OPENTUNITY flexibility market (v2)

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Author(s)	Organization
Gesa Milzer	NODES

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NODES
AEM
HEDNO
SUPSI
HYPERTECH

Anell
Estabanell Impulsa
Joanneum Research GmbH
ETRA
IPTO

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Executive Summary

This deliverable summarizes the final implementation and developments of the flexibility markets proposed at the OPENTUNITY pilot sites in Greece, Switzerland, and Spain. Each pilot examines different set up of the planned flexibility markets considering the energy infrastructure, the local and regional grid constraints to solve, coordination requirements, as well as the available local assets. The market frameworks and designs as well as the main use cases of every pilot have been presented and summarized in (D4.5, 2024).

From March until October 2025 pilot partners have examined the initial pilot implementations summarized in D4.5 and further requirements as well as necessary adaptations such as technical integrations to enable flexibility activations according to concluded trades, recruitment of additional participants as well as platform developments to improve the TSO-DSO coordination tools. These adaptations and improvements help to ensure operational feasibility and to prevent the risk of dysfunctional or ineffective testing in WP6.

This deliverable presents the updated set ups of each flexibility market to be tested in WP6. Further adaptations and changes may be implemented throughout WP6 resulting from testing scenarios and results. An overview of the OPENTUNITY flexibility market set ups is presented on page 10.

Copyright statement

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1 Introduction

1.1 Background

The European Union is driving the transition towards a sustainable, low-carbon energy system, targeting a 50% share of renewable energy sources (RES) in the energy mix by 2030. Flexibility is one measure to make the grid more resilient and robust against the varying power generation patterns of RES while ensuring security of supply. This shift requires active participation from prosumers by offering their flexibility to adapt their energy consumption and generation according to the grid capacity limitations and/or needs. This dynamic interaction between grid operators and prosumers holds a large potential to support the grid stability together with the efficient use of resources. However, it also introduces complexity in managing distribution and transmission networks requiring enhanced data connection and exchange, and enhanced system operator (SO) communication and coordination. The OPENTUNITY project contributes to this transformation developing solutions within these four categories:

- **OpenSpace**: Secure data storage and exchange
- **OpenGrid**: Smart grid solutions for operators
- **OpenFlex**: Flexibility services for prosumers
- **Openability**: Interoperability of new and existing technologies

Task 4.5, in the OpenFlex category, focuses on the implementation and management of local flexibility markets. Flexibility markets enable SOs to access flexible assets in the distribution grid to adapt power demand to power generation and to adjust the use of the grid capacity accordingly. When implemented correctly, they can complement existing grid management tools, delay or replace infrastructure upgrades, and support regulatory evolution. However, their success depends on the local energy landscapes and infrastructure, and ultimately, the efficient integration and use of flexibility markets. In phase I of Task 4.5 the consortium partners focused on the role identification and the definition of the use cases to establish an appropriate market framework and design per pilot site. The results of this phase have been summarized in deliverable D4.5. Phase II from March until October 2025 aimed at fine-tuning the pilot set ups and the operational processes for flexibility procurement through iterative testing and discussions as well as tool adaptations, accordingly. This deliverable D4.6 describes the results of these adaptations and developments from this testing phase.

1.2 Scope of the document

This report is the follow-up report of D4.5 and presents the implemented details and final results of the OPENTUNITY pilot sites in Greece, Switzerland, and Spain. From March to October 2025 the pilots and the established flexibility markets performed tests to examine the technical and operational feasibility of each flexibility market pilot set up. The results contribute to WP6 by completing the value chains of the OPENTUNITY pilots.

1.3 Structure of the document

This Deliverable documents the adaptations and changes of each pilot and flexibility market solution implemented in Task 4.5. Deliverable 4.5 describes the general set up and use cases in detail. The present deliverable describes the implemented changes by providing a short summary and overview of each flexibility market in Chapter 2, followed by a more detailed description of the flexibility market adaptations per pilot site. Chapter 6 “Conclusion and outlook” briefly summarizes the conclusions as well as possible adaptations resulting from operations in WP6.

2 OPENTUNITY Flexibility Markets – Adaptations and refinements

Task 4.5 started in July 2023 introducing the pilot partners to the concept of NODES flexibility market, the market design, the rule book and the market requirements. This initiation of Task 4.5 was finalized with the definition of the roles, the grid problems and corresponding use cases per SO at every pilot location.

In January 2024, relevant pilot partners such as the SOs and Flexibility Service Providers (FSPs) were onboarded to NODES market platform to familiarize themselves with the necessary operations and to facilitate the identification of operational and data requirements. To ensure the correct functioning of the market set ups and the smooth integration into existing operational processes, initial testing was done in parallel before the official testing phase. Deliverable D4.5 presents the detailed set up of the local flexibility markets using NODES market platform for flexibility procurement at the pilot sites in Spain, Switzerland, and Greece prior to the testing phase in Task 4.5:

Spain: The pilot addresses voltage volatility due to increased renewable energy sources (RES) in the SOs network, mainly domestic PV panels. Anell (Distribution System Operator - DSO), Estabanell Impulsa (FSP), ETRA providing tools for grid state analysis, and HYPERTECH as the technical aggregator collaborate to engage residential prosumers with flexible assets to support grid resiliency and stability. The pilot examines the process of market-based short-term flexibility procurement and further evaluates technical feasibility, user engagement, and economic viability.

Switzerland: In Massagno, AEM (DSO) and SUPSI (FSP) examine the potential of the energy pool of the local community for grid services. The pilot tests the use of flexibility from real and simulated small-scale assets for peak shaving. In addition to the operational testing of flexibility activation, this pilot will examine the metering data and baselines requirements to validate the flexibility delivery.

Greece: The pilot explores market-based flexibility procurement in one market for IPTO (Transmission System Operator- TSO) and HEDNO (DSO) with simultaneous TSO-DSO coordination. The pilot examines the use of NODES market coordination tool including the coordinator role to supervise the market activity, dynamic grid node thresholds, an integrated traffic light system and integrated communication services. IPTO and HEDNO evaluate the operational process and coordination requirements for secure and reliable market-based flexibility procurement in terms of time management and problem resolution efficiency. The FSPs, HYPERTECH and ICCS, provide flexibility from real residential assets and simulated assets.

The testing phase started in March 2025 and finishes end of October 2025 with the submission of this deliverable D4.6. The objective of these field tests is the consecutive examination of flexibility procurement scenarios per pilot aiming at evaluating:

1. The usability and feasibility of the roles and developments identified in Task 4.5 in the operational value chain.
2. Identification of strengths and weaknesses of the developments and integration into the operational value chain.
3. Preparatory requirements for Pilot activities in WP6.

4. Evaluation of problems and challenges referring to the risks and mitigation measures.

The modifications include the adaptation of roles that were identified during the first phase of Task 4.5, adaptations of the market design and rules where needed, as well as the integration of new assets. The implemented adaptations shall ensure the reliability of the operational processes and help to mitigate possible risks.

The final market set ups and main features to start with in WP6 are summarized in the table below. The following chapters will describe the adaptations in more detail.

Pilot Country	Goal	Key Actors	Assets Involved	Triggering Event	Market Setup	Risk Factors	Mitigation Strategies
Spain	Enhance grid capacity and resiliency using residential flexibility	Anell (DSO), Estabanell (Aggregator), Hypertech (FSP & BFMS), ETRA, NODES (FMO)	Residential assets: air conditioning, heat pumps, electric boilers	Grid congestion and voltage volatility due to increased residential PV injection	Local flexibility market, continuous market clearing, Pay-as-Bid	Technical barriers, low user engagement, limited data volume, post-project sustainability	Use Wi-Fi extenders, monitor equipment, organize workshops, tune recruitment messaging, use open-source data, subcontract installers
Switzerland	Peak shaving at the secondary substation using local assets aggregation from the pilot site	AEM (DSO), SUPSI (FSP – real & virtual), Hypertech (BFMS), NODES (FMO)	Real and simulated residential and municipal assets: electric boilers, heat pumps, EV chargers	Daily peaks at the local MV/LV transformer	Local Flexibility market, continuous market clearing, Pay-as-Bid	Asset availability, control challenges, monitoring reluctance, data quality concerns	Expand asset pool, use proven control solutions, leverage trust with asset owners, validate data and baseline accuracy
Greece	Secure, scalable TSO–DSO coordination in a single flexibility market	HEDNO (DSO), IPTO (TSO), Hypertech (FSP), ICCS (FSP), NODES (FMO)	Residential loads, virtual batteries, solar plants, water heaters, air conditioning, simulated assets	Grid congestion (DSO) and balancing needs (TSO)	Integrated market with ShortFlex activation, multi-round coordination scenarios, continuous and auction-based market clearing	Communication issues, low prosumer engagement, lack of regulatory framework, trust concerns	Manual fallback communication, awareness campaigns, user-friendly platform, regulatory engagement, transparency and ethical guidelines

2.1 Spain – Using flexibility to enhance grid capacity and resiliency

The Spanish pilot explores the potential of residential assets to provide grid services in response to capacity challenges caused by the growing share of home PV installations. The pilot simulates real-time flexibility procurement through the NODES platform. Key stakeholders include Anell (DSO), Estabanell (Aggregator), and NODES (FMO). The market clears continuously applying pay-as-bid. Successful matches result in binding contracts, obliging the FSPs to deliver the agreed flexibility to the DSO. No settlement will be performed in this pilot.

This pilot serves as a baseline for NODES' business-as-usual operations and provides insights into integrating residential flexibility into grid management strategies.

