JOINT PAPER

RECOMMENDATIONS TOWARDS HARMONISED EUROPEAN FLEXIBILITIES MARKETS

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1. Introduction

Among the objectives of innovation projects supported by H2020 under the same or related calls is the enablement of smooth communication and exchange between projects as well as to support this exchange ad hoc through knowledge sharing channels and coordination activities of the EC (e.g. Bridge initiative).

In this regard, the INTERRFACE and CoordiNet projects respond to the same call were also kicked off simultaneously. The two projects have the following objectives:

1. Demonstrating cost-efficient model(s) for electricity network services that (i) can be scaled up to include networks operated by other TSOs and DSOs, (ii) that will be replicable across the EU energy system, and (iii) provide the foundations for new network codes, particularly on demand-response. And as a consequence;
2. Contribute to opening up significant new revenue streams for consumers to provide grid services, and
3. Increase the share of RES in the electricity system.

Due to the importance of the issue they respond to, the two projects have since their beginning in 2019 committed to continuous collaboration. The aim is to ensure the exchange between the two projects throughout their work and not only at the very end. The result of the collaboration was to be a joint position paper at the end of the two projects. The CoordiNet project concluded in June 2022 while the INTERRFACE project lasts until December 2022. The present paper includes specific recommendations based on the learnings from both CoordiNet and INTERRFACE which may serve as a direct input for policy makers.

1.1 SCOPE OF THE DOCUMENT

The aim of the paper is to ensure the development of complementarities and avoid potential inefficient overlaps in the conduct of the two projects. This report represents the third and final step of the task, which is to provide the common position paper.

The present paper builds on the previous versions, which respectively covered an agreement on a common position paper and an agreement on the content on a common position paper. The second and third chapters of this document include an introduction of the two projects and their approach. This work went beyond a sole agreement on content, and already started a discussion based on the preparatory work done for the demonstrations regarding flexibility products and services as well as coordination schemes. As previously stated, this paper presents the final recommendations. This exercise builds on lessons learnt from the respective demonstrations of the two projects, provided in the sixth chapter. The structure of this paper follows a list of thematic topics that were selected, including the implementation standardized products for grid services. The final choice of topics for the position paper was agreed upon in a joint discussion between the two projects and covers areas of work included in the scope of both, as described in detail in section 1.1.2. The eventual conclusions drawn from the inter-project discussion are presented in chapter 7. Conclusions on other topics may be found, in the case of CoordiNet, in CoordiNet Deliverable 6.7, while INTERRFACE will continue to operate for another 6 months after the submission of this paper.

1.1.1 NOTATIONS, ABREVIATIONS AND ACRONYMS

- aFRR	- Frequency Restoration Reserves automatic activation
- ASM	- Active System Management
- BRP	- Balance Responsible Party
- BSP	- Balancing Service Provider
- BUC	- Business Use Case
- CF	- Congestion Forecast
- CM	- Congestion Management
- DA	- Day-ahead
- DER	- Distributed Energy Resource
- DSO	- Distribution System Operator
- DR	- Demand Response
- EC	- European Commission
- E.DSO	- European Distribution System Operators for Smart Grids (non-profit association)
- ENTSO-E	- European Network of Transmission System Operators for Electricity (non-profit association)
- EU	- European Union
- FCR	- Frequency Containment Reserves
- FFR	- Fast Frequency Response
- FRR	- Frequency Restoration Reserves
- FR	- Flexibility Register
- FSP	- Flexibility Service Provider

- HEMRM	- Harmonised Electricity Market Role Model
- IEGSA	- Interoperable pan-European Grid Services Architecture
- ID	- Intraday
- ISR	- Imbalance Settlement Responsible
- KPI	- Key Performance Indicator
- LV	- Low Voltage
- LFC	- Load-Frequency Control
- MADES	- MArket Data Exchange Standard
- mFRR	- Frequency Restoration Reserves manual activation
- MDR	- Metered Data Responsible
- MO	- Market Operator

1.1.2 APPROACH AND METHODOLOGY

The final agreement on the recommendations provided in this paper was reached through an approach with three major steps. First, preliminary work from CoordiNet and INTERRFACE under the lead of E.DSO. Second, regular meetings between CoordiNet and INTERRFACE to advance with the unification of separately developed recommendations. Third, the finalization of a joint document. The next paragraphs will explain how the decision-making process for the recommendations occurred. All steps were encompassed by bi-weekly meetings of representatives of the two projects to set the structure and content of the report, decide on a coherent format for respective inputs for discussion and eventually agree on a common position on each of the selected topics. The outcomes of each meeting were consolidated on paper by E.DSO and submitted for feedback to the partners of both projects in preparation to the following discussion sessions. The formal approval of the content of this document was granted by the partners and project coordinators of both INTERRFACE and CoordiNet.

Following the joint analysis considering the ASM report, both projects agreed on a set of topics to gather policy recommendations. The six topics or themes were *Roles and responsibilities*, *Requirements for information sharing*, *Requirements of prequalification process*, *Requirements of settlement processes*, *Geographical scope and network representation*, and *Customer engagement*. Recommendations on *Scalability and replicability*, were added at a later stage as one of the main topics to highlight a future-looking section. This broad allocation allowed project representatives to work on their set of proposals for policymakers. The goal of this exercise was to enable both partners to develop independent recommendations based on their respective project experiences before combining both views.

This initial drafting and analysis process enabled the project partners to explore common stances in an iterative manner. The allocation of separate recommendations into themes was intended to guide the evaluation period to reach consensus on all matters. Therefore, E.DSO presented both parties' prepared recommendations at the bi-weekly meetings. Using a deliberative approach of open discussions to all interested stakeholders, the recommendations were separated into core proposals and encapsulating descriptions. This approach was chosen by E.DSO to avoid a possible bias that could follow their strong involvement. After every meeting, the agreed changes were drafted into a new document and shared with the parties to be discussed again with additional adjustments. Thereby, a commonly agreed set of policy recommendations was developed.

Eventually, the partners of CoordiNet and INTERRACE finalized the present report by working on a joint document. This ensured that no information gets lost or is changed by any side. Additionally, it allowed all stakeholders to make final changes and provide feedback on a final draft document.

The final policy recommendations described in this paper were formulated and agreed upon through a consultation process initiated during the last semester of the CoordiNet project, guided by bi-weekly meetings led by E.DSO that involved the representatives of both INTERRFACE and CoordiNet. The outcomes of each discussion were consolidated, integrated, and submitted for feedback to the partners of both projects to continuously feed the evolution of the position paper. Seven topics, addressed by the two consortia during the course of the projects to tackle the challenges of TSO-DSO-Consumer coordination, were selected for the recommendations. Namely, Roles and Responsibilities, Requirements for information sharing, Requirements of prequalification process, Requirements of settlement process, Geographical scope and network representation, Consumer engagement, and Scalability and Replicability of the solutions developed by the two projects.

2. Inter – Project Agreement

In this chapter, the inter-project agreement regarding the content of the joint project paper is reiterated as it was formulated after the first year of operation of the two projects. The agreement did not undergo any formal modification after its first publication but constituted the basis for the following stages of the collaboration between the two projects.

2.1 CONTENT OF THE AGREEMENT ON A JOINT PAPER BETWEEN INTERRFACE AND COORDINET

INTERRFACE and CoordiNet have since the very beginning of their work been committed to collaborating with one another. The projects provided a formal agreement to produce a common position paper with specific recommendations for TSO - DSO coordination. The projects have agreed to base such position paper on the Active System Management (ASM) report (CEDEC et. al. 2019) which already informs the frameworks and proposals put forward in the deliverables drafted under both projects.

