analyzes the potential impact on energy demand.	Predicted demand surge and potential grid strain	Energy management platform	Consumer app, energy suppliers
3	Alerts sent to consumers	The app sends notifications advising users to reduce energy consumption or shift usage.	Notification to reduce energy use (turn off devices, etc.)	Consumer app	Consumers (Residential/Commercial)
4	Consumers adjust energy consumption	Consumers take action to reduce consumption based on the alerts.	Consumption data showing a reduction	Consumers	Energy management platform
5	Grid stability maintained	Reduced energy consumption helps maintain grid stability and prevent outages.	Grid status update showing stability	Energy management platform	TSO, grid operators

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Inaccurate weather data	If the weather data provided is inaccurate, alerts may be unnecessary or delayed.	Incorrect weather data or delayed impact prediction	TSO	Energy management platform, consumers
2	Alerts not received or ignored	If consumers don't receive the alerts (e.g., technical issues) or ignore them, grid strain may occur.	Alert delivery failure, consumer feedback	Consumer app, consumers	Energy management platform
3	Consumers do not adjust energy consumption	Consumers fail to respond to alerts, and grid stability is threatened.	Failure to reduce consumption during peak times	Consumers	Energy management platform, TSO
4	Emergency measures initiated	Due to lack of response, emergency measures (e.g., rolling blackouts) are initiated to prevent overload.	Emergency measures, grid overload status	TSO, Energy suppliers	Consumers, Energy suppliers

HR 4.5. BLACKOUT AND CRITICAL EMERGENCY ALERTS.

Scope and objectives

Scope:

- Real-time alerts consumers when the grid is at risk of a blackout or during a critical energy emergency.
- Multiple communication channels (SMS, email, push notifications) to ensure timely delivery of alerts.

- Instructions for consumers to reduce energy consumption, such as turning off non-essential appliances or reducing heating/cooling use.
- Feedback to consumers on the impact of their actions in stabilizing the grid.

Objectives:

- Prevent blackouts by urging consumers to take immediate action during critical grid situations.
- Reduce energy consumption through clear instructions, such as turning off non-essential appliances or shifting to backup power systems.
- Enhance consumer awareness of their role in grid stabilization by providing feedback on their actions.
- Improve grid reliability by mitigating the risk of blackouts through coordinated demand-side responses.
- Test and refine emergency communication strategies to ensure effective and timely consumer participation in energy-saving actions.

Narrative of the use case

In this use case, the app provides alerts to consumers when the grid is at risk of a blackout or when a critical energy emergency occurs. The goal is to mitigate the risk of a full blackout by ensuring that consumers take immediate action to reduce energy consumption. This may involve turning off non-essential appliances, reducing heating or cooling use, or switching to backup power systems. The app will notify users via multiple channels (SMS, email, or push notification) when a blackout is imminent and will provide specific instructions to help alleviate the grid's pressure. The app will also provide feedback to consumers on how their actions contributed to grid stabilization.

Diagram of the use case

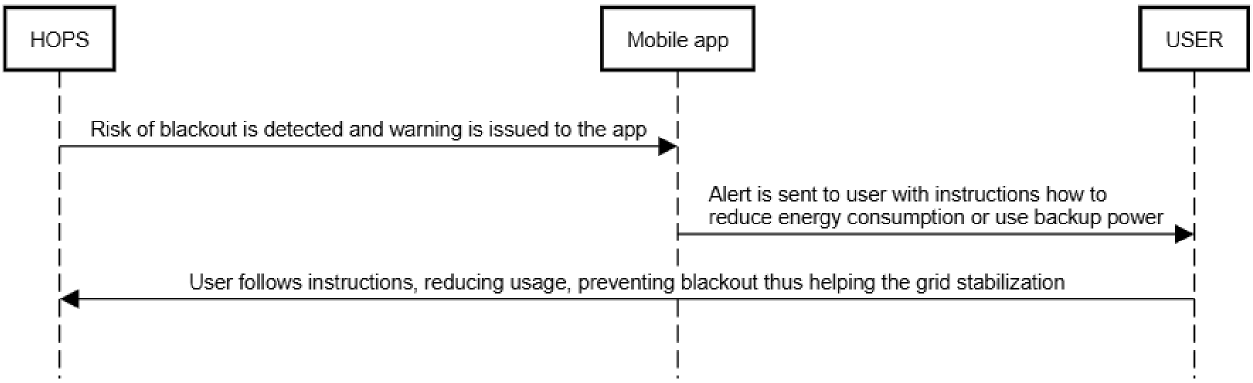


Figure 36. HR 4.5 diagram.

- The app integrates emergency data from the TSO regarding grid capacity, energy shortages, or unexpected events.
- General alerts are sent to users during these extreme situations, instructing them to take immediate action, such as reducing energy usage or switching to backup power.
- Messages may be sent through push notifications, SMS, or emails, depending on the severity.

Actors of the use case

- Consumers (Residential/Commercial Users): Respond to blackout alerts by reducing energy usage or activating backup power systems.
- Utility Companies (Electricity Distribution System Operators): Ensure that the grid can accommodate emergency conditions and reroute power to prevent outages.
- Transmission System Operator (TSO): Monitors grid capacity and provides real-time updates on the potential for blackouts.
- Backup Power Providers: Ensure that backup systems (e.g., generators) are available and functioning to support users.
- Regulatory Bodies: Oversee the implementation of emergency energy protocols and communications.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Risk of blackout detected	The TSO detects a risk of a blackout due to system failure or energy shortage.	Risk of blackout, grid status data	TSO	Energy management platform
2	Alert sent to users	The app sends immediate alerts to users with instructions to reduce energy consumption or use backup power.	Blackout warning, instructions for energy conservation	Consumer app	Consumers (Residential/Commercial)
3	Users respond to alert	Consumers take action to reduce energy consumption, turn off non-essential appliances, or activate backup power systems.	Consumption data showing reduction or backup power activation	Consumers	Energy management platform
4	Grid stabilizes	The grid stabilizes due to reduced consumption, preventing the blackout.	Grid recovery status	Energy management platform	TSO, Grid operators
5	Feedback provided	The app provides feedback to users on how their actions contributed to stabilizing the grid.	Feedback message on user contribution to grid stability	Consumer app	Consumers

Exception path

Exception paths					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication channel failure	If the primary communication channels (push notification) fail, alternate channels (SMS, phone call) are used.	Failure in primary communication, alternate methods activated	Emergency communication system	Consumers
2	Consumers ignore alert	If consumers ignore the alert and do not reduce consumption, the system may activate backup power systems to manage the load.	Activation of backup power, increased load on the grid	Consumers, Backup power systems	Energy management platform, TSO
3	Backup power failure	If backup power systems fail, the grid may experience a full overload, requiring manual intervention.	Backup power failure, alert on system status	Backup power providers	Consumers, TSO, Energy suppliers
4	Grid fails despite user action	If users fail to take action or if the load is too high despite efforts, the grid may experience a blackout or partial failure.	Notification of system overload or blackout	TSO, Energy suppliers	Consumers, Grid operators

CZ 4.1. NOTIFICATIONS OF POWER OUTAGES CAUSED BY NATURAL DISASTERS.

Scope and objectives

The scope is a to inform customer via the mobile app about serious weather events and conditions in the grid.

Narrative of the use case

This use-case will in case of extreme weather events notify customers about serious grid issues based on DSO/TSO information directly in the app via push notification (failures and planned outages are already implemented). The user receives notifications about the occurrence, progress and termination of a fault at their point of consumption. An incoming message to the mobile application's inbox triggers a push notification. Disaster conditions and weather warnings will only be notified in the form of a push notification in the mobile application.

Diagram of the use case

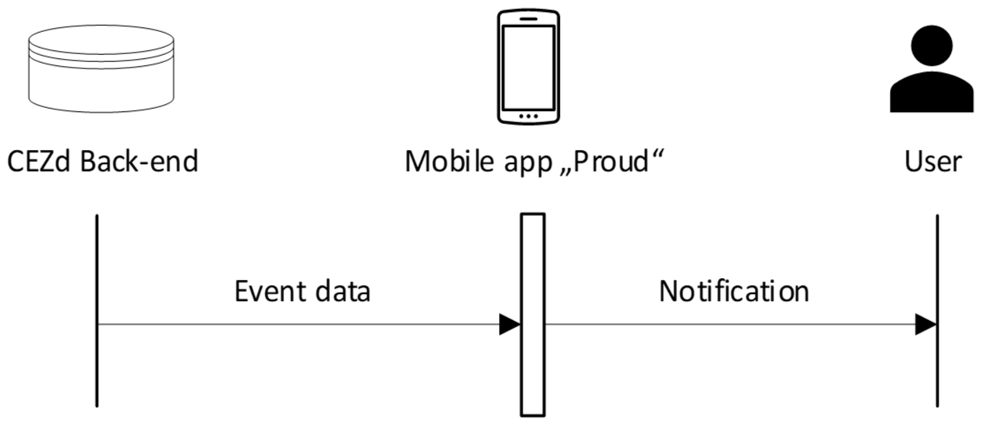


Figure 37. CZ 4.1 diagram.

Actors of the use case

- Customer (mobile application user).
- Energy data provider (DSO).
- System administrator.
- Outage management system.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App opened	The user opens the mobile application and navigates to the disaster notification section	User request	User	Mobile application
2	List displayed	The system displays the current list of selected notification options	Notification data	Mobile application	User
3	Notification modified	The user selects or modifies their notification	Updated notification selection	User	Mobile application
4	Notification received	In case of triggered event the notification is displayed	Notification data	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Data unavailable	If notification data is unavailable, the system notifies the user	Error message	Mobile application	User

RO 4.1. HELP IN PRESERVING GRID HEALTH (HGH).

Scope and objectives

Using input related to overload on transformer or general fuse and possible near-term disconnection to preserve grid against damage, users can voluntarily and temporarily reduce their consumption while further monitoring the evolution of the limitation means.

Narrative of the use case

User's behaviour regarding its own consumption is driven by their own needs and is not usually influenced at all by the grid status. However, in specific cases the simultaneous increase in consumption by most of the users connected to an MV/LV transformer may become a critical situation at the transformer level, which may enter in an overload status which is finally bringing a disconnection of the entire LV grid downstream to the transformer. Such disconnection affects the entire LV connected community and might be solved if messages are sent in advance to all users so that a voluntary and temporary reduction of consumption can avoid disconnection. The use-case tests such awareness regarding the grid status at transformer level, which can be monitored by the end-users when a danger of disconnection exists due to over-consumption of the entire LV-connected users, thus allowing them to act as a conscious energy community during grid limit situations.

Diagram of the use case

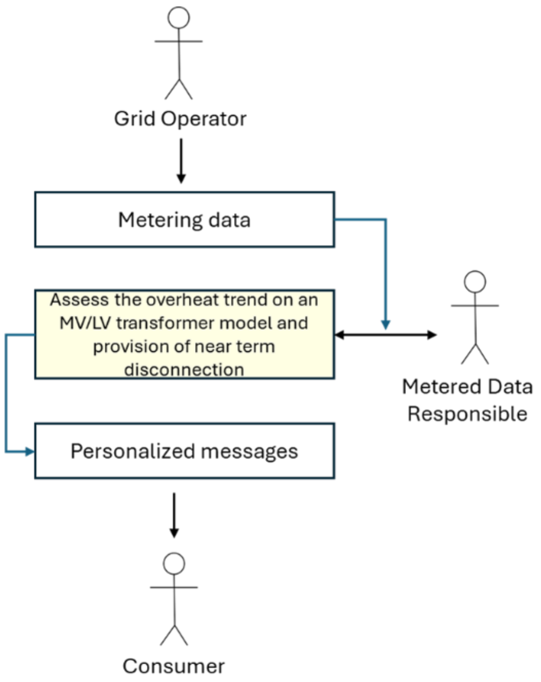


Figure 38. RO 4.1 diagram.

Actors of the use case

- Consumer.
- Metered Data Responsible (AMR system operator).
- Grid Operator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Overload on a critical section of the grid	overload is monitored in FEE or in the aggregated consumption of the dwelling and thresholds are detected	Critical section average power, timeframe	Metered Data Responsible	App
2	Send advice	Send info which points that consumption should be reduced in order to avoid grid disconnection	Message	App	Consumer
3	Check evolution of the critical section consumption	Use critical section meter data to see change of consumption	Message	Metered Data Responsible, App	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Rejection of advice due to some circumstances	Due to some circumstances, the end user does not intend to implement the advice	Notification	Customer	App
2	Advice cannot be implemented	If the customer is not in the consumption area, he might not be able to implement the advice	Lack of reaction	Customer	App

RO 4.2. HELP IN AVOIDING EXTREME GRID SITUATIONS (HAEGS).

Scope and objectives

Use Faculty of Energy Engineering (FEE) to partially simulate in twin approach (with a load-flow algorithm applied on the simulated grid, by using also similitude factors applied to real measured data) extreme grid situations which are reported in the App in order to change user behaviour and potentially improve grid status based on DSO information.

Narrative of the use case

Extreme grid situations may bring long time disconnection of energy communities. However, smart energy communities can reduce the impact of such situations and can increase their resilience by changing the community behaviour to cope with restricted energy supply or even to complete blackouts of the main grid. As it is difficult to simulate such situations within real grid situations, the use-case is using a combination of simulated grid (by using quasi real time load flow calculation) and similitude factors to apply on PV production consumption and storage, to create a twin model where specific extreme grid situations can be simulated. This is also coupled with informative and awareness messages to selected users, to allow their participation as active consumers in increasing their resilience.

Diagram of the use case

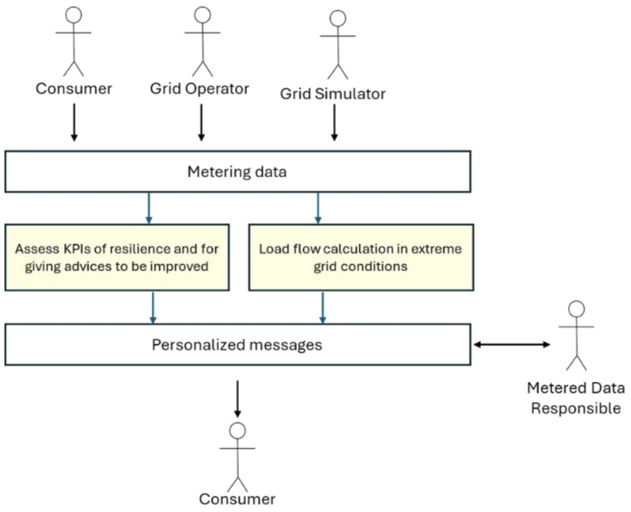


Figure 39. RO 4.2 diagram.

Actors of the use case

- Consumer.
- Metered Data Responsible (AMR system operator).
- Grid simulator.
- Grid Operator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Extreme grid situation is foreseen in near future or already exist	Extreme grid situations are detected in the simulated twin grid, having superposed some real data and extreme situations are foreseen or detected	Critical grid situation	Metered Data Responsible, quasi-real-time load-flow calculator	App
2	Send advice	Send info which points possible prosumer behavior to avoid extreme grid situations	Message	App	Prosumer, Consumer
3	Check evolution of the twin grid	Use data which describe an aspect of the extreme grid situation	Message	Metered Data Responsible, quasi-real-time load-flow calculator, App	Prosumer, Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Advice cannot be implemented	If the customer is not able to take measures for helping the grid	Limitation describing the limitation	Prosumer, Consumer	App

PL 4.1. DEMAND SIDE FLEXIBILITY BASED ON NON-ECONOMIC INCENTIVES IN SPECIFIC NETWORK SITUATIONS.

Scope and objectives

Extraordinary grid conditions create too many unforeseen situations which have gruesome impact on TAURON operations. One of means to reduce its burden is introduction of TSO's recommended usage hourly periods that were used as a ground to introduce first in Poland dynamic distribution tariff. Upon its introduction TAURON Dystrybucja targets the most flexible power customers who will engage in effective usage balancing. Furthermore, dynamic tariff allows to adjust to extreme grid conditions in close-to-real time. Thus, this will allow shifting aggregated usage within the recommended time schedule resulting in better load management.

Narrative of the use case

TAURON Dystrybucja SA has introduced a new innovative grid tariff. G14dynamic is a four-zone tariff where the duration of the time zones throughout the day - 'recommended use', 'normal use', 'recommended saving', and 'required curtailment' - varies according to the situation in the national energy system (e.g. forecast production from wind and solar provided by TSO). Customers given this information can easily determine when their electricity usage is most or least environmentally friendly and grid friendly. Those who can flexibly manage their energy consumption can thus reduce the amount of their distribution service bills.

In the eLicznik app, we want to provide the information about these zones to customers and empower them to manage their consumption in more environmentally and grid-friendly manner.

In the first step, the information will come from the national electricity system level (TSO). In the future, this information may be site-specific and come from the DSO systems.

We will put some push information to motivate our customer to:

1. Shift their energy consumption voluntarily without direct economic benefits. The need could be based on current network situation (e.g., voltage levels in the local grid).

2. Limiting the shutdown of PVs caused by voltage situation by increasing the self-consumption in certain time periods.

3. Change the PV technical parameters at your DSO. We've many cases, where our customer when rebuilding their PV installation, increases the PV power without informing the DSO.

Diagram of the use case

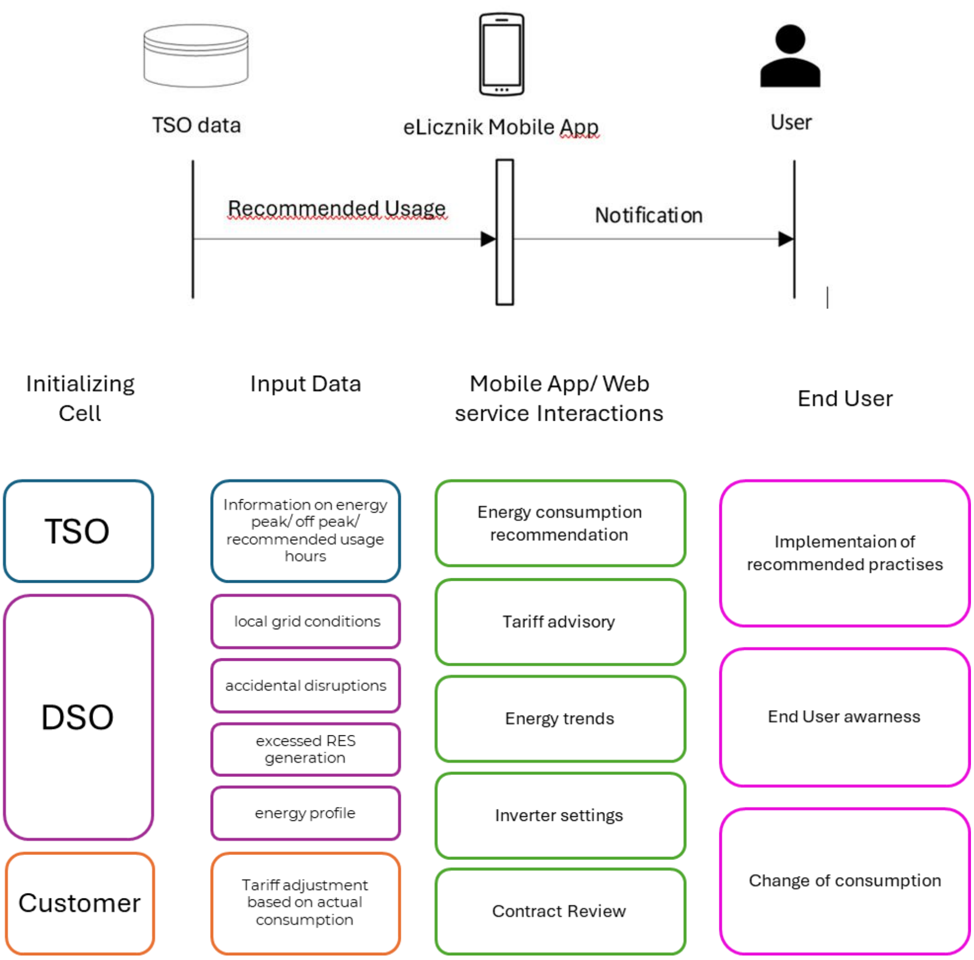


Figure 40. PL 4.1 Diagram

Actors of the use case

- PSE (TSO).
- TAURON Dystrybucja (DSO).
- Customers.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	PSE has forecasted the operation of the national electricity system by setting the energy peak hours for the next day	PSE publishes information on D+1 energy peak hours (time-slots for: 1. recommended use, 2. normal use, 3. recommended saving, 4. restriction required)	Info about the D+1 time-slots for: 1. recommended use, 2. normal use, 3. recommended saving, 4. restriction required	TSO data	DSO
2	Message sent to Customer	The DSO makes this data available to its customers via eLicznik app	Info about the time-slots for: 1. recommended use, 2. normal use, 3. recommended saving, 4. restriction required	eLicznik app	Customer
3	Change in customer energy consumption behaviour	Customer manages the consumption in order to act in a more environmentally and grid-friendly manner	Energy profile	Customer	DSO, TSO

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	PSE changed forecasted operation in real time	PSE has adjusted forecasted settings of peak and offpeak hours during actual day (D) -	Info about the D time-slots for: 1. recommended use, 2. normal use, 3. recommended saving, 4. restriction required	TSO data	DSO
2	Message sent to Customer	The DSO makes this data available to its customers via eLicznik app	Info about the time-slots for: 1. recommended use, 2. normal use, 3. recommended saving, 4. restriction required	eLicznik app/ web service	Customer
3	Change in customer energy consumption behaviour	Customer manages the consumption in order to act in a more environmentally and grid-friendly manner	Energy profile	Customer	DSO, TSO

GR 4.1. RISK MANAGEMENT AND OPERATIONAL RESILIENCE IN DISTRIBUTION SYSTEMS.

Scope and objectives

In the event of a failure in a section of the distribution network that supplies a group of consumers, the remaining part of the line is typically transferred to an adjacent feeder to ensure the continued supply of electricity. However, this scenario increases the risk of overloading network components (transformers, lines), potentially leading to further line failures and even damage to critical assets.

The objective of this use case is to mitigate such risks by proactively informing end users about the network status and encouraging them to reduce their electricity consumption during critical situations. By leveraging real-time user engagement, the approach aims to maintain service continuity while preventing further network disruptions, ultimately enhancing the resilience and stability of the distribution system.

Narrative of the use case

The loss of operation in a distribution line typically necessitates transferring users to a neighbouring line, which can burden the transformer, forcing it to operate at or near full capacity (95-100%). This state increases the risk of overloading, potentially causing service interruptions and further compromising the reliability of the distribution network.

To address this issue, regulating electricity consumption through user participation is being explored as a solution. This approach aims to use the end user as a "lever" to manage demand during critical situations, potentially alleviating strain on the system. Pertinent research focuses on implementing the demand-response mechanisms, designing effective incentives through feedback, and monitoring user response. The study also evaluates the short- and long-term impacts of this strategy on minimizing risks and improving network resilience.

Diagram of the use case

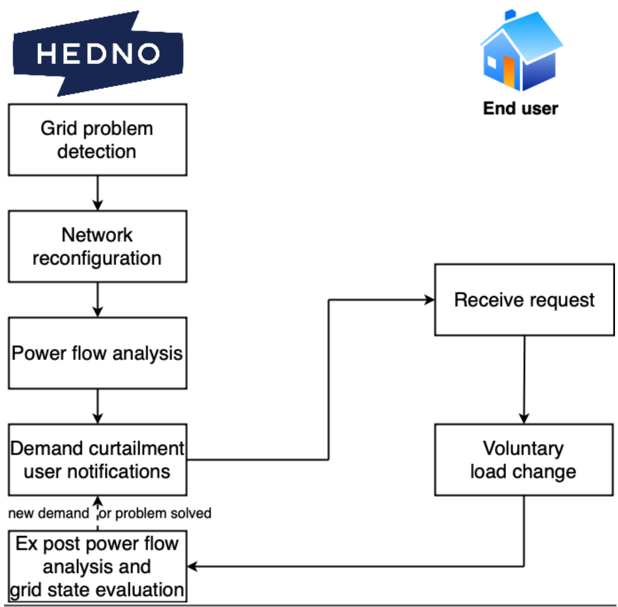


Figure 41. GR 4.1 diagram.

Actors of the use case

- Distribution System Operator.
- Customer.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid problem detected	A line fault is detected in a DSO area. Customers are automatically rerouted.	Network area affected, Grid load change, Timeframe	Local DSO Department	DSO Use Case Service Provider
2	Load flow simulation	The current grid configuration is simulated based on current and historical data.	Load flow, timeframe	DSO Use Case Service Provider	-
3	optimization	The algorithm calculates suggested load curtailment based on parameters.	Load flow, timeframe, curtailment output	DSO Use Case Service Provider	-
4	communication	Suggested curtailment is communicated to each user.	Curtailment output, timeframe	DSO Use Case Service Provider	Customer (through APP)
5	monitoring	Grid load flow is monitored	Grid load change, Timeframe	Customer (through metering)	Local DSO Department
6	evaluation	User response is evaluated	Grid load change, Timeframe	Local DSO Department	DSO Use Case Service Provider

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	No neighboring line	Users cannot be rerouted during line fault	Network area affected	Local DSO Department	DSO Use Case Service Provider
2	No smart metering in area	Users are given a generic suggestion of reducing unnecessary loads	Network area affected, Grid load change	Local DSO Department	DSO Use Case Service Provider
3	No participating users in area	BaU	Network area affected	Local DSO Department	DSO Use Case Service Provider

PT 4.1. FLEXIBILITY SERVICES UNDER EXTREME CONDITIONS.

Scope and objectives

This use case focuses on the publication of emergency signals for certain grid areas in case of anticipated extreme events such as natural disasters, wildfires, floods, etc. In this scenario, consumers are asked to adjust their energy consumption, providing critical flexibility, to maintain grid stability during crises, ensuring rapid and responsive grid management.

By leveraging the data from consumers, grid stability and resilience are ensured, even under challenging conditions. This enables a more adaptive energy network that is better equipped to handle unforeseen disruptions.

Narrative of the use case

Upon an emergency request for participation, issued by a TSO, including expected power, period of the need, deadline for participation and applicable geographical zone, consumers submit their response indicating the actions taken by them to adjust their consumption during the needed period. Based on this information, the total available flexibility that can be used to reduce grid impact is estimated and transmitted to the TSO.

Once the consumer smart meter data relative to the day of need and precedent days is available, the flexibility data, which includes the baseline curve and the real flexibility provided, is calculated and stored for subsequent consultation.

This use case gives both grid operators and consumers tools to respond quickly and appropriately during critical situations that threaten grid stability and public safety. Some indicators such as the number of participants, response time from consumers, as well as the amount of emergency flexibility activated are registered and stored for later analysis.

Diagram of the use case

The following diagram describes the different stages of the participation process and how data is transferred between all actors involved.

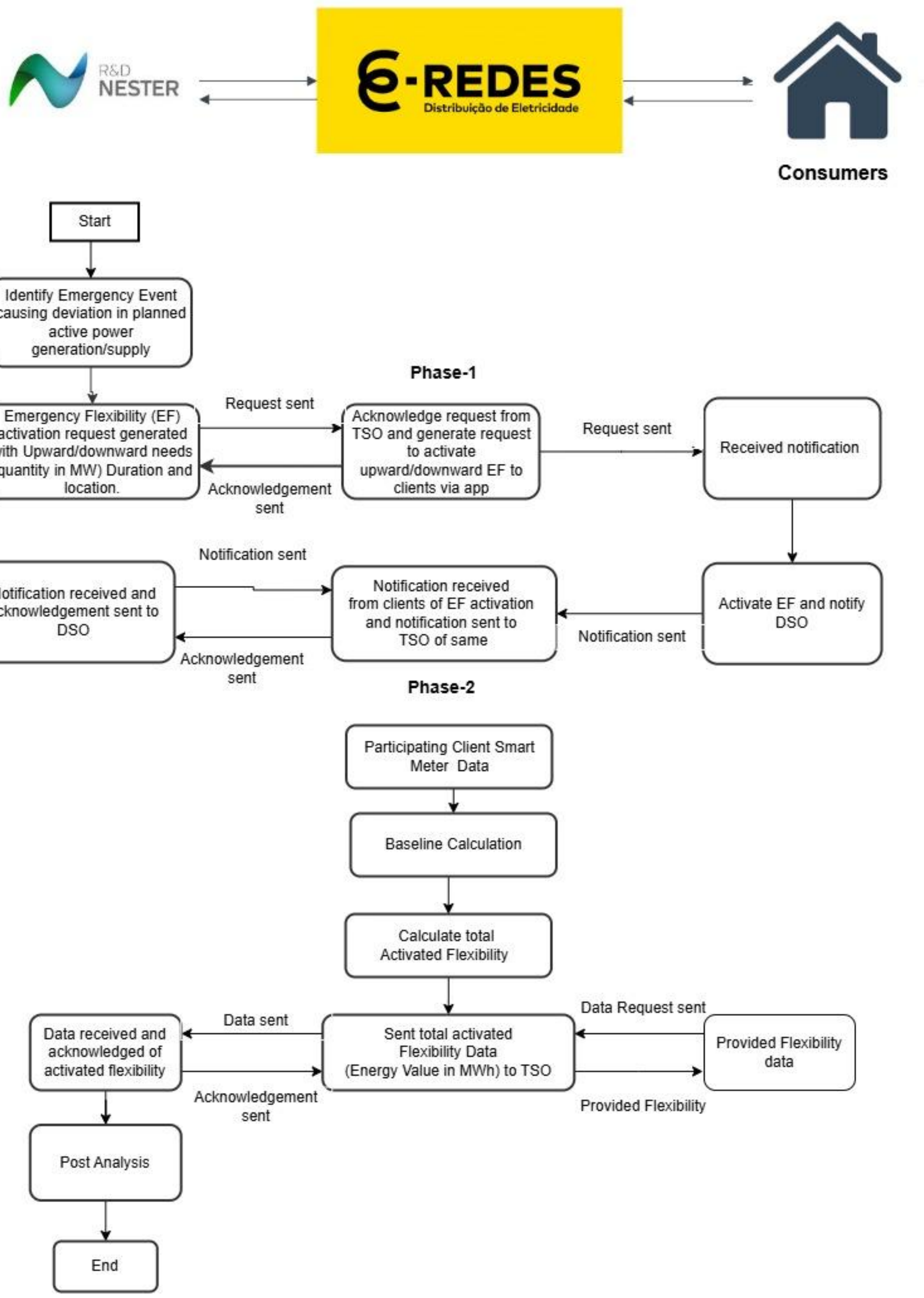


Figure 42. PT 4.1 diagram.

Actors of the use case

- Transmission system operator (TSO).
- Distribution system operator (DSO).
- Consumers.

Scenarios

The triggering event for this use case will consist in the loss of interconnection between TSOs due to extreme weather conditions that result in either significant lack of generation or excess of generation due to which system will be in alert state.

For the use case to be initiated, the following conditions must be true:

- Forecast of extreme grid event.
- Grid monitoring systems are operational.
- Consumers have a smart meter installed in their houses and measurements are automatically uploaded to a data processing platform.
- DSO and consumers have pre-signed contracts which allow DSO to use their consumption data to calculate the emergency flexibility activated by them.
- Communication and data exchange channels are available between actors and products involved.

By the end of the use case, it is expected that consumers have provided flexibility by shifting or increasing/reducing their load demand in the required time to achieve grid stability under extreme grid conditions. Their responses will be measured in terms of number of active users; response time and total amount of flexibility provided.

Main path

The following tables describe the main paths of this use case from the DSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application or Databricks Platform).

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Request is issued	A TSO shares an emergency activation request through an API, which is registered by Balcão Digital.	Request data	TSO (Market Simulator)	DSO (Balcão Digital App)
2	Delivery of request	Balcão Digital passes on the emergency activation request to the consumer.	Request data	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
3	Receival of consumer response	The consumer submits a response to the activation request on the app.	Activation response	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
4	Transmission of activated consumers list and the estimated flexibility provided	The list of consumers who activated their flexibility and an estimate of the flexibility provided by each consumer are sent to the TSO.	Consumers list of activated flexibility and provided flexibility estimation	DSO (Balcão Digital App)	TSO (Market Simulator)

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Calculation and storage of provided flexibility	Databricks Platform calculates the baseline curve, flexibility provided and, when applicable, price or green credits. Flexibility data is stored in a Databricks repository.	Flexibility data	DSO (Databricks Platform)	
2 (Applicable if previous UC is UC 1.2)	Transmission of provided flexibility	The provided flexibility obtained is sent to the TSO for post-analysis.	Provided flexibility	DSO (Databricks Platform)	TSO (Market Simulator)
3	Consultation request	The consumer makes a request to consult his flexibility data on the app.	Request	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
4	Transmission of consultation request	Balcão Digital transmits the consumer request to the Databricks Platform.	Request	DSO (Balcão Digital App)	DSO (Databricks Platform)
5	Transmission of flexibility data	The flexibility data stored in the Databricks Platform is transmitted to Balcão Digital.	Flexibility data	DSO (Databricks Platform)	DSO (Balcão Digital App)
6	Provision of flexibility data	The provided flexibility data is made available for consultation on the app.	Flexibility data	DSO (Balcão Digital App)	Consumer (Balcão Digital App)

As for the TSO´s point of view, the following main path applies for this use case:

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	TSO send a request for emergency flexibility activation with needs and location	TSO requests to activate emergency flexibility from consumers to DSO during emergency event	Emergency flexibility needs (MW), time period. Direction: upward/downward	TSO	DSO
2	DSO send request for emergency flexibility activation	DSO will send requests to consumers through the digital application to provide emergency flexibility. (upward/downward)	Request to provide emergency flexibility, time period (duration) Direction: upward/downward	DSO	Consumers
3	Consumer action	Consumers will shift or increase/decrease their load as requested	Emergency flexibility in (MW), time period /duration	Consumers	DSO
4	Consumers send notification	Consumer will notify about emergency flexibility activation to DSO	Notification of flexibility activation	Consumers	DSO
5	Activated emergency flexibility calculation/Settlement	DSO will calculate the total activated flexibility and send it to TSO	Aggregated flexibility value in (MWh)	DSO	TSO
6	TSO send acknowledgement	TSO will acknowledge the data received for	Acknowledgement of receiving total emergency	TSO	DSO

		total emergency flexibility activation from DSO	flexibility data in MWh		
7	Post Analysis	After receiving the data TSO will do the post analysis which may include grid status, requirement of other emergency analysis etc.	Grid status	TSO	TSO
8	Measurements	Response time of consumers total activated emergency flexibility by consumers and no. of unresponsive consumers will be measured/recorded, saved and sent by DSO to TSO	No. of participants, responsive consumers and their response time, total activated emergency flexibility by consumers	DSO and Consumers	TSO

Exception path

The following tables describe the exception paths of this use case from the DSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application or Databricks Platform).

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1a / 4a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Request data / Consumers list of activated flexibility and provided flexibility estimation	TSO/DSO (Market Simulator/Balcão Digital App)	TSO/DSO (Market Simulator/Balcão Digital App)
3a	Lack of participation from consumers	No responses are submitted regarding the emergency activation request issued by the TSO.	None	Consumer (Balcão Digital App)	DSO (Balcão Digital App)

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1a	Null or negative provided flexibility	A null or negative value of provided flexibility and price / green credits is obtained.	Flexibility data	DSO (Databricks Platform)	
2a / 4a / 5a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Provided flexibility / Request / Flexibility data	DSO (Balcão Digital App/Databricks Platform)	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)

As for the TSO´s point of view, the following exception path applies for this use case:

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Consumer non-compliance	Some consumers do not shift energy usage due to unwillingness /uncertainty or unavailability	Non-compliance report	consumer	DSO
2	Consumers provides partial emergency flexibility	Some consumers may provide emergency flexibility partially due to their uncertainty of usage	Report of partially activated emergency flexibility	Consumer	DSO
3	Communication failure during activation requests	Technical issues could interrupt request sending for activation between the actors	Failure message, retry request	Affected Actor	Respective Recipient

FR 3.6. EXTREME GRID SITUATION MANAGEMENT

Scope and objectives

This use case aims to improve the resilience of the French electricity grid during critical situations by promoting active consumer participation. The objective is to provide users with real time information about transmission network constraints relaying EcoWatt messages, as well to guide users on concrete actions to support grid stability, both at home and outside. This proactive approach seeks to transform passive consumers into engaged actors in the energy transition during periods of high tension on the grid.

Narrative of the use case

The mobile application displays daily forecasts and alerts from the French EcoWatt system, indicating constraints on the electrical transmission network. When a critical situation is detected, the user receives notifications containing detailed information about the state of the grid as well as personalized recommendations on actions to take to reduce pressure on the electrical system. These recommendations cover behaviours to adopt at home (reducing consumption of energy-intensive appliances, shifting certain uses) but also in the workplace and in other contexts.

