one network for Europe

# Guidelines for DSO operation and guidelines for data exchange

# D4.2


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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 |
|---|---|
| ABCM | Active Balancing and Congestion Management |
| aFRR | Automatic Frequency Restauration Reserve |
| AMI | Algorithmic Modelling Interface |
| API | Application Programming Interface |
| AS | Ancillary Service |
| BRP | Balancing Responsible Party |
| BUC(s) | Business Use Case(s) |
| CA | Commercial aggregator |
| CEP | Clean Energy Package |
| CGMES | Common Grid Model Exchange Specification |
| CIM | Common Information Model |
| cVPP | Commercial Virtual Power Plant |
| DAM | Day-Ahead Market |
| DdSE | Data-driven State Estimation |
| DDVC | Data-Driven Voltage Control |
| DEP | Data Exchange Platform |
| DER | Distributed Energy Resources |
| DLR | Dynamic Line Rating |
| DSO(s) | Distribution System Operator(s) |
| ECCo SP | ENTSO-E Communication & Connectivity Service Platform |
| EFI | Energy Flexibility Interface |
| EN | European Norm |
| ESMP | European Style Market Profile |
| FCR | Frequency Containment Reserve |
| FEG | Flexible Energy Grid |
| FP | Flexibility Platform |
| FSP | Flexibility Service Provider |
| GA | Generation Aggregator |
| GPRS | General Packet Radio Services |
| H2020 | Horizon 2020 |
| ICT | Information and Communication Technologies |
| IEC | International Electrotechnical Commission |
| JSON | JavaScript Object Notation |
| LIMS | Local infrastructure management systems |
| LV | Low Voltage |



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| | |
|---|---|
| MDO | Metered Data Operator |
| mFRR | Manual Frequency Restauration Reserve |
| MO | Market Operator |
| MO_D/MO_T | Market Operator at Distribution/Transmission level |
| MPOPF | Multi period optimal power flow |
| MQ message | Message Queuing message |
| MQTT/AMQP | MQ Telemetry Transport/Advanced Message Queuing Protocol |
| MV | Medium Voltage |
| NASM | Network Assets Sizing Manager |
| NPAM | Network Asset Management |
| PLC | Programmable logic controller |
| P/Q | Active/Reactive power |
| PV | Photovoltaic |
| RES | Renewable Energy Sources |
| REST API | Representational State Transfer Application Programming Interface |
| RR | Restoration Reserve |
| RTU | Remote Terminal Unit |
| SAREF | Smart Applications REFerence (ontology) |
| SCADA | Supervisory control and data acquisition |
| SGAM | Smart grid Architecture Model |
| SO(s) | System Operator(s) |
| STATCOM | STATic synchronous COMpensator |
| SUC(s) | System Use Case(s) |
| TSO | Transmission System Operator |
| tVPP | Technical Virtual Power Plant |
| UC(s) | Use Case(s) |
| UI | User Interface |
| UMEI | Universal Market Enabling Interface |
| UML | Unified Modelling Language |
| USEF | Universal Smart Energy Framework |
| VPP | Virtual Power Plant |
| W | Week |
| WP | Work Package |
| XML | Extensible Markup Language |



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# Executive Summary

This deliverable summarises the work done in Task 4.2 of Work Package 4 in the OneNet project. The aim of the task was to focus on DSO perspective in the data exchanges and communication between TSOs, DSOs and consumers during the procurement and use of flexibility for grid management.

The document presents two major efforts to analyse the interoperability of developing TSO-DSO-consumers data exchanges for flexibility services. Firstly, a State-of-the-Art analysis was conducted to describe the solutions developed in Horizon 2020 projects, with the focus on the interactions including DSOs as a central actor. Secondly, the deliverable presents the results of a Generic Business Process analysis of use cases from the analysed external projects and from OneNet demos. This analysis is a tool developed by the BRIDGE initiative [1] to analyse the interoperability of flexibility solutions and to identify potential implementation gaps. Using this methodology, a detailed analysis of the interfaces between different actors involved in the use cases was conducted. For the interfaces and data exchanges including DSOs, an overview of data models and communication protocols was drafted to reveal the implementation gaps. This gap analysis was subsequently used to form the main recommendations of this deliverable.

The review of external H2020 projects has revealed that although there are relatively many projects aiming at developing flexibility schemes involving DSOs, the documentation of the use cases is not sufficient to conclude an in-depth analysis of the data exchange processes. This is a significant barrier to experience and knowledge transfer outside the project, which can hinder the ability of external actors to learn from relevant use cases.

Many of the demos in the OneNet project have already adopted widely recognised data model standards, such as the Common Information Model (CIM). In other demos, however, proprietary extensions of the standard data models, or even proprietary solutions were used. The main reason for this is that the currently existing standards are not covering all the possible use cases at the DSO level and therefore are not directly applicable. Moreover, in some cases it was more cost-efficient to deploy proprietary solutions compatible with the existing systems in the country, or the proprietary solutions were less difficult to apply (as for example in exchanges with end-users). Furthermore, it is necessary to differentiate between the interfaces involving different actors. While the use of a standardised common data model, such as CIM could be recommended as a solution for interfaces between system operators, less costly and easier to implement proprietary solutions might be a better fit for data exchanges between DSOs and end users or small-scale flexibility providers. However, interoperability of used solutions should be always ensured.

# 1 Introduction

To deliver the EU's Paris Agreement commitments for reducing greenhouse gas emissions, the European Commission presented the Clean Energy Package (CEP) [2] to help industries to move away from fossil fuels and towards cleaner energy. The Electricity Directive presented in CEP shows a new framework for sustainable energy systems where customers have a central position. DSOs, being the connection point for most of the renewable generation and customers, play a key role in the energy transition, and this is where the coordination and interoperability between TSO-DSO-Customer are crucial [3].

## 1.1 WP 4 and Task 4.2 objectives

The main objective of this WP is to link the market activities with grid operation with the target to maximise the integration of FSP (Flexibility Service Providers) e.g., RES (Renewable Energy Sources). The goal is to achieve both at TSO and DSO levels while also the customer perspective is considered.

For this purpose, the work done in Tasks 4.1, 4.2 and 4.3 aimed at defining interfaces between market actors in terms of data models and communication protocols used in the context of market sequences, e.g. pre-qualification, schedules, maintenance etc., whilst covering mainly the operational challenges that arise with the introduction of new products and markets as analysed in WP2 and WP3.

Task 4.2, *Flexibility services integration and data exchange at DSO level for interoperability towards the transmission system*, acts as the connection point between Task 4.1 *TSO Interoperability* and Task 4.3 *TSO – DSO – Customer System Integration*.

This task is partially following up on the activities performed already in projects INTERRFACE, CoordiNet, Platone, EUniversal, EU-SysFlex and TDX-ASSIST, which, in some cases defined the interfaces between market and grid operations, and interfaces between system operators in other cases. Starting from these available solutions, this task sets the technical requirements to enable the utilisation of flexibility services and products identified in WP2 and WP3 of this project.

In addition to the above, this task explores the opportunities for using already existing models and tools for data exchange, developed in the above-mentioned research projects. Among others, results in terms of forecasting tools coming from these projects are being adopted in OneNet as well.

The results will be used by market operators and market participants, such as system operators, to help them implement new market and operational interfaces based on IEC standards (CIM, 61850) supporting the grid codes to potentially help vendors develop products to provide ICT solutions.





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## 1.2 Outline of the Deliverable

This document is divided into 5 chapters. Chapter 1 introduces the goal of WP4 and Task 4.2, including the outline of interactions needed for the work to be developed. Chapter 2 presents the methodology for WP4 and Task 4.2. Chapter 3 combines the analysis of the interfaces developed in the previous projects with the information collected from questionnaires, together with the tools, data models and the BUCs preliminary analysis. Chapter 4 provides the detailed business process analysis of selected use cases from external projects and OneNet, as well as the gap analysis in data exchanges between DSOs and other actors in selected OneNet demos. Chapter 5 presents recommendations on how to address the identified gaps and Chapter 6 concludes the whole document.

## 1.3 How to read this document

This deliverable was developed in parallel with the other two deliverable in OneNet WP4, the Deliverable 4.1 [4] and 4.3 [5]. While this deliverable focuses on DSO perspective, the other two deliverables analysed the same issue from the TSO and consumer perspectives. Therefore, the analysis in these deliverables is interlinked. For example, the use cases for the Generic Business Process analysis were distributed between the deliverables to avoid duplication of efforts. For that reason, it is advisable to consult all three documents to understand the full extent of the analysis.



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# 2 Methodology

This deliverable aims to enable the analysis of interoperability of flexibility assets by integrating and consolidating the lessons learnt from H2020 projects, OneNet use cases with DSO involvement, and ideally identifying a set of recommendations and best practices. The aim is also to describe in more detail the needed interfaces for interoperability at DSO level. The methodology relies on the Generic Business Processes analysis, which is an adaptation of the methodology developed by the BRIDGE Data Management Working Group in 2021 [6] and updated in 2022 [1].

The methodology of this deliverable follows the methodology described in detail in OneNet Deliverables 4.1 [4] and 4.3 [5] and therefore this section will only outline shortly the main steps followed.

## 2.1 Theoretical background – BRIDGE Reference Framework for assessment of flexibility assets

As explained in the BRIDGE report describing the methodology for assessment of Interoperability of flexibility assets, the main goal is to "*share learnings and recommendations from projects to achieve and ensure interoperability of flexibility assets, including standards assessment (adequacy, maturity …) and gaps identification"* [1]. For that purpose, the report develops a "Reference Framework" that should inform the methodologies applied in different Horizon projects and should be the "*common base to compare and harmonise the contributions from different projects with different technical solutions*" [1].

In the centre of the Reference Framework is the analysis of the **Generic Business Processes**. The analysis describes a use case (multiple uses cases can be also analysed together) in terms of actors and their business roles and the steps in the business process, which are defined as functions. The result of the Generic Business Process description is a diagram describing all the steps in the business process, which enables to identify all the interfaces and data exchanges between the involved actors. An example of the diagram, adapted for the purposes of this deliverable to include also distinction between different market phases, is presented in Figure 1 below. According to the BRIDGE methodology, the following steps are **1) map of standards** used in each interface and **2) gap analysis** of interfaces or functions that are missing proper (interoperable solutions).


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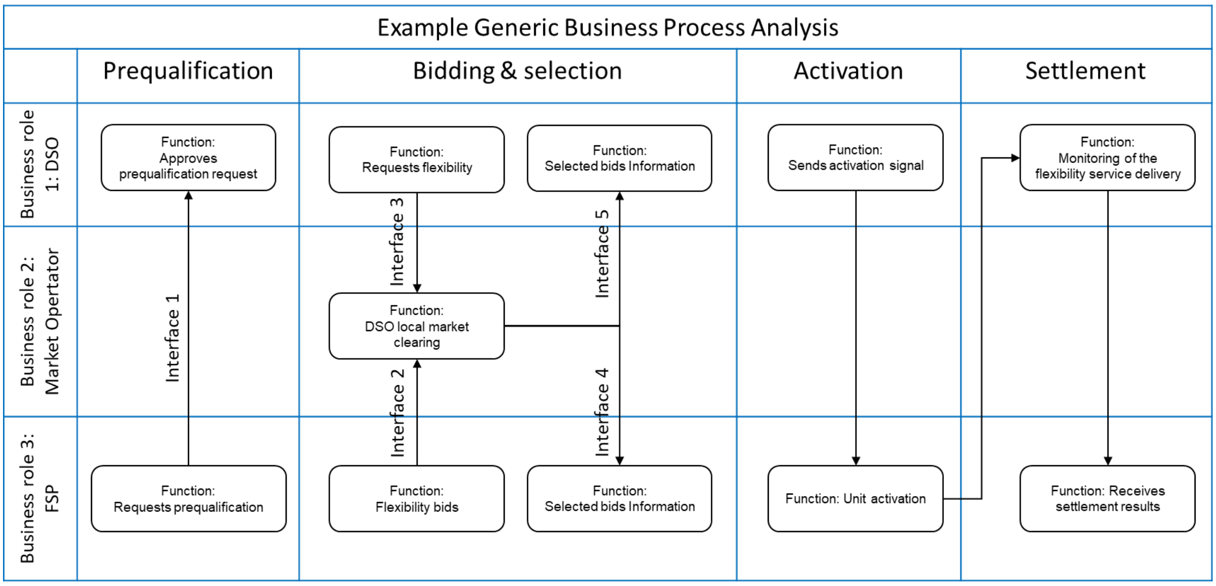


*Figure 1 Example Generic Business Process Analysis diagram used in this deliverable; source: own elaboration, based on [1]*

## 2.2 Methodology outline

Although the generic business process analysis is the core of the analysis, in this deliverable (together with the other two deliverables D4.1 and 4.3) a wider approach has been adopted to also analyse the wider context of other Horizon 2020 projects focused on flexibility. The first part, analysis of Horizon 2020 projects, was summarised in a "State of the art Analysis", presented in Chapter 3. Using a questionnaire distributed to the analysed projects (a template of the questionnaire is presented in Annex A) and desk research, overview tables were created to present the following aspects of the projects:

1. Interface, software, that links operators (market, system, and others) on data exchange for FSP integration;
2. Tools developed in relation with the interfaces described in step 1;
3. Specific standards and data models developed within the project.

The purpose of this exercise was to gain a general understanding of the general direction of the work on the development of TSO-DSO-consumer coordination and interoperability. It is important to note that this deliverable is analysing mainly the role of DSO in the interactions, and therefore the information presented in the State-of-the-Art analysis is focused on interactions involving DSOs. The final step for the State-of-the-Art analysis was the selection of use cases for the Generic Business Process analysis. The information gathered through the questionnaires and desk research was used to select the most relevant use cases from these projects that could be used for the Generic Business Process analysis and ultimately compared with the work being done on OneNet project. This is presented in Section 3.3 of this deliverable.



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The Generic Business Process Analysis is presented in Chapter 4. The use cases selected all involve DSO as one of the main actors. The result of this exercise was the identified interfaces and data exchanges between the actors involved in the use cases. For the identified interfaces, an analysis of used data models and communication protocols was concluded (in Section 4.3), and potential gaps were identified. This exercise was also limited to interactions involving DSO (as the TSO and consumer perspectives are examined in Deliverables 4.1 [4] and 2.3 [30], respectively).

Based on the identified gaps and other learnings, recommendations were formulated in Chapter 5. These recommendations are aimed not directly at the analysed Horizon 2020 projects (most of them are already concluded) and neither at OneNet demos but should inform future research project and other innovation activities. Furthermore, the findings of this deliverable and the recommendations will be used in the Work Package 11 of the OneNet project, to inform the wider recommendations and the roadmap towards interoperability that will be one of the main outputs of the work package.


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# 3 State-of-the-art analysis

In this chapter, activities performed in Horizon 2020 projects in defining interfaces between market and grid operations were analysed. As explained in the methodology chapter above, the analysis has focused mainly on the projects and interfaces involving DSOs. The aim was to explore the opportunities of already existing models and tools for data exchange for defined products and markets.

## 3.1 Selection of projects focused on the distribution network level

In the first step, several projects were considered with a focus on addressing TSO-DSO interaction, interfaces, standards, and data models for information exchange among different actors to integrate system services were considered. To build a solid basis for the review of relevant projects, a questionnaire was developed in collaboration with Task 4.1 (questionnaire template is presented in Annex A), addressing the aspects of interest, and considering Use Cases, applications and developments of the project as discussed in Annex A. Based on the questionnaire, the listed projects were thoroughly reviewed: CoordiNet [7], Crossbow [8], EUniversal [9], EU-SysFlex [10], FARCROSS [11], Flexitranstore [12], InteGRIDy [13], InterFlex [14], Interrface [15], Osmose [16], PlatOne [17], Synergy [18], TDX-Assist [19], and InterConnect [20].

After a first general review and the feedback of partners involved in these projects, the list of projects was limited to those projects which seemed promising in terms of the topics of interest of Task 4.2. The projects Osmose and Synergy were not further considered, as these projects did not have enough relevant information on the use cases to be suitable for the scope of analysis in Task 4.2. The main findings from the questionnaires are presented in Section 3.2, mainly the Interfaces between market roles, the Tools for data exchange and the Data models used and developed by the project. Section 3.3 presents the results of use case mapping of the relevant Horizon 2020 projects and explains the selection of use cases for the Generic Business Process Analysis.

## 3.2 Questionnaire analysis

In this chapter, the analysis of the 14 selected projects is presented. An overview of each project main goal is also presented in Annex B. The analysis is divided into three sub-chapters: Interfaces between Markets and DSO operators, tools for data exchange, and Models for data exchange. Given that the latter analysis is specific for DSO use, the project FARCROSS is not included, since it focuses on TSO level operations. Some projects in this analysis were still in the early stages of their execution and the interfaces or tools were still under development, leading to limited publicly available information (as for example Flexitranstore, Synergy) [1]. Therefore, the informational value of the analysis of these projects was unfortunately limited.

[1] The analysis was originally conducted in 2021 and it is possible that the information has been made available in the meantime. However, due to time constraints, it was decided not to revisit this analysis even in the light of the delayed deliverable submission.



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The first stage of our analysis was to identify which projects have defined or developed interfaces, tools, and data models. This information is depicted in Table 1. All projects include interfaces, but InterConnect is the only project that answered “No” concerning tools. Regarding data models, the answers were rather balanced.

*Table 1 Projects and elements reviewed in this document*

| Project Name | Interfaces | Tools | Data model |
|---|---|---|---|
| **CoordiNet** | YES | YES | NO |
| **Crossbow** | YES | YES | NO |
| **EUniversal** | YES | YES | YES |
| **EU-SysFlex** | YES | YES | YES |
| **FLEXITRANSTORE** | YES | YES | NO |
| **InteGRIDy** | YES | YES | NO |
| **InterConnect** | YES | NO | YES |
| **InterFlex** | YES | YES | NO |
| **INTERRFACE** | YES | YES | YES |
| **Osmose** | YES | YES | NO |
| **PlatOne** | YES | YES | NO |
| **Synergy** | YES | YES | YES |
| **TDX-Assist** | YES | YES | YES |

### 3.2.1 Interfaces between Markets and DSO Operations

Table 2 presents the review of DSO – market platform interfaces developed in the analysed projects. Some of the analysed projects also developed interfaces between DSOs and other actors, such as final consumers, but those are not relevant for this analysis and therefore disregarded in the following sections.