In particular, the points to be discussed within the inter-project paper were identified to include:

- A shared view on the defined and demonstrated standardized grid services & products, with a special focus on the definition of key parameters for enabling the participation of distributed flexibility assets.
- Convergence and divergence of the models for market coordination analyzed in the ASM report (ibid.) and additional proposed alternatives from the projects.
- Advantages and disadvantages of the abovementioned services & products and coordination models, highlighting market or local/demo conditions that favour their adoption. Particular attention was to be given by both projects to the following:
  - Scalability and replicability at the EU level of the following elements: methodologies for grid operators and third parties to safely connect, manage and coordinate flexibility providers.
  - Recommendations for requirements and specifications of the platforms developed for the implementation of coordination schemes.
  - Recommendations for EU regulation and standards concerning the roles and processes of the various market and system actors.

It was furthermore agreed between the two projects, that for information purposes, the CoordiNet project should make the terminology developed within their internal deliverable available to the INTERRFACE project.

3. Project comparison

While responding to the same call, the two projects assume different approaches to the topic. In the following, the methodologies and approaches of the two projects will be briefly described. The content of this chapter is re-adapted from the previous version of this paper to set the context for the outcomes of the INTERRFACE – CoordiNet collaboration.

3.1 COORDINET

The purpose of CoordiNet is to establish different collaboration schemes between TSOs and DSOs and consumers to contribute to the development of a smart, secure, and more resilient energy system. The project puts emphasis on the analysis and definition of flexibility in the grid at every voltage level ranging from the TSO domain to the DSO domain and to consumer participation. The aim is to demonstrate how DSOs and TSOs by acting in a coordinated manner can provide favorable cooperation conditions for all market players and remove barriers to participation of consumers and smaller market players.

CoordiNet evaluated a series of products for grid services at EU level to understand to what extent product standardization will be feasible. The project will define and detail mechanisms for the provision of the needed grid services at distribution and transmission level, including the reservation, activation, and settlement process.

Figure 1 CoordiNet

3.1.1 PILOTS

The proposed CoordiNet mechanisms were tested at three large-scale demonstration projects across 10 different locations in Spain, Sweden, and Greece. They applied different coordination schemes and tested a selection of products for grid services defined within the project. Lessons learnt from these large field demonstration projects were used to design the structure of a joined pan-European TSO-DSO coordination platform.

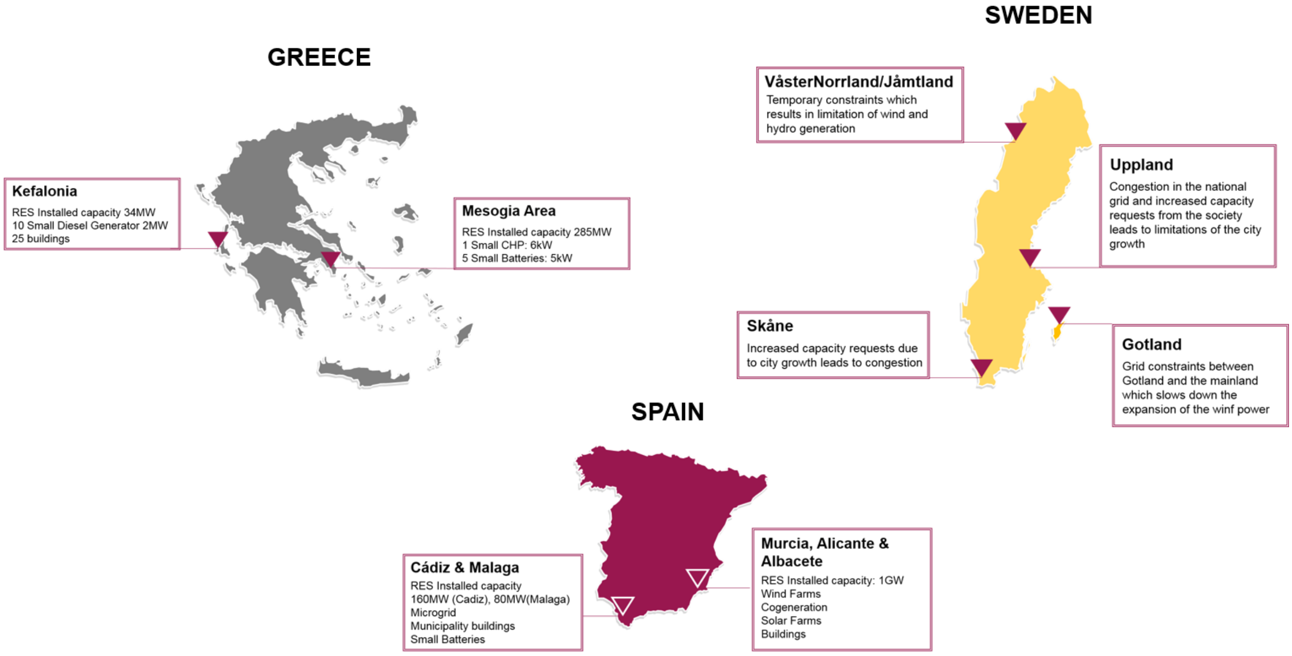

Figure 2: Coordinet demo areas

3.2 INTERRFACE

The purpose of the INTERRFACE project is to develop an interface between TSOs, DSOs, market participants and their customers. INTERRFACE will demonstrate the added value of sharing data among all participants in the electricity system value chain (customers, grids, market), from local, regional to EU level. It will also enable TSOs, DSOs and customers to coordinate their efforts to maximise the potential of distributed energy resources, demand aggregators and grid assets, to procure energy services in a cost-efficient way and create consumer benefits. It will therefore facilitate renewable energy integration and demonstrate global leadership by the EU electricity sector in a way that is cost effective and secure. It will also simulate an integrated wholesale and retail market at local and global levels, engaging consumers/prosumers so as to exploit the Distributed Energy Resources (DERs) capacity and channel it into the common EU electricity market.

The INTERRFACE project targets five main objectives:

1. To create a common architecture that connects market platforms to establish a seamless pan-European electricity exchange linking wholesale and retail markets and allows all electricity market players to trade and procure energy services in a transparent, non-discriminatory way.
2. To define and demonstrate standardized products, key parameters, and the activation and settlement process for energy services.

3. To drive collaboration in the procurement of grid services by TSOs and DSOs, and to create strong incentives to connected customers, by improving market signals and allowing them to procure services based on specific locations and grid conditions.
4. To integrate small scale and large-scale assets to increase market liquidity for grid services and facilitate scaling up of new services which are compatible across Europe.
5. To promote state-of-the-art digital technologies that consumers are familiar with in other everyday transactions (i.e., e-auctions, e-commerce, e-banking, social networks), into the electricity value chain, in order to engage end-users into next generation electricity market transactions, creating incomparable economic benefits by deferring conventional energy infrastructure investments.

Figure 3 INTERRFACE

The INTERRFACE project will design, develop, and exploit an Interoperable pan-European Grid Services Architecture (IEGSA) to act as the interface between the power system (TSO and DSO) and the customers and allow the seamless and coordinated operation of all stakeholders to use and procure common services. State-of-the-art digital tools based on blockchains and big data management will provide new opportunities for electricity market participation and thus engage consumers into the INTERRFACE proposed market structures that will be designed to exploit DER.

3.2.1 PILOTS

In order to achieve set goals, three demo areas (and seven demonstrators) will be designed focusing on the following issues:

- **Demo area 1:** Congestion management and balancing issues, locally by involving DSOs, Demand Response mechanisms, storage, and small-scale RES, at system level by integrating TSO/DSO and community and by activating local and cross-border resources to provide flexibility services for system balancing. The expected outcome of this area is to identify the efficiency of using dynamic pricing, to materialise the need of a toolset that offers the optimal call of flexibility sources to solve congestions and balancing and optimise the use of interconnectors between the actors of the energy power system.