Diagram of the use case

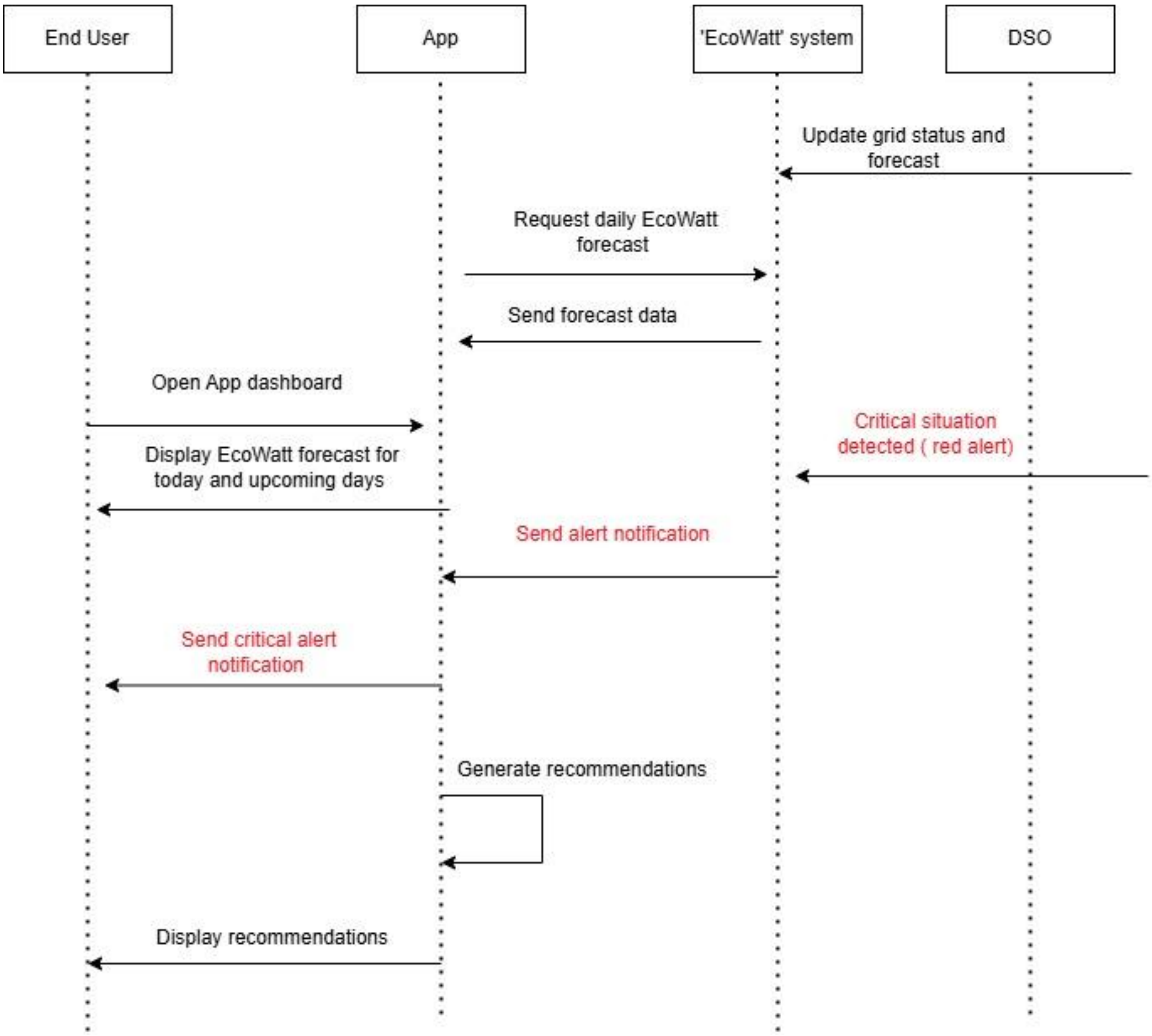


Figure 43. FR 3.6 diagram.

Actors of the use case

- End User
- My Votalis App
- EcoWatt System
- Distribution system operator (DSO).

Scenarios

Main path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Status update	The DSO updates the network status and forecasts in the EcoWatt system	EcoWatt forecast	DSO	EcoWatt system
2	Alert notification	In case of a critical situation, the application sends a notification to the user	Alert notification	App	End User
3	Recommendations	The application generates recommendations	User profile recommendations	App	App

Exception path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	EcoWatt system failure	The EcoWatt system is unavailable and can't provide forecasts to the application			

6.5. OPTIMIZING HOME ENERGY USE THROUGH ENERGY ASSETS CONTROL

CZ 3.1. CONSUMPTION PREDICTION.

Scope and objectives

The scope and objective are to predict individual energy consumption based on historical usage data alongside external factors. By analysing patterns over time, the app provides users with personalised forecasts and actionable advice on how to optimize their energy use.

Narrative of the use case

This Use Case describes the functionality of the mobile app that allows users to view energy consumption predictions based on historical data, meteorological conditions, and other relevant factors. Predictions are provided for different time horizons (day, week, month, year) and are visualized in the form of line charts. Users can track consumption trends and optimize their energy needs. The system also includes notifications for unusual consumption fluctuations.

Diagram of the use case

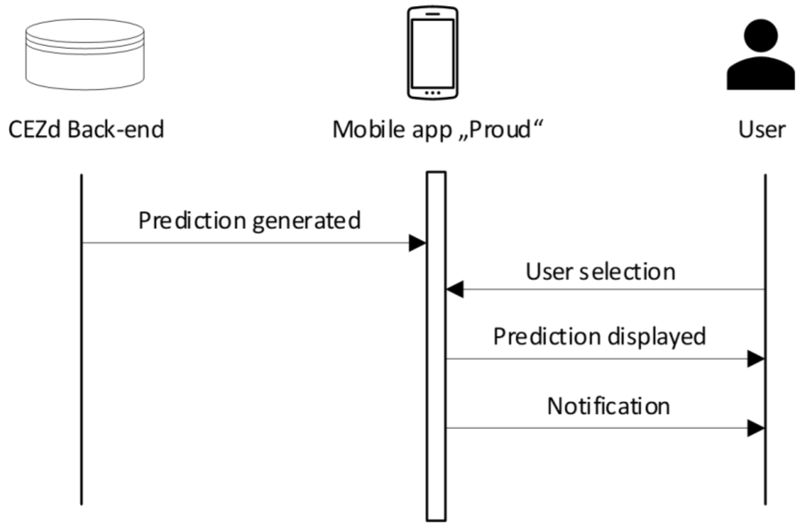


Figure 44. CZ 3.1 diagram.

Actors of the use case

- Mobile application user.
- Consumption data provider (DSO).
- Meteorological services.
- Application administrator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App opened	The user opens the mobile application and selects the consumption section	User request	User	Mobile application
2	Options displayed	The system displays the available time horizons (day, week, month, year)	Available time horizons	Mobile application	User
3	Horizon selected	The user selects the desired time horizon	User selection	User	Mobile application
4	Prediction generated	The system processes historical data and generates a consumption prediction	Historical data, prediction model results	Data provider, prediction algorithm	Mobile application
5	Prediction displayed	The prediction is displayed as a interactive chart	Predicted consumption data	Mobile application	User
6	Notification received	If the predicted consumption increase exceeds a defined threshold, the user receives a notification	Alert message	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Historical data unavailable	If historical data is unavailable, an error message is displayed to the user	Error message	Mobile application	User
2	Service unavailable	If the service is unavailable, the last downloaded data is displayed	Cached data	Mobile application	User
3	Meteorological data unavailable	If access to meteorological data fails, the prediction is calculated based only on historical data	Partial prediction	Prediction algorithm	Mobile application

CZ 3.2. ADVANCED PRESENTATION OF MEASURED DATA.

Scope and objectives

The scope and objective are to provide more detailed consumption data based on 15-minutes measuring period in new graphical interface.

Narrative of the use case

This use-case presents the consumption data in the form of graphs/charts, which will be comprehensive but easy to understand. Users will be able to track historical data, identify trends, which will help them better plan and optimize energy needs. With detailed data, they can make informed decisions and take action to reduce costs. For users with their own sources of energy production, it will enable monitoring of production and optimization of resources. A simple and intuitive interface will make working with data easier even for less technically proficient users.

Diagram of the use case

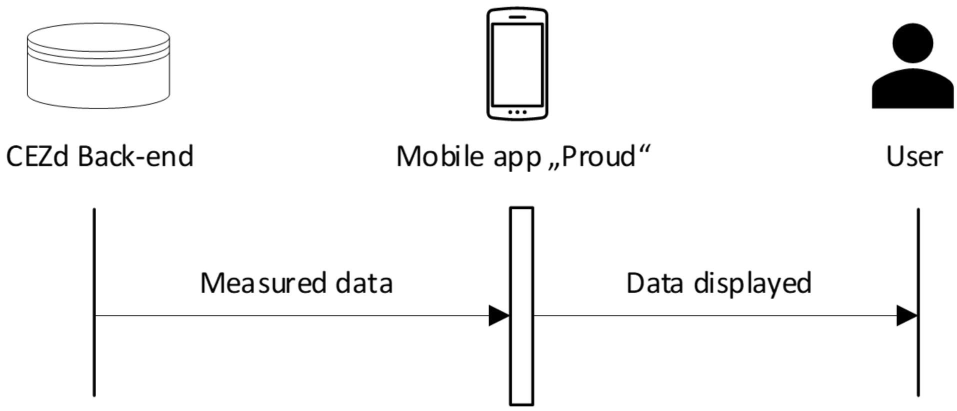


Figure 45. CZ 3.2 diagram.

Actors of the use case

- Mobile application user.
- Consumption data provider (DSO).
- Application administrator.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	App opened	The user opens the mobile application and selects the consumption section	User request	User	Mobile application
2	Options displayed	The system displays the available data in multiple views	Available data	Mobile application	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Historical data unavailable	If historical data is unavailable, an error message is displayed to the user	Error message	Mobile application	User
2	Service unavailable	If the service is unavailable, the last downloaded data is displayed	Cached data	Mobile application	User

CZ 3.3. CONSULTING RELATED TO MEASURED DATA.

Scope and objectives

Achieving voluntary energy savings through behavioural changes by providing users with personalised energy saving tips. By offering data-driven insights and practical suggestions, the objective is to motivate consumers to adopt more energy efficient habits.

Narrative of the use case

This Use Case describes the implementation of an advisory system that provides customers with personalized energy-saving tips and predictions based on measured energy consumption and production data. The system delivers automated notifications regarding daily fluctuations, medium-term, and long-term trends, allowing users to optimize their energy consumption. Additionally, customers can visualize their energy usage and production predictions through graphical representations.

Diagram of the use case

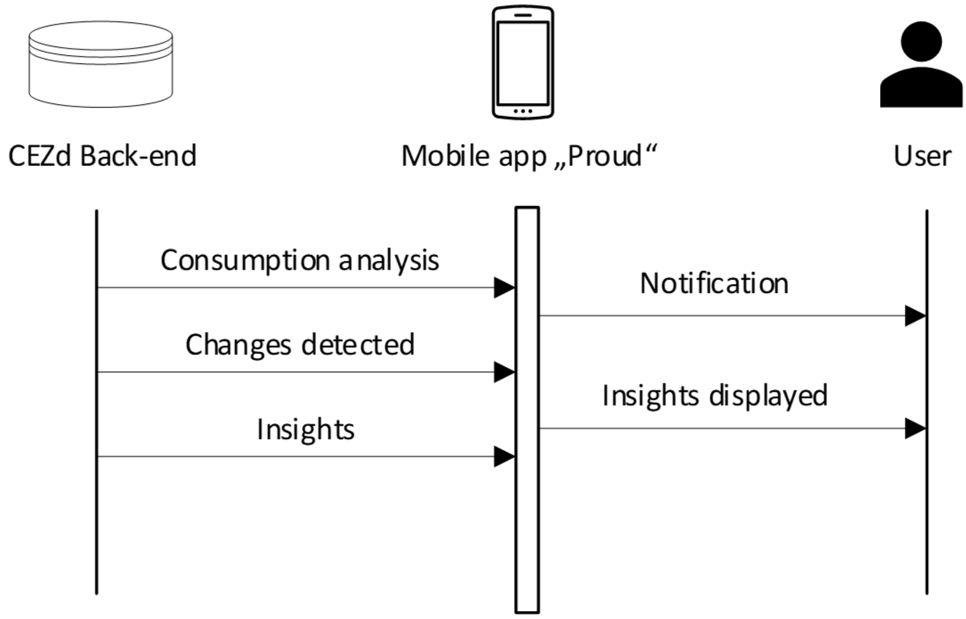


Figure 46. CZ 3.3 diagram.

Actors of the use case

- Mobile app.
- Historical consumption values.
- Prediction and notification algorithms.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	New data received	The system receives new consumption, production data	Consumption data	Data provider	Advisory system
2	Data analyzed	The system analyzes the data for trends and anomalies	Processed measurement data	Advisory system	Notification system
3	Changes detected	If a notable change is detected, a notification is generated	Notification content	Notification system	Mobile application
4	Notification received	The customer receives a notification about consumption, production changes	Notification alert	Mobile application	User
5	Insights accessed	The customer accesses the application for detailed insights	User request	Customer	Mobile application
6	Insights displayed	The system displays consumption trends and personalized tips	Advisory insights	Advisory system	User

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Historical data unavailable	If historical data is unavailable, an error message is displayed to the user	Error message	Mobile application	User
2	Service unavailable	If the service is unavailable, the last downloaded data is displayed	Cached data	Mobile application	User
3	Advisory unavailable	If system calculations fail, default recommendations are provided	Default advisory insights	Advisory system	User

PL 5.1. MESSAGES WITH GENERAL TIPS AND GUIDANCE FOR ENERGY EFFICIENCY AND AWARENESS RISING.

Scope and objectives

General issue for this case is flattening of the energy peak usage as a voluntarily undertaken activity carried out by the customer itself. Upon changing the behavioural patterns so single user aggregated volume may allow to reduce needed grid investments or capacity market expenses. Enhancing Customer awareness and readiness to align with moder approach to grid balancing using non-economic incentives like carbon emission or active usage scheduling with dynamic or non-peak tariff changes will enable large scale optimisation. During pilot TAURON will determine which purposedly created messages have the most impact for the specified focus group. Essentially TAURON will use a combination of profiling with targeted information campaign to study the drivers of such behavioural changes.

Narrative of the use case

Customers receive general information, tips, and guidance on energy efficiency practices, especially related to PV, BESS, recommended inverter settings, obligation to report the increase in installation power capacity to the DSO, etc.). This will include also promoting efficient behaviours, the use of more energy-efficient appliances, insulation options, self-generation of energy, storage solutions, etc. Messages will be created regarding customer profiling with focus to linguistics targeting and its effectiveness.

Diagram of the use case

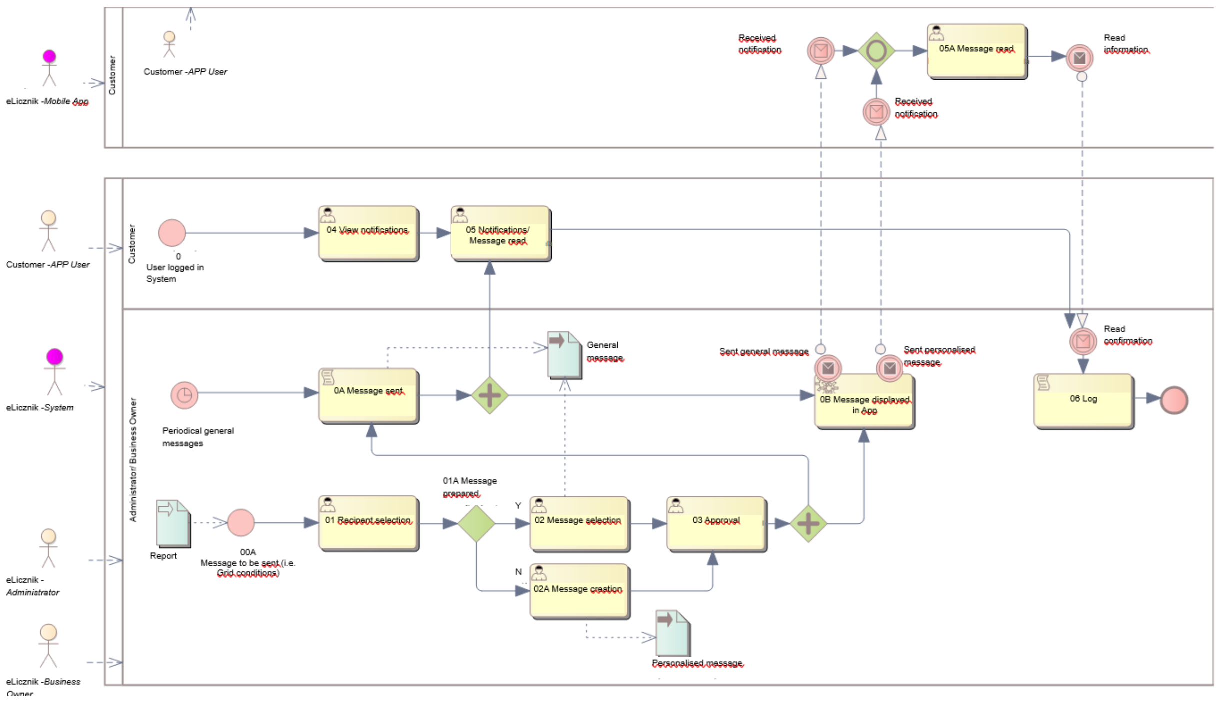


Figure 47. PL 5.1 Diagram

We will put some push information to motivate our customer to:

1. Shift their energy consumption voluntarily without direct economic benefits. The need could be based on current network situation (e.g., voltage levels in the local grid).

2. Limiting the shutdown of PVs caused by voltage situation by increasing the self-consumption in certain time periods.

3. Change the PV technical parameters at your DSO. We've many cases, where our customer when rebuilding their PV installation, increases the PV power without informing the DSO.

Actors of the use case

- TSO.
- DSO.
- Customers.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	DSO wants to communicate a set of information to a specific group of customers	The DSO can use predefined messages or create new ones and deliver them via the eLicznik app to a specific group of customers (specific geographical area, specific tariff group, PV user, BESS, customers exceeding the power of PV etc.).	Message delivered to specific a specific group of customers via eLicznik app	DSO	Customer
2	Change in customer energy consumption or action	Customer manages the consumption in order to act in a more environmentally and grid-friendly manner	Energy profile	Customer	DSO

Exception path

Exception paths					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Historical data unavailable	If historical data is unavailable, an error message is displayed to the user	Error message	WebPage/Mobile application	User
2	Service unavailable	If the service is unavailable, the last downloaded data is displayed	Cached data	WebPage /Mobile application	User

GR 1.1. SMART ENERGY MONITORING FOR ENHANCED CONSUMER CONTROL.

Scope and objectives

Empowers residents to monitor and adjust their energy use through real-time data from PVs, HVAC, and DHW, aiming at cost reduction and efficiency.

Narrative of the use case

This use case focuses on enabling residents to monitor and manage their energy consumption using the app. The solution integrates data from various energy loads, including PV production, ACs units, and boilers (DHW), allowing residents to make informed decisions about their energy use. It also supports personalized messaging based on economic benefits and energy efficiency guidance. While there are no advanced dynamic tariffs in Greece beyond the basic day/night scheme, the system enhances awareness and promotes cost-saving and efficiency improvements even within this static pricing structure.

Diagram of the use case

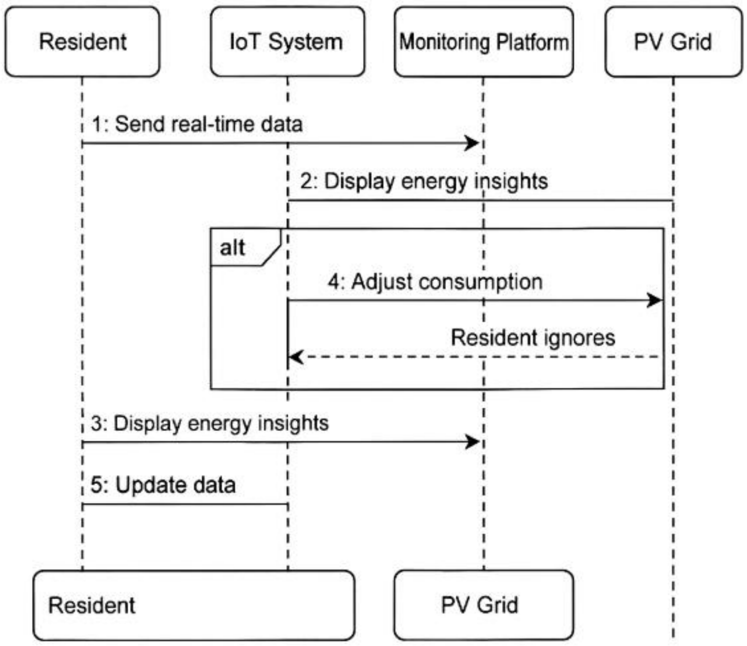


Figure 48. GR 3.1 diagram.

The solution combines data from different apps (e.g., PV production, storage, HVAC, and DHW consumption) into a single user interface. This platform provides real-time monitoring and control of energy consumption, helping residents optimize usage and reduce energy bills. The system will also send personalized messages based on economic benefits (HLUC 1), helping residents understand how changes in energy use can lead to savings.

Actors of the use case

- Residents.
- Energy service providers.
- IoT system operators.
- Smart grid operators.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User accesses Eclipse app	User logs in to monitor energy usage	Energy usage data	IoT system	Resident
2	Data aggregation	System integrates data from PV, HVAC, and DHW	Real-time energy insights	Monitoring app	Resident
3	Notification sent	App sends personalized economic benefit messages	Energy savings opportunities	System	Resident
4	User response	Resident adjusts consumption	Action confirmation	Resident	System
5	Monitoring	System records change in energy use	Adjusted consumption data	System	Energy providers

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User does not engage	No response to notifications	No change in consumption	Resident	System
2	IoT device failure	One or more devices fail to send data	Incomplete monitoring data	IoT system	Monitoring app
3	System failure	Temporary unavailability of app	No real-time access	Monitoring app	Resident

GR 3.2. PERSONALIZED ENERGY EFFICIENCY TIPS FOR HOMES WITH PV AND BATTERY SYSTEMS.

Scope and objectives

Provides smart tips to improve self-consumption and storage efficiency in homes with PV and battery systems, reducing grid dependency.

Narrative of the use case

This use case aims to provide personalized messages to residents regarding energy efficiency, particularly for homes equipped with PV panels and domestic batteries. The system will generate tips on when to use stored energy, optimize self-consumption, and reduce dependency on the grid as well inform them of the energy that is already stored etc.

The system doesn't just send generic advice — it uses real-time data from the PV and battery system, weather forecasts, household consumption patterns, and tariff schemes to send context-aware recommendations. For example:

“Tomorrow will be sunny — consider running your dishwasher in the afternoon to use stored solar energy.”

“Your battery is full — reduce grid reliance by shifting consumption now.

Diagram of the use case

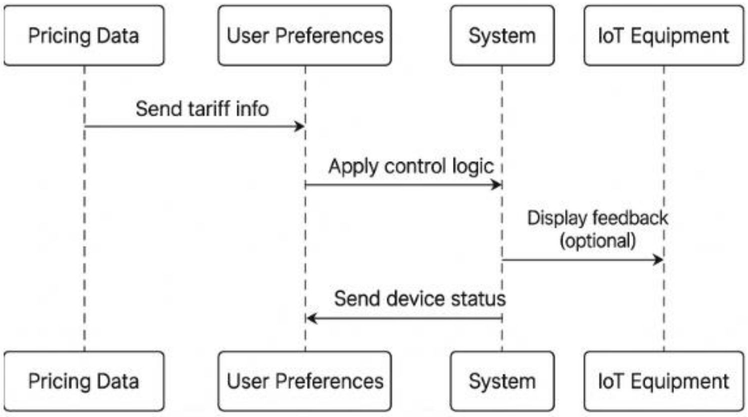


Figure 49. GR 3.2 diagram.

The system collects data from the PV panels, batteries, HVAC systems, and DHW consumption. Based on this data, it sends personalized messages to residents about energy-saving opportunities, such as when to shift their energy use to times of high solar production or when to use stored energy from batteries. The messages will also provide general tips and guidance on improving energy efficiency in day-to-day operations.

Actors of the use case

- Residents.
- Energy service providers.
- IoT system operators.
- Smart grid operators.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	System identifies efficiency opportunity	IoT system detects conditions for optimizing energy use	Energy data	IoT system	Monitoring app
2	Message sent	System sends an energy efficiency tip to resident	Personalized advice	Monitoring app	Resident
3	User response	Resident adjusts energy use based on tip	Energy-saving actions	Resident	System
4	User response	Resident adjusts consumption	Action confirmation	Resident	System
5	Monitoring	System records change in user behaviour	Adjusted consumption data	System	Energy providers

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	User does not engage	No response to notifications	No action taken	Resident	System
2	IoT device failure	One or more devices fail to send data	Incomplete monitoring data	IoT system	Monitoring app
3	System failure	Temporary unavailability of app	No messages sent	Monitoring app	Resident

SI 3.1. ADVANCED ANALYTICS OF PRODUCTION AND CONSUMPTION DATA PROVISION.

Scope and objectives

The existing Moj Elektro portal currently provides electricity distribution grid users with information only about their past energy usage. To support users in managing their consumption more effectively, a new (smartphone) application will be introduced. This app will allow users to:

- View and export 15-minute measurements for day-1, or older.
- View historical billing data.
- View predicted consumption and/or generation.

Narrative of the use case

The release of the smart phone accessible application will be carried out in the entire area of Elektro Ljubljana's electricity distribution network and the main objective is to enable grid users more details about their electricity consumption, to teach them on how to adopt their consumption to the net usage tariffs scheme and to encourage grid users to actively try to use electrical energy more efficiently.

Diagram of the use case

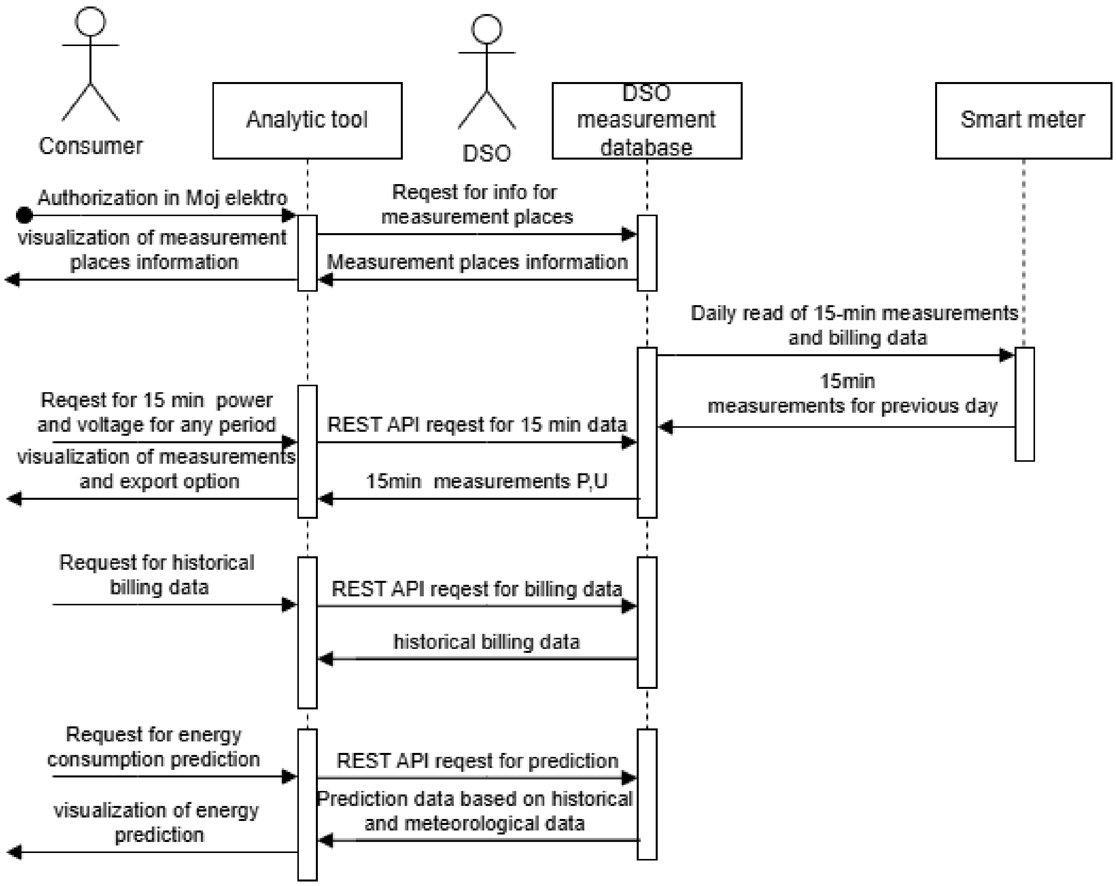


Figure 50. SI 3.1 diagram.

The company's data analytics department aims to offer improved data services to grid users.

The Moj elektro portal provides a safe (two-step verification of a user's electronic identity) and unified registration and authentication with the Rekono application, as well as autonomous management of authorisations and user rights.

The MojElektro Portal – the online user portal intended for all end consumers and their authorised representatives who can access all the metering points and metering and accounting data that they are entitled to, regardless of their supplier or distribution area. It enables an overview and export of all available 15-minute data by metering points (received and delivered active/reactive power, possibility of aggregation by hour, day, month, etc.), monitoring consumption and production above the self-supply metering points, submission of a new tax ID number for a metering point, the submission and entry of the meter reading at a metering point.

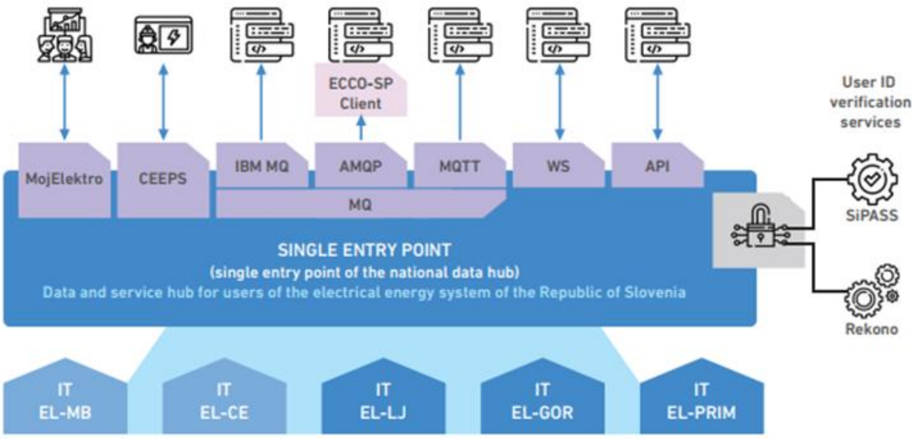


Figure 51. SI 3.1 diagram.

Actors of the use case

- Mobile application user.
- Energy data provider (DSO).
- System administrator.

Scenarios

Main path

Grid user is invited to start using the application by signing in at MOJ ELEKTRO. To a signed user one or more metering points or grid connection points can be addressed. The main provider of all information and data is the local electricity distribution company, DSO. The main source of the close to real time and historical grid user consumption data is the metering values database. These data will be processed by the analytic tool, offering grid users a complete data provision and analytics service.

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Logging to Moj elektro portal	User logs to Moj elektro portal and opens new developed application	User's credentials with two-step verification	user	Moj elektro and new developed app
2	Data Collection	Retrieve 15-minute measurements for day-1 and billing data from smart meter	Energy data	DSO	App
3	Request for 15min power and voltage	User wants to visualize 15-minute data	15 min measurements	DSO	App
4	Request for historical billing data	User wants to check historical billing data for net tariff	billing data	DSO	App
5	Request for consumption prediction	User wants to check predicted consumption	15 min predicted consumption	DSO, user	App

Exception path

Users, who will voluntarily participate as the first examiners of our smart phone available application, will have a possibility to access same solution via Web. In rare cases of inaccessible both, smart phone app and Web application, the services will not be enabled.

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Smart meter is not capable to provide the data	Because of communication error smart meter stops sending data			

6.6. PARTICIPATION IN FLEXIBILITY ENERGY MARKETS

FR 3.1. NON–ECONOMICALLY DRIVEN CONSUMER FLEXIBILITY PARTICIPATION IN POWER SYSTEM.

Scope and objectives

This use case aims to promote consumer participation in energy flexibility services (DSR) through non-economic incentives. The objective is to integrate physical and simulated sites across five European countries (France, Estonia, Finland, Denmark, and Belgium) into Demand Side Response programs, rewarding participants through energy savings.

Narrative of the use case

Users from various sites in France, Estonia, Finland, Denmark, and Belgium participate in Demand Side Response (DSR) programs with indirect benefits and where energy savings are considered direct incentives. The mobile application displays in real-time the volume of energy savings achieved through their participation in DSR events. Users can visualize both their individual contribution and the collective impact on power grid stability. The system collects consumption data, calculates savings made during DSR events, and presents this information in an engaging and comprehensible manner.

Diagram of the use case

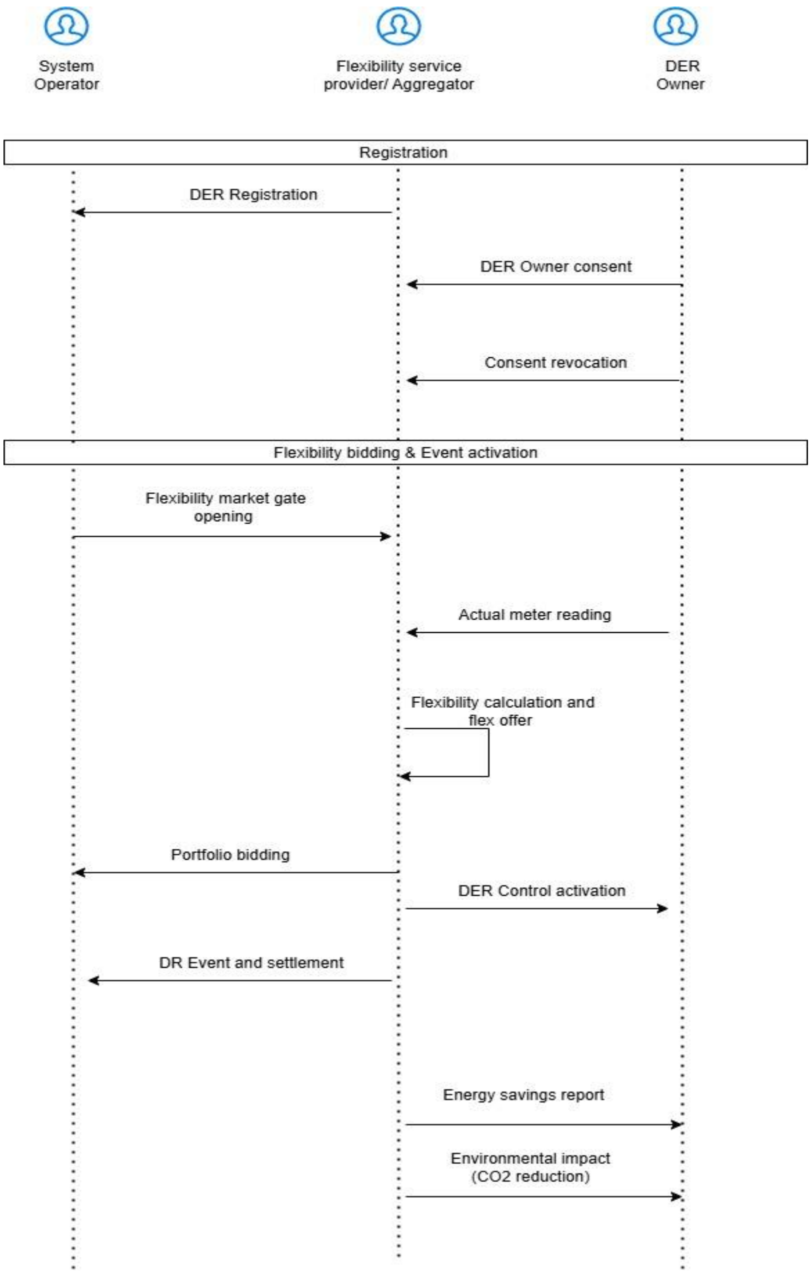


Figure 52. FR 3.1 diagram.

Actors of the use case

- Market operator.
- Flexibility services provider.
- Aggregator
- Consumer.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User Registration	User registers for the DSR program through the mobile application	User credentials and site information	User	DSR Platform
2	Data Collection	System collects consumption data from participating sites	Energy consumption data	Smart meters/Sensors	DSR Platform
3	DSR Event	DSR Provider initiates and manages the DSR event	Capacity data, services and forecasts	DSR provider	System Operator
4	Visualization of Impact	User views real-time data showing their contribution	Visualized energy savings	DSR Platform	App

Exception path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	User Opt-out	User decides to opt-out from a specific DSR event application	Opt-out confirmation	User	DSR Platform

FR 3.2. INCREASING FLEXIBILITY POTENTIAL DISTRIBUTED ENERGY RESOURCES (DER) THROUGH EXPLICIT AND IMPLICIT DEMAND RESPONSE.

Scope and objectives

Through a network of pilot sites, this use case demonstrates the synergy between explicit and implicit flexibility offerings in the energy sector. The deployment is structured as follows: in France, 5 physical pilot sites are testing an innovative mixed model combining Voltalis and D4G, allowing access to a larger flexibility potential through their platform, particularly through the management of electric vehicles, photovoltaic installations, and batteries. In Finland, 5 physical sites use only the Voltalis solution, while virtual sites complete the system in Denmark, Belgium, and Estonia, also using the Voltalis solution alone. This differentiated approach allows for evaluating the effectiveness of both integration models and analysing how solutions adapt to different energy contexts and user behaviours across regions.