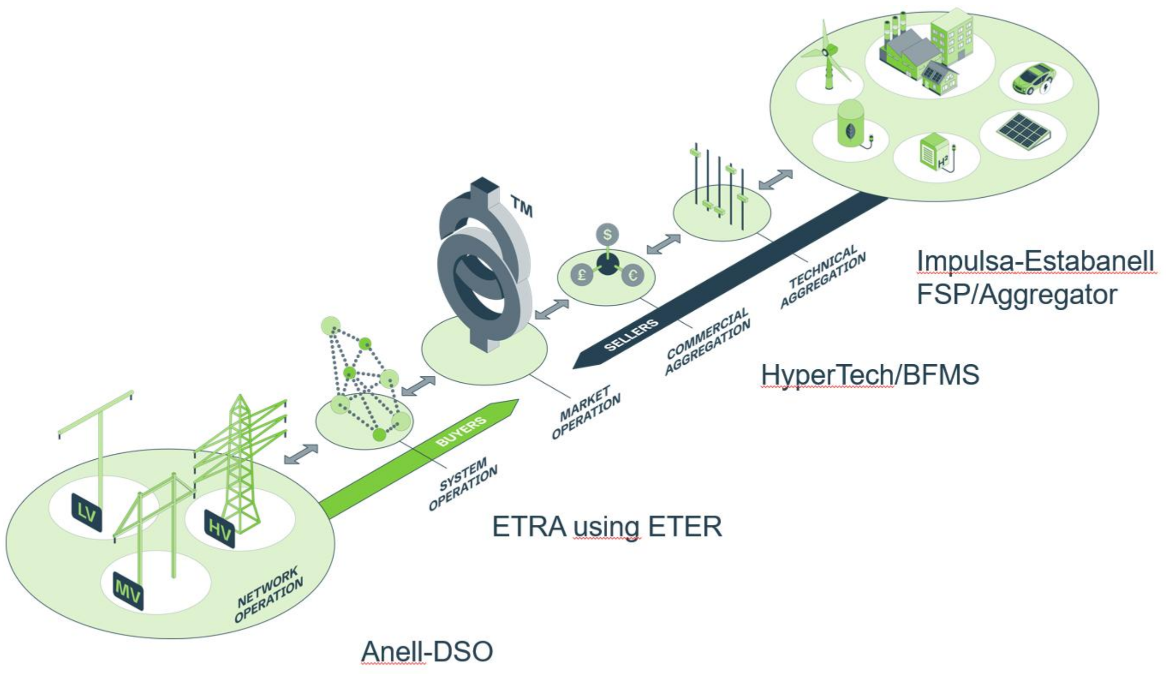
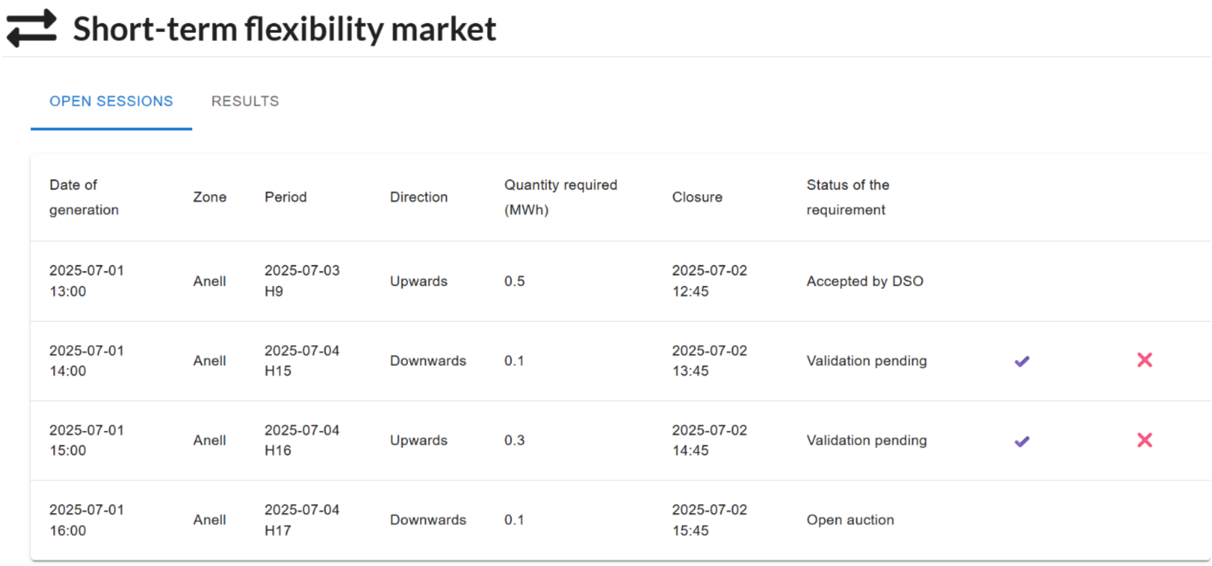


Figure 1: The flexibility value chain in the Spanish pilot

As a result of phase II the Spanish pilot has integrated new technology solutions by the consortium partners (Figure 1), ETRA for grid analyses and HyperTech as technical aggregator, to optimize the flexibility procurement process as needed: The operational processes related to grid state analysis and congestion detection have been extended by the technology provider ETRA and their technology solution ÉTER (D5.1 and D5.2). ETRA´s NILM application is interconnected to support HyperTech´s interaction and communication with its clients throughout the flexibility activation process.

Integration of ÉTER with NODES market platform

ETRA`s grid state analysis tool ÉTER has been integrated with NODES platform to simplify the operational steps of flexibility procurement for the SO, Anell, since it will only need to learn and operate the new software (ÉTER) for flexibility procurement, ultimately increasing the efficiency of operational processes. Once Anell has identified a congestion in the grid using ÉTER, the software directly places a corresponding flexibility request in the short-term flexibility market (ShortFlex™) on NODES Platform through its API (Figure 2).



Date of generation	Zone	Period	Direction	Quantity required (MWh)	Closure	Status of the requirement
2025-07-01 13:00	Anell	2025-07-03 H9	Upwards	0.5	2025-07-02 12:45	Accepted by DSO
2025-07-01 14:00	Anell	2025-07-04 H15	Downwards	0.1	2025-07-02 13:45	Validation pending
2025-07-01 15:00	Anell	2025-07-04 H16	Upwards	0.3	2025-07-02 14:45	Validation pending
2025-07-01 16:00	Anell	2025-07-04 H17	Downwards	0.1	2025-07-02 15:45	Open auction

Figure 2: ÉTER's UI for managing integration with Short-term flexibility (ShortFlex™) market

Estabanell Impulsa responds with flexibility offers using the forecasted available flexibility and the respective baseline of the controllable assets provided by HyperTech via the Building Flexibility Management System (BFMS).

The interconnection of these tools helps to augment the quality and representability of the created data during the tests performed in WP6, ultimately contributing to the following planned evaluations:

- The impact and efficiency of local flexibility as a grid service
- Price formation dynamics
- End-user and customer reaction to demand-side flexibility

From March until October 2025, several activities were undertaken to serve the technical needs of the pilot. From the DSO's side, to use ÉTER to identify present and future congestions and voltage volatility in the grid, the Anell`s grid topology was uploaded into ÉTER and the respective processes were set for sending real-time electrical data from the grid to ÉTER.

Aggregator setup and Integration of NILM application for client notification

Estabanell Impulsa underwent the transition from an energy retailer to an aggregator by adding new responsibilities in the role of the aggregator to its standard responsibilities as and energy retailer. Estabanell Impulsa explored and tested different options and providers for sensors and actuators for enabling the clients' participation in the flexibility market. Relays have been installed at the participants' households to measure their total consumption, the energy production of installed PV panels when applicable, and the individual consumption of flexible devices, namely air conditioning systems and heat pumps/electrical boilers. For activating flexibility, smart infrared remote controls for air conditioning and smart thermostats were also installed. Another key activity was the integration between ETRA and the sensors and actuators installed in the pilot, along with the integration between ETRA and HyperTech systems. Figure 3 displays the activation profile of Demand Response (DR) through residential appliances in the ETRA´s NILM application. These notifications are sent by Hypertech to notify the households about the flexibility activation of their appliances. Although it was not the initial purpose of NILM, it was decided that, the GUI of NILM will also display this information and thus reduce the number applications for the consumer, ultimately improving the efficiency of the operational process and enhancing the user-friendliness for consumers testing both NILM and Flexibility markets.

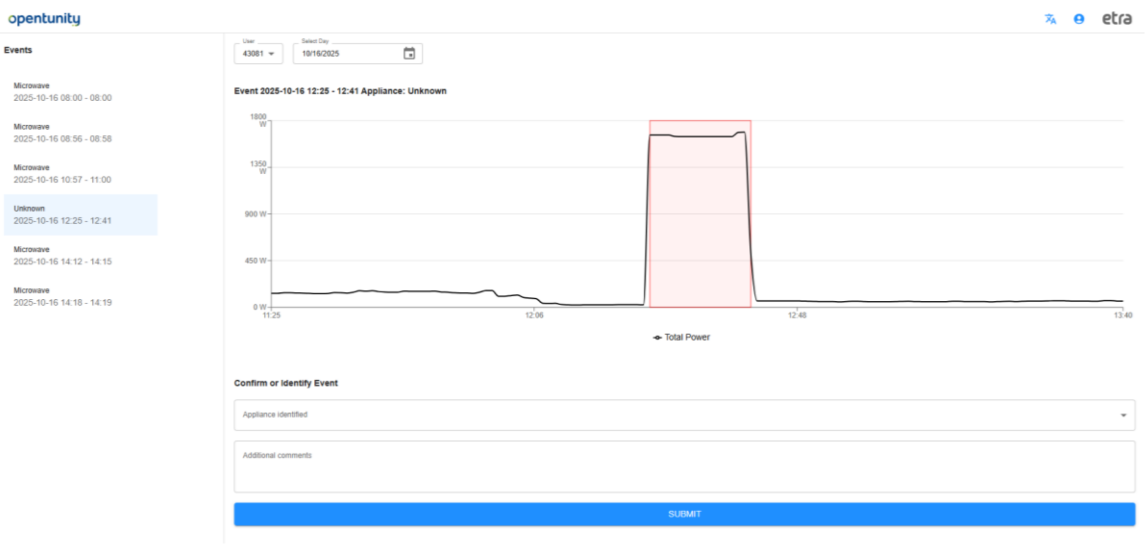


Figure 3: Flexibility activation displayed in NILM app.