Most of the projects use different types of platforms and they differ on actors connected to the platform. Only projects which have developed or tested platforms which enable information exchange between DSO, TSO, and Flexibility Service Providers (such as aggregators or prosumers) were examined further. For this reason, the project Crossbow was omitted from the subsequent analysis, as it focuses primarily on interactions between TSOs (and flexibility providers). All the other analysed project had their focus on the interfaces including DSO, TSO as well as market operators or at least flexibility service providers/aggregators.


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*Table 2 Interfaces identified in the reviewed H2020 projects*

| Project | Interfaces (Name and Description) | Actors |
|---|---|---|
| CoordiNet | Interfaces are being developed in a decentralized way.<br>**Interoperable Platforms:** The description of interfaces is done in terms of information models, timing requirements and interaction sequences. The results may be used by TSOs, DSOs, and market participants to help them implement new interfaces based on IEC standards.[7] | TSOs, DSOs, and market participants |
| EUniversal | **Universal Market Enabling Interface (UMEI)**: a unique approach to foster interoperability across Europe. UMEI API that sets the rules for the data and flexibility exchange, defined in Use Cases, between DSO and other actors (MO, Aggregators, customers and, eventually, TSO). Accessible online, for the full-lifecycle API and Use-Cases management, including the export of the APIs' code to external parties in the most common languages and data formats.[9] | DSO, MO, Aggregators, customers and, eventually, TSO |
| EU-SysFlex | **Customer – Aggregator Interface:** Sub-meter data collection from customers as well as activating customers by the aggregator.<br>**Flexibility Provider** – Flexibility Platform interface AND -System Operator – Flexibility Platform interface Prediction, two options for baseline, prequalification, bidding process, flexibility activation by SO and verification.<br>**Data Exchange Platform (DEP) interface:** All data management SUCs demonstrated take the advantage of using a DEP. DEP is 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, customers, suppliers, energy service providers). DEP stores data related to its services (e.g., a 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. Several DEPs may exist in different countries and inside one country.[10] | DSO, TSO, FSP, Customer, Aggregator |
| Flexitranstore | **Flexible Energy Grid (FEG) Platform:** To provide a powerful set of tools to players in the Energy community. It is envisioned as a different approach and a step ahead in flexibility, scalability, security, and reusability.<br>Two distinct main components. The first one presents the FEG Central Component that acts as the global registry of FEG installations and integration hub, and the second one is the FEG local component that represent the ready-to-use toolbox – installed within System Operators' (TSO, DSO) and Flexibility Providers. Secure data handling requirements have been considered.<br>The open architecture of the FEG Platform provides ease of integration within the operators' software environments and facilitates bi-directional communication with external systems, thus adding a high degree of flexibility and adaptability even in extreme brownfield situations. [12] | FSP, TSO, DSO |


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| | | |
|---|---|---|
| InteGRIDy | **Grid and Market Hub:** The main goal was to facilitate market access allowing new business models and services, while also ensuring efficient and secure network operation as well as the highest standards of data security. This central platform should be perceived as an enabler of third-party services that can now emerge in the gm-hub ecosystem. The gm-hub also establishes direct cooperation between DSO and TSO, with the market operator as an intermediary for the ancillary services market, in terms of flexibility pre-qualification, activation and management. Finally, it also enables the use of local flexibility for technical constraint management, particularly at the medium and low voltage grid level. [13] | DSO, (TSO), MO |
| InterConnect | **DSO Interface** is a digital interface that allows the data exchange between DSO and other stakeholders, namely for enabling flexibility grid support services) [20] | DSO, TSO, Aggregator/FSP |
| InterFlex | **DSO and Aggregator (USEF interaction model)** - USEF delivers the market model for the trading and commoditisation of energy flexibility, and the architecture, tools and rules to make it work effectively.<br>**Energy Flexibility Interface (EFI)** for communication between commercial aggregator (CA) and local aggregator (LA)<br>**Flexibility Aggregation Platform (FAP)** system that on one side aggregates flexibility from local aggregators (LA) and on the other side offers that aggregated flexibility to flexibility market parties (DSOs, TSOs, and BRPs) [14] | DSO, TSO, MO, Aggregator |
| INTERRFACE | **ENTSO-E Communication & Connectivity Service Platform (ECCo SP)**: proprietary communication interface developed by ENTSO-E independently from the project. The project foresees the usage of ECCo SP, in its current state, for communication platform and exchange of data encapsulated in CIM compliant format.<br>**Custom JSON API**: created for tools operated by TSO/DSO/MO to exchange data with tools developed by the project. The custom APIs are based on JSON and intended as pilot solutions for the initial tool developments. These custom APIs will be reviewed and replaced by CIM compliant APIs in the next Platform releases.[15] | DSO, TSO, MO |
| OSMOSE | Modelling the **TSO-DSO Interface** using open data only improved methodology to represent flexibilities on the distribution grids from a transmission grid point of view. [16] | DSO, TSO, FSP |
| PlatOne | **PlatOne Market Platform:** a virtual marketplace where the requests for flexibility are matched with the offers.<br>**PlatOne DSO Technical Platform:** Distributed grid management system. It performs grid state estimation and forecasting of production and consumption, it defines the flexibility requests for DSO's grid. The platform exchanges data with SCADA and distribution operation systems.<br>**PlatOne Blockchain Access Platform:** A software-based platform that certifies using Blockchain technology, the data provided by end customers, which is used for purposes of flexibility management and Grid observability.[17] | DSO, MO, Aggregators, customers and, eventually, TSO |
| Synergy | Synergy Big Data Platform has been developed to share big data among energy system players, including TSOs, DSOs, DER operators, Aggregators and others. [18] | DSO, TSO, FSP, Aggregator, DER |


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| | | |
|---|---|---|
| TDX-Assist | **MQTT/AMQP adapters:** It is an adapter to convert MQTT messages into AMQP messages.<br>**Client/server app for message exchange:** Development of Client and Server applications capable to send/receive that via AMQP interface of ECCo SP.<br>**CIM XML Generator:** Development of an application to generate CIM XML, which have been exchanged in the demonstration. [19] | DSO, TSO, FSP |



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### 3.2.2 Tools for data exchange

Table 3 presents the tools for data exchange developed in the analysed projects. The EU-SysFlex project tools for aggregator and system operator simulator are not shown in the table since their nature is not within the scope of this analysis focusing on DSO operation.

The tools developed in the analysed projects are covering a wide range of use cases and approaches. This is to be expected as they are responding to different needs and are created in various local contexts. Some of the projects focus more on coordination during network and operational planning (Synergy, InteGRIDy), others are aiming to develop flexibility trading platforms (CoordiNet, EU-Sysflex, Platone…) and others more on coordination between TSO and DSO (OSMOSE, InteGRIDy). Some projects adopt a more high-level approach, developing for example an interface for data exchange between different flexibility platforms and other actors (EUniversal) or focusing only on ontology (Interconnect). Although the projects were preselected to include some kind of data exchange between DSOs and other actors, the level of coordination between TSOs, DSOs and customers differs in each analysed project. The projects with most advanced coordination between all actors (on procurement of flexibility) are probably CoordiNet, INTERRFACE, EU-Sysflex and Platone.



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*Table 3 Tools used and developed for data exchange in H2020 projects*

| Project | Tools |
| --- | --- |
| **CoordiNet** | **CoordiNet Platform Interface** allows DSOs to call markets for congestion management in different locations, based on the structural information already in place in the G+ system.<br>**G+**: Several adaptations to the already existing G+ tool will be made so the TSO can run the congestion management market created by the DSO in the CoordiNet Platform Interface<br>**E-SIOS**: interface between the common platform and the agents of the market (FSP and sFSP).<br>**Day-ahead DSO**: sending the needs of distribution networks to different platforms. The platform also allows registering manual requirements or inputs from other platforms of the DSO different from the observability module (Local congestion management, Local voltage control, Security check for balancing).<br>**Decision support tools** (Real-Time Balancing Decision Support Tool-RTBM, Topology Manager, Forecasting platform, State estimator and power flow)<br>**Communication tools** (Enterprise Service Bus for communication framework and task scheduler, Reporting tool) [21] |
| **EUniversal** | The **UMEI interface** enables data exchange between DSO, Flexibility market operators, aggregators and grid users in the stages of prequalification; flexibility needs assessment; procurement; activation; measurement and settlement.[22]<br>**MV congestion management tool**<br>**MV flexibility scheduling tool**<br>**LV flexibility needs assessment tool**<br>**Data-driven voltage control (DDVC) tool**<br>**Dynamic line rating (DLR) tool**<br>**Data-driven State Estimation (DdSE)**<br>**LV Congestion Forecasting**<br>**LV phase and topology mapping tool**<br>**Real time DLR line monitoring** [23] [24] |



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| **EU-SysFlex** | **Flexibility Platform (FP)**: A platform for System Operators and Flexibility Service Providers that enables the trading of different flexibility products and services. A FP is operated by a Market Operator. It is used to support the prequalification, bidding, activation, and the verification processes, ensuring coordination between activities undertaken by several operators using the same flexible resources. Several national and regional FPs may exist.<br>**Data Exchange Platform – DEP**: Existing Elering's DEP with newly developed services which enables secure exchange of different types of data – e.g., flexibility bids, activation requests, etc. [25] |
| **Flexitranstore** | **Market clearing tool**: A mathematical module to calculate the clearing results (price, volume, order acceptance, etc.) – based on C executable.<br>**Market Software Demo**: Integrated into the FEG Platform and allow System Operators to run market simulations. Will also allow the operator to provide manually weather/market data, and this could be done by connecting to a local database, reading a local file, or consuming a local web service.<br>**Flexibility Assessment**: Upgraded flexibility adequacy assessment methodology, with a stepwise approach from IEA FAST to hourly simulations, for calculating specific flexibility indices such as Insufficient Ramping Rate Expectation, Flexibility Residual.[12] |
| **InteGRIDy** | **Traffic Light System**: A tool to validate flexibility activated by the TSO, so it does not create congestions at the distribution grid.<br>**MPOPF**: Multi-period optimal power flow, used to calculate the necessary flexibility to be used by the DSO.<br>**Forecast Service**: The forecast-module developed by INESC TEC predicts the consumption and generation of the customers in the network. These results are aggregated by MV distribution node.<br>**cVPP – Commercial virtual power plant**: Tool used for the aggregation of flexibility offered to the TSO.<br>**tVPP - Technical VPP**: Tool used for the aggregation of flexibility offered to the DSO) [26] |
| **InterConnect** | **Open data sharing**: Aggregated consumer metering and flexibility historical data<br>**Flexibility Operation**: Generation and communication of flexibility needs and mobilization of offers from aggregators/FSPs<br>**Observability**: Connectivity data from distributed resources to improve QoS [20]. |
| **InterFlex** | **Feed in Management, Demand Side Management, Ancillary Services** in German Demo: To demonstrate that a smart metering infrastructure can be integrated into grid control processes to control and coordinate DSO connected power generation and flexibility effectively, efficiently, and reliably.<br>**Increase DER hosting capacity of LV distribution networks by smart PV inverters, Increase DER hosting capacity in MV networks by volt-var control, Smart EV charging, Smart energy storage** in Czech Demo: To enhance the distribution network flexibility.<br>**Local infrastructure management systems (LIMS), charge point management system (CPMS), LMS and CPMS flexibility market** in Dutch Demo: Demonstrate technically, economically and contractually that a DSOs can provide. |


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| | **Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers, Optimal use of a commercial heat pump and cooling pump assets** in Swedish demo: providing energy efficiency and electricity flexibility for grid management purposes, technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation and facilitation of Micro Grid Customer Flexibility.<br><br>**Automatic Islanding, Multiservice approach for centralized storage systems, Local flexibility mechanism** in French Demo: The main objective is to validate technically, economically, and contractually the market enabling role of DSOs to increase the local energy system efficiency, viz. activating all the network and local production/ consumption flexibilities managed by aggregators, in view of meeting the local electricity system needs at minimal costs for all parties while maximizing the expected impacts for the society. Aggregators will be in charge of deploying flexibility and monetizing it on the different value pockets, including local use by the DSO and national markets/mechanisms. [14] |
| **INTERRFACE** | **Flexibility Register**: Is a country-specific module that enables Flexibility Service Providers (FSPs) to bring their flexibility resource/product to markets.<br><br>**The TSO-DSO coordination platform**: Acts as the gateway through which the operators (TSOs and DSOs) can access the Interoperable pan-European Grid Services Architecture (IEGSA) platform. It allows data exchange with operators through well-defined and interoperable APIs.<br><br>**Single Interface to Market**: Is a gateway and a point of connection of the IEGSA platform to market platforms.<br><br>**Settlement Unit**: Module is responsible for calculating the settlement, i.e., the difference between the contracted quantities and the realized quantities of energy products for the Balance Responsible Parties in a Scheduling Area<br>**Centralised Energy Management System for microgrids** (Demo 5.1 – DSO and Consumer alliance): The tool will monitor and collect data of all the flexibility resources both available within a local energy community or managed by a flexibility provider such as an Aggregator.<br><br>**Grid Services Management System for flexible LV/MV networks (**Demo 5.2 – Intelligent Distribution Nodes): The Intelligent Distribution Nodes (IDN) is an intelligent system that has the capacity to coordinate different actuations for a battery energy storage system (BESS) installed in a residential building or an energy community with the aim of integrating it into the grid system.<br><br>**Single Flexibility Platform** (Demos 5.3): Single Flexibility Platform will integrate flexibility resources on local, DSO and TSO levels to a marketplace that will allow valuation of these resources based on the needs of the different grid levels and market participants.<br><br>**Microgrid local electricity markets using the assets capabilities** (Demo 6.1 – Asset-enabled local markets): Peer-to-peer markets aim to provide trading opportunities between a large number of market players, even when buyers and sellers are fragmented. |



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| | **Flexibility services for congestion management** (Demo 6.2: Blockchain based TSO-DSO flexibility): Blockchain based TSO-DSO flexibility platform in Romania and Bulgaria where flexibility services are traded amongst prosumers, TSOs and DSOs in the long-term and operational timeframe. We enable participation of distributed generators and flexibility assets on the distribution grid level via a decentralized marketplace (EFLEX) to ensure system stability.<br><br>**A Retail-To-Wholesale Market approach for DERs integration** (Demo 7.1 – DERs into wholesale): A prototype will be developed to promote DER participation into the wholesale market, using considerable amount of data from the TSOs, DSOs, market operators and energy suppliers to provide implementation of actual and realistic representation of the wholesale and retail markets in the examined South-East Europe region, namely Romania, Bulgaria and Greece. The algorithm will implement optimal power market reserves clearing for the provision of Congestion Management services, supplementary to the Balancing (FCR, aFRR, and mFRR) services clearing.<br><br>**EUPHEMIA-based market platform to include local flexibility resources tool** (Demo 7.2 – Spatial aggregation of local flexibility): The EUPHEMIA-based market platform that includes local flexibility resources tool developed in part of the demonstration aiming Spatial Aggregation of Local Flexibility aims to provide a new auction platform-based tool to further enhance coordination of local energy and flexibility needs. |
| **OSMOSE** | **AnyMOD.jl**: Modelling high levels of intermittent generation and sectoral integration, the tool provides a Julia framework to create large scale energy system models with multiple periods of capacity expansion formulated as linear optimization problems.<br>**ANTARES**: Antares-Simulator is a power system simulator meant to be used by anybody placing value in quantifying the adequacy or the economic performance of interconnected energy systems, at short or remote time horizons. With an adequate modelling of the energy consumption, generation and transportation, the software performs probabilistic simulations of the system throughout many year-long scenarios made of 8760 hourly timeframes each)<br>**Genesys-Dynelmod**: A cost minimizing optimization problem, determining dispatch and investment decisions to cover a fixed demand for a set of consecutive years and different macro regions. It was used to forecast the European energy scenarios within the project.<br>**Prometheus/Atlas**: Modelling of weather and generation uncertainties, and flexibility levers.<br>**JMM/E2M2**: Modelling of weather and generation uncertainties, and flexibility levers. [27] |
| **PlatOne** | **Flexibility Services Management:** The Market Platform allows DSOs and TSOs to create flexibility requests. The Market Platform acquires and stores all the flexibility requests and offers.<br>**Market Outcomes Matching and Validation**: The Market Platform can match flexibility requests and offers through clearing market algorithms. The Market Platform can provide the Market Outcomes (results of market clearing) to the DSO Technical Platform for the |