- **Demo area 2:** The use of peer-to-peer transactions for activating flexibility based on free pricing. Within this area relevant use cases will be developed and tested for congestion management and balancing, to assess the role of peer-to-peer transactions in future electricity market design and estimate the cost-efficiency they can bring.
- **Demo area 3:** The necessity of an integrated retail and wholesale market which will be based on the existing Pan-EU wholesale market and will consider the DER/prosumers/storage/other assets to couple it with the retail market, with the objective of increasing the cost efficiency and aiming at creating consumers benefits.

Analysis of the approaches

While the two projects respond to the same H2020 call, they take different approaches, not least in their pilots where the large-scale demonstrations are tested. The INTERRFACE project assumed mainly a top-down approach focusing on services which are relevant to all demos (not neglecting the bottom-up requirements stemming from the demonstrators' needs), whereas the CoordiNet project assumed a bottom-up approach leaving the demo needs to define the projects service focus. Despite these differences, the knowledge-sharing process carried out during the course of the two projects highlighted how the two worked to tackle a number of common issues, synthesised in the topics chosen for this position paper. This deliverable thereby presents the common position of the two projects formulated from their findings and collaboration.

4. Services and Products

Both projects aimed to define a list of standardised products and services for flexibility management. In this chapter the products and services proposed by each project will be described and their common focuses will be highlighted. Their pros and cons as well as key parameters for enabling the participation of distributed flexibility assets will be discussed. Considering that the focus of the ASM report is on balancing and congestion management (CEDEC et al., 2019), products and services related to this will be the main focus of this chapter. The content of this chapter is re-adapted from the previous version of this deliverable, here posing special attention to the commonalities between the two projects, as highlighted in its last section.

4.1 PRODUCTS AND SERVICES IN COORDINET

4.1.1 OVERVIEW

In the CoordiNet project, grid services are understood as "services provided to distribution system operators and transmission system operators to keep the operation of the grid within the acceptable limits for security of supply and are delivered mainly by third parties" according to the ASM report. While Standard products are "harmonized products for the exchange of grid services with common characteristics across Europe (i.e., shared by all TSOs and by all DSOs or by all TSOs and DSOs)"[1].

In relation to the grid services identified by CoordiNet, one or more products have been identified for each as can be understood from the Figure 4 below. From those identified services, the tests of the CoordiNet demontrations have focused on balancing, congestion management, voltage control, and controlled islanding. These services are described in detail in the following sections.

[1] European Commission, 2017a. Commission regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (No. L312/6).

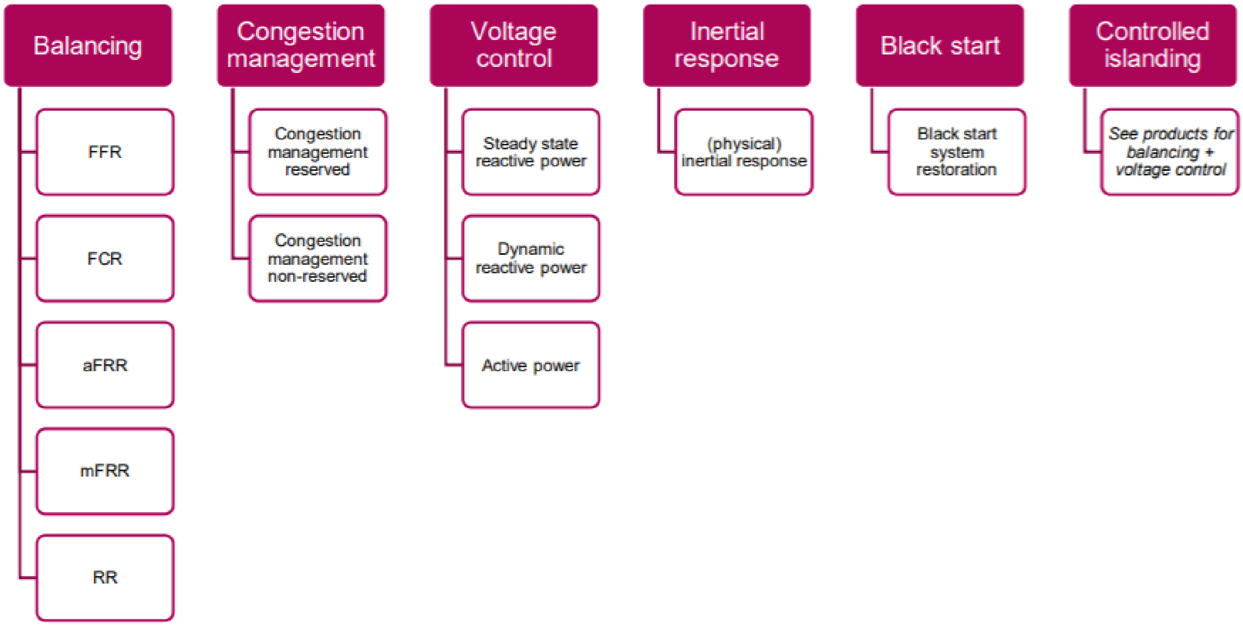

Figure 4: Products and services regarded by CoordiNet

4.1.2 BALANCING SERVICES

For the balancing service, the CoordiNet project adapted the definition provided by the EU guideline on electricity balancing. This mention that balancing is "*all actions and processes, on all timelines, through which TSOs ensure, in a continuous way, the maintenance of system frequency within a predefined stability range, and compliance with the amount of reserves needed with respect to the required quality*"[2]. The Coordinet project investigated the following products that can be used for balancing services:

- **Fast Frequency Response (FFR)** - FFR consist of a rapid injection of power or reduction of demand in a timeframe of a few seconds (before governor-driven primary frequency response units can respond) following a contingency that helps arrest the rate of change of frequency and correct supply-demand imbalances[3].

[2] European Commission, 2017a.
[3] CoordiNet 2019, D1.3, https://coordinet.netlify.app/publications/deliverables

- **Frequency containment reserves (FCR)** – *"FCR means the active power reserves available to contain system frequency after the occurrence of an imbalance"*[4] FCR is a fast-acting capacity which can increase/decrease power output in a very short time period. It is therefore important for short-term balance of power production and consumption. Its goal is to stabilize the frequency within a couple of seconds[5].
- **Frequency restoration reserves (FRR)-** *"FRR means the active power reserves available to restore system frequency to the nominal frequency and, for a synchronous area consisting of more than one LFC area, to restore power balance to the scheduled value"*. FRR can be manual or with active activation: **Frequency restoration reserves with manual activation (mFRR)** and **Frequency restoration reserves with automatic activation (aFRR)**.
- **Replacement reserves (RRs)** - *"RR means the active power reserves available to restore or support the required level of FRR to be prepared for additional system imbalances, including generation reserves"*[6]. RR are needed to restore system balance when FRR was not able to do so (it is therefore only necessary in case of large imbalances). In addition, it allows FRR units to prepare again for a potential next short-term imbalance intervention and to free up their resources[7].

[4] European Commission, 2017b. Commission regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation.
[5] CoordiNet 2019, D1.3
[6] European Commission, 2017b
[7] CoordiNet 2019, D1.3

4.1.3 CONGESTION MANAGEMENT SERVICES

In the Coordinet project congestion is defined as a condition where one or more constraints (thermal limits, voltage limits, stability limits) restrict the physical power flow through the network. The service of congestion management refers to the process of mitigating grid congestion issues by avoiding the crossover of network capacity[8]. Congestion management services are in the project divided into the two following products:

- **Congestion management reserved** - a capacity-based product procured for congestion management services at a certain availability price which is then activated when the service is needed and called upon by the relevant system operator. This product is defined to cope with structural constraint.[9]
- **Congestion management non-reserved** – an energy-based product procured for congestion management services at an energy price (most likely to be procured closer to delivery given the fact that it is energy based). In contrast to the reserved products, this product copes with sporadic constraints of less predictable character[10].

