



# **D4.2 Local Markets structure development**

March 2025

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Responsible	Organisation	Contributing WP
-------------	--------------	-----------------

Javier Zelaya	OMIE	WP4
---------------	------	-----

### Authors (organisation)

Javier Zelaya (OMIE), Manuel Rebollo (OMIE), Sergio Muñoz (OMIE), Alberto Ruiz (OMIE), Janez Gregor Golja (IRI UL), Jan Jeriha (UL), Klemen Peter Kosovinc (KOL), Gašper Mis (KOL), Gregor Gostinčar (KOL), Borut Jereb (KOL), Gašper Artač (KOL), Gregor Skrt (EPR), Denis Sodin (COMS), Prashanth Kumar Pedholla (ASM) Alessio Cavadenti (ASM), Efrén Guillo (ENER), Isabel Mas (ENER), Daniel Pastor (ETRA), Diego García-Casarrubios (ETRA), Jan Jokelainen (OPT), Juha Marjeta (OPT), Jasmina Bajec Omahen (BOR), Jayasimha Bagalkote (CYG), Peter Nemcek (CYG), Janez Humar (ELES)

### Abstract

This deliverable involves the development of the sSMART tool, essential for managing flexibility in local electricity markets within the STREAM ecosystem. This involved analysing emerging roles in energy markets and adapted by each pilot, integrating the tool with the rest of the STREAM tools to create a cohesive energy management system.

### Keywords

SMART, Final consumer, Aggregator, Energy community, Electric Vehicle, Electricity markets, Auctions, Communication, Prequalification, Qualification, Bid, Settlement

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## EXECUTIVE SUMMARY

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This report outlines the development of an **advanced system for managing the planning and use of flexibility** on the medium and low voltage side of electricity grids **through a Local Flexibility Market** using the **sMART tool**, a key element of the integrated STREAM ecosystem.

**Initially**, detailed information is gathered on **how to improve and develop the negotiation of new emerging roles** such as end-consumer, aggregator, energy community, and electric vehicle in local flexibility markets. This is done by **analysing the impact of these structural changes** on the future of energy trading, both **locally and globally**, considering key outputs from the hierarchical market control conducted in previous phases of the STREAM project. It also explores the new roles emerging in the sector and how this integration is redefining traditional market dynamics, creating new opportunities and challenges for the management and marketing of electricity.

The **report continues** with a **description of the development of the sMART tool**, which provides Flexibility Service Providers, aggregators and Distribution System Operators with an effective **solution for the management of local flexibility markets**, with all its processes designed for this new market (**pre-qualification, qualification, registration, bidding, results, settlement**). Each demo site has implemented the tool with specific features and requirements, adapting it to its own situation. The sMART tool provides Distribution System Operators with a local market mechanism **designed to solve congestion in their distribution networks in accordance with EU guidelines**, while at the same time providing price signals that increase the participation of distributed energy resources.

**Finally**, it describes the **integration process and communication mechanisms used to connect the sMART tool** with the other platforms of the STREAM project. It also details the communication services and technologies used by each pilot to **integrate the sMART tool with their sFLEX, sGRID and sENC tools** to build a cohesive and functional ecosystem.

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# 1 INTRODUCTION

## 1.1 PURPOSE OF THE DOCUMENT

This deliverable, achieved through the collaborative efforts of T4.2 Local Market Structure Development, aims to develop the sSMART tool that facilitates and improves the participation of all new actors in local markets and fully connects it with the other platforms of the STREAM project.

In order to improve and develop the negotiation of all the expected new roles, the results of the subtasks 4.1.1 and 4.1.2 are used, which included the coordination and hierarchy to control participation in the different markets. In this context, the sSMART market operator platform is developed for the pilot sites in Spain, Slovenia, and Italy, with all its processes designed in this new market, and the communication mechanisms between the sSMART local market platform and the rest of the STREAM project tools is established.

## 1.2 SCOPE OF THE DOCUMENT

This report presents the lessons learnt from the project to improve the participation of new actors in local markets. It develops the sSMART tool with all its processes designed for this new market and its connection to the rest of the STREAM tools.

It explores the STREAM pilot sites in Spain, Slovenia and Italy, highlighting the specific needs of sSMART for each demonstration site and its stakeholders.

## 1.3 STRUCTURE OF THE DOCUMENT

The document is structured in these sections:

- **Section 1:** It presents the objective, scope and structure of the document.
- **Section 2** collects the information obtained from the coordination and hierarchy to control the participation in the different markets to improve and develop the negotiation of all the new expected roles as end consumer, aggregator, energy community, electric vehicle in the local flexibility markets.
- **Section 3** explains the development of the sSMART tool to be used by Flexibility Service Providers, Aggregators and Distribution System Operators to manage the planning and use of flexibility on the medium and low voltage side of electricity grids through Local Flexibility Markets and with different transaction structures.
- **Section 4** provides technical information on the integration process and communication mechanisms to achieve the connection between the sSMART local market platform and the other tools of the STREAM project for each demo site.
- **Section 5** concludes the document with a summary of the key points and achievements.

## 2 LOCAL MARKET STRUCTURE

### 2.1 INTRODUCTION OF THE TASK

The growing involvement of new actors in the electricity sector and the development of new technologies are contributing to the enhancement of local markets in terms of efficiency, dynamism and operational effectiveness. This chapter analyses the impact of these structural changes in the sector on the future of energy trading, both at the local and global levels.

Firstly, it presents the main results of the hierarchical market monitoring conducted in previous phases of the STREAM project, which facilitates more efficient and coordinated management of energy resources in Local Flexibility Markets (LFM). Subsequently, the chapter will explore the new roles that are developing in the energy sector and how, as a result of this integration, traditional market dynamics are being redefined. These actors introduce new opportunities and challenges for electricity management and trading, as well as contributing to a greater democratisation of energy.

### 2.2 MAIN RESULTS OF HIERARCHICAL MARKET CONTROL FOR NEGOTIATION IN LFM

Electricity markets are complex systems comprising a multitude of participants, including generators, consumers, market and system operators, and regulators. The process of integrating regional and European electricity markets represents a significant current trend, with the aim of increasing liquidity, competition, and efficiency in the allocation of resources while promoting secure and stable electricity supply.

The hierarchical market control and negotiation mechanisms ensure efficient and reliable grid management by structuring the market into several layers, each with a specific role. The Day-Ahead Market sets initial price signals and balances supply and demand, while the Intra-Day Market allows for real-time adjustments, and the Ancillary Services Market maintains grid stability. The Forward Market facilitates long-term contracts, enhancing financial stability. Integrating LFM, which involve smaller, decentralized energy resources, adds adaptability and resilience, improving overall efficiency and reducing reliance on large, centralized power plants. This structured approach ensures effective price discovery, real-time adjustments, and long-term stability, creating a robust energy market capable of meeting modern demands and integrating diverse energy resources. Nevertheless, the integration of these markets with existing global markets is a significant challenge, requiring excellent coordination between all parties involved.

To address these challenges, Task 4.1 *STREAM MARKET COORDINATION DESIGN*, included in a previous deliverable [1], focused on the hierarchical market control for trading in local flexible markets. This task involved analysing previous projects and conducting several meetings to identify necessary functionalities and stakeholder requirements, forming the basis for planned implementation. Therefore, it was concluded that several key elements are essential to ensure the effective functioning of the local flexibility market.

- **Regulation and Monitoring:** Adequate regulation and supervision by an external body are essential to ensure fair competition and transparency in the market. It is the responsibility of regulatory bodies, such as ACER at the European level [2], to establish rules and monitor the electricity markets.
- **Integration and Digitization:** The integration of renewable energy, digital grid advancements and the transition to a decarbonised economy will undeniably present challenges and opportunities. The development of LFM is a direct response to these developments, managing Distributed Energy Resources (DERs) within medium and low-voltage networks.
- **Congestion and Voltage Control:** Distribution System Operators (DSOs) must adopt innovative management strategies. This includes employing advanced forecasting techniques,

dynamic pricing models and demand response programmes to effectively manage grid congestion and voltage levels.

- **Product Negotiation:** The market structure must be clearly defined with transparent eligibility criteria and registration procedures for all participants, including DER owners, Energy Communities (EnCs), aggregators, and traditional market actors. Each type of service must be technically defined and reliable to ensure compatibility and reliability. Furthermore, standardised contracts for flexibility services must be developed, including pricing mechanisms and payment terms. A reliable settlement process must also be established to guarantee accurate and punctual payments.
- **Non-Compliance Management:** The performance of flexibility assets will be evaluated by comparing the actual power output or consumption with the agreed baseline. In cases of non-compliance with the assigned energy targets, penalties will be imposed. This process ensures that all participants comply with the established rules and regulations, contributing to the stable and reliable operation of the market.

## 2.3 DIFFERENT NEW ROLES EXPECTED

The transition to a more decentralized and sustainable energy system necessitates new roles within LFM. As the adoption of renewable energy sources and Electric Vehicles (EVs) increases, the traditional top-down approach to energy distribution is evolving into a more dynamic and interactive model. Active consumers, or prosumers, both produce and consume energy, are pivotal in this shift. EnCs and aggregators also play a crucial role, coordinating the energy production and consumption of multiple households or businesses to provide collective benefits such as enhanced grid stability and optimized energy use. EVs, with their capacity to store and discharge energy, emerge as key assets in this flexible energy ecosystem. This not only aids in balancing supply and demand but also integrates renewable energy more effectively and can provide a more efficient tool for network operation and planning for DSOs.

### 2.3.1 End consumer

With the fast pace that of the current energy transition, passive consumers are increasingly becoming active consumers with potential to actively manage their consumption and generation to benefit from different energy services with the aim of achieving greater economic savings and at the same time improve the security of supply of the electricity system.

Active consumers or prosumers can:

- Actively shift their demand following economic incentives from different energy services.
- Consume and sell the production of their own generation installations.
- Store and sell electricity from the grid or the excess from their generation assets.
- Participate in energy markets directly or through aggregators or energy communities.
- Participate in energy efficiency schemes and flexibility programs.

However, the participation of individuals or small-scale flexibility in flexibility services can be limited due to the size of their assets. Accordingly, the development of new local energy markets or innovative market models is required.

With the flexible functionalities available to active consumers, their participation in the energy markets is of high value to local DSOs and to solve congestion and voltage issues in the electricity networks. Participation of active consumers leads to reduced energy costs and increased security of supply for consumers but also allows DSO to increase network capacity for distributed generation (further accelerating energy transition), to optimize the utilization of distribution network assets (transformers, lines), and to enable flexibility services by providing the required liquidity for these market services. Therefore, active consumers will play a fundamental role in local energy markets.

### 2.3.2 Aggregator

The concept of an aggregator was first defined in EU Directive 2019/944 [3], which outlines how aggregators can participate in energy markets, enhance market flexibility, and support grid stability. In consequence, each member state has adopted and implemented the directive in accordance with the requirements of national regulatory framework.

In Spain, it was replicated in RDL 23/2020-[4] as “a participant in the market that provides aggregation services and is not related with the client supplier.” However, the regulation of aggregators in Spain is lacking the definition of their characteristics or their rights and obligations regarding the participation in the energy market.

In Slovenia, it was further expanded upon in the Energy Agency (AGEN) consultation document titled “(Independent) Aggregator on Slovenian Electricity Markets” [5]. This document outlines the aggregator's impact on organized energy markets and balance responsible parties, focusing on its relationships with suppliers and other market participants. A systematic review of potential services that could be offered by the independent aggregator was conducted as part of the public consultation “Establishment of a Flexibility Market for Active Demand in Slovenia” [6], also led by AGEN. The aggregator's role in the electricity market, including local markets, is detailed in the “Rules for the Operation of the Electricity Market” [7].

In Italy, initially limited to pilot sites, aggregation now includes not only consumers but also producers of various DERs. Aggregators, who may also act as energy retailers, consolidate their customers' consumption activities. Their primary role involves facilitating low-voltage users' engagement in the flexibility market, although specific technical guidelines are still under development. Consultation 322/2019/R/eel by the Regulatory Authority for Energy, Networks, and Environment (ARERA) highlights the necessity to define ancillary services essential for dispatching activities and mechanisms for resource provision and compensation [29]. Additionally, discussions include the creation and regulation of new entities such as aggregators of widely dispersed energy sources. Regulatory gaps persist concerning the roles of DSOs and other market participants in the evolving flexibility market landscape.

The main expected functions of aggregators are:

- To aggregate controllable units for providing upward or downward regulation capacity as one unit.
- To enable the participation in different energy markets to their clients:
  - aFRR, mFRR, or RR under conditions set by the Transmission System Operator (TSO).
  - Day-Ahead or Intraday markets through closed contracts.
  - As compatible flexibility service products on other markets, potentially including locational information about individual sources of flexibility, under conditions set by the DSO.
- To calculate individual flexibility requirements.
- To verify through measurements the amount of flexibility provided individually and at aggregated level.
- To calculate and process payments for the services provided.

The participation of aggregators in energy markets as an intermediary allows for a new business model, which facilitates the participation of small prosumers, enabling additional economic savings. On the system side, increased participation of aggregated consumers and prosumers helps DSOs and other network operators to maintain the security of supply with a larger pool of flexibility resources. Through aggregators, DSOs will be able to optimise the procurement of flexibility services with a lower risk. In addition, the relationship between the client and the energy supplier should be specifically

defined with respect to the potential deviations that the participation of clients in a flexibility market may create for their consumption or generation.

### 2.3.3 Energy community

EnCs enable members (including individuals, SMEs, and local authorities) to produce and share renewable energy locally, using the infrastructure of the distribution grid. Members benefit from reduced grid management costs and other incentives, promoting decentralized energy production up to 1 MW from renewable sources. These communities foster community empowerment, optimize grid efficiency, and potentially influence electricity markets by decentralizing energy production and consumption, thereby supporting sustainability goals and influencing future energy policies.

In recent years, energy communities have raised great interest among citizens and institutions as one of the emerging tools and options to advance the energy transition, especially in the rural areas.

Energy communities are regulated by Directive 2019/944/EC and Directive 2018/2001/EC [3], which define the framework for their operation, integration, and contribution to the energy market. Currently, thanks to this regulatory framework, a very favorable scenario exists for citizen participation in the generation and management of electrical energy.

In Spain, this was regulated in RDL 23/2020 where Renewable Energy Communities are defined as “legal entities based on open and voluntary participation, autonomous, and effectively controlled by partners or members that are located in the vicinity of renewable energy projects owned and developed by said legal entities, whose partners or members are natural persons, SMEs (Small and medium-sized enterprises) or local authorities, including municipalities and whose primary purpose is to provide environmental, economic or social benefits to their partners or members or to the local areas where they operate, rather than financial gains” [4].

In Slovenia, the concept of an Energy Community is defined by two regulatory documents: the ZOEE (“Zakon o oskrbi z električno energijo”, 172/21) [8] and the ZSROVE (“Zakon o spodbujanju rabe obnovljivih virov energije”, 121/21) [9]. Currently, two legally supported forms of Energy Communities exist:

- Citizen Energy Community: This type of community is focused exclusively on the electricity sector. It involves activities such as electricity production from RES, electricity supply, consumption, aggregation, energy storage, energy efficiency services, and the provision of e-vehicle charging services, along with other energy-related services for its members.
- Renewable Energy Community: Unlike the Citizen Energy Community, the Renewable Energy Community can operate across all energy sectors. Its primary objective is to deliver environmental, economic, and social benefits to its partners or members, as well as to the local areas where it is active.

In Italy, Local Energy Communities and Citizen Energy Communities are specialized geographic areas regulated by Delibera 727/2022/R/eel [10], aimed at enhancing self-consumption of renewable energy.

Energy communities are a mechanism that facilitates citizen participation in the energy field, and that allows users to actively intervene in energy-related decisions, not only as producers but also as consumers, through new demand-side management formulas that technology and digitalization will enable in the short and medium term.

Accordingly, Energy communities support demand-side management in a similar manner as independent aggregators, by aggregating and facilitating prosumers participation in energy markets but with a much stronger focus on the creation of social and environmental value for the community above economic benefits and with greater consumer participation in the decision-making of the whole process.

The increase in number and size of energy communities makes them a key actor in local distributions networks where they can effectively provide important flexibility services to solve grid congestions or voltage issues.

### 2.3.4 Electric vehicle

The rise in EV adoption driven by the need to reduce greenhouse gas emissions and transition to more sustainable energy systems poses several challenges to the operation and planning of distribution systems. On the other hand, given their unique characteristics, EVs can serve as valuable assets for providing flexibility services to DSOs. In particular, EVs can offer:

- Demand Response and peak shaving capabilities by shifting their charging times. This functionality also serves to improve economic benefits of the users behind-the-meter.
- Energy storage capabilities by implementing Vehicle-to-Grid (V2G) functionalities, allowing for bi-directional flow of electricity.
- Flexibility services by responding to DSOs requirements with their energy storage and demand response capabilities.
- Increase DERs penetration by acting as distributed energy storage units.

The participation of EVs in flexibility markets is crucial to achieve a high liquidity in these markets for efficiently solving congestions and voltage issues in local grids. However, clear economic incentives, regulatory frameworks, and faster deployment of smart charging infrastructure are required.

EVs present a significant opportunity for DSOs to enhance grid flexibility, stability, and resilience. By integrating EVs into the grid as flexible resources, DSOs can better manage demand, support renewable energy integration, and provide essential grid services, all while contributing to a more sustainable energy future.

## 2.4 INCREASED PARTICIPATION IN LOCAL AND SYSTEM-WIDE MARKETS

The integration of new stakeholders in the electricity markets, such as final consumers, aggregators, EnCs, and EVs, can significantly improve energy trading in both local and global electricity.

The establishment of LFM for local congestion management facilitates more effective energy management at the distribution grid level. Additionally, it encourages active consumer participation and promotes the utilisation of renewable energy and demand management at the local level.



Figure 1. Different new roles in local and global electricity markets.

### 2.4.1 Increased flexibility for new participants and optimised use of resources.

The ability to manage the energy injected or consumed from the grid allows distributed resources to optimise the times of consumption (those with the lowest price) and injection (those with the highest price) in order to reduce the cost of electricity and maximise its sale value on the market. The existence of local and global markets, at different grid levels and with different time horizons makes it easier for resources to adapt their production/consumption schedules well in advance, while allowing them to benefit from the most advantageous prices that may appear on the different markets.

- **Final consumers:** Final consumers, especially those with distributed generation systems (such as solar panels, energy storage systems...), can become prosumers, producing and consuming electricity. Their ability to adjust their consumption according to market signals provides greater flexibility and trading opportunities.
- **Aggregators:** The independent aggregator offers new business opportunities, allowing small and medium-sized consumers to participate in the markets through this figure. Citizens cease to be passive consumers and become central to the energy transition through their active participation in the markets. Aggregation provides demand flexibility and enhances the integration of distributed renewables, reducing electricity costs [12].
- **Energy communities:** Local energy communities can collectively generate, consume, store, and sell electricity. This optimises the use of local resources, reduces transmission losses and can stabilise the local grid by reducing dependency on large power stations. As well as self-consumption installations, the number of energy communities and collective self-consumption initiatives has also increased.
- **Electric vehicles:** EVs can act as mobile storage units. During periods of low demand, they can be charged at low cost and during peak demand, they can feed energy back into the grid via V2G technology at an economic benefit. This also helps to balance energy supply and demand in real time.

#### 2.4.2 Global and local electricity market trading benefits

The participation of DERS in the local market does not prevent their participation in the global market. Only in case of congestion or technical problems that prevent the flow of the associated energy, their participation in the rest of the markets may be limited.

Building upon the structured approach in the electricity market of the different pilot sites, integrating new roles is poised to significantly enhance energy negotiation in both local and global electricity markets:

- **Efficiency in negotiation:** Competition among more participants and the ability to negotiate prices based on actual supply and demand can lead to fairer and more competitive prices in the electricity market. In addition, smaller and decentralised generators can promote healthier competition in the global market, reducing barriers to entry for new market participants.
- **Market price stabilisation and security of the grid:** The ability of distributed resources to respond quickly to fluctuations in supply and demand helps to stabilise prices in markets, providing a more predictable and stable pricing environment. On the other hand, DERs can be critical in emergency situations, providing a flexible and localised source of energy that can maintain supply in regions affected by natural disasters or congestions.
- **Advanced Digital Technologies:** Implementation of smart grids and digital platforms will enable real-time data analytics and automation. This enhances market transparency, improves operational efficiency, and facilitates faster decision-making in energy transactions. Market participants can leverage predictive analytics to optimize production and consumption patterns, thereby reducing costs and increasing reliability.
- **Energy Storage Solutions:** Integrating energy storage systems, including batteries and pumped hydro storage, will enable better management of intermittent renewable energy sources. Storage assets can store excess renewable energy during periods of low demand and release it during peak times, thereby stabilizing the grid and reducing reliance on fossil fuels for backup power.
- **Demand-Side Management (DSM) Strategies:** Empowering consumers to actively manage their energy usage through DSM programs will play a crucial role. By incentivizing consumers to adjust their electricity consumption patterns based on market signals (e.g., time-of-use pricing), DSM enhances grid flexibility and reduces overall system costs. This proactive

approach not only benefits individual consumers by lowering their energy bills but also contributes to grid stability and resilience.

- **Global Connectivity and Interoperability:** Enhancing interoperability between national and regional electricity markets through international grid interconnections and harmonized regulatory frameworks fosters cross-border energy trading. This integration enables efficient utilization of renewable energy resources across different time zones and geographical locations, optimizing resource allocation and enhancing energy security.
- **Diversification of energy generation and reduction of fossil fuel dependency:** With the increased integration of renewable energy by prosumers and energy communities, the generation of energy is not only diversified at the global level, but also at the local level. In addition, distributed renewable generation reduces global dependence on fossil fuels, which increases national energy security and reduces energy supply tensions.
- **Global emission reduction and promotion of sustainability:** A massive deployment of renewable energy through DERs contributes significantly to the reduction of global gas emissions. Additionally, the participation of different regions in sustainable energy generation promotes a greener and more sustainable global economy, benefiting all countries and contributing to the preservation of the environment.

## 3 DEVELOPMENT OF SMART STREAM TOOL

### 3.1 INTRODUCTION AND FRAMEWORK

The framework for LFM is based on the European Directive 2019/944, which outlines the key guidelines for the integration and management of flexibility in energy systems. This regulation aims to balance the needs of TSOs and DSOs, creating a regulatory environment that promotes equality between all market players. According to this directive, it will promote a competitive environment between new participants and existing operators, which will lead to greater competition in the market. This regulatory approach will result in the provision of a broader range of services and will also lead to a reduction in the costs faced by consumers.

The following difficulties need to be considered when applying the LFM:

- **Legal and regulatory complexity:** Unclear regulatory frameworks and administrative requirements can make it difficult for actors to participate in these markets.
- **Financial barriers:** Difficulties in accessing finance can be a significant barrier to potential participants. The financial structure of local markets should facilitate access to resources and ensure attractive financing conditions to encourage investment in flexibility.
- **Technological challenges:** Efforts are needed to digitise networks and implement interoperability specifications to facilitate the integration of LFM.
- **Risks and uncertainties:** Participation in local markets can be affected by uncertainty about market dynamics and regulatory changes.

To overcome these challenges and facilitate effective integration of LFM, it is necessary to develop sound regulatory frameworks, encourage investment in technology, and ensure fair market access. Coordination between regulators, market operators (MOs), and other key stakeholders is essential to create an environment that encourages participation and optimises the benefits of local flexibility.

The SMART tool offers DSOs a local market mechanism solution to solve congestion in their distribution network, based on EU guidelines. At the same time, it provides new price signals to incentivise the participation of DERs, thus strengthening the position of the active consumer in the electricity sector.

### 3.2 SPANISH DEMO SITE

#### 3.2.1 The role of LFM in Spain

There are currently no LFM in Spain. However, the PNIEC includes the management of DERs in local markets, reflecting Spain's commitment to develop a regulatory framework that allows and encourages DSOs to purchase flexibility services as a cost-effective alternative to more traditional network management mechanisms [14]. On the other hand, the Ministerial Order of the Ministry of Ecological Transition and Demographic Challenge (MITECO) announces the access to the regulatory test bed (sandbox) foreseen in RD 568/2022, where it is foreseen as a mechanism that will allow the development of pilot projects to promote research and innovation in the electricity sector through a controlled test environment [15].

Thanks to European projects such as **OneNET** or **Dress2Market**, which brought together different TSOs, DSOs, and electricity consumers at European and Spanish levels, the bases of LFM have been developed and defined, helping us today to be "ready" to test these markets and thus facilitate a more efficient use of the electricity system, allowing a greater integration of renewable capacity.

Other projects at the Spanish national level such as **IREMEL** have also promoted the integration of LFM in Spain [16].

For its part, OMIE together with IDAE (Institute for Energy Diversification and Saving) developed an "operating model for local electricity markets", which consists of different markets in which various active customers whose point of consumption/distribution is in the distribution networks could participate [17]. The concept is based on markets managed by the MO where energy can be transacted at free prices.

Solutions to potential barriers that could hinder the implementation of these markets for the participation of DERS, Energy Communities, and Aggregators have been identified, such as:

- Local markets are emerging as a competitive tool that will avoid costly investments in grid expansion through traditional methods, given the growing presence of renewable energies.
- DSOs will be able to employ these markets along with flexibility to organize auctions and ensure flexibility for curtailment periods, with the participation of end-users.
- Flexibility markets offer an opportunity for diverse participants to come together, generating new revenue streams and helping DSOs to control and procure grid management services.
- Transparency in the agreements and fairness to all participants are fundamental principles. In addition, these markets provide an opportunity to visualize local energy needs and resources. Competition ensures economic efficiency for end users.
- Local market platforms facilitate coordination between electricity system agents. It is crucial that these platforms are accessible and secure for all involved, eliminating barriers.
- Standardization of communication protocols is essential for effective participation in these markets.

An enabling environment is required to identify the needs of electricity system actors and assess the feasibility of integrating new actors.