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| | technical validation. The Market Platform receives the validated market outcomes from DSO Technical Platform. DSOs, TSOs and Aggregators receives Market Day Ahead outcomes from the Market Platform<br>**Services activation**: The Market Platform allows DSOs and TSOs to create service activation requests. The Market Platform can aggregate the service activation requests (from DSOs and TSOs) and provide them to all the other stakeholders.<br>**Blockchain certification**: The Market Platform can register on the blockchain all the market data through Smart Contracts based functionalities. The Market Platform allows the Market participant to verify all the market data registered in the blockchain.<br>**Settlement**: The Market Platform can read meters measurements from Shared Customer Database. The Market Platform performs the settlement comparing the metering data and BRP baseline. The Blockchain Service Layer can provide tokenization system for the settlement through Smart Contracts functionalities. The Market Platform allows to DSO, TSO and Aggregator to read the settlement outcomes.<br>**Data Acquisition**: The DSOTP can receive measurements.<br>**State Estimation Tool**: The DSOTP can trigger the State Estimation Tool via REST API. The objective of the state estimation tool is to find the most likely operating state of a power grid, which is determined via a set of state variables, based on a set of real-time, available measurements obtained throughout the grid<br>**Tariffs retrieval**: The DSOTP sends to the DSO/Aggregators tariffs that reflect the expected state of the network. The DSOTP can receive data coming from the Algorithm for DER Control and Algorithm for ancillary services.<br>**Optimal DER dispatching**: DSOTP can trigger the Algorithm for DER Control via REST API [17] |
| **Synergy** | **Network Assets Sizing Manager (NASM)**: Responsible for providing solutions regarding optimal planning and sizing of the network assets. Solutions shall involve optimal capacity for new substations and lines in case further reinforcements are needed, as well as optimal sizing of new demand connections or DERs. The Network Assets Sizing Manager is a complementary component to the Network Performance Assessment Manager, exploiting results such as reinforcement and flexibility needs to propose operational planning solutions in the short and mid-term (up to a month ahead) and in the long term (up to a year) for the provision of critical services such as congestion management in medium voltage distribution grids.<br>**Network Asset Management (NPAM)**: Responsible for the simulation of the operation of the network and incorporates all the appropriate functionalities to assess the state of the network in terms of reliability, performance, and power quality metrics. The assessment involves the evaluation of the electricity network steady-state aspects using power flow calculations. Congestion issues and operational constraints, such as voltage violations, line/transformer over-loadings are considered in the assessment. The simulation approach of the NPAM is static, which means that the dynamic behaviour of the power system elements is omitted from the analysis. The component involves the assessment of various operating conditions, incorporating the analysis of stochastic demand and generation profiles.<br>**Flexibility Based Network Manager (FBNM)**: Responsible for assisting network operators to perform their short-term planning activities by utilizing available flexibility. The manager involves the process of data exchange regarding flexibility availability between flexibility providers and network operators, identification of aggregated flexibility in substation and feeders' level, identification of flexibility deficit periods and |





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| | calculation of flexibility margins and requirements for network operators to facilitate their short-term planning. The FBNM shall utilize short-term (for the next 24 to 72 hours) flexibility estimations received by RES aggregators and retailers for the feeders under consideration, production, and consumption DER data obtained from the MV/LV feeders and substations. The component shall calculate flexibility costs, define flexibility products expressing TSO and DSO requirements and needs for congestion management and balancing.<br>**DSO-TSO Common Operational Scheduler:** Responsible for providing a common interface for the DSO and the TSO to facilitate common operational scheduling, considering the flexibility requirements for both actors for congestion management needs, balancing needs, and other relevant ancillary services. The scheduler is also there to clarify the sequence of actions and information exchange between the two operators, propose an appropriate coordination scheme, identify proper grid and asset pre-qualifications and the definite short term operational scheduling for both actors.<br>**Network Predictive Maintenance Manager**: For analysing a variety of network component data sources, including those metrics provided by the Network Component Health Estimator, to complement Maintenance Management Systems with estimations of the probability to failure of single network assets in different time frames. This information will support network maintenance operators in the optimal scheduling of the maintenance actions. [18] |



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### 3.2.3 Data models

Standards and data model analysis in projects which are relevant to DSO are shown in Table 4. InteGRIDy, Osmose and TDX-Assist did not develop specific data models within the project. In InterConnect and Synergy projects, the data exchange models are still under development.

The overview of data models and standards used in H2020 projects shows that there is already a great convergence around CIM IEC standards. Many projects directly adopt it or developing adaptations that are nevertheless compatible with the general architecture. Some projects developed alternative concepts to address specific use cases, which are usually still compatible with CIM or are developing solutions for applications not yet covered by the standards. This shows that the situation on DSO level is more varied than on TSO level and it will continue to be so as these alternative solutions are already being deployed and are creating path dependency for future developments. CIM data model is a mature concept which provides an adequate solution for a wide variety of use cases, especially in the communication among system operators. However, this is not a barrier to the existence of other solutions in parallel, which can be a better fit due to previously implemented solutions or local specifics, as long as interoperability is secured by proper communication interfaces among the applied solutions.

*Table 4 Standards and data models in H2020 projects*

| Project | Standards and data model |
|---|---|
| **CoordiNet** | 1. IEC standards (CIM, 61850)<br>The project aimed to improve ENTSO-E profiles based on IEC standards: CGMES (Common Grid Model Exchange Specification), based on IEC 61970 and IEC 61968 and CIM European Style Market profile based on IEC 62325.[21] |
| **EUniversal** | 1. Universal Market Enabling Interface (UMEI) – a unique approach to foster interoperability across Europe. UMEI API that set the rules for the data and flexibility exchange, defined in Use Cases, between DSO and other actors (MO, Aggregators, customers and, eventually, TSO).[22] |
| **EU-SysFlex** | 1. SGAM based conceptual reference model for data exchange<br>Still, in development, SGAM based reference model will be created according to the information from data exchange SUCs. All layers of SGAM will be modelled.<br>2. Data model for flexibility provision value chain<br>Initially, project-specific data model for the “Flexibility Platform” demo based on SUCs was developed. It is being translated into CIM compliant data model currently.<br>3. Recommendations for CIM extensions<br>Gap analysis of standards related to data exchange has been completed. Currently, UML modelling of Business Objects identified in SUCs is ongoing. As a result, extensions to CIM profiles can be recommended. |
| **Flexitranstore** | 1. IEC 61850 Process Bus standard<br>Standard to communicate through Ethernet between the RTU acquisition system and the RTU front-end.<br>2. USEF Framework |



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| | USEF delivers the market model for the trading and commoditisation of energy flexibility, and the architecture, tools and rules to make it work effectively. |
| **InteGRIDy** | No specific standards and data models have been developed within the project. |
| **InterConnect** | SAREF[2] |
| **InterFlex** | USEF+ (extended USEF): Define a standard for connection between DSO and aggregator. |
| **INTERRFACE** | Common Information Model (CIM): used to structure and encapsulate data in a unified format (mainly in XML messages, but also JSON) that is widely used in the energy domain for data exchange. In the project, new CIM compliant profiles are developed by the project for data exchange of specific data sets which are needed. The profiles are not yet subject to formal community-wide review and approval or standardization. |
| **OSMOSE** | The project has defined and demonstrated improvements of the IEC 61850 engineering process. |
| **PlatOne** | CIM 61968-9 standard: DSO Data Server Output Connections & Interfaces. |
| **Synergy** | There are specific standards and data models in the project, but they are still under development. |
| **TDX-Assist** | CIM series 61970, 61968 and 62325; ECCo SP as a platform for secure information transfer[3] |

## 3.3 Selection of Use Cases for Generic Business Process analysis

For the analysis of Use Cases and the identification of business objects, Business Use cases of the previously selected projects were analysed. In the first step, the BUCs related to flexibility and those that foster the exchange of data between DSO, TSO and other actors, such as Market Operator or FSPs, were listed. The mapping of the BUCs was done in a similar fashion to the work in Deliverable 3.1 [28], focusing on DSO-Market Based, TSO-DSO-Market Based interaction or TSO-DSO Technical coordination interaction. However, this deliverable takes the analysis to the next step by identifying the process phases for each BUC.

Table 5 below presents the list of all collected data. However, for the purpose of further analysis, only use cases focused on DSOs and with sufficient information to identify the interfaces that are used to exchange data and to identify the Business Objects were selected. These BUCs are highlighted in orange in the table and in practice they are all coming from the EU-Sysflex project (Some other EU-Sysflex and CoordiNet use cases are analysed from TSO perspectives in Deliverable D4.1).

The overview table indicates that from the 6 analysed projects, only two projects, CoordiNet and EU-Sysflex, have published sufficient information about their use cases to enable the execution of analysis of the data exchange between different actors. This is potentially detrimental to the replicability of project results and the lack of available information might discourage the adoption of solutions developed and tested in past projects.

[2] https://interconnectproject.eu/resources/?active=public-deliverables
[3] TDX-Assist: D1.2 Agreed models, use case list, and use case description in UML. Available at: https://cordis.europa.eu/project/id/774500/results



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Table 5 Preliminary Selection of BUCs with scope in DSO grid and market interactions

| Projects | BUC | SO | Mapping | Phases |
|---|---|---|---|---|
| EU-Sysflex | Manage reactive power flexibility to support voltage control in the Finnish demo | DSO | DSO-Market based | Prequalification<br>Bidding/Selection phase<br>Delivery Phase |
| | Manage active power flexibility to support congestion management and voltage control in the German demo | DSO/TSO | TSO-DSO Market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| | Manage reactive power flexibility to support voltage control and congestion management in the German demo | DSO/TSO | TSO-DSO Market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| | Manage active power flexibility to support mFRR/RR and congestion management in the Italian demo | DSO/TSO | TSO-DSO Market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| | Manage reactive power flexibility to support voltage control and congestion management in the Italian demo | DSO/TSO | TSO-DSO Market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| | Manage active power flexibility to support mFRR/RR and congestion management in the FlexHub Portuguese demo | DSO/TSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |



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| | Manage reactive power flexibility to support voltage control and congestion management in the FlexHub Portuguese demo | DSO/TSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| **CoordiNet** | Voltage control in the transmission system and distribution system using flexible resources connected to transmission and distribution system under the scope of a multi-level market mechanism | TSO/DSO | TSO-DSO market-based interaction | Plan/Forecast<br>Market Phase<br>Measurement & Settlement |
| | Voltage control in the transmission system and distribution system using flexible resources connected to transmission and distribution system under the scope of a fragmented market mechanism | TSO/DSO | TSO-DSO market-based interaction | Day-Ahead Market<br>Intraday Market<br>NRT Market<br>After Real-time |
| | Congestion management in the transmission system and distribution system using flexible resources connected to transmission and distribution system under the scope of a multi-level market mechanism | TSO/DSO | TSO-DSO market-based interaction | Day-Ahead Market<br>Intraday Market<br>GE Market<br>After Real-time |
| | Congestion management in the transmission system and distribution system using flexible resources connected to transmission and distribution system under the scope of a fragmented market mechanism. | TSO/DSO | TSO-DSO market-based interaction | Day-Ahead Market<br>Intraday Market<br>NRT Market<br>After Real-time |
| | Procure and manage balancing services (FRR and RR) to reduce balancing cost under the scope of a central market mechanism | TSO/DSO | TSO-DSO market-based interaction | Long-Term<br>Day-Ahead Market |
| | Voltage control provided to the TSO and DSO under the scope of a common market mechanism | TSO/DSO | TSO-DSO market-based interaction | Long-Term<br>Day-Ahead Market<br>After Real-time |



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| | Controlled Islanding provided to the DSO under the scope of a local market mechanism | DSO | DSO-Market based | Long-Term<br>Day Ahead<br>From 1 hour before real-time<br>After real-time<br>After the event takes place |
| | Congestion management in low voltage and medium voltage distribution grid under the scope of a multilevel market mechanism | TSO/DSO | TSO-DSO market-based interaction | Yearly process<br>Operational process |
| | Congestion management in low voltage and medium voltage distribution grid under the scope of a distributed market mechanism | DSO | DSO-Market based | Operational process |
| | Flexibility providers offer balancing services to the local DSO in Gotland under the scope of a local market mechanism | TSO/DSO | TSO-DSO market-based interaction | Not described |
| | Flexibility providers offer balancing services to the TSO under the scope of a multi-level market mechanism | TSO/DSO | TSO-DSO market-based interaction | Not described |
| **InterConnect** | Flexibility Management for distribution grid support | DSO | DSO-Market based | Forecast<br>Bidding/Selection phase |
| **EUniversal** | Congestion Management & Voltage Control with market-based active power flexibility -Germany | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |



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| | Congestion Management & Voltage Control with market-based reactive power flexibility - Germany | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Congestion Management & Voltage Control with market-based active power flexibility - Poland | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Congestion Management & Voltage Control with market-based reactive power flexibility - Poland | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Congestion management in MV grids for the day-ahead market (or between 1 to 3 days in advance) | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Integrated Voltage Control in MV and LV grids for the day-ahead market (active and reactive power) | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Voltage control and congestion management for some days/weeks in advance (until two/three weeks) | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring<br>Settlement |
| | Voltage Control and congestion management for medium and long-term grid planning through market mechanisms | DSO | DSO-Market based | Prequalification<br>Selection/Bidding<br>Delivery and Monitoring |



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| | | | | |
|---|---|---|---|---|
| | | | | Settlement |
| **PlatOne** | Voltage Management in transmission and distribution system using also the resources connected to the distribution system | DSO | DSO-Market based | Plan/Forecast<br>Bidding/Selection phase<br>Activation |
| | Congestion Management in transmission and distribution system using resources connected to the distribution system | DSO | DSO-Market based | Plan/Forecast<br>Bidding/Selection phase<br>Activation |
| **Interrface** | Aggregated CM to TSO/DSO Balancing mFRR to TSO Non-frequency services to TSO/DSO | TSO/DSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Delivery Phase<br>Settlement |
| | aFRR demonstration: Single Flexibility Platform | TSO/DSO | TSO-Market based Interaction | Prequalification<br>Bidding/Selection phase<br>Settlement |
| | FCR demonstration: Single Flexibility Platform | TSO/DSO | TSO-Market based Interaction | Prequalification<br>Bidding/Selection phase<br>Settlement |
| | Congestion management operational demonstration: Single Flexibility Platform | TSO/DSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Settlement |
| | Congestion management short-term demonstration: Single Flexibility Platform | TSO/DSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Settlement |
| | Congestion management long-term demonstration: Single Flexibility Platform | TSO/DSO | TSO-DSO market- | Prequalification<br>Bidding/Selection phase |


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|---|---|---|---|---|
| | | | based interaction | Settlement |
| | Flexibility services for DSO congestion management and allowing more renewable connection without unreasonable DSO network investments | DSO | DSO-Market based | Prequalification<br>Plan/Forecast<br>Bidding/Selection phase<br>Settlement |
| | Direct participation of local flexibility on the wholesale market using a single auction-based market platform | TSO/DSO | TSO-DSO market-based interaction | Prequalification<br>Bidding/Selection phase<br>Settlement |



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## 3.4 Conclusions of the State-of-the-Art analysis

As described in section 3.2, the review of completed and ongoing projects was done according to several aspects including interfaces, tools, data models and communication protocols.

In terms of DSO interfaces towards the market, the projects review indicated that interfaces are often uniquely defined, according to the specific background and the technical level of the project. In the context of OneNet, as well as in the wider effort to digitalise energy sector, a concrete and unambiguous definition for an interface is essential, as it enables interoperability and scalability.

There are numerous tools developed and exploited in previous DSO-relevant projects, for example for forecasting, decision support, services, optimisation and state estimation. Developed platforms offer solutions for data exchange and market mechanisms, but also for network assets, flexibility, feed-in and demand side management. However, as use cases and requirements in terms of data exchange were not properly described, the usability of the tools and platforms are limited to the project use cases and cannot be extended to different use cases. Here, proper detailed description of the requirements and reasoning behind solutions could improve the re-usability of tools and platforms.

Concerning applied standards and data models, these are considered crucial to enable interoperability in a comprehensive system accessed by numerous actors. However, the analysis of applied communication protocols in the covered EU projects mainly showed that they were not documented to a sufficient level that would enable robust conclusions. Most reviewed projects did not develop unique data models or standards, but used IEC standards, SGAM-based approaches, and CIM (or developed proprietary extensions of thereof). In this context, better documentation would improve the added value of the project results to be further exploited and used as a reference for decisions by future projects (or in a standard business environment).


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# 4 Generic Business Process Analysis

The first part of this chapter provides an in-depth generic business process analysis for the most relevant business cases of external projects identified in chapter 3.3. It shall be noted that the external projects were analysed together for the purposes of OneNet tasks 4.1, 4.2 and 4.3 according to the focus of the corresponding task, TSO, DSO and customer, respectively. Therefore, this chapter presents only use cases with central role of DSOs. Other use cases with involvement of DSOs were analysed and presented in deliverables D4.1 [4] and D4.3 [5]. As a result, the first section presents three use cases from the EU-SysFlex project.

The second part of this chapter presents the generic business process analysis for relevant OneNet use cases with DSO involvement. Again, the OneNet use cases were distributed between the three WP4 deliverables based on the involved actors, therefore some of the use cases with DSO involvement can be also found in the abovementioned deliverables D4.1 [4] and D4.3 [5].

The third part of this chapter presents the results of the mapping of data exchanges involving DSOs in the analysed use cases, focusing on the data models and communication protocols used. Based on this mapping, an analysis of gaps in deploying interoperable solutions was performed for each use case and is presented as well. The chapter concludes with a summary section synthesising the learnings from the gap analysis.

## 4.1 External projects' business cases

### 4.1.1 Managing active power flexibility to support congestion management and voltage control in the German demo (EU-SysFlex)

This BUC describes the optimization of flexibility usage in distribution grids and aggregation of residual flexibilities for TSOs on a schedule basis to reduce total flexibility activation and thus system costs. In this BUC, the TSO uses different resources for active power management, such as flexibilities in the distribution grid. Generation units that must indicate their available flexibility when submitting generation schedules day ahead to the DSO provide these flexibilities. These flexibilities are collected and transferred by the DSO to the TSO. The DSO will guarantee that no congestion in its distribution grid remains and no additional congestion in its distribution grid occurs when the TSO activates flexibilities for reactive and active power management or frequency reserve. The day ahead process will be continued in an intraday timeline to react on faults or forecast deviations.

**Pre-Qualification phase**

Generation Aggregator (GA) and Distribution Network Operator (DSO) sign an agreement that the GA sends schedules of planned generation, contracted frequency reserve, flexibility potential and flexibility costs day ahead so that the DSO can adjust these schedules also day ahead (compared to real-time nowadays).