A more detailed description of the integration between the BFMS, the Energy Management System (EMS) at the pilots and the NODES platform, is presented in more detail in deliverable 4.2.

The scenarios which have been described in D4.5 were reviewed in light of the following developments: Given that it was not possible to include EV charging stations compatible with the (Open Charge Point Protocol) OCPP protocol, it was not possible to have EVs as flexible assets in the Spanish pilot, thus the scenario concerning this asset won't be applicable.

A new scenario was designed, considering the interest of Estabanell Impulsa to further explore the potential of local flexibility markets. This scenario is based on the assumption that the aggregator is responsible for the deviation costs (that is, the penalty the retailer pays for the deviation of its clients' consumption from its forecast) when the deviation is due to the activation of flexibility. In this scenario, the aggregator will compare the energy prices and deviation to offer flexibility at a more competitive price. Electricity prices tend to be lower when there is more renewable energy available, and in the Iberic peninsula that is often photovoltaic solar energy. The increase in distributed photovoltaic installations behind the meter is one of the factors leading to over-voltage, one of the problems the DSO wishes to reduce with the flexibility market. It is expected that there will be an intersection between the moments in which the DSO wishes to buy flexibility and the moments of low electricity prices to incentivize consumption. In turn, consumption tends to spike in residential areas at early evening, potentially causing under-voltage and risk of congestion, another problem the DSO would request flexibility for. These are moments when the electricity price is higher, thus favourable for a decrease in consumption. As a conclusion, merely analysing the electricity prices, there seems to be an intersection between the interest of the DSO and the interest of the aggregator. However, deviation costs do not follow the same pattern as electricity prices, thus further analysis is necessary to understand when the aggregator should offer flexibility at a more competitive price. The aggregator can then either pass a share of the market profit to the clients or assure that they have a reduction on their electricity bill which justifies employing its services.

Risks and Mitigation measures

The risks that could arise during the development of the local flexibility market in the Spanish pilot are divided into three different types. The first type of risk involves technical risks that may impede the proper execution of the deployment and demonstration activities due to a technological barrier. The second category of risks is related to the participation of users during the implementation of the local energy flexibility market in the pilot. The third category includes risks associated with the continuation of the local flexibility market after the conclusion of the project. The definition of risks per category follows along with the mitigation strategy. During phase II of Task 4.5 the mitigation plans for risk prevention outlined below were addressed to reduce any potential disruptions. However, while their likelihood and potential impact have decreased overall, they cannot be excluded during the pilot execution. Consequently, the risks and implemented mitigation measures are updated as follows:

Technical Risks

Real-time connection
Description of the Risk: Lack of an automated and easy way to share real-time data from certain sources with the project partners.
Mitigation Plan: Work closely with the relevant departments of Estabanell and Anell`s SCADA and Advanced Supervision providers. The SCADA data shall be sent via MQTT, while the remaining data will be sent via SFTP to a server from ETRA.
Update: SCADA data is being sent via MQTT although some fine tuning is still required; Data from our Advanced Supervision and smart meters is being sent via SFTP to a server from ETRA. The setup for sending data from our AMI system via SFTP to ETRA is almost complete.

Observability in local flexibility market pilot area
Description of the Risk: Given that the Advanced Supervision implementation is ongoing in our grid, and that Advanced Metering Infrastructure data is not always available, these data might not be available for the smart meters of the participants from the local flexibility market pilot and respective secondary substations, which will complicate the calculation and prediction of congestion and voltage volatility in the relevant grid areas.
Mitigation Plan: Work closely with the relevant departments of Anell and monitor the situation as new participants register to the pilot. Use state estimation to calculate missing values.

Update**:** Significant advances have been made for covering the pilot participants with our AMI system; however, this was not possible in some cases for technical reasons. In these cases, the intention is to use our advanced supervision and submetering data.

Flexibility Service Provider Role
Description of the Risk: Lack of experience for fulfilling some of the activities as a flexibility service provider.
Mitigation Plan: Work together with the partners involved in the local flexibility market, to exchange knowledge and support.
Update: Estabanell Impulsa explored the market functionalities for FSPs. Furthermore, Estabanell Impulsa evaluated providers for sensors and actuators for enabling flexibility activation at participants' homes.

Fail to activate flexibility for technical complications
Description of the Risk: Failing to activate flexibility when requested for technical reasons, such as sensor/actuator failure or lack of connectivity.
Mitigation Plan: Install Wi-Fi extenders when needed. Monitor equipment performance and connectivity.
Update: Wi-Fi extenders were installed where needed.

Fail to activate flexibility overall
Description of the Risk: Failing to activate flexibility when requested even though the request is fulfilled, because another neighbour changes their consumption patterns in such a way that overall, there is no change in the consumption in the area.
Mitigation Plan: Monitor the whole area and see if more flexibility requests are needed to fulfil our goal.
Update: To be applied during pilot execution.

Fail to detect activated flexibility
Description of the Risk: Failing to detect activated flexibility using the baseline and detection algorithm.
Mitigation Plan: Have regular communication with the end-users to know their perspective and share that information with the technological developers.
Update: This risk has been mitigated by installing sensors for measuring the individual consumption of the flexible assets, collecting events/logs from the actuators and from how the context for flexibility activation has been planned.

Human resources limitations
Description of the Risk: Lack of human resources for installing the necessary equipment.
Mitigation Plan: Work closely with the relevant departments of Estabanell. Subcontract personnel if necessary.
Update: Coordinated with the relevant departments of Estabanell.

Time limitations
Description of the Risk: Delays in the implementation and execution of the pilot due to, amongst other things, some trial and error, low responsiveness from the participants, extension of the recruitment for the pilot with a citizen engagement workshop, may complicate finishing the pilot in due time.
Mitigation Plan: Keep track of different milestones and predict the needed time to complete the upcoming ones.
Update: Coordinated with the relevant departments of Estabanell and project partners.

Citizen Engagement Risks

Small number of participants
Description of the Risk: Lack of clients interested in participating in the NILM or local flexibility market pilots, in other words, use cases 1.2, 1.8 and 1.10.
Mitigation Plan: Reach to a bigger pool of people, focus on the identified key messages and highlight the advantages of participating in the pilot for them. Organize a citizen engagement workshop with a second recruitment round, where we can already present a first version of the tool.
Update: There is a small number of participants in the pilot, despite having organized two recruitment rounds, citizen engagement workshops, explored different communication channels. However, the figure is enough to perform a proof of concept for the scenarios explained previously which are the main interests for the pilot site.

Low responsiveness from participants
Description of the Risk: Participants show little activity and responsiveness to our communications, delaying and hindering the gathering of information, pilot planning, and feedback collection. This affects use cases 1.2, 1.8 and 1.10.
Mitigation Plan: Tune the key message and recruitment campaign to a client profile which tends to be more actively involved and who has interest in sustainability and/or new technologies.
Update: Low responsiveness was an issue during the process of capturing participants; with those who are participating the communication is fluid.

Small volume of data
Description of the Risk: As a consequence of low participation, and/or late registration in the pilot, the number of clients participating and the duration of their participation is low, leading to small volumes of data. This affects use cases 1.2, 1.8 and 1.10.
Mitigation Plan: Use open-source data for an initial version of the models to be developed.
Update: The NILM algorithm (explained in D4.2) was initially trained with open-source data. The data provided by pilot has been sufficient for training the NILM algorithm for new assets such as air conditioning and thus provide insights for assets' baseline calculation for flexibility calculations.

Fail to activate flexibility due to user's counteraction
Description of the Risk: Failing to activate flexibility because the requests don't match the users' needs, who then counteract on the activation.
Mitigation Plan: Understand the clients' limitations and priorities and take them into consideration when optimizing and calculating from which users to harness the needed flexibility.
Update: Comfort preferences from the end-users have been gathered and shared with technical developers.

Exploitation Risks

Product's user-friendliness
Description of the Risk: Final product is not user-friendly, which hinders its future adoption by the DSO or the end-users' interaction with it.
Mitigation Plan: Work closely with the developers of the product interface, provide them with feedback from the end-users (DSO staff or clients, depending on the use case).
Update: Feedback has been provided to the developed tools by Anell and Estabanell Impulsa, and it will continue to be. Feedback has also been gathered informally from some participants and more will be gathered in a formal way. The utilization of ÉTER as an interface with NODES platform also facilitates user-friendliness of the tested framework.

2.2 Switzerland - Peak shaving at the secondary substation using local assets

The Swiss pilot will explore the operational feasibility of using local residential and municipal assets for the optimization of the peak demand at the local secondary substation. Led by AEM (DSO), with SUPSI (FSP), HyperTech (BFMS), and NODES (Flexibility Market Operator - FMO), the pilot will test the procurement and activation of flexibility from heat pumps, electric boilers and EV chargers. The operations are mainly focused on testing asset activations. Nevertheless, asset simulations will be considered in the analysis to provide a comprehensive overview of the impacts resulting from an extended flexibility aggregation. The process and related context of the operational value chain in the Swiss pilot (Figure 4) is described in more details in D4.5.