The different processes of each stakeholder (DSOs, MOs, aggregators) within the local markets in Spain can be visualised in the following figure:

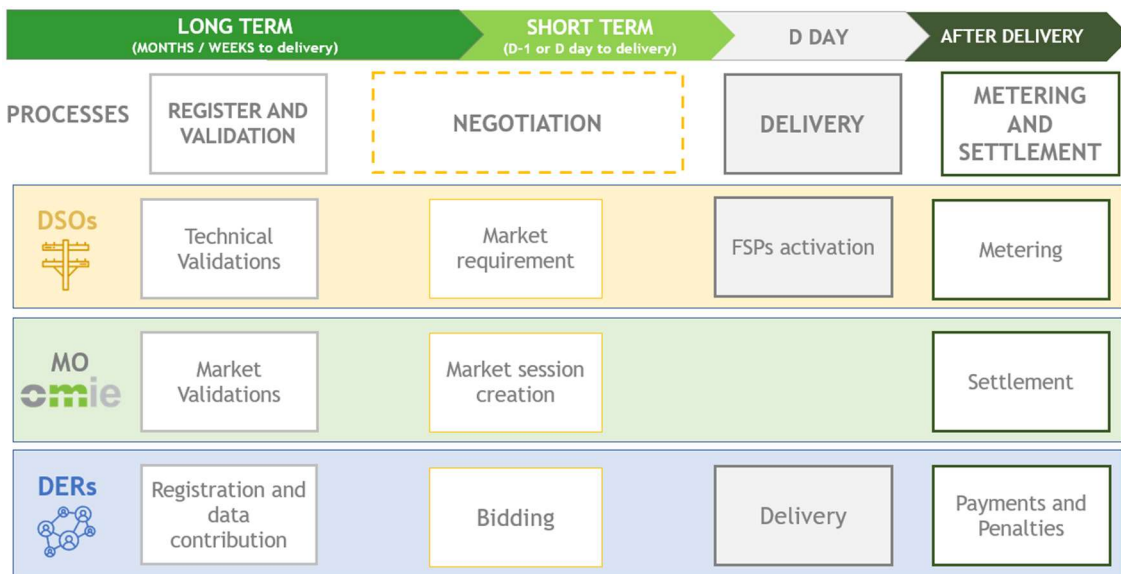


Figure 2: Processes designed in the local flexibility market in Spain

### 3.2.2 Long-term flexibility platform

#### 3.2.2.1 Registration phase

The local long-term market platform can be accessed via the following link: <https://test.disp.omie.es/>. The platform requires access credentials (username and password). These will be provided by OMIE, the designated MO for the Spanish pilot and responsible for the management of the platform.

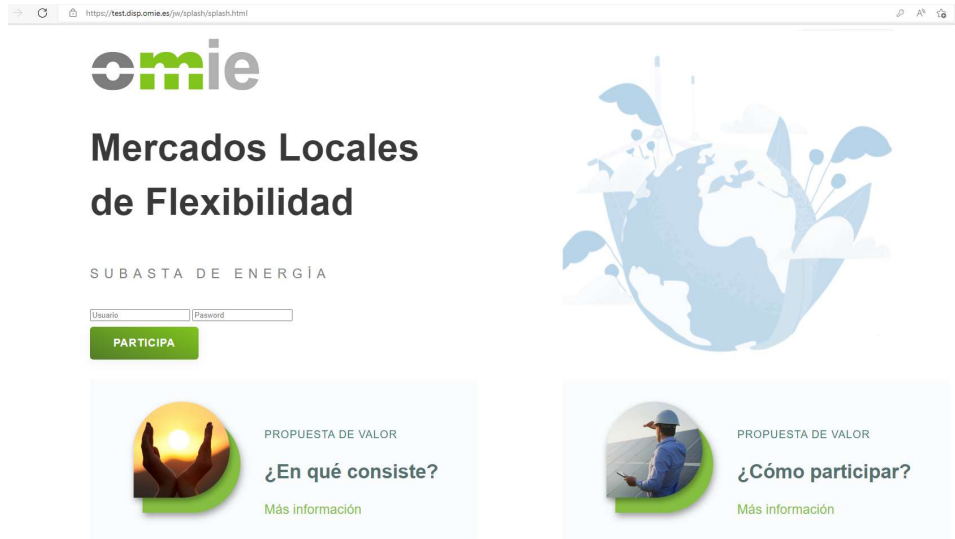


Figure 3. Login screen for public access to the Spanish SMART tool: long-term platform.

After logging in for the first time, users enter the platform's public profile, which provides detailed information about local markets: how it works, how to get involved, how the auction functions, and what resources are available. Any user with this public access will be able to see all the non-private information, including details of the assets, any upcoming or current auctions, and an introduction to what flexible markets are and how to get involved in them.

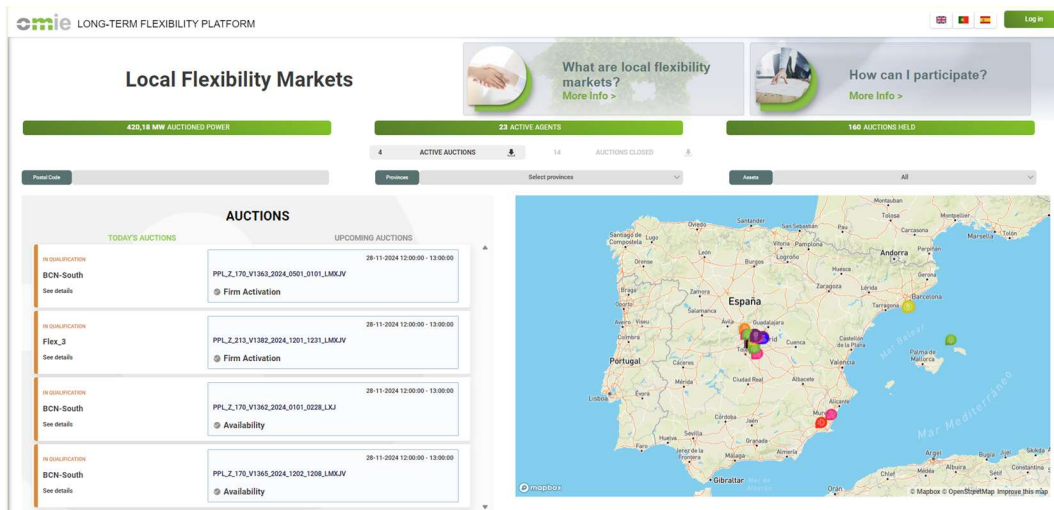


Figure 4. Main screen of Spanish SMART tool: long-term platform.

Once in the public area, to register as an Agent or Distributor, it is necessary to click on Sign up and provide the information requested by OMIE. Subsequently, OMIE will generate a personal software

certificate for private area, according to the corresponding profile, in the name of the person or entity authorised to carry out the procedures.

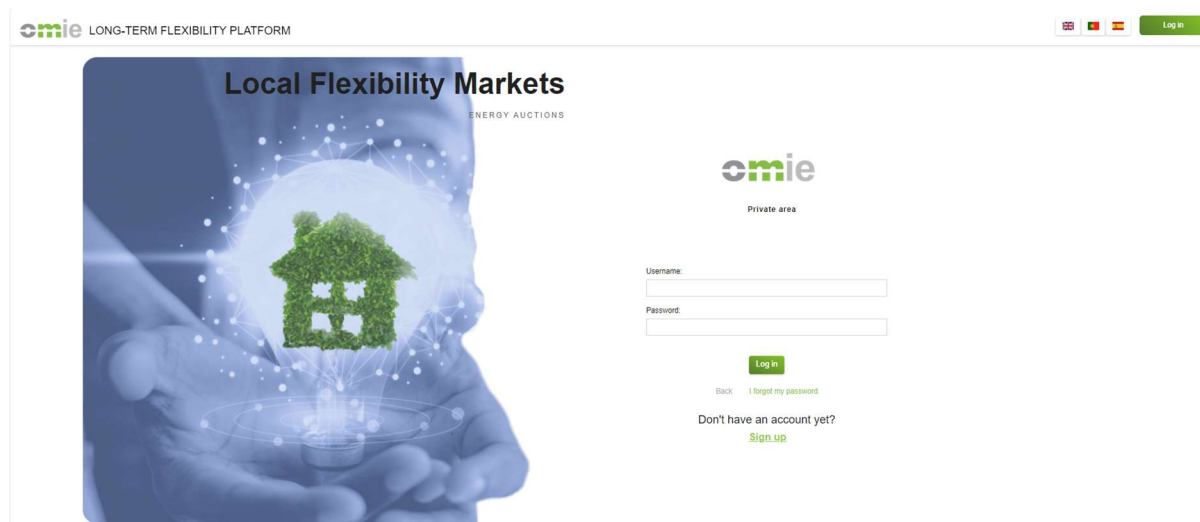


Figure 5. Login screen for private access to the Spanish SMART tool: long-term platform.

Every agent can register on the platform with a DSO profile or an agent profile, depending on their role in the market. The details required to register a new Agent are shown in the following table.

Table 1. Information for registering as a new agent in the Spanish SMART tool: long-term platform.

Data	Description
Type	Market Agent or DSO
Entity name	Name of company or natural person
Personal tax ID*	Maximum 9-digit code
Bank details (IBAN) *	Maximum 18-digit code
Confidentiality commitment (**)	Entering information via PDF
Non-collusion commitment (**)	Entering information via PDF
Address	Address of the company or natural person
Locality	Location of the company or natural person
Postal Code	Postal code of the company or natural person
Province	Province of the company or natural person
Country	Country of the company or natural person
Group phone	Contact phone number
Group email	Contact email

Name of responsible person	Name of representative person
Last name of responsible person	Last name of representative person
Powers of attorney (**)	Entering information via PDF
Personal tax ID of responsible person	Maximum 9-digit code
Phone number of the person in charge	Entering information via PDF
Address of responsible person	Address of representative person
Email of responsible person	Email of representative person
(**)	Accepted file formats: .pdf;.xml Files cannot be larger than 10Mb: 51200

Access to this system requires the use of a certificate provided to authenticate the user's identity and allow secure insertion or modification of the associated data. To provide secure access, agents must have a user certificate supplied by OMIE, which is mandatory to authenticate their identity and must be previously installed on the computer used to access the platform. After the registration has been completed, the new participant will receive the corresponding software certificate.



Figure 6. Selection of the software certificate screen for private access to the Spanish SMART tool: long-term platform.

Once a new Agent or DSO profile has been created, multiple users can be added to the same profile. These users can be configured to access the same information, with identical or customised permissions according to each user's needs. This provides flexible and secure access management.

## NEW USER


User data	
Name	<input type="text"/>
Lastname	<input type="text"/>
Personal tax ID	<input type="text"/>
Phone	<input type="text"/>
Address	<input type="text"/>
E-mail	<input type="text"/>
User grants 	<input type="text" value="Read only"/>
Power of attorney	<input type="checkbox"/> YES

Figure 7. Cration of a new user within the same profile in the Spanish sMART tool: long-term platform.

It is important to remark that the long-term and short-term platforms are fully integrated and synchronised, ensuring that the same information is available for use in both environments. Every action taken on the long-term platform, such as the registration of an aggregated zone by a DSO or the registration of an asset by an agent, is automatically replicated on the short-term platform.

### 3.2.2.2 Zone management

Zone management is unique to the DSO profile and is the section where DSOs create and manage their custom zones, in which they will summon requirements.

From the authenticated DSO profile, it is possible to view existing zones and create new zones within the platform, meaning they are dynamic zones.

The zones created on the long-term platform will be configured for both long term and short-term markets. In the 'My Aggregated Zones' screen, distribution zones can be viewed along with their corresponding information. To create a new aggregated zone, the option 'Create a New Zone' must be selected and enter the name of the zone, making sure that it is as descriptive as possible, the province to which it belongs and the postcodes that make it up. Once this information has been completed, the new zone will be registered in the system.

LONG-TERM FLEXIBILITY PLATFORM DSO\_1

## Local Flexibility Markets

Manage my zones  
Access >

Send auction request  
Access >

51,91 MW ENABLED IN MY AREAS

52 MY AUCTIONS

28,57 % PARTICIPATION

Postal Code

Provinces Select provinces

Assets All

---

### My Agregated Zones

10 Agregated zone Postal codes DSO code Show

AGREGATED ZONE	POSTAL CODES	DSO CODE
BCN_South	08040;08902;08905;08906;08907;08908;08950;08034	DSO1_LP
Batijas	28042	DSO1_LP
Ciudad de los Angeles	28041	DSO1_LP
Crevillent	03657	DSO1_LP
Madrid2	28008;28009;28010	DSO1_LP
Madrid3	28001;28002;28003;28004;28005;28006;28007;28008;28009;28010;28011;28012;28013;28014;28015;28016;28017;28018;28019;28020;28021;28022;28023;28024;28025;28026;28027;28028;28029	DSO1_LP
Madrid4	28012;28013;28014	DSO1_LP
Madrid5	28013;28014	DSO1_LP
Madrid6	28021;28022;28023;28024;28025	DSO1_LP
Madrid8	28003;28004;28005;28006	DSO1_LP <span style="float: right;">Delete</span>

17 items found, displaying 1 to 10.

---

### New Zone Agregated

New zone name:

Provinces:

Choose zip codes:

Postal codes:

Send Cancel

Figure 8. Management of DSO zones in the Spanish SMART tool: long-term platform.

### 3.2.2.3 Prequalification phase

Pre-qualification or registration of the installation is the administrative process by which the person responsible for the installation provides all the data on location, technology or power, to the MO. The information will be registered and reviewed by both OMIE and the DSO responsible for the area, who will verify the technical conditions of the registered installation. Once the process is completed, the installation will be pre-qualified for participation in all the flexibility markets required in the area where your resource is located.

Prequalification can be performed in two ways:

- **Through a form:** With the agent profile, within "Manage my Assets", fill in the "Asset Registration form".

### ASSET PRE-QUALIFICATION

<b>Asset</b>	
Name	<input type="text"/>
Description	<input type="text"/>
Telephone contact	<input type="text"/>
Meter Point	<input type="text"/>
DSO	<input type="text"/>
Agent code	AGE1_LP
Status	<input type="text" value="Pending"/>
<b>Locality</b>	
Province	<input type="text"/>
Municipality	<input type="text"/>
Address	<input type="text"/>
Postal Code	<input type="text"/>
<b>Locality coordinates: </b>	
Latitude	<input type="text"/>
Length	<input type="text"/>
<b>Technical requirements</b>	
Capacity (MW)	<input type="text"/>
Technology type	<input type="text" value="Battery"/>
Activation mode	<input type="text" value="Automatic"/>
Response time (min)	<input type="text"/>
<input type="button" value="Request"/>	

Figure 9. Asset pre-qualification form in the Spanish SMART tool: long-term platform.

- Automated Service:** Via an automated service using a REST API, which allows multiple requests from the same agent to be sent simultaneously. Each prequalification request will be in XML/JSON format (sent through SFLEX), storing a result and a descriptive message for each. The service will return a response in XML/JSON with the result of each request.

#### 3.2.2.4 Requirement requests

The requirement request is made by the DSO to call a flexibility auction, and it can only be made from their profile, requesting OMIE to validate the information on the days designated for this purpose. Once OMIE validates the information, it proceeds to publish the auction, and its content becomes public, being accessible to all profiles, DSO, agent or the public profile.

The DSO must select the parameters listed below for the requirements in each of the relevant sections:

- Auction session:** The processes of bidding, matching, and publishing results will be carried out on the day and time of the selected auction session.
- Zone:** The zone for which the auction is required is selected. Only zones that have been previously configured by the DSO requesting the auction will be available for selection. It is not possible to select the zone created by another DSO.

- **Data:** In this section the type of market to be called is selected, define the product category (availability or activation), the required capacity, the direction of the requirement, and if requested by the DSO, the minimum power required to bid, and the price limit acceptable.
- **Service window:** The time range covering the different activation periods, the days of service, the estimated activation hours, and other relevant aspects, is established.
- **Additional information:** Should further details be required or additional documentation necessary to complete the request, these may be included.

**NEW REQUIREMENT REQUEST**

DSO: DSO1\_LP

**Auction session** | Zone | Data | Service Window | Additional information

Auction session

Select an available auction's session. The processes of bidding, matching and publishing results will be carried out on the day and time of the selected auction session. If you require an extraordinary auction session outside the sessions established in CME's calendar please send your request to [innovation@cme.es](mailto:innovation@cme.es)

Auction session: 04-12-2024 12:00:00

Select an auction date: 04-12-2024 12:00:00

Calendar for April 2024:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1							1
2	2	3	4	5	6	7	8
9	9	10	11	12	13	14	15
16	16	17	18	19	20	21	22
23	23	24	25	26	27	28	29
30	30	31					

**NEW REQUIREMENT REQUEST**

DSO: DSO1\_LP

**Zone** | Data | Service Window | Additional information

Zone

Choose your area: Crevillent

Map showing the selected zone (Crevillent) in the Alicante region.

**NEW REQUIREMENT REQUEST**

DSO: DSO1\_LP

**Data** | Auction session | Zone | Additional information

Data

Product Category ID: Availability

Required Capacity (MW):

Direction ID: Increase generation/Lower consumption

Minimum power required to bid (MW):

Accepted Price Limit (Cap Price):

Availability term (EUR/MWh):

Activation term (EUR/MWh):

**NEW REQUIREMENT REQUEST**

DSO: DSO1\_LP

**Service Window** | Auction session | Zone | Additional information

Service Window

Temporal range that covers the different activation periods

Start date: 16-02-2025

End date: 22-02-2025

Days of service: Days included in the service window when DCR is required to be available

Start period ID: 05:00

End period: 09:00

Service on bank holiday: Include

Estimated activation hours:

Mandatory commitment with estimation:

Figure 10. Submission of DSO requests in the Spanish SMART tool: long-term platform.

### 3.2.2.5 Qualification phase

The qualification is a process specific to each Flexibility Service Provider (FSP) requesting to participate in a specific auction, therefore, it is necessary to request the qualification for the auction with all those installations with which you want to participate.

This process must be completed within the established timeline, which runs from the publication of the auction to the opening of the auction. It is done from the agent profile, and it is essential that this request is completed within the established deadline, as only duly qualified installations will be permitted to participate in the corresponding auction. This process requires double validation one by OMIE and the other by the DSO.

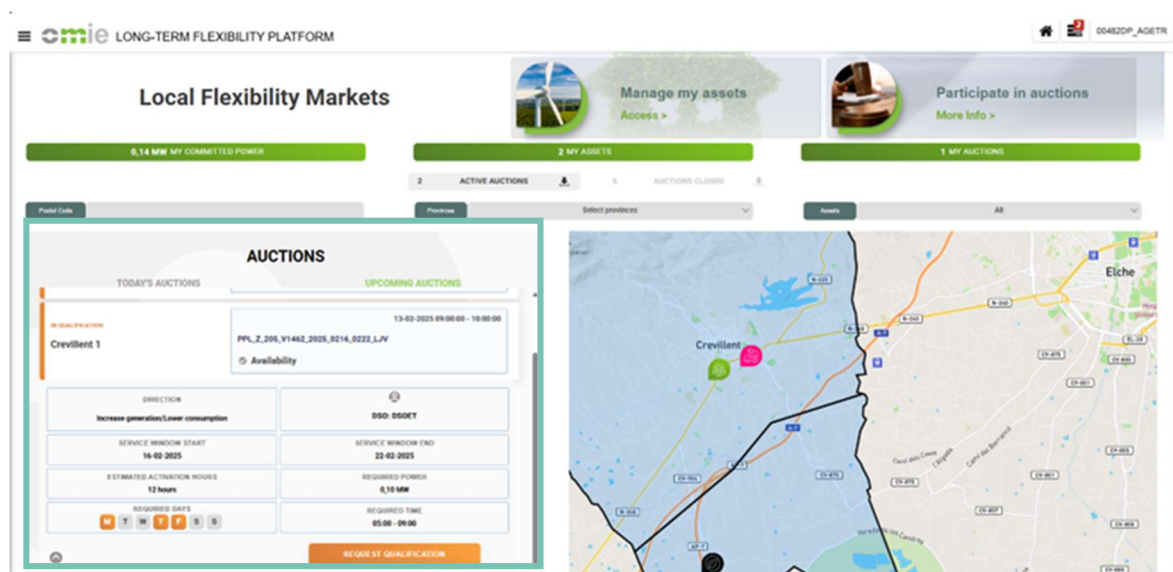


Figure 11. Qualification phase in the Spanish SMART tool: long-term platform.

The data is presented in the following table, which details the relevant specifications and parameters for each asset and auction.

Table 2. Information requested for asset qualification in the Spanish SMART tool: long-term platform.

Data	Description
Asset	Select the installation from the drop-down menu. Only pre-qualified installations are displayed.
Asset Capacity	It is automatically displayed once the installation has been selected.
Power by which the asset is qualified for the auction (MW)	For each auction, a power equal to or less than the total power of the installation may be qualified. Guarantees will be provided for the qualified power, so it is advisable to qualify only for the power that is actually wanted to bid.
Economic quantity to be provided as guarantee (EUR)	The calculation is shown automatically once the rated power has been indicated. By default, €50 per qualified MW has been set as a guarantee.
Guarantee documents / other documents (**)	Entering information via PDF

\*

Accepted file formats: .pdf;.xml

Files cannot be larger than 10Mb: 51200

Once the request for qualification has been submitted, both the technical and market parts must be accepted. After reviewing all the information provided on the installation, the DSO will proceed to accept or reject the technical part, verifying whether the agent's resource complies with the technical requirements of the network. On the other hand, the MO will validate whether the agents have provided the necessary guarantees. Acceptance of both aspects is an essential requirement for the asset to be eligible for participation in the auction.

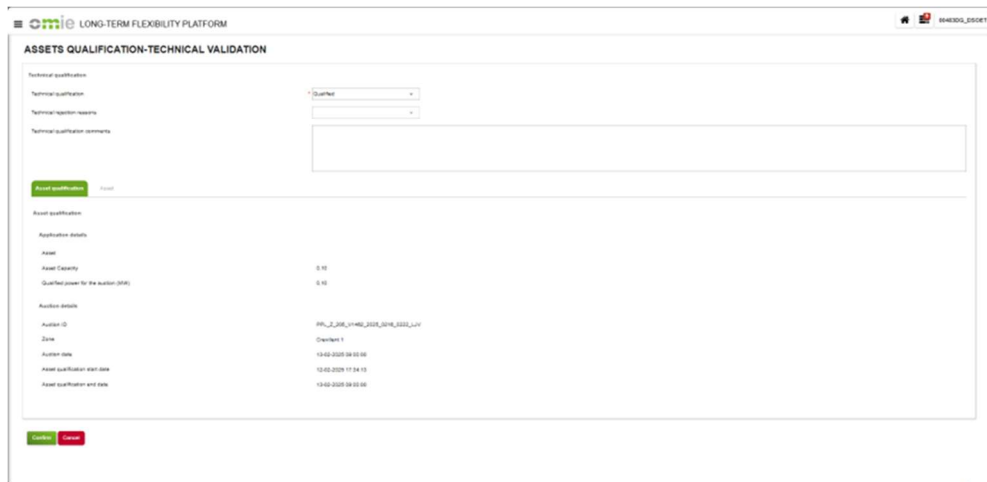


Figure 12. Validation for asset qualification in the Spanish SMART tool: long-term platform.

### 3.2.2.6 Bidding phase

When the time comes for the auction, if the agent has an asset that is qualified to participate, the “New Bid option” will be enabled. This will allow the agent to bid in the auction, provided the asset meets the established qualification requirements.

There are two types of products that can be traded in long-term auctions:

- **Firm Activation Product:** The Firm Activation Product represents a firm commitment between the resource and the DSO to generate or consume the contracted energy within the service window. The auction establishes a fixed activation window, creating a schedule of activations. The awarded resources receive a payment for each MWh delivered according to the prices matched in the auction.
- **Availability Product:** The Availability Product involves a commitment by the resource to make its capacity available, although activation is not agreed until the service window is near. This product is based on providing flexible capacity (MW) and is remunerated in two ways:
  - **Availability (€/MW):** Remuneration for the flexible capacity that the resource provides to the DSO, allowing its use if necessary.
  - **Activation (€/MWh):** Payment for each MWh of energy generated or consumed.

On the day before delivery, if the DSO needs to activate the resources, it may decide to hold a short-term market with the same type of requirement it negotiated in the long term (service window and power) but aiming for a more competitive activation price.

In this market, the resources benefiting from the long-term auction will compete with other resources to be the most competitive on the short-term trading platforms to be the most competitive for activation. The maximum bidding price will be the price resulting from the long-term auction.

If the winner of the short-term auction is different from the long-term one, then this new winner will be activated and receive the price set in the short-term auction, but the other agent will still receive the availability payment. On the other hand, if the winner is the same, it will be activated and receive the agreed availability payment from the long-term auction plus the activation payment from the short-term auction. If no short-term auction is held, or there is no match and the resource is activated, the payment will be the availability and activation terms agreed in the long-term auction.

It is important to note that the bid is made per Local Bidding Unit and not per asset. Before the auction, the agent must notify OMIE of how they wish to configure these bidding units, with the option to group multiple assets together to submit a single bid, or to establish a 1:1 relationship if preferred.

Figure 13. Access for bids submission in the Spanish sMART tool: long-term platform.

To enter a new bid, first of all, information about the auction is provided. The following values are required in the section corresponding to the bidding data:

- **Quantity to be bid in MWh:** This must always be less than or equal to the quantity qualified for the auction.
- **Bid price in €/MWh:** Two values are required to indicate the bid price:
  - Availability price: The amount requested for being available during the specified window.
  - Activation price: This is the minimum or maximum price to be charged or paid for the energy in the event of activation.

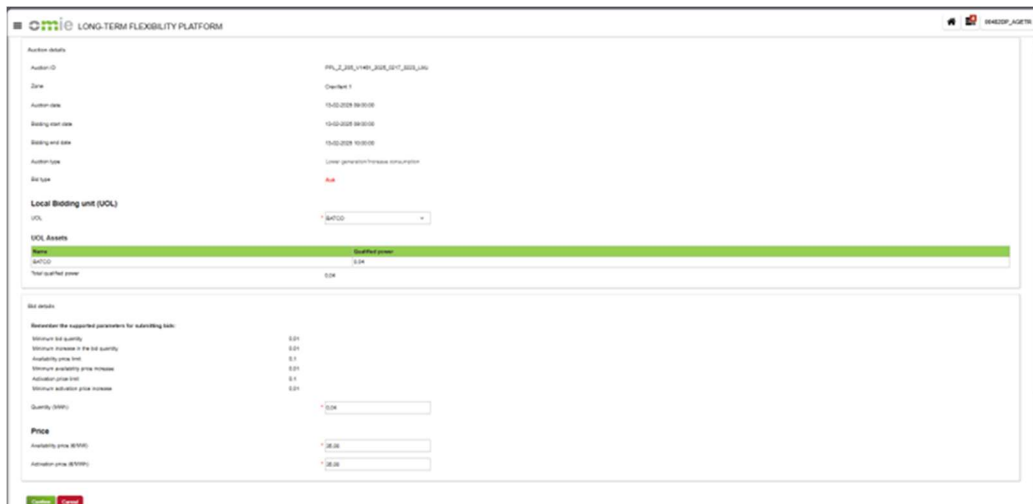


Figure 14. Bids submission in the Spanish sMART tool: long-term platform.