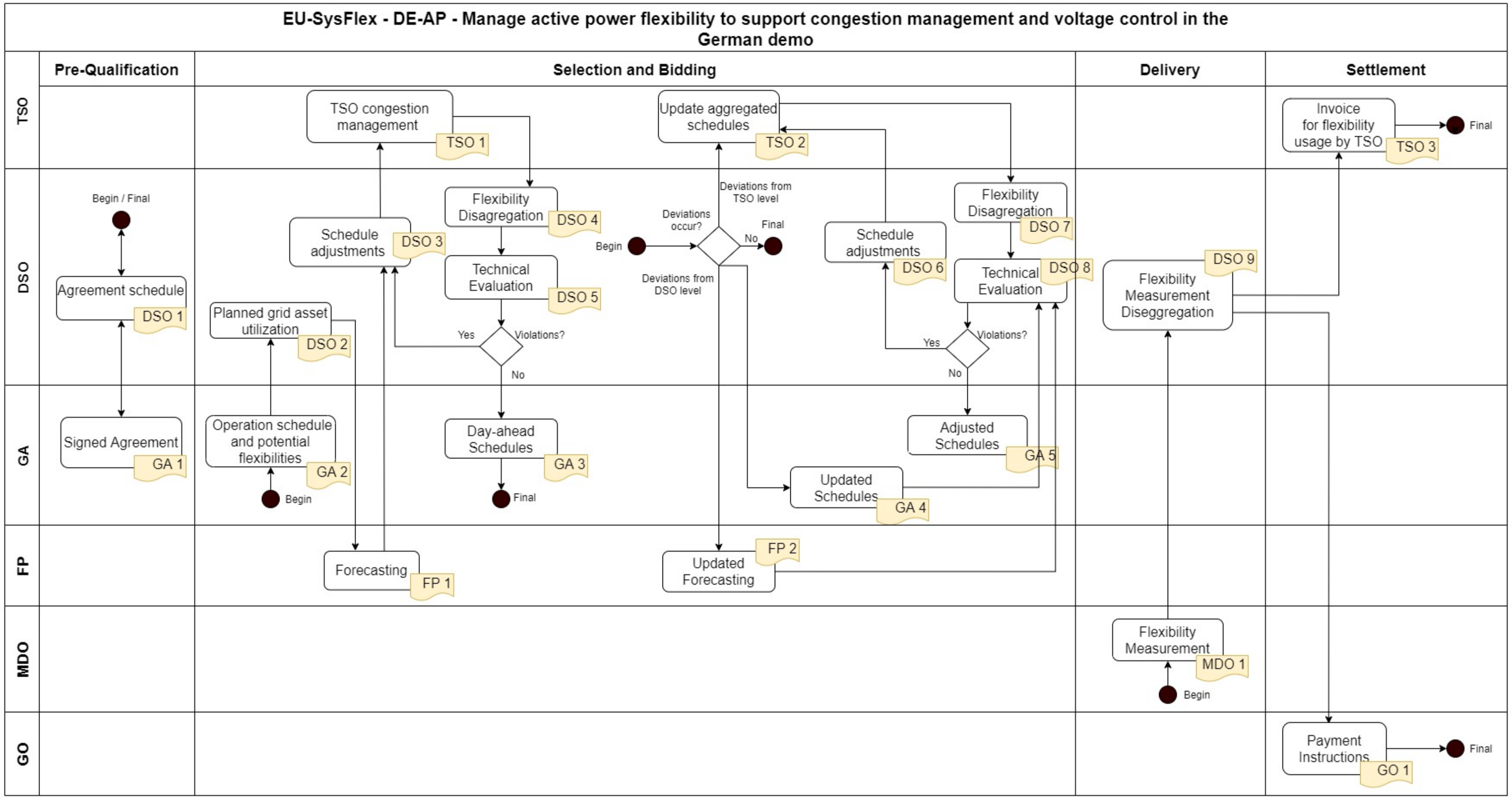


*Figure 2 Procedural overview from EU-SysFlex: DE-AP Source: own elaboration based on [29]*



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**Bidding/Selection phase**

Day ahead, the different GA submit their generation schedules, containing data about the planned generation, contracted frequency reserve capacity as well as the residual flexibility/Redispatch potential and its flexibility price. For small units without a schedule (small RES, household loads, etc.), forecasts will be used to predict their generation/consumption. The DSO aggregates the different flexibilities after gate closure of the day ahead markets and performs a load flow analysis based on the individual schedules of generation units and industrial loads and the forecasted aggregated schedules of small generation and loads. If congestions or voltage range deviations are forecasted, the DSO selects available flexibilities and submits the remaining flexibility potential to the TSO at each TSO-DSO interconnection point.

DSO and TSO determine which flexibilities shall be activated based on physical location and price, e.g., if resources from the distribution grid are selected, the TSO sends an adjusted aggregated schedule to the DSO (aggregated at the level of the TSO-DSO interface) and the DSO sends the activation signals (activation of active power flexibilities is carried out as schedule) to the generation units providing the flexibility.

**Delivery phase**

The delivery of flexibility is proven by metered data sent from the Metered Data Operator (MDO) to the DSO.

**Settlement phase**

The DSO pays the Generator Operator for the flexibility delivery (credit note) and sends an invoice to the TSO for its specific flexibility usage. Concluding this Use Case, it enables TSO to react on congestions and operation reserve needs with known and available flexibilities (including flexibilities in distribution grid).

### 4.1.2 Managing active power flexibility to support mFRR/RR and congestion management in the Italian demo (EU-SysFlex)

This Use Case is based on the provision of the active power flexibilities from distribution grid for mFRR/RR and congestion resolution services to the Transmission Network in real-time operations.

The market operator (at distribution level, MO_D) manages a local flexibility market and provide to the centralized market operator (at transmission level, MO_T) flexibility offers from customers and aggregators.

The main benefits for distribution system operator (DSO) from this Use Case are related to the exploitation of flexibilities to solve congestions in distribution grid since it cannot use its own assets (e.g., Battery Storage) for participating to the centralized transmission ancillary services (mFRR/RR market), but only for distribution system management and for solving imbalances.



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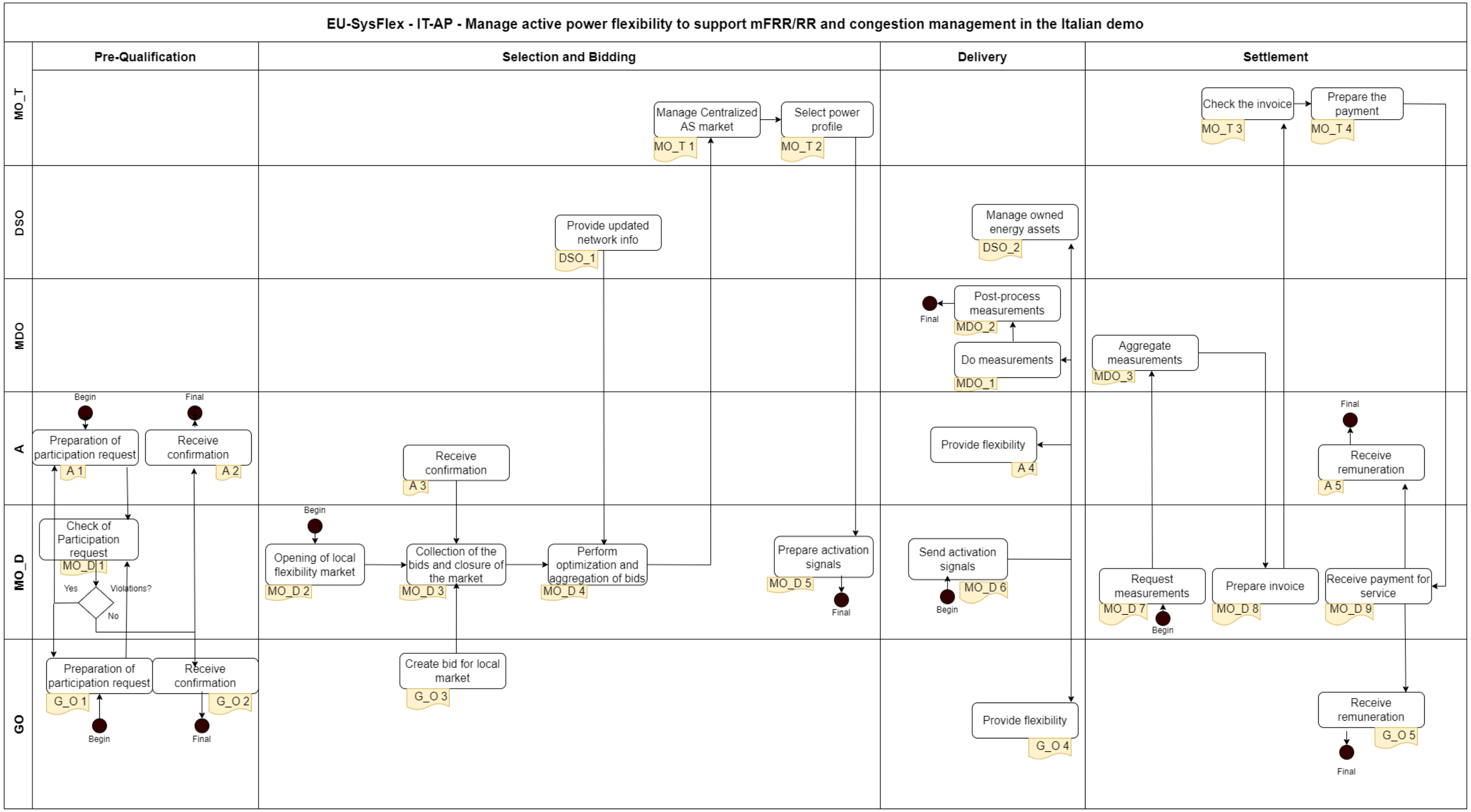


*Figure 3. Procedural overview from EU-SysFlex: IT-AP Source: own elaboration based on [29]*



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**Prequalification phase**

The generator(s) and the aggregator(s) submit a request to the local market operator. The local market operator collects the requests for the participation to the local flexibility market and checks them for consistency. In the case of any violations, the market operator rejects the unqualified resources.

In the case of positive outcomes, market operator officially registers the resources who meet the requirements for flexibilities provision communicating this to the involved actors. The market operator is responsible to periodically checking the resources and renew or revoke registration.

**Bidding and selection**

The local market operator (MO_D) opens the local flexibility market. The aggregators and the generation asset operators prepare an offer and send it to the local market operator (MO_D) analysing before the foreseen plant generation profile and evaluating the active power flexibility they can provide to the market. The market operator keeps the market open for a whole 15-minute time slot, collecting all the bids received within this time span after which it closes the market and collects from the DSO the updated network information.

Once the market is closed, the DSO communicates to the MO_D:

1. The updated network configuration,
2. The most recent resources production/consumption forecast,
3. The flexibility status of its own energy assets.

When the MO_D receives back the updated information, it verifies the activation of flexibilities running the necessary calculations and Optimal Power Flows.

At the end of this process, it aggregates the remaining flexibilities in a single bid, based on a parametric curve (energy vs cost) and offers it on the centralized AS market.

Once the previous action is finalized, the MO_T (market operator at transmission level) manages the centralized AS market and selects the active power profile which fits its needs sending back this information to the MO_D that prepares the activation signals for the delivery.

**Delivery**

This phase starts at the beginning of the time slot next to Bidding/Selection phase, when the MO_D sends simultaneously the activation signals to the resources involved, to the DSO for its assets and to the MDO for the synchronization of the measurement process. The generator(s) and aggregator(s) receive the activation signal and manage their own plant (generators) and portfolio of customers (aggregators) to provide the flexibility service.



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At the same time, the DSO receives the activation signal and manages its own energy assets. Finally, after the MDO receives from the MO_D the activation signal, it takes measures from the meters installed at the connection points of the selected resources checking also for deviations of the actual profiles from the scheduled ones. The phase ends with the MDO that stores the measurements and prepares them for the settlement phase.

**Settlement phase**

The Settlement phase begins with the MO_D that requests the measurements report to the MDO. Once the aggregate measurements are sent back to the market operator, it prepares the invoice (calculating the remuneration for the service based on the bid offered in the centralized market) sending it to the MO_T. After this the MO_T checks the invoice and prepares the payment to be sent to the MO_D. The phase ends with the MO_D that, according to the bids offered from the resources and the actual flexibility provision certified by the measurements, calculates the remuneration for each resource who participated in the local flexibility market sending then the payment to the aggregators and generators.

### 4.1.3 Managing reactive power flexibility to support voltage control and congestion management in the Italian demo (EU-SysFlex)

The Use Case described in the following paragraph summarizes the management of reactive power flexibility to support voltage control and congestion management in the Italian demo of EU-SysFlex.

The fulfilment of these services is performed by the DSO through suitable optimization processes, exploiting reactive power flexibilities connected to the distribution network. Distributed resources connected to the distribution network and DSO own assets (Battery Energy Storage Systems, STATCOM) provide the flexibilities. This flexibility portfolio may guarantee the provision of the agreed reactive power exchange between the distribution and transmission networks.

**Pre-qualification phase**

The prequalification phase begins with the generator(s) that prepares a formal request and submits it to the DSO. Same process is followed by the aggregator(s) who wishes to make its total reactive power capability available for voltage control and congestion management submitting the request to the DSO. This request specifies the details of the resources (from the aggregator's portfolio) that will be exploited for the flexibility provision. Then the DSO checks the participation requests received by the previous cited actors. In the case of any violations, the DSO prepares an official rejection document to the generators and aggregators that need to check the rejection and adjust the issues. In the case of positive result, the request is accepted the DSO officially registers the resources who meet the requirements for participating to the voltage control and congestion management and ends this task.


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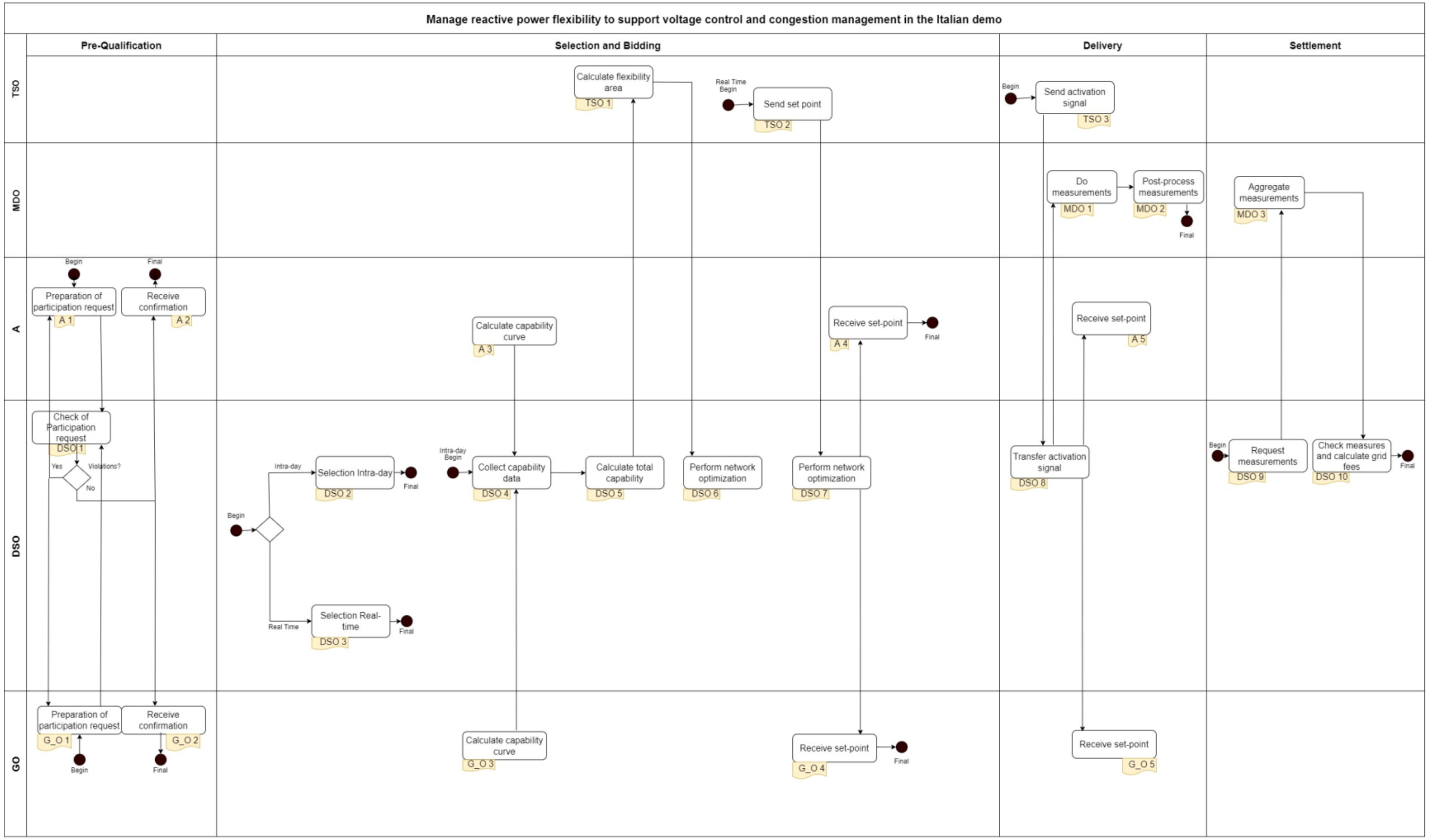


*Figure 4. Procedural overview of the Italian demo in EU-SysFlex; Source: own elaboration based on [29]*



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**Selection / Bidding**

The selection scenario considers two different main activities, based on different timeframes:

- selection process done in the intra-day (every 6 hours)
- selection process done in real-time, just before the delivery of the service (the time slot ahead).

The selection intra-day begins with the DSO that collects the capability curves from all the certified resources who want to participate to the reactive power exchange for the next intra-day time slot. The aggregator(s) and generator(s) provide these resources submit it to the DSO. After this function, the DSO aggregates all the capability curves in a single equivalent one at Primary Substation interface and communicates it to the TSO that determines the reactive power profile for that timeslot sending it back to the DSO. The intraday selection phase ends with the DSO that analyses the scheduled profile received from the TSO and performs the necessary calculations to determine the optimal allocation of capacity between the participating resources.