The separate steps of the operational value chain in the Swiss pilot are as follows:

1. HYPERTECH forecasts the baseline and available flexibility using the asset and meter data of the controllable assets received in step 0 from AEM.
2. SUPSI (step 1), the FSP/Aggregator aggregates the assets in a portfolio and calculates a respective portfolio baseline.
3. SUPSI uploads the baselines per portfolio to NODES platform.
4. AEM places a buy order on the market platform (2).
5. SUPSI as the FSP places sell orders on the NODES platform. NODES clears the market continuously applying Pay-as-Bid (3).
6. FSPs and the DSO get notified when corresponding orders match (4).
7. SUPSI communicates the list of assets and the corresponding setpoints to dispatch to the EMS manager (5).
8. Control signals are then sent to the pilot leader AEM (6) to proceed with the actual activations and service delivery (7).
9. NODES validates the delivery of flexibility from the FSP to the DSO using metering data and the baselines per portfolio.

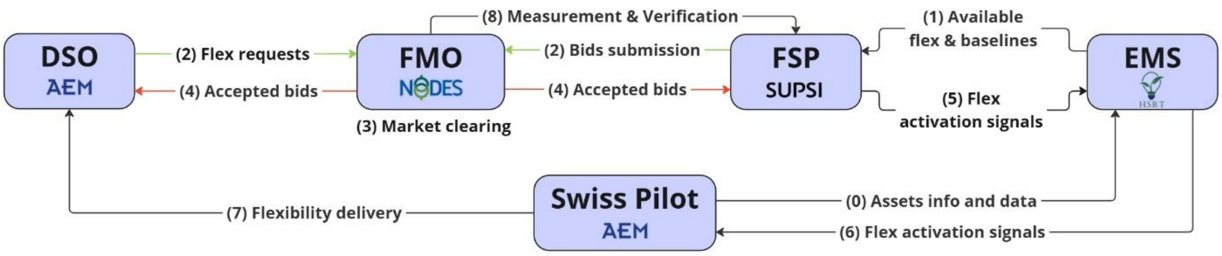
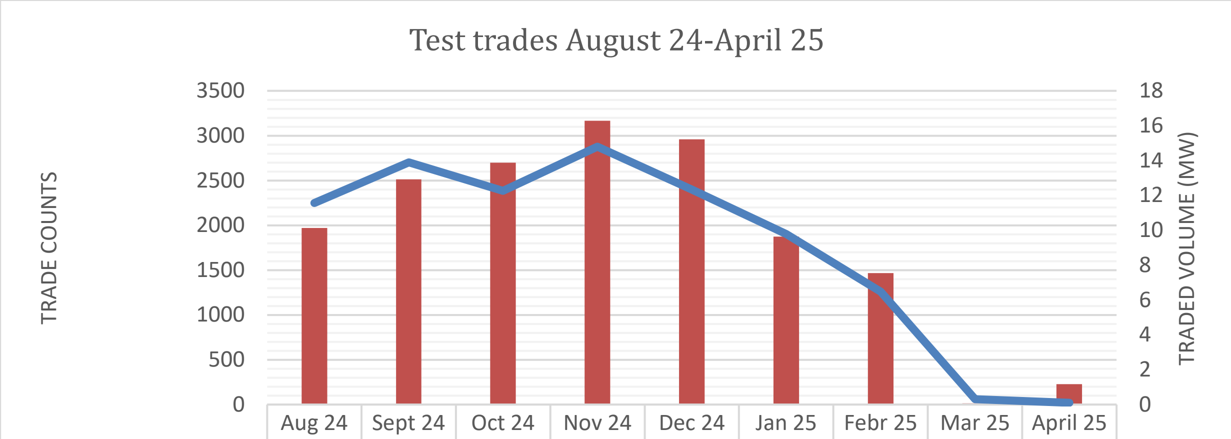


Figure 4: Operational steps and interaction along the flexibility value chain

Operational processes and data exchange

During the first phase of Task 4.5 AEM and SUPSI have successfully integrated with NODES Platform and API to examine steps 2. – 4. The submission of buy orders and sell offers by the DSO AEM and the FSP SUPSI, respectively, has been automated ensuring the correct functioning of the technical processes and the data flow between the buyer, sellers and NODES platform. As a result of this automation SUPSI and AEM traded 86.87 MW in a total of 15,862 trades from August 2024 until April 2025 (Figure 5), verifying the correct data exchange and API interaction.



	Aug 24	Sept 24	Oct 24	Nov 24	Dec 24	Jan 25	Febr 25	Mar 25	April 25
Traded Volume	10,124	12,931	13,877	16,283	15,213	9,632	7,543	0,075	1,177
Trade Count	2250	2702	2385	2877	2397	1903	1259	61	20

Figure 5: Number of test trades and respective volume from August 24 to April 25

However, these trades are performed to ensure the operational process without consideration of any grid constraint or grid specific context. The aim of phase II in the Swiss pilot was to ensure the participation of sufficient assets, as well as data availability and quality to execute flexibility activations in WP6 and hence to examine the entire flexibility value chain including the validation of delivery using metering data and baselines.

In the pilot SUPSI represents the two FSPs, one representing the real assets and one representing the simulated assets. The idea of this separation is to create a more realistic market set-up but also to examine the different types of assets, the respective flexibilities and implications for the baseline calculations.

The foundation for the flexibility procurement and evaluation objectives in WP6 was set by AEM and SUPSI through the development of the DSO and FSP modules and activation control testing during Task 4.5 to facilitate the correct operations along the entire flexibility value chain.

DSO and FSP modules integration with NODES platform

For the platform implementation as described above, the DSO and FSP, i.e. AEM and SUPSI, respectively, collaboratively ensured the platform integration with the pilot infrastructure developing dedicated services to automatically submit bids and offers on the market.

On the FSP side the work included implementing FSP price control by considering activation costs and potential gains based on forecasting (with higher forecasts allowing the FSP to demand higher prices). A dynamic pricing mechanism for DSO requests was developed, incorporating both forecasting and risk probability (with the DSO willing to pay more at the end of the month when a new peak would cause greater damage). A dynamic quantity mechanism was also designed, featuring a forecasting-based margin above which the DSO requests flexibility, a safety threshold that accounts for risks, and a threshold updated with historical data (not yet in use since flexibility is not currently activated).

On the technical side, all modules (DSO, FSP, Baseline Updater) were integrated, a temporary forecasting solution was implemented while awaiting real forecasts, and comprehensive logging was introduced. At AEM, the system was deployed as a 24/7 Docker service on AEM servers, initial parameter tuning (prices, margins, etc.) was performed, and service monitoring was established.

Flexibility activation tests

Before the start of market operations in WP6, dedicated internal tests were required for the assets to verify their control actions and the behaviour of the different technologies. Between July and August 2025, AEM completed the necessary installations and set up of the required communication mechanisms to conduct functional testing on the most relevant assets in September 2025.

Two heat pumps from the Swiss pilot site, with the anonymised IDs ECM96 and EMC97 located in municipal buildings were tested. ECM 96 uses a combined solution of a heat pump and a gas boiler to generate heat and domestic hot water, with the gas boiler serving as a backup for peak demand. At ECM 97, a large system consisting of two heat pumps working in parallel is currently in use. The systems preheat thermal storage tanks, from which hot water is supplied when the programmed setpoint is reached.

As shown in Figure 6 and Figure 7, both heat pumps operate in automatic mode by default. This means that, in the absence of external input such as flexibility activations, they follow their schedule (blue curve). Override control signals as a result of flexibility activations on NODES platform (orange curve) can be sent to modify the programmed command by turning off the heat pump or turning on the system if needed.

As shown in the figures, both systems successfully passed the individual control tests. This provides flexibility and guarantees integration into the AEM R&D API. This integration provides external partners with access to their control systems and, during the final testing phase, allows activation of the awarded flexibility.