Once a bid has been submitted, it can only be modified with the same local bidding unit, as it is not possible to submit more than one bid for the same auction and local bidding unit. If more bidding units are available, the “New Bid” and “Modify Bid” options will be enabled.

### 3.2.2.7 Results phase.

The results phase provides a detailed overview of the auction results, including information on accepted bids, quantities awarded, and final availability and activation prices. It also shows the status of each local bidding unit, indicating whether the bid was accepted or rejected.

The result display depends on the user’s access profile. For example, a DSO will be able to see all the installations that have been rated and all the offers that have been matched. However, an agent, who has a more restricted profile, will only be able to see their own rated installations and matched bids. If the agent has not rated any assets or if their offer has not been matched, they will not be able to see the matched offers or the assets rated by other agents.

UOL	AGENT	QUANTITY (MW)	AVAILABILITY PRICE (€/MWh)	ACTIVATION PRICE (€/MWh)	ALLOCATED QUANTITY (MW)
UOL1_AGE1	AGE1_LP	0.50	10.00	20.00	0.50
UOL3_AG1	AGE1_LP	0.01	20.00	10.00	0.01

Figure 15. Consultation of the auction results in the Spanish sMART tool: long-term platform.

Once the auction has taken place, the results are definitive. The awarded bids and the established conditions cannot be modified, which ensures transparency and stability in the process.

At the time of delivery, the resources allocated in the auction must be available to meet the DSO's requirements within the service window, in accordance with the commitment made in the auction. The service window is the period in which the contracted product can be ordered to be delivered.

### 3.2.2.8 Settlement phase

Settlement is the final stage that concludes the local market. It is a collaborative process between the Resource/Aggregator and the DSO in which the actual delivery of energy of the auctioned services is verified and the DSO confirms compliance/non-compliance to the MO to proceed with the appropriate collections and payments.

OMIE as the MO, in accordance with its role as the system manager of energy purchase and sale bids, is in charge of carrying out settlement for the outcomes of the matching processes on the local flexibility markets, acting as a central counterparty between DSOs and FSPs.

After each auction held in the long-term market, the matched bids are settled according to the request and the information is updated on the agents' website.

In the local long-term markets, payments to flexibility providers are made in accordance with the terms set out in the contracts resulting from the auctions. They can be:

1. **Availability Remuneration:** providers receive a payment for being available to offer flexibility when needed.
2. **Activation Remuneration:** When the DSO requests and uses the flexibility offered, an additional payment is made to the supplier for the energy delivered.

When offering a flexibility service, multiple resources may submit similar prices, making price a key factor in determining which offers to accept. There are two potential payment methods:

1. **Pay as Bid:** Each resource that wins the auction is paid the price they bid. This is known as 'Pay as Bid', as bidders are paid exactly the price they offered.
2. **Pay as Clear:** Each resource that wins the auction receives the price of the highest accepted bid, meaning they are paid the marginal market equilibrium price.

It is announced which approach will be applied in each auction. The objective is to analyse the impact of both approaches on liquidity, competition, and bidding behaviour.

### 3.2.2.9 Additional platform usability

In the main dashboard, agents can view both upcoming auctions and auctions that are ongoing on the day the query is being made. To obtain further details regarding a specific auction, an agent may click on the relevant item, which will then provide access to comprehensive information pertaining to the request.

Agent notifications are in the top right corner of the dashboard. Some of these require a specific action to be taken by a DSO profile, such as validating assets, while others are informational in content, designed to keep the agent up to date on the status of auctions or other relevant aspects of the process.

For each DSO or Agent profile, the Actions menu can be displayed in the top left-hand corner. From here, different actions can be performed depending on the type of Agent. As shown in the image below, the menu that corresponds to the DSO profile is displayed on the left-hand side, while the menu for the Agent profile is displayed on the right-hand side. Some of the options available are common to both profiles, such as viewing the Auction Map, viewing the Auction Calendar, and receiving notifications. However, other options are role-specific, allowing functionality adapted to the needs and responsibilities of each type of agent.

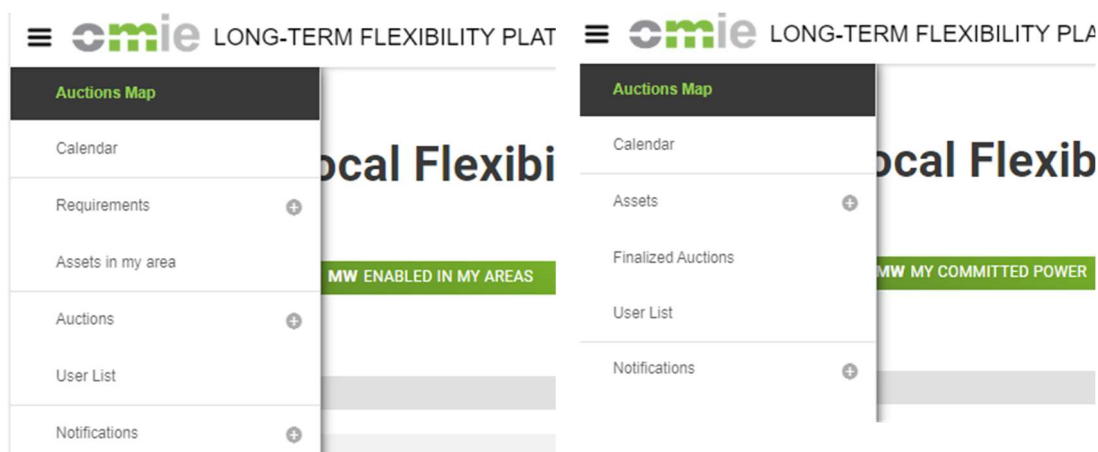


Figure 16. Action menu in the Spanish sSMART tool: long-term platform.

### 3.2.3 Short-term flexibility platform

#### 3.2.3.1 Registration phase

OMIE's trading platforms are designed to facilitate access to the market, so we have made every effort to avoid the need of agents to use specific products or loading special programs.

Access to the market is secure, using the same digital certificate and cryptographic keys as in the long-term market. OMIE only provides digital certificates.



Negotiation on OMIE's platforms may be done in one of two main ways, both of which are under identical security measures, hereby always guaranteeing confidentiality, integrity, and availability of information through all accesses:

- Browser Access:** Access through a browser to the SIOM (the market operator's information system) requires a PC with Microsoft Edge and an up-to-date version of Microsoft Windows. The portal can be accessed through the official URL issued by OMIE: <https://www.mercadoslocales.omie.es>



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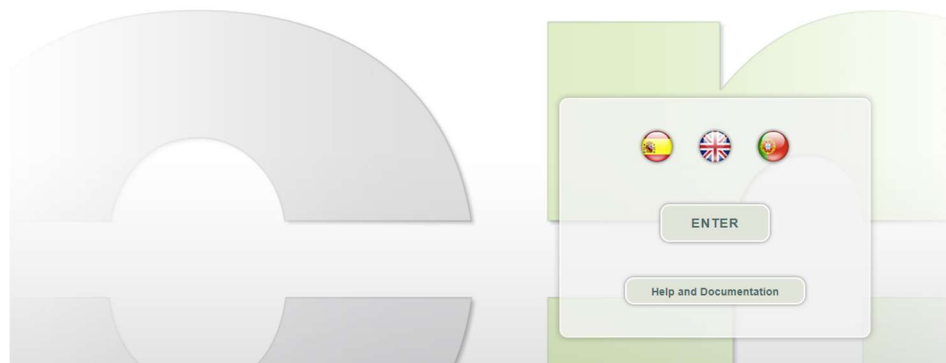


Figure 17. Login screen for private access to the Spanish SMART tool: short-term platform: long-term platform.

- App Access:** For negotiation on short-term Auctions and the Local Continuous Market, access is made possible through Web Services with a specific app that the agent can install in their environment. In addition, OMIE provides a client app (Trading Module) to operate in these short-term markets.

Status	Contract	Closure time	BAvp	BAcc	BQty	Bd	Ask	AQty	AAcc	AAvp	Lfrc	LQty	TQty
FILE	Crevent 1 20250317 H10	2025-03-17 09:00:00											
FILE	Crevent 1 20250317 H11	2025-03-17 09:00:00											
FILE	Crevent 1 20250317 H12	2025-03-17 10:00:00											
TRADE	Crevent 1 20250317 H13	2025-03-17 11:00:00											
TRADE	Crevent 1 20250317 H14	2025-03-17 12:00:00											
TRADE	Crevent 1 20250317 H15	2025-03-17 13:00:00											
TRADE	Crevent 1 20250317 H16	2025-03-17 14:00:00											
TRADE	Crevent 1 20250317 H17	2025-03-17 15:00:00											
TRADE	Crevent 1 20250317 H18	2025-03-17 16:00:00											
TRADE	Crevent 1 20250317 H19	2025-03-17 17:00:00											
TRADE	Crevent 1 20250317 H20	2025-03-17 18:00:00											
TRADE	Crevent 1 20250317 H21	2025-03-17 19:00:00											
TRADE	Crevent 1 20250317 H22	2025-03-17 20:00:00											
TRADE	Crevent 1 20250317 H23	2025-03-17 21:00:00											
TRADE	Crevent 1 20250317 H24	2025-03-17 22:00:00											

Figure 18: Trading Module

In order to provide access to trading platforms, OMIE provides an automatic installer that configures the agent's post, minimizing the manual actions that must be taken.

Accessing the market platform through a web browser provides a comprehensive environment for managing and monitoring market activities for both DSOs and agents. On the other hand, for agents to trade in short-term market, this is done through the Trading Module, or a non-OMIE application such as sFLEX or sENC in Stream, as this is a specific feature designed to optimise trading in this market.

### 3.2.3.2 Zone management

The registration of new aggregated zones, as previously indicated, is conducted on the long-term platform. This process ensures that these zones are automatically synchronised and made available for utilisation on the short-term platform. The distributor tab enables consultation of aggregated zone information.

### 3.2.3.3 Requirement requests

From the Distributor profile, DSOs have the ability to send or cancel requests, as well as set new restrictions for FSPs. Requests can be submitted in different methods: directly from the screen or by uploading a file or via an application that enables agents to interact with the web services.

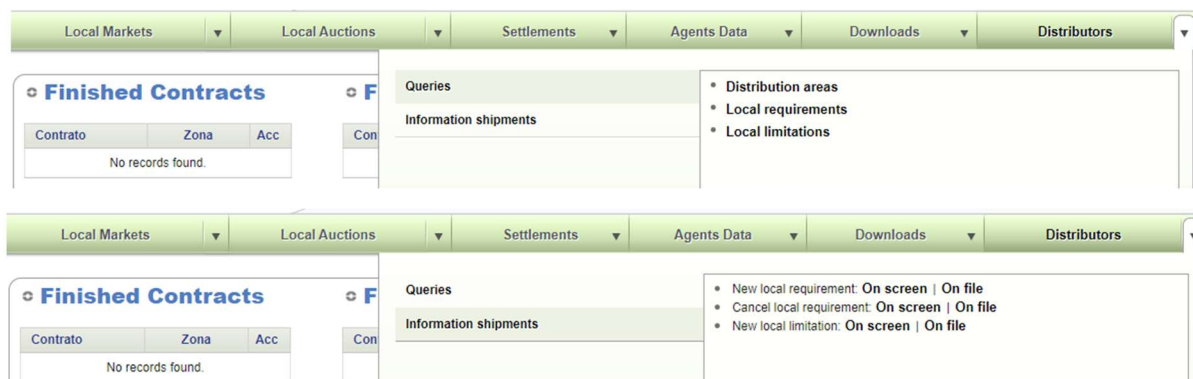


Figure 19. Submission of DSO requests and limitations in the Spanish SMART tool: short-term platform.

When selecting the option to send a new request on screen, you will access an interface in which you must enter the information necessary for the creation of the local market. However, the request can also be sent by file, in which case the corresponding XML file must be selected. Both processes allow customisation and adjustment of the necessary data according to the distributor's needs.

The DSOs are authorised to establish limitations on certain bidding units when, for justified reasons, it is considered that these may cause or are causing problems on the grid. In a similar way to the requirements, the DSOs can send the limitations either by file or via the screen. In the case of sending by file, it will be required to select the corresponding file in XML format.

### 3.2.3.4 Prequalification phase

As previously mentioned, the prequalification of new assets is also conducted on the long-term platform. In the case of an asset that has been pre-qualified through the long-term platform, it will automatically be prequalified to bid on the short-term platform. This integration ensures that the prequalification process remains consistent between the two platforms. However, the agent data tab enables consultation of bids and physical units' information and other agent information.

### 3.2.3.5 Qualification phase

The qualification process for short-term assets differs from that for long-term due to the temporal constraints between the opening and closing of the negotiation. Consequently, the short-term qualification process is performed automatically, although it is subject to the same validation criteria. Initially, the DSO can establish limitations that the asset must meet to be technically validated. Additionally, no assets can exceed their previously agreed power consumption or generation limits. Finally, the asset must provide sufficient guarantees to be able to submit a bid.

### 3.2.3.6 Bidding phase

From the download section of the market platform, agents have the possibility of downloading the trading module (LTS, Local Trading System). This platform is designed for trading in the short-term local market and allows agents to enter bids in active auctions or within the free market in their respective zones. The LTS is fully integrated into the trading platform of the Continuous Intraday Market and functions in a similar manner to that platform.

Once the executable has been downloaded, users must access the platform via the connection URL provided and select the corresponding certificate. It is important to note that access to the LTS is restricted exclusively to users possessing a certificate with an agent profile. DSOs do not have visibility of bids as they act as counterparties to the offers. Their access is restricted to consulting the results of completed auctions.

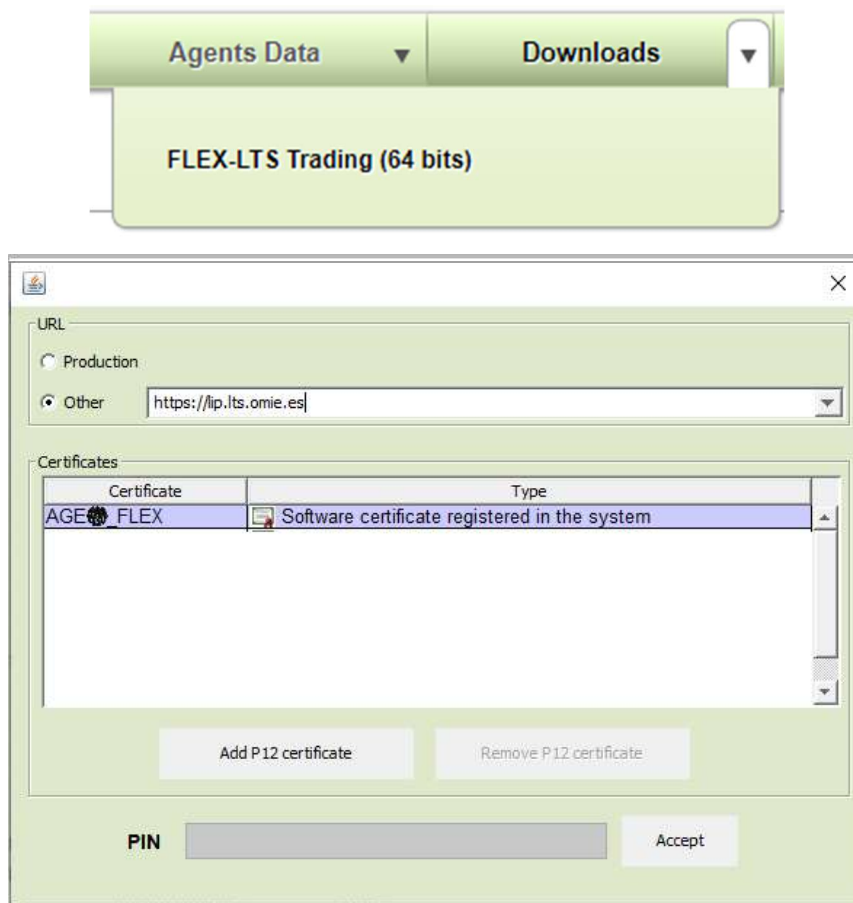


Figure 20. Access to FLEX-LTS in the Spanish SMART tool: short-term platform.

From the LTS platform, under the designated 'DSO Requirements M. - LM' tab, the agent can visualise the products requested by the DSO that are scheduled to be traded, are in the process of being traded, or have recently been traded. This functionality enables agents to efficiently monitor DSO requests and to optimally manage their participation in the relevant markets.

Status	Contract	Closure time	Qty	Bid	Ask
TRADE	ARANJUEZ 20241202 H21	2024-12-02 15:45:00	1		
TRADE	ARANJUEZ 20241202 H22	2024-12-02 15:45:00	1		
TRADE	ARANJUEZ 20241202 H23	2024-12-02 15:45:00	1		
TRADE	ARANJUEZ 20241202 H24	2024-12-02 15:45:00	1		
TRADE	ARANJUEZ 20241203 H01	2024-12-02 15:45:00	1		
TRADE	ARANJUEZ 20241203 H02	2024-12-02 15:45:00	1		
UPC	ARANJUEZ 20241203 H23	2024-12-03 15:45:00	1		
UPC	ARANJUEZ 20241203 H24	2024-12-03 15:45:00	1		
FIN	ARANJUEZ 20241202 H15	2024-12-02 12:45:00	1		
FIN	ALCALA 20241202 H17	2024-12-02 14:45:00	2		

Figure 21. View of LTS in the Spanish sSMART tool: short-term platform.

The following table explains the different sections within the LTS.

Table 3. Sections of LTS in the Spanish sSMART tool: short-term platform.

<b>Status</b>	<p>Status of the request:</p> <ul style="list-style-type: none"> <li>• UPC: (upcoming) Pending negotiation.</li> <li>• Trade: Under negotiation.</li> <li>• Fin: The negotiation has been completed.</li> </ul>
<b>Contract</b>	The area of the request, date and time are indicated.
<b>Closure time</b>	<p>Date and time of the end of the request negotiation.</p> <ul style="list-style-type: none"> <li>• Bid: Increase generation / Lower consumption</li> <li>• Ask: Lower generation / Increase consumption</li> </ul>
<b>Qty</b>	Amount of energy traded in the requirement for each contract.
<b>Dropdown menus</b>	To specify zones and time periods for the intended trading.

The product must be in Trading status for an Agent to place a bid. Once in this status, the Agent can bid by clicking the (+) icon in the BID/ASK column, depending on the type of request. This will open a pop-up window to enter the bid.

The Bid and Ask displays represent the needs of the DSO: Ask indicates that energy needs to be extracted from the grid, while Bid indicates that energy needs to be injected into the grid. Agents should select their bid units, indicate their energy in MW and price in €. In addition, an optional field is provided to add informative comments to the offer.

If the requirement is to sell (ASK - Lower generation / Increase consumption), the agent will bid in BID (buy). This means that a consumer must buy to increase what it consumes, while a producer must buy to decrease what it produces. On the other hand, if the requirement is to buy (BID - Increase generation / Lower consumption), the agent will bid in ASK (sell). In this case, a consumer will sell its energy to reduce its consumption, while a producer will increase its production and sell more energy to the grid.

Figure 22. Bids submission in LTS in the Spanish SMART tool: short-term platform.

### 3.2.3.7 Results phase.

Once the auction is finished, all transactions can be viewed, including relevant information such as the agent involved, the bidding unit, the quantity allocated, and the price. The DSO only has access to the transactions made and the results of the auctions after they have ended, while the bids are only visible to the agents involved.

The results section is designed to sort all the information according to different categories:

- **By auction:** Consult the transactions that have taken place for that auction, providing the agent, unit, quantity and price.
- **Historical:** The system allows the user to explore the history of transactions, with the option to view periods of 7, 14 or up to 30 days prior to a selected date. This functionality ensures that the user can obtain a comprehensive view of the operations and accurate data for the analysis of auctions and energy programmes.
- **Incremental schedules:** This includes a detailed summary showing, for each auction session, the programme increments allocated for each bidding unit, grouped by date, period and zone. It also has a context menu.

Sentido	Cantidad	Acc
5	Compra	1 MWh

Figure 23. Consultation of the results in the Spanish SMART tool: short-term platform.

### 3.2.3.8 Settlement phase

As in the long term, once the flexibility service agreed between the DSO and the aggregator has been verified, the MO will proceed with the appropriate collections and payments, depending on the level of compliance/non-compliance.

### 3.2.3.9 Additional platform usability

The main functionalities of the system are accessed from the main dashboard screen, which provides an organised overview of all auctions in different statuses. From this interface, users can view auctions classified into three categories: finished, active and upcoming.

In addition, the dashboard allows direct access to several tabs that allow consultation of the auction results, associated requirements, bids, etc. The information displayed corresponds to the market participant, providing a personalised view that facilitates usability of the platform and analysis of the results.

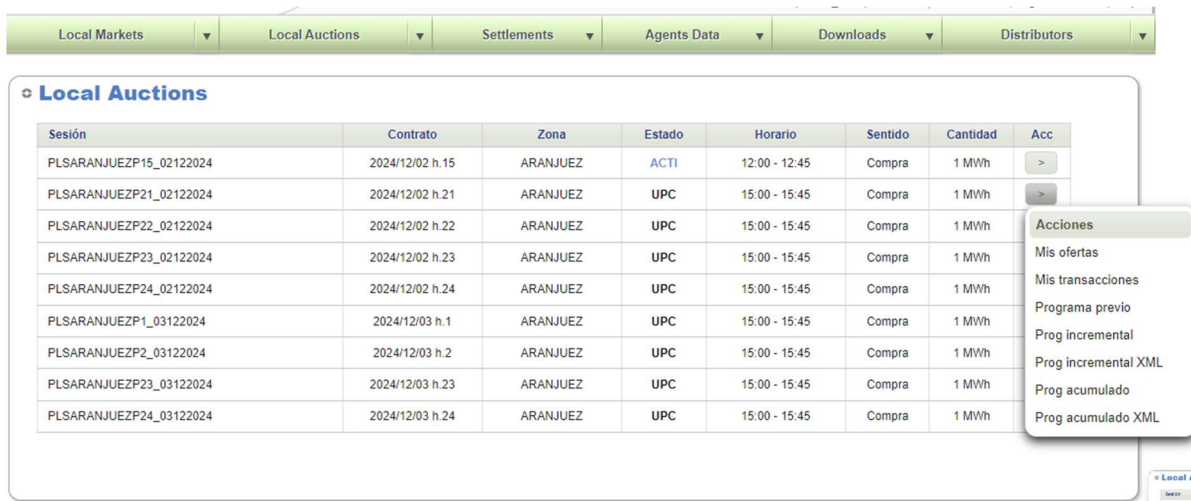


Figure 24. Additional platform usability in the Spanish SMART tool: short-term platform.

In terms of managing agent information, the Agent Data screen centralises all relevant data for each market participant. From this section, it is possible to access the agent's contact information, registered bidding units or zones, legal information, etc.

This modular and accessible design of the system ensures that users can easily navigate through the different functionalities and access the specific information they need for their activities. It also promotes transparency and organisation, facilitating both the management of auctions and the detailed analysis of data related to agents.

➤ **Short-term local flexibility market (Free participation)**

Market participants will be able to participate in the areas where their resources are located. This market is specially designed for isolated systems and EnCs.

This market is a functionality within the short-term platform where transactions will operate on a peer-to-peer basis, facilitated through the LTS in the Local Continuous Market tab.

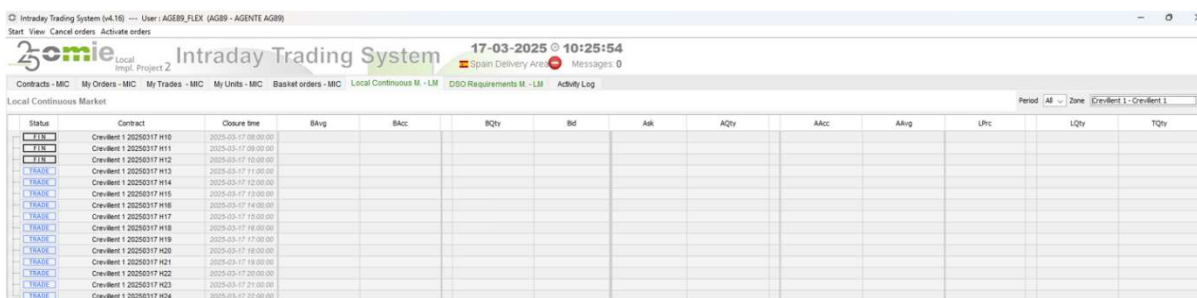


Figure 25: Local Continuous Market

### 3.3 SLOVENIAN DEMO SITE

#### 3.3.1 The role of LFM in Slovenia

In Slovenia, there is currently no fully operational LFM. However, several pilot projects, such as X-FLEX [18] and Flex4Grid, have demonstrated the functionality of LFMs on a limited scale.

As in many EU countries, Slovenian DSOs are experiencing a rise in the installation of new energy production units, primarily rooftop PV systems. This increase is accompanied by large-scale energy loads, including HPs, BESS, and EV charging stations. These developments are significantly altering the operation of the distribution network, resulting in shifts in consumption patterns and a notable increase in peak demand. Traditionally, the primary method for managing increased demand has been grid reinforcement, which involves replacing older feeders or transformers with newer, more powerful units. However, the rapid pace of new installations has rendered this approach increasingly impractical. The sheer volume of assets requiring upgrades poses a substantial economic burden. Moreover, the reinforcement process is hampered by limited personnel and the extensive time required for implementation.

Given the challenges associated with traditional grid reinforcement, the establishment of an LFM has become a key point in discussions within the Slovenian energy sector. Key stakeholders involved in these discussions include the TSO, the five Slovenian DSOs, the regulatory agency, and various other actors.

In 2019, the Agency for Energy (AGEN) published a consultation report [6] that addressed the following aspects:

- **Uses of Flexibility:** The report identified various applications of flexibility in the energy market, both implicit and explicit.
- **Stakeholders Involved:** It outlined the stakeholders connected to flexibility services and the emerging role of aggregators, including their specific functions and responsibilities.
- **Examples of LFMs:** The report showcased several examples of existing LFMs in the EU, highlighting the best practices and lessons learned.