Indeed, in real-time (at the beginning of each time slot) the TSO sends the set-point for reactive power exchange at Primary Substation interface to the DSO. The set-point may deviate from the scheduled profile (based on the actual operating conditions of the transmission network) but must be within the capability band provide by the DSO. The DSO receives the set-point from the TSO and runs another optimization process for considering the actual state of distribution network and actualizes the allocation of the requested reactive power between the resources, calculating suitable set-points and sending them to the resources. Following phase ends with the aggregator(s) and generator(s) that receive the set-points in preparation of the delivery phase.

**Delivery phase**

This phase starts at the beginning of the time slot next to selection phase, when the TSO sends the activation signal to the DSO, which transfers it to the involved resources. In this phase the resources must follow the set-points calculated in the selection phase. Then, the MDO receives from the DSO the activation signal and takes measures from the meters installed at the connection points of the selected resources. It checks also for deviations of the actual profiles from the scheduled set-points. The process ends with the MDO that stores the measurements and prepares them for the settlement phase.

**Settlement phase**

The settlement phase starts when the DSO requests, on a monthly basis, the measurements taken during the previous month to the MDO. Then, the MDO aggregates the metered data related to the resources who participated to voltage control and congestion management services and also the measurements of the power exchange at the primary substation interface. After this, it prepares a measurements report and sends it to the



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DSO. The entire phase ends with the DSO that, based on the actual capacity provided by each resource calculates a reduction to be applied to grid fees for the participating resources.

### 4.1.4 Conclusions from the external projects' use cases analysis

All three analysed use cases of the EU-SysFlex project focus on sophisticated coordination between the flexibility provider and both the Transmission and Distribution system levels (although in the second case, the TSO is not involved directly in the data exchange). In these use cases, it is either the DSO or the market platform, who manage the communication exchanges.

Since the EU-SysFlex use cases cover data exchanges between the same actors that are in the focus of OneNet project and specifically of WP4, the analysis of the data models and communication protocols in these use cases can also deliver a useful comparison with OneNet demos – this comparison is done in the Data exchange and gap analysis in chapter 4.3. However, the added value of the analysis of external projects' use cases was limited due to the lack of publicly available information and therefore it was not possible to reach significant conclusions.

The lack of publicly available information should be noted and addressed in the future, as it is a barrier to the transfer of experience and learning from EU funded projects.

## 4.2 OneNet demos' Use Cases

The analysis of the OneNet Use Cases uses information about the demos presented in the Business Use Cases description, which can be found in full detail in the OneNet Deliverable D2.3 [30].

### 4.2.1 Active power flexibility for Overloading condition in the Cyprus demo (SOCL-CY-01)

The Cyprus power system is preparing for the massive installation of PV due to the climate conditions (abundant availability of solar energy), to achieve the national climate targets. The high penetration of renewables in combination with the isolated nature of the system creates critical challenges related to frequency stability and balancing (due to the variable nature of RES generation). In addition, several distribution feeders in the island experience large concentration of PVs and as a result, local congestion problems (voltage and thermal limit violations) appear.

Active power flexibilities provided within this use case will enhance the frequency stability, relieve the congestion of the system, and achieve a cost-effective operation of the system. This business use case exploits the flexible resources of the distribution grid (large energy storage systems, PV parks, prosumers) to provide active power related services in the framework of primary, secondary reserve such as:

- Droop control of flexible resources to support frequency,
- Ramping control to compensate large power fluctuations.



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Furthermore, the business use case will enable the participation of the distributed resources in the intra-day market by providing active flexibility services, such as:

- Peak shaving service to relieve local congestion problems,
- Power regulation to track day-ahead profile.

All these services will be procured by both the transmission and distribution system operators (TSO and DSO) to the TSO market and the DSO local market. The communication between the TSO and the DSO control centre with the TSO market and the DSO local market respectively will be facilitated through the OneNet system. The energy market will allocate the services to the different flexible actors (aggregators and prosumers) according to the market rules. The activation of these services will be coordinated by the operators and/or based on the grid operating conditions.

The provision of droop and ramping control is currently provided by the conventional generation plants at the transmission level of the system, while this business use case will enable the distributed resources to provide and be remunerated for these services. In addition, peak shaving services can provide local congestion management capabilities to minimize PV curtailments and increase the penetration of photovoltaic energy.

The described business process represents the Scenario #2 – Overloading Conditions[4], where DSO procures congestion management products through the DSO local market.

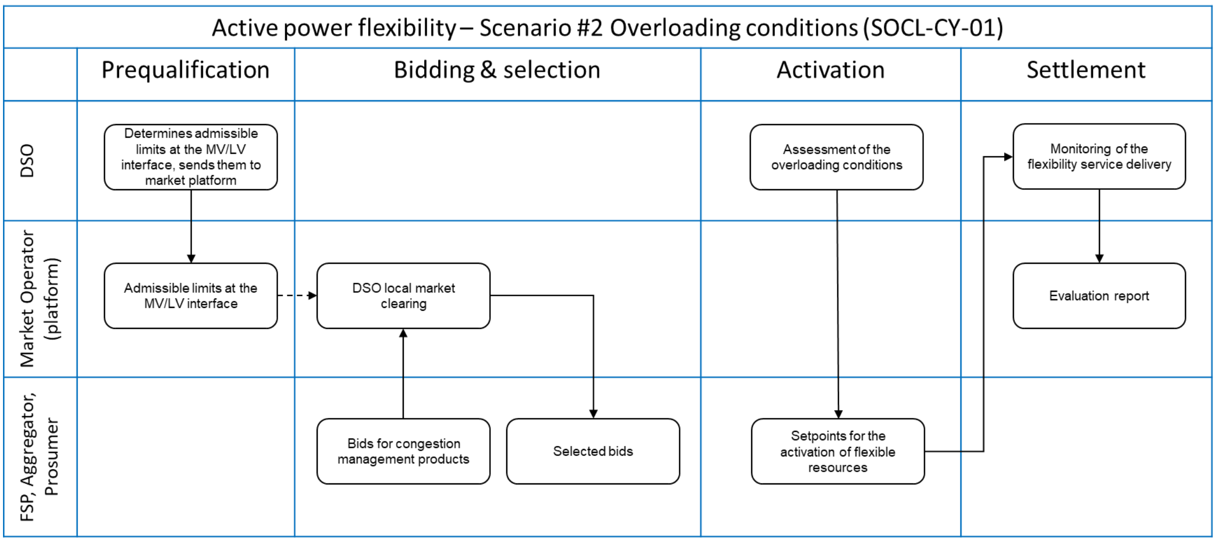


*Figure 5 Procedural overview of OneNet use case SOCL-CY-01; source: own elaboration*

**Prequalification**

DSO determines the admissible limits (for having a safe operation of the grid) at the MV/LV interface. This is done through using ABCM-D. The limits are sent to local DSO market through the OneNet system.

[4] Scenario #1 – Frequency Disturbance is analysed in deliverable D4.1 [4]



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**Bidding & Selection**

FSPs in the distribution level bid for the congestion management procured products in the market through the OneNet system. DSO local market are cleared, and the awarded bids are sent through the OneNet system to the FSPs.

**Activation**

DSO receives the measurements from substations via SCADA. Measurements from smart meters are received by the DSO AMI. The ABCM-D platform will process the measurements based on monitoring schemes and alarms will be set off in case of overloading conditions. Based on the location and the overloading conditions, the DSO defines the coordination set-points for the activation of the flexible resources through the ABCM-D platform. The coordination signals are sent to the flexible resources through the OneNet system. The flexibility service providers increase or decrease the active power output to provide energy shift and peak shaving services according to the DSO coordination set points.

**Settlement**

DSO monitors the flexible resources activation and delivery of procured services, based on smart meters reading. The evaluation report is provided to the market.

### 4.2.2 Short- and Long-term congestion management in the Spanish demo (WECL-ES-01 and 02)

This analysis sums up together the business use cases WECL-ES-01 and 02 in the Spanish demo, which focus on the use of long-term and short-term congestion management in the distribution network. The short-term use case focuses on day-ahead and intraday timeframe, whereas the long-term congestion management case deals with week- to years-ahead horizons. Although they are two separate use cases, the business process structure is to a large extent the same and some steps, such as prequalification, are handled together.


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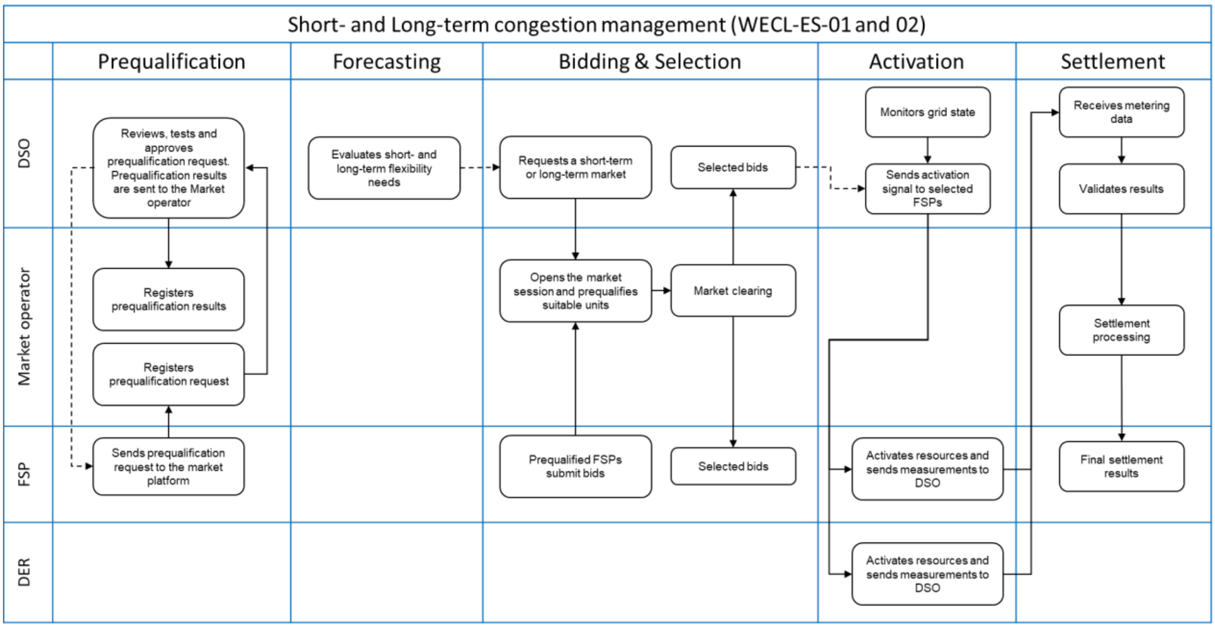


*Figure 6 Procedural overview of OneNet use cases WECL-ES-01 and 02; source: own elaboration*

**Prequalification**

The flexibility service provider submits the prequalification request to the market operator. DSO checks the validity of the requests and confirms approval of the request to the market operator. The prequalification has a grid part (ensuring that the grid where the FSP resource(s) are connected is capable of coping with the flexibility service provision) and a market part (ensuring that the FSP can deliver the required products according to the defined standards).

**Forecasting**

The DSO carries out an analysis to detect the structural congestions in the grid (in an intraday, day-ahead or longer-term timeframes). Results of previously cleared (for example, long-term) markets are also taken into account.

**Bidding & Selection**

Based on the flexibility needs identified in the previous market phase, the DSO is able to call a market through the market platform. This market will procure either availability or availability and activation. The availability means a capacity band (product defined in kW) with start and finish times defined, in which the FSP is expected to provide the flexibility upon the DSO’s call. Activation is predefined in terms of day, time, capacity and duration of activations (product defined in kWh). In principle, the day-ahead market will be open for availability and activation procurement, while the intraday will be used for activation procurement.



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During this phase there is a qualification process to check if the flexibility provider can provide the demand service in terms of quality and cost.

The results of the auction will be published to market participants. In addition, the scheduling of FSPs (for short-term congestion management) is integrated into the notification sent to the TSO.

**Activation**

This service phase takes place close to real-time and in real-time. The DSO will monitor the conditions of the grid in real time and send the activation signals to the FSPs committed in the market phase, in accordance with the type of product procured. When activating the FSPs, the DSO will consider the actual state of the grid.

For the short-term congestion management use case, the services could be requested close to real-time and therefore there is also the possibility of both manual and automatic activation by the DSO. In the case of the latter, the DSO could send activation setpoints directly to the DER, while in the case of the former, activation setpoints are sent to the FSP that manually activates the DER's flexibility.

**Settlement**

In this final service phase, the MO and/or DSO will verify if the flexibility was provided in accordance with the product procured in the market phase. This service phase can take place in the real-time and/or after the real-time. For the measurement of flexibility, a baseline must be previously defined, to which the actual metered data of the FSP can be compared too.

### 4.2.3 Improved TSO-DSO information exchange for DER activation in the French demo (WECL-FR-01)

The goal of this use case is to simplify and optimize the management of renewable production curtailments. Blockchain technology will be used to establish a decentralized trust framework among renewable energy generators, market participants, the DSO and the TSO.

Using permissioned blockchain technologies, a shared ledger will be implemented in order to establish a decentralized trust framework among renewable energy generators, market participants, the DSO and the TSO. All participants will access to the previously mentioned shared platform that will provide more transparency and visibility while preserving business confidentiality, and shared governance rules will be defined to account for the role and needs of each involved party. The platform should in particular host and give access to the following information: generators' flexibilities offers, activation orders, and metering data.

The blockchain based demonstrator will be validated on two experiments:

- The first one will be coupled with a new grid automaton system that will act near real-time to resolve grid constraints by activating the most technically and economically optimal remedial action.
- The second one will focus on production curtailment orders sent by the DSO.


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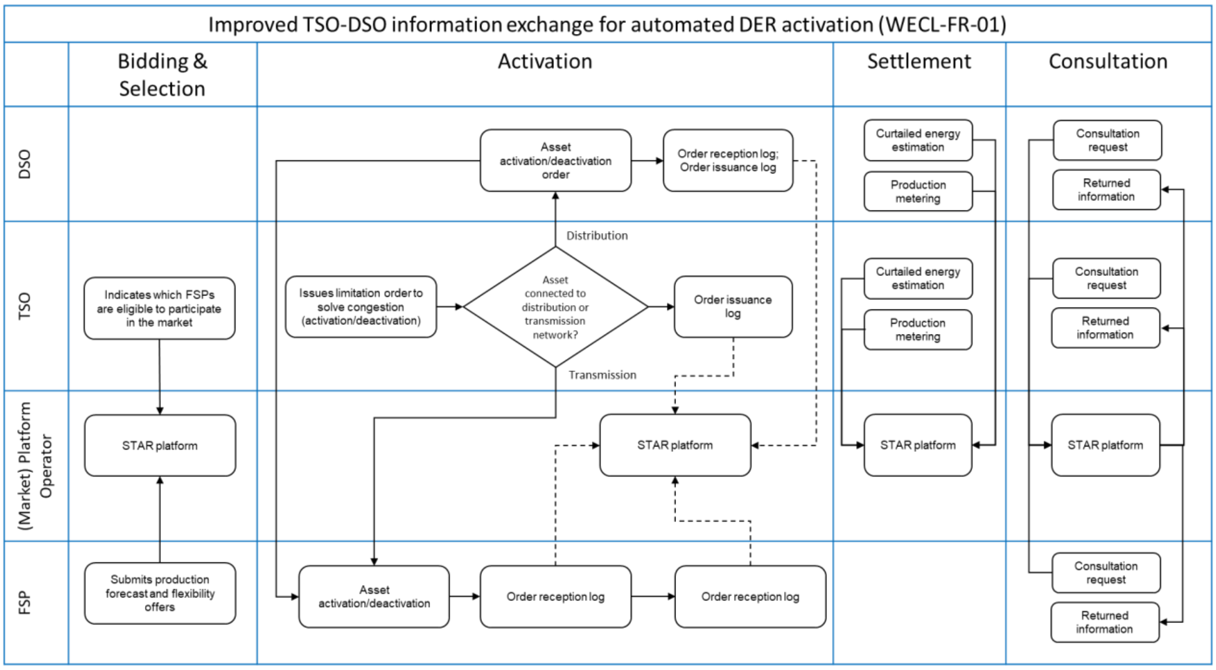


*Figure 7 Procedural overview of OneNet use Case WECL-FR-01 (automated DER activation); source: own elaboration.*

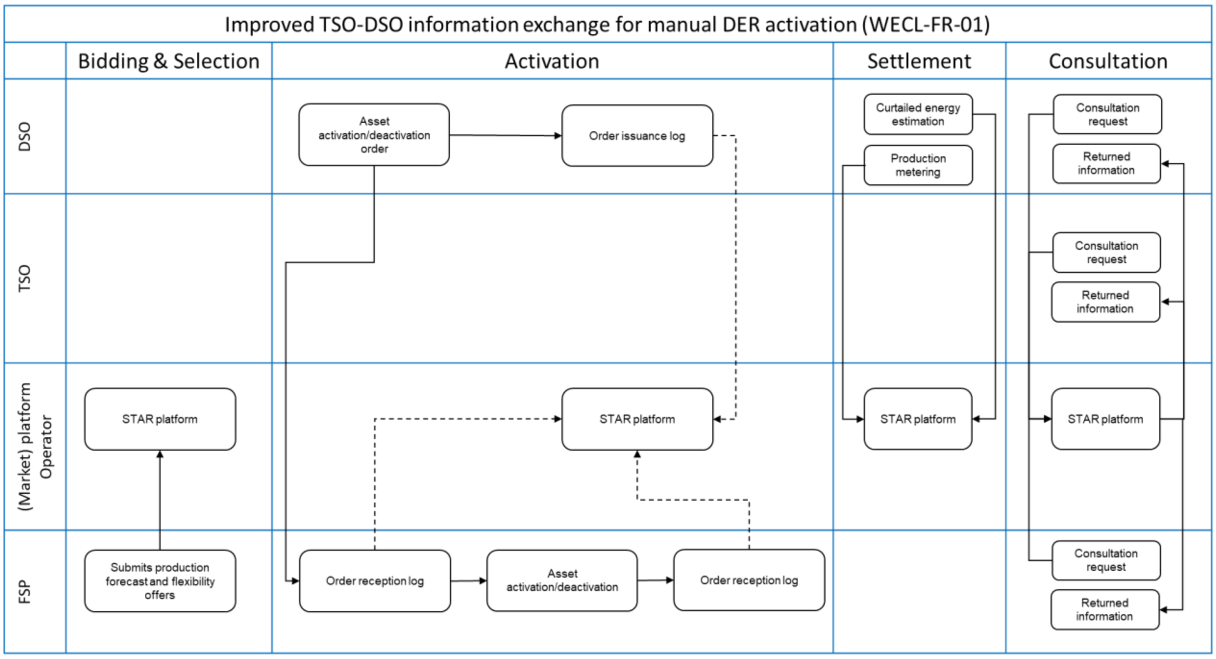


*Figure 8 Procedural overview of OneNet use Case WECL-FR-01 (manual DER activation); source: own elaboration.*



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**Bidding & Selection**

Automated DER activation

In this case, the TSO indicates to the STAR platform (market operator) the limits of what flexibility assets are eligible to participate in the flexibility markets. FSP submits to the STAR platform the production forecast and flexibility offers.

