Report on market functionality

D7.3

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Dissemination Level	Public

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957739

Issue Record

Planned delivery date	31.05.2023
Actual date of delivery	31.05.2023

Version	Date	Author(s)	Notes
0.1	10.05.2023	Janne Huvilinna	Version for internal review
0.2	30.05.2023	Arslan Ahmad, Anibal, Rinta-Luoma, Marco	Version after internal review
1.0	31.05.2023	Arslan Ahmad Bashir	Final version

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About OneNet

The project OneNet (One Network for Europe) will provide a seamless integration of all the actors in the electricity network across Europe to create the conditions for a synergistic operation that optimizes the overall energy system while creating an open and fair market structure.

OneNet is funded through the EU's eighth Framework Programme Horizon 2020, "TSO – DSO Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation" and responds to the call "Building a low-carbon, climate resilient future (LC)".

As the electrical grid moves from being a fully centralized to a highly decentralized system, grid operators have to adapt to this changing environment and adjust their current business model to accommodate faster reactions and adaptive flexibility. This is an unprecedented challenge requiring an unprecedented solution. The project brings together a consortium of over seventy partners, including key IT players, leading research institutions and the two most relevant associations for grid operators.

The key elements of the project are:

1. Definition of a common market design for Europe: this means standardized products and key parameters for grid services which aim at the coordination of all actors, from grid operators to customers;
2. Definition of a Common IT Architecture and Common IT Interfaces: this means not trying to create a single IT platform for all the products but enabling an open architecture of interactions among several platforms so that anybody can join any market across Europe; and
3. Large-scale demonstrators to implement and showcase the scalable solutions developed throughout the project. These demonstrators are organized in four clusters coming to include countries in every region of Europe and testing innovative use cases never validated before.

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List of Abbreviations and Acronyms

Acronym	Meaning
API	Application Programming Interface
aFRR	Automatic Frequency Restoration Reserve
BSP	Balancing Service Provider
BTD	Baltic Transparency Dashboard
COBA	Common Baltic Balancing Area
DEP	Data Exchange Platform
DR	Demand Response
DSO	Distribution System Operator
ECP	Energy Communication Platform
ENTSO-E	European Network of Transmission System Operators for Electricity
FSP	Flexibility Service Provider
FR	Flexibility Register
FCR	Frequency Containment Reserve
GDPR	General Data Protection Regulation
mFRR	Manual Frequency Restoration Reserve
MO	Market Operator
MARI	Manually Activated Reserve Initiative
PTDF	Power Transfer Distribution Factor
RP	Resource Provider
SUC	System Use Case
TSO	Transmission System Operator
T&D CP	TSO-DSO Coordination Platform
WP	Work Package

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Executive Summary

This document explains the current disjoint flexibility market frameworks and the proposed new universal flexibility market functionality for the Northern demonstrator. The deliverable also presents the opportunities for individual flexible resource owners and how they can be integrated to the flexibility market to competitively offer grid services, such as congestion management, power balance management etc. Due to the scale needed at transmission and distribution levels, the flexibility offered by a single prosumer does not qualify for trade at the wholesale level. Hence, the role of flexibility service providers (FSPs) is inevitable to aggregate the flexibility and offer it to the marketplaces. This brings competition to the FSP market where a prosumer can contract with any FSP based on remuneration schemes.

In the Northern cluster, the available marketplaces for real or near real time flexibility trade are mainly operated individually or jointly by TSOs, for instance, Fingrid mFRR and the common Baltic mFRR. Besides, Nord Pool Intraday also offers a mechanism to fine tune dispatch levels according to the day-ahead commitments until one hour before the physical delivery. However, in the aforesaid marketplaces, the offers or bids cannot be linked across the market boundary, particularly for the TSO-operated markets, as there would be too many market and control interfaces which are neither standardized nor interoperable. This undermines the flexibility potential utilization. In addition, the activation of market driven flexibility in a network can cause additional issues in the same as well as connected grids, for which the existing market clearing mechanisms do not offer any universal solution.

To overcome the above cited shortcomings in the existing market framework, OneNet Northern cluster (WP7) proposes a future flexibility market architecture that enables universal participation of resources irrespective of their physical location to offer services to the grid. OneNet will create open and fair market conditions enabling networks and markets to coordinate close to real time for flexibility trading. OneNet will provide a single market interface to network operators and flexibility providers.

The core components of the single flexibility market platform involve TSO&DSO coordination platform (T&D-CP), flexibility register (FR) and data exchange platform (DEP), whereas the trade takes place between system operators and FSPs and is facilitated by market operators (MOs). T&D-CP is a system that is designed to find the optimal match between bids and offers as well as avoid, through grid impact assessment, the activation of flexibilities that do not contribute or cause additional issues in the grid (constraint setting process). FR is an inherent part of the coordination platform that stores information about the flexibility assets, pre-qualification results (grid, market product), market clearing results, settlement results, as well as allocates access rights to the relevant players. DEP is a communication platform whose role is to secure data transfer between data providers and data users.

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To support the single flexibility market concept, harmonized market products are envisioned enabling bids to be linked across the market border. In the Northern cluster, the flexibility procurement using harmonized market products will be demonstrated in each of the participating TSO markets, i.e., Finland, Estonia, Latvia, and Lithuania. For this purpose, the current MO platforms will be developed and connected to the OneNet platform. The relevant MO forwards the flexibility bids, from FSPs who gave consent for congestion or balance management by SOs, to the OneNet platform. The OneNet platform performs necessary checks before running the optimization routine. The optimization considers bids, purchase offers and network topology and yields a list of cleared bids or volume of bids which are then sent back to the relevant MO for activation.

In addition, the T&D-CP performs a bid forwarding step to MARI, by which the uncleared bids or volumes can provide mFRR services. The bids are first earmarked considering their compliance with MARI format requirements and grid-safe conditions. This step is carried out to ensure that such bids, if activated by MARI, do not cause issues in the local grid, as such MARI clearing process does not consider any grid-impact assessment. Hence, bids forwarding to MARI maximizes the value stacking potential of the flexibility, as the flexibility is allowed to participate in beyond local congestion markets such as mFRR.

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1 Introduction

This deliverable examines the flexibility uptake opportunities in the current market paradigm, the flexibility value chain involving new roles, as well as routes and means to ease market entry and participation. More importantly, it focuses on the design of a future single flexibility market architecture linking offers or bids across existing European markets to match multiple network needs in a coordinated manner, within the scope of the Northern demonstrator (WP7) as part of OneNet project. The objective of OneNet is to enable the universal trade of flexibility in participating markets to offer interoperable services to a wide variety of networks at all levels. OneNet is divided into four geographical demonstration clusters as depicted in Figure 1-1 below.

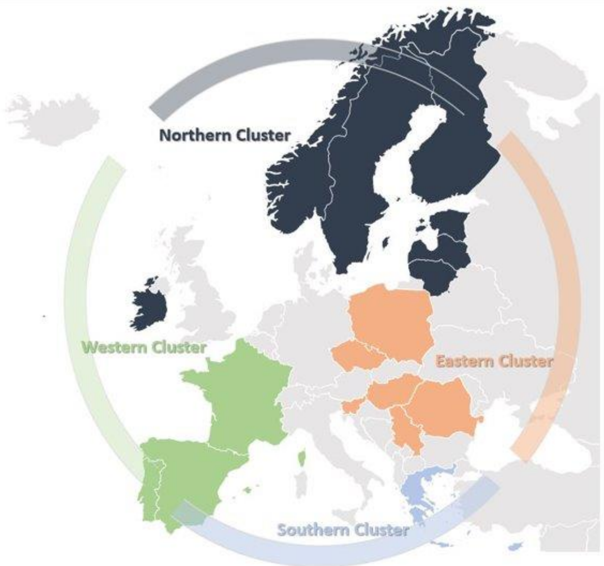

Figure 1-1. OneNet demonstration clusters [1]

To reach the goal of the OneNet project, WP7, Task 7.3 (Market operation and trading) consists of a necessary guideline for defining system use cases (SUCs) that summarizes the multilateral procurement process of flexibility products in an advanced multi-market environment enabling open competition supported by interoperability of offers. The proposed universal market is envisioned through the interaction of flexibility service provides (FSPs), system operators (SOs), market operators (MOs), and the new identified roles such as TSO-DSO coordination platform (T&D-CP), flexibility register (FR), and data exchange platform (DEP).

The FR maintains the central registry mechanism of all market participants and plays a key role in supporting the procurement process through necessary data exchange. Two core features, i.e., grid pre-qualification and locational information of resources, have been embedded into the joint flexibility procurement. The important aspect in the new market architecture is how the information about pre-qualification and location of resources are linked to the bids and network topology, which are used in the optimization-based market clearing process

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to meet the network needs. The grid bottlenecks are handled in the most cost-economical and technically effective way without causing additional issues in the connected networks, enabling value stacking potential.

The proposed design requires SOs to share accurate information and near real time state of networks with the T&D-CP. The coordination engine should be able to perform the optimization in a stipulated time period in order to allow participants to react accordingly during the physical delivery. The proposed market design will lead to increased liquidity and competition in network balancing, congestion management and flexibility procurement for other purposes. Furthermore, the new market architecture considers harmonized market products for flexibility procurement, and the corresponding bids are scrutinized after the market clearing process to add value to the planned MARI and PICASSO platforms.

The individual functionalities and concepts of the OneNet components and associated processes have already been explained in the respective deliverables. Three SUCs are identified in this context: 1) pre-qualification of a new flexibility product; 2) procurement of flexibility product incorporating interaction with the OneNet platform; 3) secondary trading, i.e., selecting a new FSP to replace a FSP who could not provide the promised product. The pre-qualification of new flexibility product SUC requires that the trade between a FSP and a SO materializes if the MO offers the relevant product. Alternatively, the SO must specify the flexibility needs based on which the MO defines a new product and initiates a pre-qualification routine under intimation to flexibility register. The procurement of flexibility product SUC consists of a process which can be divided into five main steps: opening the market, trading, matching, closing the market, and settlement. The process is briefly summarized as under:

- opening, the market will be open, and the availability of trading will be informed to all relevant parties.
- trading, flexibility service providers submit their bids and system operators publish their purchasing needs to TSO & DSO coordination platform (T&D CP).
- matching, the market operator in cooperation with T&D CP economically matches the bids and offers to find the optimum solution which also satisfy the needs of other networks, demonstrating value stacking potential.
- closing, the market operator informs the results to relevant parties in the closing scenario.
- settlement, the MO receives the verified amount of flexibility delivered for each product/FSP from Flexibility Register (FR) and calculates remuneration for each FSP.

The secondary trading SUC is quite like the normal trading, but the process is initiated when a FSP who has a binding contract to provide flexibility fails to fulfil its commitment and asks the MO to find a replacement well in advance. The processes associated to the use cases are step-wise illustrated in the Appendix A. The processes will be tested, evaluated, and to be reported in the Northern demonstrator deliverable D7.6. Considering the

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flexibility uptake from the end-user, the SUCs identify the following challenges to be addressed in the market functionality:

- Easing market participation for flexibility resource owners
- Coordination between system operators
- Consent management for data exchange between platforms and across the market border
- Harmonizing the flexibility product
- Availability of near real time metering data of the flexibility resource
- Single flexibility marketplace for network operators and FSPs

The remainder of the deliverable is structured as follows: Section 2 discusses the available flexibility opportunities and the processes for market participation in the current framework. Section 3 outlines the existing and planned marketplaces for flexibility procurement in the Northern cluster. Section 4 describes the proposed universal flexibility market architecture, processes, and functionality. Section 5 supports the proposed market design by adding harmonized market products for flexibility procurement. Finally, Section 6 concludes the deliverable.

2 Flexibility integration to the market framework

2.1 Flexibility resources

Flexibility resources are employed by consumers mainly due to associated potential cost savings realized through price arbitrage in the spot market. In other words, the current driver for investment into such resources is local energy optimization rather than offering services to the grid or market. For instance, the operation of a domestic thermal energy storage (TES) may be scheduled for charging during nighttime (or cheaper hours) to meet daily space heating demand and domestic hot water economically and uninterruptedly. In Northern Europe, TES is a ubiquitous installation in detached houses. In parallel, EV charging solution is another example entitling the user to defer the charging for as long as the utility is not compromised. Moreover, due to the increased awareness of the consumers, solar-coupled stationary battery installations are becoming a popular choice to further improve cost-savings and achieve grid-independence or net-zero energy mark. In addition, the well-insulated buildings possess a huge thermal inertia, enabling them to pre-heat or pre-cool buildings depending on the network requirements. Building thermal dynamics render space heating a good candidate to offer flexibility. However, such a demand response (DR) results in a slight sacrifice of indoor thermal comfort. Hence, the willingness of consumers to shift demand against the offered incentive plays an important role in the success of any DR program. So far, the residential flexible resources do not directly participate in the market, although the aggregated demand shifting potential and the ramp response are suitable for providing flexibility services to the grid. Table 2-1 below summarizes the advantages and drawbacks of residential flexible loads.