The report also identified several barriers to establishing a fully operational LFM in Slovenia and provided recommendations on how to address these challenges.

Some of the identified barriers (and recommendations) are presented in the list below:

- **Unsatisfactory Data Services:** Insufficient data services in the advanced metering system limit real-time access for customers.
  - **Recommendation:** Enhance data services within the AMS to provide customers with near real-time access to measurement data for flexibility market offers.
  - **Responsible:** DSOs, agency, ministry.
- **Poor Data Availability and Quality:** Limited access to key data hinders market operations, especially for smaller consumers.
  - **Recommendation:** Improve the availability and quality of data in the advanced metering system, ensuring compliance with GDPR requirements.
- **Low Consumer Awareness:** Consumers are not sufficiently informed about flexibility market opportunities.
  - **Recommendation:** Launch coordinated information campaigns to educate consumers about flexibility market opportunities.

- **Complexity of Offerings:** Diverse and complex offerings can confuse consumers, increasing risks.
  - **Recommendation:** Simplify contracts and clarify options by integrating flexibility services into comparative offerings.
- **Weak Business Case for Participation:** Lack of clear definitions of costs and benefits weakens consumer participation in flexibility services.
  - **Recommendation:** Establish transparent definitions of costs and benefits to strengthen the business case for consumer participation.
- **Insufficient Standardization:** Inadequate standardization at the technological level hinders consumer entry into flexibility markets.
  - **Recommendation:** Implement open standards for interoperability and streamline qualification processes to reduce entry costs.
- **Lack of Regulatory Framework for Aggregators:** Current regulations do not adequately address aggregator responsibilities.
  - **Recommendation:** Establish a comprehensive regulatory framework for aggregators, including clear rules for balancing responsibility and compensation.
- **Poor Coordination Between Operators:** Lack of coordination can negatively affect network operation.
  - **Recommendation:** Enhance coordination processes among electricity operators to ensure efficient system balancing and congestion management.
- **Undefined Flexibility Products:** There is no clear definition for flexibility products outside of system balancing.
  - **Recommendation:** Develop clear definitions for flexibility products through stakeholder engagement, ensuring they include necessary information for service provision.
- **Long-Term Contracts Limiting Market Liquidity:** The presence of long-term contracts may hinder market liquidity.
  - **Recommendation:** Balance the introduction of long-term and short-term products and consider implementing a quota system to enhance liquidity.
- **Inadequate Measurement and Monitoring:** Insufficient requirements for measurement and monitoring of devices limit the effectiveness of flexibility services.
  - **Recommendation:** Define minimum measurement and monitoring requirements for flexibility devices to ensure proper integration with smart meters.
- **Fragmentation of Trading Platforms:** Fragmented platforms complicate coordination among electricity operators.
  - **Recommendation:** Develop integrated trading platforms that facilitate coordination and synchronization among all stakeholders in the flexibility market.
- **Outdated AMS Implementation Plans:** Current AMS plans do not reflect technological advancements.
  - **Recommendation:** Regularly update AMS implementation plans to align with technological developments and regulatory requirements.

Borzen, the Slovenian MO, supports the development of local flexibility markets by fostering transparency, openness, and coordination within Slovenia's electricity system. As the market

operator, Borzen enables consumers and producers to participate in electricity markets. The development of local flexibility markets enhances system efficiency, reliability, and the integration of renewable energy sources. By facilitating demand-side response and decentralized energy resources, these markets help optimize grid operations and reduce congestion. Additionally, Borzen supports regulatory and market framework advancements, ensuring a fair and competitive environment for all participants. Through these initiatives, we contribute to a more sustainable and resilient energy ecosystem.

### 3.3.2 Registration and prequalification as a prerequisite for local flexibility market

Registration of the flexible devices and their prequalification is enabled through a separate tool, Device Registry (DR), specifically implemented for the Slovenian pilot by CyberGrid. Device registry is an independent platform that, in a production environment, would be operated by an independent entity such as a TSO or market operator. It contains basic device information required for identification of devices and its flexibility characteristics. Additionally, the DR performs the prequalification tests for flexible devices, identifying whether the device is capable of providing its flexibility to a specific flexibility market.

DR is a web-based platform which the users can access via internet browser, using a two-factor-authentication (password and Authenticator app). The first-time access is enabled by a DR administrator inviting a user to join the DR and update their profile.

Apart from the DR administrator, there are three different types of users that have access to the DR via UI customer portal:

- flexible device owners, to:
  - register their device in DR (and view the registered information)
  - prequalify their device for specific flexibility market product
- aggregators,
  - can be assigned FSPs for devices by a specific device owner and thus can:
    - register new devices in DR
    - prequalify the device from specific flexibility market product
  - view the device information for all the devices from different owners, which they are aggregating (Figure 26)
- DSOs
  - View the device information for devices in their DSO region

Name	Asset type	Positive flexibility [MW]	Negative flexibility [MW]	STATUS
Heat pump 01	Consumer	0.005	0.005	OFFLINE
Heat pump 02	Consumer	0.005	0.005	OFFLINE
Household 98	Prosumer	1	1	OFFLINE
STREAM test	Prosumer	4	2	ONLINE

Figure 26: Device Registry UI – Aggregator’s list of his assets

Device registry stores two types of data:

- device metadata:
  - device characteristics (Table 4)
- timeseries data:
  - this data is required for prequalification process
  - active power, baseline, positive flexibility, negative flexibility, prequalification setpoint.

### 3.3.2.1 DR architecture

The DR architecture is presented in Figure 27. Device registry receives the monitoring timeseries data from the devices via communication protocol (e.g. IEC104, MQTT...) and can send back a prequalification setpoint, to perform prequalification tests. The DR users (FDO, aggregator, DSO) can access the UI customer portal and view the device metadata, or timeseries data. The metadata or timeseries data can be accessed also by other STREAM tools: sSMART and sDATA via REST API.

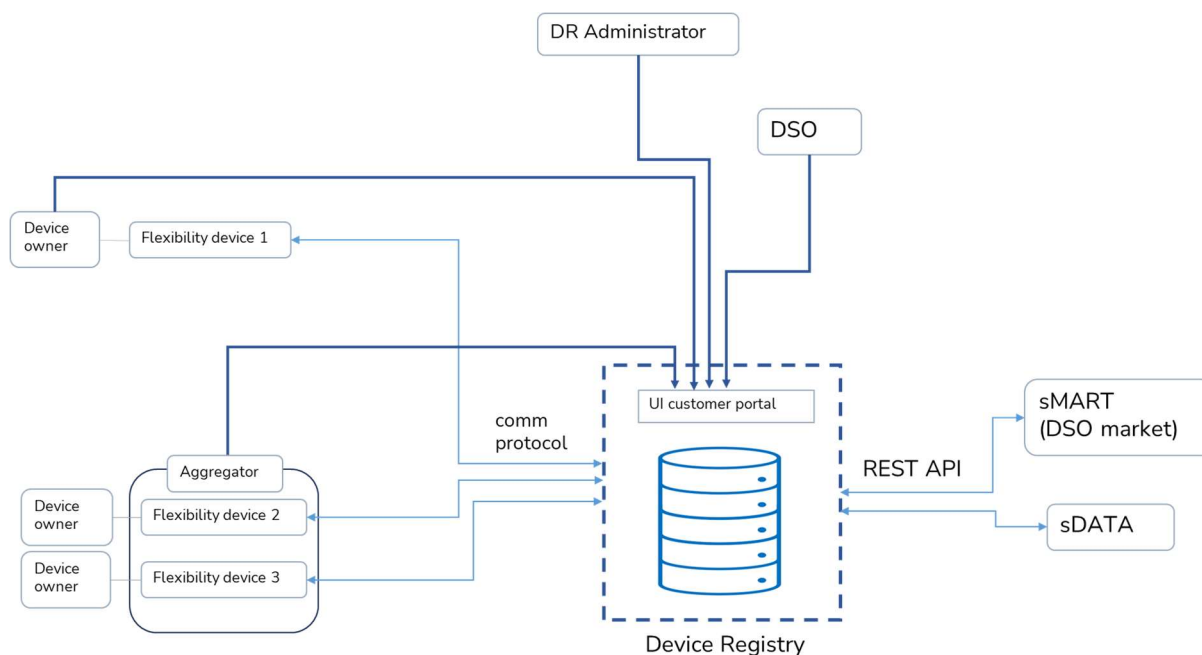


Figure 27: Device Registry architecture

In the Device Registry Portal (Figure 28), the users can perform the following actions that are subsequently validated by the DR administrator:

- Register a new device, edit device information, or remove the device from Device Registry
- FDOs can assign a new aggregator or remove the existing aggregator
- Request device prequalification for specific market product or remove a specific market product prequalification status from the device.

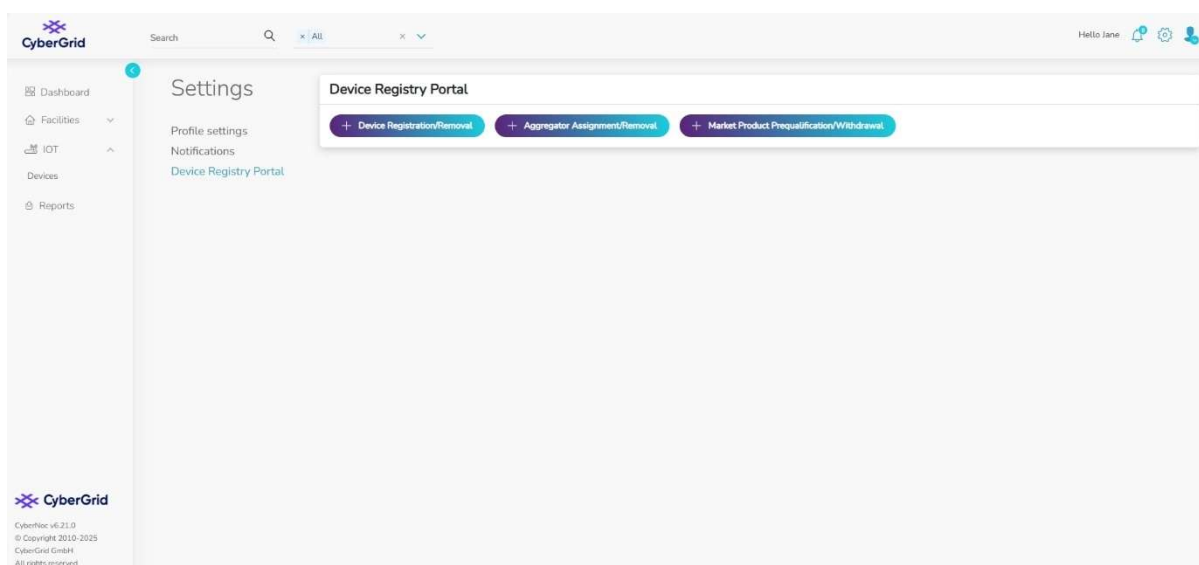


Figure 28: Device Registry Portal

### 3.3.2.2 Registration process

Device owner or aggregator can register a new device in the DR using a corresponding form (Figure 29) which is processed by the DR administrator in order to validate the registration. Multiple data are recorded for each device (Table 4).

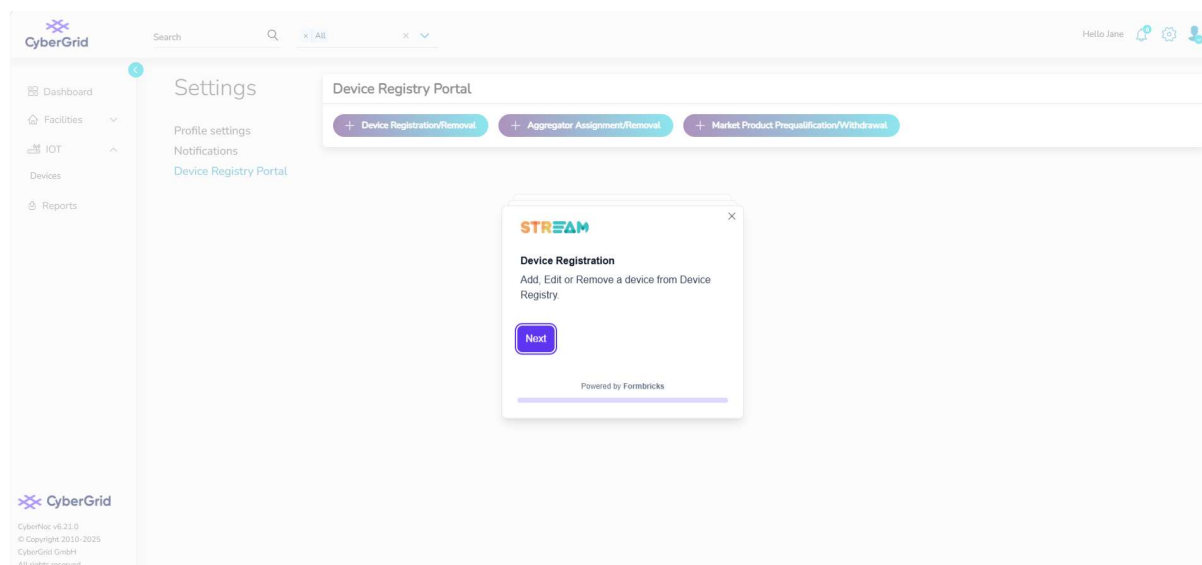


Figure 29: Device registration in DR

Table 4: Device information in DR

Asset registration information	Explanation
<b>Asset ID</b>	Unique asset system ID provided by the DR.
<b>Asset name</b>	A human readable asset name to identify it in the system.
<b>Asset status</b>	Describes the status of the asset. ("operational", "in_development", "non_operational")
<b>Asset type</b>	Describes the specific technology type of the flexible asset. ("battery", "EV_charging", "heat_pump", "photovoltaic" etc.)
<b>Voltage level</b>	Voltage level at the point of connection to the network. (0.4, 10, 20, 35) kV
<b>Installed generation capacity</b>	Installed generation capacity (kW).
<b>Installed consumption capacity</b>	Installed consumption capacity (kW).
<b>Active import capacity</b>	The flex asset's maximum flexible capacity for importing active power from the grid (i.e. negative flexibility) in kW.
<b>Active export capacity</b>	The flex asset's maximum flexible capacity for exporting active power to the grid (i.e. positive flexibility) in kW.

<b>Reactive import capacity (optional)</b>	The flex asset's maximum flexible capacity for importing reactive power from the grid in kVAR.
<b>Reactive export capacity (optional)</b>	The flex asset's maximum flexible capacity for exporting reactive power to the grid in kVAR.
<b>Response time (optional)</b>	The minimum time required for the asset to respond to an activation signal (sec).
<b>Max activation time (optional)</b>	Maximum length of time that the asset can provide the flexibility product (min).
<b>Min activation time (optional)</b>	Minimum length of time that the asset can provide the flexibility product (min).
<b>Recovery time (optional)</b>	The time required by the asset to recover from one activation until the next (min).
<b>Locational information</b>	
<b>Asset metering point ID</b>	Metering point ID where the asset is located ( <i>slo. št. merilnega mesta</i> )
<b>LV feeder ID</b>	The ID of the LV feeder, where the asset is located.
<b>MV/LV secondary substation ID</b>	MV/LV secondary substation ID, where the asset is located.
<b>MV feeder ID</b>	The ID of the MV feeder, where the asset is located.
<b>HV/MV substation ID</b>	HV/MV substation ID, where the asset is located.
<b>Market prequalification</b>	Status of market prequalification (qualified, failed, not_attempted).
<b>Aggregator</b>	Listed FSP (Flexibility service provider) of the device.

### 3.3.2.3 Prequalification process

Registered devices can be prequalified for different flexibility products upon the user's request through the Device Registry Portal (Figure 28) and the prequalification process is run by the DR which verifies whether the activation was within the tolerance limits for specific market product. The timeseries data for the prequalification process can be viewed on the chart in the DR UI (Figure 30). The prequalification status is stored in the device metadata in the device registry and can be viewed by accredited DR users (device owner, aggregator, DSO), and requested by the SMART or sDATA via REST API.

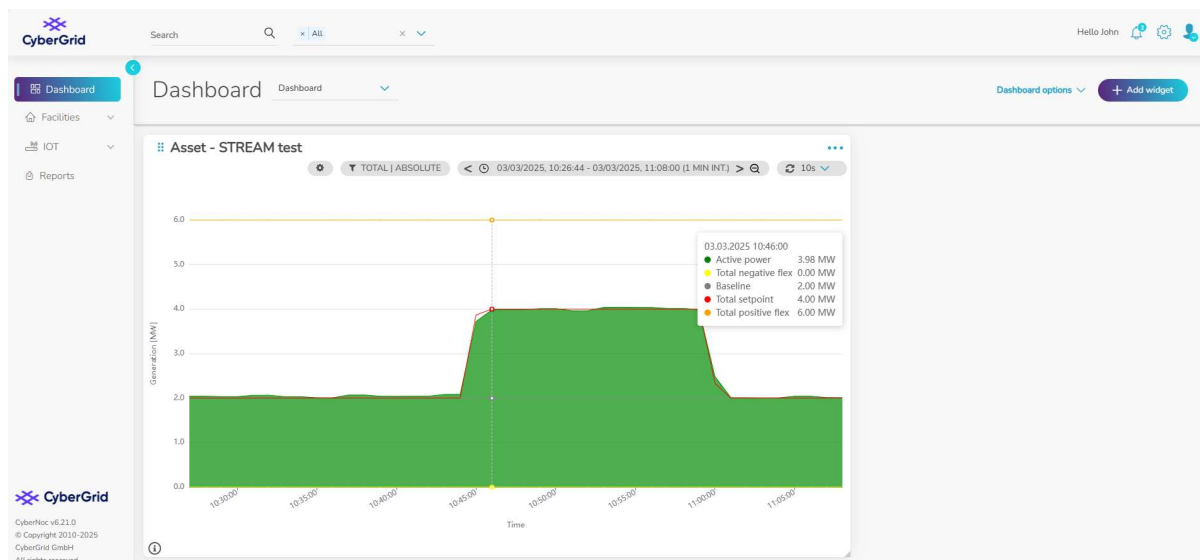


Figure 30: DR: prequalification activation

### 3.3.2.4 API development

The DR data is available to the following STREAM tools:

- sSMART
  - Data available: Metadata for device: Location, prequalification, and listed FSP (Flexibility Service Provider)
- sDATA
  - Data available: timeseries data (active power, baseline, positive flexibility, negative flexibility) and all metadata

The REST API will be implemented, based on OpenAPI specifications, which utilizes OAuth 2.0 for authentication. Any logged-in user can generate their credentials, including client-id and client-secrets, for machine-to-machine (M2M) communication. The API provides two endpoints: one for retrieving metadata (device information) and another for accessing timeseries data.

### 3.3.3 Local Flexibility Market design in Slovenia

In the SI pilot scenario, the local flexibility market facilitated by the sSMART tool empowers the DSO to secure flexibility to mitigate forecasted issues within the distribution network, more specifically, line or transformer congestions. Therefore, sSMART is a DSO congestion management market. To accomplish the objectives, sSMART is divided into two products and two timeframes: the **long-term flexibility** and the **short-term flexibility product**. These products are structured to ensure that the DSO has access to a sufficient supply of flexibility to effectively address grid-related issues. Further complementing these products are the dynamic connection agreements (DCA), which serve as an additional layer of operational security for the responsible DSO.

Both products will represent an auction-based market, with the **long-term flexibility product running periodically** (weekly/monthly) and the **short-term flexibility product active every 15 minutes**, aimed at addressing congestion issues (both at the substation and feeder level) in the distribution grid (both LV and MV). It will be developed as a software demonstration and will not achieve the production-

ready status, but the actual activation of assets will take place during the demonstration period. The tool and all its functionalities will be designed in English.

Figure 31 presents the general process of sSMART, which is divided into 7 steps:

1. DSO forwards the bids originating from DCA to sSMART,
2. sGRID forwards the calculated request for flexibility in specific grid nodes and the corresponding TLS state for each of the nodes in the grid,
3. sFLEX sends the bids for long-term and short-term flexibility to sSMART,
4. Device Registry sends the location and prequalification information of assets included in sFLEX bids to check their eligibility; existing information is updated when needed,
5. With all inputs gathered, the clearing algorithm is initiated,
6. As the result of Step 5, successful bids that are planned to be activated are forwarded back to sFLEX,
7. Results, TLS state and other related information is published on sSMART.

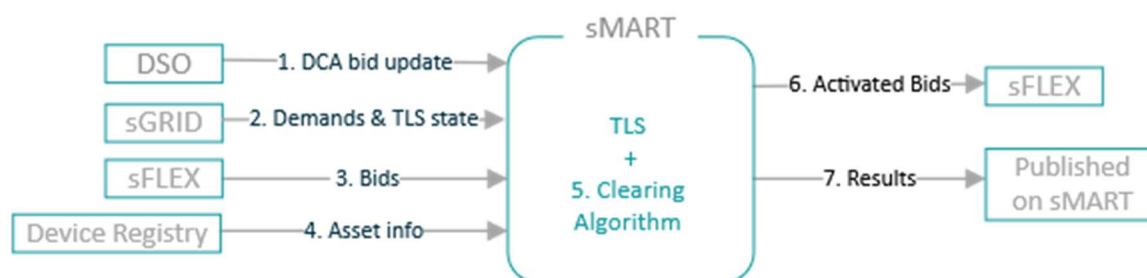


Figure 31: General process and interaction of sSMART

### 3.3.3.1 Long-term flexibility product

The first of the two sSMART market products is sSMART **long-term flexibility product**, which serves as a flexibility assurance for the DSO’s grid planning process and represents a **capacity market**. In this way, flexibility is utilised as a mechanism for investment deferral, an alternative to the conventional grid reinforcement measures. Generally, the distribution grid experiences congestion or voltage issues, which could surpass the operational limits, only a small number of times in a year. Therefore, the costly grid reinforcements would be utilised for only these periods, leading to low utilisation rate. As an alternative, the **DSO could procure flexibility from the grid** for the identified critical periods. Currently, a local market like this does not exist, so in the first step the DSOs (and other actors, such as Agency for Energy) should support flexibility procurement contracts, which are longer in terms of length and financially inviting for FSPs/companies to partake. To satisfy the planning objectives, the DSO needs to ensure this flexibility in advance – for example a week or a month in advance, in order to make sure that the required flexibility will be available in a time of need. The **DSO would publish the tender to the sSMART platform**, accompanied **with all the required information and parameters**, which are described in the table below. Additionally, the tender includes all the technical characteristics that the FSPs asset/unit needs to satisfy.

The long-term flexibility product market is structured as auctions, initiated and published by the responsible DSO. These manual auctions entail specific requests from the DSO, outlining the desired capacity, location, and duration of the service window (e.g. weekly or monthly). Subsequently, FSPs have the opportunity to submit bids in response to these requests. Upon selection, the chosen FSPs commit to **providing the requested capacity and stand ready for activation** during the designated service window.

Before submitting bids, FSPs must undergo a **registration and prequalification process** for the assets included in their bids to demonstrate their capability to deliver the registered service. Additionally, bids must contain detailed information about the assets to facilitate location verification.

Throughout the service window, the DSO retains the authority to activate the assets specified in the bids. Following the conclusion of the service window, FSPs are remunerated based on the duration of the service window and the number of successful activations. Consequently, the settlement process comprises two components: **compensation for the preparedness of assets for activation** and **compensation for the actual activations**. Market design for the long-term flexibility product is presented in Table 5.

Table 5: Required parameters of the Long-term flexibility market and their values

Characteristic	Description	Value
<b>Readiness period</b>	A period, in which the activation will likely be needed from the DSO (based on the congestion forecast).	Weekly/monthly
<b>Preparation period</b>	The period between the activation request by the DSO and the start of the ramping period.	2.5 minutes
<b>Quantity and granularity of the bid</b>	Represent the minimum change of the power output in kW offered to the platform by the FSPs. Minimum quantity 1 kW and maximum quantity is 9999 kW	1 kW
<b>Reservation Price and resolution of the bid</b>	Bid is priced in €/kW/week, with the price resolution of 0.01 €/kW/week	€/kW/week
<b>Activation Price and resolution of the bid</b>	Bid is priced in €/kW, with the price resolution of 0.01 €/kW	€/kW
<b>Location</b>	The request should include the location (some form of locational ID, that matches with the Device Registry), where the DSO would try to the congestion issue.	Substation/feeder is specified
<b>Rest Time</b>	Defined as the required time between two activations (relevant in case of direct activation and consequent activations)	0 – 720 minutes

### 3.3.3.1.1 DSO flexibility request definition

When the DSO submits the request, the following parameters need to be sent to SMART:

Table 6: Required parameters of the Long-term flexibility market demands

Parameter	Description
<b>Readiness period</b>	A period, in which the activation will likely be needed from the DSO (based on the congestion forecast).
<b>Minimal lead time</b>	Time interval between agreement/signature of the contract and the first activation. This parameter is crucial for the DSO to use this product for

	investment deferral, as the planning horizons for DSO’s are long. For example, the DSO would publish a tender for flexibility every half a year for the coming months, including the information of the minimal lead time – the time until expected issues, when the DSO will require flexibility activations.
<b>Amount</b>	Amount of flexibility needed to address the issue of forecasted congestion in kW
<b>Maximal activation price</b>	The upper limit the DSO is willing to pay in €/kWh
<b>Minimal activation price</b>	The lower price limit the FSP can input in €/kWh
<b>Maximal reservation price</b>	The upper limit the DSO is willing to pay in €/kW/week
<b>Location</b>	Location of the required flexibility, where the expected congestion might occur and where the flexibility is being procured

### 3.3.3.1.1.1 DSO Request definition explanation

As explained in the section above, the SMART long-term flexibility product is used by the DSO to ensure the needed flexibility in order to **defer the investment** for new cables/transformers by shaving the peaks present in critical periods. **These periods are determined via a long-term forecast**, which utilizes the **historical data and future network plans/projections**. The DSO first calculates the forecasted demand in a certain (problematic) part of a grid (substation and feeder level) for a number of years in advance and analyses the results, identifying the problematic periods and determining the amount of flexibility, which would be needed to solve the issue. **In the beginning, the DSO might want to procure more flexibility than needed** according to the calculations in order to ensure that the required flexibility is provided. This can then be changed, based on the DSO’s experience during the previous years. The **price limits for reservation and activation price are determined by analysis of costs needed for the conventional reinforcements** by the lifetime of the reinforcement asset. The goal of DSO is to **lower the costs connected to conventional grid reinforcements by utilizing this flexibility**, so the yearly costs for flexibility should be lower than the yearly costs of the reinforcement asset.