4.1.4 VOLTAGE CONTROL

According to CoordiNet, voltage control is used to facilitate the transfer of reactive power in an economic, efficient, and safe manner across the power system. Voltage is a localized property of the power system and, as such, it is essential that it does not exceed a certain level locally to maintain the health of grid assets. Voltage fluctuations, however, are inevitable as they are produced by changes in the network, e.g., active power injections and offtakes, reactive energy flows, and topological changes. This also means that their presence has a “local” character and that voltage requirements vary across the power system[11]. CoordiNet distinguished the following three different products that can be used for controlling voltage:

- **Steady state reactive power** - aims at providing means to control voltage under normal operation of the system. The product keeps the voltage profile within the safe range. Its provision takes place by injecting or absorbing reactive power according to a voltage set point (measured at the injection point) set by the system operator. Only units that can be controlled for the provision of reactive power in function of grid voltage will be able to participate[12]. Reactive energy is mostly efficient at the HV and MV grid level due to their low R/X ratios.

8 Ibid.
9 Ibid.
10 Ibid.
11 Ibid.
12 Ibid

- **Dynamic reactive power** - aims at providing means to control voltage under system disturbance. The dynamic reactive power product consists of a punctual regulation of reactive power injection or absorption requested by the system operator. Participation is open to all technologies capable of following the request within specified time scales. In this regard, non-synchronous generators, static compensators, and static "VAR compensators" among others can participate provided they are controlled carefully to support voltage recovery.[13]
- **Active power** - the portion of electricity that supplies energy to the load[14] This is mostly used in the LV grid level.

4.1.5 CONTROLLED ISLANDING SERVICES

Controlled islanding is often considered the final stage of power system defence plans. The difference between controlled islanding and traditional remedial action schemes is that the former does not monitor the state of specific transmission lines and generating facilities but looks at the system topology and the loads and generation in areas of the power system. Based on optimization procedures which take into account the known topology and the actual state of the grids, the size of the island and the isolation points are selected. The basis for islanding is not standard but rather depends upon the nature of the grid under consideration [15].

It should be noted that the products that can be used for controlled islanding services are the same as products for balancing and voltage control.

The different products and services tested in the regional CoordiNet demos were the following:

- **Greece:** Congestion management, voltage control
- **Spain:** Balancing, congestion management, controlled islanding, voltage control
- **Sweden:** Congestion management, balancing

An overview of the services tested in the CoordiNet BUCs is provided in Figure 5.

13 Ibid
14 OpenEI, 2017. ISGAN Smart Grid Glossary, https://openei.org/wiki/ISGAN_Smart_Grid_Glossary
15 CoordiNet 2019, D1.3

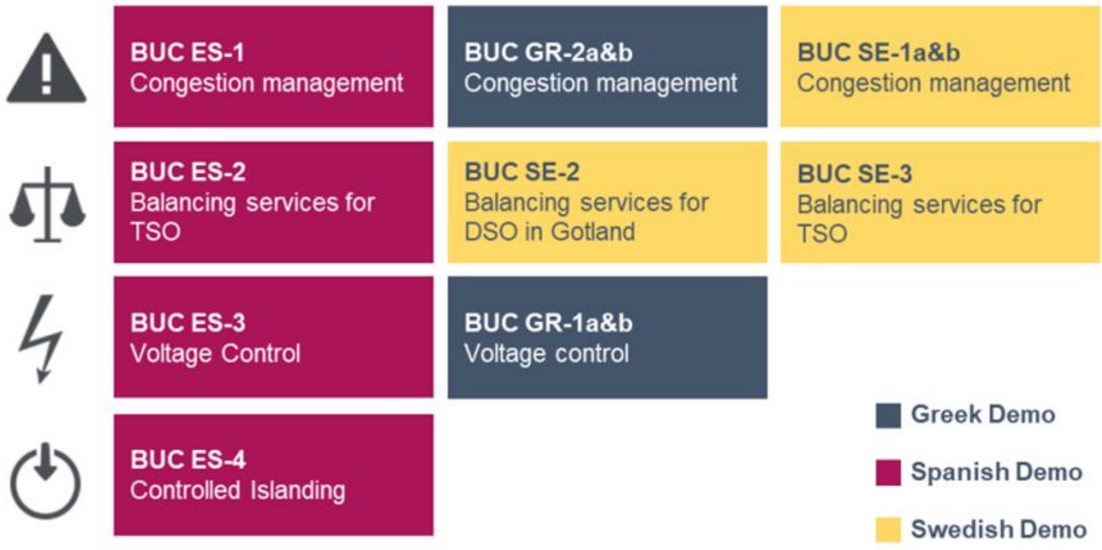

Figure 5: Products and Services tested by CoordiNet demos

4.2 PRODUCTS AND SERVICES IN INTERRFACE

4.2.1 OVERVIEW

The INTERRFACE project identified the same services and products listed in section 4.1.2 and they have been categorized according to the following classification:

- **Balancing services**

  Balancing services are part of the responsibility of TSO. As stated in the "COMMISSION REGULATION (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing", balancing consists of taking actions and processes, on all timelines, through which TSOs ensure, in a continuous way, the maintenance of system frequency within a predefined stability range.

- **Congestion management**

  Congestion management is activating a remedial action to respect operational security limits. In this context congestion is defined as "any network situation, where forecasted or realised power flows violate the thermal limits of the elements of the grid and voltage stability or the angle stability limits of the power system".

- **Non-frequency ancillary services**

  According to the Directive of the European Parliament and the Council on the internal market for electricity on common rules for the internal market in electricity, non-frequency ancillary service means a service used by TSO and DSO for steady-state voltage control, fast reactive current injections, inertia for local grid stability, short-circuit current, black start capability and island operation capability .

- **Adequacy**

  It collects the products aimed at providing the essential grid services in case of emergency (e.g. when the market is not able to coved demand).

The analysis of these services[16] has identified the importance of TSO-DSO coordination for the management of the products, even when the service is not used by both the system operators. It is also important to highlight that some products (such as reactive power) can provide different services depending on the voltage level: for instance, TSO typically activates reactive power products for non-frequency ancillary services, while DSO uses reactive power for local congestion management.

The focus of INTERRFACE is related to the practical experience of seven demonstration projects which are currently testing balancing and congestion management services in order to investigate the potential of flexible distribution resources to be promoted to market products for one or both the involved system operators.

4.1.3 CONGESTION MANAGEMENT SERVICES

INTERRFACE project joins the experience of seven demonstrators which cover an area of nine different European countries. In many of them, congestion management is not currently regulated in terms of market service (except for contertrading) and it represents the main novelty of the demonstration activity. The related reserve can be exploited for congestions at any voltage level, and it normally requires TSO-DSO interactions in order to coordinate its usage and its interference with other services (e.g. active power redispatch for congestion management might have an impact on system balancing when it is performed in the real time).

INTERRFACE hypothesized three sub-categories of congestion management services, which have been classified on the basis of their time occurrence which can be related to existing energy markets and TSO planning processes (Figure 6). Each demo area selected one (or more) congestion management category, by taking into account the foreseen necessities in terms of accuracy in predicting congestions, availability of power reserve, interactions with wholesale energy markets, etc.