Table 2-1. Advantages and disadvantages of domestic flexible resources

Asset	Advantages	Drawbacks
Thermal energy storage	▪ Thermal comfort is fully respected ▪ Medium size flexibility ≈ 25% average daily heating demand ▪ Continuous availability during the season	▪ Only available during winter season
Space heating	▪ Thermal comfort is scathed ▪ Medium size flexibility ▪ Fast reaction and high ramp rate	▪ Only available during winter season ▪ Consumer willingness ▪ Privacy concerns
Solar coupled battery system	▪ Fast reaction ▪ Wide acceptance ▪ Contribute to net zero or positive energy initiative	▪ Limited availability, i.e., uncertainty for charging ▪ Battery degradation ▪ Low round trip efficiency
Electric vehicle	▪ Low impact on car owner ▪ Fast reaction ▪ Controllable charging ▪ Medium size flexibility	▪ Consumer willingness, i.e., vehicle to grid still not widely acceptable ▪ Limited availability due to travelling ▪ Increased wear and tear of battery

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Industrial load	▪ Large flexibility ▪ High availability due to continuous processes	▪ May affect the industrial process

2.2 Flexibility service providers

The role of a flexibility service provider (FSP) is to link the flexibility resource owner (consumer or prosumer) with the flexibility market operator. The flexibility resource owner contracts with a FSP of its own choice to offer flexibility to the market. The contract authorizes the FSP for the respective load control and to employ any hardware or software infrastructure to implement the steering routine for flexibility delivery during the trading and activation phases.

Today, many loads and appliances can connect to the internet which enable to control them via external or centralized controllers. The internet connection allows to download spot prices and performs local energy optimization, which is perfectly suitable for heat pumps. The simplest control logic can be implemented using a smart energy meter with a built-in relay for switching on or off the flexible load at the consumer end. This functionality is currently in practice in DSOs in Finland. However, such a relay can only perform on/off control and unable to provide any verification data. Contrarily, larger resources, such as EV chargers, are connected to the operator’s cloud network making it easier to be controlled by external platforms or FSPs through API.

At the initial stage, the FSP analyzes the resource to determine the steering approach and to assess whether the resource is controllable and that it can yield the intended outcome for the market. It can be accomplished if the asset owner agrees to share the historical energy consumption data, day-ahead schedules for baseline consumption and the associated flexibility potential with the FSP. The FSP also has the role to validate that the candidate flexible asset can meet the technical and commercial obligations of the target market product. In market terminology, it implies pre-qualification of the offered resource in which necessary testing is performed before the asset could participate in the market. The FSP analyzes the technical attributes of the assets at individual level and compares them against the product’s specifications available in different markets. When choosing the target market and the feasible product, the FSP also considers the corresponding market volume, the product’s historical activation statistics, for example, the annual number of operating hours and the average price or income per MW etc. However, other factors such as social welfare maximization may also affect the decision.

The FSP primarily takes on the responsibility to represent the pre-qualified flexible asset on flexibility marketplaces. To date, all commercial marketplaces have set a minimum bid size requirement, for instance, in Nord Pool Intraday marketplace, the smallest acceptable bid size is set as 0.1MW. To this end, the aggregation of flexible assets becomes necessary to participate in flexibility markets if the size is smaller than the threshold. Since the FSP is responsible for turning flexibility potential into a bid, it also assumes the role of an aggregator. The FSP registers the pre-qualified flexible resources and pools together those with similar technical

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characteristics to reach the set minimum volume or capacity to enter the target market or qualify for a particular product. This step is accomplished to ensure readiness during flexibility calls, and trading to produce optimal bids and increase the likelihood of bid acceptance. For activation, the control logic should be compatible with the aggregated resource as well as the product specification. The logic corresponds to the sequence of activating individual assets in a group versus timelines. Depending on the product or cleared bid volume, it is possible that only a part of the aggregated resource needs to be activated.

In a nutshell, the FSP acts as an aggregation and market interface for the flexibility resource owner. Contracting with the FSP empowers the consumer to participate in competitive flexibility markets, but on the other hand, poses concerns on consumer's privacy due to authorization for load control. The introduction of the FSP's role may have an adverse impact on the retail electricity market as well. The commitments made by the FSP for flexibility availability and activations conflict with the forecasted demand that electricity retailer has tendered in the wholesale market framework for a group of customers that include flexibility resource owners simultaneously participating in flexibility markets. Steering flexible loads by the FSP will impart unpredictable forecast deviations for the retailer, thus forcing it to significantly raise the risk margin on offered prices. To prevent such a scenario, a regulation that eradicates the risk imposed due to direct load control by FSP towards retailer's obligations must come into force before realizing the competitive market uptake of the aggregated flexibility. One possible solution requires that the FSP undertakes contractual aggregation instead, where it has a contract with the retailer that enables both parties to share the associated risks. An even better solution is to have a retailer taking on the role of FSP as well, where it can easily manage the risks imposed due to deviations from the forecasted delivery.

2.3 Flexibility contracts

To integrate flexibility resource owners to flexibility markets, flexibility contracts and reward frameworks should be established. Besides local energy management, the benefit for the consumer or prosumer to provide flexibility is to receive an adequate level of compensation. However, the activation of flexibility somehow affects the consumers' lifestyle. The offered compensation should be therefore directly proportional to the level of discomfort borne by the consumer. Consumers have the freedom to choose their FSP and switch to any other FSP after terminating the current flexibility contract. This creates competition compelling FSPs to meet the expectations of consumers in respect of compensation. On the other hand, FSPs need to develop the interest of consumers to enable them to understand the potential benefits of load control.

The simplest form of flexibility contract is envisioned when FSP is authorized for direct load control via a smart meter and the consumer may be rewarded with a fixed monthly premium in addition to the cost savings realized through shifting load from expensive periods to cheaper time slots in a spot price-based electricity sales contract. A better solution includes volume-based reward in which the delivered flexibility is compensated as a

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fixed amount per kWh or associated with the actual market outcome. In the latter method, the FSP needs to know the delivered flexibility at the resource owner's level and define the invoicing or payment method which is quite burdensome. However, it is plausible in the case of relatively large consumers with higher ranges of flexibility. In addition, the contract should be compliant with GDPR and clearly specify the ownership of control and measuring equipment. Large or commercial consumers require more advanced load control equipment which is indeed more expensive compared to that of residential or small consumers. Switching among FSPs is rendered easier and efficient if the resource owner owns the control equipment. The contract should also lay down clauses about the testing of the load control feature. The flexibility contracts can be fixed term or open-ended. The template of the contract depends on the country-specific regulations and target market characteristics.

In some cases, the retailer (or balance responsible party) is also taking the role of the FSP to avoid possible risks of imbalances due to load control. Here, the sales and flexibility contracts are combined into a single bond. The offered premium may be fixed, or volume based. However, the trading optimization problem for the retailer becomes too complicated due to emulating the consumer's response on multiple markets without knowing the respective outcomes. Lastly, necessary communication with the consumer is useful to demonstrate the impact of authorizing load control. In Finland, the metering data of individual consumers or load points is stored and made available in the central data repository called 'Datahub' operated by Fingrid. The metering data is restricted in a sense that only the consumer, the relevant retailer and the DSO have access to that data for invoicing purposes.

2.4 Flexibility measurement

The smart meters currently installed at the consumers' premises are capable of recording energy consumption at 15-min time unit. Whereas most of the electricity markets across the EU are transitioning from a one-hour time step to a 15-min settlement period, some markets, particularly ancillary services markets, require even faster implementation of power changes. Such activations require a different method to measure the actual power changes and to verify whether the responsible party has delivered according to the commitment. The capacity to measure and verify the delivery is a major hurdle for smaller consumers to participate (directly or aggregated form) in markets with shorter imbalance settlement periods. On top of that, no standards exist for governing such metering data. Devising a common acceptable standard for verification of delivered bids is a key issue to be addressed to achieve higher participation of smaller consumers in markets with shorter settlement units.

Although there are a few measures which could be applied to verify such activations in shorter periods. By utilizing the aggregated data during flexibility activations across relevant DSO networks and matching it with the accepted flexibility bids in the market, the FSP who did not fulfil its commitment could be identified. A necessary

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condition for it to work requires that most of the FSPs should have delivered what they promised. This diagnostic method can function well if minimum bid size is significant enough so that the effect of activating individual bids is evident. This might eradicate the need to measure individual activations. However, the best solution involves measurements in real or near real time. Smart meters can provide this needed real-time interface but a separate device to read the data is also needed. This device will send the data to an information system. Such a device has a cost and the information system requiring internet connectivity also has a considerable cost which together limit the minimum size of controllable loads.

2.5 Flexibility cost and compensation

Flexibility costs should consider market entry barriers, steering and activation costs, mark-up for FSP and reward for the resource provider. Generally, the operating principle of flexibility markets is different than those of spot markets which function as an auction and the price is determined collectively by demand and supply. Contrarily, the price of flexibility is driven by complex product requirements, pre-qualification process and the allied control equipment. Generally complex market products also have higher prices. However, the flexible resource needs to be metered and controllable, which impose separate hardware, software, and IoT costs. Nevertheless, the flexibility price is tied to the hourly spot price. For instance, the price of regulation power in Fingrid's balancing power market is constrained by the spot price at either end depending on the regulation direction.

The above specified cost parameters justify the minimum price of the flexibility bid. Of course, the FSP would like to maximize the price of the bid but there is a risk of not getting called off by the market operator, since the FSP cannot see how much the affected network operator is willing to pay to solve the congestion, for example. If the worked price is too high, the bid is not accepted, and no revenue is generated. Consequently, the FSP needs to tune the cost parameters and modify the approach. The FSP can also analyse the historical price profile for the market product to determine the possible drivers and define its strategy accordingly.

The role of the FSP calls for a suitable markup for providing services to the resource owners and flexibility markets. The FSP acts as an aggregation and market interface to flexibility resource owners. In other words, it connects flexibility assets to network operators through competitive market uptake. In order for the flexibility service business to be sustainable, the profit margin should be appealing, which the FSP can realize through efficient grouping of resources, identifying potential markets, allocating effective resources, accurate forecasting methods and further portfolio registration. Lastly, it is the FSP's responsibility to reward the flexibility resource owners according to the value the individual resource adds to the market. In practice, the FSP aggregates several resources together to form an optimal bid, therefore the reward mechanism is defined per resource group. Devising a rewarding mechanism per individual resource owner is quite cumbersome, as already detailed in the preceding sub-section.

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3 Flexibility marketplaces in the Northern cluster

3.1 Nord Pool Intraday

Nord Pool is Europe's leading power market and offers trading, clearing, settlement and associated services in both day-ahead and intraday markets across 16 European countries. We have been pioneering power markets for over 30 years and will continue doing so as the energy system is transforming into a decarbonised one. Nord Pool provides liquid, efficient and secure day-ahead and intraday markets and we are committed to simple, straight-through trading, expanding across all timeframes, for all our customers regardless of their size or where they trade from. Our primary product is a transparent and reliable power price produced within our markets every hour, every day.

3.2 Piclo

Piclo's mission is to decarbonise the grid. Piclo develops software solutions that make energy networks smarter, flexible and more sustainable. Its flagship product, Piclo Flex is the leading marketplace for energy flexibility services, enabling distribution system operators to source energy flexibility from flexible service providers during times of high demand or low supply. As of 2023, the flexibility contracts awarded on Piclo Flex has totalled £57.4m with 16GW of flex capacity registered and 1.1GW of flexible capacity procured. Piclo currently supports the business-as-usual flexibility procurement for major DSOs in the UK – UK Power Networks, SP Energy Networks and Electricity NorthWest, Portugal's E-REDES and Lithuania's Energijos Skirstymo Operatorius (ESO). Aside from its market-leading position in the UK, Piclo has a growing presence in mainland Europe and the USA. Within the OneNet project Piclo is involved in the Northern Demonstrator Flexibility Platform T&D CP component. In particular, Piclo will be filling the Market Operator role in the LT-P-C-E product flexibility trading process for Latvian and Lithuanian demos.

3.3 Real-time balancing power markets

3.3.1 Finland

As the Finnish TSO, Fingrid is responsible for the balance management of the Finnish power system. For this purpose, there are several reserve and balancing products to procure the needed flexible capacity and balancing energy for smaller balance deviation but also for disturbances. For balancing energy procurement, the Manual Frequency Restoration Reserve (mFRR) is used. This is a well-established and liquid market, and the product is based on the harmonized European requirements. In the Nordic countries each TSO operates their national balancing market, but they are coordinated with each other so that the common synchronous area can be balanced more efficiently. In the future, the coordination will be done on the European level, when the MARI

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platform is taken into use. In addition to the balancing energy market, Fingrid also operates a balancing capacity market for mFRR, which supplements the energy market by ensuring a sufficient amount of supply on the market [2].

In addition to balancing, the mFRR product is also used for other grid operation purposes. Redispatching of units is conducted by using mFRR and it can help in local maintenance situations, e.g., by guaranteeing sufficient voltage support in the area. Also, mFRR redispatching is used to solve possible internal congestions which might occur locally during planned or unplanned outages, or in the main transmission grid when the north-south power transfer is close to the allowed limits. Today, the redispatching actions are conducted by the operational planners, who use their expertise to evaluate the location of assets which might be usable for redispatching in the respective situation. In the future more sophisticated tools will probably be needed, as the use of flexibility is getting more common. When mFRR bids are used for other purposes than balancing, it is called special regulation, and it doesn't affect the imbalance price.