### 3.3.3.1.2 FSP bid definition

There are characteristics that the FSPs have to satisfy when submitting a flexibility bid to SMART. They can be divided between required and variable parameters. Required parameters have to be satisfied and variable parameters have to be defined, otherwise the bid is considered as void. Required parameters were defined in Table 5. Variable parameters are presented in the table below.

Table 7: Required parameters of the Long-term flexibility market bids

Parameter	Description
<b>Activation price</b>	Price in €/kWh, with the granularity of 0.01 €/kWh
<b>Reservation price</b>	Price in €/kW/week, with the granularity of 0.01 €/kW
<b>Direction</b>	Either upward or downward direction of the bid. It defines whether the FSP will need to increase or decrease their power output.

<b>Quantity</b>	The amount of flexibility (change of power output) of the bid in kW. The granularity of the bid is 1 kW.
<b>Divisibility</b>	Bids can be either divisible or indivisible. This is a parameter of the bid, which specifies if partial activation of the bid is allowed or not. Indivisible bids can only be activated in full.
<b>Location</b>	Location of the bid provided via the device registry.
<b>Minimum duration between the end of deactivation period and the following activation (Rest time)</b>	Defined as the required time between one and the other activation (relevant in case of direct activation and consequent activations)
<b>Maximal number of consecutive activations</b>	Max number of activations in the readiness period before Rest time is required (1 – X)

### 3.3.3.1.3 Relevant timeline

The figure below demonstrates the timelines and activation of a standard product within the long-term flexibility market.

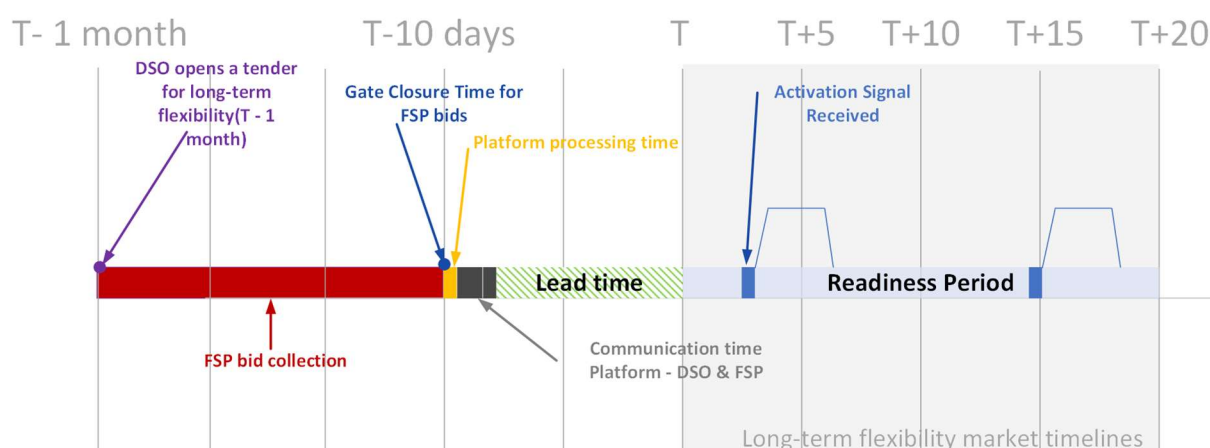


Figure 32: Estimated timelines of long-term flexibility market for illustration purposes

### 3.3.3.2 Short-term flexibility product

The **short-term flexibility product** serves as a means for the DSO to secure flexibility on a short-term basis, complementing the long-term flexibility market. This market operates through an auction mechanism initiated by the DSO through the integration with sGRID, wherein details such as the requested timeframe, power capacity, and location are provided, along with the location of the forecasted issue the DSO intends to address. The DSO has the capability to initiate an auction up to one week prior to physical delivery, with bids originating from FSPs and DCAs accepted until the GCT. Just like in the long-term flexibility market, assets included in the bids must undergo prequalification and meet the locational criteria established by the DSO.

Short-term local flexibility market represents an **energy market** which **combines the capacity bids** from the long-term local flexibility market and **new sFLEX bids for the energy market**. As dictated by

the TLS, the short-term local flexibility market can **also take the Dynamic Connection Agreements into account**.

### 3.3.3.2.1 Traffic Light System (TLS)

The **operation mode of the short-term local flexibility** market is heavily dependent on the TLS allocated to the portion/element of the network. The general operation of the TLS stages is defined in D4.1 [1], here we only summarise it for clarity purposes.

The SI pilot site implements a concept with **four TLS stages**, designated for specific grid sections based on voltage levels: LV feeder, MV/LV secondary substation, MV feeder, and HV/MV substation. The TLS stages are integrated with the sGRID tool and require clear limits to determine stage colours in the grid.

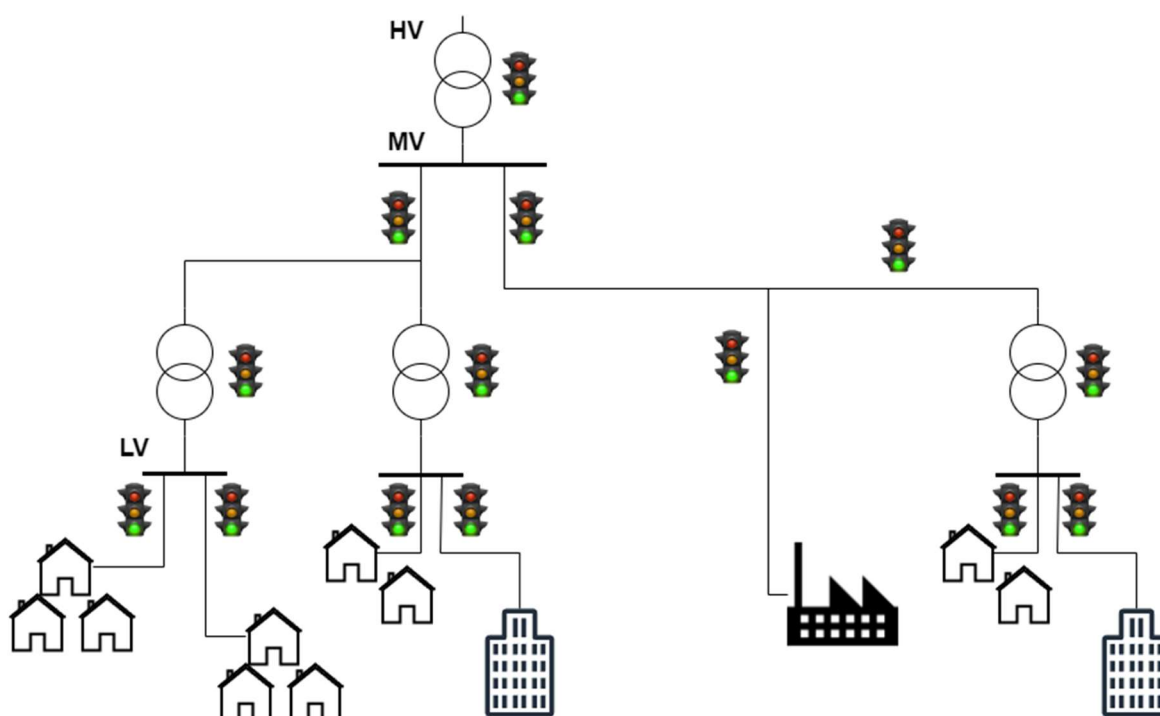


Figure 33: TLS hierarchy design in SI Pilot Site

There are two types of grid limits: development/planning limits and operational limits.

1. **Development/planning limits** are set lower than operational limits due to the lengthy process of building new network elements. These limits incentivise market flexibility to address potential issues before reaching operational limits and vary based on grid elements. They are defined in the network codes for DSO grid planning but are usually case-specific.
2. **Operational limits** are based on technical specifications and signify the maximum thresholds for safe and stable network operation, ensuring the grid handles fluctuations in demand and supply effectively. Remaining within these limits is crucial for maintaining system reliability and preventing disruptions.

The TLS design and the specific stages are summarized in the table below.

Table 8: SI pilot site TLS design overview from D4.1

Stage	Description
-------	-------------

<b>Green – no market</b>	<ul style="list-style-type: none"> <li>• Network operates smoothly within predefined grid limits (both planning and operational)</li> <li>• No restrictions apply</li> <li>• Transactions verified against calculated grid capacities</li> </ul>
<b>Yellow – market initiated, activation of short-flex &amp; long-flex</b>	<ul style="list-style-type: none"> <li>• sGRID forecasts congestion, indicating load exceeds planning limit</li> <li>• Required flexibility calculated and communicated to SMART</li> <li>• Congestion management market initiated</li> <li>• Attempt to procure flexibility via short-flex product &amp; Activation of long-flex products if short-flex insufficient</li> </ul>
<b>Orange – market initiated, activation of short-flex, long-flex &amp; DCA</b>	<ul style="list-style-type: none"> <li>• Yellow with the addition of:                             <ul style="list-style-type: none"> <li>○ Forecasted congestion exceeds operational limits</li> <li>○ DCA introduced into procurement of flexibility</li> </ul> </li> </ul>
<b>Red – no market</b>	<ul style="list-style-type: none"> <li>• Rules-based solution implementation by DSO</li> <li>• Compliance with compulsory rules and network codes</li> <li>• Direct load management, emergency curtailment, or protection device activation</li> <li>• Reserved for emergency situations after exhausting other stages</li> </ul>

Each subsequent TLS state is solved independently, based on a bottom-up approach starting at the LV-feeders and continuing up to the HV/MV substation.

### 3.3.3.2.2 DSO flexibility request

The amount of the requested flexibility by the DSO is calculated automatically by sGRID and communicated with the SMART tool.

### 3.3.3.2.3 FSP bid definition

Characteristics that FSPs have to satisfy when submitting a flexibility energy bid to the SMART platform. They are presented in table below.

*Table 9: Required parameters of the short-term flexibility market bids*

Characteristic	Description	Limits
<b>Preparation period</b>	The period between the activation request by the DSO and the start of the ramping period.	2.5 minutes
<b>Minimum and maximum quantity</b>	Represent the minimum and maximum allowed change of the power output in kW offered to the platform by the FSPs.  (or MWh depending on the DSO requirements for the specific grid element)	Minimum 1 kW, maximum 9999 kW

The other type of parameters are variable parameters, which have to be specified by the FSP submitting the bid.

*Table 10: Variable parameters of the short-term flexibility market bids*

Parameter	Description
-----------	-------------

<b>Bid price</b>	Price in €/kWh, with the granularity of 0.01 €/kWh (or MWh depending on the DSO requirements for the specific grid element)
<b>Direction</b>	Either upward or downward direction of the bid. It defines whether the FSP will need to increase or decrease their power output.
<b>Quantity</b>	The granularity of the bid in kWh with a minimum of 1 kWh. (or MWh depending on the DSO requirements for the specific grid element)
<b>Location</b>	Location of the bid provided via the device registry.

### 3.3.3.2.4 Relevant timeline

The figure below demonstrates the indicative timelines and activation of a standard short-term flexibility product within the local flexibility market.

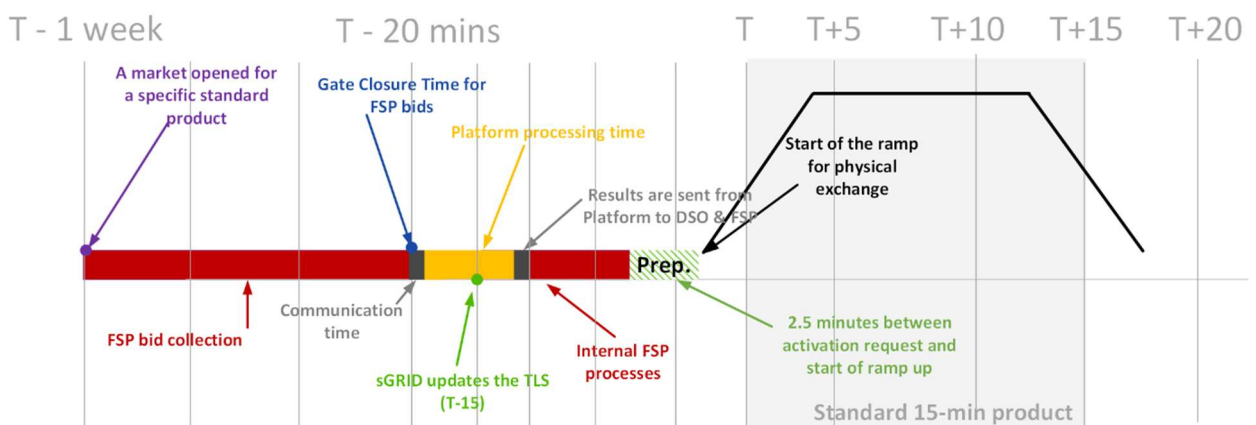


Figure 34: Estimated timelines of short-term flexibility market for illustration purposes

### 3.3.3.3 Activation baseline

The baseline for activation will be the average 15-minute measurement previous to the time of the standard product. As we have a 15-minute measurement resolution in the SI pilot site, the average 15-minute measurement prior to the activation will be compared to the activation timeslot of the activation. Due to the fact that the DSO CM market on the local level is not yet established, the limits to the prices should be more forgiving in order to attract FSPs and companies to perceive this market as financially attractive. Additionally, the penalties for not providing the agreed amount of flexibility should not be too punishing, as not to discourage the FSPs/companies. **To encourage the participation in this market, 80% of the agreed value or above should count as successful activation.**

### 3.3.3.4 Clearing Algorithm

The clearing algorithm is based on the common merit order list and the pricing method is based on the marginal pricing (pay-as-cleared). The pay-as-cleared algorithm makes use of the price of the last bid of a standard product, that has been activated to satisfy the DSO flexibility demands. This price is used for all market participants. The advantages of such a pricing algorithm include:

- Level playing field for all participants,
- FSPs should not be inclined to add a premium to the price

The orders shall consist only of standard product orders. The orders on the Common Merit Order List (CMOL) will be **sorted first by the price and second by the timestamp**. The best bids available will be activated first and will have the priority in dispatching. **FSPs shall submit the standard product bids to SMART until the appropriate GCT**. Only bids submitted in euro (€) will be considered. Bids in any other currency will be considered void. Furthermore, bids with any of the necessary parameters missing will be considered void.

Table 11: Objectives, constraints, and outputs of sSMART

Objectives	Constraints	Results
Maximise welfare for a given set of orders and demands	Only eligible orders are taken into account, with location and prequalification status considered as eligibility criteria	The list of activated bids, price, and satisfied demands are published on sSMART and sent back to the FSPs.
Minimise the amount of activated flexibility		

In the long-term flexibility market, inputs include the DSO demands for opening of the tender and the related FSP bids. For short-term flexibility market inputs are dictated by the TLS stage:

<b>Yellow</b> – market initiated, activation of short-flex & long-flex	Clearing algorithm takes the available short-flex & long-flex products into account when preparing the CMOL and compares it to the demands by the DSO.
<b>Orange</b> – market initiated, activation of short-flex, long-flex & DCA	In addition to the short-flex & long-flex products, the assets available via Dynamic Connection Agreements are considered when preparing the CMOL. Afterwards, all 3 sets of available assets are compared to the DSO demands.

Figure 35 presents an illustration of the clearing algorithm used in the sSMART short-term flexibility market, in case of an orange TLS stage.

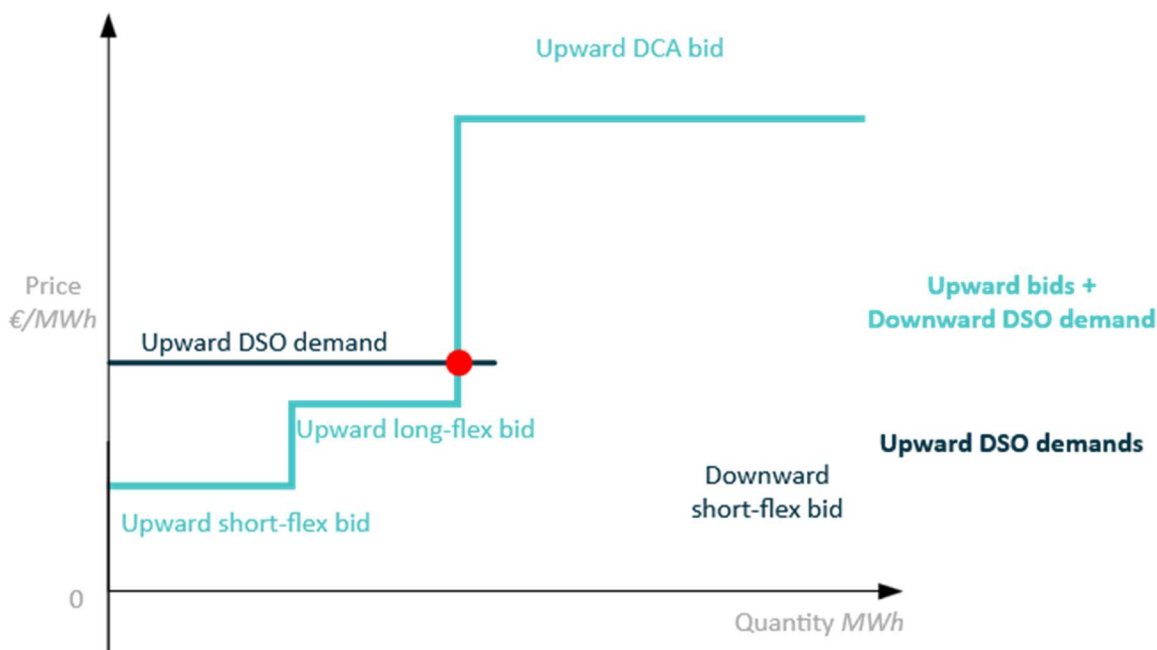


Figure 35: Example of the clearing algorithm

### 3.3.4 sSMART user interface overview

The sSMART tool provides the **core set of functionalities** required by a local flexibility market that will allow us to demonstrate the new market design. Regarding the accessibility, sSMART is divided into two parts: **UI and API**. The API is provided for the integration with tools, that allows higher throughput and a connection to the automated systems. Alternatively, the sSMART UI and general operational functionalities of the local flexibility market are presented in this section.

This **section specifies the sSMART UI** and the functionalities enabling the insights into the local flexibility market, as well as some additional functionalities enabling the demonstration of platform’s use, such as user registration, authentication, management of assets, trading, and administration.

Table 12: Groups of functionalities in sSMART – SI Pilot

<b>Onboarding</b>	Login
<b>Administration</b>	Management of participants and organisations
	Management of markets and market sessions
<b>Market sessions</b>	Long-term flexibility product (capacity bids - LT)
	Short-term flexibility product (energy bids – ST)
<b>Asset management</b>	Money assets
	Bids
	Activations
	Trading history

#### 3.3.4.1 User authentication and Login

##### 3.3.4.1.1 Initial screen – Login

The login screen, as illustrated in Figure 36, aligns with the STREAM visual identity. Users access the platform through this interface, which ensures secure authentication.

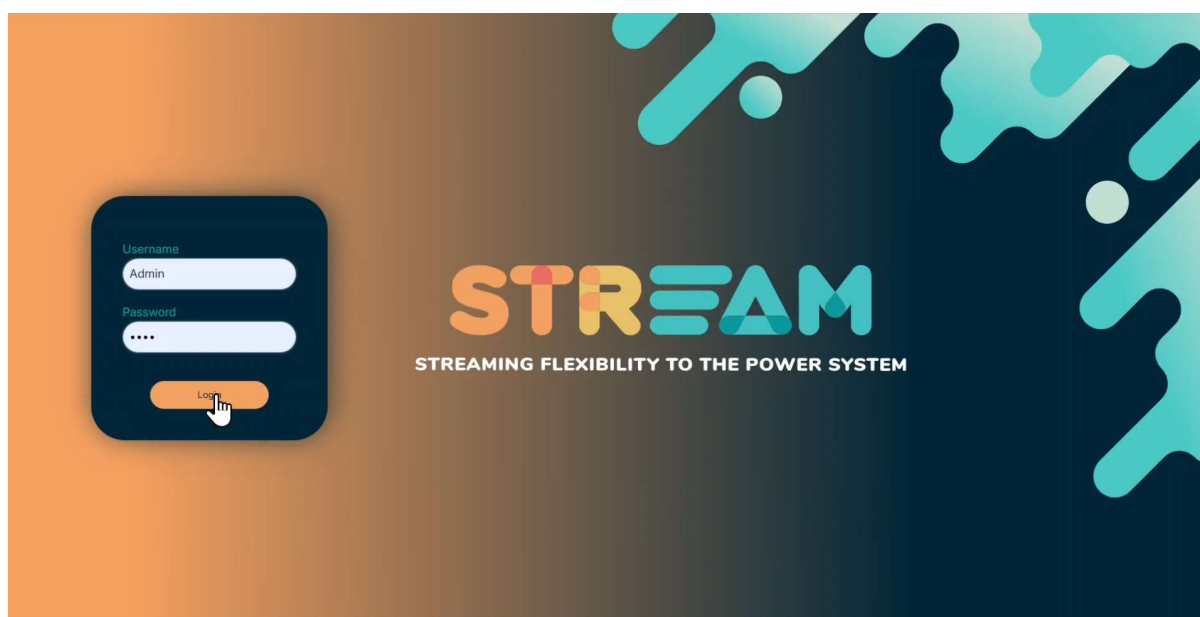


Figure 36: sSMART - SI Pilot - Login screen

### 3.3.4.1.2 Home screen – After Login

Once logged in, the main dashboard is displayed, featuring the core functionality of the sSMART trading platform. The left-hand menu provides quick navigation across the tool’s features, with the key elements visible in Figure 37:

- **Market Sessions:** Displays an overview of all active and past market sessions. As seen in Figure 38, the table columns can be added/removed as necessary to create the desired view. Additionally, as seen in Figure 39, each view includes specific filtering options, allowing market sessions to be filtered by market types, status, gate open/close time, delivery times, etc.
- **Order Book:** Located in the top-right section, it presents all bids placed within a selected market session. Administrators have full visibility of all orders, while market participants can only view bids associated with their organisation.
- **Order book visualisation:** The element on the bottom left includes the visual representation of the order book.
- **Assets:** In the bottom-central position, this section displays eligible assets for participation in the selected market. For an asset to be eligible, it must be prequalified and connected to the necessary power point.
- **Participants:** The element on the bottom right includes the participants whose assets are prequalified for market participation.

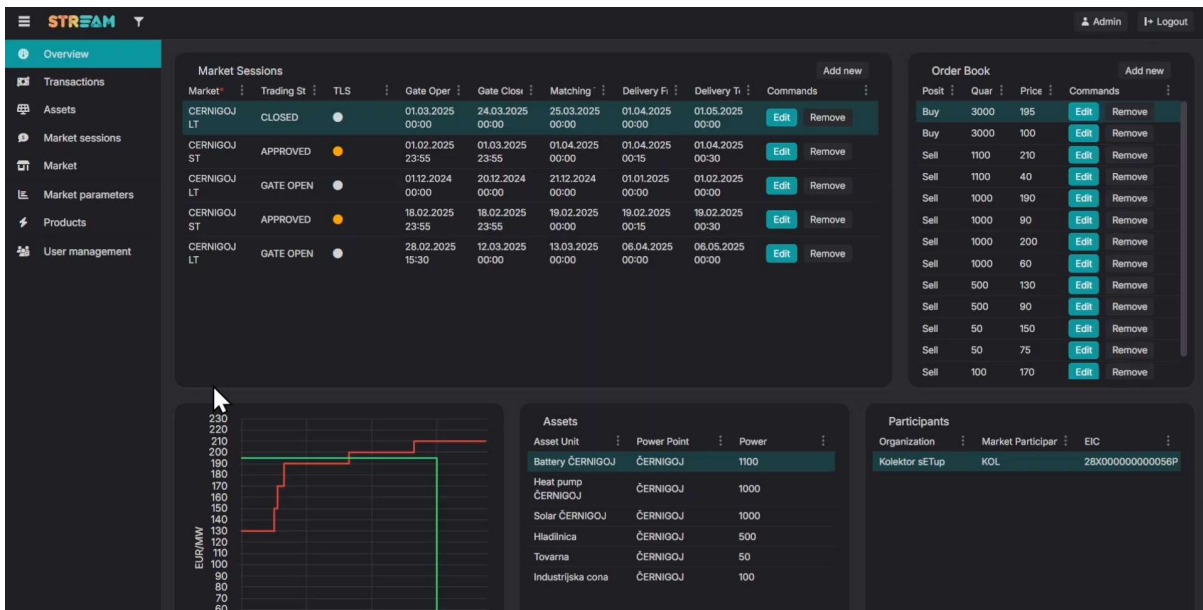


Figure 37: sSMART - SI Pilot - Main screen - trading overview

All elements on every screen can be customised, allowing users to modify displayed columns based on their specific needs.