[16] INTERRFACE 2020, D3.1 http://interrface.eu/sites/default/files/publications/INTERRFACE_D3.1_V1.0.pdf

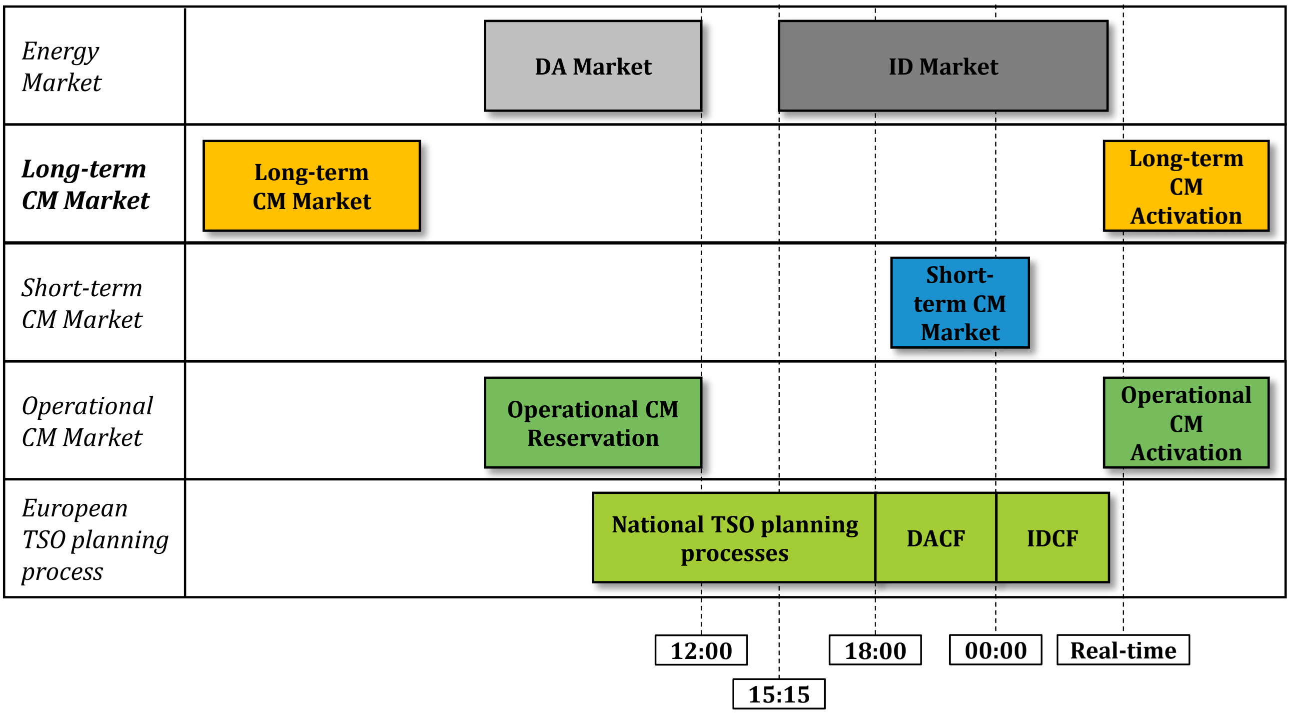

Figure 6: Timeline of energy and ancillary services markets. Day-Ahead (DA), Intra-Day (ID) occurrences with respect to Congestion Management (CM) markets and Congestion Forecast (CF)

- ## Long-Term-Planning congestion management

Long-term-planning congestion management consists of a service that may serve network reinforcement deferral, network support during construction and planned maintenance, where location-specific flexibility assets are being activated for shaving or shifting peak demand and production in order to compensate for the lack of grid connections, loads or production units. The considered timeframe is months (or even years) before planned delivery and the related interference with other markets (energy and ancillary services) can be predicted and compensated. Having considered the long timeframe, both the availability (capacity) and related energy are considered for the settlement/remuneration of the service.

- ## Short-Term-Planning congestion management

Short-term planning congestion management considers physical network congestions that can only be predicted accurately within the same timeframe of wholesale energy markets (day-ahead and intraday processes). In fact, the current demonstration activities are investigating the interactions of this service with energy markets, also exploring their full integration. For this reason, energy price based remuneration of the service has been selected within the settlement process.

- ## Operational congestion management

Operational congestion management occurs when congestions cannot be accurately predicted in advance. In this case, the provision of the service results to be more cost effective when the activation of the related products is triggered in real time when the actual necessity is confirmed. Contrarily to short-term congestion management, this denotes the need for an earlier reservation process, aimed at guaranteeing the reliable delivery of the considered service in areas characterized by significant risk of (nonpredictable) congestions. Many demonstrators are currently implementing operational congestion management, which has the potential of being integrated (or interacting) with other realtime markets (i.e., balancing). The existence of a reservation process and the realtime activation leads to a remuneration scheme based on both capacity and activation energy.

Even though the congestion management products are similar, and there are concrete possibilities for developing a management strategy equal for all the demonstrators, their actual implementation depends on country in which they are activated. Being an innovative service, the main differences are driven by the combination of congestion management with existing (and regulated) markets. In fact, according to the description, this service can be integrated mostly with local energy and balancing markets which procedures and timings are country dependent.

4.2.3 BALANCING SERVICES

Contrarily to congestion management, balancing is a currently regulated set of services and reserves and the responsibility of its efficient management is normally in charge of the TSO. Although in many countries, distribution resources can be participating in balancing services already (mostly FRR), some gaps are still experienced and the INTERFFACE demonstration activities propose different solutions.

As it happens for congestion management, balancing is characterized by a sequence of processes which can be significantly affected by extending the perimeter of FRR reserve to the inclusion of resources located in the distribution system:

- **Prequalification**

  Technical capability of distribution resources in providing balancing services, as well as the potential presence of physical bottlenecks between distribution and transmission systems need to be considered.

- **Reservation, Procurement and Activation of reserve**

  TSO-DSO interactions are foreseen in order to allow the monitoring and management of resources located at distribution level for the exploitation of balancing services. Coordination is also needed for the collection and aggregation of local flexibility bids.

- **Settlement**

  Automatic and transparent settlement procedures need to be developed, especially in countries where distribution reserves are regulated already but settlement is performed manually.

In addition to these points, some demonstrators are also investigating the full/partial integration of balancing services with operational congestion management (which used products very similar to FRR). However, no significant variations with respect to the current, regulated and country-specific balancing management strategy are proposed, except for what concerns TSO-DSO coordination. In fact, some of the most investigated aspects are related to:

- The participation of distribution resources to balancing services, which flexibility might be limited by distribution grid bottlenecks.

- The reservation (or direct activation) of local resources for distribution congestion management, and its impact on the balancing reserve.

4.3 SUMMARY OF COMMON FOCUSES

Summarising the ties in the work done by the two projects, a similar set of services with minor differences have been identified. While both projects identify balancing and congestion management, INTERRFACE includes two other high-level services, adequacy and non-frequency ancillary services, while CoordiNet suggests an additional four: voltage control, controlled islanding, inertial response and blacks start. It should be noted that the latter two services, although defined and described in the project, were not part of the demonstration campaigns. Yet, all additional four services defined by CoordiNet can be easily classified as part of the non-frequency ancillary services of INTERRFACE.

Similarities between the two projects are as well noted in the specifications of the products related to the services. When it comes to balancing, both depart from the guidelines provided by the European Commission (European Commission 2017a). On top of these, INTERRFACE offers a specific view regarding the participation of resources connected at distribution level with concern for physical bottlenecks between distribution and transmission. Other shared concerns presented, such as coordination and transparent settlement, relate rather to market design and coordination and depend less on the product specification.