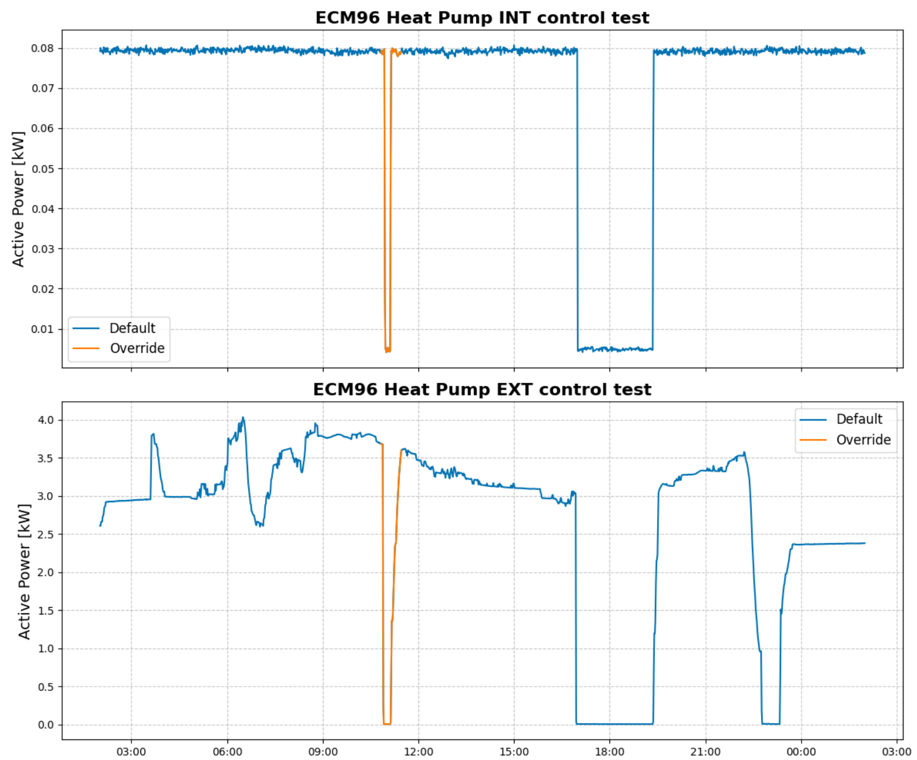


Figure 6: ECM 96 heat pump control test

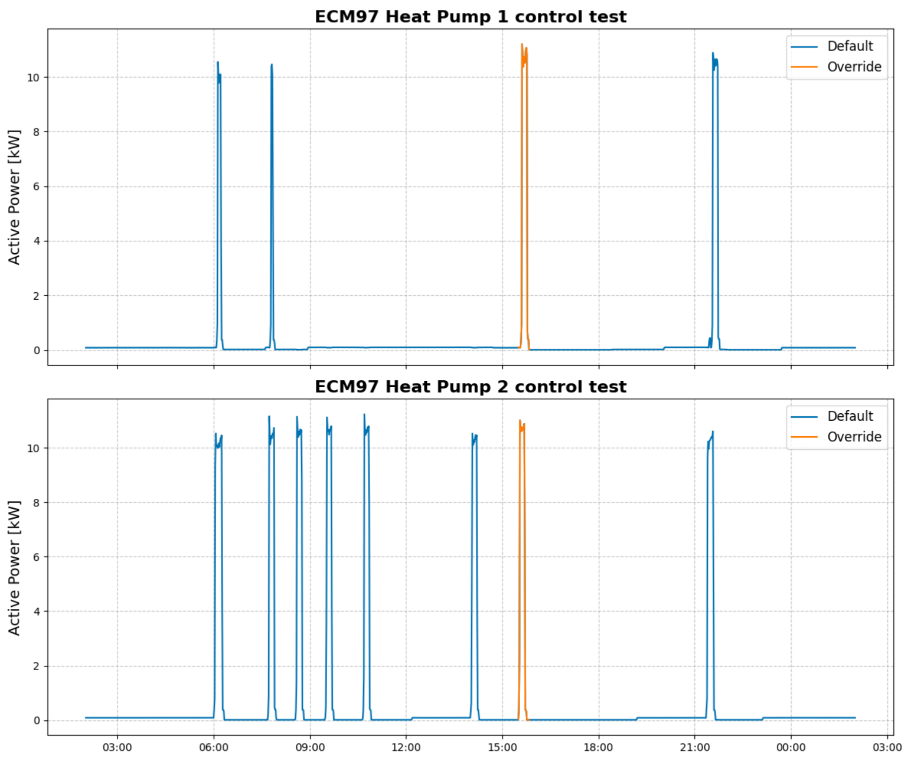


Figure 7: ECM 97 heat pump control test

The same results were achieved when controlling one sample of the V1G EV charger (Figure 8). Two tests were conducted: one with power limitation of the charging session (orange curve), and one with a complete stop of the session followed by a restart (green curve).

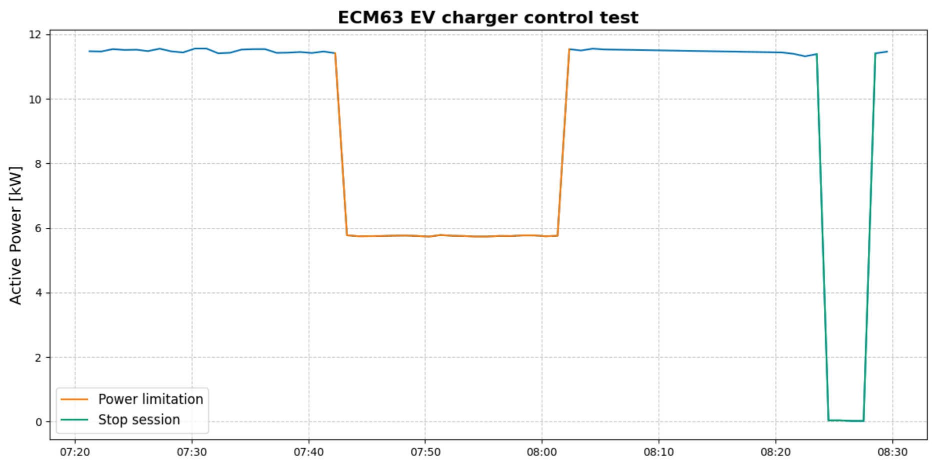


Figure 8: ECM 63 EV charger control test

The operational testing in WP6 will provide insights into the effectiveness of flexibility in optimising daily peaks in AEM's local distribution grid. This economic optimisation is essential to reduce the power tariffs both of the DSO's and end users' and to provide cost savings options in addition to better network management. Furthermore, analysis of the future usage of flexibility will be conducted, considering the potential to scale the solution upwards to all secondary substations in the AEM grid, as well as considering other flexibility use cases, such as congestion management or voltage control.

Risks and Mitigation measures

With the adaptations described above, most risks outlined in D4.5 have been successfully reduced or solved. However, entering into a more mature phase of flexibility market testing, new risks could arise during the development of the local flexibility market in the Swiss pilot scheme which fall into two categories. The first category involves technical risks that could hinder the proper execution of deployment and demonstration activities due to technological barriers. The second category relates to user participation in the implementation of the local energy flexibility market in the pilot scheme. The definition of each risk category, along with the mitigation strategy, is provided below:

Technical Risks

Asset monitoring
Description of the Risk: Lack of asset monitoring in the pilot site
Mitigation Plan: AEM works closely with the municipality and the residential users directly in the area of the pilot site. After the engagement activities, assets under control were equipped with sensors and gateways specifically installed to guarantee the real-time monitoring and the asset control.

Data quality
Description of the Risk: Risk of missing or unreliable data due to sensor faults or communication failures at the pilot site.
Mitigation Plan: AEM's R&D database and data management platform are equipped with a monitoring module that has basic yet essential features for analysing missing communication with sensors and searching for missing data or outliers.

Data observability
Description of the Risk: The Advanced Metering Infrastructure (AMI) system gathers data from all customers within the AMI territory. As the frequency of reading 10,000 points of delivery (PODs) from smart meters cannot be the same for all areas, there is an average offset of six hours in data transmission across the entire grid.
Mitigation Plan: AEM is responsible for constantly checking the quality of communication between the data concentrators used to collect data from smart meters in the pilot area. It is also responsible for verifying that the sensors' clocks are correctly synchronised.

EV charger control availability
Description of the Risk: Public EV chargers cannot guarantee fixed charging times, and their availability is extremely difficult to predict. Therefore, if the vehicle or vehicles are not charging within the required timeframe, it is possible that market demand cannot be met.

Mitigation Plan: Considering that a business case based on controlling public EV chargers usually involves oversized portfolios where flexibility is not 100% ideal, a sufficient buffer is required to maximise activation probability. To address this issue, AEM will ensure that a vehicle is in charging mode at each EV charger during the validation tests.

Citizen Engagement Risks

Small number of participants
Description of the Risk: Lack of end-users interested in participating in the test of the service
Mitigation Plan: Given the legislative complexity of gathering one-minute data from end users, the AEM approach will focus on engaging at least one customer with a long-standing relationship with and trust in the company in the testing tool. Local flexibility: analysis and inspections will be conducted in all buildings in the energy community. If necessary, the community will be extended to include all end users in the same pilot feeder. The scope of AEM is to prove the concept of use cases related to the flexibility market. The task will then be considered complete when all relevant asset technologies are on the market. To analyse the potential scalability of the service to cover the entire feeder, other uncontrollable assets will be simulated.

Lack of responses from participants
Description of the Risk: residential customers, especially those living in condominiums managed by a real estate agency, are usually difficult to be engaged, due to lack of interest and limited benefits.
Mitigation Plan: in addition to conducting residential engagement in the building as part of the pilot site, AEM will also engage with the local municipality responsible for managing two relevant buildings at the pilot site.

Flexibility activation failure
Description of the Risk: Flexibility is failing to be activated because the requests do not match the users' needs or affect their comfort.
Mitigation Plan: as this only affects the flexibility of the thermal systems - the only assets installed at the customer's premises in the pilot - AEM has planned to mitigate this risk by carrying out additional checks and verifications before activating the controls. The inspection will also focus on systems with preheating, avoiding changes to the direct heating of buildings or their domestic hot water demand.

2.3 Greece – Market-based flexibility procurement with simultaneous TSO–DSO coordination

The Greek pilot aims at establishing one integrated flexibility market with simultaneous TSO-DSO coordination. While phase I of Task 4.5 served to understand and identify necessary processes and tool requirements for TSO-DSO coordination, phase II was conducted to improve the process flow and the functionality of the developed tools. Consequently, phase II serves for the conceptual and operational integration of the tools and coordination activities in the process of market-based flexibility procurement.

Flexibility procurement timeline

As a result, the market design has adopted the new market timeline (Figure 9) which was implemented in an iterative process and based on continuous testing and discussions with HEDNO (DSO) and IPTO (TSO) partners during phase II. The timeline defines the sequence of market operations to ensure alignment with existing processes and other market frameworks. For IPTO, it is crucial that this timeline corresponds to the national Balancing Market Rulebook and guidelines, and that it integrates seamlessly with the internal Integrated Scheduling Process (ISP). The ISP addresses forecasted generation-demand imbalances and secures the necessary reserves to maintain grid stability. The ISP produces a market schedule in 15-minute intervals, determining awarded balancing capacities for Frequency Containment Reserve (FCR), automatic Frequency Restoration Reserve (aFRR), and manual Frequency Restoration Reserve (mFRR), using a Mixed-Integer Linear Programming (MILP) model to minimize zonal imbalance costs. This co-optimization process considers both energy and capacity bids, system constraints within the Hellenic Electricity Transmission System (HETS), and operator requirements, aiming to minimize the overall cost of balancing services. The process operates on a day-ahead basis, optimizing the procurement of balancing capacity through offers submitted by Balancing Service Entities (BSEs). The ISP's is usually solved 3 times per day, but there can be an ad-hoc solution for unexpected incidents.