Narrative of the use case

The selected pilot sites are in France, Finland, Denmark, Belgium and Estonia, focusing on domestic loads. These areas were selected to reflect a wide range of domestic uses and markets, with wide variations between countries in terms of energy mix, type of appliances in homes and businesses, DSR awareness, retail tariffs and market access to aggregators.

The objective is to develop end-user benefit awareness and control tools in targeted countries as well as test commercial offers for implicit/explicit DSR.

Although this use case is classified in HLUC3, the approach of it aims to cover also HLUC1 and HLUC2 comprehensively and measurably:

- HLUC1: by exploring the implementation of economic aspects through a revenue sharing system with end users or others mechanism. While the exact details of this model are yet to be defined, the plan is to measure its effectiveness through monitoring financial transactions, user participation rates, and the volume of savings generated.

- HLUC2: by incorporating non-economic incentives focused on environmental aspects. A dedicated carbon footprint dashboard will be available on both the D4G application and the myVoltalis application. Impact will be evaluated through monitoring user engagement and the evolution of their behaviour in response to environmental indicators.
- HLUC3: the technical solution is based on a complete architecture integrating Voltalis modules, the Dcbel station, the D4G platform and the Voltalis platform. This infrastructure enables intelligent management of various equipment (heating, heat pump, electric vehicles, photovoltaic panels) through secure communication between platforms. Performance will be measured by the technology adoption rate and their effective contribution to energy flexibility.

By using visualization and management tools, as well as energy efficiency tips for controlling the consumer energy behaviour, users will also be able to assess their financial and carbon footprint benefits of their participation into energy markets including selected DSR programs while taking control of their energy usage and home appliance leveraging open data exchange standards as defined through the Eddie pilot dataspace.

This case demonstrates the integration of residential energy management technologies through two distinct approaches. The first, deployed in France, combines explicit and implicit flexibility through the partnership between Voltalis and D4G. This synergy relies on three main components: the Voltalis cloud platform for energy management and appliance control and operations on power markets, Dcbel's Home Energy Station for managing energy-intensive equipment, and the D4G Insights platform dedicated to multi-DER flexibility orchestration.

The system architecture in France and Estonia is based on an API implementation ensuring secure communication between the Voltalis and D4G platform.

Users benefit from two complementary applications: MyVoltalis for heating and water heater control, and D4G for managing electric vehicles and photovoltaic installations.

In other participating countries, only the Voltalis solution will be deployed focusing on explicit flexibility through the MyVoltalis platform; with physical sites in Finland and simulators in Denmark, Belgium and Estonia.

This differentiated approach will allow evaluation of the effectiveness of both models and understanding of regional specificities in energy engagement. The deployment across this diverse network of pilot sites will enable analysis of the solutions' adaptability to different energy contexts and user behaviours in each country.

Diagram of the use case

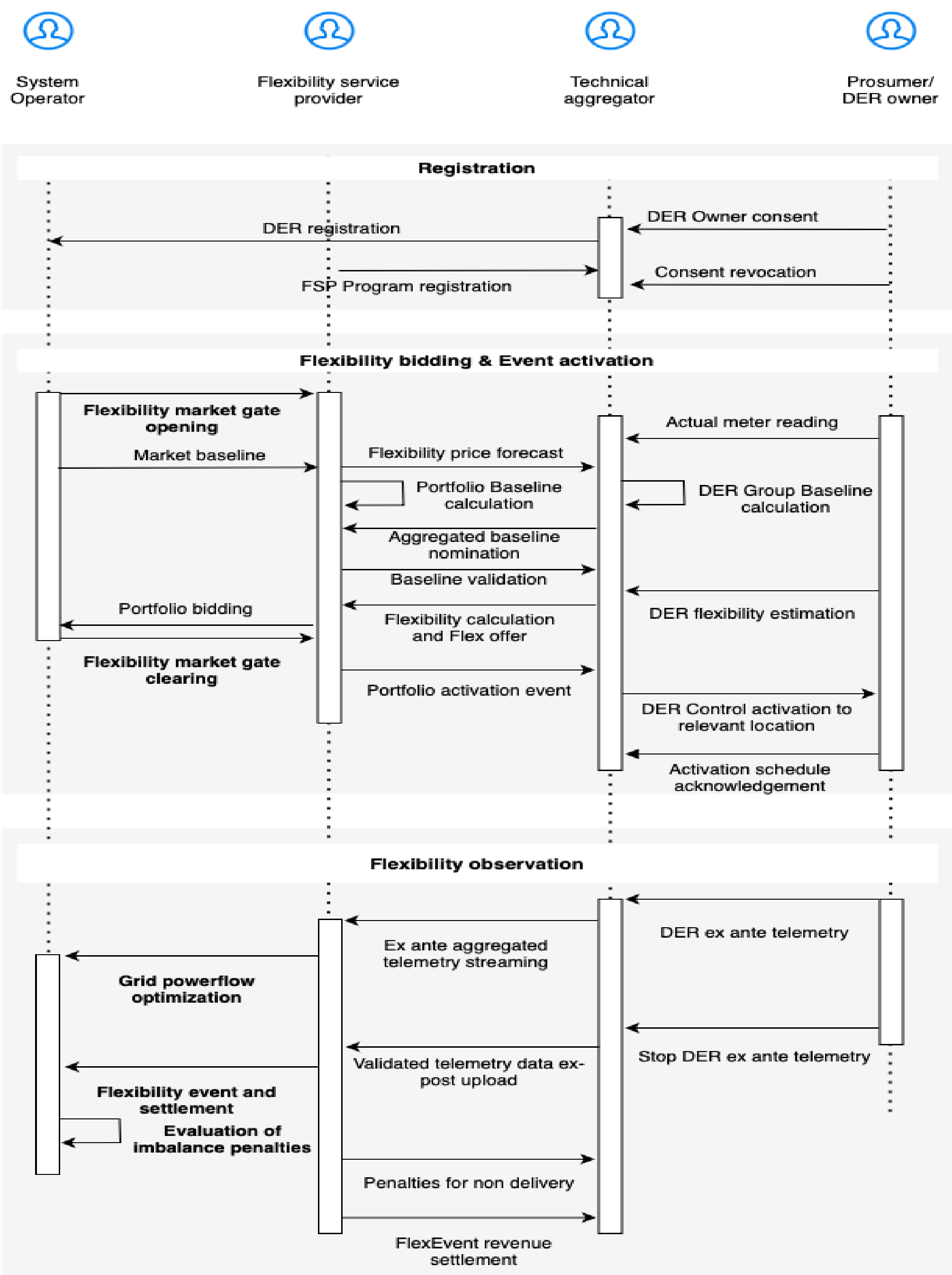


Figure 53. FR 3.2 diagram.

- Voltalis acts as both technology provider and aggregator: the Voltalis platform dynamically balances energy needs in real time, thanks to proprietary software and hardware. The Voltalis platform also integrates third-party data, which allows connection and operation of smart appliances outside of the Voltalis ecosystem, delivering a complete home and business automation solution while supporting owner markets.
- **Communication from D4G to Voltalis:** D4G first transmits all information about its flexibility capabilities, including electric vehicle charge status, home battery capacity, and availability time slots. The platform also sends real-time status of dcbel equipment and confirmations of load shedding orders and post-report.
- **Communication from Voltalis to D4G:** Taking into account user preferences and the type of appliances connected, Voltalis develops and transmits DSR orders, that specify desired load shedding time slots and their power requirements.
- **Validation and Execution Process:** DSR (Demand Side Response) orders are analysed and executed by D4G. D4G defines user parameters and preferences that serve as limits. Once the program is validated, orders are transmitted with the necessary regulation parameters, and D4G provides continuous feedback on equipment performance and status.
- **Technical Architecture:** D4G acts as a central hub that collects and manages information from dcbel equipment, then communicates it to Voltalis via a dedicated API. This architecture enables a clear separation of responsibilities while maintaining operational coherence in equipment management.

Actors of the use case

- Market operator.
- Energy service company.
- Flexibility provider.
- Technology provider.
- Consumer.
- System operator.
- Smart appliances manufacturer.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Consent Submission	Authentication and initial registration	Identification data and consent	Customer	D4G, Voltalis
2	Registration process	Flex Product prequalification and DER group registration	DER registration data and pre-qualification specifications	D4G	System Operator, Voltalis
3	Market Opening	Price forecasting and market opening	Forecasted prices by flexibility product	System Operator	Voltalis, D4G
4	Flexibility Estimation	Baseline calculation and estimation	DER flexibility estimation data	Voltalis	D4G, Voltalis
5	Flexibility Offer	Offer calculation and submission	Portfolio flexibility offers	D4G	Voltalis
6	DER Activation	Resource activation and control	Activation orders	Voltalis	D4G, Voltalis
7	Delivery Verification	Monitoring and verification	Telemetry and verification data	D4G, Voltalis	D4G, Voltalis
8	Revenue Distribution	Revenue calculation and distribution	Settlement and distribution data	Voltalis	D4G, Customer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Prequalification failure	Technical network verification fails	Prequalification failure report	System Operator	Voltalis
2	Flexibility non-delivery	Delivery deviation assessment	Non-compliance data and penalty calculation	Voltalis	D4G, Voltalis
3	Delivery imbalance	Imbalance a penalties calculation	Imbalance measurement and penalty amounts	System Operators	Voltalis
4	DER Control failure	Failed direct control attempt	Control error report	CEMS/ DER Group	Voltalis, Dcbel
5	Portfolio non-compliance	Failed delivery verification	Portfolio non-compliance report	D4G	Voltalis

PT 1.1. ECONOMICALLY DRIVEN CONSUMER FLEXIBILITY PARTICIPATION IN SYSTEM SERVICES.

Scope and objectives

This use case focuses on automating and promoting the participation of consumers in energy markets through economic incentives. Consumers submit flexibility bids, which are evaluated based on grid needs and economic benefits. Selected consumers activate their flexibility, helping to balance supply and demand while receiving financial compensation for their contributions.

This represents a forward-looking approach to fostering consumer participation in energy markets, where the system automates many of the complex interactions between consumers, market operators, and the grid. By reducing the barriers for consumers and making the process seamless, the use case supports a more dynamic, responsive grid with optimized consumer involvement.

Narrative of the use case

This use case focuses on the development of an automated system to enable prosumers (consumers with generation or flexibility potential) to actively participate in energy markets based on economic incentives. The system streamlines the process of integrating consumer flexibility, such as demand-side management, into the grid through automated bidding and selection mechanisms.

The process begins with the TSO issuing a request for bids at the transmission system operator (TSO) or distribution system operator (DSO) interconnection point. The DSO (E-REDES) makes this information available through their app to their clients. Clients (prosumers) submit bids indicating their available flexibility in terms of power capacity, time periods, and pricing requirements. The DSO collects the bids and stores them for evaluating grid constraints. If the proposed flexibility does not create distribution grid constraints, E-REDES passes on these bids to the Market Simulator. In the case of potential grid constraints, the bids are automatically rejected. A sub-selection process ensures the grid remains stable while still leveraging available flexibility. The information received by the Market Simulator is evaluated to select the bids that are potentially cleared in a market environment. These selected bids are notified to the DSO. Once accepted, clients are notified via the Balcão Digital App, and they receive a notice to activate the flexibility at the agreed time. The activated flexibility is measured against a baseline, and a price is calculated for the service provided. Throughout this process, clients benefit from notifications about their bid status and the opportunity to contribute to grid stability while earning based on the economic value of their flexibility.

Diagram of the use case

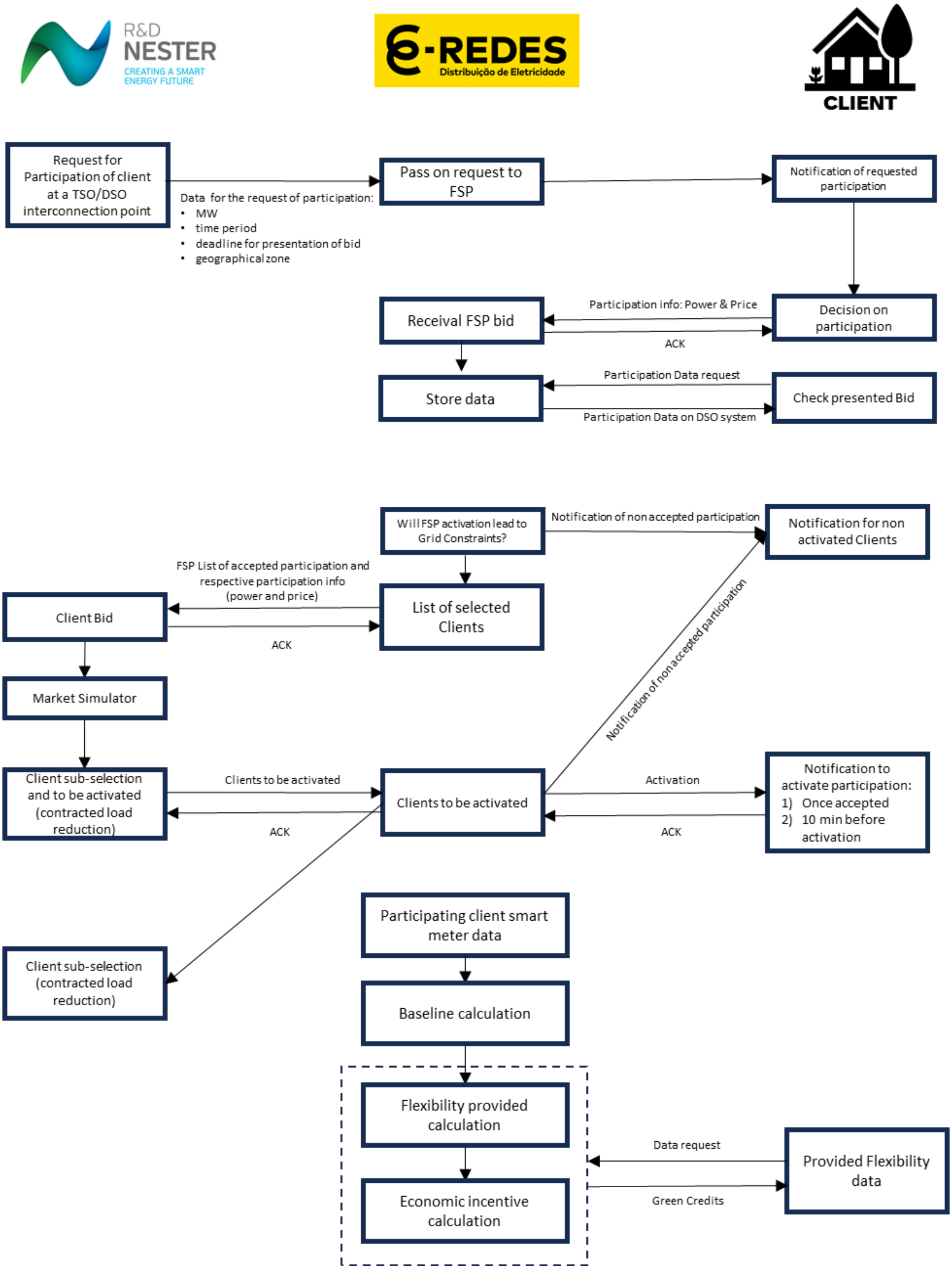


Figure 54. PT 1.1 diagram.

Actors of the use case

- Transmission system operator (TSO).
- Distribution system operator (DSO).
- Consumer.

Scenarios

The triggering event for this use case will consist of requesting bids of consumers at a TSO/DSO interconnection point.

For the use case to be initiated, the following conditions must be true:

- Consumers have a smart meter installed in their houses and measurements are automatically uploaded to a data processing platform.
- DSO and consumers have pre-signed contracts which allow DSO to use their consumption data to calculate the flexibility activated by them.
- The MO forecasts the needs required for the mFRR service requested to the consumers.
- Communication and data exchange channels are available between actors and products involved.

By the end of the use case, it is expected that consumers have provided flexibility by shifting or increasing/reducing their load demand in the required time to achieve grid stability in exchange for a simulated financial compensation. Their responses will be measured in terms of number of active users; response time and total amount of flexibility provided.

Main path

The following tables as well as the table presented before regarding the calculation of provided flexibility describe the main paths of this use case from the DSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application, Databricks Platform or Operational Planning System).

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Request is issued	A TSO shares a bid request through an API, which is registered by Balcão Digital.	Request data	TSO (Market Simulator)	DSO (Balcão Digital App)
2	Delivery of request	Balcão Digital passes on the bid request to the consumer.	Request data	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
3	Receival of consumer data	The consumer submits a bid through the app.	Bid data	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
4	Transmission of consumer data	Balcão Digital transmits the consumer data to the Databricks Platform.	Bid data	DSO (Balcão Digital App)	DSO (Databricks Platform)
5	Storage of consumer data	Consumer data is stored in the Databricks Platform for subsequent consultation.	Bid data	DSO (Databricks Platform)	
6	Consultation request	The consumer makes a request to consult the submitted bid on the app.	Request	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
7	Transmission of consultation request	Balcão Digital transmits the consumer request to the Databricks Platform.	Request	DSO (Balcão Digital App)	DSO (Databricks Platform)
8	Transmission of consumer data	Consumer data stored in the Databricks Platform is transmitted to Balcão Digital.	Bid data	DSO (Databricks Platform)	DSO (Balcão Digital App)
9	Provision of consumer data	Consumer bid is made available for consultation on the app.	Bid data	DSO (Balcão Digital App)	Consumer (Balcão Digital App)

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Upload of consumers list	The list of consumers who submitted a bid on the app is uploaded to the operational planning system.	Consumers list of submitted bids	DSO (Databricks Platform)	DSO (Operational Planning System)
2	Selection of consumers	The activation of consumers is tested in order to assess if any would lead to grid constraints. Based on this information, a selection of consumers is made.	Consumers list of accepted bids	DSO (Operational Planning System)	
3	Upload of accepted consumers list	The list of accepted consumers is uploaded to the Databricks Platform.	Consumers list of accepted bids	DSO (Operational Planning System)	DSO (Databricks Platform)
4	Transmission of accepted consumers list	Databricks Platform transmits the list of accepted consumers to Balcão Digital.	Consumers list of accepted bids	DSO (Databricks Platform)	DSO (Balcão Digital App)
5	Non accepted consumers notification	A notification of non-accepted bid is sent to the consumer.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
6	Transmission of accepted consumers data	Balcão Digital transmits the data submitted by the accepted consumers to the TSO.	Bid data	DSO (Balcão Digital App)	TSO (Market Simulator)
7	Receival of activated consumers list	Upon a sub-selection carried out by the TSO, the list of consumers to be activated is sent to Balcão Digital through an API.	Consumers list of activated bids	TSO (Market Simulator)	DSO (Balcão Digital App)
8	Transmission and storage of	The list of consumers to be activated is sent to the Databricks	Consumers list of activated bids	DSO (Balcão Digital App)	DSO (Databricks Platform)

	activated consumers list	Platform and stored in a repository.			
9	Non activated consumers notification	A notification of non-accepted bid is sent to the consumer.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
10	Activated consumers notification	The consumer is notified that his bid was accepted and that he shall activate his flexibility in the needed time period.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)

The following tables regarding the participation of consumers in energy markets through economic incentives along with the process involved in soliciting bids from capacity providers and selecting the most appropriate bids. The tables describe the main paths of this use case from the TSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application, and Clients).

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	TSO issues a request for flexibility bids	TSO requests bids from Consumers via DSO for ancillary services.	Bid request: MW, time period. Format [1] through API endpoints	TSO (Market Simulator)	DSO
2	Consumers submit flexibility bids	Prosumers respond with their flexibility bids for participation.	Bid data: Power, price. Proprietary format and proprietary communication channel	Consumer	DSO
3	DSO validates bids	DSO validates economic feasibility & technical constrains of all received bids.	List of technically validated bids. Format [1] through API endpoints	DSO	TSO (Market Simulator)
4	Aggregation of validated bids	TSO aggregates the validated bids into a final list for market simulation.	Aggregated bid data	TSO (Market Simulator)	TSO (Market Simulator)

5	TSO/MO computes market clearing	Market Simulator processes the aggregated bids to clear and identify bids to be activated.	The energy market clearing schedule for the current market hour including the cleared bids (list of selected Consumers)	TSO (Market Simulator)	TSO (Market Simulator)
6	Notification of selected bids	Consumers are informed (via DSO app) of their selection for participation in ancillary services.	List of selected bids. Format [1] through API endpoints	TSO (Market Simulator)	DSO
7	Notification of bid status to Consumer	Consumers are informed about the acceptance or rejection of their bids.	Notification of bid status. Proprietary format and proprietary communication channel	DSO	Consumer
8	Activation of selected flexibility	Selected flexibility providers are activated for ancillary service.	Activation instructions. Proprietary format and proprietary communication channel	DSO	Consumers
9	Measurement and compensation for flexibility	Provided flexibility is measured and compensated based on baseline.	Provided flexibility, baseline data, payment. Proprietary format and proprietary communication channel	DSO	Consumers

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Consumers submit flexibility bids	Prosumers respond with their flexibility bids for participation.	Bid data: Power, price	Consumer	DSO
2	DSO validates bids	DSO validates the technical feasibility of all received bids.	List of technically validated bids communicated in the Reserve Bid Document Uml Model and Schema requested by TSO	DSO	TSO (Market Simulator)
3	Ordering of validated bids	TSO orders the bids into a final list based on power and price for market simulator.	Ordered bid data	TSO (Market Simulator)	TSO (Market Simulator)
4	Pass ordered individual bid to market simulator	TSO passes each bid individually to the market simulator based on the order to analyse its clearing	Individual bids from ordered bid data	TSO (Market Simulator)	TSO (Market Simulator)
5	MO computes market clearing	Market Simulator processes the bids to clear and identify bids to be activated.	The energy market clearing schedule for the current market hour including the cleared bids (list of selected Consumers)	TSO (Market Simulator)	TSO (Market Simulator)
6	Notification of selected bids	Consumers are informed (via DSO app) of their selection for participation in ancillary services.	List of selected bids	TSO (Market Simulator)	DSO

Exception paths

As for the exception paths, the following are differentiated from DSO´s and TSO´s perspective:

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1a / 4a / 7a / 8a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Request data / Bid data / Request	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)	DSO (Balcão Digital App/Databricks Platform)
3a	Lack of participation from consumers	No bid is submitted in response to the request made by the TSO.	None	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
5a	Data corruption	Consumer data backups must be carried out to avoid loss of information.	Bid data	DSO (Databricks Platform)	

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
2a	Null consumers selection	All consumers activations will lead to grid constraints, which cancels Steps 7-10.	Consumers list of accepted bids	DSO (Operational Planning System)	
4a / 6a / 7a / 8a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Consumers list of accepted or activated bids / Bid data	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)

7a	Null consumers sub-selection	The list of consumers to be activated sent by the TSO is null. This cancels Step 10.	Consumers list of activated bids	TSO (Market Simulator)	DSO (Balcão Digital App)

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Communication failure during bid/offer exchange	Technical issues interrupt the exchange of information between actors (e.g., TSO, DSO, or consumers).	Failure message, retry request	Affected Actor	Respective Recipient
2	Insufficient bids/offers to meet service requirements	Total bids/offers received and validated fail to meet the aggregated capacity or technical requirements.	Notification of insufficient bids/offers	TSO (Market Simulator)	DSO
3	DSO unable to validate bids/offers	DSO encounters technical or data issues preventing the validation of submitted bids/offers.	Notification of validation failure	DSO	TSO (Market Simulator)
4	Invalid bids/offers submitted by clients	Bids/offers submitted by clients are incomplete, non-compliant, or exceed technical/market requirements.	Error notification, reason for rejection	DSO	Consumers

PT 2.1. NON-ECONOMICALLY DRIVEN CONSUMER FLEXIBILITY PARTICIPATION IN SYSTEM SERVICES.

Scope and objectives

This use case emphasizes non-economic incentives, such as green credits, to motivate consumer participation in energy markets. Clients provide flexibility to the grid in exchange for sustainability-based rewards, contributing to grid stability while enhancing their environmental impact.

Narrative of the use case

The second Portuguese Pilot Use Case represents a process focused on integrating consumer flexibility based on non-economic incentives, particularly related to sustainability goals such as green credit accumulation. It elaborates on how prosumers (clients with flexibility to offer) can participate in energy markets through non-economic motivations, emphasizing the environmental and social benefits of their contributions. The system streamlines the process of integrating consumer flexibility, such as demand-side management, into the grid through automated bidding and selection mechanisms.

In this process, the initial step begins with a request from TSO for the participation of clients within the distribution grid. The participation information includes data on the client's available flexibility in terms of power, period, and other relevant details. TSO uses a market simulator to evaluate client participation and then compiles a list of selected clients based on their ability to contribute flexibility. Clients are activated if their participation is deemed valuable to the grid.

E-REDES (the Distribution System Operator) is responsible for managing the bid data from Flexibility Service Providers (FSP) and checking the participation request for grid constraints. If activation would create grid constraints the corresponding bids are rejected, making sure the selection process ensures only the appropriate flexibility is utilized, based on contracted load reduction. Once participation is confirmed, E-REDES sends notifications via Balcão Digital App about accepted or rejected participation as well as notices for clients to activate their flexibility when appropriate.

On the Client side, prosumers receive notifications of their requested participation, review the details, and decide on whether to proceed. The flexibility provided is then measured against a baseline, and the client receives green credits as a non-economic incentive for their environmental contributions.

Diagram of the use case

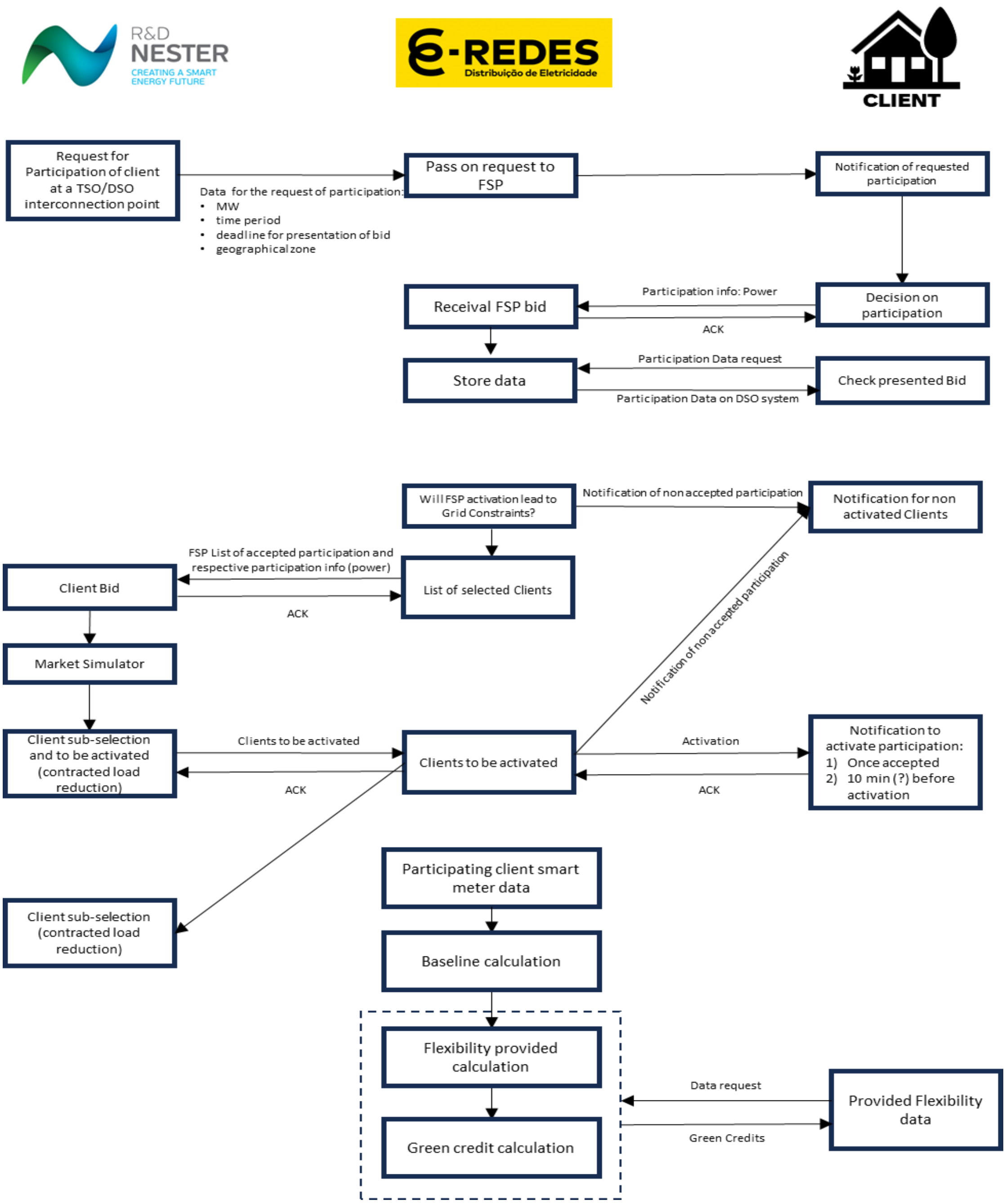


Figure 55. PT 2.1 diagram.

Actors of the use case

- Transmission system operator (TSO).
- Distribution system operator (DSO).
- Consumer.

Scenarios

The triggering event for this use case will consist of requesting bids of consumers at a TSO/DSO interconnection point.

For the use case to be initiated, the following conditions must be true:

- Consumers have a smart meter installed in their houses and measurements are automatically uploaded to a data processing platform.
- DSO and consumers have pre-signed contracts which allow DSO to use their consumption data to calculate the flexibility activated by them.
- The MO forecasts the needs required for the mFRR service requested to the consumers.
- Communication and data exchange channels are available between actors and products involved.

By the end of the use case, it is expected that consumers have provided flexibility by shifting or increasing/reducing their load demand in the required time to achieve grid stability in exchange for a simulated non-financial compensation. Their responses will be measured in terms of number of active users; response time and total amount of flexibility provided.

Main path

The following tables, as well as the table presented regarding the calculation of provided flexibility, describe the main paths of this use case from the DSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application, Databricks Platform or Operational Planning System).

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Request is issued	A TSO shares a participation request through an API, which is registered by Balcão Digital.	Request data	TSO (Market Simulator)	DSO (Balcão Digital App)
2	Delivery of request	Balcão Digital passes on the participation request to the consumer.	Request data	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
3	Receival of consumer data	The consumer submits some participation info through the app.	Participation info	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
4	Transmission of consumer data	Balcão Digital transmits the consumer data to the Databricks Platform.	Participation info	DSO (Balcão Digital App)	DSO (Databricks Platform)
5	Storage of consumer data	Consumer data is stored in the Databricks Platform for subsequent consultation.	Participation info	DSO (Databricks Platform)	
6	Consultation request	The consumer makes a request to consult the submitted participation info on the app.	Request	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
7	Transmission of consultation request	Balcão Digital transmits the consumer request to the Databricks Platform.	Request	DSO (Balcão Digital App)	DSO (Databricks Platform)
8	Transmission of consumer data	Consumer data stored in the Databricks Platform is transmitted to Balcão Digital.	Participation info	DSO (Databricks Platform)	DSO (Balcão Digital App)

9	Provision of consumer data	Consumer participation info is made available for consultation on the app.	Participation info	DSO (Balcão Digital App)	Consumer (Balcão Digital App)

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Upload of consumers list	The list of consumers who submitted some participation info on the app is uploaded to the operational planning system.	Consumers list of submitted participation info	DSO (Databricks Platform)	DSO (Operational Planning System)
2	Selection of consumers	The activation of consumers is tested in order to assess if any would lead to grid constraints. Based on this information, a selection of consumers is made.	Consumers list of accepted participation	DSO (Operational Planning System)	
3	Upload of accepted consumers list	The list of accepted consumers is uploaded to the Databricks Platform.	Consumers list of accepted participation	DSO (Operational Planning System)	DSO (Databricks Platform)
4	Transmission of accepted consumers list	Databricks Platform transmits the list of accepted consumers to Balcão Digital.	Consumers list of accepted participation	DSO (Databricks Platform)	DSO (Balcão Digital App)
5	Non accepted consumers notification	A notification of non-accepted participation is sent to the consumer.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
6	Transmission of accepted consumers data	Balcão Digital transmits the data submitted by the accepted consumers to the TSO.	Participation info	DSO (Balcão Digital App)	TSO (Market Simulator)

7	Receival of activated consumers list	Upon a sub-selection carried out by the TSO, the list of consumers to be activated is sent to Balcão Digital through an API.	Consumers list of activated participation	TSO (Market Simulator)	DSO (Balcão Digital App)
8	Transmission and storage of activated consumers list	The list of consumers to be activated is sent to the Databricks Platform and stored in a repository.	Consumers list of activated participation	DSO (Balcão Digital App)	DSO (Databricks Platform)
9	Non activated consumers notification	A notification of non-accepted participation is sent to the consumer.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)
10	Activated consumers notification	The consumer is notified that his participation was accepted and that he shall activate his flexibility in the needed time period.	Notification	DSO (Balcão Digital App)	Consumer (Balcão Digital App)

The following tables regarding the participation of consumers in energy markets through non-economic incentives along with the process involved in soliciting bids from capacity providers and selecting the most appropriate bids. The tables describe the main paths of this use case from the TSO's point of view, referencing the products involved in each step (Market Simulator, Balcão Digital Application, and Clients).

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	TSO issues a request for flexibility bids	TSO requests bids from Consumers via DSO for ancillary services.	Bid request: MW, time period. Format [1] through API endpoints	TSO (Market Simulator)	DSO
2	Consumers submit flexibility bids	Prosumers respond with their flexibility bids for participation.	Bid data: Power. Proprietary format and proprietary communication channel	Consumer	DSO
3	DSO validates bids	DSO validates the technical feasibility of all received bids & organize the priority of the bids	List of bids. Format [1] through API endpoints	DSO	TSO (Market Simulator)
4	Aggregation of validated bids	TSO aggregates the validated bids into a final list for market simulation.	Aggregated bid data	TSO (Market Simulator)	TSO (Market Simulator)
5	TSO/MO computes market clearing	Market Simulator processes the aggregated bids to clear and identify bids to be activated.	The energy market clearing schedule for the current market hour including the cleared bids (list of selected Consumers)	TSO (Market Simulator)	TSO (Market Simulator)
6	Notification of selected bids	Consumers are informed (via DSO app) of their selection for participation in ancillary services.	List of selected bids. Format [1] through API endpoints	TSO (Market Simulator)	DSO
7	Notification of bid status to Consumer	Consumers are informed about the acceptance or rejection of their bids.	Notification of bid status. Proprietary format and proprietary communication channel	DSO	Consumer

8	Activation of selected flexibility	Selected flexibility providers are activated for ancillary service.	Activation instructions. Proprietary format and proprietary communication channel	DSO	Consumers
9	Measurement and compensation for flexibility	Provided flexibility is measured and compensated based on baseline.	Provided flexibility, baseline data, compensation. Proprietary format and proprietary communication channel	DSO	Consumers

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Consumers submit flexibility offers	Prosumers respond with their available flexibility for participation.	Participation data: Power, green credits	Consumers	DSO
2	DSO validates bids	DSO validates the technical feasibility of all received bids.	List of technically validated bids communicated in the Reserve Bid Document Uml Model and Schema requested by TSO	DSO	TSO
3	Ordering of validated bids	TSO orders the bids into a final list based on power and green credits for market simulator.	Ordered bid data	TSO	TSO
4	Pass ordered individual bid to market simulator	TSO passes each bid individually to the market simulator based on the order to analyse its clearing	Individual bids from ordered bid data	TSO	TSO

5	TSO/MO computes market clearing	Market Simulator processes the aggregated bids to clear and identify bids to be activated.	The energy market clearing schedule for the current market hour including the cleared bids (list of selected Consumers)	TSO	TSO
6	Notification of selected bids	Consumers are informed (via DSO app) of their selection for participation in ancillary services.	List of selected bids	TSO	DSO

Exception path

As for the exception paths, the following are differentiated from DSO´s and TSO´s perspective:

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1a / 4a / 7a / 8a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Request data / Participation info / Request	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)	DSO (Balcão Digital App/Databricks Platform)
3a	Lack of participation from consumers	No participation info is submitted in response to the request made by the TSO.	None	Consumer (Balcão Digital App)	DSO (Balcão Digital App)
5a	Data corruption	Consumer data backups must be carried out to avoid loss of information.	Participation info	DSO (Databricks Platform)	

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
2a	Null consumers selection	All consumers activations will lead to grid constraints, which cancels Steps 7-10.	Consumers list of accepted participation	DSO (Operational Planning System)	
4a / 6a / 7a / 8a	Communication problem	In the event of a communication problem, the assets involved shall temporarily store the data and retry to transmit it once the problem is solved (if possible).	Consumers list of accepted or activated participation / Participation info	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)	TSO/DSO (Market Simulator/Balcão Digital App/Databricks Platform)
7a	Null consumers sub-selection	The list of consumers to be activated sent by the TSO is null. This cancels Step 10.	Consumers list of activated participation	TSO (Market Simulator)	DSO (Balcão Digital App)

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Communication failure during bid/offer exchange	Technical issues interrupt the exchange of information between actors (e.g., TSO, DSO, or consumers).	Failure message, retry request	Affected Actor	Respective Recipient
2	Insufficient bids/offers to meet service requirements	Total bids/offers received and validated fail to meet the aggregated capacity or technical requirements.	Notification of insufficient bids/offers	TSO (Market Simulator)	DSO
3	DSO unable to validate bids/offers	DSO encounters technical or data issues preventing the validation of submitted bids/offers.	Notification of validation failure	DSO	TSO (Market Simulator)

4	Invalid bids/offers submitted by clients	Bids/offers submitted by clients are incomplete, non-compliant, or exceed technical/market requirements.	Error notification, reason for rejection	DSO	Consumers

SW 1.1. EXTENDED FLEXIBILITY SERVICES FOR HOUSEHOLDS.