In the case of congestion management, which does not yet enjoy its own EU guidelines, different approaches can be seen. The INTERRFACE project identifies three sub-categories of congestion management, long-term planning, short-term planning and operational congestion management, further divided according to the timeframes of the market. In CoordiNet, two different products are offered depending on whether the constraints they aim to solve are sporadic or structural. Despite these different classification choices, CoordiNet's service concerning structural congestion management can be compared to the short- and long-term planning of INTERRFACE, while the sporadic one resembles INTERRFACE's operational congestion management. It has to be noted that, regarding timeframes, INTERRFACE distinguishes products also based on the market in which they are offered, whereas CoordiNet does not.

Finally, products with and without reservation seem to be considered necessary by both projects, in order to guarantee product availability. It should be noted that CoordiNet suggests using the same services for controlled islanding as for congestion management, and that the complementarity of the INTERRFACE specification may also be valid here.

5. Coordination Schemes

This chapter aims to describe the coordination schemes applied in the two projects and compare them to those identified in the Active System Management (ASM) report (CEDEC et. al. 2019), as described next. There is a general consensus that one single coordination scheme will never fit all across the diverse TSO-DSO landscape in Europe. The very same fact has led to the development of a multitude of related, however different, coordination schemes corresponding to specific local situations. The content of this chapter is re-adapted from the previous version of this paper, here posing special attention to the commonalities between the two projects, as highlighted in its last section. This overview aims at setting the context for the final outcomes of the INTERRFACE-CoordiNet collaboration, represented by the common recommendations in Chapter 6.

5.1 AN INTEGRATED APPROACH TO ACTIVE SYSTEM MANAGEMENT (ASM)

The purpose of the ASM report has been to formulate a general baseline, harmonising and simplifying the various schemes. The report has been developed by the four associations representing the DSOs at EU level; CEDEC, Eurelectric, GEODE and E.DSO, who is active in the CoordiNet project, together with the body representing the TSOs, ENTSO-E, active in the INTERRFACE project.

The ASM report focusses on TSO-DSO coordination with respect to congestion management and balancing. It recognises that active system management can be used for other purposes but limits its scope to these two services given their importance for ensuring the security of supply. The ASM report supposes three main market models, depending on the management of the merit order list of flexibility bids.

To determine which of the three options should be applied, a few simple questions can guide the classification as illustrated in the ASM report (see Figure 7) and described below:

- Is locational information available?
- Is it possible to use balancing bids for congestion management in the distribution system?
- Is there a combined market for TSO and DSO congestion management?

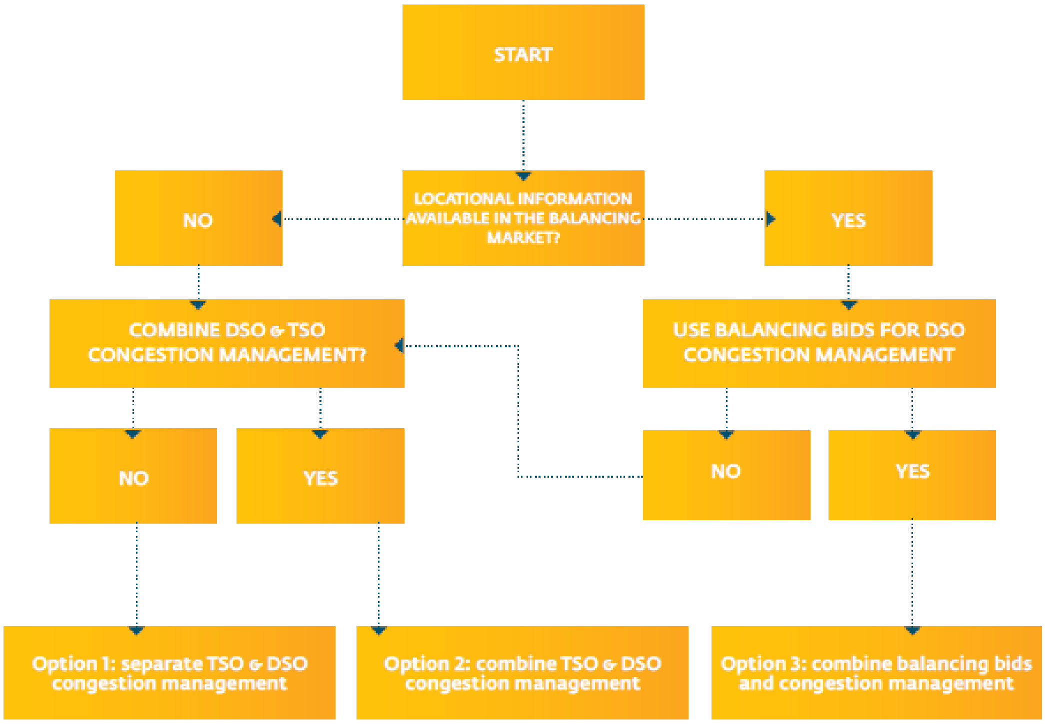

Figure 7: The three possible models for market coordination (CEDEC et. al. 2019)

The structure of the three different options proposed by the ASM report are illustrated and explained in Figure 8.

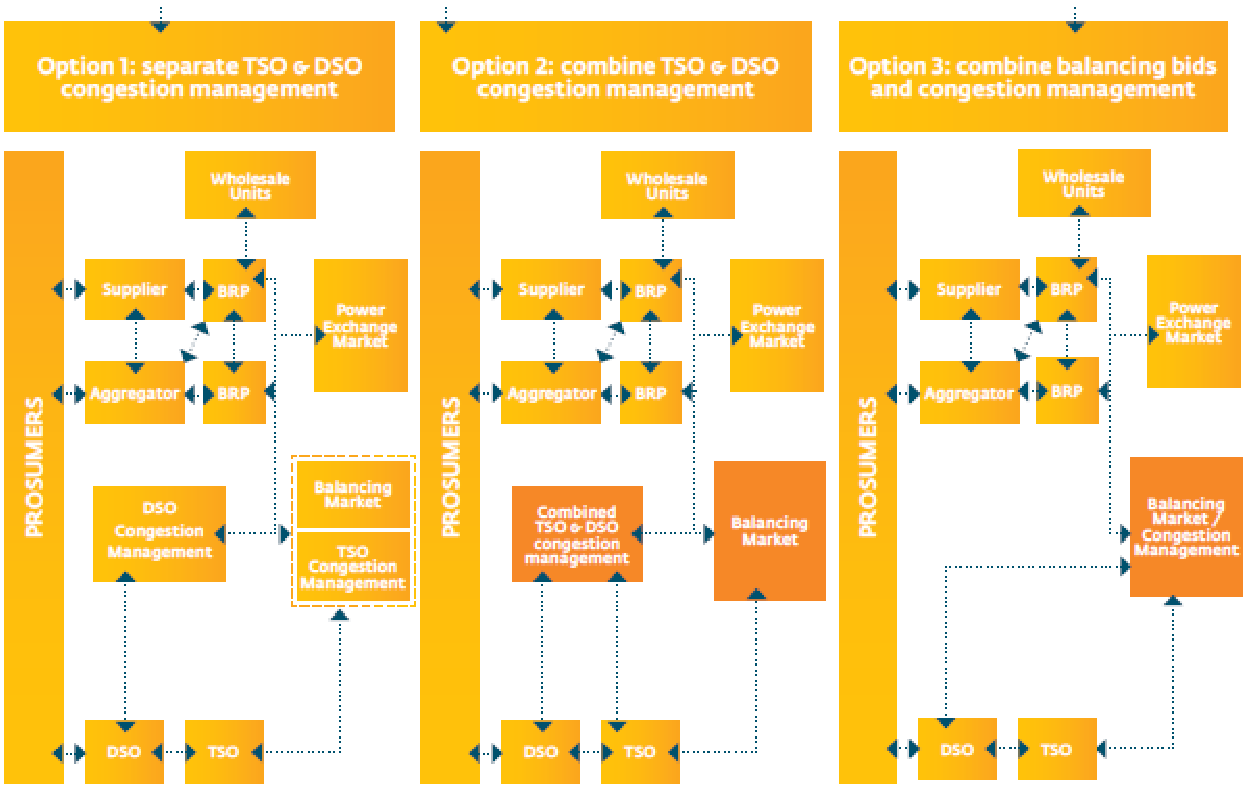

Figure 8: The three possible models for market coordination (CEDEC et. al. 2019).