Considering the operational and coordination requirements of IPTO and HEDNO, the integrated Local Flexibility Market (LFM) in the pilot site operates through a four-round timeline, with market clearing being executed in three of the rounds, as presented in Figure 9. Round I, ending at 14:00 on the day before delivery (D-1), collects flexibility offers to inform the SOs and as data input to the ISP without any market clearing. Round II (14:00–16:15) allows FSPs and SOs to submit updated bids until 15:15, followed by a 30-minute coordination phase where the DSO and TSO assess potential grid constraint violations. This round concludes with a manually triggered auction to match bids and offers.

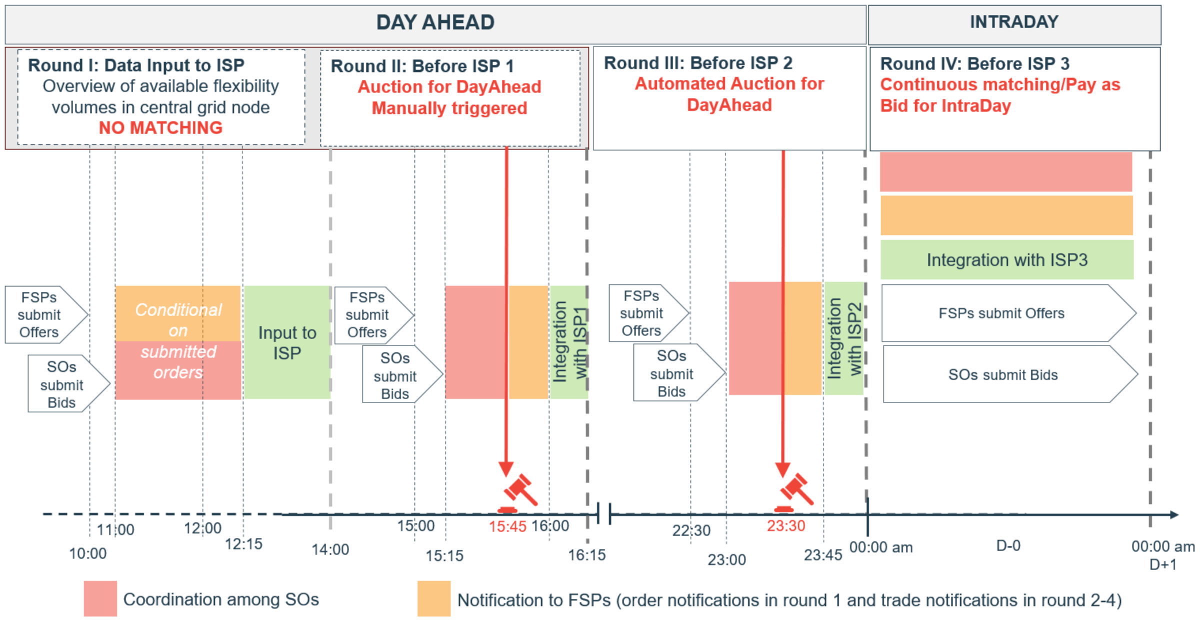


Figure 9: Time line for market operations in the LFM at the pilot site

Trades resulting from this process are binding, and FSPs are notified of their delivery obligations. Between 16:00 and 16:15 on D-1, these results are integrated into ISP1. Round III follows the same structure but applies an automated auction, with operations continuing until midnight on the dispatch day (D), when ISP2 is finalized. Round IV functions as an intraday market, with continuous market clearing applying pay-as-bid. During this phase, SOs and FSPs can permanently submit offers and bids, respectively. TSO–DSO coordination is maintained throughout the entire flexibility procurement process.

Adaptations of the rulebook may be considered throughout WP6 to further align the market operations with the SOs `operational processes and coordination requirements.

NODES Market Coordination Tool

The timeline for flexibility procurement at the pilot site (Figure 9) includes reserved time slots for TSO-DSO coordination to prevent and avoid that activation of flexibility violates any capacity limits in the distribution and transmission network. During Phase I of Task 4.5 and summarized in D4.5, the required coordination and communication tools have been developed. These include:

a. Establishment of a Coordinator Role in the flexibility value chain
b. Dynamic grid nodes thresholds
c. Dedicated market communication tool

During Phase II and in close collaboration with HEDNO and IPTO, these tools along with their functionality and usability, have been refined to improve their effectiveness. The result, the Market Coordination Tool, is designed to streamline collaboration between System Operators (SOs) during the flexibility procurement process. It now incorporates several refined key features such as the Coordinator Role (CR), dynamic grid node thresholds, and indirect and direct communication mechanisms, ie. a traffic light system and an integrated messaging service, respectively:

Coordinator Role (CR)

Within the NODES platform, the CR serves as a supervisory function that oversees market operations and supports decision-making when coordination between the TSO and the DSO is required. Depending on the scenario, the CR may be assigned to HEDNO, IPTO, and/or NODES.

Dynamic Grid Node Thresholds

Each SO can define and adjust capacity thresholds for the grid nodes within their control (Figure 10). These thresholds help to ensure that flexibility activations remain within safe limits. When a flexibility request is submitted, the threshold per grid node is communicated to the buyer, ie. HEDNO and IPTO, via the platform's traffic light system.

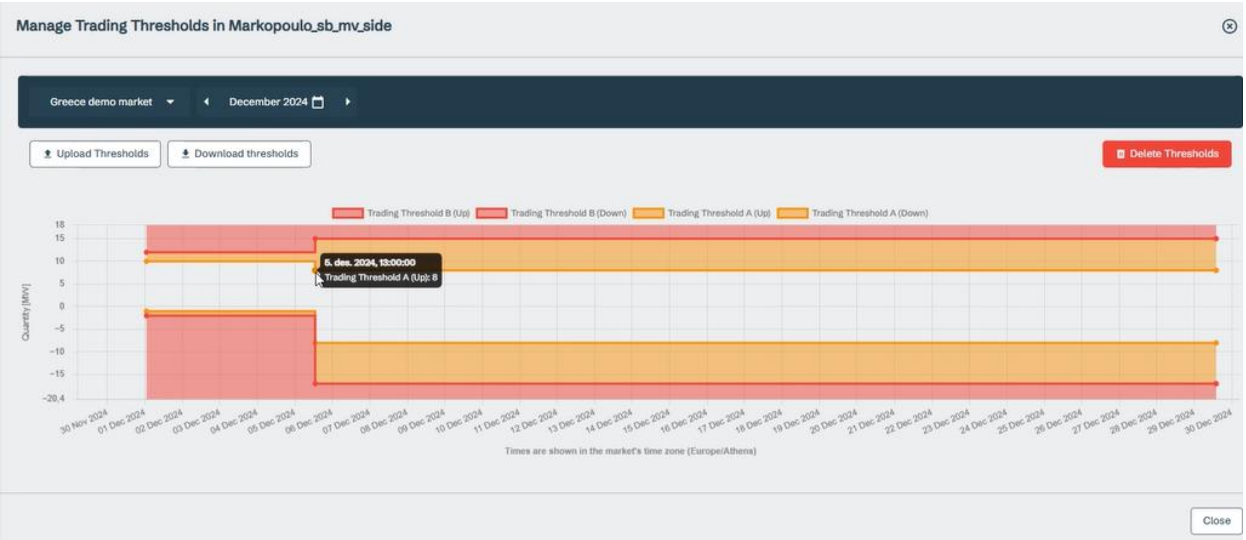


Figure 10: Insertion of capacity thresholds per grid node

Traffic Light System

When a SO places a flexibility purchase order in an order book, the request is evaluated against the predefined grid node thresholds. Possible violations as a result of the buy order are communicated using the traffic light system both upon order creation and in the order book (Figure 11). For the purpose of TSO-DSO coordination the settlement imbalance periods in the Greek market, 15min trading slots, are marked with the respective traffic light indicating the time slots where coordination is required. The traffic light system is only visible to the buyers, ie. SOs, highlighting:

"Green light" displayed without any colour: Normal conditions—activation is allowed without restrictions.

Yellow: Potential grid issues—coordination is required.

Red: Flexibility activation violates grid constraints—the request may be rejected according to the market rule book as a result of TSO-DSO coordination.