Scope and objectives

This use case focuses on the household batteries aggregation service to offer balancing to the grid.

Narrative of the use case

This use case is focused on our (CheckWatt´s) aggregation service, Currently VPP, which aggregates 15,000 household batteries into a single resource that can be offered to the grid for balancing purposes but also to DSO for local flexibility markets. We intend to extend the current service with more ancillary services. An existing app will be further developed.

By collecting the capacity from several smaller sources, Currently, acts as a collective counterparty to grid owners (known as TSO) and delivers support services, e.g., FFR, FCR-N, FCR-D up and FCR-D down, as well as local flex to local grid owners (known as DSO). CheckWatt bids its available capacity, provided by owners of renewable flexibility resources (ranging from homeowners to large energy parks) to flexibility off takers (buyers of flexibility, i.e., TSOs, BRPs and DSOs), who pay for stabilization and other services provided by CheckWatt. CheckWatt collects these payments, shares them with its partners, and compensates resource owners for their participation.

The hardware involved is an IoT Gateway, batteries with Battery Management System, solar inverters, Smart meters and other sensors.

Diagram of the use case

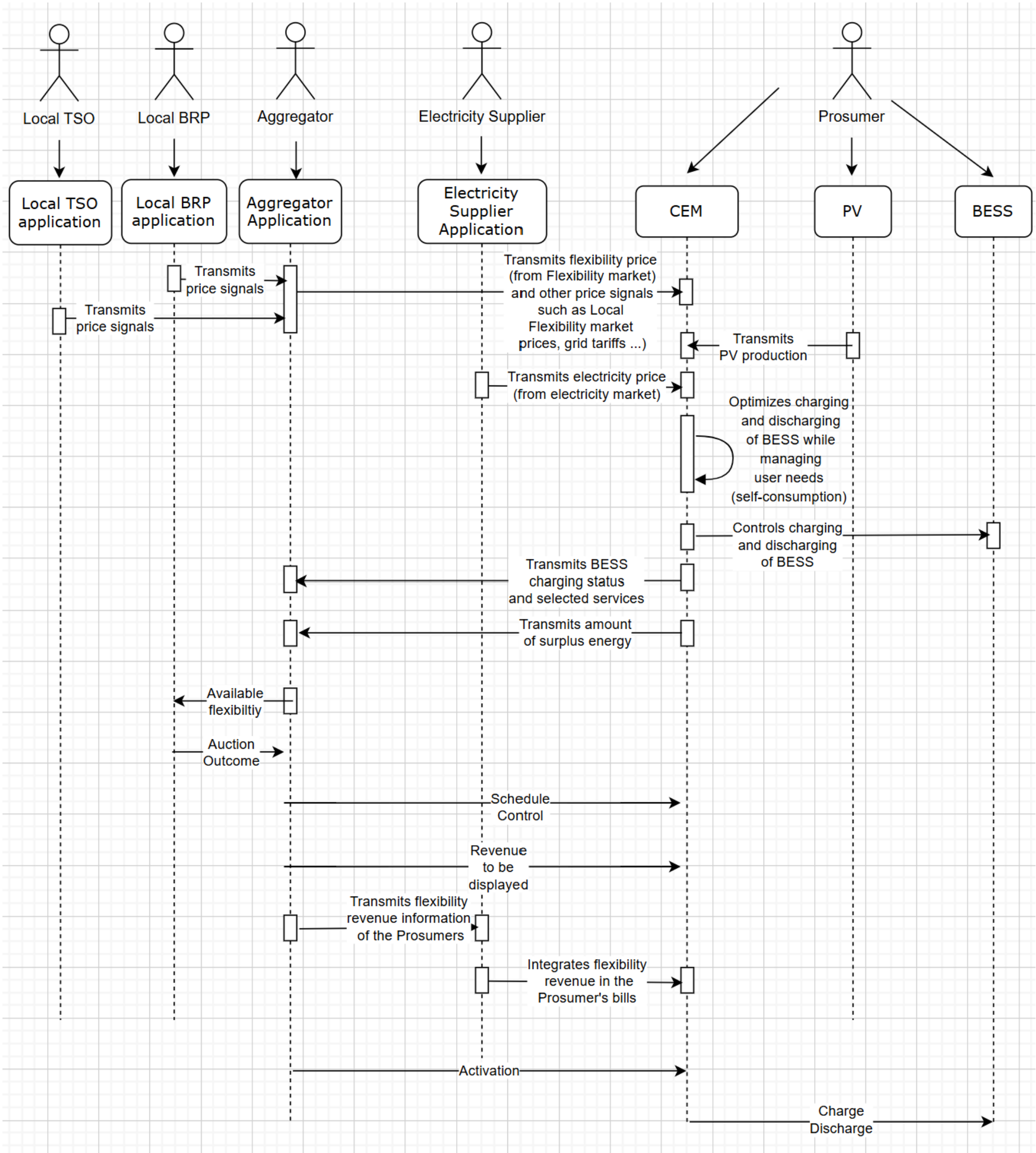


Figure 56. SW 1.1 diagram.

Actors of the use case

- Resource owner (household).
- TSO (Svenska Kraftnät).
- DSO.
- BRP.
- VPP.

- Aggregator.
- Electricity Trader.
- Nordpool.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	New day occurs (0000). Auction opens	For each BRP, analyse available aggregated resources and most profitable service (FCR-D, FCR-N, mFRR, FFR)		VPP	BRP
2	Send bids	The flexibility offers are sent to selected market for auction.	Power, timeframe	VPP	BRP
3	Accept bid	The BRP interested accepts the offer	Power, price, time	VPP	BRP
4	Report revenue for winning bids	The BRP reports back the amount of winning bids and the revenues	Revenue	BRP	VPP
5	Update consumer account	The revenue share for the consumer is calculated		VPP	Consumer
6	Visualise revenues	The aggregated revenues so far this month is visualize in end user app	Daily revenues	VPP	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Not enough resources available	At least 100 kW of aggregated resources must exist to make a bid	Aggregated amount	VPP	

SW 1.2. SERVICE STACKING FOR REVENUE OPTIMISATION

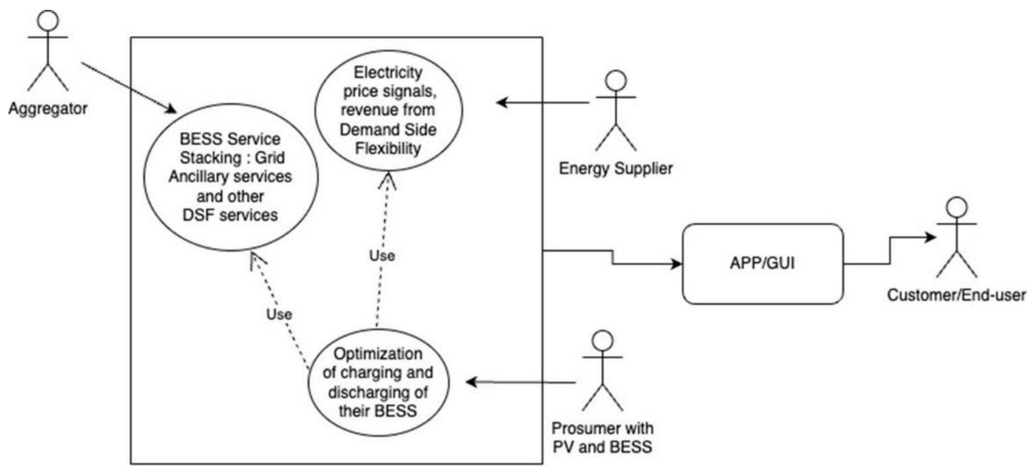
Scope and objectives

Combining flex services from the TSO with flex services for the local DSO. Find a user-friendly way to introduce these services to the user. For instance, how can we visualize both local flex (DSO service) and FCR-D (TSO service).

Narrative of the use case

This use case is focused on providing two different types of flex services, DSO service such as local flex and TSO service such as FCR-D, FCR-N, FFR, etc. The combination of these services is also known as service stacking. The objective of doing this is to maximize the revenue for the customer. The challenge once the service is integrated into the system is to visualize this in an informative and user-friendly way.

Diagram of the use case



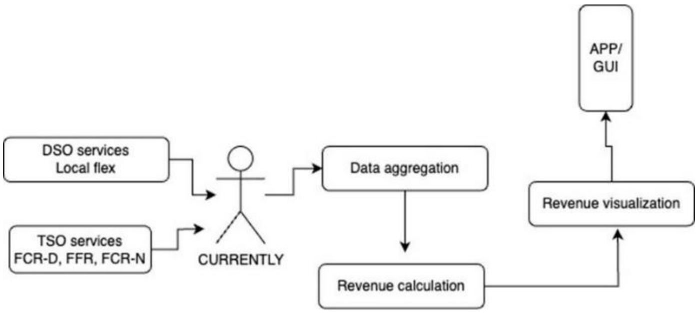


Figure 57. SW 1.2 diagram.

Actors of the use case

- VPP: Virtual Power Plant called Currently provided by CheckWatt.
- Aggregator: CheckWatt.
- TSO: Transmission System Operator. In Sweden it is Svenska kraftnät.
- DSO: Distribution System Operator. In Sweden it is divided between regional grid companies and local grid companies.
- Nordpool: a pan-European power exchange.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	New day occurs (0000). Auction opens	For each BRP, analyse available aggregated resources and most profitable service (FCR-D, FCR-N, mFRR, FFR)		VPP	BRP
2	Send bids	The flexibility offers are sent to selected market for auction.	Power, timeframe	VPP	BRP
3	Accept bid	The BRP interested accepts the offer	Power, price, time	VPP	BRP
4	Report revenue for winning bids	The BRP reports back the amount of winning bids and the revenues	Revenue	BRP	VPP
5	Update consumer account	The revenue share for the consumer is calculated		VPP	Consumer
6	Visualise revenues	The aggregated revenues so far this month is visualize in end user app	Daily revenues	VPP	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Not enough resources available	At least 100 kW of aggregated resources must exist to make a bid	Aggregated amount	VPP	

SW 3.1. INTRODUCE BEHIND THE METER SERVICES.

Scope and objectives

Introduce behind the meter services such as Peak shaving, Energy Arbitrage and Self consumption. These services will not generate revenue (as is the case with flexibility services) but it will generate savings. In this use case we need to find a user-friendly way to combine revenue and savings.

Narrative of the use case

Behind-the-meter services refer to energy systems like solar panels and batteries that generate or store electricity on-site—typically at homes or businesses. These systems operate independently of the main power grid, meaning the energy they provide doesn't pass through a utility meter before use. They are different from flex services because they generate savings and not revenue. In this use case, the data will be shown in a user-friendly way to the user.

Diagram of the use case

See use case SW 1.1.

Actors of the use case

- Resource owner (household).
- DSO.
- VPP.
- Aggregator.
- Electricity Trader.
- Nordpool.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	Spot price published	Retrieve spot price	Spot prices	Nordpool	VPP
2	Decide on energy arbitrage action	Analyse and calculate price peaks and price bottoms.	Spot prices	VPP	VPP
3	Schedule battery charge	Update the schedule in CM10 for charging battery	Schedule	VPP	Consumer Gateway
4	Schedule battery discharge	Update the schedule in CM10 for discharging battery	Schedule	VPP	Consumer Gateway

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Flexibility activation occurs	A grid disturbance occurs triggers and activation. The battery charge/discharge must be stopped	Frequency	TSO	VPP
2	No arbitrage options	If difference exceeds threshold we can progress, otherwise break	Spot price	Nordpool	VPP

SW 4.1. COMBINE FLEX-SERVICES WITH BEHIND THE METER SERVICES.

Scope and objectives

The objective with this use case is to combine all different types of services and present it to the user.

Narrative of the use case

This use case is about combining Flexibility services with Behind-the-meter Services. Currently, which aggregates 15,000 household batteries into a single resource that can be offered to the grid for balancing purposes but also to DSO for local flexibility markets. We intend to extend the current service with more ancillary services. An existing app will be further developed.

By collecting the capacity from several smaller sources, Currently, acts as a collective counterparty to grid owners (known as TSO) and delivers support services, e.g., FFR, FCR-N, FCR-D up and FCR-D down, as well as local flex to local grid owners (known as DSO). CheckWatt bids its available capacity, provided by owners of renewable flexibility resources (ranging from homeowners to large energy parks) to flexibility off takers (buyers of flexibility, i.e., TSOs, BRPs and DSOs), who pay for stabilization and other services provided by CheckWatt. CheckWatt collects these payments, shares them with its partners, and compensates resource owners for their participation.

The hardware involved is an IoT Gateway, batteries with Battery Management System, solar inverters, Smart meters, sensors. We will also evaluate the NILM module with a selected set of pilot users.

Behind-the-meter services refer to energy systems like solar panels and batteries that generate or store electricity on-site—typically at homes or businesses. These systems operate independently of the main power grid, meaning the energy they provide doesn’t pass through a utility meter before use. They are different from flex services because they generate savings and not revenue. In this use case, the data will be shown in a user-friendly way to the user.

Diagram of the use case

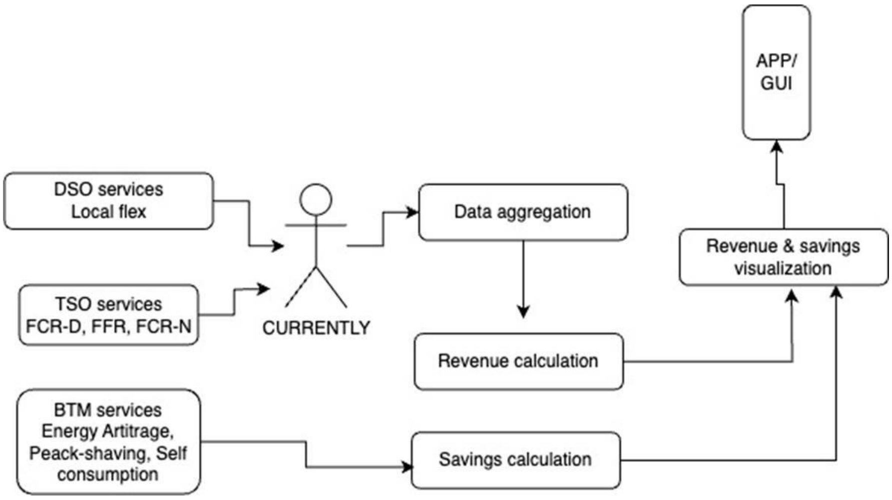


Figure 58. SW 4.1 diagram.

See also SW 1.1 for more details.

Actors of the use case

- VPP: Virtual Power Plant called Currently provided by CheckWatt.
- Aggregator: CheckWatt.
- TSO: Transmission System Operator. In Sweden it is Svenska kraftnät.
- DSO: Distribution System Operator. In Sweden it is divided between regional grid companies and local grid companies.
- Nordpool: a pan-European power exchange.

Scenarios

Main path

Step no.	Event	Description of process	Info. exchanged	Actor producing the information	Actor receiving the information
1	New day occurs (0000). Auction opens	For each BRP, analyse available aggregated resources and most profitable service (FCR-D, FCR-N, mFRR, FFR)		VPP	BRP
2	Send bids	The flexibility offers are sent to selected market for auction.	Power, timeframe	VPP	BRP
3	Accept bid	The BRP interested accepts the offer	Power, price, time	VPP	BRP
4	Report revenue for winning bids	The BRP reports back the amount of winning bids and the revenues	Revenue	BRP	VPP
5	Update consumer account	The revenue share for the consumer is calculated		VPP	Consumer
6	Visualise revenues	The aggregated revenues so far this month is visualize in end user app	Daily revenues	VPP	Consumer

Exception path

Step no.	Event	Description of process	Info. Exchanged	Actor producing the information	Actor receiving the information
1	Not enough resources available	At least 100 kW of aggregated resources must exist to make a bid	Aggregated amount	VPP	

6.7. SMART CHARGING OF EVS FOR GRID SUPPORT.

ES 4.1. SMART EV CHARGING IN OVERDEMAND GRID STATUS.

Scope and objectives

In this use case, the objective is to make the grid's needs compatible with the customer's preferences. To achieve this, the Distribution Control Centre will send a flexibility request through SIORD. This request will be sent to the successful bidder, who will execute the agreed flexibility to return the grid to its normal operating limits. The special feature of this case is that the electric vehicle chargers will belong to Iberdrola's public charging platform.

Narrative of the use case

In this use case, the smart charging of electric vehicles is proposed in a station where the massive arrival of vehicles causes a specific problem in the electrical grid (either due to high load on the line or overvoltage). When a customer arrives at a charging point, he/she selects the basic data of the charging program, in addition to a series of service preferences in cases where the electrical grid is affected (accept modifications in the charging power, accept station changes, never disturb, etc.), in exchange for financial benefits. These preferences, housed in a retailer's database, are input data for an optimization algorithm, which is responsible for providing the best possible service, according to the circumstances of the network. In addition, the needs detected by the DSOs at specific points in the network are sent to a neutral flexibility platform (SIORD), before feeding the optimization algorithm. This use case shows the option of the local market bid submissions or even bilateral agreements between the DSO and the FSP. Therefore, the figure of local market operator is not mandatory.

Regarding SIORD, it is a unique shared platform for all the 333 Spanish DSO that unifies the communication protocols and standards for those “Single Generation Units” (SGU) that should provide real-time as mandatory. SIORD is a new DSO shared data hub to unify the communication links and standardize protocols between Generation &

Demand Control Centres (GD-CC) (or SIORD Operators) and DSO, a new DSO-shared data hub to monitor and control DER in Spain as a common, homogeneous, and more efficient solution to exchange real-time data. This is an efficient and cheaper alternative to provide real-time data to the grid operators.

SIORD, already in production, is prepared to support different communication protocols for the connection and exchange of information between the DSOs and the resources connected to the distribution grid.

SIORD does not store data, it only receives real-time data from the resources, mainly reagent flows and switch status via each operator and forwards this data only to the distributed renewable generation to which the resource is connected. The above communication scheme is also used if the System Operator or the DSO must send setpoints to the resource. The system provides a centralized SCADA management that allows the monitoring, management and maintenance of the different components required by the platform, define new connections, checking the quality of communication links, programming KPIs for different users, etc.

SIORD Operator of distributed energy resources (OPS), is the interlocutor with the distribution grid managers in the operation, sending real-time information on the facilities and ensuring that its instructions are carried out to always guarantee the reliability of the distribution grid. GD-CCs can be enabled as OPSs, but the requirements to be OPSs should be less demanding than to be GD-CCs, so GD-CCs are a subset within OPSs. In the future, when local_flexibility services are implemented, aggregators will be OPSs when they develop the operational functions of their flexible resources.

Information Platforms with Distributed Energy Resources (PIRED) are existing monitoring platforms, simpler and for smaller resources, without the requirements demanded to OPS, oriented in this case only to monitoring.

SIORD will also act as a Management Portal for exchanging information about flexibility services. It can transmit different types of data, depending on the kind of flexibility service, the characteristics of the distributed resources, and the national regulatory framework that applies to the case. It also enables the communications with the new flexibility market operators.

Diagram of the use case

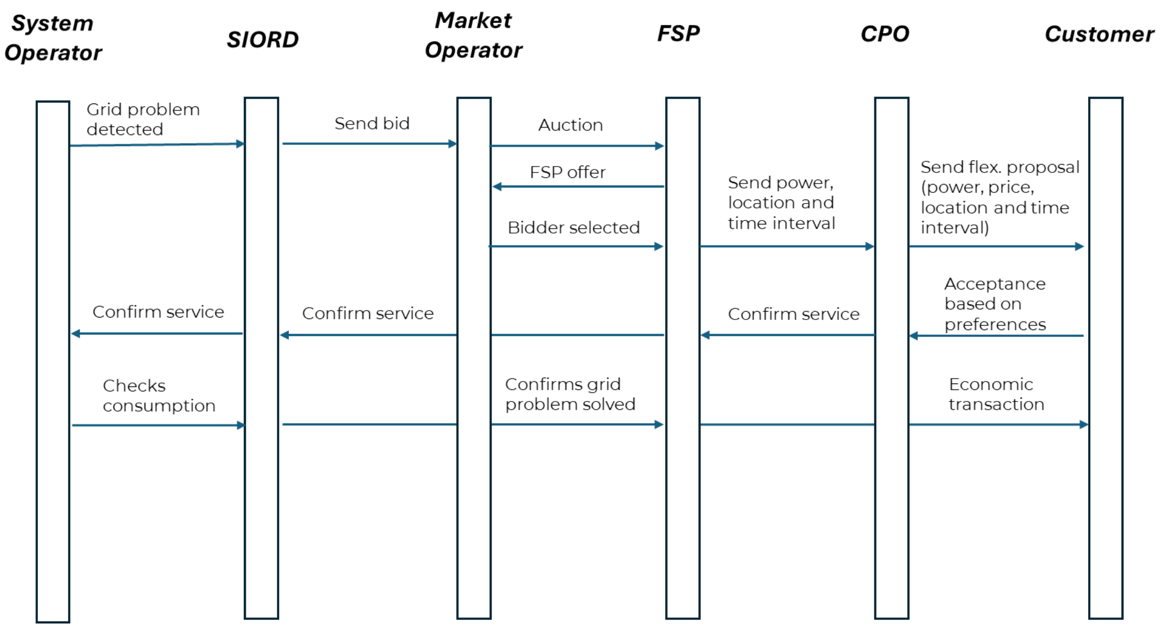


Figure 59. ES 4.1 Diagram.

The next figure shows the relationship among:

- DSO.
- SIORD.
- Local market platforms (if applies)
- Aggregators.
- Distribution and generation control centres.
- OPS (SIORD operator).
- PIRED (Information Platforms with Distributed Energy Resources).

The DSO exchange information with the local platforms (the needs) and SIORD. These local platforms receive bids and send assignments to the aggregators and FSPs. There is also an information exchange between SIORD and CC-GD, OPS or PIRED which are in contact with flexible assets.

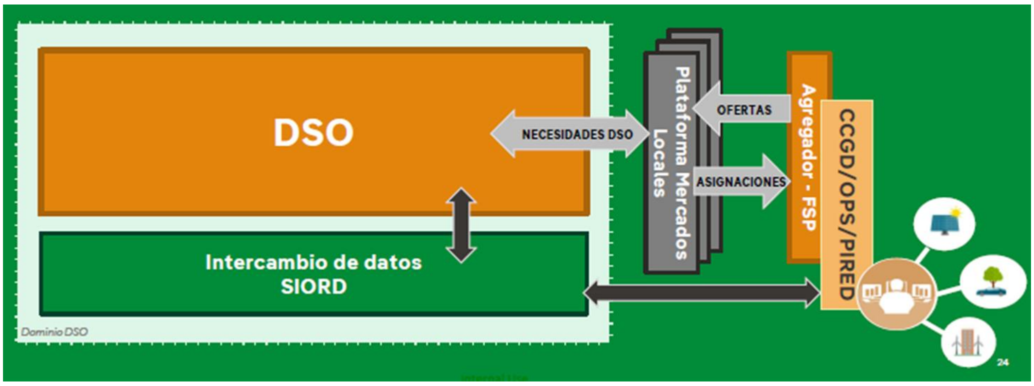


Figure 60. ES 4.1. SIORD interconnection with the different actor platforms.

The SIORD platform trades information from different DSOs and uses PIRED and CCGD for exchanging data (for example, monitorization) with the distributed generation or consumption energy resources.

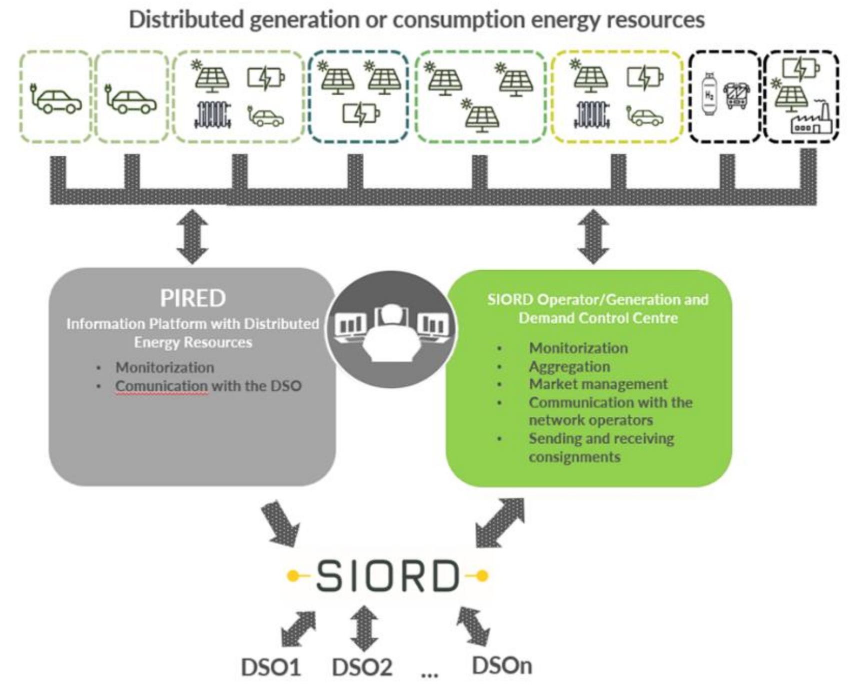


Figure 61. ES 1.1 SIORD diagram.

Actors of the use case

- Distribution System Operator.
- Market Information Aggregator (SIORD).
- Market Operator.
- Energy Service Company.
- Flexibility Service Provider.
- Charging Point Operator.
- Consumer.

Scenarios

Main path

Basic path 1					
Step no.	**Event**	**Description of process**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Grid problem detected	A grid problem is detected in a DSO area. The necessity is sent to SIORD.	Network area affected // Power needed to solve // Timeframe	System Operator (i-DE)	Market Information Aggregator (SIORD)
2	Send bid	The power requested is sent to market for auction. At least one expected bid to contribute to solve the problem.	Power, timeframe	Market Information Aggregator (SIORD)	Market Operator (Local)
3	Send bid	The market operator sends bids to one/several flexibility service provider/s	Power, price, time	Market Operator (Local)	Flexibility Service Provider
4	Send flexibility proposal	FSP sends proposal to the CPO for modification of charging program	Power, price, time and location	Flexibility Service Provider	Charging Point Operator
5	Send information	CPO informs customer about the new charging program	Power, price	Charging Point Operator	Customer
6	Accept flexibility proposal	Customer accepts proposal of the FSP	Response (Yes/No)	Customer	Charging Point Operator

7	Send confirmation	CPO informs FSP about the service	Confirmation	Charging Point Operator	Flexibility Service Provider
8	Send confirmation	The FSP informs SIORD	Power, price, time	Flexibility Service Provider	Market Information Aggregator (SIORD)
9	Send response	SIORD gives feedback to DSO, which clients are going to be monitored from FSP	Power, time, customer/s	Market Information Aggregator (SIORD)	System Operator
10	Check grid consumption	DSO checks that the restriction from the grid has disappeared	Power, voltage and time	System Operator	Market Information Aggregator (SIORD)
11	Send confirmation	SIORD sends to FSP the confirmation from DSO	Response (Yes/No)	Market Information Aggregator (SIORD)	Flexibility Service Provider
12	Send confirmation	FSP sends the confirmation to the customer, who receives the payment	Response (Yes/No)	Flexibility Service Provider	Customer

Exception path

Exception paths					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
3	No valid offers	The market operator does not receive any offers from a suitable FSP area	Power, price, time	FSP	System Operator
10	Restriction is still present	Grid congestion not solved. Send a new offer close to real-time	Power, voltage, time	DSO	Flexibility Service Provider

ES 1.1. SMART EV RESIDENTIAL CHARGING (I).

Scope and objectives

In this use case, the objective is to make the grid's needs compatible with the customer's preferences. To achieve this, the Distribution Control Centre will send a flexibility request through SIORD. This request will be sent to the successful bidder customer, who will execute the agreed flexibility to return the grid to its normal operating limits. The special feature of this case is that the charging session is performed at households, usually during night hours and without the supervision of the customer.

For the DSO, the advantages are reduced network investments since its assets are not subject to operating conditions close to the limit, reduction of power peaks that could occur in certain areas of the network or during periods of the day, improved efficiency (lower losses) and improved TIEPI.

Narrative of the use case

The use case consists of the residential smart charging of EVs due to an electrical congestion in a neighbourhood (either due to high load on the line or overvoltage). The idea is to see the flexibility possibilities (reduce charging power, delay the beginning of the program, reduce final state-of-charge, ...), keeping the customer preferences when it is possible. These preferences, housed in a retailer's database, are input data for an optimization algorithm, which is responsible for providing the best possible service, according to the circumstances of the network. In addition, the needs detected by the DSOs at specific points in the network are sent to a neutral flexibility platform (SIORD), before feeding the optimization algorithm.

Usually, the residential EV charging is performed during night. Therefore, it is necessary to model default preferences by the user. Hence, the aggregator knows the amount of flexibility that can be provided for that request.

For more detailed information about the SIORD platform, see use case ES4.1.

Diagram of the use case

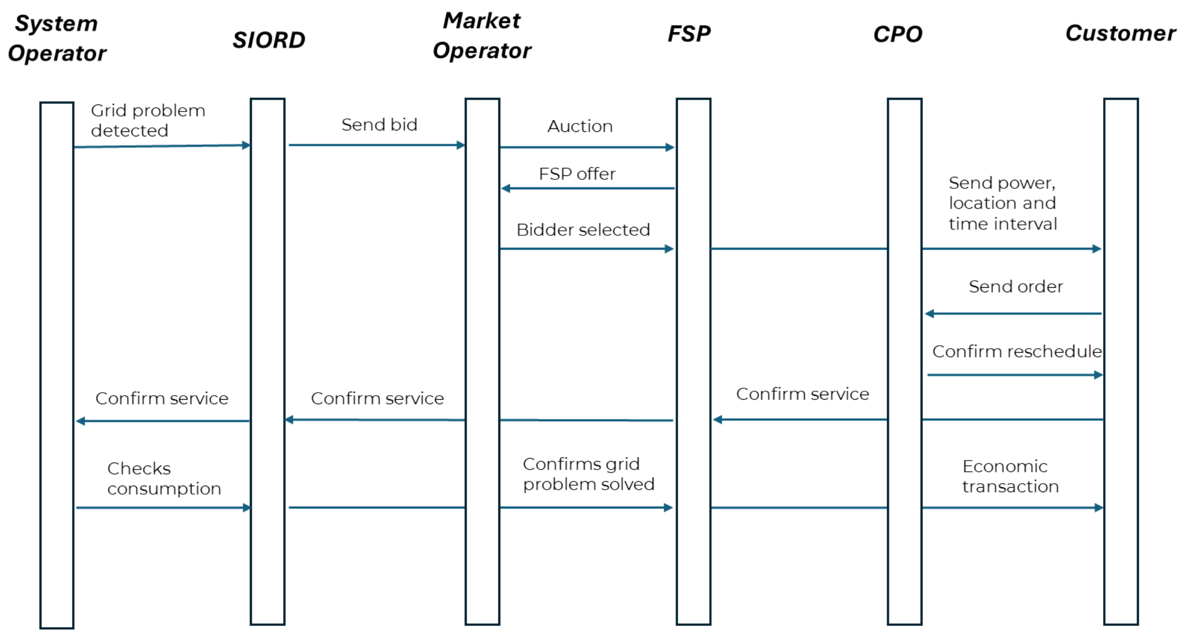


Figure 62. ES 1.1 Diagram

For the SIORD diagram, see use case ES4.1.

Actors of the use case

- Distribution System Operator.
- Market Information Aggregator (SIORD).
- Market Operator.
- Energy Service Company.
- Flexibility Service Provider.
- Charging Point Operator.
- Consumer.

Scenarios

Main path

Basic path 1					
Step no.	**Event**	**Description of process**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Grid problem detected	A grid problem is detected in a DSO area. The necessity is sent to SIORD.	Network area affected // Power needed to solve // Timeframe	System Operator (i-DE)	Market Information Aggregator (SIORD)
2	Send bid	The power requested is sent to market for auction. At least one expected bid to contribute to solve the problem.	Power, timeframe	Market Information Aggregator (SIORD)	Market Operator (Local)
3	Send bid	The market operator sends bids to one/several flexibility service provider/s	Power, price, time	Market Operator (Local)	Flexibility Service Provider
4	Send flexibility proposal	FSP sends proposal to the customer for modification of charging program	Power, price, time and location	Flexibility Service Provider	Customer
5	Send information	Private customer informs CPO about the new charging program	Power, price, location	Customer	Charging Point Operator
6	CPO confirms	CPO informs FSP that customer has been done	Confirmation of new program	Charging Point Operator	Customer
7	Customer confirms	Customer informs FSP that the reschedule has been modified	Confirmation	Customer	Flexibility Service Provider
8	Service ready for activation	The FSP sends to SIORD that customer is ready	Confirmation	Flexibility Service Provider	Market Information Aggregator (SIORD)
9	Send response	SIORD gives feedback to DSO, which clients are going to be	Power, time, customer/s	Market Information Aggregator (SIORD)	System Operator

		monitored from FSP			
10	Check grid consumption	DSO checks that the restriction from the grid has disappeared	Power, voltage and time	System Operator	Market Information Aggregator (SIORD)
11	Send confirmation	SIORD sends to FSP the confirmation from DSO	Response (Yes/No)	Market Information Aggregator (SIORD)	Flexibility Service Provider

Exception path

Exception path					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
3	No valid offers	The market operator does not receive any offers from a suitable FSP area	Power, price, time	FSP	System Operator
9	Restriction is still present	Grid congestion not solved. Send a new offer close to real-time	Power, voltage, time	DSO	Flexibility Service Provider

ES 2.1. SMART EV RESIDENTIAL CHARGING (II).

Scope and objectives

In this use case, the objective is to reduce the CO2 footprint from residential EV charging throughout the adoption of specific charging sessions that minimize CO2 emissions. This will consider the emissions of the national electricity system and propose the customer charges the electric vehicle according to a certain pattern without necessarily implying an economic benefit.

The challenge of the use case is how these new charging profiles will affect the DSO grid.

Narrative of the use case

Home electric vehicle charging mostly occurs at night, as this coincides with the hours when electricity is typically cheapest, and the vehicle is parked.

However, CO2 emissions from the national electricity system vary from hour to hour during the same night and across nights of the week. Furthermore, given the absence of photovoltaic production, there could be lower greenhouse gas emissions during other periods, such as weekend mornings.

Therefore, even if there is no economic benefit for the customer from changing home charging habits, it would result in a reduction in CO2 emissions. The benefits for the DSO are greater integration of renewable energies (lower curtailment) by charging vehicles during hours when there is greater production.

For more detailed information about the SIORD platform, see use case ES4.1.

Diagram of the use case

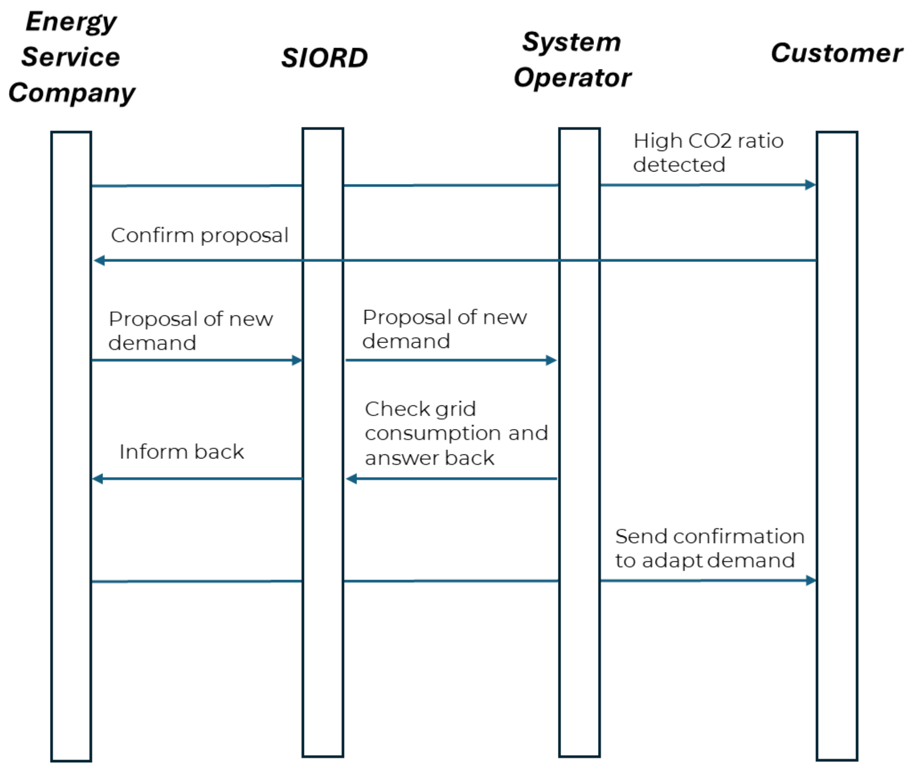


Figure 63. ES 2.1 Diagram

For the SIORD diagram, see use case ES4.1.