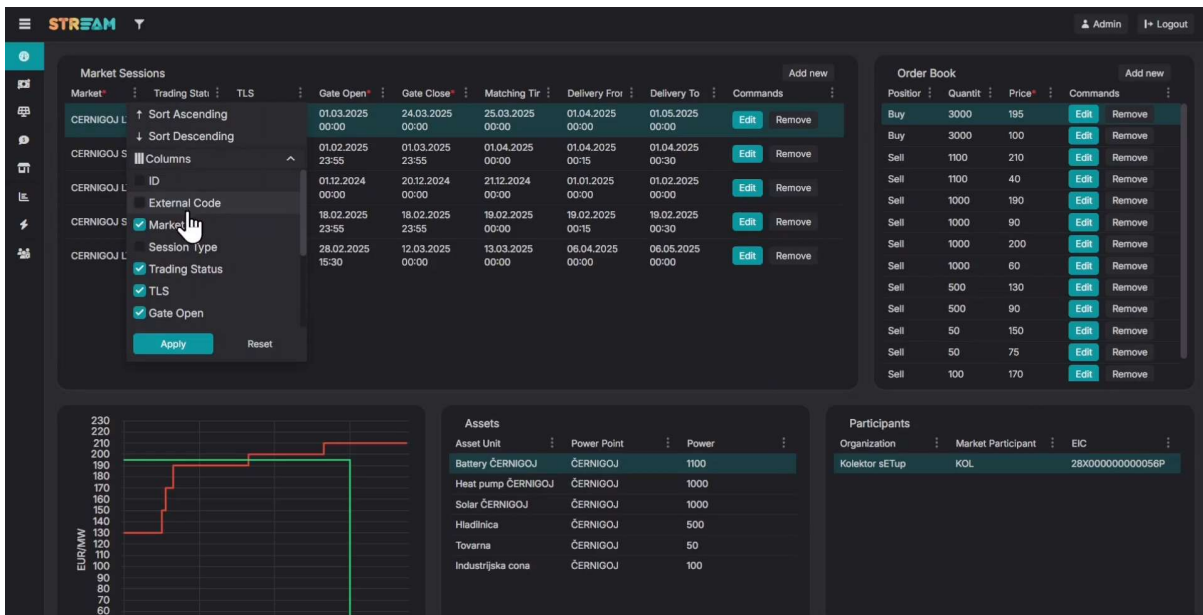


Figure 38: sSMART - SI Pilot - view customization

The platform also offers advanced filtering options to enhance usability, enabling users to refine views based on market structure, trading status, and delivery schedules. Given that the SI Pilot market design includes two products (long-term and short-term flexibility) across multiple grid locations, filtering is essential for effective navigation and market participation.

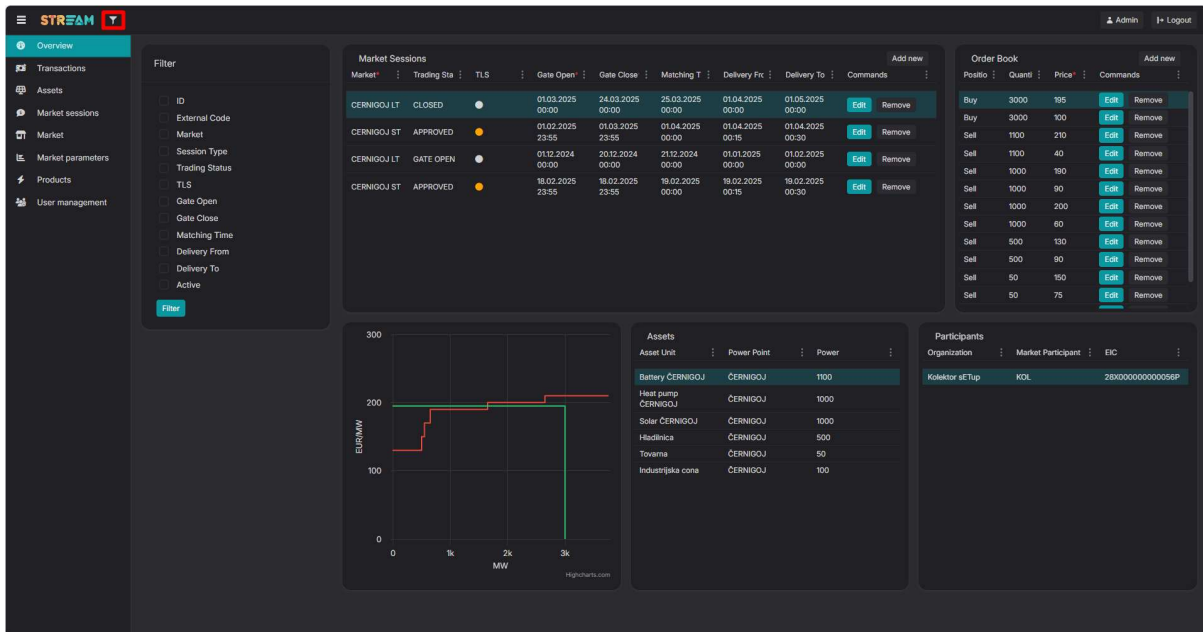


Figure 39: sSMART - SI Pilot - Advanced Filtering

### 3.3.4.2 Organisation and User Management

The sSMART tool provides functionalities for managing organisations, contacts, and users. At the time of this deliverable's preparation, the following organisations are registered: Elektro Primorska, the DSO, and Kolektor sETup, the Flexibility Provider, in the SI Pilot of Ajdovščina.

User management is structured into four layers:

- **Organisation Management** (Admin only): The administrator is responsible for adding or removing organisations.
- **Market Participants**: Each organisation has assigned market participants.
- **Contacts**: Each organisation must designate at least one contact person responsible for user management.
- **Users**: Organisation-specific users who interact with the platform.

Each organisation can only manage its own users and contacts, while the administrator has full visibility and control over all users. Additionally, administrators have the ability to impersonate users, allowing them to troubleshoot operational issues and observe platform behaviour from different perspectives—an essential feature in research projects.

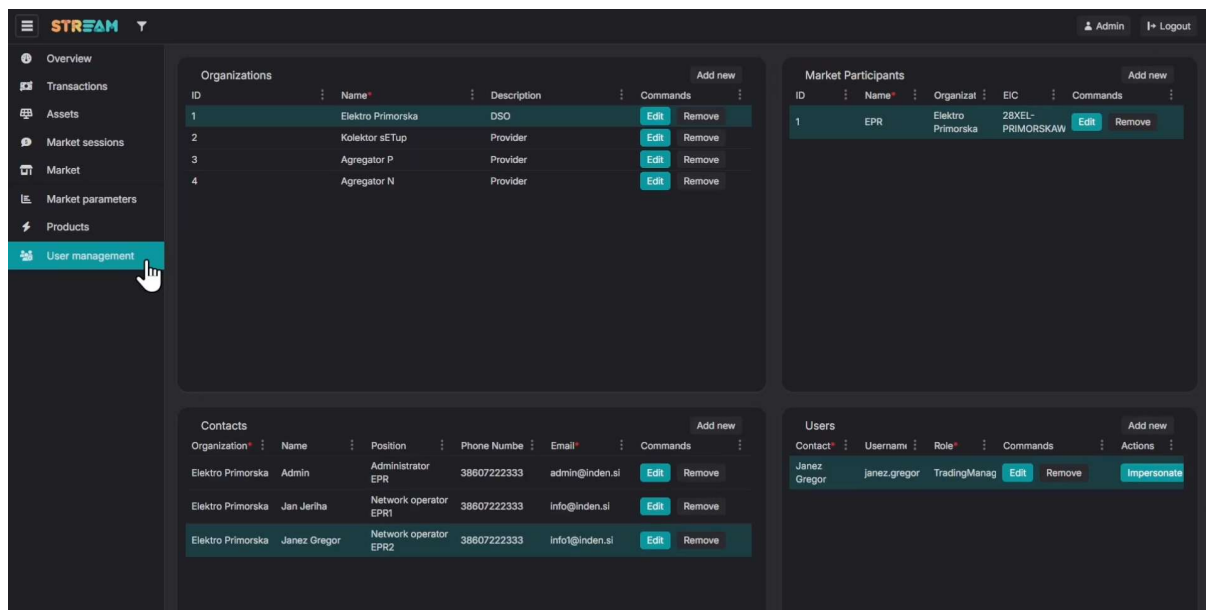


Figure 40: sSMART - SI Pilot - User management

### 3.3.4.3 Management of markets

The local flexibility market involves numerous grid elements that could require flexibility services. However, not all elements need a market at all times. To streamline market operations, the **DSO** initiates a market at a **specific grid point** where flexibility is required. Different **market products** (long-term/short-term flexibility) are allocated to the market.

Once a market is selected, the middle panel Figure 41 on displays **all associated market sessions**, while additional elements showcase grid information and available assets. Information updates dynamically when a different grid point is selected.

Local flexibility market design is specific in a way that a very large number of grid elements are eligible where the DSO could request the flexibility. But not all of them need a market at a specific moment. To streamline the clarity and overview of the markets, the market first needs to be initiated at a specific power point, where the DSO identifies the need for flexibility. For example, the screen below demonstrates that there are two power points where the market was initiated: Černigoj & RTP. Additionally, various market products can be allocated to a specific market (point in the grid). Different market products are presented in Figure 41. When a specific market is selected, the middle element presents all market sessions that are connected to the specific point in the grid. The elements below showcase the general information about the power point and the assets that are available for the market. All of the information is refreshed when a different power point is selected.

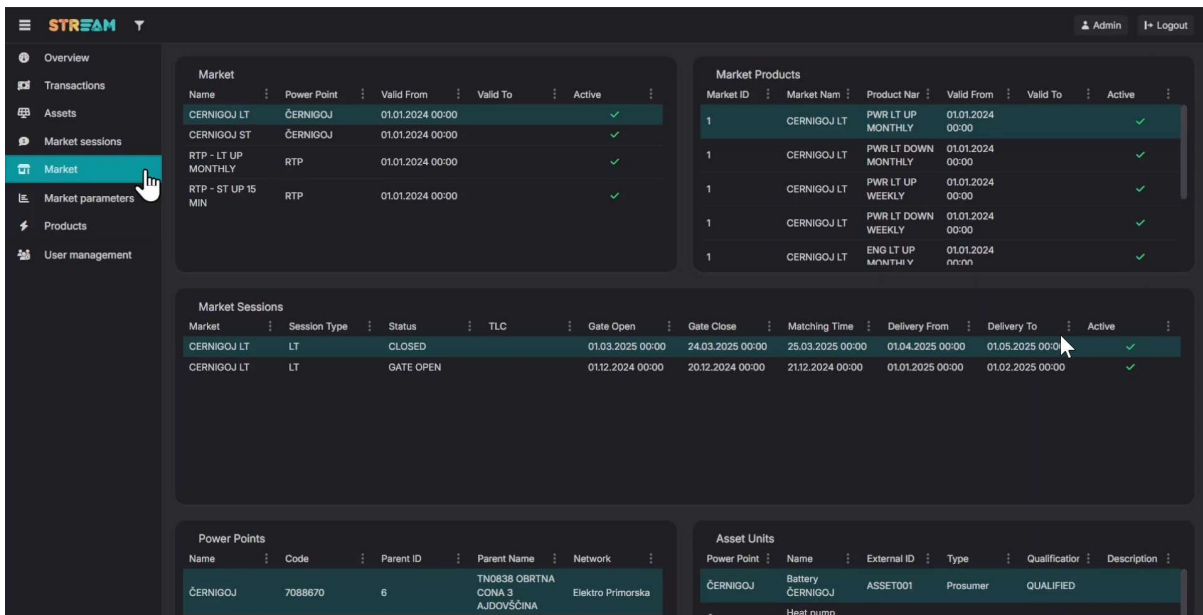


Figure 41: sSMART - SI Pilot - Market overview

### 3.3.4.3.1 Market parameters and Initiation

To create a **new market**, the **Market Parameters** screen provides an overview of existing grid points and active markets. DSOs can initiate a new market by entering relevant details such as the **market name, grid point, and validity period**.

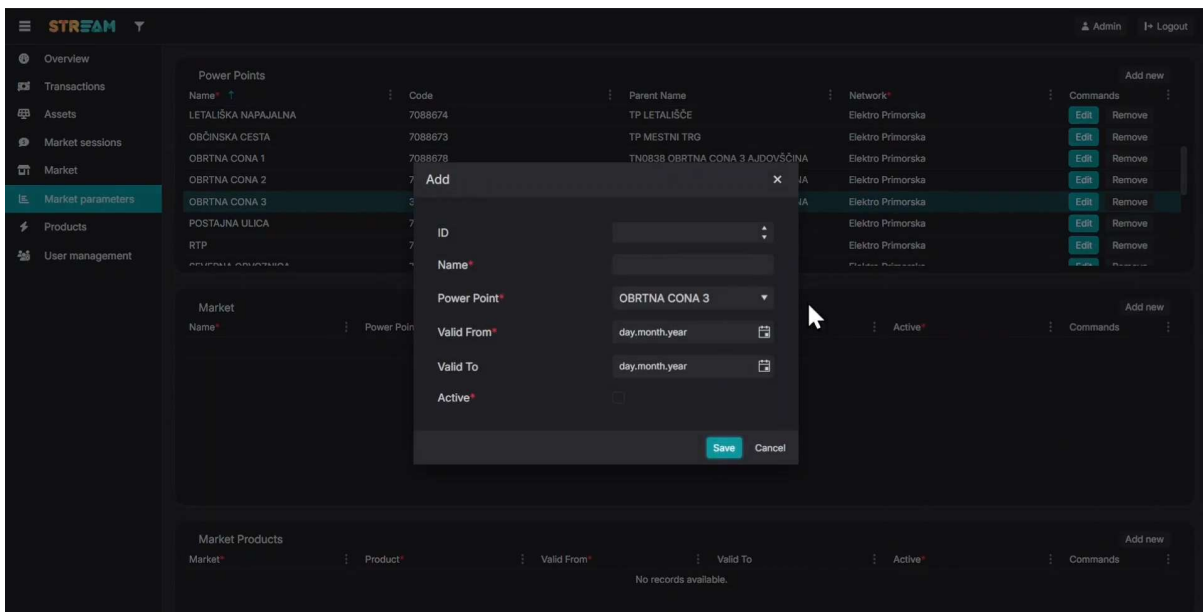


Figure 42: sSMART - SI Pilot - New market initiation

### 3.3.4.3.2 Market Sessions

Market sessions represent discrete trading periods within an active market. The **Market Session** screen provides an overview of all past and active sessions, which can be filtered based on relevant parameters.

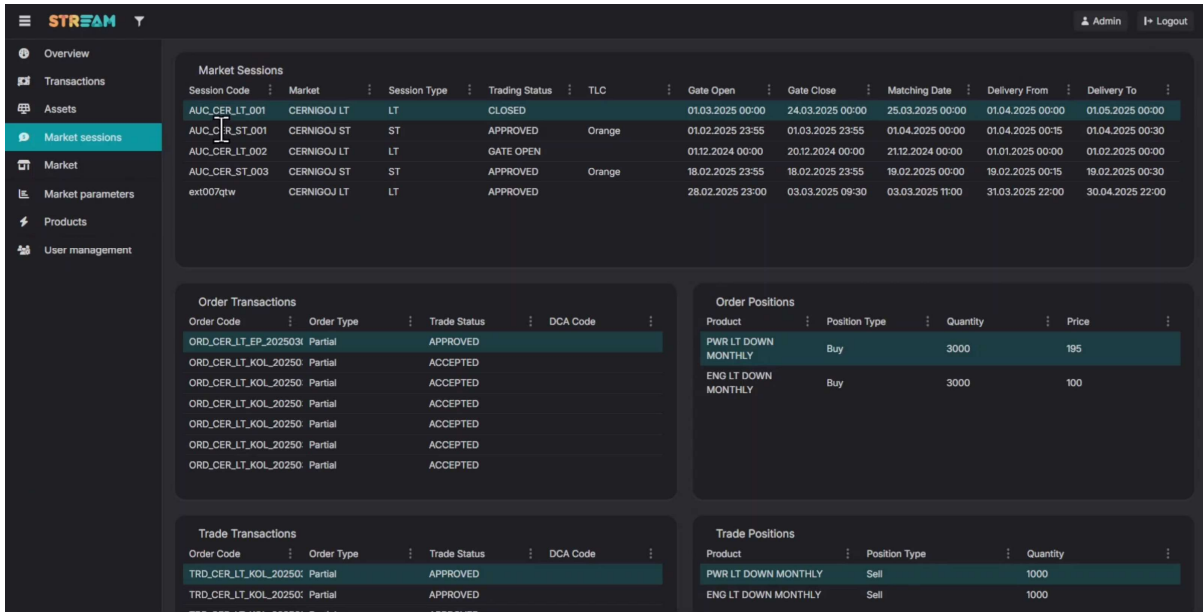


Figure 43: SMART - SI Pilot - Market session overview

The DSO can open a new market session. For the long-term flexibility product, this is done manually as the required flexibility is the outcome of analysis performed on the low-voltage grid. The required parameters need to be added, when initiating a new market session. For the short-term flexibility product, the market session opens automatically and the requested flexibility is obtained via the communication with sGRID.

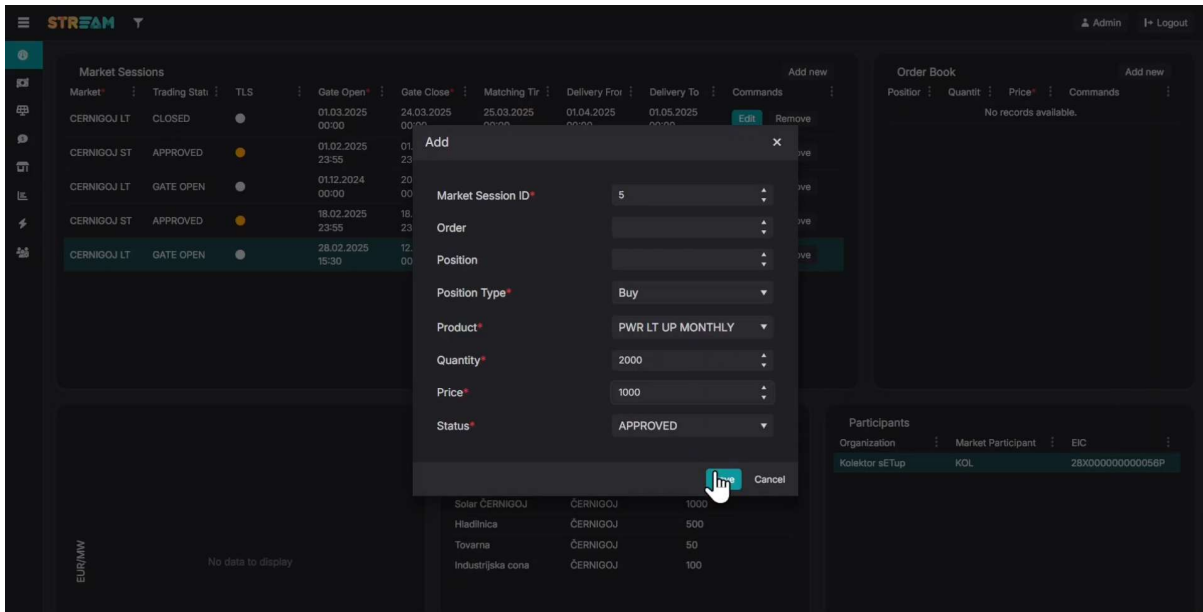


Figure 44: SMART - SI Pilot - Adding a new market session

### 3.3.4.3.3 Management of products

DSOs can define **market products** available within **SMART**. Each product must be registered before it can be used in market operations. The following differentiations are envisioned for products: long-term (capacity) or short-term (energy) products, weekly or monthly auctions for long-term and 15min duration for short-term products, direction up or down. It also enables additional customisation (activation duration) in case any changes are need.

ID	Name	Label	Block	Commodity	Calendar	Market Area	Time Period	Service Typ	Direction	Quantity Tj	Commands
1	PWR LT UP MONTHLY	Power	BASE MONTH	Electricity/Ancilli power/kW	Slovenia			Flexibility	UP	Power	Edit Remove
2	PWR LT DOWN MONTHLY	Power	BASE MONTH	Electricity/Ancilli power/kW	Slovenia			Flexibility	DOWN	Power	Edit Remove
3	PWR LT UP WEEKLY	Power	BASE WEEK	Electricity/Ancilli power/kW	Slovenia			Flexibility	UP	Power	Edit Remove
4	PWR LT DOWN WEEKLY	Power	BASE WEEK	Electricity/Ancilli power/kW	Slovenia			Flexibility	DOWN	Power	Edit Remove
5	ENG ST UP 15 MIN	Energy	15min	Electricity/Ancilli energy/kWh	Slovenia			Flexibility	UP	Power	Edit Remove
6	ENG ST DOWN 15 MIN	Energy	15min	Electricity/Ancilli energy/kWh	Slovenia			Flexibility	DOWN	Power	Edit Remove
7	ENG LT UP MONTHLY	Energy	BASE MONTH	Electricity/Ancilli energy/kWh	Slovenia			Flexibility	UP	Power	Edit Remove
8	ENG LT DOWN MONTHLY	Energy	BASE MONTH	Electricity/Ancilli energy/kWh	Slovenia			Flexibility	DOWN	Power	Edit Remove

Figure 45: SMART - SI Pilot - Market products

### 3.3.4.4 Asset management

The **Asset Management** screen displays all assets registered in **SMART**. Key parameters include: Power Point (location and connection in the grid), rate power, prequalification status, and asset operator. In this example, all assets are operated by the market participant KOL, with varying asset types and prequalification statuses. The selected asset is prequalified in both directions.

Similarly, as before, the admin can view all assets and the market participants can only view assets that are related to the organisation. Integration with the **STREAM ecosystem** ensures asset parameters are displayed in **SMART**, while actual management occurs in the **Device Registry**.

ID	Asset Unit	Asset Code	Description	Asset Type	Power Point	Qualification Status	Market Participant	Commands
1	Battery ČERNIGOJ	ASSET001		Prosumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove
2	Heat pump ČERNIGOJ	ASSET002		Prosumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove
3	Solar ČERNIGOJ	ASSET003	Solar	Consumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove
4	Hladnica	ASSET004		Consumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove
5	Tovarna	ASSET005		Consumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove
6	Industrijska cone	ASSET006		Consumer	ČERNIGOJ	QUALIFIED	KOL	Edit Remove

Figure 46: SMART - SI Pilot - Assets and asset management

### 3.3.4.5 Trade history

This section presents the *Transactions* view, which includes all orders placed in the **SMART**. The admin and operator of the platform (the DSO) can view orders placed by all market participants and can filter

by market session or transaction type order placed in sSMART or trade accepted for activation along with the general functionalities of editing orders. Other market participants can view their transactions in sSMART.

ID	Market Session	Order Code	Transaction Type	Order Type	Market Participant	Trade Status	DCA Code	Active	Commands
1	AUC_CER_LT_001	ORD_CER_LT_EP_202	Order	Partial	EPR	APPROVED		✓	Edit Remove
2	AUC_CER_ST_001	ORD_CER_ST_EP_202	Order	Partial	EPR	APPROVED		✓	Edit Remove
3	AUC_CER_LT_002	ORD_CER_LT_EP_202	Order	Partial	EPR	APPROVED		✓	Edit Remove
4	AUC_CER_ST_003	ORD_CER_ST_EP_202	Order	Partial	EPR	APPROVED		✓	Edit Remove
5	AUC_CER_ST_001	DCA_CER_ST_202505	Order	Partial	EPR	APPROVED	testDCA1	✓	Edit Remove
6	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
7	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
8	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
9	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
10	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
11	AUC_CER_LT_001	ORD_CER_LT_KOL_20	Order	Partial	KOL	ACCEPTED		✓	Edit Remove
12	AUC_CER_LT_001	TRD_CER_LT_KOL_20	Trade	Partial	KOL	APPROVED		✓	Edit Remove
13	AUC_CER_LT_001	TRD_CER_LT_KOL_20	Trade	Partial	KOL	APPROVED		✓	Edit Remove

ID	Transact	Product	Position	Quantity	Quantity	Price	Price Un	Currenc	Asset Ur	Rest Tim	Max con	Creation	Active	Commands
1	ORD_CER_LT	PWR LT DOWN MONTHLY	Buy	3000	kW	195	kW	EUR		02.10.2025 00:00		02.10.2025 00:00	✓	Edit Remove
2	ORD_CER_LT	ENG LT DOWN MONTHLY	Buy	3000	kW	100	MWh	EUR		02.11.2025 00:00		02.11.2025 00:00	✓	Edit Remove

Figure 47: sSMART - SI Pilot - Trade/Order history

### 3.4 ITALIAN DEMO SITE

#### 3.4.1 The role of LFM in Italy.

LFM play an essential role in Italy's energy transition, addressing the challenges and opportunities brought about by the increasing penetration of renewable energy and the decentralization of the electricity system. These markets are designed to enable the use of local resources to manage supply and demand imbalances, particularly at the distribution grid level, where traditional centralized solutions may not be sufficient. The primary function of LFMs in Italy is to provide a mechanism for managing grid stability and congestion in local areas. As renewable energy sources like wind and solar become more prevalent, their intermittent nature introduces variability in energy production. LFMs help mitigate these fluctuations by coordinating distributed energy resources (DERs) such as solar panels, batteries, electric vehicles, and demand response systems. These DERs can offer flexibility by either increasing or decreasing energy consumption or generation in response to grid needs.

LFMs also play a critical role in reducing the need for costly grid reinforcements. Instead of expanding or upgrading the physical infrastructure to accommodate new energy demands or additional renewable generation, LFMs optimize existing grid assets. This approach minimizes capital expenditure while still ensuring a reliable supply of electricity, especially in areas where the grid is constrained.

A key benefit of LFMs is their ability to integrate prosumers (consumers who also produce energy) into the market. These individuals or businesses can actively participate by providing flexibility services, such as adjusting their energy consumption or supplying stored energy back to the grid. This not only enhances the efficiency of the system but also creates new revenue streams for participants, fostering greater engagement and democratization of the energy sector.

The role of LFMs extends to supporting Italy's Distribution System Operators (DSOs), which are tasked with managing the local electricity grids. LFMs enable DSOs to procure flexibility services from local

resources, allowing them to manage grid operations more effectively and ensure the seamless integration of renewable energy. This local focus complements the broader efforts of the national Transmission System Operator (TSO), Terna, by addressing challenges specific to the distribution network. Furthermore, LFMs align with Italy's and the European Union's decarbonization goals by promoting the use of clean, decentralized energy sources. They help maximize the utilization of renewable energy, reducing curtailment and minimizing reliance on fossil fuel-based power plants, particularly during peak demand periods.

Despite their potential, the development of LFMs in Italy faces several challenges. The regulatory framework governing their operation is still evolving, with a need for clearer rules on the interaction between DSOs and the TSO. Standardization of market platforms and procedures is also a priority to ensure interoperability and efficiency. Additionally, widespread adoption of LFMs requires significant investments in digitalization and grid modernization, as well as efforts to raise awareness among stakeholders about their benefits.

The role of LFM in Italy is essential in addressing the challenges of the energy transition, particularly in integrating renewable energy sources and managing the electricity grid efficiently. These markets involve grid operators, such as Terna (TSO) and local distributors (DSOs), alongside other energy system stakeholders, providing the flexibility services needed to balance supply and demand and prevent grid congestion at a local level. In Italy, the Regulatory Authority for Energy, Networks, and Environment (ARERA) has launched pilot projects to develop LFM. The increasing adoption of renewable energy sources, like photovoltaic systems, and the electrification of consumption, driven by technologies such as electric vehicles and heat pumps, introduce new complexities. The variability of energy production and growing electricity demands call for advanced tools to manage the grid. Flexibility, defined as the ability to adapt energy consumption or production in response to specific technical requests or price signals, thus becomes a critical component. LFM enables these dynamics to be managed on a smaller scale compared to national markets, addressing specific issues within distribution networks.