Manual DER activation

FSP submits to the STAR platform the production forecast and flexibility offers.

**Activation**

Automated DER activation

Grid automation system will act in near real-time to resolve grid constraints by activating the most technically and economically optimal remedial action.

Manual DER activation

DSO manually activates flexibilities to solve grid congestion.

**Settlement**

Automated DER activation

TSO and DSO submit the curtailed energy estimations and production measurements to the STAR platform.

Manual DER activation

DSO submits the curtailed energy estimations and production measurements to the STAR platform.

**Consultation**

At any time, the platform will enable the different actors to have access authorized information through interfaces.

### 4.2.4 Nodal Area Congestion Management in the Czech demo (EACL-CZ-01)

The newly created IT environment shall cover activities related to procurement of non-frequency services. The system shall:

- accommodate different types of non-frequency services;
- enable DSOs to procure non-frequency services in a way that fits to needs of operation of distribution grid;
- allow access for FSP/units to the platform to provide non-frequency services enable via traffic light system availability for activation of relevant resources.


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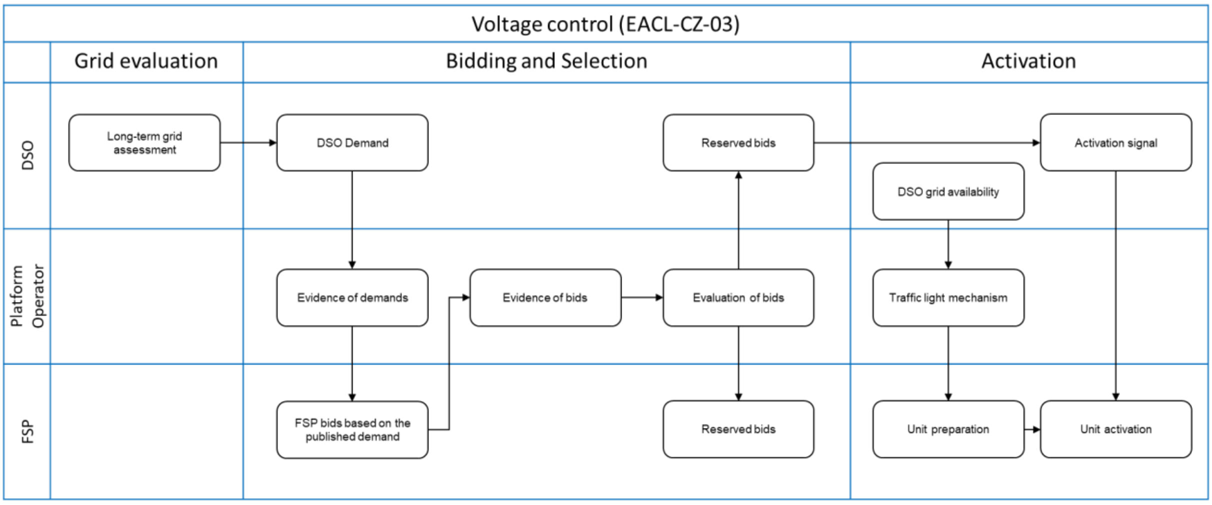


*Figure 9 Procedural overview of OneNet use case EACL-CZ-01; source: own elaboration.*

**Prequalification phase**

The FSP (units/users) will request an access to the system – at this initial phase the relevant DSO will serve as an interface. After the unit is recognised through DSO authentication, it is registered through the system provider.

**Selection / Bidding**

DSO sends flexibility demand to the platform via ECP through dedicated XML message. The message contains details of the demand and list of units which might provide this service.

FSPs indicate the total amount of flexibility available for given period. Similarly, as for the flexibility demand, there is a dedicated XML message containing details on type of service and duration.

The platform verifies the relevance of offers -the correct XML message format, traffic light status to given units etc. and subsequently the platform informs DSOs about offers available. DSOs inform the relevant units their bids were selected.

**Delivery phase**

DSOs report system availability regarding the planned and unplanned grid events. The platform highlights the reported grid events (according to reported data) to individual units.

**Settlement phase**

The metering/billing is processed bilaterally between DSO and flexibility provider.


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### 4.2.5 Reactive power overflow management in the Czech demo (EACL-CZ-02)

This use case defines market-based procurement of non-frequency service (reactive power flow) for DSO. Reactive power overflows from DSO to TSO are controlled through management of the reactive power provided through units (generators/units) at the Middle Voltage/High Voltage level. The product is meant to keep reactive power overflows within limits agreed between DSO and TSO.

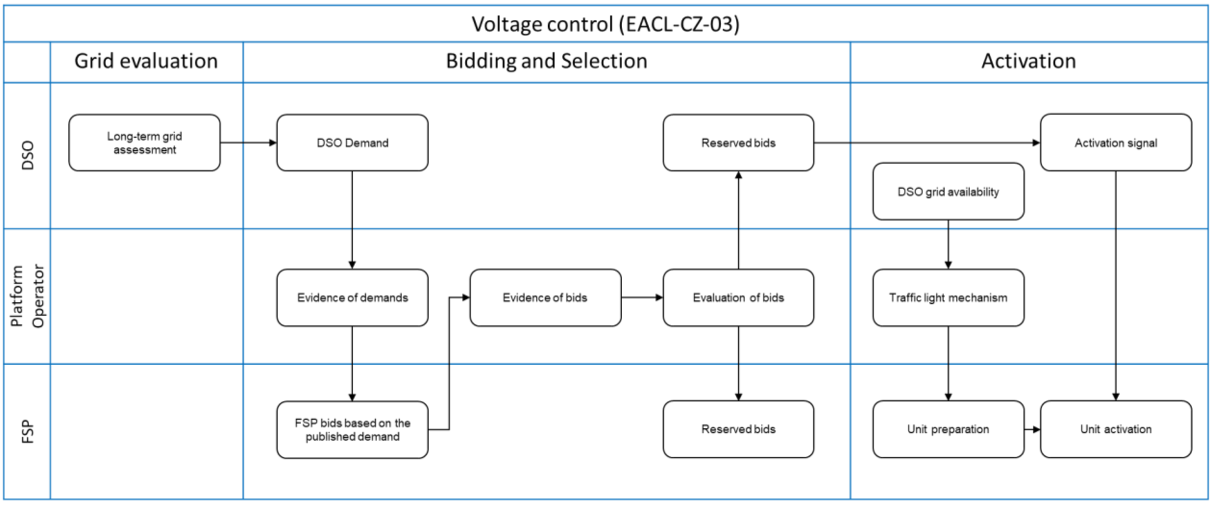


*Figure 10 Procedural overview of OneNet use case EACL-CZ-02; source: own elaboration.*

**Grid evaluation**

Grid is evaluated in terms of production of reactive power and in terms of exchange of reactive power in the TSO/DSO connection points.

**Bidding and Selection**

DSO identifies relevant flexibility capacities to address overproduction of reactive power and sends flexibility demand to the platform – this includes location, capacity and duration. The aggregator informs platform about available flexibility capacity. The platform matches demand/supply and informs market parties on the results.

**Activation**

Once relevant offer is accepted by the DSO (at least part of that) given provider will receive confirmation through the platform. After the service is accepted (by both parties) relevant provider sends the list of units/generators involved in the provision of the service. This list of units/generators is than delivered to the dispatch control centre of the relevant DSO – to enable direct control of the relevant units/generators by the DSOs for grid service purposes.

**Settlement**

The metering/billing is processed bilaterally between DSO and flexibility provider.


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### 4.2.6 Voltage control in the Czech demo (EACL-CZ-03)

This use case describes market-based procurement of non-frequency service (voltage control) for DSO. The voltage is controlled through management of the reactive power provided through units (generators/units) at the Medium Voltage/High Voltage level. The product is meant to keep voltage in given limits in terms of quality of supply.

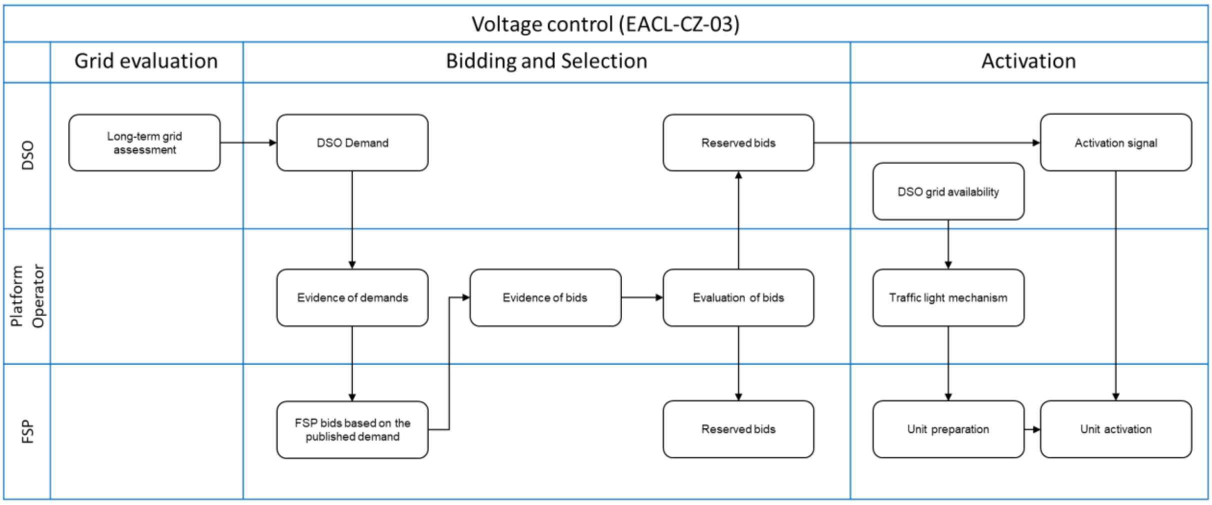


*Figure 11 Procedural overview of OneNet use case EACL-CZ-03; source: own elaboration.*

#### Grid evaluation

The grid is evaluated in terms of production of reactive power and in terms of exchange of reactive power in the TSO/DSO connection points.

#### Bidding and selection

The DSO identifies relevant flexibility capacities to address voltage issues and sends flexibility demand to the platform – this includes location, capacity and duration. The aggregator informs platform about available flexibility capacity. The platform matches demand/supply and informs market parties on the results.

#### Activation

Once a relevant offer is accepted by the DSO (at least part of that), the given provider will receive confirmation through the platform. After the service is accepted (by both parties) relevant provider sends the list of units/generators involved in the provision of the service. This list of units/generators is than delivered to the dispatch control centre of the relevant DSO – to enable direct control of the relevant units/generators by the DSOs for grid service purposes.

#### Settlement

The metering/billing is processed bilaterally between DSO and flexibility provider.



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## 4.2.7 Congestion management in distribution grids under market conditions in the Slovenian demo (EACL-SL-01)

This use case describes a locational congestion management service of existing congested secondary MV/LV transformer (substation). Flexibility (capacity) is procured from aggregated demand response (heat pumps) by the means of active power curtailment.

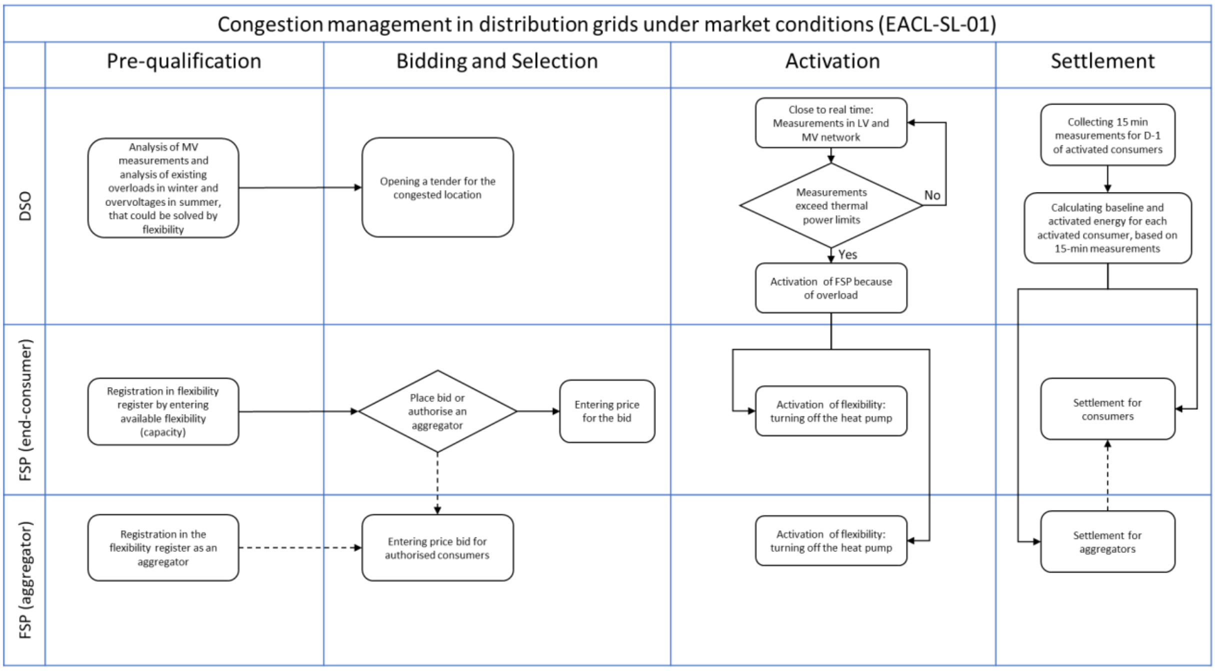


*Figure 12 Procedural overview of OneNet use case EACL-SL-01; source: own elaboration.*

**Prequalification phase**

There are different levels of prequalification possible depending on the needs of particular product. In the first step of the prequalification process, secure access (with certificate or SMS authentication) will be used so that every consumer can register flexibility only for their own metering measurement place/points only. As all information about the metering points and all the measurements are included in the system (contracted power), consumer cannot insert flexibility higher than its contracted power. Moreover, during the registration process, the consumer must agree with terms and conditions for providing service and proceed with adequate prequalification required for offered services.

**Selection/Bidding**

Based on analysis of network congestion, the DSO is opening a tender for a certain area with network problems. The tender is published on DSO's website and includes both technical and commercial specifications. Based on analysis of historical measurements, the DSO has to define what kind of 'flexible product' is needed (seasonal – winter, summer or monthly, daily schedule of possible activations, duration and maximum number


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of activations, response time of activation, total amount of flexible power etc). End consumers which have registered flexibility and are connected to the area with congestion issue receive message about new tender so they can add a bid for their flexibility, or they can authorize aggregator to place a bid in their place. In that case, the aggregator places a bid for consumers which are all in the same problematic network and they have agreement (contract) with the aggregator. By entering the bid (price for energy), the aggregator confirms that it has an agreement / contract with the customer to provide flexibility and thus the aggregators take responsibility for non-response in case of activation. Tendering system than selects most favourable bidders and sends contracts.

**Delivery phase**

The DSO activates the FSP (end consumers or an aggregator) to lower consumption. Activation of end consumer is done with an SMS, e-mail, or phone call. For aggregators, MQ message is used instead. The aggregator shall respond with an acknowledgement of receipt of the MQ message. This message is pushed over SEDM-p regardless of DSO, since MQ message defines who is the sender and receiver of the message and other data for activation (start and end time of activation, requested power and direction of the product).

**Settlement phase**

After the services activation, a settlement system calculates baseline and activated energy. If FSP is an end consumer, settlement information can see in 'Moj elektro' web portal, where data is being displayed, so the end consumer can check their performance. Payment of the 'reward' for activated energy is done every 3 months into a bank account. If the FSP is an aggregator, the settlement information can see in Central electro-energy portal Slovenia (CEEPS). The Aggregator periodically issue an invoice on the basis of the billing available in CEEPS.

### 4.2.8 Voltage control in distribution grids under market conditions in the Slovenian demo (EACL-SI-02)

This use case describes the procurement of flexibility services for voltage control in low-voltage distribution network. The voltage is controlled through the activation of flexibility resources connected to the LV grid, such as battery storage, curtailment of PVs or demand side management. The services are offered and activated by the aggregators which receive the activation signal from the DSO through the market platform. This product is meant to keep the voltage inside of EN 50160 limits.

For the demo site a small village with 26 customers was selected. This village has relatively high penetration of RES, where 8 customers have existing solar PV, while 2 more are foreseen for installation. Additionally, 3 customers have installed battery storage.