Actors of the use case

- Distribution System Operator.
- Energy Service Company.
- Market Information Aggregator (SIORD).
- Charging Point Operator.
- Consumer.

Scenarios

Main path

Basic path					
Step no.	**Event**	**Description of process**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Reassign charging sessions based on CO2 emissions	The Energy Service Company proposes the change on the customer consumption pattern based on the CO2 emissions of the national grid	Network area affected // Power needed to solve // Timeframe	Energy Service Company	Customer
2	Confirmation of the proposal	Customer confirms the proposal to change the charging program based on emissions	Power, time and location	Customer	Energy Service Company
3	Proposal of new charging schedules	The Energy Service Company proposes the change to DSO	Customers affected // Power needed to solve // Timeframe	Energy Service Company	Market Information Aggregator (SIORD)
4	Send proposal to DSO	The information in SIORD is received by DSO	Power needed to solve // Grid lines affected // Timeframe	Market Information Aggregator (SIORD)	System Operator
5	Check grid consumption	DSO checks that the new grid demand is possible	Yes/No	System Operator	Market Information Aggregator (SIORD)
6	Confirmation	SIORD informs Energy Service	Yes/No	Market Information	Energy Service Company

		Company about the DSO answer		Aggregator (SIORD)	
7	Confirmation	Energy Service Company allows customer to adapt demand	Confirmation	Energy Service Company	Customer

Exception path

Exception path					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
5	Send response	The DSO denies the proposal	Response (No)	System Operator (DSO)	Market Information Aggregator (SIORD)

ES 4.2. SMART EV CHARGING IN PRIVATE COMPANIES.

Scope and objectives

In this use case, the objective is to make the grid's needs compatible with the customer's preferences. To achieve this, the Distribution Control Centre will send a flexibility request through SIORD. This request will be sent to the successful bidder customer, who will execute the agreed flexibility to return the grid to its normal operating limits. The special feature of this case is double:

- The customer optimizes its EV fleet during grid emergency or congestion situations.
- The charging optimization of the EV fleet considering the number of charging points and the EV necessities.

Narrative of the use case

The main differentiator of this case is how to handle the recharging of multiple company vehicles when the charging requests or needs exceed the capacity of the charging station. Being a private company, there is additional flexibility by being able to manage the fleet jointly and provide the best solution for all the vehicles.

When charging power is reduced due to network requirements, it becomes a challenge to support simultaneous charging from multiple chargers of a fleet. The goal is to explore the optimal balance between solving a network problem (more chargers providing flexibility) and allowing vehicles to reach a sufficient state of charge.

The flexibility service is provided by a local market or a bilateral agreement between DSO and FSP.

For more detailed information about the SIORD platform, see UC ES 4.1.

Diagram of the use case

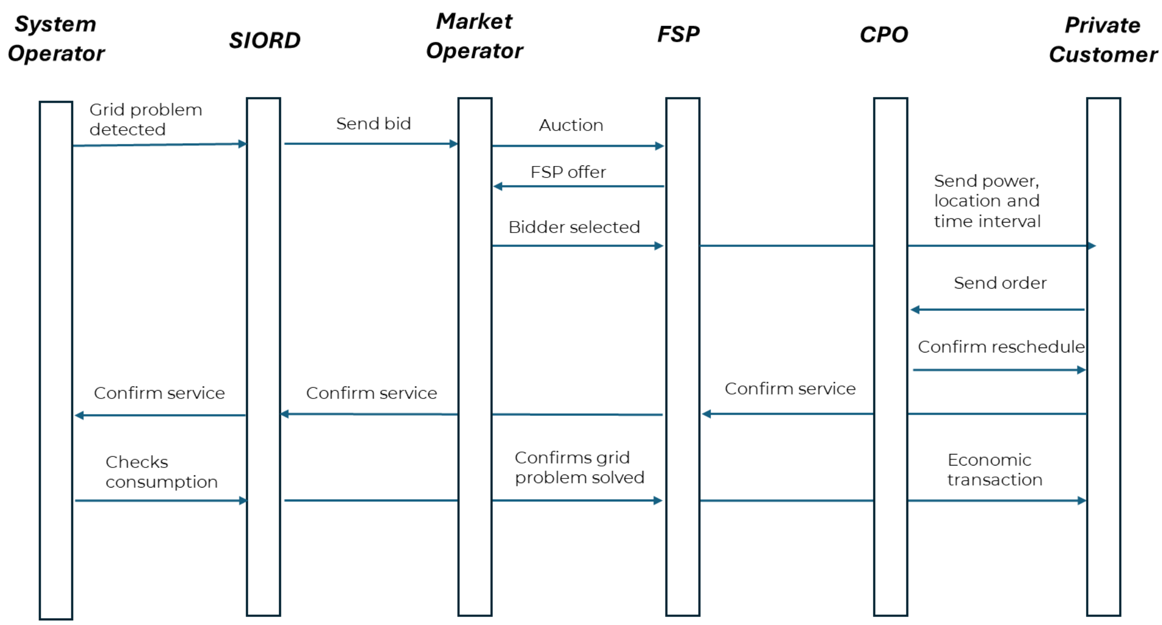


Figure 64. ES 4.2. Diagram

Actors of the use case

- Distribution System Operator.
- Market Information Aggregator (SIORD).
- Market Operator.
- Energy Service Company.
- Flexibility Service Provider.
- Charging Point Operator.
- Consumer.

Scenarios

Main path

Basic path					
Step no.	**Event**	**Description of process**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Grid problem detected	A grid problem is detected in a DSO area. The necessity is sent to SIORD.	Network area affected // Power needed to solve // Timeframe	System Operator (i-DE)	Market Information Aggregator (SIORD)
2	Send bid	The power requested is sent to market for auction. At least one expected bid to contribute to solve the problem.	Power, timeframe	Market Information Aggregator (SIORD)	Market Operator (Local)
3	Send bid	The market operator sends bids to one/several flexibility service provider/s	Power, price, time	Market Operator (Local)	Flexibility Service Provider
4	Send flexibility proposal	FSP sends proposal to the private customer (CPO) for modification of charging program	Power, price, location, time	Flexibility Service Provider	Customer
5	Send information	Private customer informs CPO about the new charging program	Power, price, location	Customer	Charging Point Operator
6	CPO confirms	CPO informs FSP that customer has been done	Confirmation of new program	Charging Point Operator	Customer

7	Customer confirms	Customer informs FSP that the reschedule has been modified	Confirmation	Customer	Flexibility Service Provider
8	Service ready for activation	The FSP sends to SIORD that customer is ready	Confirmation	Flexibility Service Provider	Market Information Aggregator (SIORD)
9	Send response	SIORD gives feedback to DSO, which clients are going to be monitored from FSP	Power, time, customer/s	Market Information Aggregator (SIORD)	System Operator
10	Check grid consumption	DSO checks that the restriction from the grid has disappeared	Power, voltage and time	System Operator	Market Information Aggregator (SIORD)
11	Send confirmation	SIORD sends to FSP the confirmation from DSO	Response (Yes/No)	Market Information Aggregator (SIORD)	Flexibility Service Provider
12	Send confirmation	FSP sends the confirmation to the customer, who receives the payment	Response (Yes/No)	Flexibility Service Provider	Customer

Exception path

Exception paths					
Step no.	**Event**	**Description of process**	**Info. Exchanged**	**Actor producing the information**	**Actor receiving the information**
3	No valid offers	The market operator does not receive any offers from a suitable FSP area	Power, price, time	FSP	System Operator
10	Restriction is still present	Grid congestion not solved. Send a new offer close to real-time	Power, voltage, time	DSO	Flexibility Service Provider

7. DESCRIPTION OF REQUIREMENTS METHODOLOGY.

As an outcome of Task 2.3 – Definition and Consolidation of CERF Requirements, a comprehensive set of 112 distinct requirements have been identified. These requirements are the result of a systematic and collaborative effort of all the partners, aimed at capturing and formalizing the technical, functional, and operational needs of the ECLIPSE project. Each requirement is carefully described to represent a specific aspect of the innovative components and technologies being developed within the project, serving as a foundational reference for design, development, and validation activities.

This section outlines the methodology adopted to elicit and structure these requirements. It also highlights their strategic importance in ensuring that the project objectives are met in a coherent and traceable manner. The approach followed during this task involved considering the pilot use cases, reviewing relevant documentation about previous projects and iterating through several phases to ensure the relevance, clarity, and feasibility of each requirement.

While the focus here is on providing a conceptual overview of the requirement definition process and its significance to the overall project, the full list of all 112 requirements, including detailed descriptions, categories, and other information, can be found in Annex I. This annex serves as a central reference point for all consortium partners and project contributors throughout the lifecycle of the ECLIPSE project.

7.1. REQUIREMENTS CLASSIFICATION GROUPS.

For better organization and manageability of the work, the 112 requirements were grouped into seven classification categories (which were later reduced to five, as it will be explain in the following sections). These groups were designed to reflect different domains of functionality within the project, facilitating easier analysis and implementation. The classification helps stakeholders focus on specific areas of interest and ensures that related requirements are treated in a consistent and coherent manner:

Description	Requirement ID prefix
CERF Data Spaces	DAT
CERF Digital Twin Services	DTS
CERF Energy Services	SVC
Energy Apps	APP
Energy Assets Communication	EAC
Energy Assets Infrastructure	EAI
General Requirements	GEN

Table 11. List of requirements classification groups from Volere.

7.2. REQUIREMENTS PRIORITIZATION.

To support effective project planning and resource allocation, the ECLIPSE project consortium has established a priority classification system to evaluate and rank the requirements based on their relevance and impact. This system consists of five distinct priority levels, ranging from 1 star (lowest priority) to 5 stars (highest priority). Each level reflects the requirement's importance in relation to the core objectives of the project and its potential contribution to the development of innovative solutions and application prototypes. The priority classes have been defined as follows:

- **5 stars – High:** Requirements classified under this category are either directly responsible for delivering a key innovation of the project or are essential enablers for such innovations. Their fulfilment is critical to achieving the main goals of the ECLIPSE project.
- **4–3 stars – Medium:** These requirements, while not directly tied to the realization of a core innovation, are necessary or significantly beneficial for the successful development of the application prototypes. They are considered highly relevant from the perspective of application developers and are important for ensuring practical implementation and usability.

- **2–1 star– Low:** Requirements in this group are neither essential for delivering key innovations nor for developing the project's application prototypes. However, they may offer added value in a broader or future context, potentially extending the usability and functionality of project outcomes beyond the current scope.

Given this classification, the successful fulfilment of high-priority requirements is essential to the overall success of the project. Additionally, to ensure comprehensive support for developers and end-users, addressing medium-priority requirements is strongly encouraged. In contrast, low-priority requirements, while not immediately relevant, may provide useful enhancements or added features if resources and time permit once the more critical items have been addressed.

7.3. VOLERE TOOL.

To establish a comprehensive and optimized set of requirements, ETRA initially developed a web-based tool grounded in the Volere methodology. Since its creation, this tool has been effectively utilized across multiple projects. Within the ECLIPSE Digital Project initiative, it has supported the specification, verification, and prioritization of requirements.

Due to security protocols, the tool is accessible only to users with authorized credentials. At the beginning, the different partner organizations and members are registered in the platform. From this point on, when the users are successfully authenticated, the platform enables them to oversee the entire requirement specification workflow, from the initial formulation of requirements through their review and validation stages, culminating in the final approved list.

7.3.1. REQUIREMENTS DEFINITION.

The requirements definition process is illustrated in the figure below. New requirements may be submitted during both the validation and revision phases of each iteration. During the validation phase, submitted requirements are reviewed, and any relevant dependencies, conflicts, or objections can be recorded. This phase lasts approximately one and a half weeks, after which it transitions into the revision phase.

In the revision phase, the previously identified dependencies, conflicts, and objections are addressed and resolved collaboratively by the involved partners. This phase also spans roughly one and a half weeks. Upon its conclusion, the iteration counter is incremented, and the cycle returns to the validation phase, continuing in this iterative manner until the final iteration is completed.

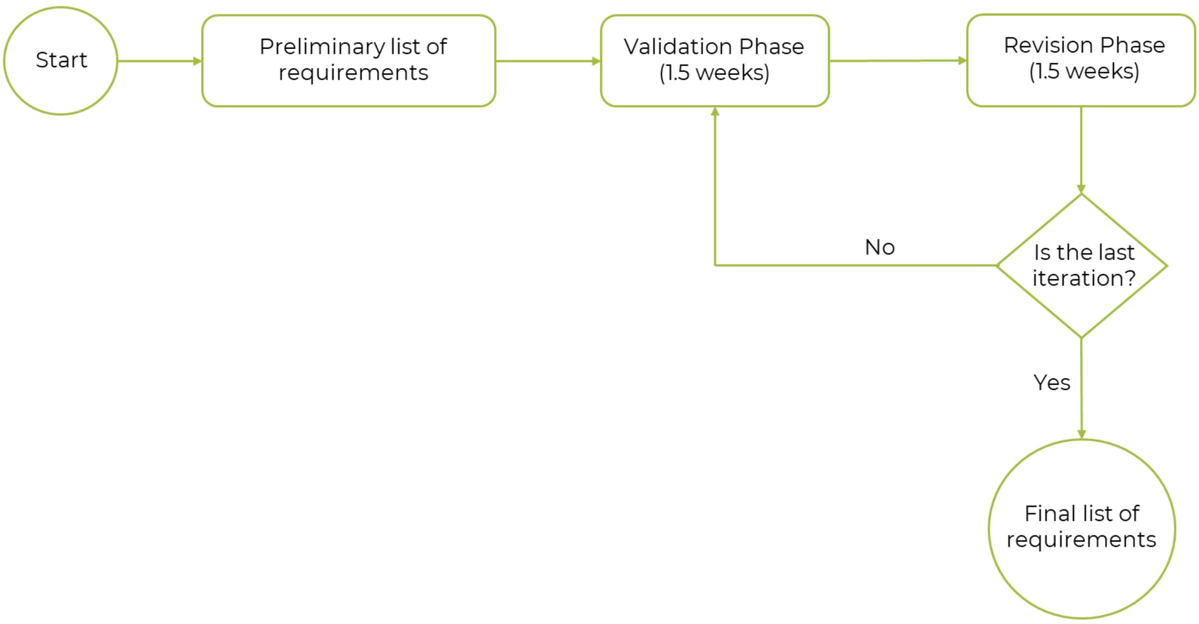


Figure 65. Requirements definition process flow chart.

Within the Volere tool, users have access to a comprehensive list of submitted requirements, as shown in the figure below. New requirements can be added via the "New Requirement" button. The interface allows users to view detailed information for each requirement, as well as to edit or delete the entries they have contributed.

Requirements list
This is the list of system and software requirements that must accomplish the project.

Show requirements history | Export to CSV

Description | Classification | Organization | Version

New requirement — Expand table — Go downwards

Id.	Description	Classification	Type	Priority	Author		Dep.	Conf.	Obj.
Unique Id.	*A one sentence statement of the intention of the requirement*	*The classification group which the requirement belongs to*	*The type from the template*	*Priority*	*Author of the requirement*				
APP_001	The energy applications based on CERF must provide to the final consumers with simple, useful and user-friendly information on their energy patterns.	Energy Apps	Usability and humanity requirements	★★★★☆	ETRA (Lola Alacreu García)				
APP_002	When demand is actively managed without constant intervention, the APP should receive the mechanisms automatically, keeping the preferences and limits previously established.	Energy Apps	Functional and data requirements	★★★☆☆	IBER (Javier Fernandez)				
APP_005	In efficiency actions like high acceptance among users or with high overall effectiveness, the system should provide insights based on anonymized third-party data.	Energy Apps	Functional and data requirements	★★★☆☆	IBER (Javier Fernandez)				
APP_007	Standard interfaces, data exchange protocols and data models (e.g., through an ontology like SAREF) should be adopted for the development of energy-saving applications.	Energy Apps	Functional and data requirements	★★★★★	EDSO (Selene Liverani)				
APP_008	The energy app shall provide, when in place/scope, clear economic signals stimulating users to change their energy consumption behaviour.	Energy Apps	The client, the customer and other stakeholders	★★★★☆	EDSO (Selene Liverani)				
APP_009	When possible, functions for automating user assets' responses to the recommendations provided by the applications should be made available (to be voluntarily activated by the user).	Energy Apps	Users of the product	★★★★☆	EDSO (Selene Liverani)				
APP_010	An exchange channel between the user and the developer/owner of the application should be implemented to allow for the submission of user feedback and the continuous improvement of the app.	Energy Apps	Usability and humanity requirements	★★★★☆	EDSO (Selene Liverani)				

Figure 66. Volere tool requirements list.

When adding a new requirement, a menu shows up, and the user is required to add information for all the necessary requirement fields:

The fields are:

- Classification: Associated product within seven categories: energy apps, CERF energy services, CERF digital twin services, CERF data spaces, energy assets communication, energy assets infrastructure and general requirements.
- Description: a clear and concise definition of the requirement. It must follow the Easy Approach to Requirements Syntax (EARS) for functional requirements.

[Trigger] [Precondition] Actor Action [Object]

- Example: "When an order is shipped and order terms are not prepaid, the system shall create an invoice."

Figure 68. EARS syntax for functional requirements.

- Type: Volere defines many types of requirements, but the most common usually are functional and data, usability and humanity, performance, operational, security and legal.
- Priority: the implementation priority, ranging from 1 to 5 stars.

- Rationale: the motivation behind the requirement.
- Acceptance criteria: the condition to mark the requirement as fulfilled.
- Comments: any additional information, remarks, etc.

After that, the added requirement can be inspected and updated, if necessary, in the menu shown in the figure below.

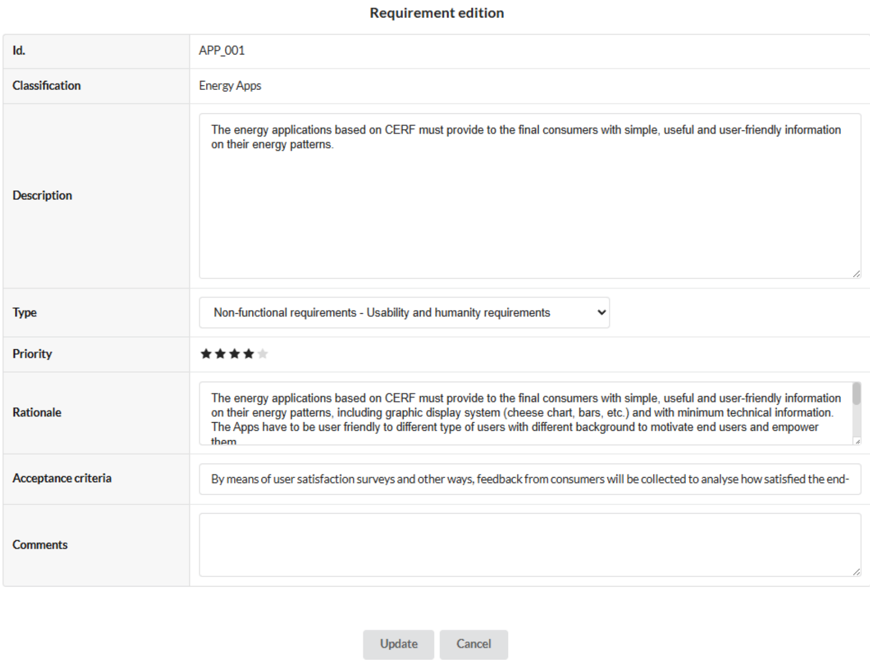


Figure 67. Requirement edition menu in Volere.

7.3.2. VALIDATION PHASE.

After the requirements have been defined and during the validation phase, all submitted requirements must be reviewed and approved. To do so, all users participating in the definition process must check the list in order to identify any dependencies, conflicts, or objections associated with the requirements:

- Dependency: Indicates that a requirement relies on the implementation or outcome of another requirement.
- Conflict: Arises when the implementation of one requirement is incompatible with another, or when a requirement is insufficiently defined, leading to potential contradictions.

- Objection: Represents a formal expression of disagreement, opposition, or disapproval concerning a specific requirement.

These issues can be added to the implied requirements at the bottom of the list, in the menu called “Dependencies, conflicts and objections”.

7.3.3. REVISION PHASE.

During the revision phase, any dependencies, conflicts, or objections raised by the reviewers in the previous phase must be addressed by the original authors of the respective requirements. In cases where the authors disagree with the validator’s feedback, they are encouraged to provide their perspective in the “Revisor’s Comments” section, offering additional explanations or clarifications. It’s important to note that only the original authors are permitted to add comments or input related to these specific issues. On the other hand, if the authors agree on the comments from the reviewer, they must address the necessary changes to fulfil the reviewer’s comments and then tick the checkbox to indicate the issue has been solved from their side.

The figure below illustrates the revision interface within the Volere tool. The columns titled “Requirements Revised” and “Validator’s Approval” include checkboxes that support tracking the status of each revision. These elements, in combination with the comment fields, enhance communication and collaboration between the requirement authors and validators. The “Requirements Revised” checkbox is only enabled for the requirement’s author, while the “Validator’s Approval” checkbox is reserved solely for validators.

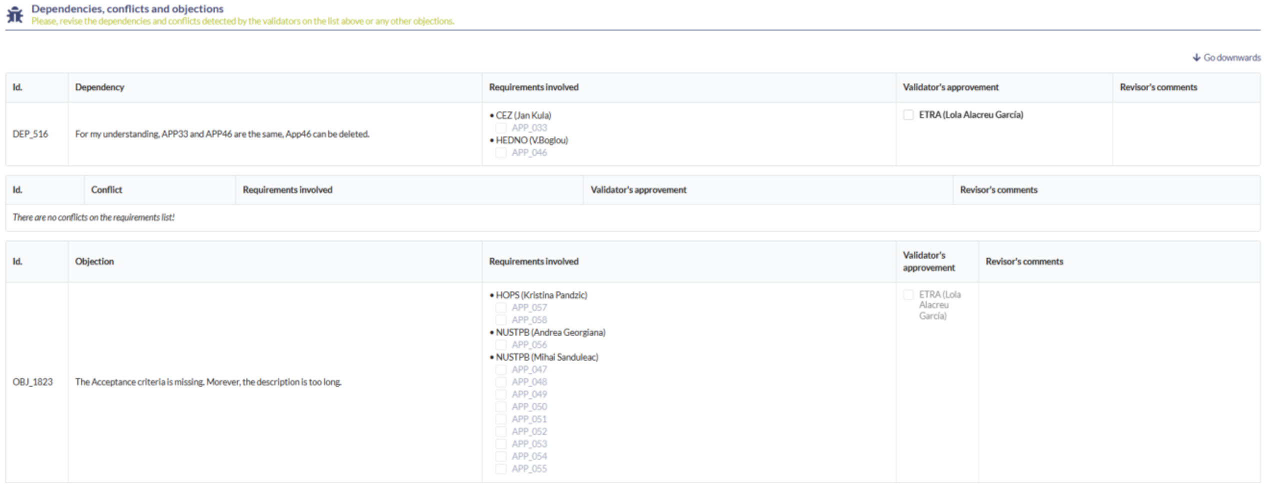


Figure 68. Revision interface in Volere tool.

The revision process involves the following steps:

- Identification: authors begin by reviewing which of their requirements have been flagged with objections, dependencies, or conflicts.
- Assessment and Response: after examining the validator's remarks, if the author agrees, they may proceed to update or remove the requirement as necessary. If the author disagrees, they can add clarifying comments to justify the requirement's intent or improve its description.
- Marking as Revised: once the necessary actions are taken, the author should mark the corresponding checkbox to indicate the requirement has been revised.
- Validator Approval: validators are then responsible for reviewing the updates and confirming that the issues raised have been appropriately addressed by checking the approval box.

7.4. POST-PROCESS FILTERING AND RESULTS.

Upon completion of the sixth iteration, a provisional list of requirements was compiled, comprising a total of 119 requirements distributed across seven categories (refer to the figure below).

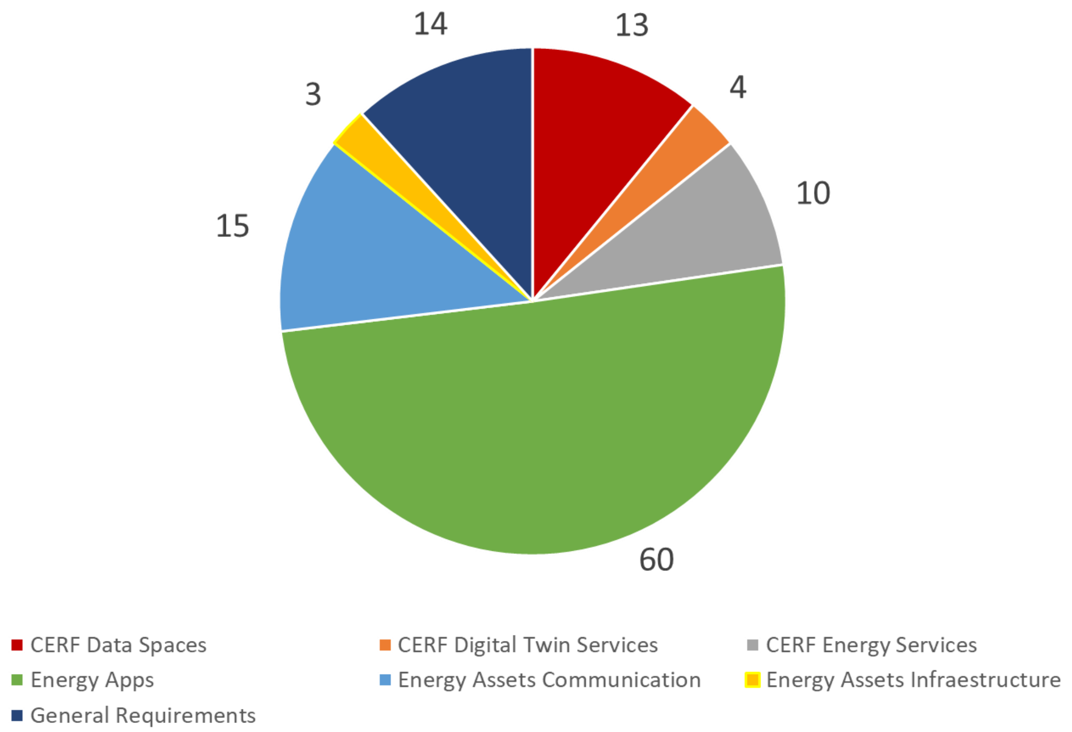


Figure 69. Provisional list of requirements by category.

This preliminary list was exported from Volere in CSV format for further refinement. From this point onward, ETRA took responsibility for filtering, reviewing, and enhancing the dataset to ensure the production of a well-structured and finalized list. The refinement process included several key actions:

- Resolution of outstanding issues: First, any unresolved dependencies, conflicts, and objections remaining after the sixth iteration were manually reviewed and resolved by ETRA, in coordination with the original authors of the affected requirements. These open issues are illustrated in the following figure.
- Completion and Standardization of Requirement Information: The full list was reviewed to address missing or incomplete data. This included adding missing rationale, acceptance criteria, or priority values. Reorganizing and relocating

content was also performed to improve clarity. For example, concise requirement descriptions were retained in the primary field, while supplementary details were moved to the comments or rationale sections.

- Balancing the Distribution Across Categories: It was observed that the distribution of requirements across categories was significantly uneven. Specifically, the "Energy Apps" category contained 60 requirements, accounting for half of the total, while other critical categories, such as those related to the CERF (Common Energy Reference Framework), contained only 27 requirements. While the importance of energy applications is acknowledged, particularly in their role of enabling end users to interact with CERF outputs, the core value of the project lies in the CERF services themselves. Therefore, several requirements originally categorized under Energy Apps were reclassified under the CERF and Energy Assets categories to achieve a more representative distribution.
- Category Consolidation: Two categories, "Energy Assets Communication" and "Energy Assets Infrastructure," were found to have a limited number of requirements, with one of them containing only a single item. To streamline the structure, these categories were merged into a unified category named "Energy Assets" (EAS).
- Integration of NILM-related Requirements: To leverage the potential of Non-Intrusive Load Monitoring (NILM) technology, an approach that uses overall smart meter consumption to estimate appliance-level usage, new requirements related to NILM were added to the list. These additions reflect the project's intention to enhance data analysis capabilities and energy efficiency measures.
- Deletion of Digital Twin Services requirements: Finally, it was noticed that there were no partners that considered any of the requirements under the Digital Twin Services category in their use cases. As a results, the four requirements under this category have been removed, reducing the final list from 116 to 112 requirements.

Following these refinements, the updated list was distributed to all project partners for final review. After a two-week feedback period, the final list of requirements was consolidated, incorporating any additional suggestions received. The finalized list comprises 112 requirements organized across five categories.

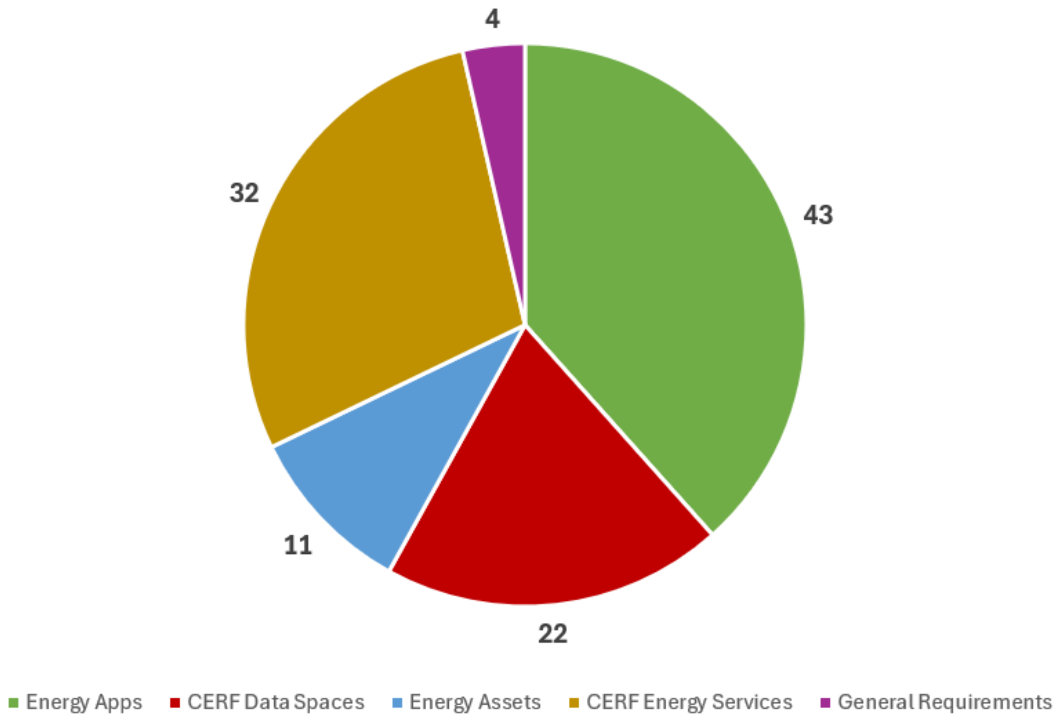


Figure 70. Final list of requirements by category.

8. PILOT SITE AREA DESCRIPTION.

This chapter provides an overview of the area where the use cases will be tested, and will be further detailed in the "Preparation, Coordination, and Monitoring of Demonstration Activities" work package (WP5).

8.1. AUSTRIA

The pilot site envisions to demonstrate the operation in at least four different locations primarily concentrated within Austria. It offers a valuable opportunity to test the interoperability considerations and reference framework characteristics of the proposed solution within a familiar context. The pilot focuses on historical data access from the national data access provider (DAP) and/or near real-time data from the smart meters of the consumers.

8.2. BULGARIA

The pilot site for this project covers the entire territory of Bulgaria. The area includes a wide range of urban and rural households. The mobile application, developed by ETRA, is the core focus of the project, and there are no limitations based on geolocation. The use cases are targeted at household customers.

8.3. CROATIA

The Croatian pilot site encompasses the entire territory of Croatia. HOPS, as the sole transmission system operator in the country, has access to all users of the Croatian transmission network and is therefore not limited to specific regions. The use cases are primarily targeted at household customers but will also include a sandbox use case for grid balancing services aimed at flexibility aggregators, as well as a sandbox use case for dynamic tariffs involving approximately 100–200 users initially. The remaining use cases have no limit on the number of participants.

8.4. CYPRUS

The selected pilot site is the wider Nicosia Region, the capital and largest urban area of Cyprus, centrally located on the island. It includes both the urban centre and surrounding suburban and rural zones, with a population of approximately 330,000 inhabitants. As a political, administrative, and economic hub, Nicosia presents a diverse and representative mix of residential, commercial, and industrial consumers. Most of the energy demand comes from residential and commercial users, while industrial loads are less prominent. The area accounts for roughly 35–40% of Cyprus's total electricity consumption, making it a critical region for national energy planning.

Nicosia was chosen for this pilot due to its diverse load types, which shape a complex demand profile. This makes it ideal for testing energy efficiency measures and demand-side flexibility. The aim is to reshape the daily load curve by lowering peak demand in the morning and afternoon, and addressing low-load periods around midday, while accounting for seasonal variations. The region's consumer diversity and infrastructure make it an effective setting for promoting energy-efficient behaviour, improving grid performance, and enabling better integration of renewable energy sources.

8.5. CZECH REPUBLIC

The pilot site for this project is the entire ČEZ Distribuce area, located in the North and West parts of Czech Republic. This extensive region, managed by ČEZ Distribuce, has more than 3,8 million connection points. Due to focus on mobile app and its features, there is no limitation in the geolocation area. The use cases focus on household customers; the anticipated amount of app users related to the ECLIPSE Project is 120,000 – 150,000 across the whole distribution area.

Figure 71. Distribution area of ČEZ Distribuce.

8.6. FRANCE

The ECLIPSE project pilot sites are distributed across several European countries and fall into two main categories: physical sites and virtual sites.

The physical sites include four confirmed installations in France, with 1 or 2 additional sites potentially being added. These are mixed sites, where homes will be equipped with solar panels, batteries, electric vehicles (EVs), and heat pumps (HPs). They will also feature various DERs, such as Voltalis smart meters and Dcbel home stations, enabling the testing and prototyping of multi-DER flexibility orchestration workflows. In addition, between 5 and 10 physical sites are planned in Finland.

The virtual sites consist of approximately ten deployments in each of the four participating countries—Belgium, Estonia, Denmark, and Finland—for a total of at least 40 virtual sites, with the possibility of expansion depending on the project's testing progress.

The project primarily targets residential customers equipped with heat pumps, leveraging the D4G solution, which integrates a complete suite of smart energy management systems.

Figure 72. France pilot sites.

8.7. GREECE

METLEN PILOT SITE

The pilot site is in Aspra Spitia, Viotia, Greece, within the industrial complex of Agios Nikolaos. This area hosts significant energy infrastructure including aluminium production facilities and gas-fired combined-cycle power plants, making it a strategically important industrial and energy hub. The residential settlement consists of 1,088 housing units, accommodating around 3,000 residents, most of whom are employees of METLEN. For the pilot, 44 residential premises are involved: 15 equipped with photovoltaic (PV) solar panels and domestic batteries, 29 equipped with Internet of Things (IoT) monitoring and control equipment.

METLEN manages the local grid aspects including street lighting, water and waste management, and maintenance of communal energy assets such as Domestic Hot Water (DHW) boilers. The presence of a Vehicle-to-Home (V2H) charger in one residence adds further complexity and flexibility to the local grid.

Aspra Spitia was chosen due to METLEN's existing comprehensive role as facility manager and energy supplier in the settlement, providing a unique, real-world environment with a mixed-use industrial and residential energy ecosystem. The site offers an ideal testbed for integrating renewable energy generation, energy storage, IoT monitoring, and demand response solutions in a live environment with engaged users. The mix of residential units with PV installations, domestic batteries, and IoT equipment, enables holistic testing of ECLIPSE's energy management innovations.