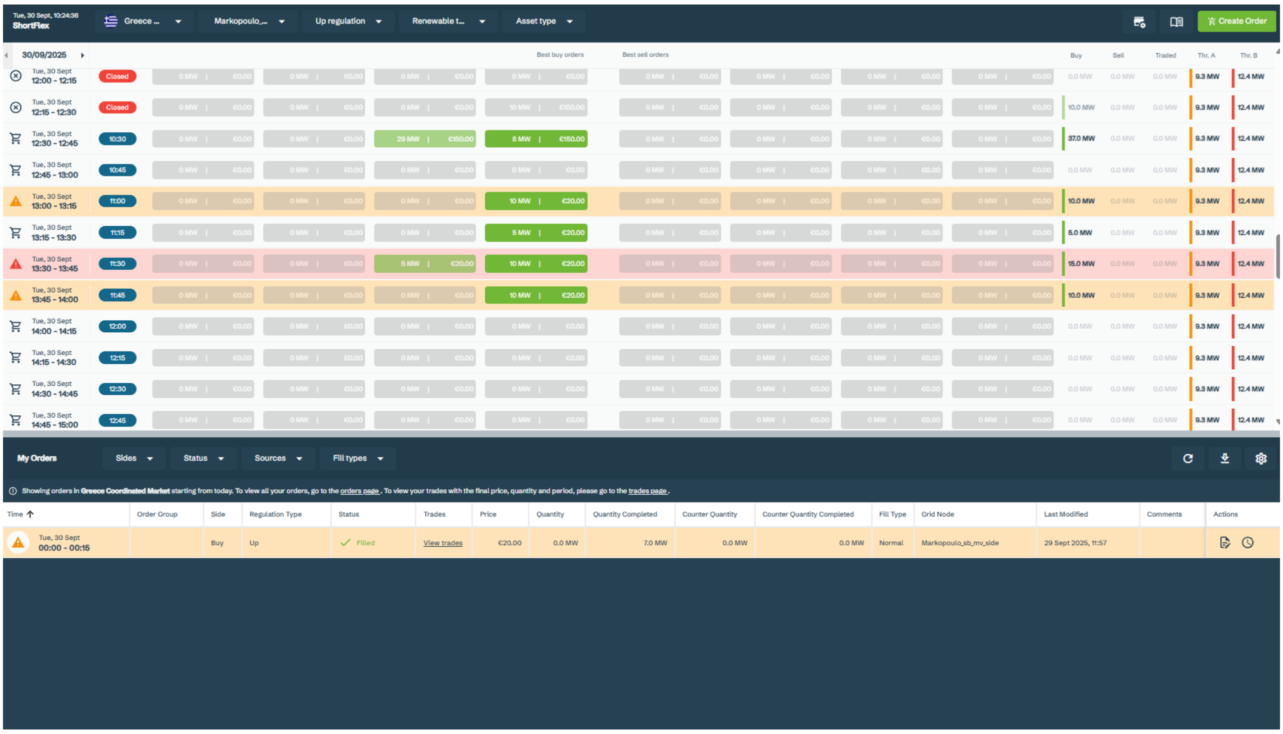


Figure 11: Traffic light system highlighting timeslots with bids exceeding the grid node threshold

<u>Market Coordination Messages</u>

A built-in messaging service on the NODES platform enables real-time communication between SOs to support collaborative decision-making Figure 12).

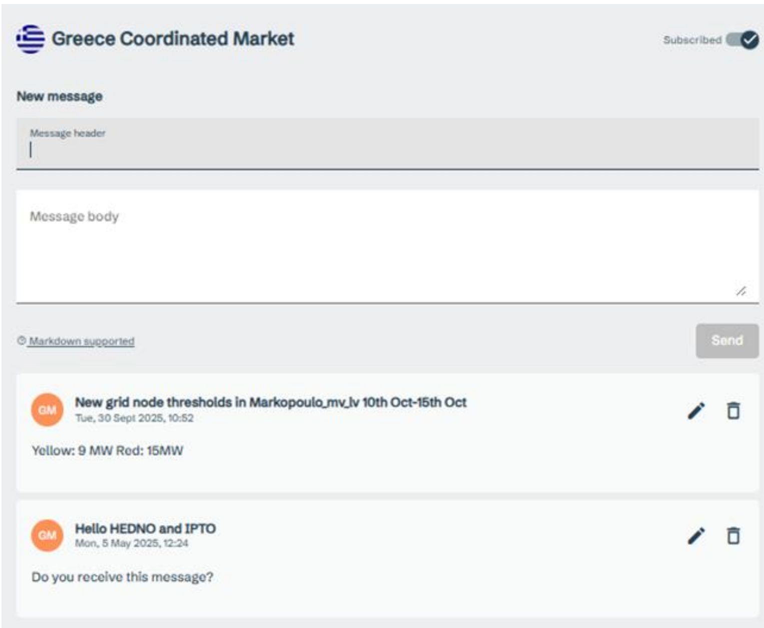
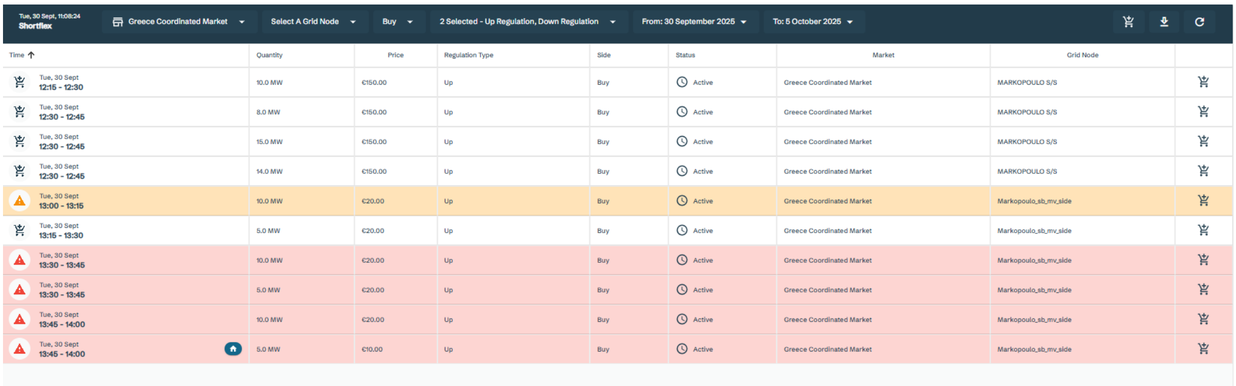


Figure 12: Market messaging service for CR

NODES Market Coordination Tool including the CR, dynamic thresholds, and communication tools sets the coordination framework to enable secure and efficient flexibility activations across different grid levels. This system is scalable and supports the broader implementation of an integrated flexibility market across Greece.

In addition to the Market Coordination Tool further mechanisms have been integrated in the platform to increase visibility and simplify coordination, such as:

- Flagging of your own bids – to help identifying your own bids on the market
- Creation of a corresponding order list per grid node (Figure 13). This list summarizes all existing offers and volumes per order book and can be used as input for TSO-DSO coordination as well as power flow analysis.



Time	Quantity	Price	Regulation Type	Side	Status	Market	Grid Node
Tue, 30 Sept 12:15 - 12:30	10.0 MW	€150.00	Up	Buy	Active	Greece Coordinated Market	MARKOPOULO S/S
Tue, 30 Sept 12:30 - 12:45	8.0 MW	€150.00	Up	Buy	Active	Greece Coordinated Market	MARKOPOULO S/S
Tue, 30 Sept 12:30 - 12:45	15.0 MW	€150.00	Up	Buy	Active	Greece Coordinated Market	MARKOPOULO S/S
Tue, 30 Sept 12:30 - 12:45	14.0 MW	€150.00	Up	Buy	Active	Greece Coordinated Market	MARKOPOULO S/S
Tue, 30 Sept 13:00 - 13:15	10.0 MW	€20.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side
Tue, 30 Sept 13:15 - 13:30	5.0 MW	€20.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side
Tue, 30 Sept 13:30 - 13:45	10.0 MW	€20.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side
Tue, 30 Sept 13:30 - 13:45	5.0 MW	€20.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side
Tue, 30 Sept 13:45 - 14:00	10.0 MW	€20.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side
Tue, 30 Sept 13:45 - 14:00	5.0 MW	€10.00	Up	Buy	Active	Greece Coordinated Market	Markopoulo_sb_mv_side

Figure 13: List view of bids and orders with integrated traffic light system to facilitate coordination

Further improvements regarding the auction market clearing and the traffic light system may be integrated during WP6 as part of the continuous discussion and testing cycle within the Greek pilot consortium.

Coordination Scenarios

Despite the implementation of the Market Coordination Tool, TSO-DSO coordination remains complex and time consuming. It is in the interest of the SOs to balance the coordination efforts with operational effectiveness and efficiency. Therefore, one part of the testing activities in WP4 and WP6 include an evaluation of coordination activities in terms of problem resolution efficiency and time management. The CR plays a central part in managing market activities and resolving potential conflicts between the TSO and the DSO during flexibility activation across grid levels. To improve the balance of additional operational requirements due to coordination efforts, three scenarios are examined to evaluate to which extent coordination tasks and functions can be executed by the FMO, and/or automated in the long term.

Three distinct CR configurations are tested:

Scenario 1: CR assigned to the FMO

Scenario 2: CR held jointly by both SOs (IPTO and HEDNO) for yellow traffic light scenarios while NODES solves green and red traffic light scenarios according to the rule book.

Scenario 3: A hybrid model where CR is shared between SOs and FMO based on event criticality.

Each scenario is evaluated against its efficiency in resolving grid issues, grid-wide optimization, implementation complexity, and communication needs. The goal is to identify a coordination model that is neutral, scalable, timely, and operationally effective. The metrics for each of the scenarios will be:

1. Time required for coordination, ie. coordination time under/above 30 min according to the time line.
2. Number of traffic light cases solved (yellow and red).
3. Total activated volume (MWh) per trading period as an indicator for possible alternative measures to solve grid constraints.

Scenario 1: Flexibility Market Operator as Coordinator

In this centralized model, NODES acts as the sole Coordinator under all operational conditions. Management of flexibility requests triggering a red traffic light must be pre-defined in the rule book and may result in automatic rejection/deletion of the order. Green-light requests proceed without intervention. For yellow-light cases, NODES will equally apply solutions agreed and documented in the market rulebook.

This approach offers high automation and transparency, reducing delays in conflict resolution. However, it limits the involvement of SOs, potentially leading to suboptimal flexibility activations. Moreover, reliance on static rules may hinder adaptability in dynamic grid conditions, increasing the risk of misalignment with real-time operational needs.

Scenario 2: Hybrid Coordination

In the hybrid setup, NODES retains the CR for green and red traffic light cases, while yellow-light requests are managed jointly by IPTO and HEDNO. This model increases SO engagement, allowing expert judgment in complex situations. The resolution process may involve negotiating alternative flexibility options—such as adjusting volumes or selecting different assets—to meet both operators' needs without breaching grid constraints. While this enhances decision quality, it may introduce delays due to the time required for bilateral coordination. Diverging priorities between SOs could also prolong conflict resolution.

Scenario 3: Multi-Level Coordination with Prioritization

This scenario introduces a dynamic CR assignment based on the criticality of the event. NODES manages green and red traffic light cases. For yellow-light requests:

- High-criticality events (those nearing grid thresholds) are handled by IPTO and HEDNO.