Fingrid operates the IT-system used for facilitating the mFRR market, called Vaksi. Balance service providers (BSPs) submit their energy bids to the system either by using the user interface or by using ENTSO-E's Energy Communication Platform (ECP), which has become the de facto option [3]. The activations were still communicated some years ago often by telephone, but today the activation signals are sent automatically through the aforementioned ECP platform or through a secure network separated from the public telecommunication system. When activated, the BSPs are required to send real-time metering data from the unit with 1-minute intervals to Fingrid. Fingrid's operators can monitor the activations, but they are not separately verified automatically per se. The trades are reported to the imbalance settlement, which brings the incentive to activate the units as agreed.

3.3.2 Common Baltic balancing market

3.3.2.1 mFRR energy market

The Baltic states include Estonia, Latvia and Lithuania and since January 1st, 2018, Baltic TSOs operate a common model for balancing of power systems. This led to the introduction of a common balancing area and a common balancing energy market for the Baltics [4]. In the common balancing energy market only mFRR product is available to balance the power systems, however the same product can be utilized for other system needs e.g., congestion management. When mFRR is used for other purposes than power system balancing it is called a special activation.

To ensure the common Baltic balancing energy market operation a system named Common Baltic Balancing Area (COBA) was created and is still in use today. COBA is the key system in which all available Baltic mFRR energy bids are collected, and where TSO dispatchers can view and utilize the bids to ensure the balance of the

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Baltic power systems. However, COBA does not interact with just any external system to receive all the necessary market information, therefore each Baltic TSO is always involved as the middleman in data exchange between COBA and external systems. Nationally each Baltic TSO is responsible for exchanging data with BSPs connected to their power systems, which includes e.g. gathering of BSP energy bids and forwarding them to COBA, receiving COBA energy bid activation orders and forward this information to BSP and performing the balancing settlement [5].

The data of Baltic balancing market is being published on ENTSO-E transparency platform as well as on Baltic transparency dashboard (BTD). The BTD was created by The Baltic TSOs for all market participants as an easy-to-use source of market information, where data can be viewed in table and graph views and be exported [6].

In 2024 the existing common balancing model and common balancing energy market of the Baltics is foreseen to change once the Baltic TSOs join MARI, the common European platform for exchange of mFRR energy. Joining MARI platform introduces change to the existing mFRR product parameters, most notably the reduction of the balancing market time unit (MTU) from 60 minutes to 15 minutes [7]. Moreover, balancing market size, BSP market participation opportunities and system coordination change, extending from Baltic to a European level.

3.3.2.2 New balancing products in planning

Baltic TSOs are continuously working on the implementation of further balancing products. These include aFRR and FCR as well as the introduction of capacity component next to energy. Figure 3.1 visualises the next steps towards fully harmonised Baltic balancing market.

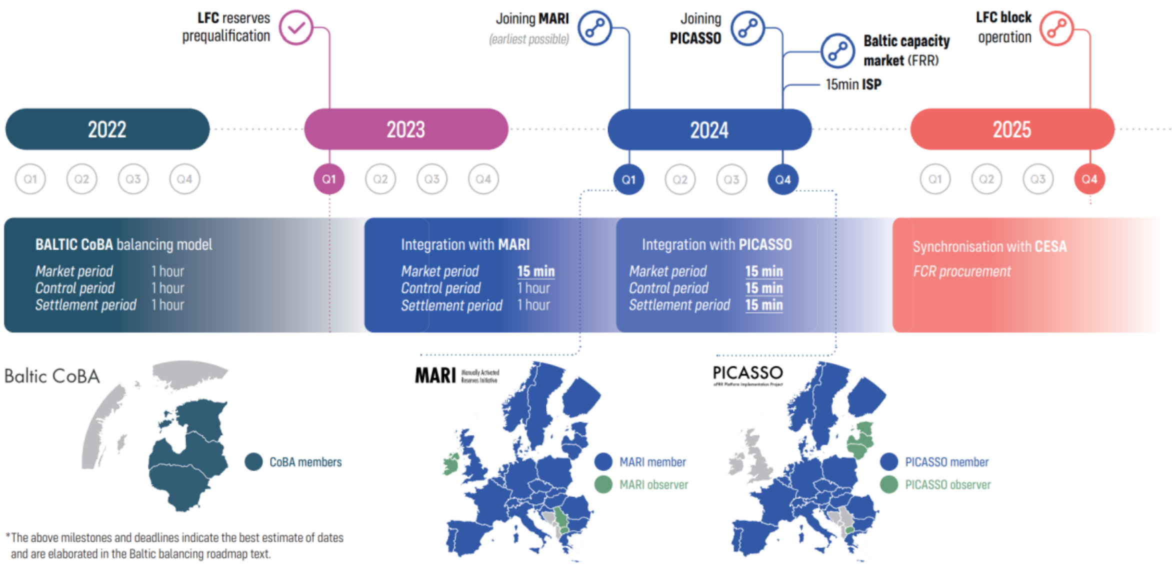

Figure 3-1 - Baltic Balancing Roadmap [8]

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The synchronization with Central Europe implies the creation of Baltic Load-Frequency Control (LFC) block consisting of Estonian, Latvian and Lithuanian LFC areas and requiring the combination of mFRR, aFRR and FCR products. aFRR product in compliance with European regulatory and PICASSO platform requirements is planned to be introduced by end of 2024. It should contribute to the synchronization process as well as ensure power system load and frequency control within a 15-minute balance control period.

Balancing capacity services in the common market of the Baltic countries will be purchased in daily auctions for 15-minute periods in day ahead. Starting from 2025 aFRR and mFRR services will be purchased in the market, and after the synchronization with the Continental European network also FCR. These reserves differ in their response speed and duration – FCR must be activated within 30 seconds, aFRR within 5 minutes, and mFRR within 15 minutes. Cross-zonal network capacity between the Baltic countries will be allocated for balancing capacity if the economic benefit to consumers demonstrates that it is more beneficial compared to the usage for day-ahead market.

Litgrid, AST and Elering have made calculations of what the demand for these services will be. Total required amount of upward and downward frequency restoration capacity in 2025 will reach up to 1513 MW, part of which will be temporarily ensured by the transmission system and dedicated battery storage operators' available capacities, like energy storage and reserve power plant, but 80 percent of this need will be bought in the market. Operators' reserves will not be remunerated and will be used only as a last-resort option if no further market-based resources are available. After the synchronization, the need for 25 MW of FCR will complement this amount. The breakthrough of the renewable energy means that at least until 2031 this demand will continue to grow rapidly [9].

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4 New market design for universal flexibility uptake

4.1 Drivers of flexibility

The ongoing energy transition provides insight into the outlook of flexibility needs in the network and its competitive uptake through markets. This subsection highlights the possible flexibility drivers at different hierarchy levels of the grid.

4.1.1 TSO

TSO needs a wide range of flexibility services to perform power balance management, re-dispatching, congestion management, countertrading and investment deferrals etc. Location-specific congestions and power imbalances are usually forecasted in advance, so that the flexible capacity may be procured and utilized accordingly. In case of network upgrade deferral, flexible capacity is procured using non-firm connection agreements, the benefit of which is the fast interconnection for the connecting party.

Flexibility comes from the allied distribution networks, signifying coordination between TSO and DSOs. Currently, the number of flexible resources to provide ancillary services is limited. TSO accesses and activates these resources in the capacity of zonal MO or using bilateral agreements. However, the accelerated onset of fluctuating renewable generation installments and transition of grids from centralized to decentralized power cells commend more flexibility needs in future. In such a scenario, the procurement of flexibility will require coordination between the TSO and the DSO to share the available flexibility in the most optimal way. This endorses the design and development of new types of flexibility services and the flexibility market. The competition in flexibility offering will unlock more available resources, thus lowering the barrier for entry.

4.1.2 DSO

The ultimate objective of the DSO is to maintain electricity quality and supply continuity. It must keep track of energy-dense areas or over-loaded feeders to make decisions concerning network investments. The DSO facilitates the green energy transition by hosting more distributed energy sources enabling increased electrification of other energy sectors. However, it may lead to local congestions and poor voltage conditions. Hence, DSO needs to decide whether to strengthen the target network or seek alternative solutions on the demand side. Therefore, it requires information on customers' willingness to provide flexibility services in the target areas. If DSO chooses to upgrade a segment of the network, it will nonetheless alleviate the problem by increasing the peak-load or generation limits. But since the reinforcement is specifically tailored to relieve peak hours, it will lessen the efficiency of the grid, forcing DSOs to operate over-dimensioned grids and charging respective costs from the consumer. This over-dimensioned grid problem can be tackled by unlocking flexibility, as the peak load which causes grid congestions, occurs only for a few days per year. To this end, a DSO mainly

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functions as a market-facilitator to mitigate such congestions through market-based flexibility uptake. Unleashing such flexibility in the form of up-regulation (decrease consumption) also postpones the grid reinforcements and improves the quality of supply.

Further, the rising photo-voltaic installations at the utility side is another reason for local grid congestions. The peak generation event at all prosumers connected to the same feeder occurs at the same time. Accordingly, down regulation (increase consumption) can be procured to keep the grid operation within limits and to allow more PVs to be hosted by the distribution grid. The congestion may also be due to the planned maintenance activities. Although, there might exist alternative ways of supplying the feeder, for instance, the n-1 option might be under-rated. Utilizing flexibility services, DSO can request up-regulation to tackle the issue and maintain power quality.

4.1.3 Flexibility asset owner

For the flexibility resource owner, the primary driver is the financial compensation. By providing flexibility during peak hours, the asset owner (prosumer / consumer) benefits from price stability on the resource level [1]. Likewise, on aggregated level, offering flexibility could contribute to price stability at the spot market. The grid avails stability in static or dynamic conditions by using flexibility. The distribution tariff is capped by an adequate level when flexibility is harnessed for network management purposes, which also reflects in lower power outages. Unlocking flexibility also promotes environmental protection by reducing the operation of expensive emission-based generation during critical hours. Hence, the market uptake of flexibility not only adds value to the consumer and the grid, but also secures positive outcome in terms of carbon emissions.

4.2 Flexibility market architecture

The uptake of flexibility markets requires several new functionalities that don't yet exist in the current market paradigm. On one hand, this needs regulation on both the European and member state level. On the other hand, new processes and IT systems are needed for the facilitation of these functionalities. The Northern Demonstrator of the OneNet project took an approach to develop further an open and modular architecture which aims at facilitating an efficient and transparent market framework for flexibility markets.

The basis of this architecture came from the assignment of roles and responsibilities for the new functionalities which are built on top of the existing ones [10], [11]. Different roles include both regulated and competitive roles. In the architecture, these both have their responsibilities and their seamless cooperation ensure the efficiency of the framework. The OneNet platform is designed to work seamlessly with other components and system roles in the Northern demonstrator. It consists of two main components – flexibility register (FR) and TSO-DSO coordination platform (T&D-CP) which have interfaces for market stakeholders such

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as market operators and system operators, data administrators and OneNet middleware ecosystem, as depicted in Figure 4-1.

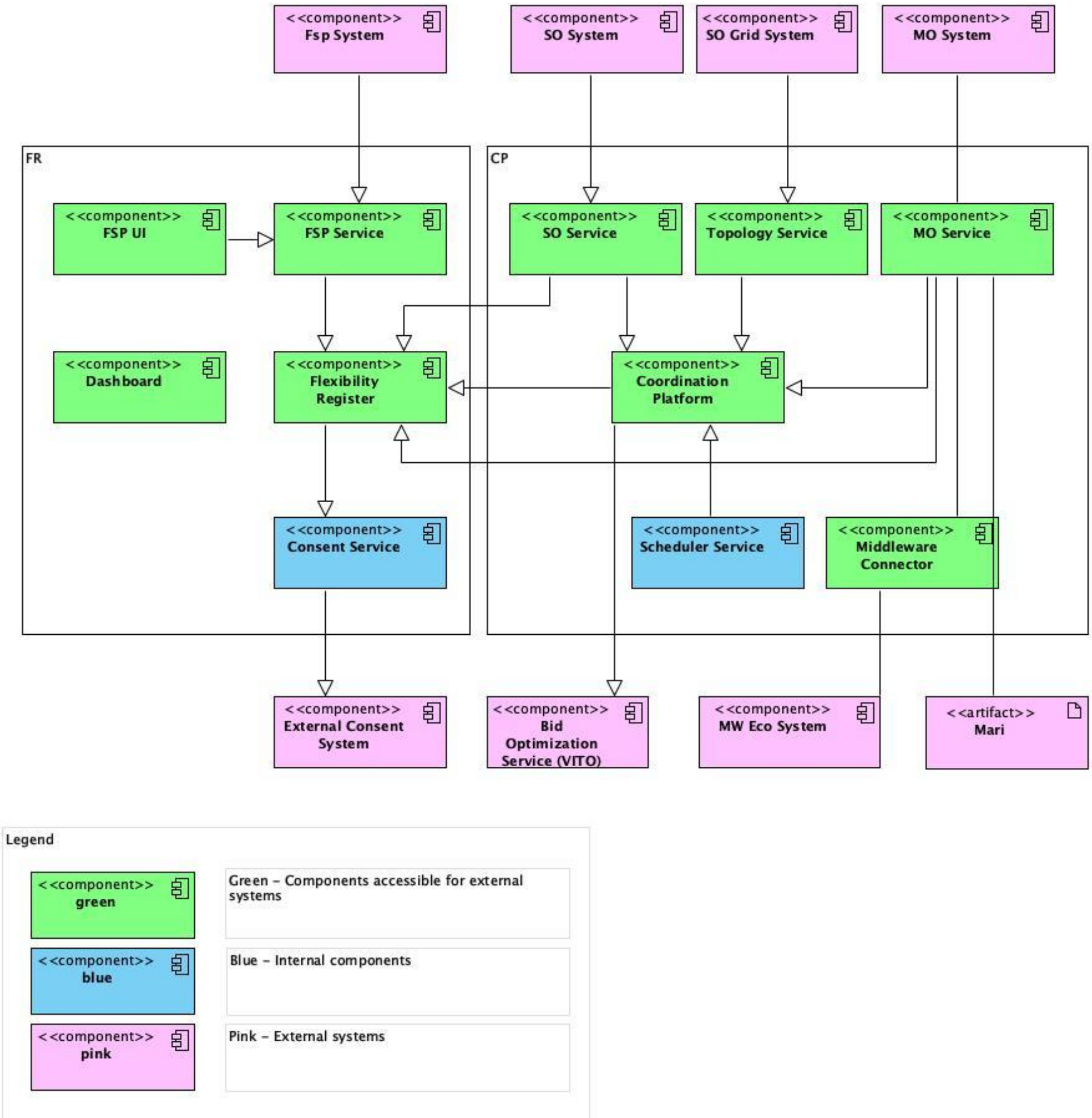

Figure 4-1. High level architecture of the OneNet platform in the Northern demonstrator [10]

An important aspect of the architecture is also standard flexibility products (defined in section 5) which were designed in the Northern Demonstrator to answer the needs of the System Operators but also work across market borders in different countries.