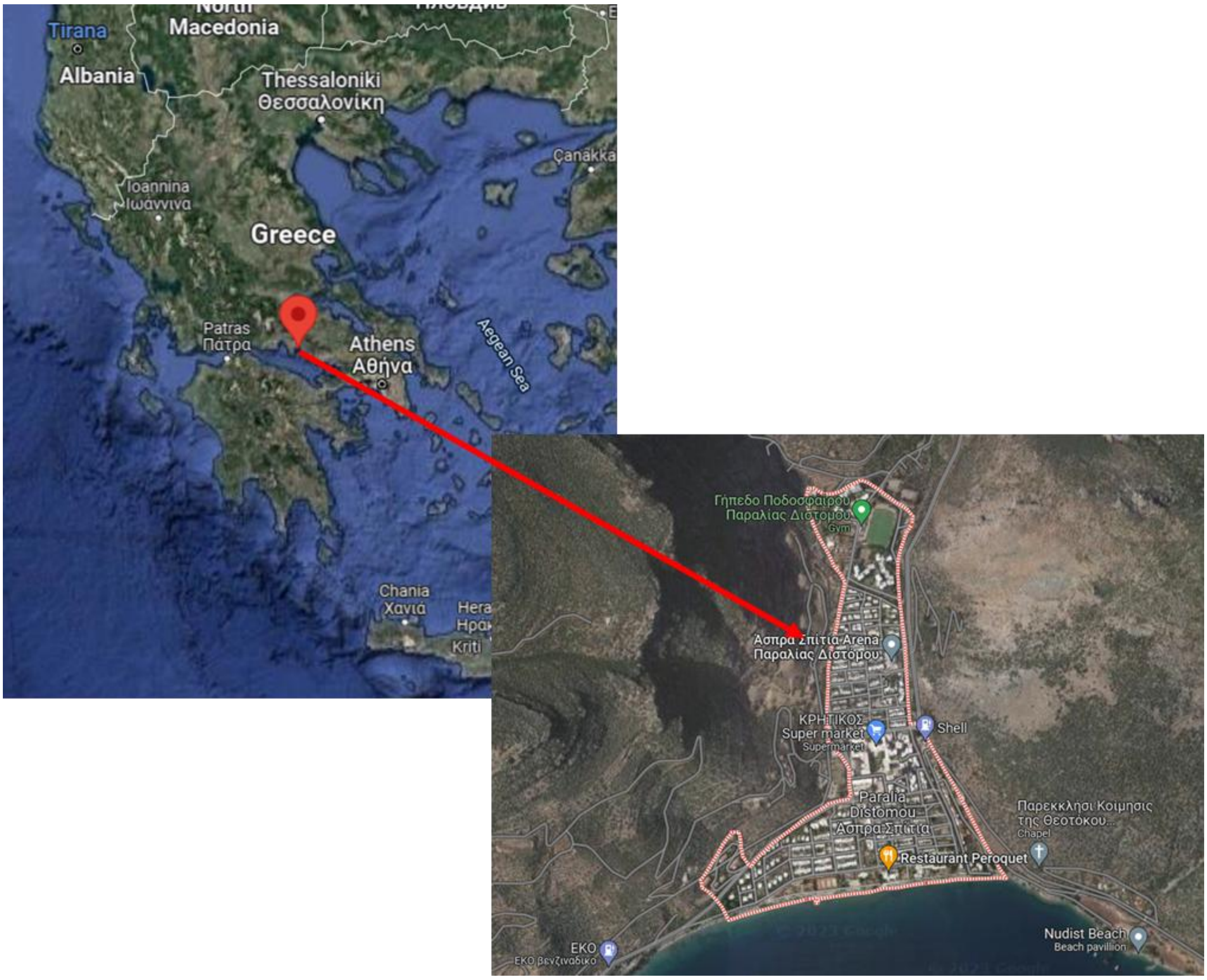


Figure 73. Greek pilot site "Aspra Spitia" owned by METLEN.

HEDNO VIRTUAL SITE

The HEDNO virtual pilot simulates the Mesogeia region, a suburban area of the capital of Greece, Athens, in the Attica region. The energy system in Mesogeia is interconnected with the mainland grid, serving the municipalities of Koropi, Lavrio, and Nea Makri, as well as supplying power to the islands of Kea, Andros, and Tinos. It is a semi-rural area that includes customers in its LV and MV networks, varied from households to small, medium, and large industries. The area benefits from installations of photovoltaics (PVs), including rooftop PVs. It is a representative subset of the Greek distribution network. The aim of the virtual pilot is to investigate emergency congestion and/or disruption management through connecting part of a problematic line to a different feeder, potentially overloading it. Distributed generation contributes to the importance and difficulty of the issue. The investigated network structure allows for this type of change.

The virtual pilot focuses on the distribution system operator (DSO) -MV side- of the Markopoulo HV/MV substation, which consists of three 40/50MVA transformers that step the voltage down from 150kV to 20kV. A capacitor bank of 24MVar is utilized for voltage support. The Markopoulo substation serves 123 medium-voltage (MV) customers and approximately 2,812 low-voltage (LV) customers. Smart electronic meters deployed for all MV customers and selected LV customers are distributed across feeders connected to the substation's three transformers. HEDNO operates an advanced metering infrastructure (AMI) integrated with a meter data management system, which processes, validates, and stores metering data collected at 15-minute intervals. HEDNO monitors the MV side through the usage of a distribution management system (DMS). The role of the DMS is to monitor and supervise the HV/MV substation. The SCADA supervises the protection relays that are in the MV of the substation. The state of the relays is transmitted to the SCADA, based on the communication protocol IEC 870-5-103. SCADA systems leverage the present telecommunications network to transfer tele-control signals, metering data, event signals, and alarm signals.

The overall topology of the energy distribution network that is connected to the Markopoulo HV/MV substation, has been integrated into the HEDNO's GIS system. This integration provides highly accurate data on the positions of the various elements of the topology, such as the exact location of the network's consumers, pillars, substations, and switches, as well as the exact characteristics such as length, diameter, and type of conductor, and the location of the topology of the lines. The data provided by HEDNO's GIS system can be exported to multiple file types, especially to .csv, excel, kml, shape and GeoJSON and CIM.

As part of the ECLIPSE project, a virtual simulation environment will be developed to replicate the state of the energy distribution system, by taking into consideration real operational data from an actual segment of the HEDNO network in the Markopoulo substation. The object of the HEDNO virtual pilot in ECLIPSE is to investigate a simplified fault handling scenario, in which cooperative end users are engaged through voluntary incentives. Their interaction with grid signals, which is delivered via an Energy App-based communication scheme, will be simulated to assess the potential of user-driven energy management in enhancing fault response and grid resilience. In the evolving energy landscape, fault handling is increasingly complex with new load/generation additions and consumer behaviour. Line rerouting can be a simple yet very effective temporary solution to ensure service continuation, further enhancing disruption metrics. Consumers are ever more aware of energy management, which can be leveraged to empower grid stability. The current virtual pilot investigates a simple communication scheme with a clear goal as a case basis for further implementation in the future. The extended digital infrastructure will allow HEDNO to both produce a thorough simulation based on real availability and needs and investigate how ECLIPSE advancements conform to the installed communication systems.

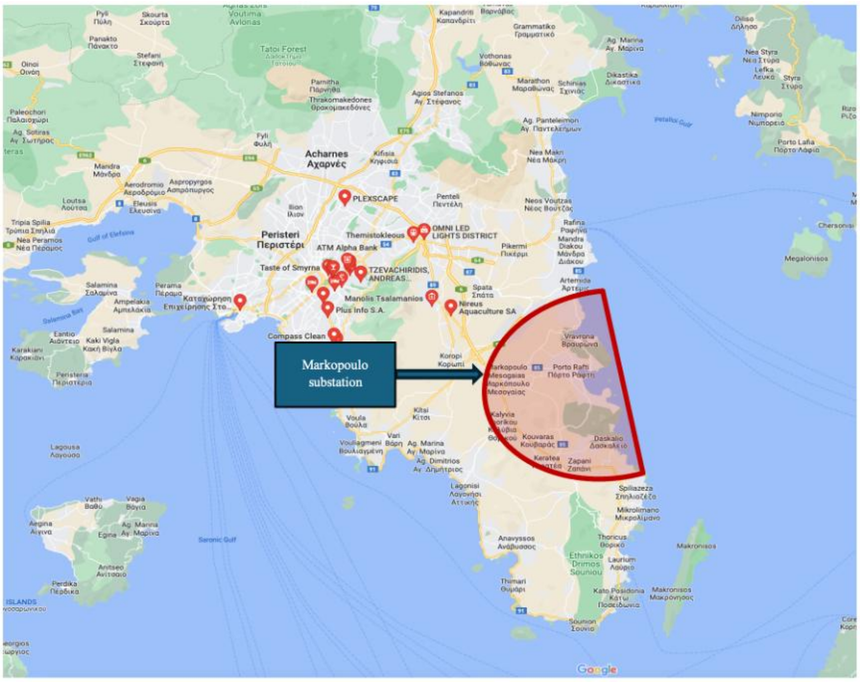


Figure 74. HEDNO - Greek virtual pilot location.

8.8. POLAND

TAURON Dystrybucja will invite broad range of customers to join in the Polish Pilot from whole DSO operating area in southern part of Poland. The use cases focus on four groups to be involved with minimal total number 1000 customers (power connection points may be multiple for single customer):

- Group 1 - 500 end customers equipped with a smart meter (households and businesses).
- Group 2 - 450 prosumers (PV, PV+ESS) from across the OSD area
- Group 3 - Energy Community/Cluster “Żywiecka Energia Przyszłości”
- Group 4 - 50 prosumers equipped with PV located in areas where increased grid voltage problems have been identified.

Figure 75. Poland demo site.

8.9. PORTUGAL

The Portuguese pilot will take place in the northern region of the country, in three areas: Guarda, Braga and Porto, the last two highly urbanized, and will involve at least fifty residential consumers. These regions have approximately 1.500.000 LV consumers, which correspond to 25% of the total LV consumers in mainland Portugal. All project participants must have smart meters installed in their homes.

The choice of these pilot sites considered the high customer adherence to previous innovation projects in these areas.

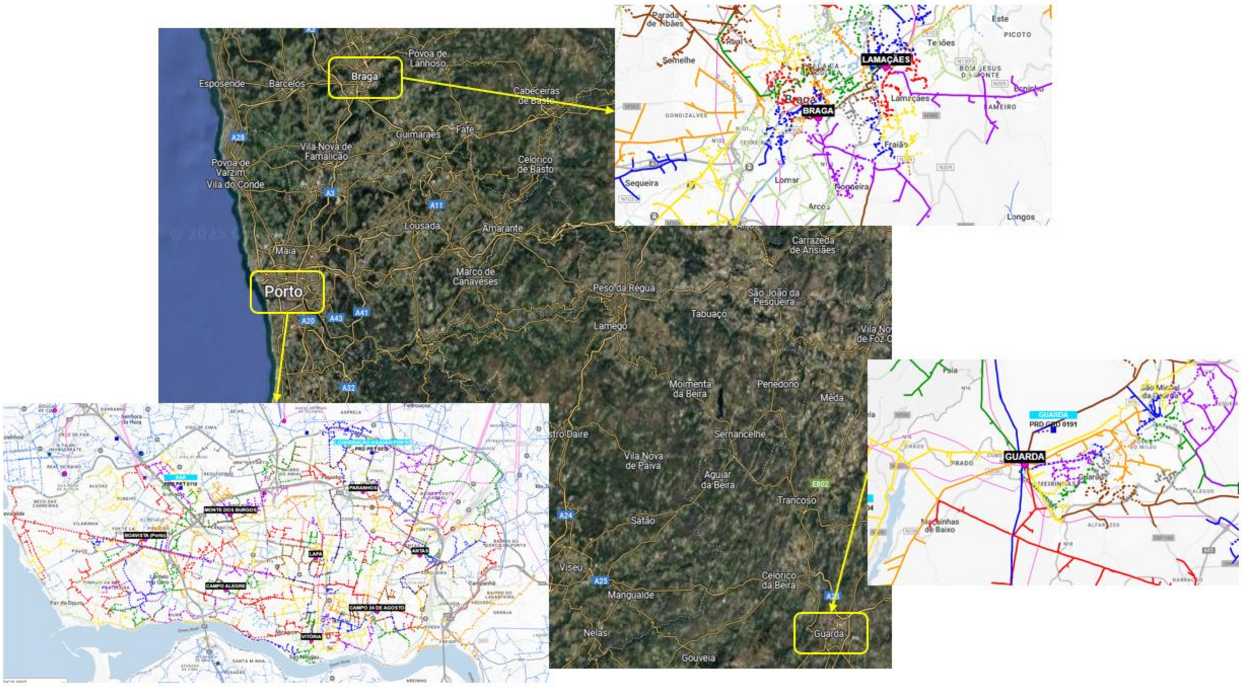


Figure 76. Portuguese Pilot Sites.

8.10. ROMANIA

UNSTPB (National University of Science and Technology Politehnica Bucharest – engl. NUSTPB, previously under the name of UPB) main teaching area lies on the south part of Dâmbovița River in Bucharest, Romania, while NUSTPB student campus is nearby the teaching facilities, meaning on the north side of the river, as presented in the figure below.

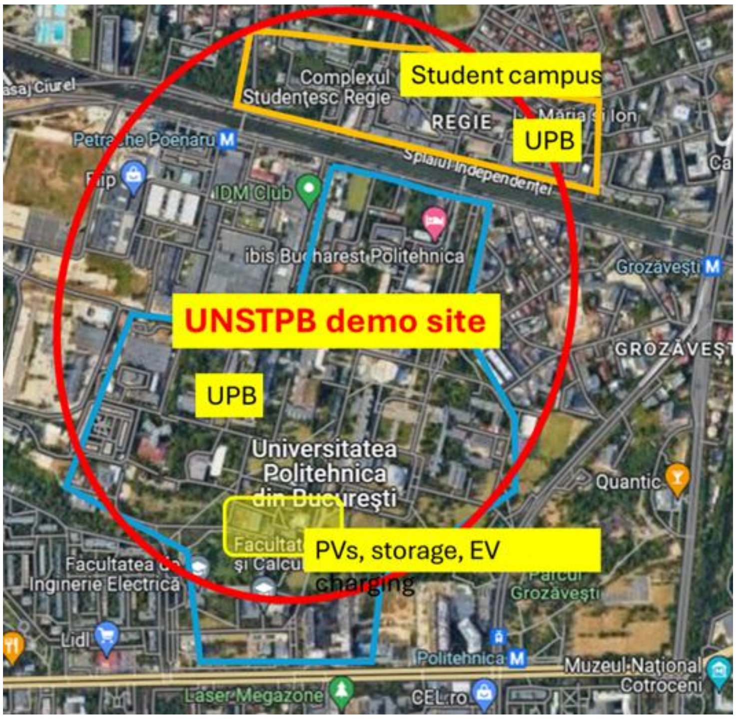


Figure 77. Overview of the NUSTPB demo site

Activities in the demonstrator of NUSTPB will use and improve the infrastructure and functionalities which has been made in previous H2020 projects. As such, the demonstrator will include two zones of the NUSTPB complex namely:

- A student campus set of consumption points
- A cluster of PV production, storage, EV charging and a didactic/research room in the Faculty of Power Engineering (using and further developing infrastructure from H2020 WEDISTRICT). This cluster acts as a living lab, as it is 24/7 all-time available and monitored for all needed purposes. The PV production, the didactic area consumption, EV charging station and additional ECLIPSE-related local air-to-air heat pumps and meteo sensors will be monitored as an enhanced prosumer, which will be used as a user integrated in the faculty general consumption and production (aggregation).

Figure 78. NUSTPB student campus

Figure 79. PV system at the Faculty of Power Engineering in NUSTPB.

The monitoring system which is operational and running also after the WEDISTRICT project finalization in September 2024 is briefly presented through captured images of the SCADA user interface in figures below, to be further developed and adapted for the challenges for the ECLIPSE project.

Figure 80. Main PV system in NUSTPB (40 kW).

Figure 81. Second PV system in NUSTPB (26 kW).

The demo intends to implement various levels of energy monitoring aggregation:

- Implement a smart metering system for one building, at selected single room users (five to ten metering points), for a level 1 monitoring, considering their direct acceptance as well to fulfil GDPR requirements.

- Implement additional smart meter systems for a second building, where two to three student dwellings are commonly metered, thus having aggregated information from such small clusters, a second level of data acquisition. More than 60 metering points are considered (6 floors, each with up to 12 single phase metering points).
- A third and fourth level of aggregation is for energy monitoring for entire floors of the previous building as well as for its entire consumption.
- A level 1 monitoring is also provided for public areas in the Faculty of Energy Engineering, for consumption as well as for the rooftop PV production.

In this way, a three-level monitoring system will be used to collect energy data acting as: the level of community (level 3 and 4), of smaller clusters (2-3 dwellings) (level 2) and at distinctive user level (level 1). As a particularity, all consumptions and production points are connected in low voltage networks belonging to NUSTPB.
In both sites of the NUTSPB demonstrator the low voltage grid belongs to UNSTPB, while in the teaching areas of NUSTPB, where faculties are located, NUSTPB is owner also of an MV network which supply the faculties (figure below).

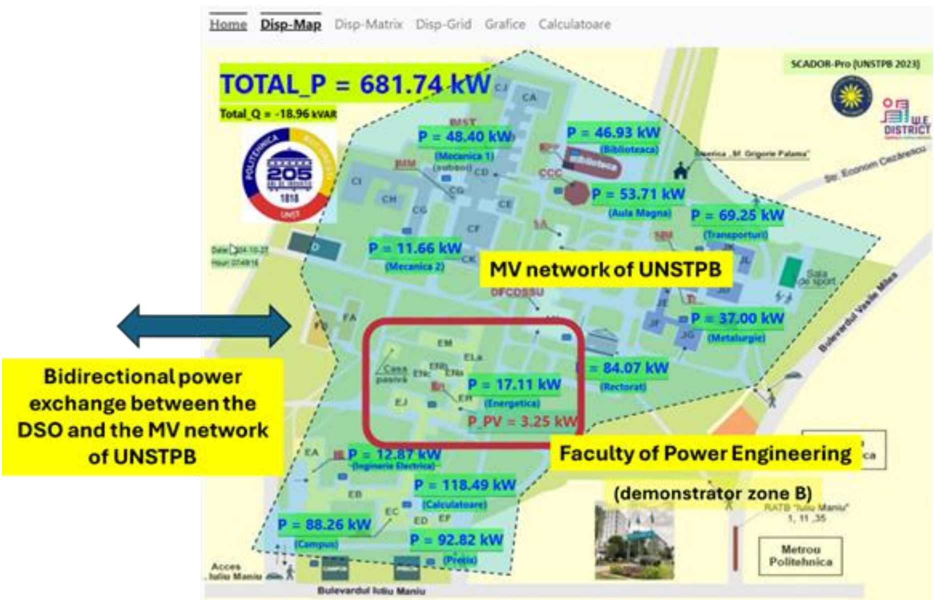


Figure 82. The demonstrator of the Faculty of Power Engineering being supplied by the MV network of UNSTPB.

The site has been selected as having complex consumptions and production assets, which are suitable for the project purposes.

8.11. SLOVENIA

The Slovenian pilot will offer to test the ECLIPSE solution to electricity distribution power network users. Since Elektro Ljubljana is part of Slovenia's electric power grid, and the largest of five electricity distribution companies in the country the pilot will enhance one third of all potential Slovenian users. The company's core activities are the management and operation of the distribution system and the maintenance, construction and renovation of electricity distribution infrastructure in central and south-eastern Slovenia, which covers an area of 6166 km2.

Figure 83. Slovenian demo site.

Slovenian users of the application will sign-in Moj Elektro and decide to use the ECLIPSE application services. The benefit for them will be to optimize their cost for the net usage, to manage their working days power peaks and to learn and accept energy saving tips.

8.12. SPAIN

The smart charging use cases for the Spanish demonstration will be carried out in the Autonomous Community of Madrid, where i-DE manages 2 million of its 11 million supply points across Spain.

One of the key locations for the demo will be the Iberdrola Training Campus, situated in the northern part of the region. Spanning 180,000 m², the campus trains approximately 13,000 individuals each year and offers an ideal setting for testing innovative solutions in a controlled environment.

This site has been proposed as the main venue for the Spanish demo, enabling real-world developments to be trialled before potential deployment in later stages of the project.

Between September 2025 and March 2026, around 15 smart charging and V2G chargers will be installed to support both Iberdrola's fleet and employee vehicles.

Figure 84. Spanish demo site. In the left, in green it is represented the distribution area from i-DE in Spain. In the right, an image of the Iberdrola Campus located in San Agustín de Guadalix (Madrid).

8.13. SWEDEN

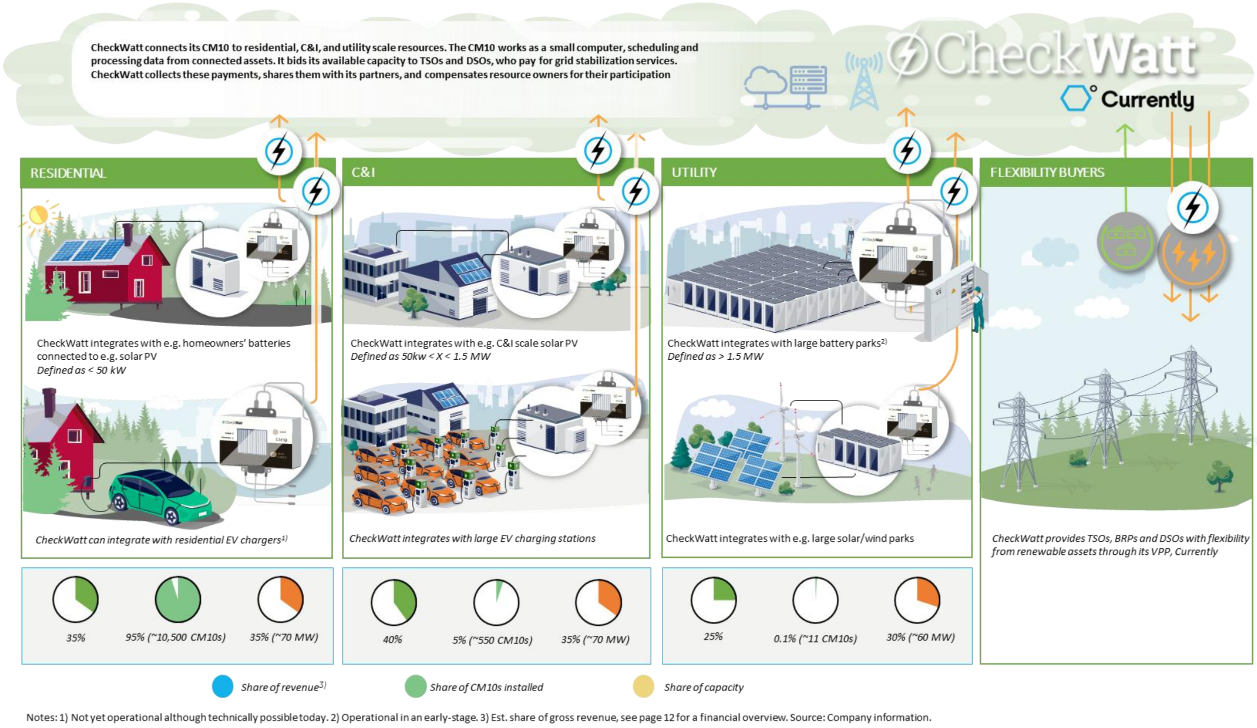


Figure 85. CheckWatt ecosystem (Currently).

The Swedish pilot is focused on Checkwatt aggregation service *Currently*, which aggregates 15000 household batteries into a single resource that can be offered to the grid for balancing purposes but also to DSO for local flexibility markets. The image below shows an example of a residential battery with inverter installation (to the left) and one Commercial & Industrial battery installation (to the right).

Figure 86. Swedish demo site. Residential battery with inverter (left) and a Commercial & industrial battery installation (right)

We intend to extend current service with more ancillary services but also several behind-the-meter services like energy arbitrage, peak shaving and benchmarking of solar production and energy consumption. An existing app will be further developed and extended, as seen below.

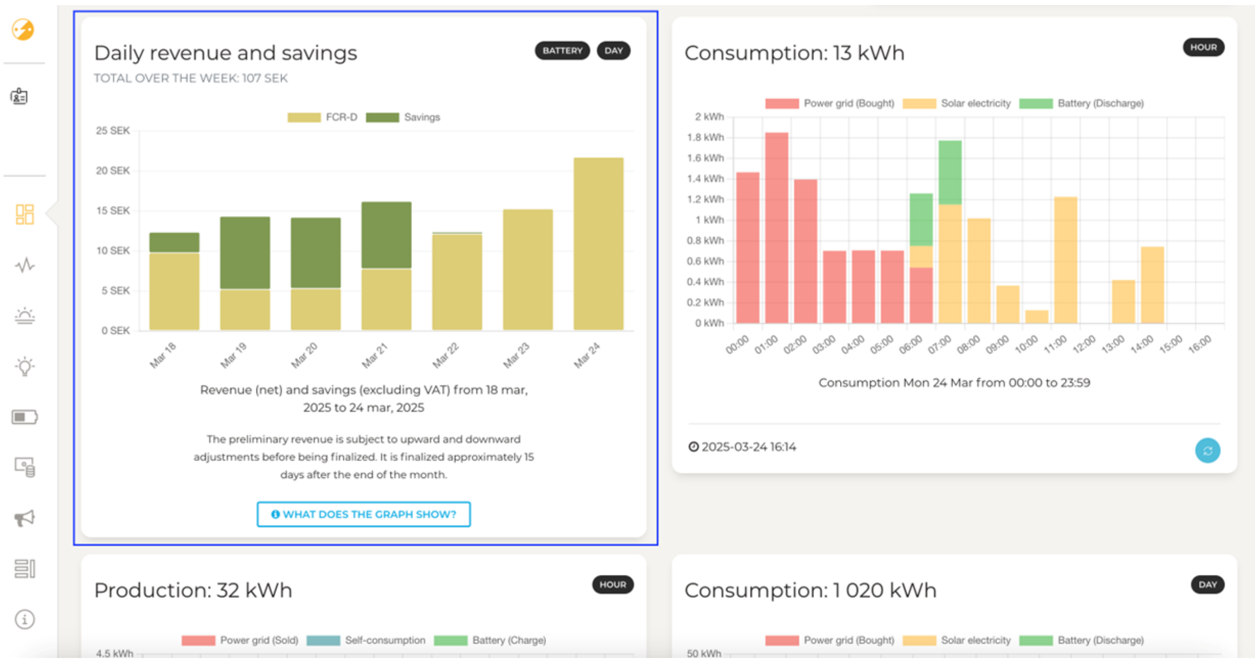


Figure 87. APP screenshots for Swedish demo.

By collecting the capacity from several smaller sources, *Currently* acts as a collective counterparty to grid owners (known as TSO) and delivers support services, e.g., FFR, FCR-N, FCR-D up and FCR-D down, as well as local flex to local grid owners (known as DSO). CheckWatt bids its available capacity, provided by owners of renewable flexibility resources (ranging from homeowners to large energy parks) to flexibility off takers (buyers of flexibility, i.e., TSOs, BRPs) and DSOs, who pay for stabilization and other services provided by CheckWatt. CheckWatt collects these payments, shares them with its partners, and compensates resource owners for their participation.

9. Pilot sites vs HLUCs & UCs.

After the previous chapter, where the pilot site areas have been introduced, this section aims to explain the relationship among these pilot sites, the high-level use cases and use cases themselves.

The following table shows the distribution of high use cases and use cases in every pilot site:

Country	Use case	HLUC	Acronym	Category
Austria	Personalised messages for consumer flexibility based on economic benefits	1	AT1.1	Energy invoice reduction for consumers
Austria	Personalised messages focusing on non-economic incentives for benefits of the system	2	AT2.1	Carbon footprint reduction & customer awareness
Austria	Energy efficiency potential at aggregated level	3	AT3.1	Carbon footprint reduction & customer awareness
Austria	Extreme Grid Situation Management	4	AT4.1	Enhancing quality of supply and grid resilience
Austria	Energy Awareness and Education	5	AT5.1	Carbon footprint reduction & customer awareness
Bulgaria	Energy efficiency potential	3	BG3.1	Energy invoice reduction for consumers
Bulgaria	Energy consumption optimization tips - alert	4	BG4.1	Enhancing quality of supply and grid resilience
Croatia	Tailored Notifications for Cost-Effective Energy Consumption	1	HR1.1	Energy invoice reduction for consumers
Croatia	Sandbox Tariff Program for Active Energy Engagement	1	HR1.2	Energy invoice reduction for consumers

Croatia	Sandbox for Voluntary Participation in Energy Balancing Market	4	HR4.1	Enhancing quality of supply and grid resilience
Croatia	RES Share Notification for Sustainable Energy Decisions	2	HR2.1	Carbon footprint reduction & customer awareness
Croatia	Optimizing Energy Consumption for Grid Stability via Demand Response	4	HR4.2	Enhancing quality of supply and grid resilience
Croatia	Environmental Awareness Notifications (General Information)	5	HR5.1	Carbon footprint reduction & customer awareness
Croatia	Emergency Grid Overload Alerts	4	HR4.3	Enhancing quality of supply and grid resilience
Croatia	Severe Weather and Emergency Response Alerts	4	HR4.4	Enhancing quality of supply and grid resilience
Croatia	Blackout and Critical Emergency Alerts	4	HR4.5	Enhancing quality of supply and grid resilience
France	Increasing flexibility potential of buildings' distributed energy resources (DER) through explicit and implicit demand response	3	FR3.1	Participation in flexibility energy markets
France	Increasing flexibility potential of buildings' distributed energy resources (DER) through explicit and implicit demand response	3	FR3.2	Participation in flexibility energy markets

France	Near real-time measurements with power limit notification	3	FR3.3	Energy invoice reduction for consumers
France	Non-economic incentive	3	FR3.4	Carbon footprint reduction & customer awareness
France	Energy Tips and goal	3	FR3.5	Carbon footprint reduction & customer awareness
France	Extreme Grids Situation Management	3	FR3.6	Enhancing quality of supply and grid resilience
Greece	Risk Management and Operational Resilience in Distribution Systems	4	GR4.1	Enhancing quality of supply and grid resilience
Greece	Tailored Energy Messages for Consumer Flexibility and Sustainability.	3	GR3.1	Optimizing home energy use through energy assets control
Greece	Smart Energy Monitoring for enhanced consumer control	1	GR1.1	Optimizing home energy use through energy assets control
Greece	Personalized Energy Efficiency Tips for Homes with PV and Battery Systems	3	GR3.2	Optimizing home energy use through energy assets control

Cyprus	Consumer notifications for Cost-Effective Energy Consumption	1	CY1.1	Energy invoice reduction for consumers
Cyprus	Environmental awareness notifications for sustainable consumer behaviour	2	CY2.1	Carbon footprint reduction & customer awareness
Cyprus	Customized energy efficiency tips for sustainable consumer behaviour	5	CY5.1	Carbon footprint reduction & customer awareness
Czech Republic	Consumption prediction	3	CZ3.1	Optimizing home energy use through energy assets control
Czech Republic	Advanced presentation of measured data	3	CZ3.2	Optimizing home energy use through energy assets control
Czech Republic	Consulting related to measured data	3	CZ3.3	Optimizing home energy use through energy assets control
Czech Republic	Personalised Tariff Recommendation based on home appliances	1	CZ1.1	Energy invoice reduction for consumers
Czech Republic	Energy goals for sustainable energy use.	2	CZ2.1	Carbon footprint reduction & customer awareness

Czech Republic	Notifications of power outages caused by natural disasters	4	CZ4.1	Enhancing quality of supply and grid resilience
Czech Republic	Energy tips for consumption reduction	5	CZ5.2	Carbon footprint reduction & customer awareness
Romania	Follow_the_Sun	2	RO2.1	Carbon footprint reduction & customer awareness
Romania	Help in preserving grid health (HGH)	4	RO4.1	Enhancing quality of supply and grid resilience
Romania	Help in avoiding extreme grid situations (HAEGS)	4	RO4.2	Enhancing quality of supply and grid resilience
Romania	Recommendation on Energy Management for Residential Buildings	5	RO5.1	Carbon footprint reduction & customer awareness
Poland	Demand side flexibility based on non-economic incentives in specific network situations	4	PL4.1	Enhancing quality of supply and grid resilience
Poland	Messages with general tips and guidance for energy efficiency and awareness rising	5	PL5.1	Optimizing home energy use through energy assets control
Portugal	Economically Driven Consumer Flexibility Participation in System Services.	1	PT1.1	Participation in flexibility energy markets

Portugal	Flexibility Services under Extreme Conditions	4	PT4.1	Enhancing quality of supply and grid resilience
Portugal	Non-economically driven consumer flexibility participation in system services	2	PT2.1	Participation in flexibility energy markets
Slovenia	Advanced analytics of production and consumption data provision	3	SI3.1	Optimizing home energy use through energy assets control
Slovenia	Near real-time measurements with power limit notification	1	SL1.1	Energy invoice reduction for consumers
Slovenia	Energy-Saving Tips	2	SL2.1	Carbon footprint reduction & customer awareness
Spain	Smart EV Charging in Overdemand Grid Status	4	ES4.1	Smart charging of EVs for grid support
Spain	Smart EV Residential Charging (I)	1	ES1.1	Smart charging of EVs for grid support
Spain	Smart EV Residential Charging (II)	2	ES2.1	Smart charging of EVs for grid support
Spain	Smart EV Charging in Private Companies	4	ES4.2	Smart charging of EVs for grid support
Sweden	Extended flexibility services for households	1	SW1.1	Participation in flexibility energy markets

Sweden	Service stacking	1	SW1.2	Participation in flexibility energy markets
Sweden	Introduce behind the meter services	3	SW 3.1	Participation in flexibility energy markets
Sweden	Combine flex-services with behind the meter services	4	SW 4.1	Participation in flexibility energy markets

Table 12. Pilot sites vs HLUC and UC.

- HLUC1 will be included in 11 of the 56 use cases, specifically in Austria, Croatia, Cyprus, Czech Republic, Greece, Portugal, Slovenia, Spain and Sweden.
- HLUC2 will be included in 8 use cases of Austria, Croatia, Cyprus, Czech Republic, Romania, Portugal, Slovenia and Spain.
- HLUC3 will be incorporated in 15 use cases of Austria, Bulgaria, France, Greece, Czech Republic, Slovenia and Sweden.
- HLUC4 will be in 16 uses cases of Austria, Bulgaria, Croatia, Greece, Czech Republic, Romania, Poland, Portugal, Spain and Sweden.
- Finally, HLUC5 will be in 6 uses cases of Austria, Croatia, Cyprus, Czech Republic, Romania and Poland.

10. KPIs FROM DEMOS.

Use cases belonging to the ECLIPSE project demonstrators must include some type of measurement that demonstrates the success of the test. To achieve this, a series of Key Performance Indicator (KPIs) are proposed. These KPIs must be carefully chosen to fulfil their function. The KPIs will be calculated in WP6, to evaluate the project impact. The general characteristics that those KPIs must have the following:

- Achievable: The objectives set must be realistic.
- Measurable: Although it may sound obvious, a KPI must be measurable.
- Relevant: To select only the most important, without overloading.
- Periodic: The indicator must be able to be analysed periodically.
- Accurate: Choose only the most accurate part of all the information collected.

To ease the selection, some additional questions must answer the KPIs proposal:

- What is the object being analysed?
- What is the objective you want to achieve?
- What specific thing do you want to measure?
- Under what environment will you measure?
- From what perspective will you draw samples?

The use cases have been grouped into six categories, each of which may share similarities or even KPIs. It´s very important to compare between the actual measure with a representative previous period (month, same month of previous year, average of previous months, …). Below are some suggestions for each category:

- Energy invoice reduction for consumers.
  - Percentage reduction of the bill (which concepts? All?) compared to the reference period.
  - Percentage reduction of consumption compared to the reference period.
- Carbon footprint reduction & customer awareness.
  - Percentage reduction of CO2 emissions compared to the previous period (which period?). Who is going to give the information? The retailer?
  - Some kind of measure of awareness. Are going to be done surveys before and after the pilot?
- Enhancing quality of supply and grid resilience.

  - Number of interruptions avoided.
  - Average duration of interruption compared to the reference period.
- Optimizing home energy use through energy assets control.
  - Generation increases compared to the reference period.
  - Percentage time of self-consumption compared to the reference period.
- Participation in flexibility energy markets.
  - Knowledge of flexibility markets among population.
  - Percentage of customers participating in flexibility markets.
- Smart charging of EVs.
  - Percentage cost reduction of EV charge compared to the reference period.
  - Percentage increase of revenues coming from flexibility markets compared to the reference period.

A workshop was held at the Paris meeting on March 27th, 2025, requesting members to define a first draft of the KPIs. The result of this workshop is available bellow. In summary:

- The category of Energy invoice reduction for consumers includes KPIs regarding economical savings, changes in load consumption or application usage.
- Regarding Carbon footprint reduction & customer awareness category, the applications will show the CO2 emissions per user and sustainable energy management information, as well as the response rates to the messages received.
- For the category of Enhancing quality of supply and grid resilience, to highlight the supervision of the grid, the reduction of calls to the DSO or the reduction of time out of grid overloads.
- Regarding Management of consumption and generation, the most important KPIs proposed are Prediction successful and compatible with real consumption, best time to use the PV and money savings.
- For Participation in flexibility energy markets category, the following aspects are proposed: Number of bids submitted & activated & mobilized flexibility amount, get high proportion of user acceptance visualization and a minimum percentage of clients contacted/activated during the project.

- For EV Smart charging Category, the reduction on the customer Bill will be monitored as well as the amount of CO_2 emissions avoided or the feed-back on the responses from the customer side to flexibility offers. Secondly, it will be monitored the satisfaction of the customer and from the DSO side, the possibility of deferral grid investments.

From the KPIs proposed by the partners we can conclude that, in general, they try to describe the performance of the UC, but they are too generic and need more detail. A more complete version will be presented in future WPs, when the demos will be clearly defined. As suggestions, the following are proposed:

- The improvement (so the success) must be measured in relationship with a well-defined baseline (for example, the reduction of the bill compared with the same month of previous year).
- If possible, baselines of all the projects should be similar or with the same criteria. That way could ease the comparison among different proposals of different use cases.
- Indicate how the data will be collected and possible alternatives of data.
- Possible thresholds from which the test is considered a success or failure.