- Low-criticality events are managed by NODES, following procedures outlined in the rule book.

This differentiated approach ensures strategic oversight for grid-sensitive situations while maintaining efficiency for routine cases. It optimizes SO involvement and reduces delays in low-risk scenarios. However, the dynamic reassignment of the CR role adds complexity and requires dynamic and effective communication. Furthermore, it requires a clear categorization of criticality levels and related actions.

The scenarios will be tested and adapted throughout WP6 testing. The continuous examination of the Greek pilot set up with the predefined timeline, TSO-DSO coordination tools and the scenarios during WP6 will provide valid insights into necessary adaptations of the market design and rule book as well as useful coordination mechanisms. The aim is to implement technological solutions together with an operational process flow that helps to prevent and reduce congestion in the distribution grid and facilitate access to flexibility for the TSO for balancing services.

Risks and Mitigation measures

The risks that could arise during the development of the local energy flexibility market in the Greek pilot are divided into three different types as listed below. The first type of risk involves technical risks, which may emerge due to communication and control issues between the FSPs and the SOs as well as between the TSO and the DSO. The second category of risks is related to the participation of users and the total flexibility volume during the implementation of the local energy flexibility market in the Greek pilot. The third category includes risks associated with the continuation of the local energy flexibility market after the conclusion of the project. The definition of risks per category follows, along with the mitigation strategy.

Between D4.5 and this deliverable, the identified risks have been addressed to the extent possible. This has been achieved either through the development of new mechanisms, in the case of technical risks, or through the implementation of specific actions regarding engagement risks. Specifically concerning the technical risk, the communication issue for coordination between HEDNO and IPTO has been tackled by integrating the NODES Market Coordination Tool as described above into the platform. However, other clusters of risks remain active, like the communication between DSO and its smart meters, installed in the FSPs side, as they could potentially arise during the testing period. To address engagement risks, an initiative to inform and educate prosumers about the active role they can have in flexibility markets has already begun with the implementation of the Greek demo mailing list. Through this channel, initial activities have been carried out, such as sending interactive material about OPENTUNITY technologies and the local flexibility market of the Greek demo. The remaining risks have not changed significantly as they concern later stages, mainly the implementation and evaluation stage of the local energy flexibility market in the Greek pilot.

Technical risk

Inadequate communication between participants
Description of the Risk: Regarding the Greek Pilot in the OPENTUNITY project, the flexibility market being developed will enable FSPs to trade power and provide services to address challenges in the transmission and distribution systems. However, during the project implementation, the required communication and control systems between the end-users and FSPs, as well as the smart meters from the DSO side to verify FSP behavior in real time, could not be established. Moreover, insufficient coordination, due to lack of proper communication between TSO and DSO, may lead to congestion management and/or balancing issues on the HV side or to the MV and LV side. Those pose significant technical risks, as the absence of these systems could slow down the proper execution of buy/sell orders and prevent the validation of delivered flexibility services. Such technological limitations may impede the project's deployment and impact on the future exploitation of its technologies.

Mitigation Plan: To mitigate this risk, a manual communication system will be implemented. The FSP will communicate flexibility requests to assets via phone or text message, and end users will manually control their loads to provide the requested services. Validation of flexibility delivery will be performed both by the SOs for internal purposes and by NODES as official service as a market operator. While not ideal, this approach offers an interim solution to ensure the demonstration and evaluation of a real-world flexibility procedure. Regarding the DSO-TSO coordination, an analytical scheme will be implemented utilizing the NODES flexibility market platform.

Updated state: The communication challenge between HEDNO and IPTO has been addressed by integrating the NODES Market Communication Tool into the platform. However, other risk clusters remain active, as they are associated with the testing period, which has not yet commenced.

User engagement risks

Insufficient flexibility volumes to serve TSO needs

The risk of insufficient flexibility volumes to perform realistic tests for balancing by the TSO still remains. The limitation of participation to households represented by the participating FSPs, reduces the reliable replication and testing of flexibility activations in the distribution grid for balancing. This may create a lack of insights as small and medium companies may as single units or aggregated offer sufficient volumes to solve grid constraints. Furthermore, their flexibility activation and offering may significantly differ from households.

Updated state: The risk concerning insufficient flexibility volumes for realistic flexibility activation on the TSO side continues to be relevant, given that the pilot's testing phase has not commenced. Consequently, the project will adhere to the defined mitigation plan, wherein participating FSPs will emulate flexibility volumes. This will enable the validation of the TSO-DSO coordination process and tools, despite the lack of real-life market activations.

Lack of trust in the flexibility market and its participants

Description of the Risk: Another significant risk that may affect citizen engagement is the potential lack of trust in the flexibility market system and its participants. Prosumers that are unfamiliar with the energy market or its regulations may have doubts about the intentions of system operators and stakeholders. Concerns could include data privacy, reliability of payments, or transparency in how flexibility services are operated. If users perceive that the market is designed primarily for the benefit of large corporations or if they are unclear about how their data is used, they may be unwilling to participate.

Mitigation Plan: In order to successfully build trust among prosumers and the operators, a transparent and user-centric approach is required. First, market operators should ensure clear communication about the objectives of the flexibility market, the roles of various participants, and the benefits for prosumers. Providing easy-to-understand documentation or videos that explain how the market functions, and data privacy protection can mitigate concerns. Setting clear ethical guidelines regarding the operation of the flexibility market can also reinforce trust. These guidelines should emphasize data privacy, consumer rights, and the fair distribution of benefits. Transparency in how flexibility services influence the broader grid, along with regular updates on market performance and prosumer contributions, should also be prioritized. Trust can also be built through a communication system. Implementing a user-feedback mechanism where participants can mention concerns, ask questions, or provide suggestions would allow for continuous improvement and greater user confidence.

Updated state: To engage potential prosumers and to tackle any trust issue, a communication initiative for the Greek pilot has been established, based on a mailing list. Registered users receive informational interactive materials on the pilot's technologies. The initial outreach has been completed, and additional activities are planned for the near future.

Deployment risks

Regulatory Barriers to Flexibility Market Exploitation
Description of the Risk: A key exploitation risk in the OPENTUNITY project is related to the regulatory framework in Greece. Currently, there is no specific legislation supporting the operation of a flexibility market at the distribution level, with only preliminary laws covering the transmission system market. This regulatory barrier poses a significant challenge to the exploitation and broader utilization of the project's technologies after the project ends. Without the necessary regulatory framework, it will be difficult to operationalize and sustain the flexibility market within the Greek distribution system.
Mitigation Plan: To address this risk, HEDNO and IPTO will collaborate based on the findings and observations gathered throughout the OPENTUNITY project. They will engage with the relevant regulatory authorities, communicating the project's results and operational requirements of the flexibility market. This dialogue will aim to influence and guide the development of new legislation necessary to support operation of a flexibility market in Greece, that includes both DSO and TSO. This proactive approach seeks to ensure the legal framework aligns with the operational needs of the flexibility market following the project's conclusion. Updated state: N/A

Regulatory barrier to prosumer engagement in flexibility market
Description of the Risk: Complex regulations and limited incentives hold back the utilization of new technologies. The absence of a regulatory framework and possible restrictions on the energy trading platform may also delay or prevent prosumer engagement.
Mitigation Plan: Measures to protect prosumers from high wholesale electricity prices during volatile periods through fair pricing mechanisms and anti-market manipulation measures are necessary. However, these measures should not undermine the incentive for prosumers to get involved and offer their flexibility. Updated state: N/A

3 Conclusion and Outlook

This deliverable describes the final market set up of the flexibility markets developed during Task 4.5 in the pilot locations in Spain, Switzerland and Greece. Each flexibility market and specific development areas is set up according to the use case, grid infrastructure and coordination requirements, prevalent asset types as well as risk and mitigation measures. The presented documentation describes the adaptations and improvements of the flexibility market implementations resulting from operational testing during Task 4.5.

The Spanish pilot included new roles and tools to overcome technical and operational barriers, as well as to improve user-friendliness of operations.

The Swiss pilot has increased the pool of assets that participate in the pilot, including assets that allow for real activations as part of the testing in WP6. This will be a significant step to complete the entire flexibility value chain. Furthermore, the Swiss pilot has enabled data access and exchange between the assets, the FSPs, the FMO and the DSO enabling to evaluate the validation of flexibility delivery.

The Greek pilot, due to the participation of the TSO and the DSO, focusses predominantly on the integration of coordination and communication tools to ensure flexibility activation across grid levels with minimum risk for grid violations. The tested operations include the operations related to flexibility trading as well as coordination following a defined market timeline.

The market set ups and solutions from Task 4.5 will be tested as part of the pilot site test cases in WP6. The framework and conceptual alignment within WP6 will allow for a more holistic examination of the flexibility market activities in the specific test locations as well as further requirements and developments.

4 References and acronyms

4.1 References

1. D4.5, OPENTUNITY project. *Establishment and Implementation of Flexibility Markets.*
2. *Opentunity Grant Agreement. EC, 2022.* (s.f.).
3. *www. nodesmarket.com*

4.2 Acronyms

AMI	Advanced Metering Infrastructure
API	Automatic Programming Interface
BFMS	Building Flexibility Management System
BSP	Balancing Service Provider
CR	Coordinator Role
DSO	Distribution System Operator
EMS	Energy Management System
ESCO	Energy Service Company
FMO	Flexibility Market Operator
FSP	Flexibility Service Provider
ISP	Integrated Scheduling Process
LFM	Local Flexibility Market
MCT	Market Coordination Tool
MILP	Mixed-Integer Linear Programming
mFRR	Manual Frequency Restoration Reserve
NILM	Nonintrusive Load Monitoring
OCPP	Open Charge Point Protocol
SMX	Smart Meter Extension
SO	System Operator
TSO	Transmission System Operator
UC	Use Case