4.3 Flexibility register

One of the core components of the architecture designed by the Northern demonstrator is the Flexibility register (FR) [10]. The role of the FR is to support the market-based procurement of flexibility for grid services. This is achieved by managing information about flexible resources and resource groups, Flexibility Service

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Providers (FSPs), flexibility contracts connecting FSPs to the owners of the resources, and metering and scheduling data in the FR. The FR is tightly integrated to the TSO-DSO Coordination Platform (T&D CP), Market Operators (MOs) and FSPs. In the information architecture, the important aspect is how the information about the flexible resources are glued to the grid topology through the information about their connection point in the FR. Again, this information is used when the bids on the market refer to the resources and thus the locational information can be utilized to provide grid services.

4.3.1 Preparation to flexibility trading phase

The processes that prepare FSPs and flexible resources to flexibility trading are conducted in the FR. The processes include managing flexibility contracts between FSPs and resource owners, registering FSPs and their resources and conducting product prequalification resource group. These processes are a prerequisite to participation on the markets by ensuring that the market parties are eligible to trading and their resources can fill the requirements of the products and sufficient information is in place.

4.3.2 Procurement and delivery phase

During the procurement and delivery of flexibility services the role of FR is to support the processes of other system roles by providing required information. The objective is to enable the FSPs to efficiently offer their resources on different markets and the SOs to procure the flexibilities in the context of OneNet Northern demonstration scope. When considering especially congestion management services, the information stored in the FR is crucial, since the use of the flexibility on the markets is based on the resources connected to the bids and their location in relation to the grid topology. To enable these market processes to work, up-to-date and uniform information of the flexible resources, their location and prequalification status is a prerequisite.

4.3.3 Verification and settlement phase

After the procurement and delivery phase, the role of FR is to conduct the verification and settlement of the delivered flexibility services. The verification process quantifies the amount of delivered flexibility and the settlement process uses this information to conclude financial and imbalance settlement done partly outside of FR. The Northern Demonstration concept presents two alternatives for establishing the reference value for against which the behavior of the resources is evaluated in the verification process. These two are the baseline calculated by the FR and schedules sent by the FSP operating the respective resources. When the baseline option is used, the calculation is conducted by the FR based on historical metering data provided by the FSP or the Metering Data Responsible. After the determination of the delivered flexibility the information is used to conduct the financial settlement. In the concept of the Northern Demonstrator it is required also to allocate the expenses of the flexibility procurement between the SOs benefitting from it. This is also conducted within the FR.

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4.4 TSO-DSO Coordination platform

As described in detail in the OneNet deliverable D7.4 (2022) [11], the TSO-DSO Coordination Platform (T&D CP) enables seamless and coordinated procurement, selection and activation of flexibilities provided by any demand side, generation and storage unit or aggregated group of units [11]. T&D CP is capable of handling different products (energy and capacity products, from near-real-time to long-term products) for different system needs (congestion management, balancing) and for the good of any participating system operator (TSO, DSO) in the most optimal way. This means less costs for the operators and energy consumers and user-friendly access to the marketplace for FSPs. The descriptions of three T&D CP related system use cases are referenced hereby.

4.4.1 Grid Qualification of Resource

The scope of the SUC is the qualification of flexibility resources from grid capacity perspective in prequalification phase. In general, grid qualification of a flexibility resource may take place in prequalification, procurement, and activation phases. However, the qualification in procurement phase and in case of short-term and long-term products in activation phase is part of bid optimization (Section 5.4.2). In the case of near-real-time products, the grid qualification would not be feasible in activation phase. Grid impact assessment is a central activity of grid qualification process. Two alternatives are possible. In the first alternative the T&D CP is not involved because concerned SO identifies grid restrictions (constraints) by itself. In second alternative restrictions are calculated by T&D CP. A dedicated algorithm calculates the grid restrictions based on input information like resource information, network topology and node limitations. The objective is to determine in which network node the activation of the resource would violate the node limitation.

4.4.2 Bid Optimization

The scope of the SUC is optimizing the flexibility bids based on minimizing total costs, avoiding further issues in the grids and enabling value-stacking. An algorithm performs bid optimization processes for both capacity and energy products. Optimizing means matching flexibility bids and purchase offers in the most economical way, which takes into account total costs for the SO(s) and synergies (value-stacking). The optimization of the market clearing takes into consideration the effects on all the grids involved, to ensure that any combinations of bids purchased would not lead to any operational issues for any of the grids involved. That could be achieved following a PTDF approach, and as such, grid qualification in the procurement phase and bid optimization are performed within the same optimization process. After the optimization, remaining bids and bids earmarked for balancing only need to be shared with relevant European platform (MARI, PICASSO). The information about cleared bids as the result of optimization will be sent to relevant MOs who interact directly with the FSPs. MOs are expected to request the FSPs to activate the resources according to the optimization results. The optimization process is described in more detail in Section 5.5.

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4.4.3 Flexibility Call for Tender Opening

The scope of the SUC is opening flexibility call for tender and sharing information about ongoing calls with market and system operators. A call for tender of flexibility services is used in case of capacity products and it covers, in addition to product specifications, particular periods (week ahead, day ahead, intraday, etc.), location, quantity. The call for tender is initiated by the SO who needs flexibility. Information about all calls is collected and stored centrally at T&D CP and made available to concerned MOs and SOs.

4.5 Optimization module

4.5.1 General Overview of the Optimization-Based Market Clearing Module

A key component for the efficient functionality of any flexibility market is having a market clearing engine capable of choosing the optimal set of bids to clear, and the proportions thereof, to meet the flexibility needs of the system operators in the most efficient manner. This is the role underlying the functionality of the optimization-based market clearing module (thereafter, the optimization module) of the OneNet Northern demo. The Northern demo of OneNet generally follows a joint procurement mechanism between the TSOs and DSOs in each of the procured products (i.e., a common market), in which the flexibility procurement process of a certain flexibility product (i.e., NRT-P-E, ST-P-E, ST-P-C, LT-P-C/E, an LT-P-C) is co-optimized to jointly meet the needs of all the participating SOs at the minimum cost, and while abiding by the network limitations of the grids involved. A representative figure of this process is showcased in Figure 4-2.

Joint procurement covers the case when multiple SOs are interested in procuring the same product (joint purchasing of a set of flexibility bids) or when flexibility is offered through bids from resources connected in the grid of one SO to another SO. There are cases where an SO may be the only entity interested in purchasing a particular product using flexibility connected only to its own grid (e.g., a DSO interested in purchasing the LT-P-C/E product for resolving anticipated congestions in its own grid), in which case, the common market will turn into a single market for that particular SO. The optimization-based market clearing process can accommodate these different variations.

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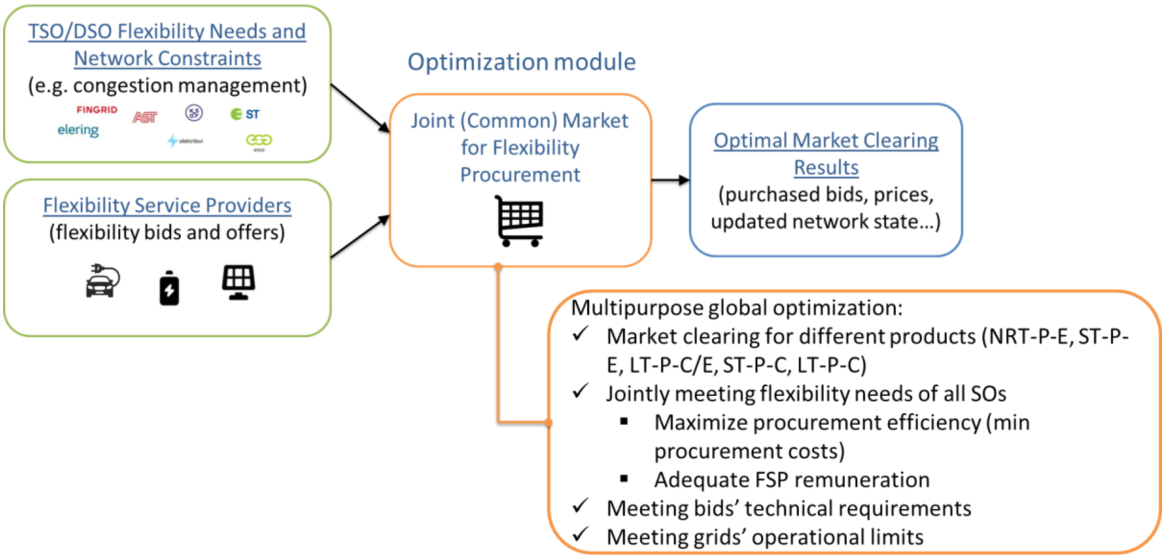

Figure 4-2 General Overview of the Optimization-Based Market Clearing Module

As such, the goal of the optimization module is (i) to maximize the flexibility procurement efficiency (i.e., minimize the total flexibility purchasing cost), and (ii) to provide an adequate and consistent remuneration to the FSPs, while concurrently (iii) abiding by the operational limits of the grids involved and (iv) the technical requirements of the FSPs specified through their submitted bid types.

In this respect, the optimization module receives the TSOs/DSOs flexibility needs and network constraints (along with indicated specifications of the market clearing run as part of a purchase offer) and the FSPs' flexibility bids/offers and chooses the optimal set of bids to clear to meet those needs at the minimum possible cost and while abiding by the operational constraints of all the grids involved (the inputs required vary from one product to the other, depending on the product specification). The optimization module, hence, outputs the cleared bids, the total flexibility procurement cost, and the updated status of the grid considering the activation of the purchased bids.

The optimization module is developed following a general and scalable methodology, which enables its implementation for the optimal procurement of different products, considering capacity and energy products, and different time frames, i.e., long-term, short-term, and near real-time, for meeting different system and grid needs (e.g., congestion management and balancing). The resulting optimization problem solved is a mixed integer linear programming problem (MILP), which is solved optimally and in a timely manner through the deployed algorithm.

4.5.2 Joint Bid Optimization and Grid Qualification

The optimization process performs bid and grid qualifications concurrently. In other words, it selects the most optimal set of bids to purchase to meet the original needs of the SOs (bid optimization), while making sure

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that these bids do not violate the operational limits (e.g., line flow limits) of all the grids involved (grid qualification). To quantify the effects of the procured flexibility on the grid operation, a network modeling (i.e., network model and power flow equations) is embedded in the optimization process using Power Transfer Distribution Factors (PTDFs). Using the network topology and the PTDFs, any changes in injections or offtakes at a set of nodes in the grid (due to the delivered upward or downward flexibility by generation and load resources) can be translated into modifications to the line flows in the grid. This allows quantifying the effects of purchasing any set of bids not only on resolving any initial flexibility needs (e.g., congestion management) but also their effects on the flows of all other lines represented in the system.

As such, the optimization process ensures that the flexibility that is purchased through the set of bids can meet the needs of the system for which the flexibility market is set up (i.e., congestion management and/or balancing within the interconnected system) while at the same time not causing any other network operational issues within the systems participating. This yields a setting in which the grid qualification is embedded in the flexibility procurement process, ensuring the most optimal set of bids is purchased while taking into account the network limitations (ensuring the viability of procuring this flexibility, that this purchased flexibility resolves the initial needs, and that it does not lead to additional unintentional network issues). As the grid impact assessment is taken into account in the optimization process, the choice of optimal bids transcends the mere concept of a merit order list (in which bids are, e.g., ranked from least to most expensive and cleared in order until the flexibility needs are met) and requires a dedicated optimization mechanism (additional details on this process are provided in [11].