For more details, bellow it is specified the KPIs for every category.

10.1. ENERGY INVOICE REDUCTION FOR CONSUMERS.

- Reduction of Bills.
- Shifting Loads to the cheaper energy slot (if time of use available).
- Increase of self-consumption for the specific hours of the day.
- Track consumption charge (through DSO data).
- Track charge in billing of end users.
- Number of notifications sent to end users.
- Number of end users using the App.
- % of goals fulfilled.

- % of consumption savings.
- % of users actively clicking at this function.
- % of notifications with active feedback from the customer.
- Impact on energy consumption.

10.2. CARBON FOOTPRINT REDUCTION & CUSTOMER AWARENESS.

- The app should be able to provide notification based on external data signals e.g. from DSO.
- Reduce CO2 Emissions.
- User engagement (number of users that decided to receive notifications)
- Objective that we want to achieve is getting the users more informed about sustainable energy management.
- Track change in consumption through DSO data.
- Track grid status.
- Number of notifications sent.
- Number of users opted in.
- Number of energy savings tips displayed.
- % of customers decreasing consumption.
- Response rate to messages.
- Response rate to sustainability scores.

10.3. ENHANCING QUALITY OF SUPPLY AND GRID RESILIENCE.

- Inducing behavioural change to reduce demand during Grid congestions etc. or avoid consumption aggregation during peak hours.
- Track grid stress/Stability through engagement of users (demand response).
- Track consumption changes in times when the notification has been sent.
- % of acceptance changes of proposed distribution tariff.
- % of calls to "Call Centre" decreased after using this function.
- % Load reduction effectiveness.
- Avoid disconnect the end user.
- Grid safety and stability.

10.4. OPTIMIZING HOME ENERGY USE THROUGH ENERGY ASSETS CONTROL.

- Prediction successful and compatible with real consumption% of successful predictions.
- Daily energy consumption.
- Monthly energy consumption.
- Money savings.
- Best time to use the PV.
- Energy disposal to the grid by the PV.
- Battery Storage.
- Battery efficiency.
- Energy performance.
- 30% Increase on dynamic Tariff.
- 30% Response increment in Tips/Guidance application.

10.5. PARTICIPATION IN FLEXIBILITY ENERGY MARKETS.

- Grid Stability Improvements.
- Number of bids submitted & activated & mobilized flexibility amount.
- % of clients participating in grid flexibility.
- % of clients contacted.
- % of clients activated in the project.
- Add at least 2 flexibility services.
- At least 2 behind the meter services.
- Get 80% acceptance from user (visualization/GUI).

10.6. SMART CHARGING OF EVS FOR GRID SUPPORT

- Charger usage percentage.
- Average power per charger and station.
- Customer satisfaction index.
- Estimated reduced power with smart charging vs. normal power consumed without smart charging.
- Estimated impact on network planning.
- Percentage increase of revenues coming from flexibility markets compared to the reference period.
- CO2 emissions reduced due to flexibility capabilities.

11. REQUIREMENTS VS USE CASES MAPPING.

In the following table, it is presented the relationship between requirements proposal and use cases.

When a requirement applies to a specific use case, it has been highlighted by specifying the code(s) of the requirement(s), as stated in Annex I. On the other hand, if the requirement doesn´t apply to the UC, the cell remains empty. Additionally, the column headers of the table represent the name of the five categories in which the requirements have been grouped.

Demo country	CERF Data Spaces	CERF Energy Services	Energy Apps	Energy Assets	General Requirements
Austria (AT)	DAT_003, DAT_004, DAT_005, DAT_006, DAT_021,	SVC_002, SVC_018, SVC_021, SVC_025 (when applicable), SVC_027, SVC_029, SVC_030,	APP_001, APP_010, APP_018, APP_019, APP_020, APP_022, APP_026, APP_027, APP_028, APP_029 (Optional), APP_030	EAS_015	GEN_007
Bulgaria (BG)	DAT_003, DAT_004, DAT_005, DAT_015	SVC_002	APP_001, APP_009, APP_010, APP_012,	EAS_015	GEN_007, GEN_020

			APP_013, APP_027, APP_028, APP_032, APP_033, APP_071, APP_074, APP_075		
Croatia (HR)	DAT_003, DAT_004, DAT_005, DAT_016	SVC_018, SVC_020	APP_001, APP_010, APP_032, APP_033,	EAS_009	GEN_007
Cyprus (CY)	DAT_003, DAT_004, DAT_005	SVC_002	APP_001, APP_032, APP_033,	EAS_015	GEN_007, GEN_025
Czech Republic (CZ)	DAT_003	SVC_007, SVC_015	APP_001, APP_010, APP_012, APP_026, APP_032, APP_033, APP_034, APP_039, APP_052,		GEN_020
France (FR)	DAT_014, DAT_023, DAT_003, DAT_016, DAT_022,	SVC_033, SVC_007, SVC_012, SVC_019, SVC_020, SVC_021, SVC_023	APP_069, APP_068 APP_071, APP_073, APP_064, APP_065, APP_066,	EAS_015	GEN_020

			APP_001, APP_012, APP_027, APP_033, APP_059		
Greece (GR) - METLEN	DAT_003, DAT_016		APP_001, APP_010, APP_013, APP_027, APP_032, APP_052, APP_074, APP_076	EAS_015	GEN_007, GEN_020
Greece (GR) – HEDNO	DAT_003, DAT_015, DAT_016, DAT_020	SVC_007, SVC_013, SVC_022	APP_001, APP_010, APP_027, APP_033, APP_038, APP_040, APP_041, APP_044, APP_052, APP_074	EAS_014	
Poland (PL)	DAT_003, DAT_014, DAT_016, DAT_022	SVC_026, SVC_027, SVC_030	APP_001, APP_012, APP_018, APP_029, APP_059		GEN_007, GEN_020

Portugal (PT)	DAT_003, DAT_015, DAT_017, DAT_018	SVC_007, SVC_009, SVC_010, SVC_016, SVC_017, SVC_018, SVC_022, SVC_026	APP_010, APP_012, APP_030, APP_038, APP_039	EAS_004, EAS_005, EAS_009	GEN_020, GEN_024
Romania (RO)			APP_047, APP_048, APP_049, APP_050, APP_052, APP_053, APP_054		GEN_020
Slovenia (SI)	DAT_001, DAT_002, DAT_003, DAT_004, DAT_015, DAT_016, DAT_017, DAT_019, DAT_020, DAT_021, DAT_022	SVC_001, SVC_017, SVC_018, SVC_021, SVC_024, SVC_027, SVC_028, SVC_034, SVC_036, SVC_037 (optional SVC_007, SVC_013, SVC_019, SVC_020, SVC_025,	APP_001, APP_010, APP_012, APP_019, APP_020, APP_026, APP_028, APP_075 (optional APP_009, APP_032, APP_034, APP_076)	EAS_009, EAS_015 (optional EAS_012, EAS_013)	GEN_020 (optional GEN_007).

		SVC_031, SVC_032)			
Spain (ES)	DAT_001, DAT_003, DAT_004, DAT_008, DAT_009, DAT_018, DAT_020, DAT_021, DAT_022	SVC_001, SVC_007, SVC_012, SVC_013, SVC_014, SVC_015, SVC_016, SVC_017, SVC_018, SVC_023, SVC_024, SVC_025, SVC_027, SVC_028, SVC_029, SVC_032, SVC_037	APP_001, APP_002, APP_012, APP_027, APP_028, APP_033, APP_038, APP_039, APP_040, APP_041, APP_064, APP_065, APP_068, APP_069, APP_071, APP_073	EAS_004, EAS_010, EAS_011, EAS_012, EAS_014	GEN_023
Sweden (SW)	DAT_002, DAT_003, DAT_004, DAT_014	SVC_009	APP_001, APP_012, APP_020, APP_028, APP_029, APP_059, APP_064, APP_071	EAS_002, EAS_003, EAS_009	GEN_007, GEN_020

Table 13. Requirements by demo site.

12. CONCLUSIONS & RECOMMENDATIONS

This document shows the proposed use cases that will be tested in the different pilot areas and will be the basis for the development of WP5.

The 56 proposed use cases have been grouped into 6 categories and have been linked to the 112 requirements, also grouped in 6 categories, agreed by the partners using the Volere tool. The following conclusions have been highlighted following the work done in WP2:

- IEC 62559-2 has been considered during the UC definition process. The proposals are aligned with the standard.
- The number of UCs included inside the 5 HLUC are well distributed. Thus, the HLUCs are well-covered in ECLIPSE project.
- The Volere tool has achieved the information exchange objective among partners, which has ended up in well-defined categories that contain enough requirements.
- For each UC a sequence diagram has been presented (following the HEMRM methodology) that will help to define the architecture and information exchange of the CERF (WP4 and WP3 respectively).

Furthermore, a series of KPIs have been defined that will measure the success of the tests.

Although the result is considered satisfactory and represents a good proposal for the following WPs, a series of recommendations are listed below:

- In the future, more heterogeneous use cases could be considered, such as the coordination between energy storage stand-alone batteries (specifically, determining which units would take on a grid-forming role and which would operate in a grid-following mode). Additionally, the recent black-out on the Iberian Peninsula could lead to new scenarios, such as exploring how service restoration could be accelerated using system flexibility.
- A set of preliminary KPIs has been proposed (after a presential workshop) with the information already available, nevertheless these KPIs must be confirmed or improved when the demo sites start evaluating the use cases.

- The requirements definition should be considered in the definition of the CERF APP so that it could consider the Volere work done.
- The conclusions among the different pilot sites should be shared as well as with other related projects, so that the conclusions are homogeneous, and the UCs themselves become more complete and transcend the scope of the project.

13. ANNEXES

13.1. ANNEX I – LIST OF REQUIREMENTS

Requirement ID	APP_001
Description	The energy applications based on CERF must provide final consumers with simple, useful and user-friendly information on their energy patterns.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	The energy applications based on CERF must provide the final consumers with simple, useful and user-friendly information on their energy patterns, including graphic display system (cheese chart, bars, etc.) and with minimum technical information. The Apps have to be user friendly to different types of users with different backgrounds to motivate end users and empower them.
Acceptance criteria	By means of user satisfaction surveys and other ways, feedback from consumers will be collected to analyse how satisfied the end-users are with the applications.
Priority	4
Comments	The apps will deliver personalized messages to specific groups of customers. Messages, due to different priorities, can be in the form of regular messages (inbox) or push notifications in mobile apps. There are many contexts for such use, e.g., promotion of self-consumption of energy directed to prosumers, a call to report increased PV installation capacity to the DSO, etc.
Author	Lola Alacreu García

Table 1. Requirement APP_001

Requirement ID	**APP_002**
Description	When demand is actively managed without constant intervention, the APP should receive the mechanisms automatically, keeping the preferences and limits previously established.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	Customer should introduce his preferences and allow the system to connect or disconnect some devices fulfilling schedules, temperatures, ... A disregarded system will be more successful than the opposite (manual messages).
Acceptance criteria	A standard protocol that allows APP and devices to keep in touch.
Priority	3
Comments	For example, by allowing the DSO to send instructions to some devices (delaying a washing machine, altering home temperature setpoints, etc.).
Author	Javier Fernandez

Table 2. Requirement APP_002

Requirement ID	**APP_005**
Description	In efficiency actions like high acceptance among users or with high overall effectiveness, the system should provide insights based on anonymized third-party data.
Classification	Energy Apps

Type	Functional and data requirements
Rationale	If customer knows the success of a proposal, maybe is easier to choose which one apply.
Acceptance criteria	Order from more accepted to less accepted proposals with a minimum of %.
Priority	3
Comments	
Author	Javier Fernandez

Table 3. Requirement APP_005

Requirement ID	**APP_009**
Description	When possible, functions for automating user assets' responses to the recommendations provided by the applications should be made available (to be voluntarily activated by the user).
Classification	Energy Apps
Type	Users of the product
Rationale	From the InterConnect findings: user experience can be simplified by implementing automated responses to the application's recommendations. This supports sustaining user engagement over time, as they might lose interest or find the interaction with the application too time-consuming, especially when it comes to manually adjusting consumption.
Acceptance criteria	Availability of automation functions.
Priority	4

Comments	
Author	Selene Liverani

Table 4. Requirement APP_009

Requirement ID	**APP_010**
Description	An exchange channel between the user and the developer/owner of the application should be implemented to allow for the submission of user feedback and the continuous improvement of the app.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	From the InterConnect recommendations: Sustaining user engagement over time can be a challenge. Establishing an exchange and ensuring the continuous improvement of the app based on their feedback will help maintain their active engagement over time.
Acceptance criteria	Channel(s) for the reception of user feedback provided
Priority	4
Comments	Examples: signalling a malfunctioning, suggesting an improvement in the user interface, etc.
Author	Selene Liverani

Table 5. Requirement APP_010

Requirement ID	**APP_012**

Description	The developed applications should provide stable services over time (i.e. functioning and updated).
Classification	Energy Apps
Type	Performance requirements
Rationale	From the InterConnect recommendations: Consumers can become sceptical about the effectiveness or reliability of energy-saving technologies if they have negative experiences. As such, it is essential to guarantee the stability of the digital services provided to retain users.
Acceptance criteria	Continuity of service and periodic updates are provided
Priority	5
Comments	
Author	Selene Liverani

Table 6. Requirement APP_012

Requirement ID	**APP_013**
Description	When the energy efficiency application is opened or when the user requests it, it suggests a video tutorial in the native language.
Classification	Energy Apps
Type	The scope of the product
Rationale	Improvement of the application for better understanding and use by each user.
Acceptance criteria	Creation of videos and adding to the energy efficiency application.

Priority	2
Comments	
Author	Radostina Marinova

Table 7. Requirement APP_013

Requirement ID	**APP_018**
Description	The app should be designed in such a way that different providers (e.g., DSO, service provider, energy community) can organize their data storage separately.
Classification	Energy Apps
Type	The scope of the product
Rationale	There might be different data streams which should be kept separated in the application for easy understanding and GDPR compliance.
Acceptance criteria	Separated data storage possibilities exist
Priority	4
Comments	
Author	Christoph Schaffer

Table 8. Requirement APP_018

Requirement ID	**APP_019**

Description	The app should be designed to easily apply the CI (Corporate Identity) guidelines of different providers. It should also be possible to use the CI of multiple providers within the app.
Classification	Energy Apps
Type	Look and feel requirements
Rationale	Different functionalities and different services might require CI features of the service provider so the applications should be flexible to be adapted
Acceptance criteria	The apps must be able to support individual CI requirements
Priority	3
Comments	
Author	Christoph Schaffer

Table 9. Requirement APP_019

Requirement ID	**APP_020**
Description	The app should support user groups with varying levels of experience.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	The application should be designed in a way that it is adopted by different levels of experience. For instance, a simplified view that explains the most relevant parts in an easy-to-understand way. On the other hand, it should also have view for geeks who are much deeper into the topic and need more information.

Acceptance criteria	Multiple views must be supported (beginner view, pro view, aggregated view etc)
Priority	5
Comments	Additionally, mechanisms should be in place to clearly explain the different parameters and underlying mechanisms.
Author	Christoph Schaffer

Table 10. Requirement APP_020

Requirement ID	**APP_022**
Description	Participation in different market services, such as peer-to-peer trading and energy communities, should be simple and user-friendly.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	To keep users involved for changing energy landscape, energy communities and P2P trading shall be made simpler even for users who are not from energy domain
Acceptance criteria	User friendly artifacts for participation in different market services
Priority	5
Comments	
Author	Christoph Schaffer

Table 11. Requirement APP_022

Requirement ID	**APP_026**
Description	Multiple customer systems (different houses and apartments ...) should be manageable within a single app.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	One user might have multiple apartments and houses. It is important to give users information in one main app user instance. It is increasingly more important with the increase of P2P and energy community initiatives
Acceptance criteria	Multiple customer systems should be allowed to be added by the users and manage within the same app
Priority	5
Comments	
Author	Christoph Schaffer

Table 12. Requirement APP_026

Requirement ID	**APP_027**
Description	The app should have the possibility to switch languages with at least English supported to increase user acceptance beyond local region
Classification	Energy Apps
Type	The scope of the product
Rationale	If only the regional language is supported, then it will be hard to go beyond silos when discussing about CERF

Acceptance criteria	Functionality to switch languages available with at least English as one of the languages
Priority	4
Comments	
Author	Shievam Kashyap

Table 13. Requirement APP_027

Requirement ID	**APP_028**
Description	The Energy app must allow the end-user to configure which data to look at and which data to compare.
Classification	Energy Apps
Type	The scope of the work
Rationale	User will have different services available and will appreciate a flexible user interface.
Acceptance criteria	User satisfaction surveys, feedback from consumers will be collected to analyse how satisfied the end-users are with the applications.
Priority	4
Comments	
Author	Peter Rosengren

Table 14. Requirement APP_028

Requirement ID	**APP_029**

Description	Apps should take care of Accessibility compliance (EN 301 549)
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	A checklist for digital solutions being developed
Acceptance criteria	Abide by the standard for Accessibility compliance and measure how many of those are adopted
Priority	3
Comments	EN 301 549 is a European standard designed to promote best practices in digital accessibility, ensuring that digital products and services are usable by everyone, including people with disabilities. It serves as a guideline for creating accessible digital solutions.
Author	Shievam Kashyap

Table 15. Requirement APP_029

Requirement ID	**APP_030**
Description	The apps should support CIM (Common Information Model)
Classification	Energy Apps
Type	The scope of the product
Rationale	A common data schema will allow interoperability of solutions
Acceptance criteria	ESMP (European Style Market Profile) version of CIM followed
Priority	5
Comments	

Author	Shievam Kashyap

Table 16. Requirement APP_030

Requirement ID	**APP_032**
Description	When the user opens the app, the functionality shall display an energy consumption forecast based on historical data, weather conditions, and other relevant factors, allowing the user to efficiently monitor and optimize energy usage.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	Consumption forecast based on historical data gives the customer benefit in higher visibility of energy bill at the end of the period.
Acceptance criteria	Prediction accuracy is close to the reality.
Priority	4
Comments	
Author	Jan Kula

Table 17. Requirement APP_032

Requirement ID	**APP_033**
Description	When emergency or extreme weather conditions appear in the grid, the app shall inform the customer with push notification.
Classification	Energy Apps

Type	Functional and data requirements
Rationale	Customer should be informed in case of possibility of power outage. Not only in case the outage is real.
Acceptance criteria	The information from weather forecasts is integrated into the app notification service and delivered to the customers.
Priority	3
Comments	
Author	Jan Kula

Table 18. Requirement APP_033

Requirement ID	**APP_034**
Description	When the system recognizes a defined consumption pattern, the system shall recommend to the user a change of distribution tariff in order to save on the electricity bill.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	For example, a customer may add new home appliances, such as electric heating, a heat pump, or an EV, without updating their distribution tariff, resulting in higher electricity bill. If the app could recommend a tariff change based on real consumption data, the customer could save on part of the distribution fee.
Acceptance criteria	Due to the change of distribution tariff, the customer save money on the distribution part of the electricity bill.
Priority	3

Comments	
Author	Jan Kula

Table 19. Requirement APP_034

Requirement ID	**APP_038**
Description	At the end of a certain period, to those customers that have received at least one proposal, the system should show a new KPI presenting the proposals accepted versus those proposed.
Classification	Energy Apps
Type	Performance requirements
Rationale	The objective of these KPI is to allow DSO and retailer to analyse the effectiveness of their own proposals and to improve them.
Acceptance criteria	Data should have enough quality to make possible a trustable analysis.
Priority	3
Comments	For example, since last 3 months, the APP shows the proposals accepted vs proposals sent to the customer. For example, during January, February and March, 3 proposals accepted from 10 sent
Author	Raul Peña

Table 20. Requirement APP_038

Requirement ID	**APP_039**

Description	When a user has accepted a presented proposal, the system should have a functionality that measures the effectiveness of the actions made by the user to reduce energy consumption.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	The awareness of the effectiveness of the actions will move consumers to apply energy efficiency actions and will increase the user engagement.
Acceptance criteria	Realistic and homogeneous criteria to evaluate the impact of user actions in economics, CO_2, and other aspects.
Priority	3
Comments	For example, monthly consumption after accepting the proposal vs one of these options: 1.- same month of the previous year, if not possible, 2.- previous month of this year, if not possible, 3.- previous week.
Author	Raul Peña

Table 21. Requirement APP_039

Requirement ID	**APP_040**
Description	When the user is registered in the tool and at least accepts one proposal, a green friendly certificate will be awarded for a specific period of time.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	Customer engagement can be achieved if a document that periodically certificates its consumption is agreed. Specially in a business model.

Acceptance criteria	Measurable and homogeneous criteria to evaluate the impact of user actions in economics, CO_2, and other aspects.
Priority	3
Comments	This certificate will be available on a specific website in order to highlight the good behaviour of the customer.
Author	Raul Peña

Table 22. Requirement APP_040

Requirement ID	**APP_041**
Description	When a certificate is given to a user, if the customer wants to keep it, he/she must accept at least one proposal before the due date of the certificate.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	Customer engagement can be achieved if a document that periodically certificates its consumption is agreed. Specially in a business model.
Acceptance criteria	Measurable and homogeneous criteria to evaluate the impact of user actions in economics, CO_2, and other aspects.
Priority	3
Comments	For example, if the certificate is going to expire in one month, the customer must accept at least one of the proposals in order to prolong the certificate 3 months more.
Author	Raul Peña

Table 23. Requirement APP_041

Requirement ID	APP_044
Description	When a grid issue triggers, the app must allow the information exchange between customer and DSO.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	Direct communication channel between customer and DSO is more effective than using the retailer in between them. The information exchange must be available in any case, but especially when a grid issue triggers.
Acceptance criteria	A guided questions for the customer in order to know if the tool sends the command to the retailer and/or DSO. The message automatically arrives to each one.
Priority	4
Comments	
Author	Javier Fernandez

Table 24. Requirement APP_044

Requirement ID	APP_047
Description	Received information should contain personal data as well as various aggregations of the same data which can give a wider understanding of the context.
Classification	Energy Apps

Type	Functional and data requirements
Rationale	By comparison with different groups, this multi-level aggregation may bring a better synchronization of behaviour between individuals and communities.
Acceptance criteria	Information is provided, when possible and relevant
Priority	4
Comments	For instance, the average power of the user on the last hour may be accompanied with info about the average power of the neighbours (anonymized by aggregation) and of the district.
Author	Mihai Sanduleac

Table 25. Requirement APP_047

Requirement ID	**APP_048**
Description	Forecast Future Bills: Predict future electricity bills based on current usage patterns, with an option to set a target budget. (maybe additional request to APP_032).
Classification	Energy Apps
Type	Functional and data requirements
Rationale	Early information on abnormal usage patterns, to allow possible correction before bill is issued
Acceptance criteria	Information is provided, when possible and relevant
Priority	4

Comments	Such information may give valuable information in time to make corrections of the energy usage patterns, to approach better the target budget of the future bill
Author	Mihai Sanduleac

Table 26. Requirement APP_048

Requirement ID	**APP_049**
Description	The App should provide real-time awareness regarding the current share of renewables at different levels.
Classification	Energy Apps
Type	The scope of the product
Rationale	Such information enables the change of consumption behaviour at a certain time, if the share of renewable is high (then consumption can be increased by purpose) or low (voluntary decrease of energy consumption may reduce the CO2-related production)
Acceptance criteria	Information is provided, when possible and relevant
Priority	5
Comments	In this respect, while providing in real time information regarding the consumption, it should also show which is the share of renewables in the total production at the level of community and/or at country level.
Author	Mihai Sanduleac

Table 27. Requirement APP_049

Requirement ID	**APP_050**

Description	If the App delivers cross-border information from neighbours with a different time zones (e.g. data from Central European time and from East European Time), an appropriate display/presentation of each timestamp and related data should be implemented.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	This may avoid wrong interpretation of data from other's time zones if comparison between them is done in the same view of the App's UI
Acceptance criteria	Information is provided, when possible and relevant
Priority	2
Comments	
Author	Mihai Sanduleac

Table 28. Requirement APP_050

Requirement ID	**APP_052**
Description	The App should provide a Support & FAQs section with guides or the option to contact support for troubleshooting and advice.
Classification	Energy Apps
Type	Operational requirements
Rationale	Allows to solve easier problems which overpass the current experience of the user.
Acceptance criteria	Information is provided, in adequate form

Priority	4
Comments	
Author	Mihai Sanduleac

Table 29. Requirement APP_052

Requirement ID	**APP_053**
Description	The App of a certain user may allow in an easy way to share voluntarily some of its energy data to a friend.
Classification	Energy Apps
Type	Usability and humanity requirements
Rationale	Such functionality may ease sharing personal example to somebody else and enforce similar community behaviour, while still keeping the GDPR, as it is based on consent.
Acceptance criteria	Information is provided, when possible and relevant
Priority	3
Comments	Such opening for sharing personal data may have various restrictions to be easily configured, such as time period, time granularity of the energy data (each 1 minute, each hour, day or month)
Author	Mihai Sanduleac

Table 30. Requirement APP_053

Requirement ID	**APP_054**

Description	Missed current opportunities on providing energy services may be listed in the App, at the wish of the end-user.
Classification	Energy Apps
Type	Look and feel requirements
Rationale	Such information may increase the will of a certain user to participate in the future to another DR request
Acceptance criteria	Information is provided, when possible and relevant
Priority	2
Comments	For instance, a Demand Response service which has been already engaged in the region can be presented (from the aggregator) for instance: "During this period, 25 end-users opted to decrease their consumption based on DR request, and they are paid with 1.3 Euros per each decrease kWh"
Author	Mihai Sanduleac

Table 31. Requirement APP_054

Requirement ID	**APP_057**
Description	The app should contain notifications that highlight facts about the electricity generation mix, grid stability, and renewable energy efforts, giving users a clearer understanding of their local energy ecosystem.
Classification	Energy Apps
Type	The scope of the product
Rationale	To educate and engage users about sustainability in the context of Croatia's transmission network, promoting awareness of its energy sources and consumption patterns

Acceptance criteria	Notifications shown to the user when the condition triggers.
Priority	2
Comments	Users can also be informed about major milestones, environmental statistics, and the benefits
Author	Kristina Pandzic

Table 32. Requirement APP_057

Requirement ID	**APP_059**
Description	The tool must support an increasing number of users and data without performance degradation.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	A scalable system ensures that future growth in demand does not compromise performance.
Acceptance criteria	The system maintains response times under 2 seconds with 10,000 concurrent users and processes data efficiently with a 99.9% uptime
Priority	3
Comments	
Author	Covadonga

Table 33. Requirement APP_059

Requirement ID	**APP_064**

Description	The energy applications based on CERF should allow a user to configure different flexibility programs, including the opt-in and opt-out conditions and terms for participants.
Classification	Energy Apps
Type	Functional and data requirements
Rationale	The flexibility market is quickly evolving towards a variety of flexibility programs requiring specific certifications and registration mechanisms for a variety of DER types.
Acceptance criteria	The registration to a flexibility program is characterized by a set of opt-in and opt-out conditions and attributes
Priority	4
Comments	
Author	Witold Krasny

Table 34. Requirement APP_064

Requirement ID	**APP_065**
Description	The energy application based on CERF should allow a user to easily switch a DER group from one flexibility program to another
Classification	Energy Apps
Type	The scope of the product
Rationale	While new Flexibility Service Providers are entering the market and are introducing new flexibility monetization offerings, DER owners should have the possibility continuously challenge the financial performance of their DERs in the participation in a given program, and eventually chose another

	one that may better suit their DERs and their consumption / production behaviour.
Acceptance criteria	Different flexibility providers are able to propose flexibility programs, while DER owners can dynamically register / de-register from these flexibility programs
Priority	3
Comments	
Author	Witold Krasny

Table 35. Requirement APP_065

Requirement ID	**APP_066**
Description	The energy application based on CERF should allow a technical aggregator to propose a flew offer in volume or in volume + price.
Classification	Energy Apps
Type	The scope of the product
Rationale	The DER owner is looking to have more control and transparency over his DER revenue opportunity
Acceptance criteria	The data model and messages exchanged between the technical aggregator and flexibility service provider allow the inclusion of volume and price in the flexibility bid / flex offer
Priority	3
Comments	
Author	Witold Krasny

Table 36. Requirement APP_066

Requirement ID	APP_068
Description	The application must maintain a history of the cumulative benefits from the user's flexibility actions, including avoided CO2 emissions and realized savings.
Classification	Energy Apps
Type	The scope of the product
Rationale	The application must maintain a history of the cumulative benefits from the user's flexibility actions, including avoided CO2 emissions and realized savings.
Acceptance criteria	The application correctly displays the history of cumulative user flexibility benefits, including at minimum CO2 emissions avoided and savings achieved, with a history that can be consulted over a certain period
Priority	3
Comments	
Author	Aurore Fourcroy

Table 37. Requirement APP_068

Requirement ID	APP_069
Description	The application should provide a configuration of personal settings and preferences (availability hours, eligible equipment) including direct access to customer service
Classification	Energy Apps
Type	Users of the product

Rationale	Personalization of flexibility parameters is essential to ensure user engagement and system effectiveness. By allowing users to define their own availability time slots and select eligible equipment, the application respects their individual constraints, increases their sense of control, and promotes active participation in energy flexibility programs.
Acceptance criteria	The user interface allows intuitive configuration of availability time slots and selection of participating equipment. With direct access to customer service through multiple channels (chat, phone, email) accessible from this same interface. The configured preferences are correctly applied during flexibility events, and the user can modify their settings at any time.
Priority	3
Comments	
Author	Aurore Fourcroy

Table 38. Requirement APP_069

Requirement ID	**APP_071**
Description	The application should provide a dashboard for performance monitoring including analysis of flexibility benefits
Classification	Energy Apps
Type	The scope of the product
Rationale	A performance dashboard allows users to clearly visualize the impact of their flexibility actions, which strengthens their engagement and understanding of the economic and environmental benefits associated with their participation.

Acceptance criteria	The dashboard displays key metrics including financial savings achieved, CO2 emission reduction, and flexibility action history over a configurable period, with intuitive graphical visualizations.
Priority	4
Comments	
Author	Aurore Fourcroy

Table 39. Requirement APP_071

Requirement ID	**APP_073**
Description	The application should provide the ability to opt out of scheduled load shedding under predefined conditions
Classification	Energy Apps
Type	Users of the product
Rationale	Providing users with the ability to opt out of scheduled load shedding under predefined conditions strengthens their sense of control and confidence in the system, which encourages more active participation in flexibility programs.
Acceptance criteria	The application must allow users to define specific conditions under which they can opt out of scheduled load shedding. The system must immediately confirm that this request has been taken into account and adjust the load shedding programs accordingly.
Priority	4
Comments	
Author	Aurore Fourcroy

Table 40. Requirement APP_073

Requirement ID	APP_074
Description	The system shall provide real-time alerts and warnings when it is not functioning properly.
Classification	Energy Apps
Type	The scope of the product
Rationale	Ensuring that users receive timely alerts and guidance when the system malfunctions minimize downtime, improves user experience, and enhances overall system reliability. Providing troubleshooting steps or contact information empowers users to resolve issues efficiently without unnecessary delays.
Acceptance criteria	1.The system shall display an alert whenever a malfunction or error occurs. 2.Alerts shall clearly describe the nature of the issue in user-friendly language. 3.Each alert shall provide at least one suggested action for troubleshooting. 4.If the issue cannot be resolved by the user, the alert shall include contact details for technical support. 5.Alerts shall be delivered in real-time without significant delay. 6.Users shall be able to acknowledge or dismiss alerts as appropriate
Priority	4
Comments	It would be nice to offer clear, actionable steps for troubleshooting the issue or direct the user to the appropriate contact for further assistance.
Author	Peter Rosengren

Table 41. Requirement APP_074

Requirement ID	APP_075

Description	The app shall feature a graphical user interface for the house owner to check the results of NILM and the eco-labelling
Classification	Energy Apps
Type	The scope of the product
Rationale	The GUI is useful for the users to visualize and analyse in a clear way the results of the NILM and extract conclusions.
Acceptance criteria	The GUI is implemented with both a consumption representation split by appliance and an interface for performing the eco-labelling calculation
Priority	4
Comments	
Author	Alejandro Vicent

Table 42. Requirement APP_075

Requirement ID	**APP_076**
Description	The app shall let users introduce the details of the appliances they have in their houses
Classification	Energy Apps
Type	The scope of the product
Rationale	For the NILM algorithm to properly work and label the appliances, this minimal list of information is required.
Acceptance criteria	A menu where the user can input their appliances is developed.
Priority	4

Comments	
Author	Alejandro Vicent

Table 43. Requirement APP_076

Requirement ID	**DAT_001**
Description	Requests must include the necessary information to identify the corresponding data source where the requested data is stored
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	CERF Data Spaces are expected to manage a broad set of data sources, and a routing mechanism must be in place for requests to be properly fulfilled.
Acceptance criteria	Data requests are fulfilled with the expected results (owner, type, timeframe, etc.)
Priority	5
Comments	
Author	Diego Garcia

Table 44. Requirement DAT_001

Requirement ID	**DAT_002**
Description	The project pilot sites should provide to the project the historical and current data in order to demonstrate and evaluate CERF.
Classification	CERF Data Spaces

Type	Operational requirements
Rationale	The data is required in order to evaluate the project and also to demonstrate the CERF. The pilots should provide historical data from 3 previous years, if possible.
Acceptance criteria	The project demo sites should give access to these data at least from the beginning of the project, and until the end of the project, in a secure way, at least to the technical partners involved in the project.
Priority	5
Comments	This data should include: energy consumption and production (smart meters readings), energy consumers billing, energy tariffs, emissions calculated, energy mix, power outages, numbers and types of alerts displays, energy consumption and production forecasts, etc. and personal data from customers (name, ID, telephone, email, address, etc.).
Author	Lola Alacreu García

Table 45. Requirement DAT_002

Requirement ID	**DAT_003**
Description	The personal data, and other sensitive data, provided by the demo sites from their customers should be protected, and/or anonymised.
Classification	CERF Data Spaces
Type	Security requirements
Rationale	The data from customers will be protected in order to protect their personal data.

Acceptance criteria	The data from demo sites customers will be saved, processed and protected following EU regulations.
Priority	5
Comments	
Author	Lola Alacreu García

Table 46. Requirement DAT_003

Requirement ID	**DAT_004**
Description	The sharing of private data should only occur in compliance with strict consent management.
Classification	CERF Data Spaces
Type	The scope of the product
Rationale	Data minimization and data privacy adhering to GDPR
Acceptance criteria	Desired functionality should be added for consent management. Data owners should be able to view the data policy applied in the app at any time and be able to withdraw their consent to data sharing if such sharing is obligatory.
Priority	4
Comments	
Author	Christoph Schaffer

Table 47. Requirement DAT_004

Requirement ID	DAT_005
Description	Service Level Agreements (SLAs) should be defined and monitored to ensure data quality. Services based on this data should have access to this information.
Classification	CERF Data Spaces
Type	Operational requirements
Rationale	SLAs ensure that the data seekers get what they expect from data providers. Additionally, the quality of services is maintained as contracted for data transaction.
Acceptance criteria	SLAs definition and monitoring shall be possible
Priority	4
Comments	
Author	Christoph Schaffer

Table 48. Requirement DAT_005

Requirement ID	DAT_006
Description	There should be a way to cross-validate the data that is provided by the dataspace
Classification	CERF Data Spaces
Type	The scope of the product
Rationale	To maintain integrity of CERF data space, there needs to be a cross-validation for data available

Acceptance criteria	Data validation service/mechanism in place
Priority	4
Comments	Example: Consider data is provided by the user which has monetary or energy balancing implications. It can be altered by the user for personal benefits. To maintain the integrity of the dataspace, the data-seeker should be able to cross-validate the data.
Author	Christoph Schaffer

Table 49. Requirement DAT_006

Requirement ID	**DAT_007**
Description	Ensure the creation, update, and maintenance of accurate metadata for all data assets.
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	Ensuring accurate metadata for all data assets is essential for data integrity, traceability, and efficient data management.
Acceptance criteria	Accurate and up-to-date metadata must be created, updated, and maintained for all data assets, with regular audits confirming its completeness and correctness.
Priority	3
Comments	
Author	Katerina Drivakou

Table 50. Requirement DAT_007

Requirement ID	DAT_008
Description	When a flexibility service is being provided, the FSP and the DSO must have a follow-up tool agreed with the best real-time slot possible.
Classification	CERF Data Spaces
Type	Operational requirements
Rationale	If a deviation of the service agreement is detected, both actors (DSO and FSP) may look for new alternatives as soon as possible.
Acceptance criteria	The tool must be reliable, available for both and closer enough to real-time.
Priority	4
Comments	For example, the DSO monitorization could be shown via a web page to the FSP.
Author	Raul Peña

Table 51. Requirement DAT_008

Requirement ID	DAT_009
Description	When a DSO has a new necessity that affects another DSO grid area, the information must be shared among them.
Classification	CERF Data Spaces
Type	Operational requirements
Rationale	If the grid necessity has influence in other DSO assets, this DSO should have the ability to restrict the solution proposed.