In these markets, grid operators identify areas with critical issues, such as congestion or imbalances, and define the flexibility services needed to address them. Producers, consumers, prosumers, and aggregators respond to these needs. Market participants can submit flexibility bids, outlining their capabilities to adjust consumption or production, along with pricing and conditions. Grid operators then select the most suitable offers based on cost and geographic location relative to the identified issues. Once accepted, the resources are activated to resolve grid challenges, with notice periods ranging from a few minutes to longer timescales. Participants are compensated for the services provided, encouraging the development and adoption of technologies such as energy storage systems.

The benefits of this approach are numerous. LFM help manage grid congestion without resorting to costly infrastructure upgrades, such as line reinforcements. They also enable better integration of renewable energy sources, avoiding excess energy waste and reducing the need for disconnections. Additionally, this system improves economic efficiency by activating only the resources strictly necessary and promotes a more sustainable, resilient, and decentralized energy model.

### 3.4.2 Registration phase

In the case of Italian pilot, EMOT, acting as charging point operator, electric mobility service provider, and electric vehicle fleet manager, is responsible for registering and prequalifying charging stations and electric vehicles to be involved in Local Flexibility Markets (LFM) negotiation. In particular, EMOT uses a graphic user interface, based on Flutter v3.19, to register new devices, as shown in the figures below.

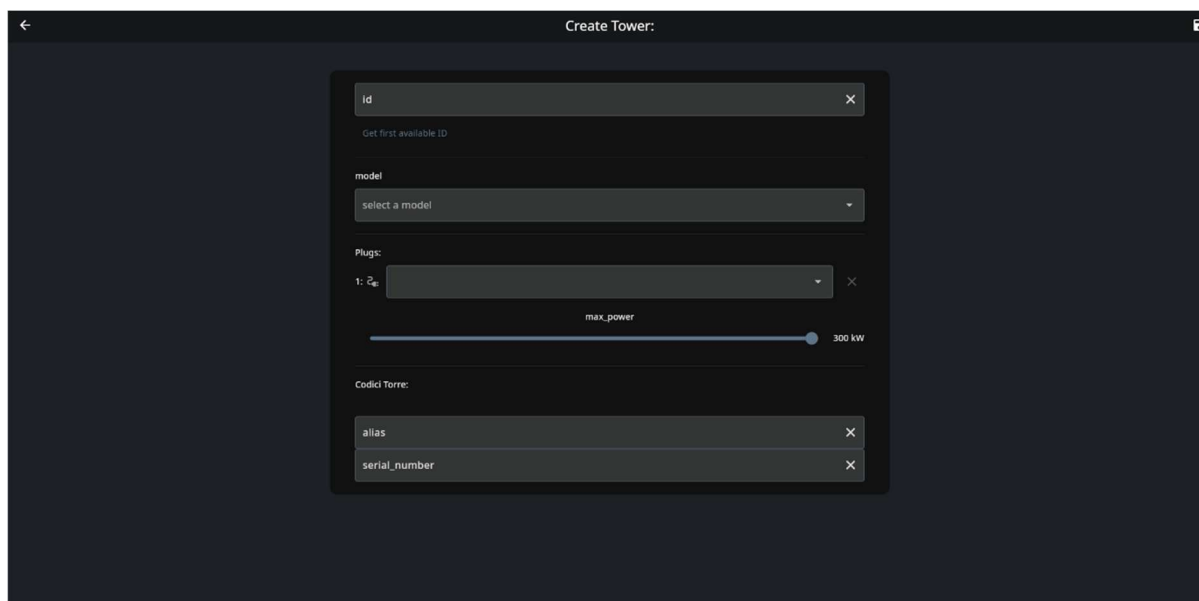


Figure 48: EMOT GUI to register new device

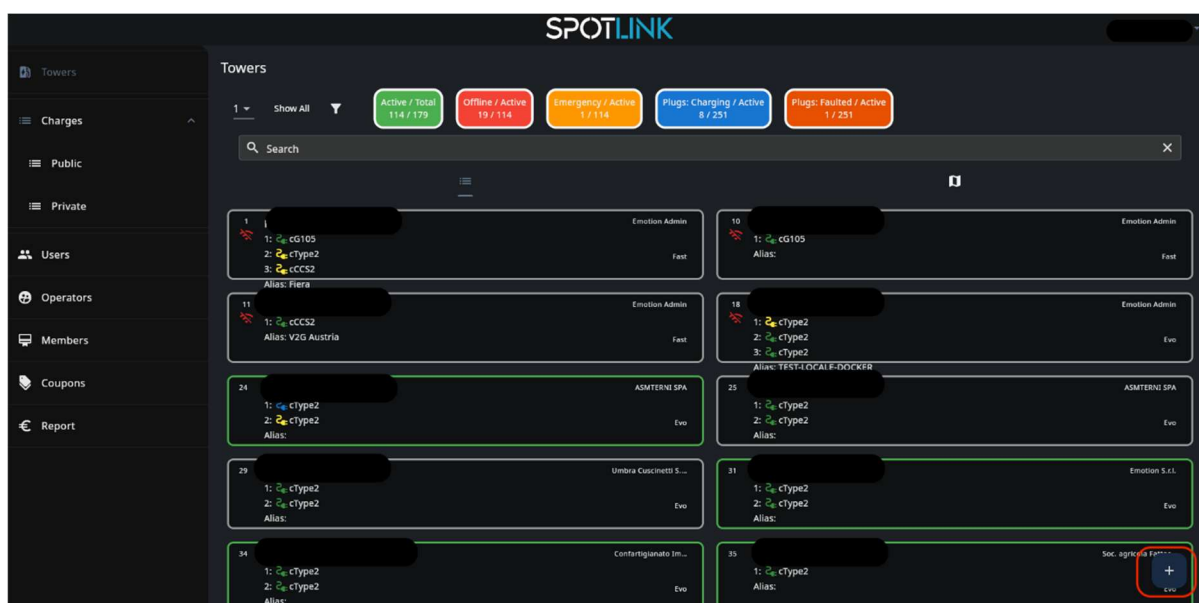


Figure 49: EMOT GUI with an overview of registered devices

EMOT operator registers a new device on a PostgreSQL v14 database via a Django REST v4.2, as shown in the figures below.

PostgreSQL » db » tantor » public » Tabella: data\_stores\_vehiclestate

## Tabella: data\_stores\_vehiclestate

[Visualizza dati](#)  
 **[Visualizza struttura](#)**  
 [Modifica tabella](#)  
 [Nuovo elemento](#)

Colonna	Tipo	Commento
<b>id</b>	bigint <i>Auto incremento</i> [ <b>GENERATED BY DEFAULT AS IDENTITY</b> ]	
<b>battery_percentage</b>	double precision	
<b>velocity</b>	double precision	
<b>timestamp</b>	timestampz	
<b>in_charge</b>	boolean	
<b>efficiency</b>	character varying(255)	
<b>charges_count</b>	smallint	
<b>km_tot</b>	double precision	
<b>kwh_charged</b>	numeric(9,2)	
<b>vehicle_id</b>	bigint	

### Indici

<b>PRIMARY</b>	<i>id</i>
<b>INDEX</b>	<i>vehicle_id</i>

[Modifica indici](#)

### Chiavi esterne

Sorgente	Obiettivo	ON DELETE	ON UPDATE	
<b>vehicle_id</b>	products_vehicle( <i>id</i> )	NO ACTION	NO ACTION	<a href="#">Modifica</a>

[Aggiungi foreign key](#)

### Trigger

[Aggiungi trigger](#)

Figure 50: Electric vehicle registration structure in EMOT database

### 3.4.3 Prequalification phase

Each registered device has to be provided with a technical description to be involved in Local Flexibility Markets (LFM) negotiation; if the technical description is suitable for DSO pre-defined requirements, like specific geographic location and electric power output, the device is prequalified and it is uploaded on the Italian pilot electric mobility platform developed by EMOT.

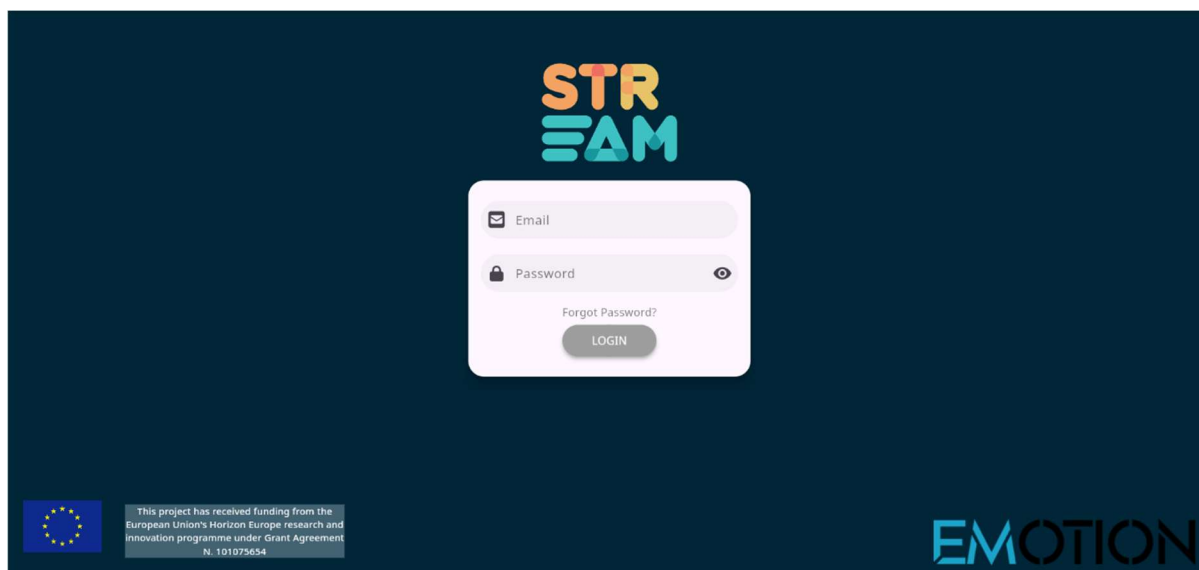


Figure 51: Italian pilot electric mobility platform login

As shown in the figure below, charging station technical details include:

- Model,
- Country,
- City,
- Address,
- Maximum value of power output in alternating current,
- Maximum value of power output in direct current,
- Plugs connector type.

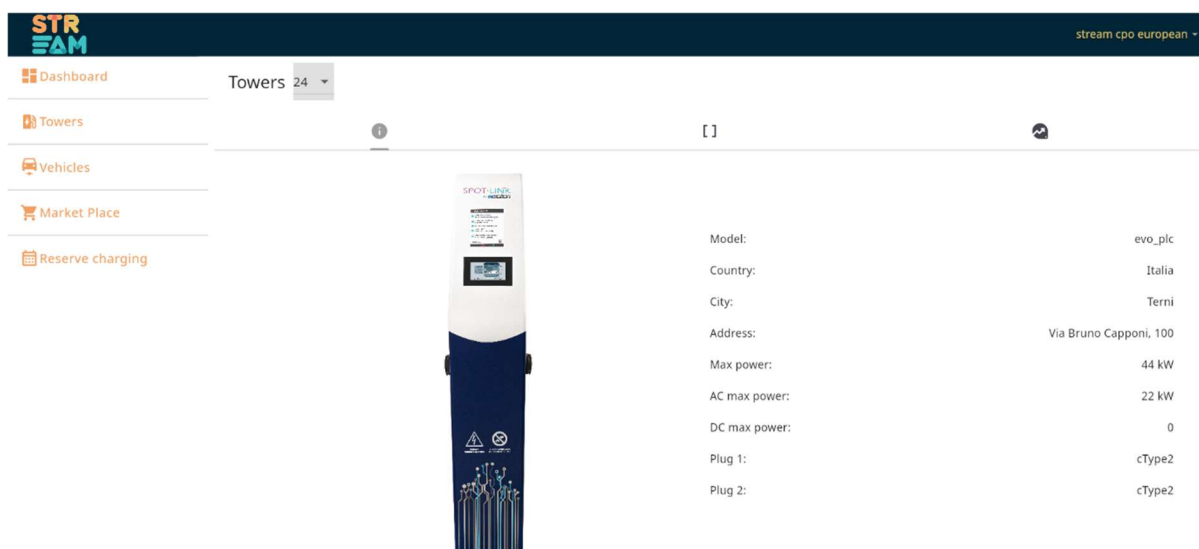


Figure 52: Charging station technical details in the Italian pilot electric mobility platform

Regarding EV, technical details include:

- Model,
- Battery capacity,
- Maximum value of charging power.

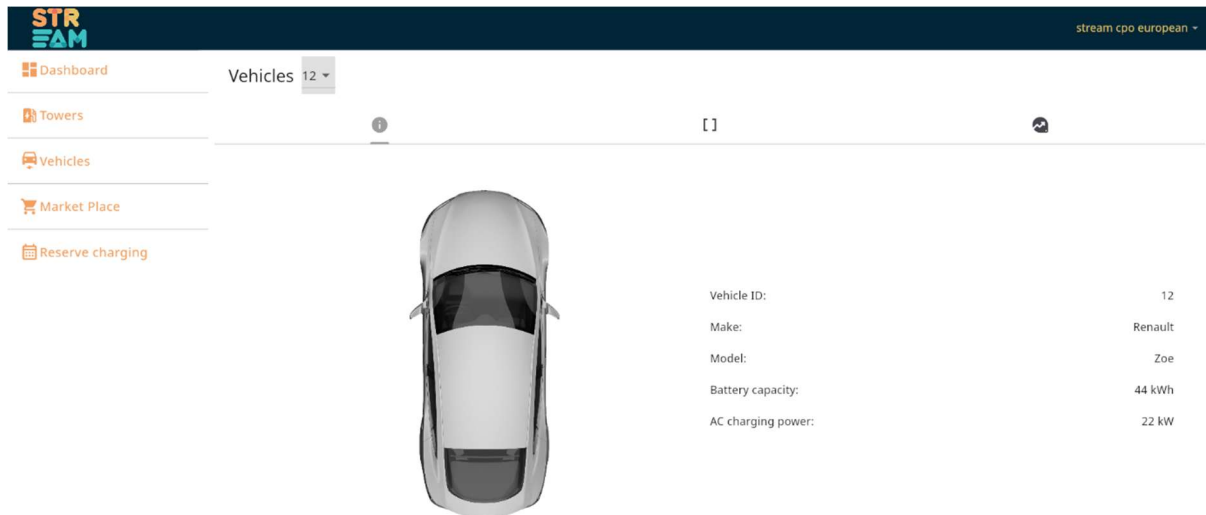


Figure 53: Electric vehicle technical details in the Italian pilot electric mobility platform

A key characteristic for the device to be involved in Local Flexibility Markets (LFM) negotiation is to be enabled for real-time monitoring service. Data collected from charging stations and EVs are accessible via electric mobility platform, both real-time and historical data.



Figure 54: Charging station historical data in the Italian pilot electric mobility platform

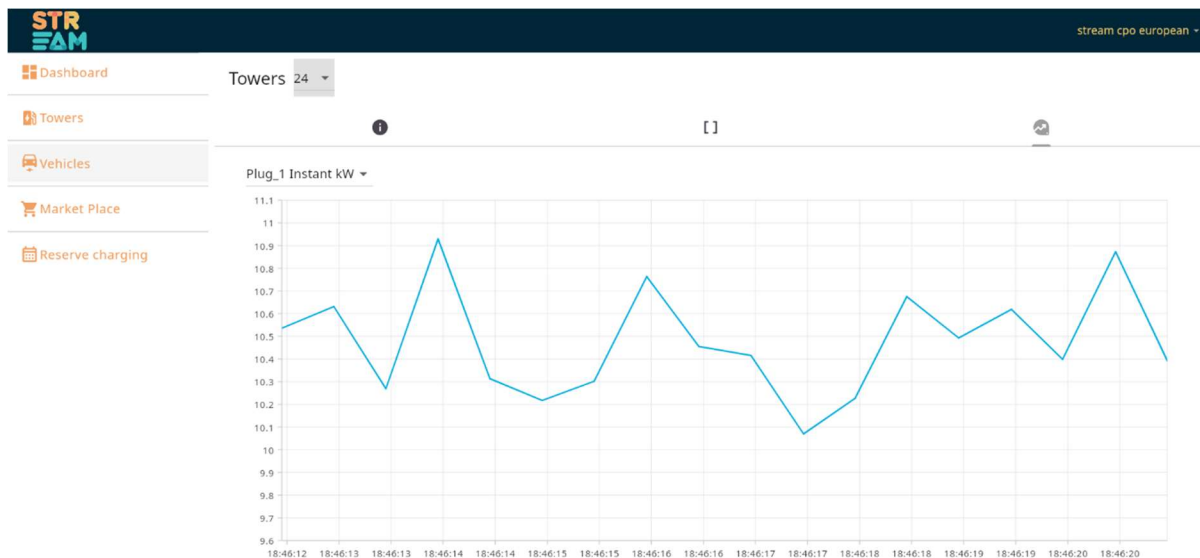


Figure 55: Charging station real-time data in the Italian pilot electric mobility platform

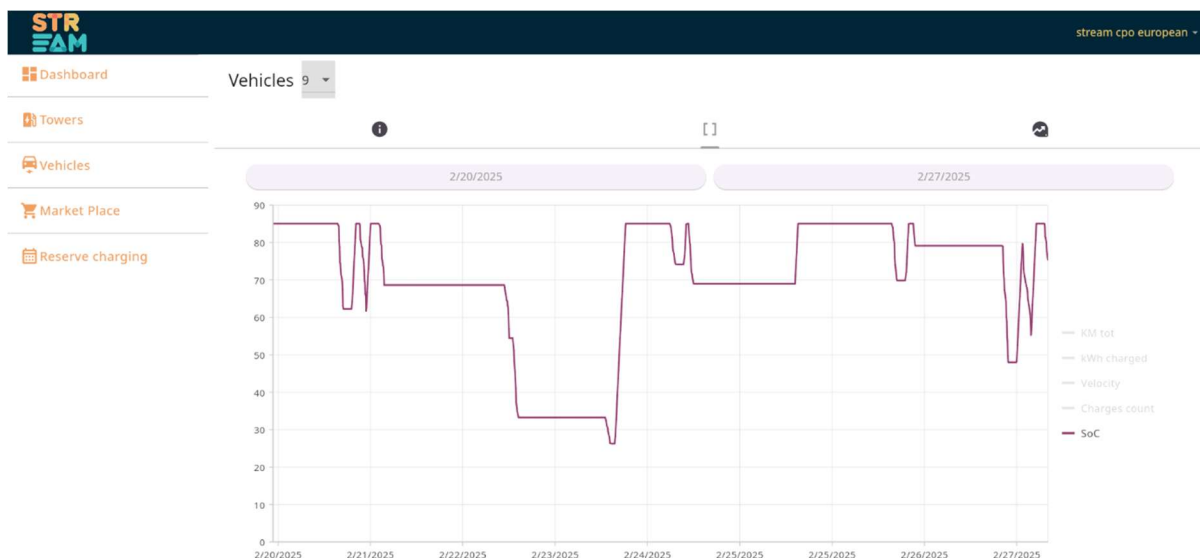


Figure 56: Electric vehicle historical data in the Italian pilot electric mobility platform

### 3.4.4 Qualification phase

The qualification phase focuses on the process of submitting and validating flexibility requests by the Distribution System Operator (DSO) through the User Interface (UI). This phase ensures that the flexibility needs are accurately communicated and that market participants can respond effectively.

#### User Interface Overview

After logging into the UI, the DSO can access day-ahead congestion forecasts for transformers in a specific area of the grid. These forecasts are crucial for the DSO to assess when and where additional grid flexibility may be required. The system displays a map of all transformers, allowing the DSO to identify areas of the network with potential problems and plan accordingly. The UI provides two options for displaying transformers as shown in Figure 57.

- List view: Displays transformers in a structured list format.
- Map view: Shows transformers on an interactive map.

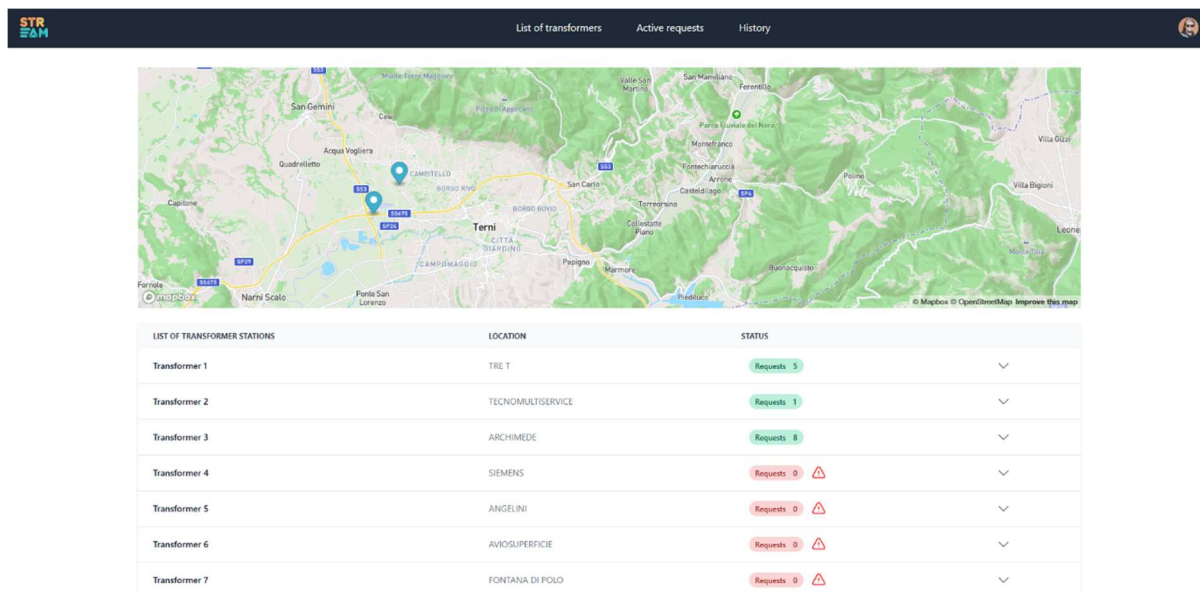


Figure 57: SMART – IT pilot – transformers with activatable flexibility

This provides flexibility in how the DSO navigates and selects the appropriate transformer for further analysis. In either case, once the DSO selects a transformer, additional menus appear as shown in Figure 58.

- On the left side, a graph displaying the day-ahead congestion forecast for the selected transformer is shown. This helps the DSO determine when and how much flexibility is needed.
- On the right side, all currently active flexibility requests for the transformer are listed, along with a button to create a new request.

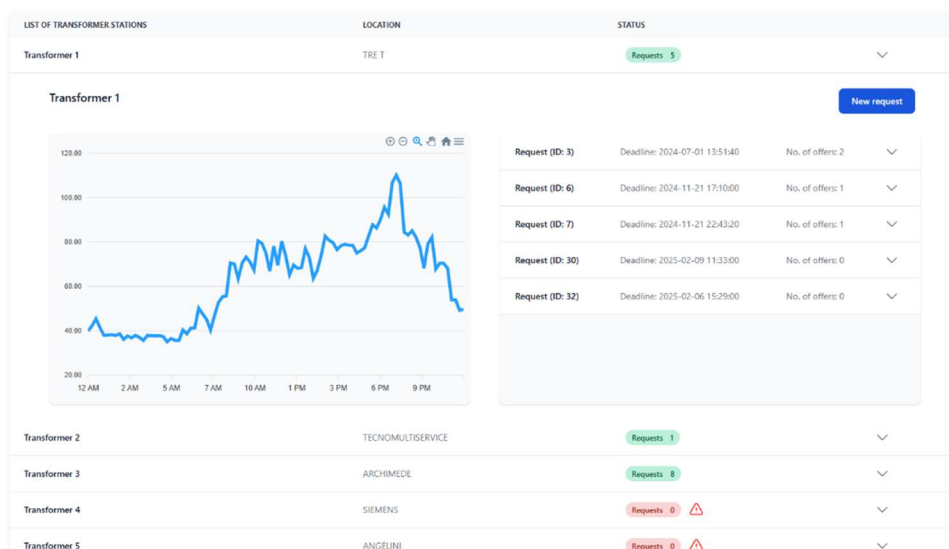


Figure 58: SMART – IT pilot – congestion forecast

To create a new flexibility request, the DSO clicks on the "New request" button. The system then prompts the DSO to input the required parameters:

- Start and end time: Defines the time window for the requested flexibility.
- Required energy amount: Specifies the amount of flexibility needed (in kWh).

- Maximum price: Indicates the highest price the DSO is willing to pay for the flexibility service.
- Transformer location: Associates the request with a specific part of the grid experiencing congestion.
- Bid submission deadline: Specifies the time by which market participants must submit their bids.

After entering this information and clicking on "Create request" button, as shown in Figure 59, the request is submitted for market bidding, allowing participants to view and respond to the request based on the defined parameters.

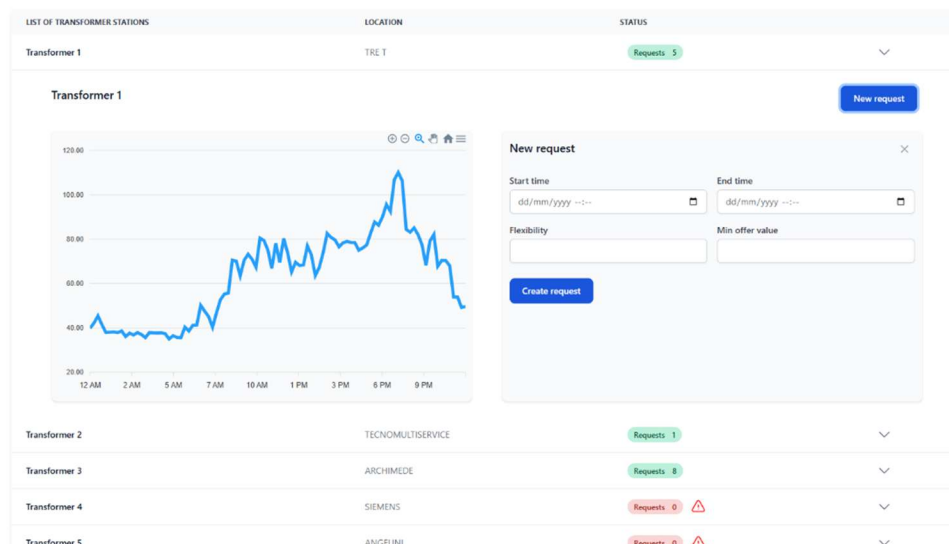


Figure 59: sSMART – IT pilot – creating flexibility request

By completing the qualification phase, the flexibility request is made available for market bidding, enabling participants to submit offers according to the specified criteria.