4.5.3 Bid Forwarding Process to the MARI Platform

In addition to optimizing the purchasing of flexibility for meeting local system needs (e.g., congestion management at the TSO and DSO levels), and in particular for the NRT-P-E product, the optimization module performs a bid forwarding step to MARI (Manually Activated Reserves Initiative) [12] through which those bids can deliver manual frequency restoration reserves (mFRR) services. The bid forwarding process is composed of two steps, a MARI-check and a Grid-check:

1. The MARI-check step ensures that all forwarded bids (i.e., unused full or portions of bids in the congestion management process in the Northern demo) abide by the format requirements of MARI (and makes adjustments accordingly).
2. The Grid-check steps inspects whether the bids can be safely forwarded by checking whether those bids, if activated by MARI, would cause any network issues in the local grids. The bids that are deemed to cause issues are then filtered out from the set of forwarded bids. This step is needed as the MARI clearing process does not typically take into account network constraints in the local grids.

The MARI-Check and Grid-check process are highlighted in Figure 4-3.

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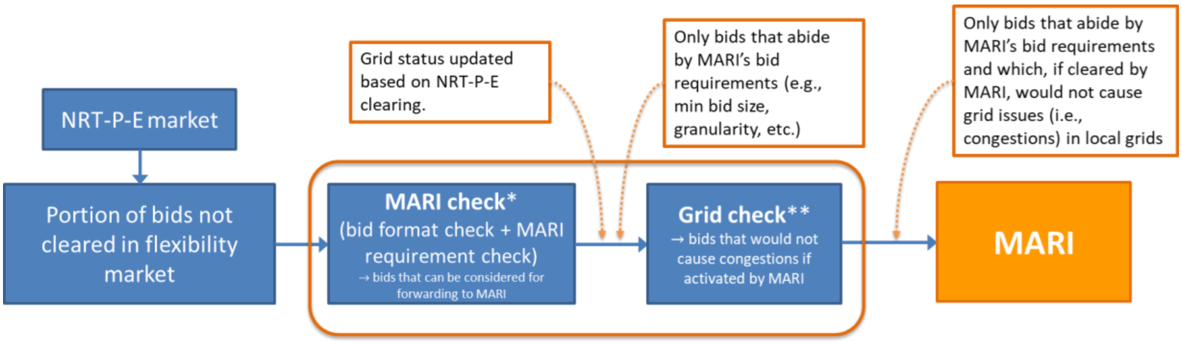

Figure 4-3 Bid Forwarding to MARI Through the Optimization Module: MARI-Check and Grid-Check

As such, including the MARI forwarding process in the optimization process allows maximizing the value stacking potential of the flexibility offered, as it opens up the opportunity for this flexibility to participate, in a grid-safe manner, to additional markets beyond the local congestion management market (as, for example, participation in the provision of manual frequency restoration reserves through MARI). A representation of the optimization process, including the link to MARI, is highlighted in Figure 4-4 [11].

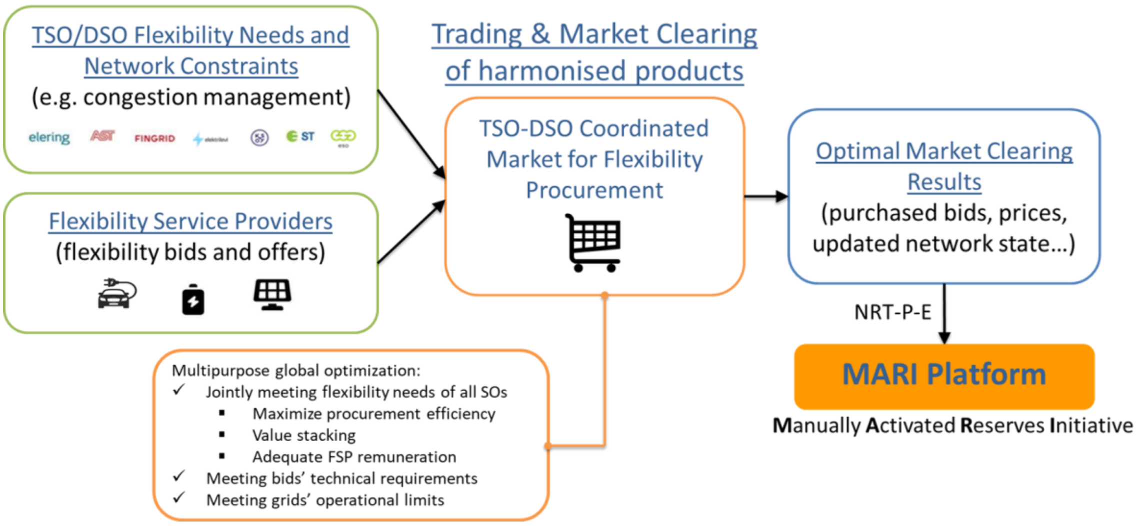

Figure 4-4 Schematic Representation of The Optimization Module Including the Forwarding to MARI Step

4.5.4 Bid Types

The optimization module allows the use of different bid formats for the trading of the products, which provides flexibility for FSPs in the specification of their bids to meet their technical requirements, while also allowing a degree of harmonization with other platforms, such as, MARI [12].

The bid formats accepted are of two main categories: simple bids and complex bids. Simple bids are of three different categories governing the degree of divisibility of those bids, namely:

1. Fully divisible bids which are bids specified by a maximum quantity and a price, where a fully divisible bid can be cleared at any proportion between 0 and the indicated maximum quantity. For example, a fully divisible bid of maximum quantity of 5 MW and a price of 20 €/MW can be cleared at any level between 0 and 5 MW. The unit price of that bid is 20 €/MW at any clearing level.
2. Indivisible bids, which are bids that are also specified by a maximum quantity and a price, but where the bid can only be cleared at its maximum quantity (i.e., all or nothing). For example, an indivisible bid of maximum quantity of 5 MW and a price of 20 €/MW, can be cleared only at 5 MW if it is to be purchased (i.e., cannot be cleared at any level below 5 MW). The unit price of that bid is 20 €/MW.
3. Partially divisible bids, which are bids that are indicated by a price, a maximum quantity, and a minimum clearing level. These bids cannot be cleared below their minimum clearing requirements, and can be cleared at a proportion between their minimum clearing requirements and their maximum quantity. For example, a partially divisible bid of maximum quantity of 5 MW, a minimum clearing requirement of 2MW, and a price of 20 €/MW, can be cleared at any level between 2MW and 5 MW (i.e., cannot be cleared at any level below 2MW, and is fully divisible in the range of 2MW to 5 MW). The unit price of that bid at any clearing level in the allowed range is 20 €/MW.

Those three types of simple bids are represented in Figure 4-5-5.

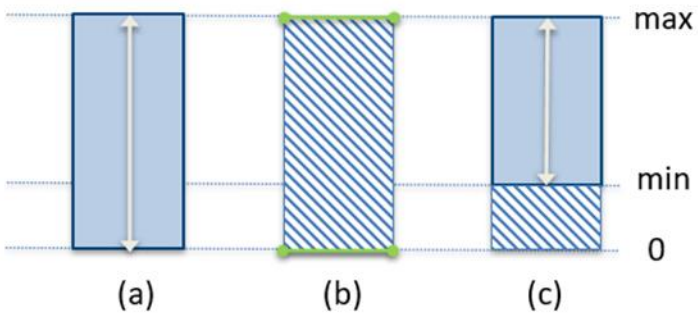

Figure 4-5 Types of Simple Bids Considered in the Northern Demo. (a) Fully Divisible: clearing in the range [0, max], (b) Fully Indivisible: 0 or max, (c) Partially Divisible: clearing in the range [min, max] [11]

In addition to the simple bids, the optimization module accepts two types of complex bids, which group simple bids based on different logical connections, namely:

1. Exclusive bids: exclusive bids consist of a set of indivisible bids from which a maximum of one bid can be purchased (a purchasing of one bid excludes the purchasing of others). The bids forming the exclusive bid can have different quantities and prices, but should, however, be of the same direction (i.e., either all upward flexibility bids or all downward flexibility bids). This shows a slight differentiation from the current exclusive bids definition for the MARI platform, in which the bids forming an exclusive set can have different directions and types [12].

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2. Multipart bids: multipart bids are composed of one simple bid, considered as the parent bid, and a group of simple bids considered as children bids. In this respect, children bids can be purchased (i.e., cleared) at any level (in accordance with their type) only if the parent bid is purchased (at any level, depending on its type). The bids forming the multipart bids (parent or children) can be of any simple bid type, and can have different quantities and prices. However, all the bids should be of the same flexibility direction (i.e., either all upward flexibility bids or all downward flexibility bids). This also shows a slight differentiation from the multipart bids currently considered in the MARI development, where in the latter, the bids in the multipart bids follow a clearing order based on their prices [12].

4.5.5 Optimization Module Inputs and Outputs

A detailed description of the inputs and outputs of the optimization module is provided in D7.4 [11]. In short, the input consists of three main sets:

1. A Purchase Offer including the fundamental information to launch a market clearing optimization session (including key information such as the product type, the timing, the imbalance position of the system and allowed modifications thereof, the total cost cap of the market session if required, etc.)
2. Network data: including information about the network (topology, PTDFs, base flows, line criticality, interconnection between systems, etc.). This, hence, provides a representation of the interconnected network which allows quantifying the effect of clearing any set of bids on resolving the initial flexibility need and on the state of the grid as a whole. The Network Data enable, hence, representing the network topology, power flows, network characteristics, and operational limits. The Network data is composed of three main categories summarized next.
    a. The list of the nodes of each network, while indicating whether a certain node is a slack bus (in a transmission network), and/or whether it is an interface node of a transmission network (indicating whether it is connected to another system), or whether it is a root node in a radial network.
    b. The list of the lines of each network, which include the nodes they connect, their anticipated initial flows, the line capacity limits, their criticality (a critical line is a line whose congestion should be managed – either through alleviation or prevention), etc. The line representation (similar to a one line diagram representation in power system analyses) can represent other components such as transformers.
    c. The PTDF matrix of each network.

    Those inputs are to be provided for each of the systems considered and can accommodate meshed and radial systems.
3. Bid data: the bid data includes the set of bids submitted by the FSPs including their quantity and price parameters along with their type-related parameters (i.e., the different requirements for simple bids –

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fully divisible, fully indivisible, and partially divisible, and for complex bids – exclusive bids and multipart bids), as specified in Section 4.5.4.

The optimization outputs the set of bids cleared and their quantities, the set of bids to be forwarded to MARI (and their quantities) in case of the NRT-P-E – i.e., the bids which have passed the MARI and grid checks, the total procurement cost, the updated state of the grid (e.g., line flows) considering the activation of the purchased bids, the updated imbalance position of the system, and other key elements such as the optimization output status, a timestamp, etc.

The sets of inputs, requirements and outputs can differ from one product to the other, based on the design and requirements of the product itself. The detailed descriptions of the inputs and outputs specification per product are provided in D7.4 [11].

4.5.6 API

The optimization module is integrated in the T&D CP platform of the Northern demo through a developed API. The integration is showcased in Figure 4-6.

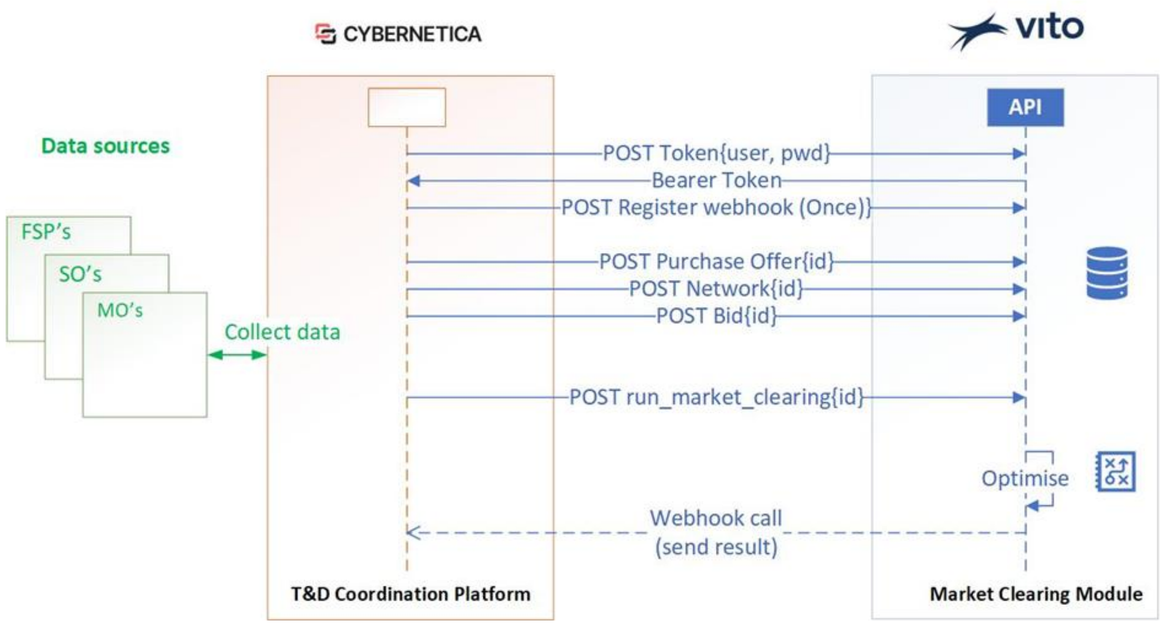

Figure 4-6 Optimization Module API and Integration in the T&D CP Platform [11]

The API (hosted by VITO) allows accessibility to the optimization module. Through the API, the information needed for each market session are communicated to the optimization module, which then receives those inputs and clears the market (i.e., through running the optimization process), after which the outputs are sent back by the optimization module to the webhook provided by the T&D CP. The optimization module is an integral component of the T&D CP. The T&D CP receives the input needed from the market participants (i.e., network and purchase offer data from the SOs, and the bid data from the MOs), and sends the required inputs in the

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specified formats to the optimization module (each request is associated with a unique request ID). The API then checks whether the inputs respect the specifications, in which case the optimization-based market clearing process is run. Then, the optimization module communicates the outputs when ready to the T&D CP platform through the provided webhook.