Acceptance criteria	Both DSOs must agree how to deal with specific incidences between their borders
Priority	3
Comments	
Author	Raul Peña

Table 52. Requirement DAT_009

Requirement ID	**DAT_010**
Description	The dataspace should implement monitoring performance metrics for data exchange to ensure efficiency and effectiveness
Classification	CERF Data Spaces
Type	Performance requirements
Rationale	The dataspace should ensure that it is efficient for data exchanges
Acceptance criteria	These metrics should be regularly reviewed, and alerts must be triggered if performance falls below predefined thresholds, enabling quick identification and resolution of issues.
Priority	3
Comments	
Author	Maria Papadimitriou

Table 53. Requirement DAT_010

Requirement ID	**DAT_011**

Description	The framework should enable multi-party data sharing agreements with automated compliance checks.
Classification	CERF Data Spaces
Type	Legal requirements
Rationale	Multiple stakeholders (DSOs, FSPs, aggregators, etc.) must exchange sensitive operational and billing data in real time while ensuring compliance with GDPR and energy regulations.
Acceptance criteria	The system should provide an automated verification of compliance and given data usage. Data usage logs in turn should be fully auditable and traceable.
Priority	4
Comments	Potentially avoids NDAs, streamlines the legal process, and allows for easier continuous support.
Author	George Falekas

Table 54. Requirement DAT_011

Requirement ID	**DAT_013**
Description	The framework should support flexible data retention policies configurable by each stakeholder.
Classification	CERF Data Spaces
Type	Security requirements
Rationale	Different market participants may have varying legal or business-driven requirements on how long data is stored.

Acceptance criteria	Administrators can set retention periods (e.g., 3 months, 1 year, etc.) per data type. Data older than the set retention period is automatically purged or archived securely.
Priority	3
Comments	Should help with GDPR compliance and data minimization.
Author	George Falekas

Table 55. Requirement DAT_013

Requirement ID	**DAT_014**
Description	The energy application based on CERF should be compliant with the EU Data Governance Act prescriptions regarding data privacy and user consent.
Classification	CERF Data Spaces
Type	Security requirements
Rationale	Europe's Data Governance Act will impose a consent procedure for any flexibility orchestration use case involving private energy consumption / production data.
Acceptance criteria	The application is able to integrate or connect to a service for consent submission and administration.
Priority	4
Comments	It should allow a flexible configuration of user consent attribute. This capability goes beyond baseline authentication and login rules, as it should fully capture the user consent guidelines related to the use of private data as defined by the Data Governance Act. Under this framework, the user / DER owner should be able to easily provide consent for the use of his

	persona DER data or remove consent. Consents should also be managed at flexibility register level (for example by a technical aggregator) by a consent administrator.
Author	Witold Krasny

Table 56. Requirement DAT_014

Requirement ID	**DAT_015**
Description	All personal and/or sensitive data shared among the systems must be encrypted
Classification	CERF Data Spaces
Type	Security requirements
Rationale	Personal and sensitive data should not be accessed by unauthorised parties
Acceptance criteria	No communication of sensitive data is performed unencrypted
Priority	5
Comments	
Author	Diego Garcia

Table 57. Requirement DAT_015

Requirement ID	**DAT_016**
Description	The CERF based application should be compliant with GDPR and other data protection regulatory measures.
Classification	CERF Data Spaces

Type	Legal requirements
Rationale	From the InterConnect recommendations: the project recommends ensuring the compliance of the CERF based application with the GDPR and other regulatory measures and considering the use of aggregated data at higher levels of abstraction.
Acceptance criteria	Compliance with GDPR
Priority	5
Comments	
Author	Selene Liverani

Table 58. Requirement DAT_016

Requirement ID	**DAT_017**
Description	Customer ownership over data generated by them should be safeguarded by agreements.
Classification	CERF Data Spaces
Type	Legal requirements
Rationale	From the InterConnect recommendations: it is important to reach a consensus on data ownership, ensuring that data generated by the customer belongs to the customer. In this context, the project puts forth including in these agreements not only electricity measurements but also data from IoT devices belonging to the customer or purchase information held by the sellers of goods and services.
Acceptance criteria	Use/sharing of customer data by/to other parties through the app is regulated by agreements under the explicit consent of the user

Priority	5
Comments	If the data is shared with other parties through the app, the system should require explicit consent. Examples of customer data: smart meter measurements, EV charging data, and data gathered by IoT devices
Author	Selene Liverani

Table 59. Requirement DAT_017

Requirement ID	**DAT_018**
Description	Availability of information flows 99.9% + availability – Measured on the number of connections requested due to the on-demand nature of the pilot.
Classification	CERF Data Spaces
Type	Operational requirements
Rationale	Ensures reliable and consistent communication between systems to meet the on-demand nature of the pilot and maintain operational effectiveness.
Acceptance criteria	System availability is measured and verified to have 99.9% uptime over a monitoring period
Priority	5
Comments	
Author	Kamalanathan Ganesan

Table 60. Requirement DAT_018

Requirement ID	**DAT_019**

Description	All data shared within the project should be described in the data catalogue
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	Coordination of the data sharing
Acceptance criteria	Description included in the catalogue
Priority	3
Comments	
Author	Dune Sebilleau

Table 61. Requirement DAT_019

Requirement ID	**DAT_020**
Description	All interfaces should use standard protocols and data models
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	Interoperability of the components
Acceptance criteria	The protocols and data models should be described in the interoperability profiles
Priority	4
Comments	
Author	Dune Sebilleau

Table 62. Requirement DAT_020

Requirement ID	DAT_021
Description	Standard interfaces, data exchange protocols and data models (e.g., through an ontology like SAREF) should be adopted for the development of energy-saving applications.
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	From the InterConnect recommendations. This choice was recommended to support alignment with the creation of an Energy Data Space.
Acceptance criteria	Compliance and adoption of standard interfaces and data protocols/models should be clearly stated
Priority	5
Comments	
Author	Selene Liverani

Table 63. Requirement DAT_021

Requirement ID	DAT_022
Description	In the normal use of the tool, the user management system should guarantee confidentiality and restricted access.
Classification	CERF Data Spaces
Type	Security requirements

Rationale	A user management system should guarantee restricted access, confidentiality and interoperability.
Acceptance criteria	After providing valid credentials, the user is only able to access the information they are entitled to.
Priority	4
Comments	
Author	Javier Fernandez

Table 64. Requirement DAT_022

Requirement ID	**DAT_023**
Description	The CERF should comply with latest CIM data model and both IEC62325 and IEC62746-4 standards to facilitate interoperability
Classification	CERF Data Spaces
Type	Functional and data requirements
Rationale	Compliance with data model standards will largely facilitate interoperability, limit frictions in system integration and enable near real time data exchanges that will be key to enable the wide range of energy management and flexibility orchestration use cases.
Acceptance criteria	Semantics, nature of messages and APIs are consistent with IEC62325 ESMP and IEC62746-4
Priority	5
Comments	
Author	Witold Krasny

Table 65. Requirement DAT_023

Requirement ID	**DTS_001**
Description	When the customer wants to register a new monitored device in the APP, a digital twin will be modelled to reproduce the behavior of the installation (home, company, industry, etc).
Classification	CERF Digital Twin Services
Type	The scope of the product
Rationale	Different exploitation modes of the installation devices can be modelled by having a digital twin.
Acceptance criteria	The catalogue of devices from the digital twin must follow a standard data template.
Priority	3
Comments	For example, a washing-machine model should include the data with the cycles of washing, interruption cycles, demand profile, etc.
Author	Raul Peña

Table 66. Requirement DTS_001

Requirement ID	**DTS_002**
Description	When a customer wants to include a new device for digital-twin purpose, the models from this device should be designed by the original manufacturer (OEM), based on a template, to be included in the library of the customer´s APP.
Classification	CERF Digital Twin Services

Type	Operational requirements
Rationale	If a digital twin of the installation is the sum of its devices, the OEM is the best actor who knows the energy demand of each individual device. This way, it is assured that information will be available in the APP, so the manufacturers will directly upload the model in the library.
Acceptance criteria	The digital twin model of the manufacturer should follow a data template regarding communication protocols with the APP.
Priority	3
Comments	The manufacturers will benefit from this idea, so the competence between them is promoted.
Author	Raul Peña

Table 67. Requirement DTS_002

Requirement ID	**DTS_003**
Description	Adopt synchronization mechanisms for real-time data exchanges to ensure all twins and models are updated with the latest information available.
Classification	CERF Digital Twin Services
Type	Operational requirements
Rationale	Important to ensure that everything follows 'one source of truth'
Acceptance criteria	The system must verify that all connected components are accurately synchronized and that any data discrepancies are flagged for resolution.
Priority	5
Comments	

Author	Maria Papadimitriou

Table 68. Requirement DTS_003

Requirement ID	**DTS_004**
Description	The Digital Twin should support existing input and output streams through an appropriate backend.
Classification	CERF Digital Twin Services
Type	Functional and data requirements
Rationale	To eventually allow for real-time analysis and functional operations, existing stakeholder data I/O should be compatible.
Acceptance criteria	Directives such as the Semantic Interoperability Framework and the CERF are followed and practically defined after working out issues through the pilots.
Priority	3
Comments	Real-time operation is very difficult to achieve and will require many iterations but working out I/O to function seamlessly will help immensely.
Author	George Falekas

Table 69. Requirement DTS_004

Requirement ID	**EAS_002**
Description	Change the smart meter contracted power according to the flexibility offered by the client.
Classification	Energy Assets

Type	Operational requirements
Rationale	Improve the reliability of flexibility services
Acceptance criteria	Contracted power change at the smart meter after acceptance of flexibility bid
Priority	3
Comments	This change should be carried out for the period of supplied flexibility in accordance with the client´s bid. This is a voluntary adhesion product that DSOs can use and clients can join freely.
Author	Sita Carvalho

Table 70. Requirement EAS_002

Requirement ID	**EAS_003**
Description	Measuring and control equipment must provide at least two different communication methods to provide redundancy in case of communication failure
Classification	Energy Assets
Type	Functional and data requirements
Rationale	Grid operators require this to certify device to be used for ancillary services
Acceptance criteria	Functional tests
Priority	4
Comments	

Author	Peter Rosengren

Table 71. Requirement EAS_003

Requirement ID	**EAS_004**
Description	Implementation of the IEC 60870-5-104 standard for communication protocols.
Classification	Energy Assets
Type	The client, the customer and other stakeholders
Rationale	Ensures seamless and reliable communication between grid components and systems, enhancing interoperability and reducing risks of communication failures.
Acceptance criteria	All communication interfaces comply with the IEC 60870-5-104 standard and pass interoperability testing.
Priority	5
Comments	
Author	Kamalanathan Ganesan

Table 72. Requirement EAS_004

Requirement ID	**EAS_005**
Description	Use of the IEC 62325-351:2016 CIM European market model exchange profile for TSO needs.
Classification	Energy Assets

Type	The scope of the work
Rationale	Aligns with established standards for data exchange in European energy markets, ensuring compatibility and accurate market communication.
Acceptance criteria	Data exchange protocols are tested and validated against the IEC 62325-351 standard for compliance.
Priority	5
Comments	
Author	Kamalanathan Ganesan

Table 73. Requirement EAS_005

Requirement ID	**EAS_009**
Description	Connections must be secure and must adhere to certified security standards (e.g. ISO-27001)
Classification	Energy Assets
Type	Security requirements
Rationale	Ensuring that connections are secure and adhere to certified security standards is essential for protecting sensitive data, maintaining the integrity of systems, and meeting regulatory compliance.
Acceptance criteria	All network connections must comply with certified security standards, such as ISO-27001
Priority	4
Comments	

Author	Álvaro Rodríguez Gómez

Table 74. Requirement EAS_009

Requirement ID	**EAS_010**
Description	Security tests must be conducted to verify the security mechanisms implemented
Classification	Energy Assets
Type	Security requirements
Rationale	Conducting security tests is critical to verify the effectiveness of implemented security mechanisms, ensuring they function as intended and provide the necessary protection against threats. These tests help identify vulnerabilities early, reducing the risk of security breaches and ensuring compliance with security standards.
Acceptance criteria	Security tests must be performed on all critical components and its results must demonstrate that all security mechanisms are functioning as intended.
Priority	3
Comments	
Author	Álvaro Rodríguez Gómez

Table 75. Requirement EAS_010

Requirement ID	**EAS_011**
Description	Each vulnerability identified through security tests must have corresponding mitigation plans to prevent any potential risks.

Classification	Energy Assets
Type	Security requirements
Rationale	Having corresponding mitigation plans ensures that identified risks are addressed promptly, reducing the potential for exploitation. This proactive approach strengthens the overall security posture and protects against future threats.
Acceptance criteria	For each vulnerability identified, a mitigation plan must be created, outlining specific actions to address the issue, the responsible parties, and a timeline for resolution.
Priority	3
Comments	
Author	Álvaro Rodríguez Gómez

Table 76. Requirement EAS_011

Requirement ID	**EAS_012**
Description	Scalable high frequency data exchanges have to be handled, so an adequate architecture has to be adopted.
Classification	Energy Assets
Type	Performance requirements
Rationale	Handling scalable high-frequency data exchanges requires a flexible and robust architecture to ensure seamless performance and manageability as the system grows. Using containers and Kubernetes for orchestration allows for efficient scaling, resource allocation, and fault tolerance, ensuring the system can handle increased load while maintaining performance and availability.

Acceptance criteria	The system architecture must utilize Docker containers for deploying software components, with Kubernetes managing the orchestration to ensure scalability and high availability.
Priority	4
Comments	SIORD employs a System Architecture based on Software Components deployed in "containers" (Docker), managed by the Kubernetes service orchestration cluster
Author	Álvaro Rodríguez Gómez

Table 77. Requirement EAS_012

Requirement ID	**EAS_013**
Description	Communication channels must be secure, so once the connection is established there is no need for authentication or authorization protocols for data exchanges.
Classification	Energy Assets
Type	Security requirements
Rationale	Secure communication channels ensure that once a connection is established, the data exchanged is protected from unauthorized access or tampering. By establishing secure connections upfront, authentication and authorization protocols can be simplified, reducing overhead while maintaining data integrity and confidentiality.
Acceptance criteria	The communication channels must be secured using protocols like TLS or IPsec to encrypt the connection. Once the secure connection is established, no further authentication or authorization is required for ongoing data exchanges, as long as the integrity and confidentiality of the data are maintained.

Priority	3
Comments	
Author	Álvaro Rodríguez Gómez

Table 78. Requirement EAS_013

Requirement ID	**EAS_014**
Description	In order to see the values at a certain moment of the signals of a device, they can be exported and downloaded in a JSON file, where information of each signal can be seen.
Classification	Energy Assets
Type	Operational requirements
Rationale	Exporting signal values in a JSON file allows for easy access and analysis of device data at a specific point in time. This format is both human-readable and machine-parsable, making it convenient for troubleshooting, reporting, and further processing.
Acceptance criteria	The system must allow users to export and download device signal values in a JSON format. The JSON file should include detailed information for each signal, such as signal name, timestamp, and value, ensuring all relevant data is clearly represented and easily accessible.
Priority	3
Comments	
Author	Álvaro Rodríguez Gómez

Table 79. Requirement EAS_014

Requirement ID	EAS_015
Description	The energy applications based on CERF should be able to handle large volumes of streamed DER data, within near time data exchanged, with the capacity to configure time stamping and set temporal granularity for flexibility events.
Classification	Energy Assets
Type	Functional and data requirements
Rationale	Future flexibility programs will involve near real time data exchanges and large volumes of DER exchanged in fine granularity and high volumetry. Classical API technologies might show limitations while sate streaming services appear to best suit these kind of use cases.
Acceptance criteria	The future solution is ready to orchestrate large volumes of near real time data exchanges
Priority	4
Comments	
Author	Witold Krasny

Table 80. Requirement EAS_015

Requirement ID	GEN_007
Description	An analysis must be done in order to assess and provide insights on national and European regulations impacting the CERF implementation.
Classification	General Requirements
Type	Legal requirements

Rationale	Comprehensive analysis can significantly aid in identifying viable business models and regulatory pathways that lead to significant impact of the CERF implementation.
Acceptance criteria	The analysis must be able to provide important information related to relevant local and European Regulations and identify and highlight opportunities and barriers within the regulatory landscape.
Priority	5
Comments	
Author	Lola Alacreu García

Table 81. Requirement GEN_007

Requirement ID	**GEN_020**
Description	All systems developed within the ECLIPSE project should be thoroughly tested, including components functionality tests, interoperability tests and integration tests.
Classification	General Requirements
Type	Operational requirements
Rationale	To ensure the proper behaviour of the systems, and reduce or avoid issues to be encountered at deployment stages of the project
Acceptance criteria	A list of the tests performed, and their results should be transmitted to the technical manager
Priority	4
Comments	

Author	Dune Sebilleau

Table 82. Requirement GEN_020

Requirement ID	**GEN_023**
Description	When there is a DSO necessity, this must be adapted to a standardized service.
Classification	General Requirements
Type	Legal requirements
Rationale	New FSPs can offer standardized products in other markets, so the competence increases.
Acceptance criteria	The new DSO need is included in a standardized catalogue.
Priority	2
Comments	
Author	Raul Peña

Table 83. Requirement GEN_023

Requirement ID	**GEN_024**
Description	When a set of flexibility options are available in the market, a priority order must be followed.
Classification	General Requirements
Type	Cultural and political requirements

Rationale	Maybe other aspects must be considered while choosing one flexibility option or another, apart from the economical one.
Acceptance criteria	Choose a balance between the cheapest solutions versus social acceptance.
Priority	2
Comments	For example, if there are three medium-voltage lines with problems and a flexibility service needs to be provided to one of them (imagine one school, another with households and the third with a factory). One FSP is present in each of the lines, with an agreement with each stakeholder. It is foreseen that the school offer one is going to be the cheapest. But which offer is going to be chosen first?
Author	Raul Peña

Table 84. Requirement GEN_024

Requirement ID	**SVC_001**
Description	User data used as input by the Energy Services must not be stored after the corresponding request has been fulfilled
Classification	CERF Energy Services
Type	Functional and data requirements
Rationale	User data is sensible and must only be persistently stored in the authorised data source(s)
Acceptance criteria	User data is deleted once the corresponding request has been finished
Priority	4
Comments	

Author	Diego Garcia

Table 85. Requirement SVC_001

Requirement ID	**SVC_002**
Description	External interventions in private systems (e.g., activation of a maximum feed-in restriction) must be displayed immediately in the corresponding app.
Classification	CERF Energy Services
Type	Usability and humanity requirements
Rationale	Smartly manage and communicate users about external interventions to inform users immediately about exigencies
Acceptance criteria	The app should be able to handle external signals
Priority	4
Comments	
Author	Christoph Schaffer

Table 86. Requirement SVC_002

Requirement ID	**SVC_007**
Description	When the behaviour of a registered user is environmentally responsible, the system should recognise the positive behaviour of the user.
Classification	CERF Energy Services
Type	Usability and humanity requirements

Rationale	The less consumption or CO_2 footprint, the more potential customers can be interested.
Acceptance criteria	An easy way to distinguish for the user among different levels. For example, in a pharmacy more or less than 1 kg/CO_2 every day could be A+ rate.
Priority	5
Comments	For example: A+, A, B, ... classification from high to low companies environmentally friendly.
Author	Raul Peña

Table 87. Requirement SVC_007

Requirement ID	**SVC_009**
Description	Size of the aggregated minimum bid to participate in the energy service provided to the TSO
Classification	CERF Energy Services
Type	The scope of the work
Rationale	Only bids that are aggregated to a capacity of 1MW are allowed to participate in the mFRR market for providing the service to the system operator
Acceptance criteria	Any bid that matches or exceeds 1MW is accepted for each market time unit.
Priority	5
Comments	
Author	Kamalanathan Ganesan

Table 88. Requirement SVC_009

Requirement ID	SVC_010
Description	Support for multiple incentive mechanisms (economic and non-economic) in bid evaluation.
Classification	CERF Energy Services
Type	The scope of the product
Rationale	Allows the system to evaluate and integrate flexibility bids based on various criteria, catering to different types of prosumers and grid requirements.
Acceptance criteria	Market simulator successfully evaluates bids using both economic and non-economic criteria.
Priority	5
Comments	
Author	Kamalanathan Ganesan

Table 89. Requirement SVC_010

Requirement ID	SVC_012
Description	If a load displacement occurs, the FSP must indicate where and when this load is going to be feeder.
Classification	CERF Energy Services
Type	The scope of the product
Rationale	If the DSO has a baseline of the grid area, the new load displacement must be confirmed by the DSO.

Acceptance criteria	The FSP must indicate where, when and during how long the new load is going to be feeder.
Priority	3
Comments	For example, if a charging station is going to close for 1 hour, where are the cars going to be charged during this period? To which line are they going to be moved?
Author	Raul Peña

Table 90. Requirement SVC_012

Requirement ID	**SVC_013**
Description	The energy services for each power distribution network segment should pertain to the users connected to that specific segment.
Classification	CERF Energy Services
Type	Functional and data requirements
Rationale	Since power distribution networks are dispersed, and often the same segment of the distribution network extends across areas with different postal codes, the association of users with the respective network segment they are connected to and the related energy services, should be based on the HV/MV and MV/LV transformers to which they are connected.
Acceptance criteria	Each user is associated with the corresponding energy services available for the network through their connection to the transformers they are connected to.
Priority	4
Comments	

Author	V.Boglou

Table 91. Requirement SVC_013

Requirement ID	**SVC_014**
Description	The system should allow participants to set automated demand response rules that trigger device actions (e.g., EV charging pause) under certain tariff conditions.
Classification	CERF Energy Services
Type	Usability and humanity requirements
Rationale	Encourages broad participation in demand response by making it frictionless for end-users and third-party FSPs.
Acceptance criteria	Users can configure simple rule sets (e.g., "Pause charging if price > X").
Priority	4
Comments	Basic flexibility integration with end users as "service providers".
Author	George Falekas

Table 92. Requirement SVC_014

Requirement ID	**SVC_015**
Description	The system should track and manage reward mechanisms (e.g., tokens, discounts) for users who voluntarily reduce or shift load.
Classification	CERF Energy Services
Type	Performance requirements

Rationale	There are multiple cases where load demand shift is not required but suggested (excluding user changing due to tariff). Users who comply should have a financial benefit, albeit small, and know that they are acknowledged to encourage behaviour.
Acceptance criteria	There is a way to reward volunteers with a way other than reduced tariffs. Pilots showcase this method's performance through adequate load shift and user acceptance.
Priority	3
Comments	Users can be rewarded with reducing fixed payments, or through rewards with collaborating advertisers.
Author	George Falekas

Table 93. Requirement SVC_015

Requirement ID	**SVC_016**
Description	If a flexibility petition is sent by DSO, certain conditions must be defined to prove that the service has been fulfilled or rejected.
Classification	CERF Energy Services
Type	Operational requirements
Rationale	There must exist a procedure (data-base) of customers in favour of providing flexibility. During the monitorization of the service, there should exist a comparison between the maximum value admitted versus the actual value measured, and in which moments the value has been surpassed.
Acceptance criteria	Amount of time and percentage of maximum value accepted for a customer that previously has been registered.
Priority	4

Comments	For example, DSO wants a maximum voltage level in the grid of 20 kV for 30 minutes, achieving it on the 99% of time and without surpassing more than the 101% of voltage. The service is accomplished if during no more than 20 seconds the voltage of 20,2 kV is not lower.
Author	Raul Peña

Table 94. Requirement SVC_016

Requirement ID	**SVC_017**
Description	All stakeholders should be defined.
Classification	CERF Energy Services
Type	The client, the customer and other stakeholders
Rationale	Definition of the System of Interest
Acceptance criteria	As required by the Architecture Description of the ISO/IEC/IEEE 42010 standard, stakeholders need to be well identified and position in the architecture description
Priority	5
Comments	Examples of stakeholders: client, owner, user, consumer, supplier, designer, maintainer, auditor, CEO, certification authority, architect. http://www.iso-architecture.org/ieee-1471/cm/
Author	Diana Jimenez

Table 95. Requirement SVC_017

Requirement ID	**SVC_018**

Description	The roles and names should be referenced from HEMRM (Harmonised Electricity Market Role Model)
Classification	CERF Energy Services
Type	Naming conventions and definitions
Rationale	Each region might have a different common name for a role. It can lead to confusion on European level. Therefore, we should align our terms and roles with HEMRM
Acceptance criteria	Common vocabulary created based on HEMRM and followed
Priority	4
Comments	
Author	Shievam Kashyap

Table 96. Requirement SVC_018

Requirement ID	**SVC_019**
Description	The quality of service of each component developed within the ECLIPSE project should be monitored during the deployment phase of the project.
Classification	CERF Energy Services
Type	Performance requirements
Rationale	Ensuring the quality of service in a high TRL project
Acceptance criteria	The quality of service is monitored, the maintenance is planned and the issues are addressed
Priority	4

Comments	Any issue arising during the monitoring should be addressed to ensure that the product reaches the expected TRL level at the end of the project. The monitoring of the components after the end of the project should also be planned.
Author	Dune Sebilleau

Table 97. Requirement SVC_019

Requirement ID	**SVC_020**
Description	The tool must align with EU guidelines on energy efficiency and responsible consumption.
Classification	CERF Energy Services
Type	Legal requirements
Rationale	Regulatory compliance ensures legal operation and maximizes adoption by energy providers and governments.
Acceptance criteria	A regulatory compliance audit confirms adherence to EU energy directives, including Energy Efficiency Directive (EED).
Priority	5
Comments	
Author	Covadonga

Table 98. Requirement SVC_020

Requirement ID	**SVC_021**

Description	Measuring equipment in the pilots must have (or be complemented with) IoT capabilities in order to send (near) real-time data.
Classification	CERF Energy Services
Type	Operational requirements
Rationale	Measuring data is essential both for basic monitoring of the pilot and to feed the algorithms of the tool
Acceptance criteria	Measurements from field equipment are periodically received by the tool.
Priority	5
Comments	The geographical information should be able to be textual form for more user friendliness.
Author	Lola Alacreu García

Table 99. Requirement SVC_021

Requirement ID	**SVC_022**
Description	Latency of communication for emergency signals
Classification	CERF Energy Services
Type	The client, the customer and other stakeholders
Rationale	Rapid communication is critical during emergency scenarios to ensure timely activation of flexibility and maintain grid stability.
Acceptance criteria	Communication latency for emergency signals is tested and should remain below few seconds in simulated runs.
Priority	5

Comments	
Author	Kamalanathan Ganesan

Table 100. Requirement SVC_022

Requirement ID	**SVC_023**
Description	When a FSP propose a flexibility solution, the data availability (speed and refresh) must be good enough for a reliable control.
Classification	CERF Energy Services
Type	Performance requirements
Rationale	The better data availability, the better control from DSO.
Acceptance criteria	The best possible starting from real-time timestamp. If this is not possible, 5 or 15 minute slots (the best possible).
Priority	5
Comments	
Author	Raul Peña

Table 101. Requirement SVC_023

Requirement ID	**SVC_024**
Description	When there exists a telecommunication failure and there is no possibility of keeping track, a procedure for monitoring or extrapolate the data must exist.
Classification	CERF Energy Services

Type	Performance requirements
Rationale	When there is an issue on the final result of the flexibility product, there must be a calculus method accepted by all actors.
Acceptance criteria	A procedure must be agreed and must cover all the incidences/failures.
Priority	5
Comments	For example, if the voltage sensor on the line fails, other sensor of the same line could be employed. Other way, an extrapolation process could be done with the last reliable data received.
Author	Raul Peña

Table 102. Requirement SVC_024

Requirement ID	**SVC_025**
Description	The energy services shall provide, when in place/scope, clear economic signals stimulating users to change their energy consumption behaviour.
Classification	CERF Energy Services
Type	The client, the customer and other stakeholders
Rationale	From the InterConnect recommendations: Beyond economic benefits, the project found social responsibility to play an important role in user engagement.
Acceptance criteria	A communication channel from DSO to customer or DSO to retailer to customer should be put in place in line with existing regulatory and contractual conditions.
Priority	4

Comments	The economic signals can be provided from DSO to customer or from DSO to retailer to customer in accordance with existing regulatory and contractual conditions. Note: originally only one requirement was included to encompass this one and APP_035. In later iterations, the two requirements were split.
Author	Selene Liverani

Table 103. Requirement SVC_025

Requirement ID	**SVC_026**
Description	When information on the forecast situation in the National Energy System (done by TSO) for the following day is available, the services provide data on the time periods of the day in which reduced or increased energy consumption is recommended.
Classification	CERF Energy Services
Type	The scope of the product
Rationale	Active customer should be able to receive the information about the recommended time intervals in which it is suggested to reduce or increase energy consumption. Such information is needed to enable customers to use electricity and power in an optimal way for the power system and the environment.
Acceptance criteria	Minimum data that allows the customer to make decisions.
Priority	3
Comments	
Author	Andrzej Szyp

Table 104. Requirement SVC_026

Requirement ID	SVC_027
Description	Personalized messaging
Classification	CERF Energy Services
Type	The scope of the product
Rationale	DSO should be able to use the apps to deliver personalized messages to specific groups of customers. Messages, due to different priorities, can be in the form of regular messages (inbox) or push notifications in mobile apps. There are many contexts for such use, e.g., promotion of self-consumption of energy directed to prosumers, a call to report increased PV installation capacity to the DSO, etc.
Acceptance criteria	By means of user satisfaction surveys and other ways, feedback from consumers will be collected to analyse how satisfied the end-users are with the applications.
Priority	4
Comments	The way the notifications work should be user-definable
Author	Andrzej Szyp

Table 105. Requirement SVC_027

Requirement ID	SVC_028
Description	Integration and visualization of different data streams, like weather forecast and spot prices, must be allowed.
Classification	CERF Energy Services
Type	Functional and data requirements

Rationale	This is important to provide relevant information to end-users
Acceptance criteria	User satisfaction surveys, feedback from consumers will be collected to analyse how satisfied the end-users are with the applications.
Priority	4
Comments	Focused on basic functionality for use of external sources. First to integrate the sources, i.e. understanding the format and parsing it. Then to visualize the data, typically in different graphs showing average temperature etc.
Author	Peter Rosengren

Table 106. Requirement SVC_028

Requirement ID	**SVC_029**
Description	Mechanisms should be provided to enable the easy integration of third-party services.
Classification	CERF Energy Services
Type	Functional and data requirements
Rationale	Since the apps should be designed to incorporate new services easily, such mechanisms will save precious time to market. It will also save from reinventing the wheel
Acceptance criteria	Architecture supporting microservices. Interactive elements associated with such a service should be displayable in the Customer App without the need for reimplementation.
Priority	5
Comments	

Author	Christoph Schaffer

Table 107. Requirement SVC_029

Requirement ID	**SVC_030**
Description	Transparent insights into the contents of their energy bills should be provided to users.
Classification	CERF Energy Services
Type	Usability and humanity requirements
Rationale	Often, the bills are complicated with multiple entries that might not be easy for non-energy aware users. The transparent insight through apps makes users aware of their actions and increase energy-literacy
Acceptance criteria	A clear view of what's in their energy bills should be given to users.
Priority	4
Comments	
Author	Christoph Schaffer

Table 108. Requirement SVC_030

Requirement ID	**SVC_031**
Description	Provide users with a clear view of how their actions produce a real, positive impact on the environment.
Classification	CERF Energy Services
Type	The client, the customer and other stakeholders

Rationale	From the InterConnect recommendations: Beyond economic benefits, the project found social responsibility to play an important role in user engagement.
Acceptance criteria	The impact of the user action is terms of saved GHG emissions should be determined following a transparent and standard methodology and clearly reported in the app.
Priority	3
Comments	Note: originally only one requirement was included to encompass this one and APP_008. In later iterations, the two requirements were split.
Author	Selene Liverani

Table 109. Requirement SVC_031

Requirement ID	**SVC_032**
Description	The services should be able to calculate the hour with maximum energy consumption for each day.
Classification	CERF Energy Services
Type	The scope of the product
Rationale	This is to support user with power tariffs.
Acceptance criteria	User satisfaction surveys, feedback from consumers will be collected to analyse how satisfied the end-users are with the applications.
Priority	4
Comments	It should also indicate the three hours during the month with the highest consumption.

Author	Peter Rosengren

Table 110. Requirement SVC_032

Requirement ID	**SVC_033**
Description	The services based on CERF should enable both explicit flexibility orchestration and implicit flexibility orchestration
Classification	CERF Energy Services
Type	Functional and data requirements
Rationale	Certain flexibility programs will only be eligible to explicit flexibility trading in order to fully control the chain of activation, while other flexibility programs will be best suited for implicit flexibility activation based on tariff signals.
Acceptance criteria	They must support explicit flexibility orchestration, where users or systems can manually specify and control the allocation and adjustment of resources, and implicit flexibility orchestration, where the system automatically adjusts resources based on predefined conditions, such as energy demand or supply fluctuations.
Priority	4
Comments	
Author	Witold Krasny

Table 111. Requirement SVC_033

Requirement ID	**SVC_034**

Description	The NILM algorithm should be able to identify for a load time series, the individual loads and propose a category/type for each of them.
Classification	CERF Energy Services
Type	The scope of the product
Rationale	This is the basic wanted NILM feature
Acceptance criteria	A time series of multiple loads is provided
Priority	4
Comments	
Author	Alejandro Vicent

Table 112. Requirement SVC_034

Requirement ID	**SVC_035**
Description	The NILM algorithm should be able to label the individual loads identified according to the EU energy labelling criteria for appliances
Classification	CERF Energy Services
Type	The scope of the product
Rationale	Energy labelling is a simple way of presenting the appliances energy efficiency that can be used to compare different models/brands and assess the correctness of the official labels.
Acceptance criteria	Each appliance of each house is labelled with the appropriate energy efficiency label
Priority	4

Comments	
Author	Alejandro Vicent

Table 113. Requirement SVC_035

Requirement ID	**SVC_036**
Description	The NILM algorithm should work with 1h/15min granularity data
Classification	CERF Energy Services
Type	Functional and data requirements
Rationale	For producing representative and accurate data, the frequency in which the data is produced should be low.
Acceptance criteria	The granularity data is provided at least each 1 hour.
Priority	3
Comments	
Author	Alejandro Vicent

Table 114. Requirement SVC_036

Requirement ID	**SVC_037**
Description	The energy consumption data should be received from the smart meters periodically
Classification	CERF Energy Services
Type	Functional and data requirements

Rationale	For the NILM to compute its calculations, it needs the data from the smart meters.
Acceptance criteria	The data from the smart meters is received.
Priority	5
Comments	
Author	Alejandro Vicent

Table 115. Requirement SVC_037

Requirement ID	**SVC_038**
Description	The NILM module shall detect abnormal behaviour in the energy assets
Classification	CERF Energy Services
Type	The scope of the product
Rationale	The consumption per appliance can be used to detect deviations and abnormal consumptions in the appliances.
Acceptance criteria	Some analysis and/or monitoring on the energy assets is performed
Priority	3
Comments	
Author	Alejandro Vicent

Table 116. Requirement SVC_038

14. REFERENCES AND ACRONYMS

14.1. REFERENCES

- ECLIPSE GRANT AGREEMENT, Project 101158494, 2024.
- EDDIE Framework: Home - EDDIE - European distributed data infrastructure for energy
- AIIDA: Home - EDDIE - European distributed data infrastructure for energy

14.2. ACRONYMS

Acronym	Definition
AMI	Advanced Metering Infrastructure
AMR	Automated Metering Reading
API	Application Programming Interface
APP	Application
BESS	Battery Energy Storage System
BEV	Battery Electric Vehicle
BRP	Balance Responsible Party
BSP	Balancing Service Provider
CERF	Common European Reference Framework
DAP	Data Access Provider
DHW	Domestic Hot Water
DMS	Distribucion Management System
DSO	Distribution System Operator

DSR	Demand Side Response
EARS	Easy Approach to Requirements Syntax
EC	European Commission
ESCO	Energy Service Company
ESS	Energy Storage System
EV	Electric Vehicle
EU	European Union
FCR-D	Frequency Containment Reserve for Disturbances
FCR-N	Frequency Containment Reserve for Normal Operation
FFR	Fast Frequency Response
FSP	Flexibility Service Provider
GD-CC	Generation and Demand Control Centres
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
HEMRM	Harmonised Electricity Market Role Model
HLUC	High Level Use Case
HP	Heat Pump
HVAC	Heating, Ventilation and Air Conditioning
IOT	Internet Of Things
KPI	Key Performance Indicator
LV	Low Voltage

MDA	Meter Data Administrator
mFRR	manual Frequency Restoration Reserve
MV	Medium Voltage
NILM	Non-Intrusive Load Monitoring
OPS	Operator of distributed energy Sources
PHEV	Plug-in Hybrid Electric Vehicle
PIRED	Plataformas de Información de Recursos Energéticos Distribuidos
PV	Photovoltaic
RES	Renewable Energy Share
SCADA	Supervisory Control and Data Acquisition
SGU	Single Generation Unit
SIORD	Sistema de Información de los Operadores de Redes de Distribución
TIEPI	Tiempo de Interrupción Equivalente a la Potencia Instalada
TSO	Transmission System Operator
UC	Use Case
V2G	Vehicle To Grid
V2H	Vehicle To Home
VPP	Virtual Power Plant
WP	Work Package

Thank You

If you have any questions, please get in touch with us.

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