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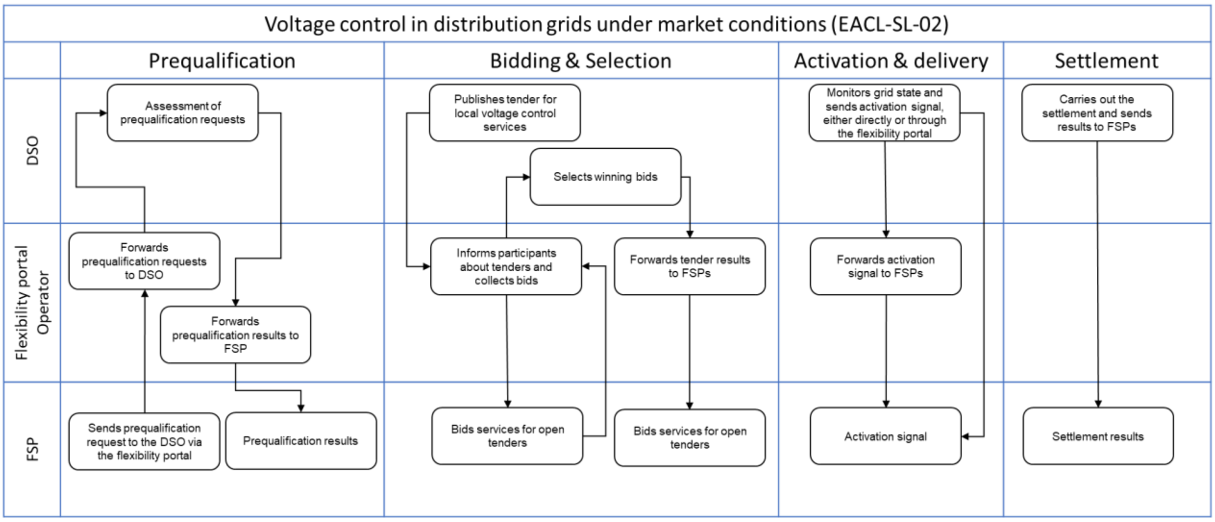


*Figure 13 Procedural overview of OneNet use case EACL-SL-02; source: own elaboration.*

**Prequalification**

All 3 batteries and all 8 PVs have qualified to provide flexibility services, more specifically they have qualified to provide voltage control services. All the flexibility resources have been verified in terms of technical capabilities of providing these services. In general, this phase consists of 3rd party flexibility resources applying to provide flexibility services either through aggregators or by active customers themselves. The flexibility resources which are connected to the DSO network can apply to provide flexibility services either to the DSO, in the case of this pilot the services are voltage control, or they can apply to provide flexibility services to the TSO which is not the scope of this pilot. The DSO then determines whether this flexibility resource is technically capable to provide the desired services which is done internally in the network planning and operations departments. Flexibility services apply for qualification through the Slovenian national flexibility portal.

**Bidding & Selection**

The DSO issues a tender where flexibility services for voltage control are required. In the case of this pilot, the village was selected. The DSO publishes the network nodes where voltages are predicted to be outside of allowed limits (230V ± 10%). If there are several potential flexibility service providers in the area, the bidding phase begins where all potential providers of voltage control services submit their bids according to the specified parameters (e.g., time period, time to activate, quantities, price, ...). After receiving all the bids, the DSO selects the most appropriate bid considering all the parameters. The DSO informs all the bidders of the final selection. The bidding and selection phases are both managed through the Slovenian national flexibility portal.

**Delivery**

When the time of activation comes, the DSO issues an activation signal. The DSO has internal technical systems which in real-time calculate the required flexibility to maintain voltages within allowed limits. When



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approaching the limits, the DSO sends the activation signal either through the Slovenian national flexibility portal which is rerouted to the selected flexibility service provider, or the signal is sent to the FSP directly.

**Settlement**

With regards to the baseline, the activated flexibility amount is determined. Based on the agreed price of the flexibility, the required settlement is calculated and carried out through financial departments at the end of each month at respective partners.

### 4.2.9 MV feeder voltage control in the Hungarian demo (EACL-HU-01)

This use case is dealing with the voltage violation problems of the MV network due to increasing renewable penetration. Too many renewable resources connected to a power line (not only MV) can cause voltage deviation beyond the standard ranges in the line. The main goal is to mitigate voltage variations of MV feeders by activating flexibility services and to keep actual voltage values of MV feeders within the standard bands.

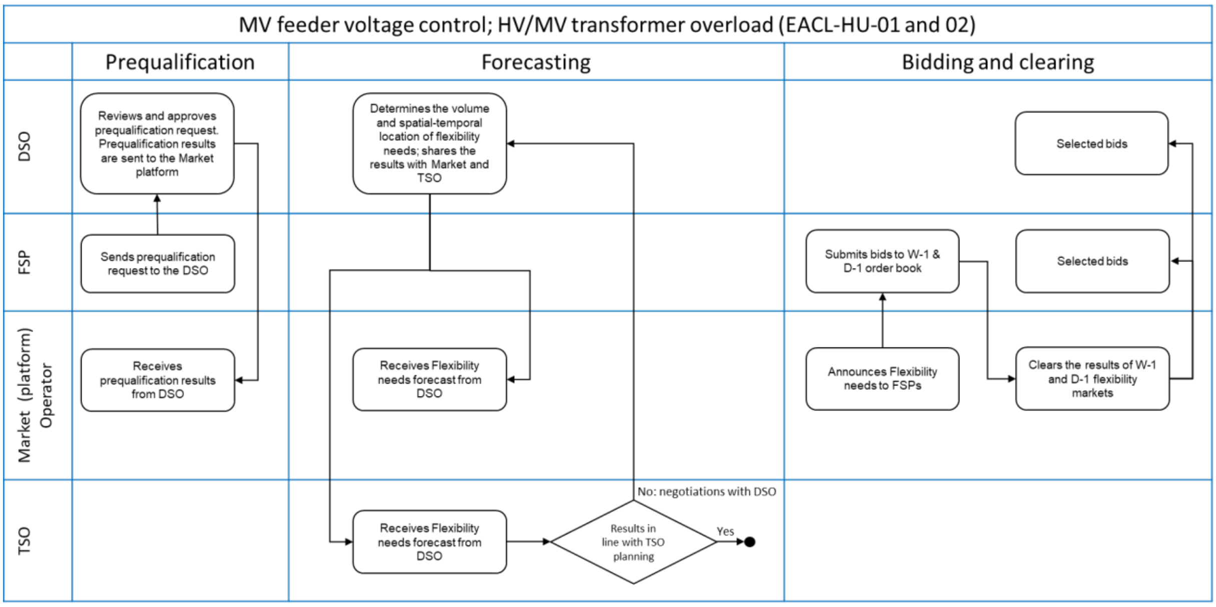


*Figure 14 Procedural overview of OneNet use cases EACL-HU-01 and 02; source: own elaboration.*

**Prequalification**

The flexibility service provider sends a request to the DSO for prequalification. The DSO analyses the results and approves the FSP prequalification. The prequalification data include location identifier, product parameters and assignment of the FSO to a certain substation/MV feeder. The process is based on standardized methodology and clear requirements and the result (including location, P/Q min/max) are stored in the flexibility platform. Based on the location information the DSOs determine the impact factor for each node on which the concerned unit has an effect.


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**Forecasting**

Based on the historical grid operational data and external data inputs, DSO determines the flexibility needs – both in temporal and locational dimensions. DSO informs TSO about the predicted flexibility needs. The TSO considers this information in the operation of the transmission system and all related technical matters. If a DSO request is not acceptable for the TSO, the TSO indicates this issue and starts to negotiate with DSO about the situation. Afterwards, DSO shares the resulting flexibility needs request with the market platform.

**Selection/Bidding**

The BUC operates on two time-horizons, each related to the specified grid service:

- capacity auction
- and energy activation (scheduled), respectively.

Capacity auctions will be driven by technical needs of the DSOs, which are determined on a weekly basis based on weekly maintenance plans. Gate opens at W-1 Monday 0:00 and closes at W-1 Friday 14:00, thus enabling bidders a fairly long time to place bids, but the market can be cleared during working hours on W-1. Results of the auction are to be published by W-1 Friday 15:00.

Energy bids can be submitted between W-1 Monday 0:00 and D-1 6:00. The early gate opening supports the procurement of services that are expected to be necessary with probability. The gate closure on D-1 allows SOs to procure services based on day-ahead predictions and network calculations. Results of the clearing are to be published by D-1 7:00, which is 60 minutes ahead of local daily balancing capacity market gate closure, and well before the active period of DAM market bidding. This allows market players to participate on flexibility and day-ahead markets separately, and also supports that uncleared flexibility bids are submitted to shorter horizon markets (DAM, BAM).

The market platform aggregates the supply bids in the order book and carries out market clearing process in W-1 and D-1 timeframe. The order book processes all the input data via an algorithm, then forwards the clearing results towards the user interfaces and the capacity register.

### 4.2.10 HV/MV transformer overload in the Hungarian demo (EACL-HU-02)

The main goal of this BUC is to mitigate the overloading of HV/MV transformers by activating flexibility services in all operational states of the power system. Due to the proliferation of PV plants, connected to DSO MV lines or directly to the MV side of HV/MV substations, violation of standard voltage bands on MV lines is a forthcoming issue in Hungary. This technical issue can be mitigated by P and/or Q injection and withdrawal on MV level.


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The generic analysis of the business processes has revealed that they are the same as the one described for the other Hungarian use case (EACL-HU-01), and therefore it is already presented above for the previous use case.

### 4.2.11 Conclusions from the OneNet use cases analysis

The analysis shows that the OneNet use cases do not always cover data exchanges in all market phases. In most cases, bidding, selection, and activation is covered, while the forecasting, prequalification and settlement phases are covered less frequently. It is assumed that this is because DSOs are using already existing solutions for the market phases that are not covered (for example, existing prequalification procedure is used and therefore not mentioned in the business use case description). However, adopting this approach carries a risk of overlooking interoperability issues between the implemented solutions and also diminishes the informational value of the BUC description. Although it was not discovered that this would pose a problem for the OneNet demos, a more holistic approach considering all market phases in the analysis is advisable for future projects. Moreover, most of the use cases do not directly cover the data exchanges that include TSOs as well (this is though due to the focus of this deliverable on DSO-centric use cases, other use cases with more prominent involvement of TSOs are covered in deliverable D4.1).

In most cases, it is the flexibility platform (or register, market, and others) that plays the central intermediary role in the data exchanges. Therefore, it should be ensured that especially this type of actors adopt widely accepted standards for data exchanges.

## 4.3 Data exchanges and Gap analysis

This section analyses the gaps in data exchange processes in the most relevant EU-Sysflex project use cases (as a representative of the external H2020 projects) and OneNet demo business cases (relevant for the activities of DSOs). The analysis for the EU-Sysflex project is presented below in Table 6.

Table 7 covers the OneNet use cases. The tables also present in detail the characterisation of the data exchanges, including the concerned interfaces between roles, the used information model and the communication protocol. However, it was not always possible to collect the information on the required level of detail, and therefore, for some demos, there is only a general information covering multiple interfaces provided.


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*Table 6 Analysis of EU-Sysflex data exchange processes*

| Project | Use Case Name/ID | Perspective | Interface | Used information model | Communication protocol used | Extension/ modification/ deviation | Gaps identified (if any) |
|---|---|---|---|---|---|---|---|
| **EU-Sysflex** | Manage reactive power flexibility to support voltage control and congestion management in the German demo. | DSO/TSO | DSO 1 - GA 1<br>GA 2 - DSO 2<br>DSO 2 - FP1<br>FP1 - DSO 3<br>DSO 3 - TSO 1<br>TSO 1 - DSO 4<br>DSO 5 - GA 3 | CIM,<br>Custom,<br>IEC 60870-5-101 | | N/A | There is no standard to provide forecast for required field assets and aggregated data on certain connection points. In CIM this information is currently described by profiles and classes. |
| **EU-Sysflex** | Flexibility Platform | Customer | FSP1 - FPO2<br>FPO6 - FSP2<br>FSP2 - FPO7<br>FPO21 - FSP3<br>FSP3 - FPO16<br>FSP4 - FPO17 | Project specific data model was created. In next phase it was translated into CIM compliant data model (but was not completed for all business objects). | | CIM extension for consent management process was proposed. | The existing CIM/CGMES does not fully support the consent management that was developed in this use case. Therefore, CIM was extended as a customized solution. |

*Table 7 Analysis of OneNet Demos data exchange processes*

| Use Case ID | Use Case Name | Interface | Action | Data model | Communication protocol | Explanations and gaps identified |
|---|---|---|---|---|---|---|
| **SOCL-CY-01** | Active Power #Scen. 2: Overloading conditions (congestion management) | DSO-MO | Prequalification results | Proprietary data model | IEEE C37.118<br><br>Ethernet; PLC; GPRS; MQTT | Proprietary data models and communication protocols are used within the demo testing environment |
| | | DSO-FSP | Activation signal | | | |
| | | FSP-DSO | Activation measurements | | | |
| | | DSO-MO | Settlement data | | | |
| **WECL-ES-01;**<br><br>**WECL-ES-02** | Long-term congestion management;<br><br>Short-term congestion management | MO-DSO | Prequalification requests | | Web UI, Email | Proprietary solutions adopted to be compatible with the existing systems and procedures – to reduce costs and minimise entry barriers for participants |
| | | DSO-MO | Prequalification results | | Web UI | |
| | | DSO-MO | Flexibility request | | Web UI (.xml) | |
| | | MO-DSO | Selected bids | | Web UI | |
| | | DSO-FSP | Activation signal | | Web UI | |
| | | FSP-DSO | Activation measurements | | Web UI | |
| | | DSO-MO | Settlement data | | Web UI | |
| **WECL-FR-01** | Improved monitoring of flexibility for congestion management | TSO-DSO | Activation order | ESMP, ISO8601 , CIM based | REST API (CSV), manual | Current European style market profile needs to be extended for DSO needs; manual activation signals are a possibility for some FSPs |
| | | DSO-FSP | Activation signal | | | |
| | | DSO-MO | Message log | | | |
| | | DSO-MO | Settlement data | | | |
| | | DSO-MO | Consultation data exchange | | | |



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| | | | | | | |
|---|---|---|---|---|---|---|
| **EACL-CZ-01;**<br>**EACL-CZ-02** | Nodal Area Congestion Management;<br>Reactive power overflow management | DSO-Flex Platform | Flexibility request | CIM XML - proprietary | REST API | In the Czech use cases, proprietary data model is used. For internal use manual uploads/downloads of messages are being used, which could be automated in the future |
| | | Flex Platform-DSO | Selected bids | | | |
| | | DSO-FSP | Activation signal | | | |
| | | DSO-Flex platform | DSO grid status (traffic light mechanism) | | ECP | |
| **EACL-CZ-03** | Voltage Control | DSO-Flex Platform | Flexibility request | CIM XML<br>Proprietary | Web services<br>Ethernet<br>ECP<br>AMQP | Similar to EACL-CZ01/02 |
| | | Flex Platform-DSO | Selected bids | | | |
| | | DSO-FSP | Activation signal | | | |
| | | DSO-Flex platform | DSO grid status (traffic light mechanism) | | | |
| **EACL-SL-01** | Congestion management in distribution grids under market conditions | DSO-FSP | Activation signal | CIM XML | MQTT | The Slovenian use cases use common data model as well as communication protocol, with the exception of DSO-DER activation signals, which are manually activated via SMS or email.<br>Current European style market profile with proprietary extensions: The documents for TSO balancing purposes have been modified for DSO non-frequency services. |
| | | DSO-FSP | Settlement results | CIM XML | MQTT | |
| | | DSO-DER | Settlement results | CIM XML | MQTT | |
| | | DSO-DER | Activation signal | SMS | SMS | SMS used for manual activation of small-scale actors |
| **EACL-SL-02** | Voltage Control | MO-DSO | Prequalification requests | CIM XML | MQTT | Same as EACL-SL-01. |


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| | | | | | | |
|---|---|---|---|---|---|---|
| | | DSO-MO | Prequalification results | CIM XML | MQTT | |
| | | DSO-MO | Flexibility request | CIM XML | MQTT | |
| | | MO-DSO | Flexibility offers | CIM XML | MQTT | |
| | | DSO-MO | Selected bids | CIM XML | MQTT | |
| | | DSO-MO | Activation signal | CIM XML | MQTT | |
| | | DSO-MO | Settlement results | CIM XML | MQTT | |
| | | DSO-FSP | Activation signal | CIM XML/Mail, SMS | MQTT | SMS/mail used for manual activation of small-scale actors |
| **EACL-HU-01;**<br>**EACL-HU-02** | MV feeder voltage control;<br>HV/MV transformer overload | FSP-DSO | Prequalification requests | Proprietary XML | Web services<br>File transfer<br>Internet protocols<br>Industrial protocol stack | Proprietary data model applied, and proprietary communication protocols used. |
| | | DSO-MO | Prequalification results | Proprietary XML | | |
| | | MO-DSO | Selected bids | Proprietary XML | | |
| | | DSO-MO | Flexibility needs forecast/request | Proprietary XML | | |
| | | DSO-TSO | Flexibility needs forecast/request | CIM | | CIM used for TSO-DSO coordination |



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### 4.3.1 Summary of the gaps identified in OneNet and EU-Sysflex Use Cases

Some gaps were identified in the harmonization and standardization, mainly because the markets for DSO ancillary services are so far only in the development (or early implementation) stage in most European countries, or non-existent at all. This is a stark difference to the TSO ancillary services market, which is effectively in a mature state and in the process of pan-European harmonisation. DSO markets are also locally oriented and therefore require more often bespoke solutions adapted to local conditions. As a result, the incentives for harmonisation of applied solutions, as well as for wider-scale standardisation are limited. However, in cases where the OneNet use cases are piloting coordination between TSO and DSO for acquisition of ancillary services, the data model and communication protocols are mostly harmonised.