- ## Option 1

This model considers a separated TSO and DSO congestion management. This means that local congestion management markets may emerge as a separate response to DSO congestion management, independent from the TSO. Meanwhile, the congestion management and balancing of the TSO, can take two forms, either separate (1a) or merged operation of their congestion management and balancing (1b). The report underlines that such an option might be needed to catalyse market-based congestion management offers, but that due attention should be paid to market models to avoid market fragmentation in the long run[17].

- ## Option 2

This option considers a dedicated market for congestion management which covers both TSO and DSO needs (needs which may at times overlap) and thereby allows for the streamlining of the requirements to market processes and rules[18].

- ## Option 3

The last option proposes a market which integrates the processes for both congestion and balancing. The establishment of a single market would facilitate access to all bids for TSOs and DSO necessitating their mutual coordination. It should be noted that to apply this model and use balancing bids for congestion management, locational information must be available.

5.2 COORDINET

5.2.1 COORDINATION SCHEMES APPLIED

The CoordiNet project took its starting point regarding coordination schemes in the SmartNet project. In the work of CoordiNet, the coordination schemes proposed by SmartNet were adapted according to a detailed literature review taking into consideration the current debates on the topic fostered not least by other projects. This work was covered in the D1.3 "Definitions and scenarios for the demonstration campaigns" (Kessels, et al, 2019).

The project identified that coordination is needed when flexibility services can be offered to various system operators (e.g. flexibility on the distribution level can provide a service to both the DSO and TSO), and when the procurement of a certain flexibility by one system operator affects the operation of the grid of another operator (e.g., the procurement of distribution-level flexibility by the TSO would require coordination with the DSO to

[17] CEDEC et al. 2019
[18] Ibid.

ensure that operational issues in the distribution grid related to activation of this distributed flexibility are avoided). Given the interconnection between the DSO-level and TSO-level (an obvious manifestation of this interconnection is captured by their interface power exchange), the procurement of flexibility within each level has to at least abide by certain shared constraints (e.g. capacity of interconnection transformers, voltage levels at root nodes, etc.). These constraints must also be followed by the market design and its clearing.
Depending on the needs for coordination, CoordiNet suggested different market designs cognizant of 1) the services needed by the different system operators, 2) availability of flexibility at different grid (voltage) levels, and 3) the need for coordination between the system operators to enable the (joint) procurement of flexibility while keeping the operational safety of all grids involved.
To cover these 3 scopes, CoordiNet proposed four different classification layers to establish the most suitable coordination scheme in a given situation, which are:

- Need: The needs of which system operator will be addressed?
- Buyer: Which stakeholder(s) can buy the flexibility to answer to a certain need?
- Market: How many markets are considered?
- Resources: Does the TSO have access to DER? (ibid.)

This classification led to the identification of seven different coordination possibilities, which can be grasped from Table 1.

<table>
<tr><th></th><th>NEED
Which SO-need(s) will be addressed?</th><th>BUYER
Which stakeholder(s) buy(s) the flexibility to answer the considered need(s)?</th><th># MARKETS
How many markets are considered?</th><th>RESOURCES
Does the TSO have access to DER?</th></tr>
<tr><td>Local Market Model</td><td>Local need</td><td>DSO</td><td>1</td><td>NA</td></tr>
<tr><td>Central Market Model</td><td>Central need</td><td>TSO</td><td>1</td><td>Yes or No</td></tr>
<tr><td>Common Market Model</td><td rowspan="4">Local and central need</td><td rowspan="3">DSO and TSO</td><td>1</td><td>Yes</td></tr>
<tr><td>Multi-level Market Model</td><td rowspan="2">> 1</td><td>Yes</td></tr>
<tr><td>Fragmented Market Model</td><td>No</td></tr>
<tr><td>Integrated Market Model</td><td>DSO, TSO and commercial parties</td><td>1</td><td>Yes</td></tr>
<tr><td rowspan="2">Distributed Market Model</td><td>Local need</td><td rowspan="2">Peers</td><td rowspan="2">≥ 1</td><td rowspan="2">NA</td></tr>
<tr><td>Local and central need</td></tr>
</table>

Table 1: Categorization structure of coordination schemes considered within the CoordiNet Project

When looking closer at the actual application of these seven coordination schemes into the different demonstrators, it is possible to identify sub-market models. In this regard the design aspects producing the most relevant differences suggesting the creation of sub-models are pricing schemes and market targets. This is the case of the application of the Multi-level Market Model in Sweden and Greece. The variation can be detected when it comes to the roles of the market participants as well as differences exist concerning timing. Another difference is whether the market is organised symmetrically or asymmetrically. This refers to whether flexibility offers are submitted and cleared all together or if buyers can pick simultaneously with the submission and no clearing mechanism is in place[19].

5.2.2 COMPLEMENTARITY WITH THE ASM REPORT

The main differences between coordination schemes of CoordiNet and those proposed by the ASM lies in the approach. The ASM report focuses on the TSO – DSO communication in general and mainly in the context of balancing and congestion management while it pays little consideration of the specifications of the market model itself, something which is however considered in CoordiNet.

The coordination schemes proposed in the ASM report are based on data information exchange and ICT solutions. Thus, when it comes to identifying which needs a market should cover, who will buy flexibility services, and who will sell it and in which markets, the ASM report suggests firstly to define whether the TSO and DSO will solve congestion problems together or if they join their actions just for the bidding process D7.2.3 and the possible interconnection with the procurement of balancing services. Instead, CoordiNet studies how the coordination between TSO – DSO can be used as the basis for setting up (joint) markets, as well as their properties, and interactions (including the interaction and interconnection between multiple markets, when non-joint markets are set up). Indeed, the departure point of CoordiNet considers which services are needed by which system operators, and which services can be offered by which flexibility source available at which grid level.

As such, the seven coordination schemes developed within CoordiNet are not in opposition to the ASM report. As they add an extended scope focussing on the design of the market, its hierarchy, and architecture, the CoordiNet project's coordination schemes can be seen as complimentary to the ASM report. The proposed coordination schemes for the procurement of grid services within CoordiNet, indeed, coincide with the market options presented in the ASM report. This can be understood from the table below and will be further discussed in the following section.

[19] CoordiNet, 2021, D2.1, https://coordinet.netlify.app/publications/deliverables

ASM	CoordiNet
Option 1	• Multi-level market model, • Fragmented market model, • Central market model, • Local market model
Option 2	• Common market model, • Integrated market model,
Option 3	• Common market model, • Integrated market model,
Out of scope	• Local market model • Distributed market model • Central market model

Table 2: CoordiNet Market Models compared to the ASM report

As visualised in Table 2, the multi-level and fragmented market models consider separate markets for the TSO and DSO. These two market frameworks, therefore, fall under option 1 of the ASM report which as well considers separate markets (however, focussed on congestion management). This is true even though in the model of CoordiNet, the separate markets will have to share some common operational constraints to ensure the secure operation of each of the grids. For example, a market such as the multi-level market model which provides services to the transmission system by activating flexibility located in the distribution system, should in its clearing ensure that no violations are caused to the operational limits within the distribution system. Similarly, activation of flexibility on the distribution level to provide services for the distribution system (such as in, both, the fragmented and multi-level market models) should ensure that this activation would not lead to serious imbalances on the transmission grid by, e.g., regulating the interface flows between the grids.