**Summary of qualification process**

**1. Creating a Flexibility Request:**

- The DSO selects a transformer from either the list or map view.
- Clicks on the button to create a new flexibility request.
- Defines the start and end time either manually or by selecting them interactively on the congestion graph.
- Inputs the required energy (kWh) and maximum price they are prepared to pay for the provided flexibility.

**2. Submission and market notification:**

- The request is submitted to the flexibility market.
- Market participants receive a notification about the new request.

**3.4.5 Bidding phase**

After DSO has created an energy flexibility request, an indication of such creation appears on the electric mobility platform. CPO, following a verification of its ability to satisfy the energy flexibility request, can provide an offer in the dedicated section of the electric mobility platform.

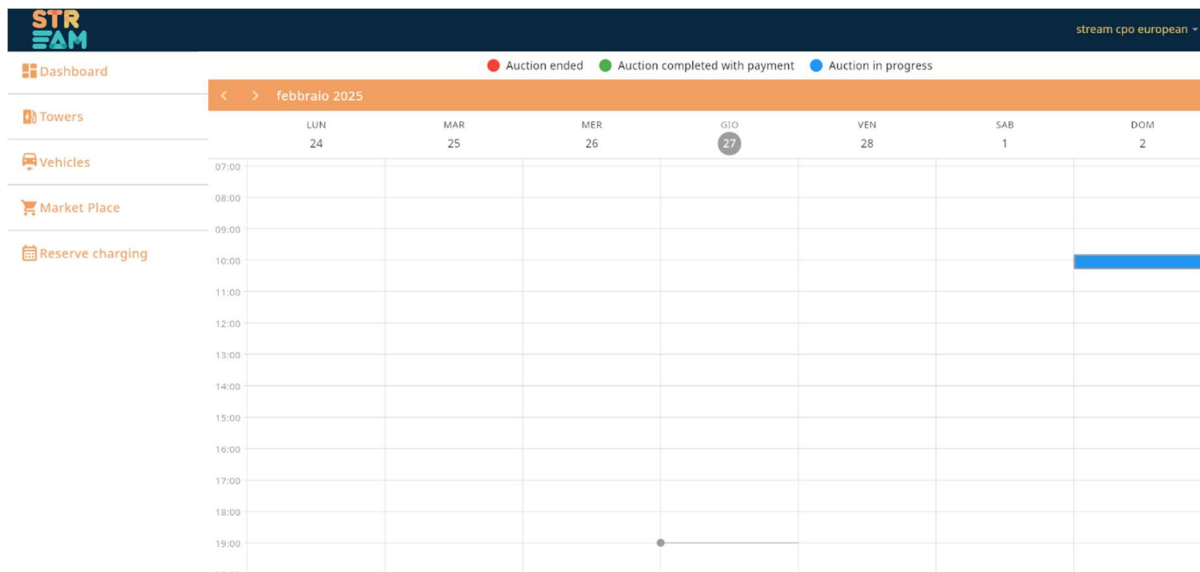


Figure 60: Marketplace calendar in the Italian pilot electric mobility platform

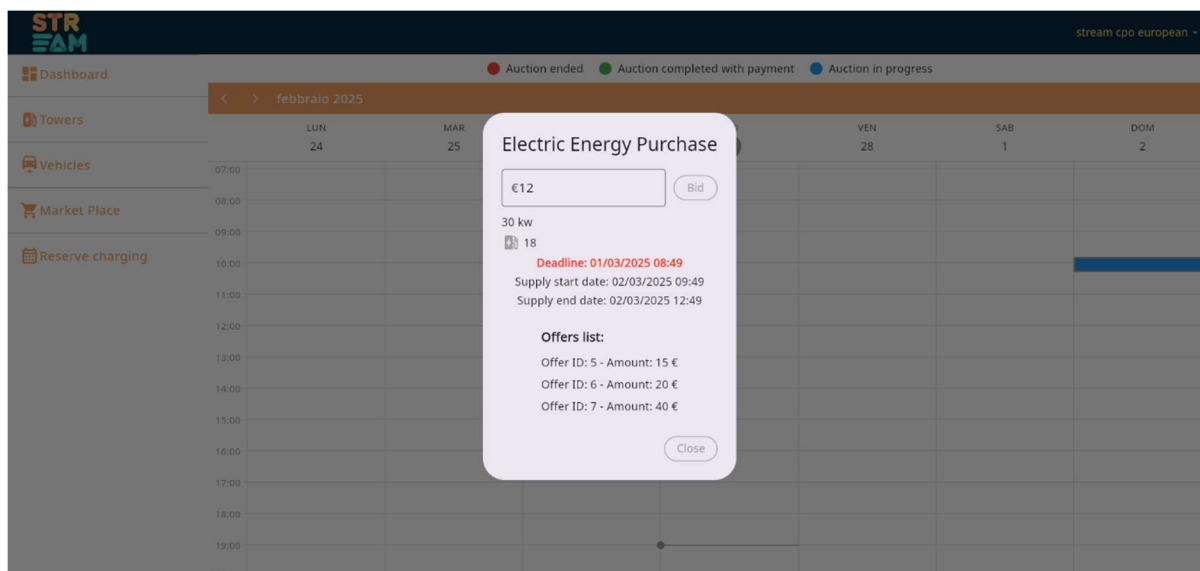


Figure 61: CPO energy flexibility offer in the Italian pilot electric mobility platform

### 3.4.6 Results phase

Once the DSO accepts one of the bids submitted by the marketplace participants, the auction is completed and the results of the flexibility session are recorded and displayed in the "History" tab of the DSO user interface (UI), as shown in the Figure 62. This tab provides an overview of all successfully processed requests as well as all bids with the corresponding IDs and prices and the winning offer. The DSO can only access this information if the auction has been successfully completed, while ongoing requests remain visible on the "Active requests" tab.

STREAM Flexibility Management		List of transformers	Active requests	History	adm
Trafo ID	REQUEST ID	SELECTED OFFER	NUMBER OF OFFERS		
Trafo ID: 19	Request ID: 6	1	Offers 3		
Request ID: 6					
OFFER ID	VALUE				
1	70000000 €	This offer was selected!			
2	50000000 €				
3	30000000 €				
6	333330000000 €				
9	99999900000000 €				
Trafo ID: 19	Request ID: 7	4	Offers 1		
Trafo ID: 3	Request ID: 9	5	Offers 1		
Trafo ID: 20	Request ID: 11	8	Offers 1		
Trafo ID: 20	Request ID: 15	20	Offers 4		
Trafo ID: 3	Request ID: 16	11	Offers 2		
Trafo ID: 19	Request ID: 17	10	Offers 1		

Figure 62: sSMART – IT pilot – successfully concluded flexibility requests

The results shown here reflect the DSO's view of concluded flexibility transactions.

### 3.4.7 Settlement phase

Settlement is the final stage that concludes the local market, and it envisages a micropayment in token from DSO to CPO, following the verification of compliance with auctioned service.

As described in the bidding phase, CPO provides an offer to DSO flexibility request indicating the service provision cost. Following the conclusion of the auction, the winner is announced, and a Ethereum smart contract is executed between the parties.

```
> https emotion-projects.eu/marketplace/request/1 --verify=no
HTTP/1.1 200 OK
Content-Length: 306
Content-Type: application/json
Date: Fri, 27 Sep 2024 15:03:55 GMT
Server: Werkzeug/1.0.1 Python/3.10.14

{
  "deadline": "2024-09-25 16:45:00",
  "decided": null,
  "decision": [],
  "extra": [
    3,
    1727250911,
    19,
    78
  ],
  "from": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
  "id": 1,
  "offers": [
    1,
    2,
    3
  ],
  "state": "open"
}
```

Figure 63: DSO flexibility request in blockchain-based marketplace

```
HTTP/1.1 200 OK
Content-Length: 1071
Content-Type: application/json
Date: Fri, 27 Sep 2024 15:08:15 GMT
Server: Werkzeug/1.0.1 Python/3.10.14

{
  "offers": [
    {
      "author": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
      "extra": [
        100000000
      ],
      "id": 1,
      "request_id": 1,
      "state": "open"
    },
    {
      "author": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
      "extra": null,
      "id": 2,
      "request_id": 1,
      "state": "pending"
    },
    {
      "author": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
      "extra": null,
      "id": 3,
      "request_id": 1,
      "state": "pending"
    },
    {
      "author": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
      "extra": [
        23
      ],
      "id": 5,
      "request_id": 1,
      "state": "open"
    },
    {
      "author": "0x4005Ea3d4F2598b183A1680dbd9718dcb0941494",
      "extra": null,
      "id": 4,
      "request_id": 2,
      "state": "pending"
    }
  ]
}
```

Figure 64: CPO flexibility offers in blockchain-based marketplace

Smart meters monitor energy flows in the charging stations, thus allowing to automatically verify the amount of energy supplied in the time window of the DSO flexibility request. Finally, if the request

condition has been satisfied, a micropayment in Ethereum tokens of the amount agreed at the beginning is automatically made using MetaMask [19].

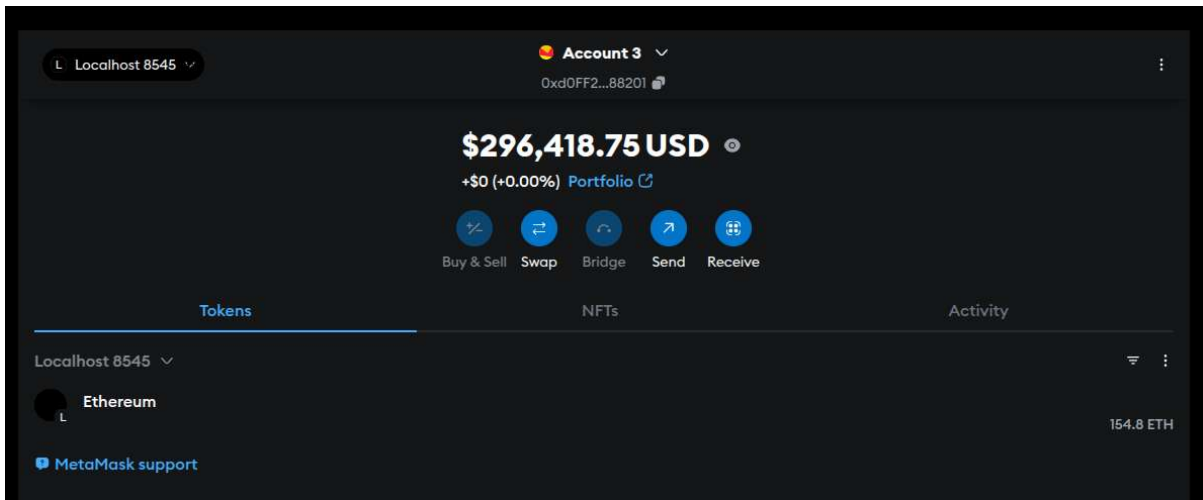


Figure 65: DSO Ethereum wallet in MetaMask

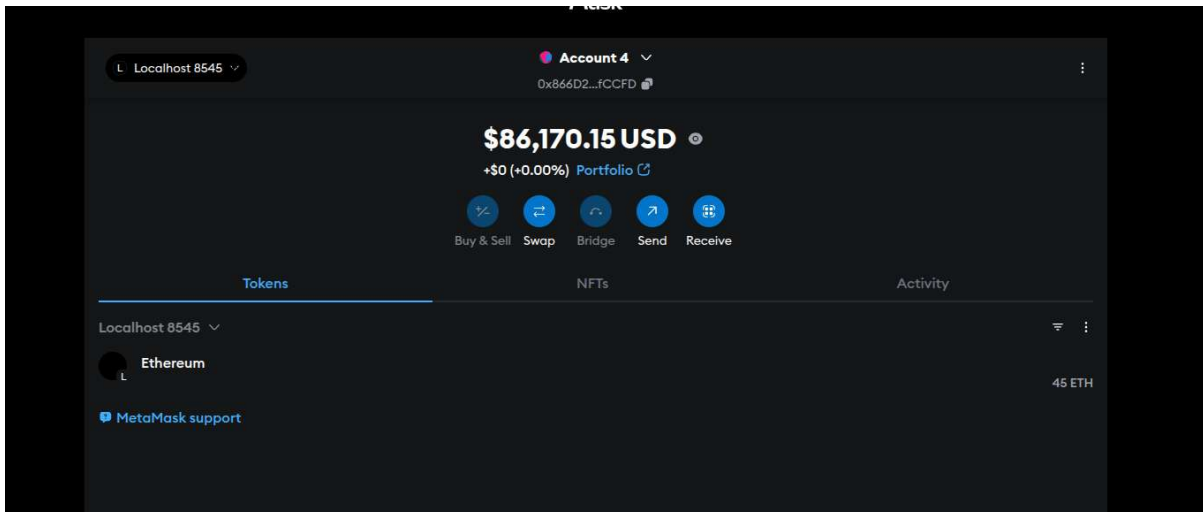


Figure 66: CPO Ethereum wallet in MetaMask

## 4 CONNECTING SMART PLATFORM TO OTHER STREAM TOOLS

### 4.1 INTRODUCTION OF THE TASK

This chapter describes the integration process and communication mechanisms between the sSMART local market platform and the rest of the STREAM project tools. Each of the project pilots has contributed with specific developments and protocols, adapted to their needs and contexts, to achieve this manual and automatized interconnection of tools, forming a cohesive and functional ecosystem that achieves the project's objectives. This chapter addresses the communication services and technologies used by each pilot to connect the Smart Platform with the rest of the sFLEX, sGRID and sENC platforms that each of the pilots comprises.

### 4.2 SPANISH DEMO SITE: SGRID, SFLEX, AND SENC - SMART CONNECTION

A common set of services has been developed to connect ETRA's tools (sGRID, sFLEX, and sENC) to sSMART in the Spanish pilot. The decision was taken to centralize the communication with the API sSMART exposes, then instantiate it using configuration depending on the role of the actor interacting.

The sSMART connector in the Spanish pilot consists of a service communications module in charge of interfacing the market API and handling messages in both directions, together with a market participation module that implements the market actions based on the logic of the tool it is working on behalf of.

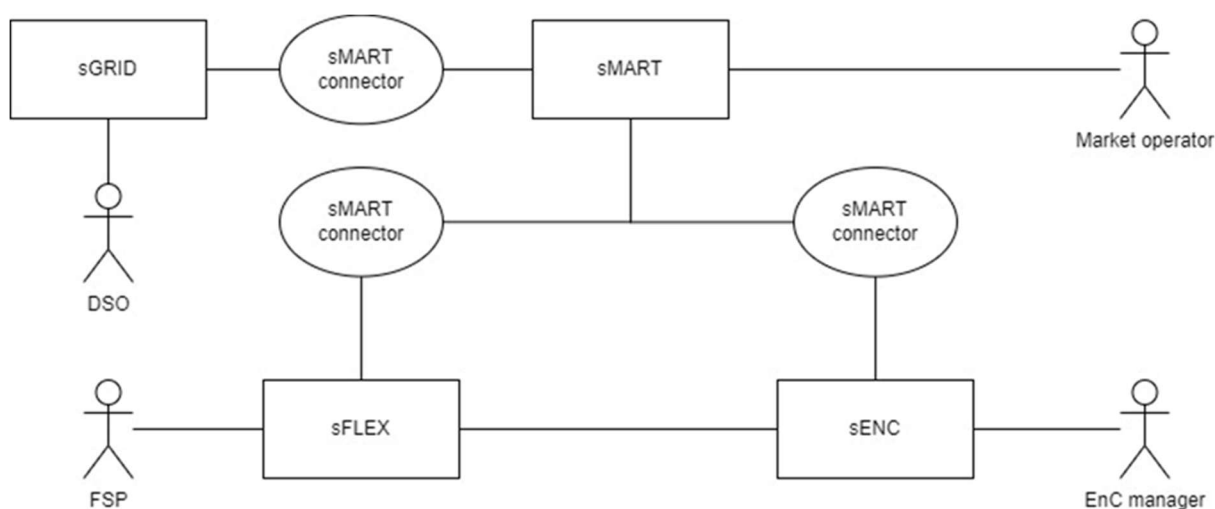


Figure 67: sSMART connector in the Spanish pilot

The communications part of the sSMART connector is a backend service implemented in Node.js [20]. Depending on the instance, the module uses the corresponding certificate associated to the agent registered in the market (DSO, FSP, EnC manager). The certificate identifies the agent in the market and grants the module with access to their information: units, contracts, orders, and trades.

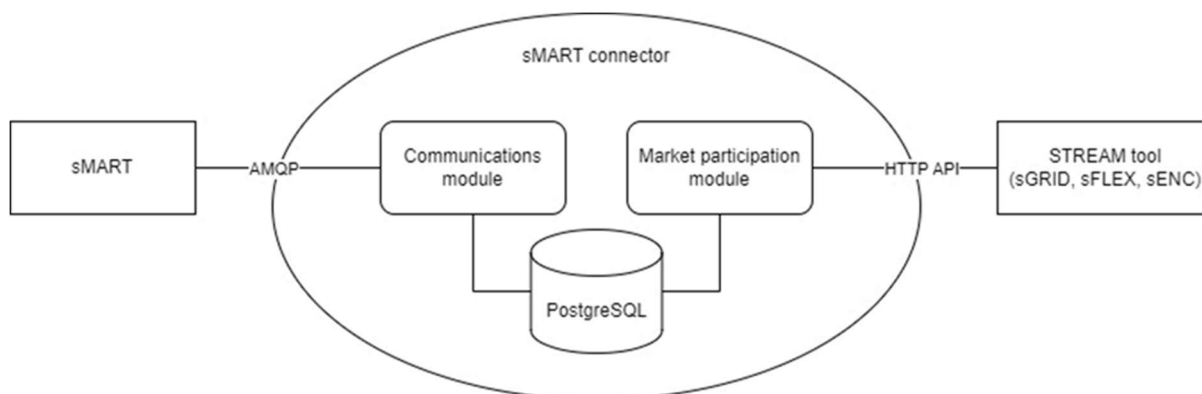


Figure 68: sSMART connector architecture

Besides the login process, performed through a secured HTTP request, the rest of message exchanges between the module and the market are performed through AMQP. The module takes care of the coordination of requests and responses, as they take place asynchronously and to/from different endpoints. The information gathered from the market when the module starts is used to build the current status of the agent—namely their order book—which will then be updated with subsequent operations.

The market participation module communicates with the corresponding STREAM tool via HTTP to gather their business information related to its participation in the market. From sGRID, it receives requests from the DSO based on current and future load flow analyses of the grid. In the case of sFLEX and sENC, assesses the current status and forecasted flexibility of their managed assets. This information, together with operation restrictions (energy prices, EnC optimization goals, asset schedule, DSO needs, etc.), is used to create the bids that will be sent to the market. This information is stored in an internal repository based on PostgreSQL, where the status of the interaction of the agent with the market is maintained [21].

The sSMART communication with sGRID is performed via SoapUI, a web services testing tool that allows users to interact with APIs by creating SOAP projects. For its configuration, a certificate is required to be imported in the SSL preferences. In addition, the “FileSignature” tool is used to sign XMLs, which are sent through SoapUI for testing and response verification. Finally, the OMIE web site is consulted to verify the signed transactions and ensure that the submissions have been made correctly. This process facilitates the management and testing of web services by interacting with the sSMART API.

### 4.3 SLOVENIAN DEMO SITE: SGRID AND SFLEX AND DEVICE REGISTRY - SMART CONNECTION

sSMART has **one main module**, the local flexibility market. In addition to the main module, there are several functionalities and connected STREAM tools that support the operation of sSMART. In the context of the STREAM ecosystem, sSMART enables utilisation of small-scale flexibility originating from the LV grid (via **sFLEX**) with the centralised list of assets’ important parameters and services (provided by **Device Registry**) coupled with the LV grid limits and status (Traffic Light System via **sGRID**).

The architecture of sSMART consists of a backend implemented in .NET handling the core functionalities, the frontend was developed using Angular and the PostgreSQL is used as the database for data storage and management.

The communication between the components is managed by a backend service that facilitates secure and efficient data exchange using **HTTPS and JSON-based REST APIs**. It ensures communication with sSMART’s API, allowing reliable transmission of market-related information. The authentication process is managed via secure HTTPS requests, while most of the data exchange between the tools

and the market occurs through JSON-based messaging. Upon reception by sSMART, **predefined JSON files** undergo a **validation process** to ensure data integrity and market consistency. This validation checks whether the received data is structured correctly and relevant to the associated auctions. It also verifies that the referenced auctions are open and active, ensuring that only valid transactions proceed while preventing erroneous or outdated submissions. The order and relevance of exchanged data is further described in section 3.3.3.

#### 4.4 ITALIAN DEMO SITE: SGRID, SFLEX, AND SENC - SMART CONNECTION

A common integration framework has been developed to seamlessly connect the Italian tools (sGRID, sFLEX and sENC) with sSMART and ensure efficient interaction within the Italian pilot. The architecture centralizes the communication with sSMART's API and configures each instance based on the specific role of the interacting actor.

The sSMART connector in the Italian pilot includes two key components: a service communication module that handles API interactions and message exchange, and a market participation module.

The communication module is a backend service implemented in Elixir Phoenix that uses LiveView for real-time interactivity and JavaScript hooks for dynamic updates.

Apart from the secure login process via an HTTP request, most of the data exchange between the tools and the market is handled asynchronously via AMQP. This design ensures coordinated request-response processing across multiple endpoints. At startup, the module collects existing market data to determine the agent's current status, in particular its order book, which is then updated with new transactions and market actions.

The market participation module connects to the relevant STREAM tool via HTTP collecting business-related information essential for market engagement. Specifically:

- From sGRID, it receives congestion forecasts to assess grid constraints and make informed market decisions.
- From sFLEX, it retrieves water pump operation schedules to optimize energy consumption and participation strategies.
- From sENC, it gathers multi-objective optimization results, balancing various operational goals in market interactions.

This collected data, along with operational constraints such as energy prices, energy community optimization strategies, asset schedules and DSO requirements, feeds into the bid generation process. The generated bids are then submitted to the market, ensuring a strategic and data-driven approach to market participation. To ensure the integrity of the system, all relevant information is stored in a PostgreSQL-based repository that permanently tracks the DSO's interactions with the market and ensures a reliable audit trail.

## 5 CONCLUSIONS

**Local flexibility markets** have been identified as pivotal in facilitating the transition to a sustainable and efficient energy system, offering **economic and operational benefits** for all stakeholders. The SMART tool has been developed to achieve this goal. These markets facilitate the participation of new participants, including energy communities and small assets, thereby providing opportunities for existing participants in wholesale markets. Aggregation platforms facilitate the integration of **diverse local market models**, customised to meet the specific requirements of each member state, **enabling centralized participation** in both local and global markets.

**Local short-term flexibility markets** are crucial for efficiently and swiftly managing the needs of the distribution grid, providing benefits to both system operators and market participants. These markets are particularly advantageous for electric vehicle owners, who can offer the energy stored in their batteries to the grid during periods of high demand. Storage systems can release stored energy during high demand and recharge during low demand periods. Additionally, distributed generation systems like solar PV can adjust their output in response to market signals, selling excess energy during peak demand.

**Local markets for long-term flexibility** are essential for the effective planning and optimisation of the distribution grid. They provide security, stability, and efficiency, while also facilitating the integration of renewable energy sources. These markets are designed to anticipate and ensure the **availability of flexibility resources**, allowing DSOs and other market participants to plan well in advance. These long-term markets are well-suited for fleets of electric vehicles that can commit to providing flexibility for extended periods, ensuring their availability to the DSO. Large energy storage assets can also provide flexibility over extended periods, thus contributing to grid balancing. Renewable generation assets, such as wind and solar farms, can also offer flexibility on specific schedules, adjusting their **output according to the requirements of the DSO**.

**The SMART tool** is a comprehensive solution that covers all processes related to the procurement, operation, and settlement of flexibility services, simplifying their management. This platform enables DSOs to announce their flexibility needs, enhancing transparency and facilitating planning and decision-making. The SMART local market platform has been developed to ensure that all market participants, such as DERs, aggregators, DSOs, and energy communities, have both **manual and automated interconnections of tools**, creating a cohesive and functional ecosystem that meets the project's objectives.

## 6 REFERENCES AND ACRONYMS

### 6.1 REFERENCES

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## 6.2 ACRONYMS

### Acronyms list

<b>ACER</b>	Agency for the Cooperation of Energy Regulators
<b>aFRR</b>	Automatic Frequency Restoration Reserve
<b>AGEN</b>	Energy Agency
<b>ARERA</b>	Autorità di Regolazione per Energia Reti e Ambiente
<b>CMOL</b>	Common Merit Order List
<b>DCA</b>	Dynamic Connection Agreements
<b>DERS</b>	Distributed Energy Resource
<b>DLR</b>	Dynamic Line Rating
<b>DR</b>	Device Registry
<b>DSO</b>	Distribution System Operator
<b>DTR</b>	Dynamic Transformer Rating
<b>EnC</b>	Energy community
<b>EV</b>	Electric vehicles
<b>FSP</b>	Flexibility Service Providers
<b>GCT</b>	Gate Closure Time
<b>HV – MV – LV</b>	High - Medium – Low Voltage
<b>IDAE</b>	Institute for Energy Diversification and Saving
<b>LFM</b>	Local Flexibility Market
<b>LTS</b>	Local Trading System
<b>mFRR</b>	Manual Frequency Restoration Reserve
<b>MITECO</b>	Ministry of Ecological Transition and Demographic Challenge
<b>MO</b>	Market Operator
<b>PV</b>	Photovoltaic
<b>SI</b>	Slovenia
<b>SO</b>	System Operator

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TLS	Traffic Light System
TSO	Transmission System Operator
V2G	Vehicle-to-Grid

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