The analysis also shows that communication protocols used are not defined for each interface between the different actors, but rather more generally for the whole use case (or in relation to a specific function). One identified reason for this is that households and other consumers with lower technical capabilities are involved more often than in TSO operated markets.

The analysis indicates that business use cases in the Czech demo use modified CIM XML for the specific information about the availability of the grid traffic light system. The Slovenian demo explicitly stated the need for extension of ESMP to DSO needs, e.g., non-frequency services. Another message was the insufficiency of available standards to cover all data exchanges, as on the national level in Slovenia. This is also in line with the Spanish and French demo experiences. Particularly interesting in that regard is the application of manual up- and downloads of messages. While the Hungarian demo uses standard CIM model for TSO-DSO coordination, a custom data model was applied in the DSO interactions with other actors.

The analysis of EU-Sysflex project use cases gaps supports the findings from those of OneNet project, as it also points out the gaps in CIM standards when applied to the DSO level data exchanges.





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# 5 Recommendations for DSOs to overcome the identified gaps in data exchange practices

This chapter lists the recommendations and indications of future actions for each of the gaps identified in the gap analysis of OneNet use cases and a generalised set of high-level recommendations and learnings for data exchange interfaces between DSO and other actors. Concrete recommendations for external projects were not drafted, as this is not the task of this deliverable (and the one project analysed, EU-Sysflex, has been completed anyway). The recommendations are presented in Table 8 , per each of the analysed demo and interface involving DSO.

*Table 8 Identified gaps in the OneNet demos and indications of possible future actions*

| Demo | Interface | Gaps listed and suggestion of possible actions |
|---|---|---|
| **Cyprus demo** | MO-DSO | Proprietary data model and communication protocols applied. In the next steps (application of the solutions developed in the testing environment to the real-life), utilisation of existing data model standards should be considered |
| | FSP-DSO | Proprietary data model applied; interoperability with other data interfaces should be guaranteed |
| **Spanish demo** | MO-DSO | Proprietary solutions deployed due to path dependency with existing systems. Switching to common standards would probably make sense only as a part of a wider systemic change. |
| | FSP-DSO | Proprietary solutions deployed; interoperability with other data interfaces should be guaranteed. |
| **French demo** | TSO-DSO | IEC 62325 already adopted in the demo, although with proprietary extensions; ESMP standards need to be updated to include more DSO-related use cases |
| | MO-DSO | |
| | FSP-DSO | There is a possibility to automate the manual activation signals |
| **Czech demo** | MO-DSO | Proprietary extension of CIM data model is used in the Czech demo. |
| | FSP-DSO | Proprietary extension of CIM data model is used; interoperability with other data interfaces should be guaranteed |
| **Slovenian demo** | FSP-DSO | IEC 62335 used, but with proprietary extensions. Current ESMP standard needs to be extended for DSO needs. |
| | MO-DSO | |
| | DER-DSO | SMS/mail activation used for small-scale consumers. Automation of the process could be considered in the future |
| **Hungarian demo** | TSO-DSO | CIM standards in use. |
| | MO-DSO | Proprietary data model applied; In the future, adoption of common data models should be considered, if it makes economic sense. |
| | FSP-DSO | Proprietary data model applied; interoperability with other data interfaces should be guaranteed |

In general, there were 4 types of data exchange interfaces involving DSO identified:

- TSO-DSO
- DSO-MO (including operators of market platforms, for the sake of simplicity also technical coordination platforms)
- DSO-FSP (including aggregators)
- DSO-DER (meaning a single unit/active customer)


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There are some high-level lessons learned and recommendations that can be derived. These are also in line with general recommendations for interoperability, developed for example by BRIDGE [31] or SmartEn [32].

For **TSO-DSO coordination**, it is recommended to adopt the CIM based standards.

For **data exchanges between DSO and Market platform operators**, most of the analysed demos have developed proprietary extension of CIM standards or a proprietary data model. The two main identified reasons for applying these solutions are the compatibility with existing systems and the limitations of the existing standards (such as the ESMP) for the use on the DSO level. The recommendation from this finding is to extend the scope of the standards (IEC 62325, 61968, 61850) to be more easily usable for DSO application. Moreover, an important learning is that due to the existence of legacy systems, data exchange interoperability needs to be tackled on a higher level than for a single use case.

For **data exchanges between DSO and Flexibility providers**, especially small-scale actors such as active consumers or even single devices, the scope of available standards is the widest. It is also the view of involved experts that it is harder to find a balance between the implementation cost and interoperability benefits of developing solutions that is in line with sophisticated data models (such as CIM) on the one side, and less costly/easier to apply proprietary solutions on the other side. For that reason, it is not possible to recommend a general adoption of a single standard, as the costs and benefits should be always considered in the specific local conditions.

However, it is important to reiterate that a general level of interoperability in data exchanges between all the involved actors should always be assured. OneNet will develop further recommendations concerning this issue in an “interoperability roadmap”, as a part of Work Package 11 activities.


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# 6 Conclusions

The present report provides conclusions regarding how H2020 projects and OneNet demos address topics such as the technical requirements to enable the utilisation of flexibility services and products and the opportunities for using already existing models and tools for data exchange.

Firstly, it should be noted that on a general level the availability of information about data models and communication protocols used by DSOs is quite limited, which has also impacted the validity of the analysis of H2020 projects. This is a clear gap that complicates the replicability of solutions developed within the projects and acts as a barrier to knowledge dissemination. Research projects should pay attention to clearly explaining and sharing openly the solutions they are using.

The analysis of DSO – market platform interfaces in Horizon Europe projects shows that in most projects, bespoke platforms are developed and implemented. Similarly, the analysed projects have developed a multitude of tools for data exchange, depending on the type of markets or services the projects have been explored. When it comes to the models for data exchange deployed in the projects, most of them are using the IEC standards. CIM is used to structure and encapsulate data in a unified format mainly through XML messages, though they have a proprietary format in many cases. Several OneNet use cases also apply a proprietary information model. The analysis of used communication protocols suggests that a variety of formats is used, including for example MQTT or REST API.

The identified gaps and subsequent recommendations are common across many of the analysed use cases. The analysis indicates that although many of them use the IEC standards for data exchange, the biggest barrier for the adoption is that the standards themselves are not developed enough to cover all the use cases and functions related to DSO operated flexibility markets and DSO flexibility services.

This leads to the situation where proprietary solutions are deployed at the DSO level, either because of non-existing standards or because of specific local needs. It is necessary to acknowledge the existence of these solutions and that the created path dependency means that they will continue to exist in the foreseeable future.

Acknowledging this diversity, the recommendations are differentiated based on the actors involved in the data exchange. While the use of a standardised common data model, such as CIM could be recommended as a solution for interfaces between system operators, less costly and easier to implement proprietary solutions might be a better fit for data exchanges between DSOs and end users or small-scale flexibility providers. However, interoperability of used solutions should be always ensured.

Besides the recommendations on data models, two other lessons were highlighted by the analysis in this deliverable:


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Firstly, there is a clear need to advance the standardisation work on data models to cover DSO-specific use cases. This should be a European-level undertaking which requires the engagement of industry stakeholders, but also policymakers via implementing acts. European rather than national solutions should be the goal.

And secondly, research and innovation projects should make sure the documentation is covering all the necessary details and make it publicly available (for example through the BRIDGE Use Case Repository) to enhance learning and knowledge transfer.


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# Annex A Questionnaire template from Task 4.1 and Task 4.2 for H2020 Projects review

| Projects Reviewer Information | | |
|---|---|---|
| 1 | Name and Surname | |
| 2 | E-mail | |
| 3 | Organisation | |

| Background information | | |
|---|---|---|
| [Project Name] – [Demo Name (optional)] | Starting date | |
| | Ending date | |
| What is the objective of the project under review? [provide a brief explanation of the main objectives of this project] | | |
| | | |
| Has the project been completed? | [Y/N] | |

| Interfaces | | | |
|---|---|---|---|
| Interface, software, that links operators (market, system, and others) on data exchange for FSP integration. | | | |
| Were any specific interfaces between markets and grid operators developed within the project? | [Y/N] | | |
| If yes, for what are these interfaces? Can you define them in terms of information models, timing requirements and interaction sequences?<br>[Provide a short description of the interface and reference to the relevant documentation, add lines as necessary] | | | |
| Developed interfaces | Description | Actors and Roles (DSO, TSO, MO) | References |
| #1 | | | |

| Tools | |
|---|---|
| Were tools (like forecasting, data exchange, bid selection/optimization, pre-qualification, settlement, flexibility registers, state estimation, coordination, baseline calculation tools, etc.) developed in relation with the above-mentioned interfaces? | [Y/N] |
| If yes, what are these tools? [Please provide a short description of the tool functionality and related references, add lines as necessary] | |





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| Developed tool | Description | References |
|---|---|---|
| #1 | | |

| Standards and data model | | |
|---|---|---|
| Were any specific standards and data models developed within the project? | | [Y/N] |
| If yes, what are these standards and data models? [Please provide a short description about the related application and links to relevant references | | |
| Standard or data model | Application description | References |
| #1 | | |

| Glossary and definitions | |
|---|---|
| Have you created a list of definitions of terms (glossary)? | [Y/N] |
| If yes, please provide references for them *[add or delete rows as needed]* | |
| References | |
| #1 | |

| Role models | | |
|---|---|---|
| Have you created a list of definitions of roles? | [Y/N] | |
| If yes, do you apply specific role models and which ones? | | |
| Role model | | |
| #1 | | |
| If yes, list the definitions and provide references *[add rows as needed]* | | |
| Role definition | Reference | |
| #1 | | |
| If new roles for the model have been proposed, please list and shortly describe them | | |
| New role model | Description | References |
| #1 | | |

| System Use Cases | | | | |
|---|---|---|---|---|
| Have SUCs been defined for the reviewed project? | | | [Y/N] | |
| If yes, provide the name, a very short description, the BUC related with SUC and link to the references. | | | | |
| Name | Description/objective | Associated BUCs | Roles/actors | References |



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| #1 | | | | |
|---|---|---|---|---|

| Sequence/flow or any other process diagrams | | | |
|---|---|---|---|
| Have sequence/process diagrams been defined for the reviewed project? | | [Y/N] | |
| If yes, provide the name and link to the references. | | | |
| Name | Associated BUCs | Roles/actors | References |
| #1 | | | |



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# Annex B List of the 14 H2020 projects analysed in Task 4.2

| Project Name | Status | Main Goal |
|---|---|---|
| CoordiNet (Jan 2019 -Jun 2022) | Completed | The purpose of CoordiNet is to establish different collaboration schemes between transmission system operators (TSOs), distribution system operators (DSOs) and customers to contribute to the development of a smart, secure and more resilient energy system. Special emphasis will be on the analysis and definition of flexibility in the grid at every voltage level ranging from the TSO and DSO domain to customer participation. |
| Crossbow (Nov 2017 – Oct 2021) | Completed | CROSSBOW will propose the shared use of resources to foster cross-border management of variable renewable energies and storage units, enabling higher penetration of clean energies whilst reducing network operational costs and improving the economic benefits of RES and storage units.<br>The objective is to demonstrate several different, though complementary, technologies, offering Transmission System Operators higher flexibility and robustness through:<br>1) A better control of exchange power at interconnection points;<br>2) new storage solutions – distributed and centralized-, offering ancillary services to operate Virtual Storage Plants (VSP);<br>3) better ICT and Communications -e.g., better network observability, enabling flexible generation and Demand Response schemas;<br>4) the definition of a transnational wholesale market, proposing fair and sustainable remuneration for clean energies through the definition of new business models supporting the participation of new players –i.e., aggregators - and the reduction of costs. |
| EUniversal (Feb 2020 – Nov 2023) | On-Going | The EUniversal project, funded by the European Union, aims to develop a universal approach on the use of flexibility by Distribution System Operators (DSO) and their interaction with the new flexibility markets, enabled through the development of the concept of the Universal Market Enabling Interface (UMEI) – a unique approach to foster interoperability across Europe.<br>The UMEI represents an innovative, agnostic, adaptable, modular and evolutionary approach that will be the basis for the development of new innovative services, market solutions and, above all, implementing the real mechanisms for active customer, prosumer, and energy communities' participation in the energy transition. |
| EU-SysFlex (Nov 2017 – Oct 2021) | Completed | EU-SysFlex aims to come up with new types of services that will meet the needs of the system with more than 50% of renewable energy sources. It will find the right blend of flexibility and system services to support secure and resilient transmission system operation. |
| FARCROSS (Oct 2019 – Oct 2023) | On-Going | FARCROSS aims to connect major stakeholders of the energy value chain and demonstrate integrated hardware and software solutions that will facilitate the “unlocking” of the resources for the cross-border electricity flows and regional cooperation and will enhance the exploitation/capacity efficiency of the transmission grid assets. |
| FLEXITRANSTORE | Completed | FLEXITRANSTORE (An Integrated Platform for Increased FLEXIbility in smart TRANSmission grids with STORage Entities and large penetration of Renewable Energy Sources) aims to contribute to the evolution towards a |


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| | | |
|---|---|---|
| (Nov 2017 - Oct 2021) | | pan-European transmission network with high flexibility and high interconnection levels. This will facilitate the transformation of the current energy production mix by hosting an increasing share of renewable energy sources. Novel smart grid technologies, control and storage methods and new market approaches will be developed, installed, demonstrated and tested introducing flexibility to the European power system. |
| InteGRIDy<br>(Jan 2017 – Oct 2020) | Completed | The main objectives of the project are:<br>1. To demonstrate how DSOs may enable the different stakeholders to participate in the energy market activity and to develop and implement new business models, making use of new data management and customer involvement approaches.<br>2. To demonstrate scalable and replicable solutions in an integrated environment that enable DSOs to plan and operate the network with a high share of DER in a stable, secure and economic way, using flexibility inherently offered by specific technologies and by interaction with different stakeholders. |
| InterConnect<br>(Oct 2019 – Feb 2024) | On-Going | InterConnect aims to contribute to the democratization of efficient energy management, through a flexible and interoperable ecosystem where demand-side flexibility can be soundly integrated with effective benefits to end-users.<br>Over the last few years several projects and technology providers have come up with solutions that allow every energy user to have awareness and control over his appliances, but there has always been a major issue with interoperability. End-users should be able to choose and change their technology providers, without having to replace their installation, every time they feel this need and still be able to adopt sustainable behaviour and benefit from technological advances. |
| Interflex<br>(Jan 2017 – Dec 2019) | Completed | InterFlex investigates the INTERactions between FLEXibilities provided by energy market players and the distribution grid, with a particular focus on energy storage, smart charging of electric vehicles, demand response, islanding, grid automation and the integration of different energy carriers (gas, heat, electricity).<br>Furthermore, aspects related to the interoperability of systems, replicability of solutions and the identification of relevant business models constitute major objectives. |
| INTERRFACE | Completed | The key principle of INTERRFACE is to "remove barriers" to unleash the potential of the existing and future resources to be an active part in the power system for the benefit of the customers and grid operators. It will demonstrate new concepts by deploying pan-EU markets that provide services for congestion management and flexibility, by using microgrids and peer-to-peer transactions to engage customers, and by creating a platform for further research. |
| Osmose | On-Going | The OSMOSE project aims to identify and develop the optimal mix of flexibilities for the European power system to enable the Energy Transition.<br>Four large-scale demonstrators led by Transmission System Operators explore the technical and economic feasibility of innovative flexibility services and providers, including grid forming, multi-services by hybrid storage, near real-time cross border exchanges, and smart zonal energy management system. |



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| | | |
|---|---|---|
| PlatOne | Completed | PlatOne - "PLATform for Operation of distribution Networks –aims to develop an architecture for testing and implementing a data acquisitions system based on a two-layer approach (an access layer for customers and a service layer) that will allow greater stakeholder involvement and will enable efficient and smart network management. The tools used for this purpose will be based on platforms able to receive data from different sources, such as weather forecasting systems or distributed smart devices spread all over the urban area. These platforms, by talking to each other and exchanging data, will allow collecting and elaborating information useful for DSOs, transmission system operators (TSOs), customers and aggregators. In particular, the DSO will invest in a standard, open, non-discriminating, economic dispute settlement blockchain-based infrastructure, to give both the customers and the aggregator the possibility to become flexibility market players more easily. This solution will see the DSO<br>evolve into a new form: a market enabler for end users and a smarter observer of the distribution<br>network. By defining this innovative two-layer architecture, Platone removes technical barriers to the achievement of a carbon-free society by 2050, creating the ecosystem for new market mechanisms for a rapid roll out among DSOs and for a large involvement of customers in the active management of grids and in the flexibility markets. |
| Synergy<br>(Jan 2020 – Jun 2023) | Completed | SYNERGY introduces a novel reference big data architecture and platform that leverages data, primary or secondarily related to the electricity domain, coming from diverse sources (APIs, historical data, statistics, sensors/ IoT, weather, energy markets and various other open data sources) to help electricity stakeholders to simultaneously enhance their data reach, improve their internal intelligence on electricity-related optimization functions while getting involved in novel data (intelligence) sharing/trading models, to shift individual decision-making at a collective intelligence level.<br>To this end, SYNERGY will develop a highly effective Big Energy Data Platform and AI Analytics Marketplace, accompanied by big data-enabled applications for the totality of electricity value chain stakeholders (altogether integrated into the SYNERGY Big Data-driven EaaS Framework). |
| TDX-Assist<br>(Oct 2017 – Sep 2020) | Completed | The objective is to design and develop novel ICT tools and techniques that facilitate scalable and secure information systems and data exchange between TSOs and DSOs. The three main novel aspects of the ICT tools and techniques to be developed in the proposed project are as follows: scalability – the tools and techniques will be able to deal with new users and increasingly larger volumes of information and data; security – the tools and techniques will ensure that overall system operation is protected against external threats and attacks; and interoperability – the information exchange and communications between the system operators will be based on existing and emerging international smart grid ICT standards |


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