A token is required to receive authorization for the use of the APIs, along with a number of cybersecurity measures including: network segmentation (API running in DMZ), firewall and packet inspection (SSL termination on firewall), regular security patching and updates, monitoring and alerting, reverse proxy on the API server only exposes HTTP port 80 for certain domain names to the outside, input validation layer before accepting incoming request, among others.

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5 Development of new market products

New market functionalities entail new products to meet system operators' needs across the designated market border, and achieve interoperability among existing European markets, thus promoting open competition and realizing a pan-European solution. The key characteristic of the Northern demonstrator is the introduction of common flexibility products, enabling both TSOs and DSOs to use these products for congestion and balance management in all participating countries. Three attributes are chosen to define these products. Firstly, the time to physical delivery – the product can be long-term (LT), short-term (ST) or near real-time (NRT); secondly, the proposed product can be used to procure capacity (C) or energy (E); thirdly, the product can be used for procuring active power (P) or reactive power (Q). The proposed products are interconnected to the existing day-ahead, intra-day and real-time balancing products in the Nordic electricity market. For instance, the short-term product is compatible with day-ahead and intra-day market products. Table 5-1 lists the harmonized market products proposed in the Northern demonstrator.

Table 5-1 Northern demonstrator products and mapping to OneNet Harmonized Products [11]

Northern demonstrator product	Description	OneNet Harmonised Product
NRT-P-E (Near-Real-Time Active Energy)	Energy product used by SOs responsible for frequency and congestion management. Single product for frequency restoration and congestion management. Procured in near-real-time (15min). Activated manually.	Corrective local active. The product is consistent with mFRR
ST-P-E (Short-Term Active Energy)	Procured day to a month ahead. Active power energy product. Used by SOs for congestion management.	Predictive short term local active
ST-P-C (Short-Term Active Capacity)	Procured day to a month ahead. Active power capacity product. Used by SOs for congestion management and frequency.	Predictive short term local active
LT-P-C (Long-Term Active Capacity)	Procured months to years ahead. Active power capacity product. Used by SOs for congestion management.	Predictive long-term local active
LT-P-C/E (Long-Term Active Capacity/Energy)	Procured months to years ahead. Active power product with simultaneous procurement of capacity and energy. Used by SOs for congestion management.	Predictive long-term local active

5.1 Near real-time active energy (NRT-P-E)

The near-real-time active energy (NRT-P-E) product is an energy product to procure active power in the near-real time. Transmission and distribution system operators can jointly purchase flexibility bids using this product,

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for congestion management and/or balancing in the interconnected system. The activation energy part of the existing mFRR (manual frequency restoration reserve) product could be part of the NRT-P-E product. The mFRR is defined as “active power reserves available to restore system frequency to the nominal frequency, while it is activated manually whenever it is required’’. For procuring flexibility through NRT-P-E product, the purchase offers are submitted to the T&D-CP at the latest 23,5 minutes before the physical delivery. Optimization-based market clearing is run close to the actual activation time.

In the Northern Demonstrator, NRT-P-E will be demonstrated in all four countries: Finland, Estonia, Latvia, Lithuania. For this purpose, the MO platform developed by TSO for the mFRR product will be connected to the Northern Demonstrator platform. The MO sends the list of mFRR bids, from FSP that already gave the consent, to be used for the CM by DSO and TSO in near-real-time. To select the optimum bids, the T&D CP will run an optimization and select some mFRR bids. Then, the uncleared portion of bids and updated purchase offer of TSO can be transferred to the MARI system for coordinated balancing use utilizing cross-border exchange. Appendix B shows the interaction of MO, the Northern Demonstrator platform, and other actors in the flexibility procurement value chain.

5.2 Short-term active energy (ST-P-E)

The short-term active energy (ST-P-E) product is an energy product to procure active power in the short term. Transmission and distribution system operators can jointly purchase flexibility bids using this product, for congestion management and/or balancing the interconnected system. For procuring flexibility through ST-P-E product, the purchase offers are submitted to the T&D-CP at the latest 60 minutes before the physical delivery. ST-P-E product can be used to react against unexpected incidents that require correction ahead of delivery. The product is tradable via modified power exchange intraday markets or other platforms. In addition to current bidding area level utilization, this product can be used to solve more local problems by introducing more granular locational information. By this modification to the intraday trading, market parties’ access to different markets can be enhanced, when simultaneous participation to the wholesale and CM markets is enabled.

5.3 Short-term active power capacity (ST-P-C)

The short-term active capacity (ST-P-C) product is a capacity product to procure active power in the short term. The need to procure flexibility via ST-P-C product is specified by a SO by submitting a flexibility call for tender. Its market clearing optimisation process is similar to the LT-P-C, apart from the timestamp (LT-P-C is used for long term while the ST-P-C is used for the short term). The capacity part of the existing mFRR, which is used as an available reserve capacity for frequency restoration, can be an example of this product.

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5.4 Long-term active power (LT-P-C)

The long-term active capacity (LT-P-C) product is a capacity product to procure active power in the long term. Transmission and distribution system operators can jointly reserve flexibility bids using this product, for congestion management and/or balancing the interconnected system.

5.5 Long-term active capacity/energy (LT-P-C/E)

The long-term active capacity/energy (LT-P-C/E) product is a capacity and energy product to procure active power in the long term. It is designed for the needs of distribution system operators to optimally reserve capacity for congestion management and to also optimally activate the capacity reserved when needed. As the product is focused on DSOs, only one system operator purchases flexibility at the time, thus no interconnected systems are considered for this product. In the demonstration, the market will be operated by Piclo, while TSO and DSO will purchase flexibility from the market based on their long-term CM needs.

5.6 15-min time unit requirements

Due to the more fluctuating production, more granular metering and forecasting is required for power balance in real time. In the future, a 15-minute time interval for metering, trading, and imbalance settlement will replace the current 60-minute interval prevailing in Europe. The European day-ahead markets will switch to 15-minute interval unit in 2025. Finland is in the forefront in this transition as 15-minute imbalance settlement period has recently begun in May 2023 and 15-minute intraday products will be available for intra-zonal trading [13].

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6 Conclusion

Due to massive installations of fluctuating renewable generation, power systems are transitioning from centralized to decentralized and cellular systems. Network operators need to accept this paradigm shift and fine tune their current operational models to accommodate fast variations and adaptive flexibility. To enable this, the Northern demonstrator of the OneNet project proposed a new market architecture to enable market driven flexibility uptake by multiple networks in a coordinated way. The market architecture was developed with existing market operators and by realizing new roles, namely, FR and T&D-CP. The new market architecture enables seamless participation of flexibility resources regardless of physical location and market borders.

The deliverable presented the market structure, involved actors, interaction of systems, and associated processes in the context of the Northern demonstrator. The proposed market functionality was explained considering the use cases and the platform interfaces exchanging data. The document also showcased how the use cases address the identified challenges related to the flexibility value chain. The functionality of systems and processes associated with the use cases will be tested in each demo site and reported in deliverable D7.6. For interoperability, harmonized flexibility market products applicable in each of the demo sites were proposed that enable linking bids and offers across market boundaries.

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Appendix A System use case 'Add a new product'

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
7.3.1	Flexibility market, Market operation and trading	Add New Product

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	07.05.2021	Poria Divshali, Sirpa Repo	First draft	For T7.3 discussion
2	01.06.2021	Poria Divshali	Changed based on May 21st and 31st and comment provided until Jun 1st. Complete some missing description.	For T7.3 partner review

Scope and objectives of use case

Scope and objectives of use case	
Scope	Prequalification of a new flexibility product from MO perspective
Objective(s)	Creating a new product in the market
Related business case(s)	Northern regional flexibility market

Narrative of Use Case

Narrative of use case
Short description
In order to have any trade between a Flexibility provider and system operator, at least a market needs to offer the flexibility product. Here the process of adding a product to a market will be reviewed. The process starts from the need for a system operator (SO). When a SO need any type of flexibility, contact market operators (MO) to find which product is suitable for its need. If there is no product, which is suitable for the need of the SO, it needs to define the product properties and send it to MO. Here, MO will decide whether wants to offer this product in its market or not. If MO wants to offer the product, it will publish the description and inform the flexibility register to start the prequalification process.

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Complete description

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
	Cover SO needs	The amount of unsatisfied flexibility need Target Value: 0	Providing the flexibility product for all needs of different SOs
	Avoidance of similar products	The number of products having any overlap Target Value: 0	

Use case conditions

Use case conditions	
Assumptions	
1	Solutions for consent management for sharing private data are in place in all countries of the region.
Prerequisites	
--	

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
Other system use cases related to Market Operator, TSO-DSO coordination, Flexibility Register, and Customer onboarding
Level of depth
Prioritisation
Generic, regional or national relation
Nature of use case
System use case
Further keywords for classification

General remarks

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General remarks

Diagrams of use case

Diagram(s) of use case

Technical details

Actors

Actors			
Grouping		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Market Operator (MO)	Business	A market operator is a party that provides a service whereby the offers to sell electricity **or electricity flexibility** are matched with bids to buy electricity **or electricity flexibility**.	HEMRM [14] definition with extensions (in bold) proposed by BRIDGE. Includes also TSOs and DSOs performing the role of MO.
System Operator (SO)	Business	A party responsible for operating, ensuring the maintenance of and, if necessary, developing the system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution or transmission of electricity.	HEMRM definition.
Flexibility Register (FR)	System	A system that stores information about flexibility assets, results of qualification (both product and grid), market results, grid information and the results of the settlement as well as aggregates flexibility information as well as allocates access rights to the various actors and controls the level of access.	Based on the BRIDGE proposal for Flexibility Register Operator definition.
TSO-DSO coordination platform (T&D CP)	System	A system that is designed to avoid, through grid impact assessment, activation of flexibilities which either do not contribute to solving system needs or even worsen the situation (constraint setting process) as well as to find the best value-stack of available flexibilities to be activated (optimization process).	

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Consent Administrator (CA)	Business	A party responsible for administrating a register of consents for a domain. The Consent Administrator makes this information available on request for entitled parties in the sector.	HEMRM definition.

References

References						
No.	**Reference Type**	**Reference**	**Status**	**Impact on use case**	**Originator / organisation**	**Link**

Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
7.3.1.1	MO steps in add new product		MO			

Steps – Scenarios

Scenario								
Scenario name	MO steps in add new product							
Step No	**Event**	**Name of process/activity**	**Description of process/activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
1		Check the existing product.	SO contact relevant MO to Identify whether there is an existing product for flexibility need		SO	MO	ProdSpec	
2		Conditional: Create and Send product	If there is no existing product, SO need to define		SO	MO	ProdSpec	

		information	a new product specification					
3		Decide whether MO wants to offer this product in its market	implement a product based on SO flexibility need		MO	MO	Response	
4		Inform MO decision whether wants to offer the product	MO inform SO regarding the decision		MO	SO	Response	
5		Send product specifications	Publish product specifications and requirements in case of a positive decision in 1.4		MO	FR	ProdSpec	

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
ProdSpec	Product Specification	The technical specification of the flexibility product (technical parameters, validation, requirements)	
Consent	Customer Consent	Permission of data owner to use its private data.	
Response	Response	Positive or negative reply to a request.	

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Appendix B System use case 'Procurement with interaction with OneNet platform'

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
7.3.1	Flexibility market, Market operation, and trading	Procurement

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	07.05.2021	Poria Divshali, Sirpa Repo	First draft	For T7.3 discussion
2	01.06.2021	Poria Divshali	Changed based on May 21st and 31st and comment provided until Jun 1st. Complete some missing descriptions.	For T7.3 partner review
3	03.12.2021	Poria Divshali	Update to interact through the OneNet Platform	For T7.3 partner review
4	11.02.2022	Kaja Trees	Draw the diagram	For OneNet consortium

Scope and objectives of use case

Scope and objectives of use case	
Scope	Procurement of flexibility products from MO perspective
Objective(s)	Product procurement in the market
Related business case(s)	Northern regional flexibility market

Narrative of Use Case

Narrative of use case
Short description
The procurement process of flexibility products in a market can be divided into five main processes: opening the market, trading, matching, closing the market, and settlement. In the opening scenario, the market will be open and the availability of trading will be informed to all relevant parties. In trading, flexibility service providers submit their bids and system operators publish their purchasing needs to TSO & DSO coordination platform (T & D CP).

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In the matching scenario, the market operator in cooperation with the T & D CP matches the bids and offers to find the optimum solution. Then, the market operator informs the results to relevant parties in the closing scenario Finally, In the settlement, The MO receives the verified amount of flexibility delivered for each product/FSP from Flexibility Register (FR) and calculates remuneration for each FSP.
Complete description

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***

Use case conditions

Use case conditions	
Assumptions	
1	Solutions for consent management for sharing private data are in place in all countries of the region.
2	
Prerequisites	

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
Other system use cases related to Market Operator, TSO-DSO coordination, Flexibility Register, and Customer onboarding
Level of depth
Prioritisation
Generic, regional or national relation
Nature of use case
System use case
Further keywords for classification

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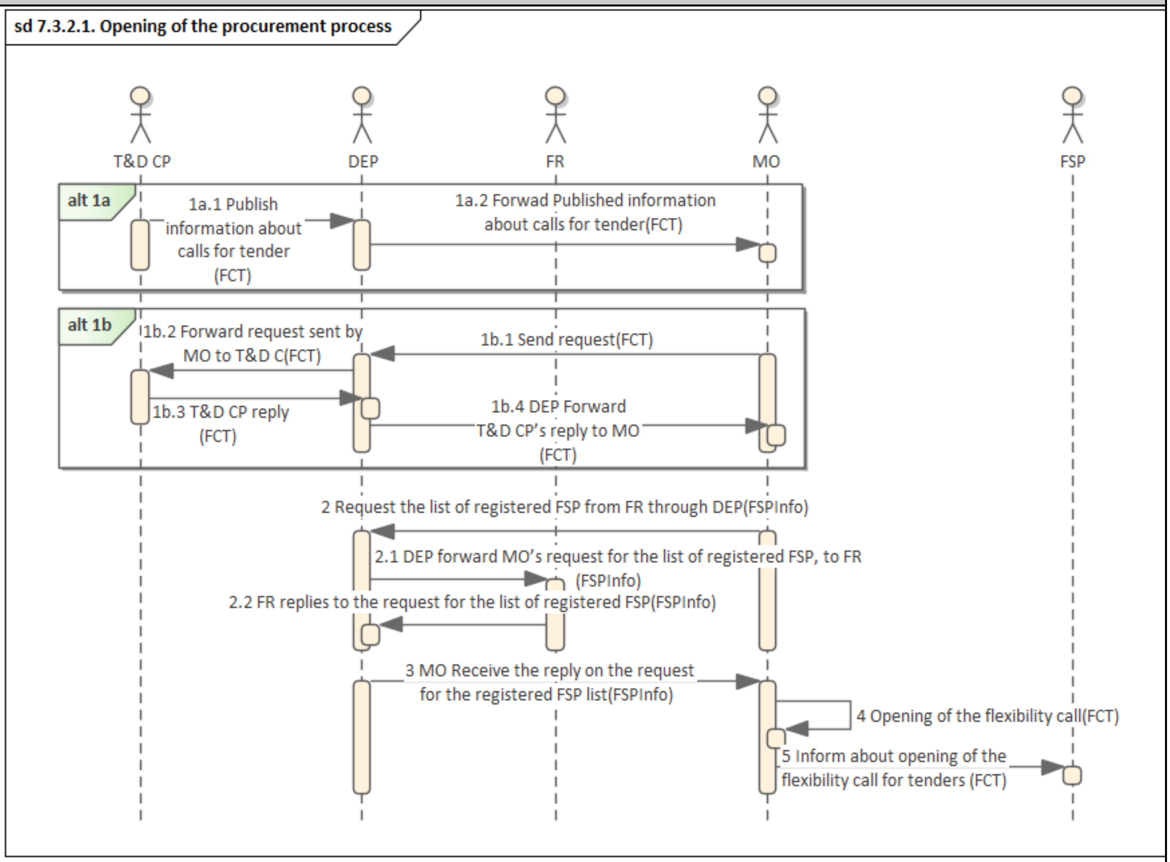
General remarks

General remarks

Diagrams of use case

Diagram(s) of use case


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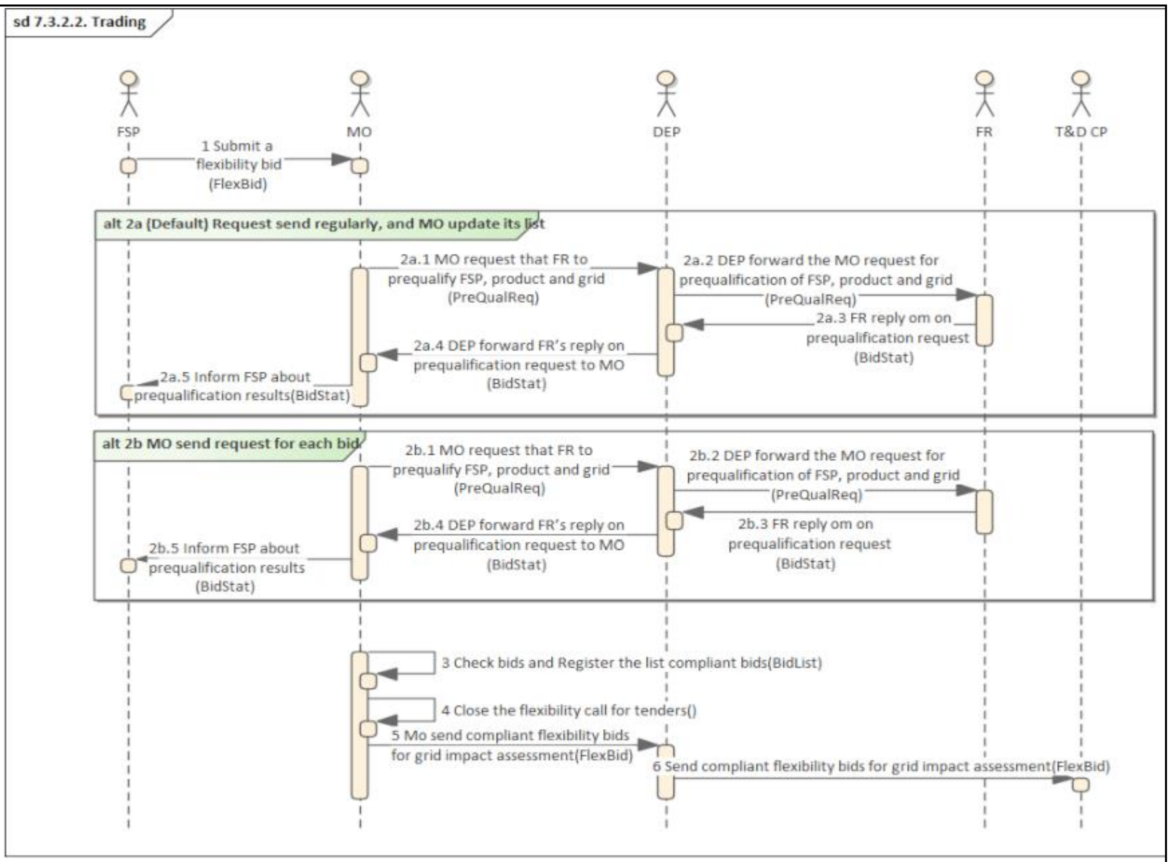

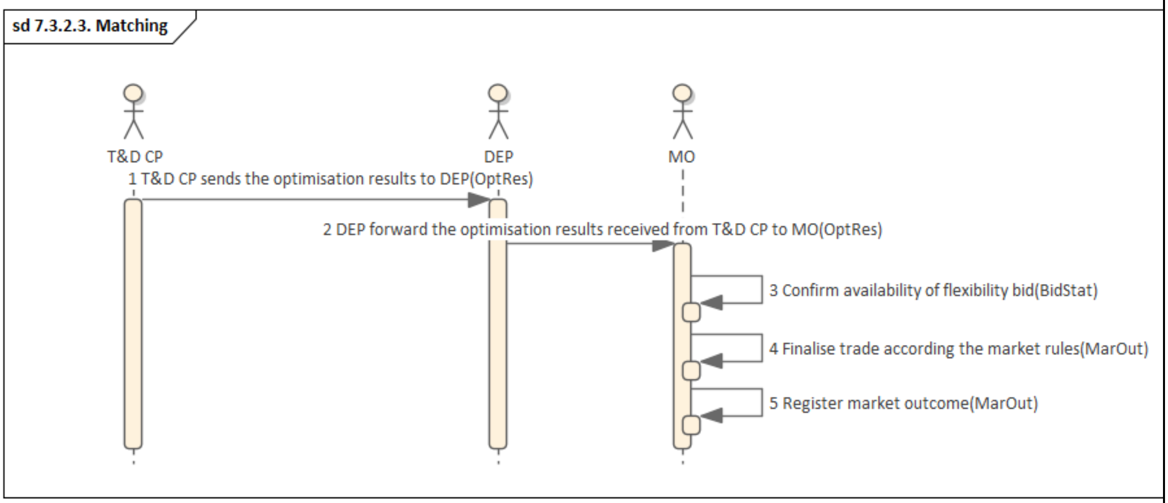

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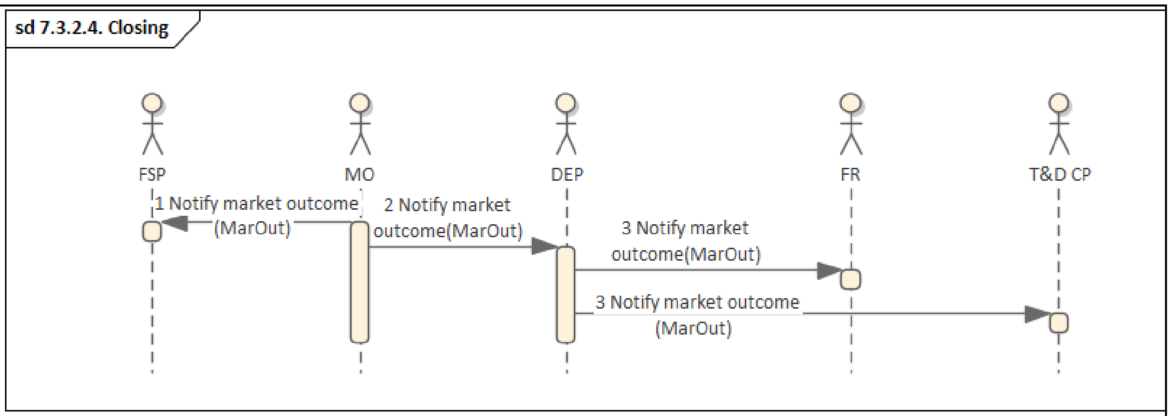

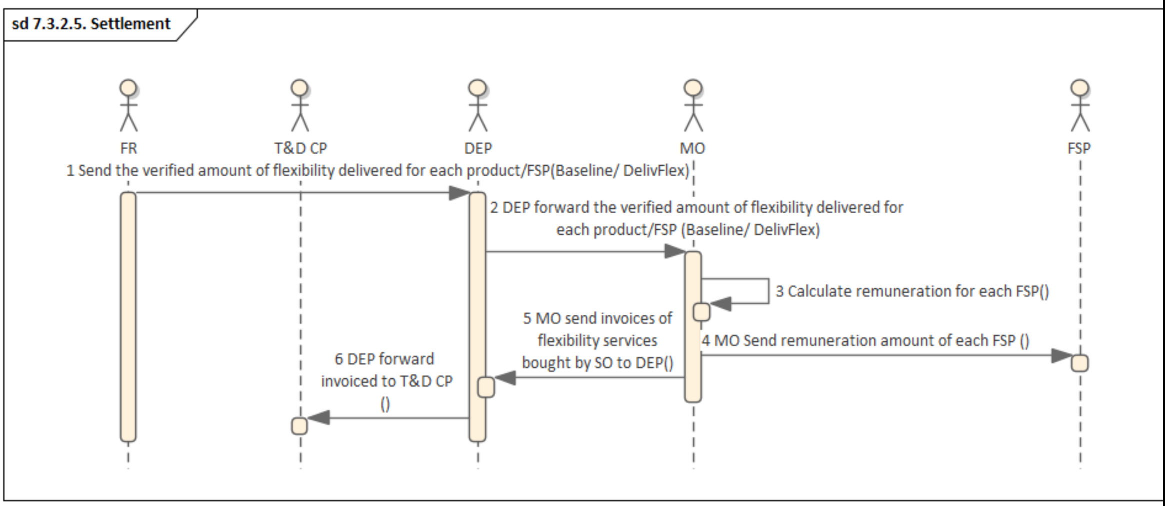

Technical details

Actors

Actors			
Grouping	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Market Operator (MO)	Business	A market operator is a party that provides a service whereby the offers to sell electricity **or electricity flexibility** are matched with bids to buy electricity **or electricity flexibility**.	HEMRM definition with extensions (in bold) proposed by BRIDGE. Includes also TSOs and DSOs

			performing the role of MO.
System Operator (SO)	Business	A party responsible for operating, ensuring the maintenance of and, if necessary, developing the system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution or transmission of electricity.	HEMRM definition.
Flexibility Register (FR)	System	System that stores information about flexibility assets, results of qualification (both product and grid), market results, grid information as well as perform flexibility verification and settlement, aggregates flexibility information, allocates access rights to the various actors, and controls the level of access.	Based on BRIDGE proposal for Flexibility Register Operator definition.
TSO-DSO coordination platform (T&D CP)	System	A system that is designed to avoid, through grid impact assessment, activation of flexibilities which either do not contribute to solving system needs or even worsen the situation (constraint setting process) as well as to find the best value-stack of available flexibilities to be activated (optimization process). T&D CP is a system under optimisation operator (OO).	
Imbalance Settlement Responsible (ISR)	Business	A party that is responsible for settlement of the difference between the contracted quantities with physical delivery and the established quantities of energy products for the Balance Responsible Parties in a Scheduling Area.	HEMRM definition.
Data Exchange Platform (DEP)	System	A communication platform the basic functionality of which is to secure data transfer (routing) from data providers (e.g. data hubs, flexibility service providers, TSOs, DSOs) to the data users (e.g. TSOs, DSOs, consumers, suppliers, energy service providers). DEP stores data related to its services (e.g. cryptographic hash of the data requested). The DEP does not store core energy data (e.g. meter data, grid data, market data) while these data can be stored by data hubs.	BRIDGE proposal.

Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
7.3.2.1	Opening of the procurement process		MO			

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7.3.2.2	Trading		MO			
7.3.2.3	Matching		MO			
7.3.2.4	Closing		MO			
7.3.2.5	Settlement		MO			

Steps – Scenarios

Scenario								
Scenario name	7.3.2.1. Opening of the procurement process							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.a1		Alt. 1 – Publish information about calls for tender	T&D CP publishes a new call for a specific product. DEP will inform MO (Unless it is continuous trading)		T&D CP	DEP	FCT	
1.a2		Alt. 1 – Forward Published information about calls for tender	DEP sends the published calls by T&D CP for a specific product and MO checks published information (Unless it is continuous trading)		DEP	MO	FCT	
1.b1		Alt. 2 – Send request	MO request from T&D CP about ongoing calls, through DEP		MO	DEP	FCT	
1.b2		Alt. 2 – Forward request sent by MO to T&D CP	DEP forward MO's request to T&D CP about ongoing calls		DEP	T&D CP		
1.b3		Alt. 2 – T&D CP reply	T&D CP reply the request by sending the information about ongoing calls to DEP		T&D CP	DEP	FCT	
1.b4		Alt. 2 – DEP Forward T&D	DEP Forward T&D CP's reply by sending		DEP	MO	FCT	

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		CP's reply to MO	the information about ongoing calls					
2		Request the list of registered FSP from FR through DEP	MO need to have the list of the FSP to inform them about the call opening		MO	DEP	FSPInfo	
2.1		DEP forward MO's request for the list of registered FSP, to FR	MO need to have the list of the FSP to inform them about the call opening		DEP	FR	FSPInfo	
2.2		FR replies to the request for the list of registered FSP	FR replies to the request for the list of registered FSP MO needs this list and will get through DEP.		FR	DEP	FSPInfo	
3		MO Receive the reply on the request for the registered FSP list	DEP forward the FR's replies regarding the registered FSP list to MO.		DEP	MO	FSPInfo	
4		Opening of the flexibility call	if MO decide to continue		MO	MO	FCT	
5		Inform about opening of the flexibility call for tenders	FSPs should receive information about call for tenders opening.		MO	FSP	FCT	

Scenario								
Scenario name		7.3.2.2. Trading						
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1		Submit a flexibility bid	Bid information should include resource/location information if flexibility is		FSP	MO	FlexBid	

			provided for the products where location matters.					
2.a		MO request that FR to prequalify FSP, product and grid. The request send through DEP	MO needs to make sure that FSP, product and grid are prequalified by FR. Alt 1 (Default): This request send once a while, e.g. daily, and MO update its list Alt : MO send request for each bid (FSP need give the consents for MO, DEP, and T&D CP, …)		MO	DEP	PreQualReq FlexBid	
2.a		DEP forward the MO request for prequalification of FSP, product and grid	MO needs to make sure that FSP, product and grid are prequalified by FR. Alt 1 (Default): This request send once a while, e.g. daily, and MO update its list Alt : MO send request for each bid (FSP need give the consents for MO, T&D CP, …)		DEP	FR	PreQualReq FlexBid	
2.b		FR reply to on prequalification request	FR send the reply of the MO request for		FR	DEP	BidStat	

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			prequalification to DEP					
2.b		DEP forward FR's reply on prequalification request to MO	DEP forward FR's reply on prequalification request to MO		DEP	MO	BidStat	
2.c		Inform FSP about prequalification results	MO inform FSP about prequalification results		MO	FSP		
3		Check bids and Register the list compliant bids	MO check the general properties of the bid, e.g. bid format, whether the call is ongoing and also check FSP, product and grid are prequalified by FR (According to steps 2.a and 2.b.)		MO	MO	BidLis	New
4		Close the flexibility call for tenders	Gate closure, the info will be displayed in MO webpage		MO	MO	---	
5		Mo send compliant flexibility bids for grid impact assessment	All the attributes associated to FlexBid should be forwarded T&D CP through DEP		MO	DEP	FlexBid	
6		Send compliant flexibility bids for grid impact assessment	All the attributes associated to FlexBid should be forwarded		DEP	T&D CP	FlexBid	

Scenario	
Scenario name	7.3.2.3. Matching

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Step No	*Event*	*Name of process/activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information exchanged (IDs)*	*Requirement, R-IDs*
1		T&D CP sends the optimisation results to DEP	T&D CP optimise the bid by matching flexibility bids and purchase offers, which directly received from SO, in most economic way taking into account synergies (value-stacking). Then it send the results to MO through DEP.		T&D CP	DEP	OptRes	
2		DEP forward the optimisation results received from T&D CP to MO	DEP forward the optimisation results received from T&D CP to MO		DEP	MO	OptRes	
3		Confirm availability of flexibility bid	Check if the bid is still available (apply only to locational Intraday market)		MO	MO	- BidStat	
4		Finalise trade according the market rules	MO will finalise the trade and the payment according to the market rules (e.g. pay as bid or pay as cleared)		MO	MO	MarOut	
5		Register market outcome			MO	MO	MarOut	New

Scenario								
Scenario name	7.3.2.4. Closing							
Step No	*Event*	*Name of process/activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information exchanged (IDs)*	*Requirement, R-IDs*
1		Notify market outcome			MO	FSP	MarOut	

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2		Notify market outcome	MO send the market outcome to DEP		MO	DEP	MarOut	
3		Notify market outcome	DEP forward the Market outcome to FR and T&D CP		DEP	FR, T&D CP	MarOut	

Scenario								
Scenario name	7.3.2.5. Settlement							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1		Send the verified amount of flexibility delivered for each product/FSP	FR calculate and validate the actual flexibility delivered by each FSP in each product		FR	DEP	RefValue/ DelivFlex	
2		DEP forward the verified amount of flexibility delivered for each product/FSP	FR calculate and validate the actual flexibility delivered by each FSP in each product		DEP	MO	RefValue/ DelivFlex	
3		Calculate remuneration for each FSP			MO	MO		
4		MO Send remuneration amount of each FSP			MO	FSP		
5		MO send invoices of flexibility services bought by SO to DEP			MO	DEP		
6		DEP forward invoiced to T&D CP			DEP	T&D CP		

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Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
FCT	Flexibility Call for Tender	Flexibility call specification for a specific product	
FSPInfo	Flexibility service provider information	Information about FSP, which is needed to register to the flexibility register	
FlexBid	Flexibility Bid	Offer made by Flexibility Service Provider for selling flexibility.	
PreQualReq	Pre-Qualification Request	FSP, product and grid Prequalification info	
BidStat	Bid status	Status of the bid, including availability and results of the prequalification (FSP, product, grid)	
BidLis	Bid list	The list of compliant bids.	
OptRes	Optimisation results	Optimisation of Merit Order List taking into account the possible synergies of using the same bid for more than one service and/or buyer.	
MarOut	Market Outcome	the results of matching the offers/bid by MO	
DelivFlex	Delivered flexibility amount	Difference between baseline/reference value and metering data	
RefValue	Reference value	Estimation of the behaviour of a resource which can be compared to the metered data.	

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Requirements (optional)

Requirements (optional)		
Categories ID	***Category name for requirements***	***Category description***
Requirement R-ID	***Requirement name***	***Requirement description***

Common terms and definitions

Common terms and definitions	
Term	***Definition***

Custom information (optional)

Custom information (optional)		
Key	***Value***	***Refers to section***

Appendix C System use case 'Secondary trading'

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
7.3.1	Flexibility market, Market operation and trading	Secondary trading

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	07.05.2021	Poria Divshali, Sirpa Repo	First draft	For T7.3 discussion
2	04.06.2021	Poria Divshali	Changed based on May 21st and 31st and comment provided until Jun 4th. Complete some missing description.	For T7.3 partner review

Scope and objectives of use case

Scope and objectives of use case	
Scope	Selecting a new FSP to replace a FSP cannot provide the promised product
Objective(s)	Replacing FSP, which failed to provide flexibility
Related business case(s)	Northern regional flexibility market

Narrative of Use Case

Narrative of use case
Short description
When a FSP, which have a bidding contract for providing a flexibility product for future, realises that cannot fulfil the contract, it can inform and ask market operator to find a replacement for it. This process called secondary trading and it is quite similar to the normal trading, but the process trigged by sending a request from the FSP, which is not capable to fulfil the contract.
Complete description

Key performance indicators (KPI)

Key performance indicators

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ID	Name	Description	Reference to mentioned use case objectives
	Secondary trading performance	The rate of output contract to requested. Target Value: 1	Providing the flexibility product for all needs of different SO

Use case conditions

Use case conditions	
Assumptions	
1	Solutions for consent management for sharing private data are in place in all countries of the region.
2	TSO & DSO coordination platform and Flexibility register as described by the OneNet Northern Demonstrator are in place usable by the actors
Prerequisites	

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
Other system use cases related to Market Operator, TSO-DSO coordination, Flexibility Register, and Customer onboarding
Level of depth
Prioritisation
Generic, regional or national relation
Nature of use case
System use case
Further keywords for classification

General remarks

General remarks

Technical details

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Actors

Actors			
Grouping	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Market Operator (MO)	Business	A market operator is a party that provides a service whereby the offers to sell electricity **or electricity flexibility** are matched with bids to buy electricity **or electricity flexibility**.	HEMRM definition with extensions (in bold) proposed by BRIDGE. Includes also TSOs and DSOs performing the role of MO.
System Operator (SO)	system	A party responsible for operating, ensuring the maintenance of and, if necessary, developing the system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution or transmission of electricity.	HEMRM definition.
Flexibility Register (FR)	System	System that stores information about flexibility assets, results of qualification (both product and grid), market results, grid information as well as perform flexibility verification and settlement, aggregates flexibility information, allocates access rights to the various actors and controls the level of access.	Based on BRIDGE proposal for Flexibility Register Operator definition.
TSO-DSO coordination platform (T&D CP)	System	System that is designed to avoid, through grid impact assessment, activation of flexibilities which either do not contribute to solving system needs or even worsen the situation (constraint setting process) as well as to find the best value-stack of available flexibilities to be activated (optimization process).	

References

References						
No.	***Reference Type***	***Reference***	***Status***	***Impact on use case***	***Originator / organisation***	***Link***

Step by step analysis of use case

Overview of scenarios

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Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
7.3.1.1	MO steps in New Product prequalification		MO			

Steps – Scenarios

Scenario								
Scenario name	CONDITIONAL Secondary Trading							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1		FSP inform the need for trading in the secondary market	FSP, who is not capable to fulfil the contract need to inform MO.		FSP	MO	FSPInfo	new
2		Validation of the trade needs (Contract)	MO need to check the condition of trade needs (contract of mot capable FSP). For example, is this request for secondary trading happen well in advance of delivery time		MO	MO	---	new
3		Request the list of registered FSP	MO need to have the list of the FSP to inform them about the call opening		MO	FR	FSPInfo	
4		Receive the reply of request the list of registered FSP	MO need to have the list of the FSP to inform them about the call opening		FR	MO	FSPInfo	
5		MO publishes the need for a take-over of the contract	The need (contract) of the FSP, which is not capable to fulfil the contract, is published in MO platform and other registered FSP get the information.		MO	(other)FSP	FlexCont	
6		Bid for contract	Other registered FSP can view contract up for trade and bid through the MO to take over that contract		(other)FSP	MO	FlexBid	
7		Send contract bids for grid impact assessment	All the attributes associated to FlexBid should be forwarded		MO	T&D CP	FlexBid	new
8		Receive grid impact assessment results	T&D CP analyse the bids and find the optimum solution		T&D CP	MO	OptRes	new

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9		Notification of the market results	MO inform the new FSP		MO	FSP	MarOut	
10		Notification to SO of new contract holder	Once FSP's have agreed to trade the MO must notify the SO to activate the correct asset and the right FSP is verified and paid.		MO	T&D CP, FR	MarOut	

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
FSPInfo	FSP Registration	Required information to register FSP	
FlexCont	Flexibility Contract	The Obligation of the flexibility contractual that the original FSP cannot provide	
FlexBid	Flexibility Bid	Offer made by Flexibility Service Provider for selling flexibility.	
OptRes	Optimisation results	Optimisation of Merit Order List taking into account the possible synergies of using the same bid for more than one service and/or buyer.	
MarOut	Market Outcom	the results of matching the offers/bid by MO	

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