As for the common and integrated market models, those market designs consider a completely joint market in which flexibility is traded from different grid levels to meet the service needs of different system operators. If this mechanism is implemented solely for congestion management (where for balancing, the TSO maintains a separate market), this would fall under option 2 of the ASM report. While if the traded products in the common or integrated markets are used for both congestion management and balancing, this would fall under option 3 of the ASM report.

The central market model, which considers the TSO to be the only purchaser of flexibility, would not necessitate market coordination other than for making sure that flexibility procurement from the distribution level does not cause any operational issues in the distribution grid (as discussed for the multi-level market model). This can be covered either as part of the market itself (by considering distribution-level constraints in the market-clearing) or in a prior prequalification phase. The central market can therefore on the one hand be considered to be beyond the scope of the ASM report. Alternatively, it can be considered to fall under option 1 as TSO and DSO congestion management are separate; with the congestion management at the TSO level being based on a market framework, and that of the DSO based on non-market-based solutions.

In the case of the local market, only distribution-level flexibility to meet DSO level needs is considered, which may suggest that the model is beyond the scope of the ASM report. However, the activation of flexibility at DSO level might still require coordination to make sure that the operation of the transmission system is not affected negatively by, for example, causing unintended imbalances. Given that in the local market the DSO runs its own congestion management market, separate from the TSO, this market model could be considered to fall under option 1 of the ASM report or to be an extension thereof. This local market enables defining less demanding technical requirements for the smallest flexibility resources in the prequalification processes, asset monitoring, etc. At the end, this market provides higher liquidity to the flexibility markets. Conclusively, the Multilevel Model of CoordiNet would fall under option 1 of the ASM, as well as the project's Fragmented Market Model. On the other hand, the Common Market Model and the Integrated Market Model can be seen as alternatives to or extensions of Option 2 and 3. Meanwhile, the Distributed Market Model, the Local Market Model and the Central Market Model, taken into account by CoordiNet, are not directly covered in the ASM report as they do not per se imply coordination between separate TSO and DSO markets (beyond the possible need or requirement for maintaining shared constraints). Hence, these models could also be considered to be extensions to the market options presented in the ASM report.

Lastly, it should be mentioned that the coordination schemes proposed by CoordiNet are to be service agnostic, allowing for them to be applied to different services or even a combination of services. This is as well in line with the recommendations of the ASM report. Indeed, the comparison with the ASM report coordination options (option 1 to 3) presented in this section, was carried out within the scope of congestion management and balancing as a service. This was done to allow a direct comparison with options 1 – 3 of the ASM report. Nonetheless, these coordination schemes can support the provision of other services, beyond congestion management and balancing, as manifested through the different implementations in the CoordiNet demo sites considering various coordination schemes for different services.

5.2.3 CRITERIA

The 7 proposed schemes will be tested in the three different demos sites as follows:

- **Greece**: Multi-level Market Model, Fragmented Market Model
- **Spain**: Common Market Model, Local Market Model, Central Market Model
- **Sweden**: Multi-level Market Model, Distributed Market Model, Local Market Model (Gotland)[20]

The criteria applied by each demo to the selection of coordination schemes will be explained further after Figure 9.

[20] ibid

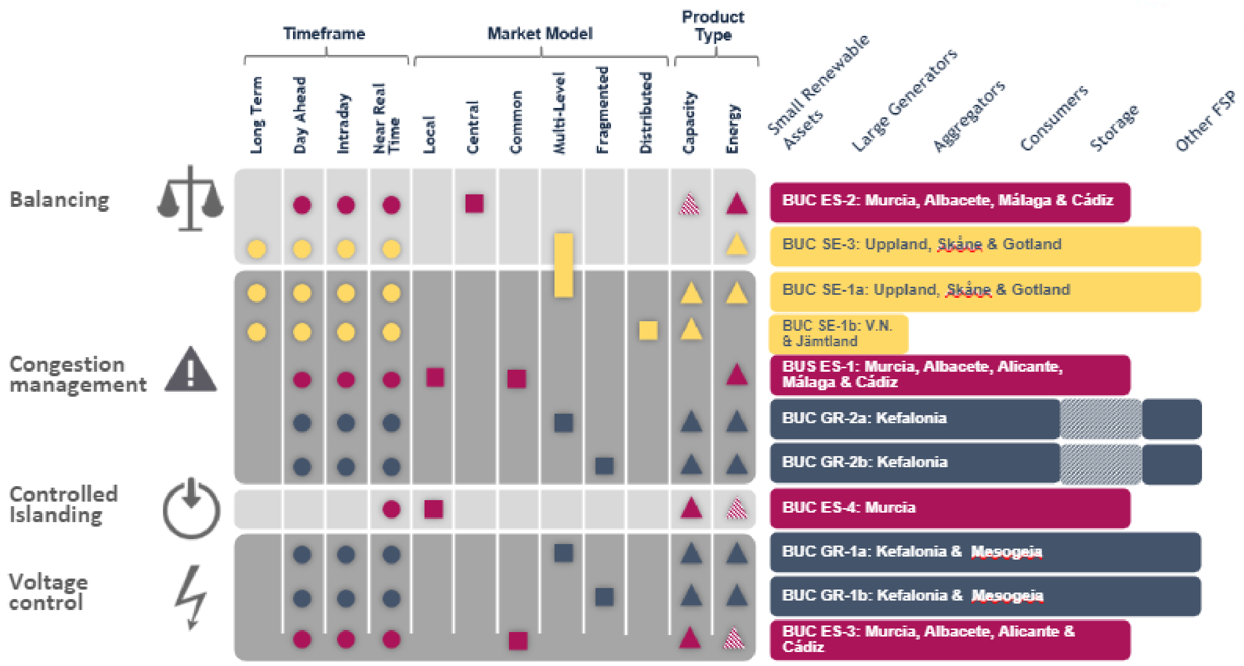

Figure 9: Overview of CoordiNet demo activities

In the case of the Greek demo of CoordiNet, the focus was placed on the creation of a local electricity market which would ensure the reliable operation of the distribution grid. The overall goal of such a market was to promote the proactive management of the DERs located in the distribution grid. The main criteria for selecting the Multi-level Market Model and the Fragmented Market Model for testing in the demo were in this regard technical and regulatory. Both coordination schemes promoted the establishment of a local market that would consider in detail the distribution network components and therefore ensure the secure and reliable operation of the distribution grid. In addition, the coordination schemes ensured the independent operation of transmission and distribution grids by the corresponding TSOs and DSOs, while exchanging only the most critical data, such as offers and flows, in an aggregated form, thus minimizing the complexity of data exchange. Finally, the integration of the proposed coordination schemes with the existing market was also taken under consideration, since from a TSO perspective, the current market practices are slightly reformed to integrate the exchanged data with the tested local markets operated by the DSO.

In the case of the Spanish demo, three different market models were selected for testing, namely, the Central Market Model, the Local Market Model and the Common Market Model. The Central Market Model was used for balancing and was chosen as it is the already established market. The service is the responsibility of the TSO and the balancing markets are being harmonized at the EU level. However, DER are increasingly participating in those markets, which requires improving the TSO-DSO coordination. The Common Market Model was used for voltage control and congestion management. This coordination scheme was chosen as the activation of both services impacts both TSO and DSO networks. The common market was therefore expected to be the most efficient solution. Furthermore, for congestion management, there was an already established market and the CoordiNet developments are fully integrated into such market. Lastly, the Local Market Model was used for congestion management at LV. This coordination scheme was chosen as the impacts on the TSO are limited. Furthermore, this scheme was expected to have lower implementation costs for congestions at LV in comparison with alternatives. The product attributes can be tailored to specific flexibility of FSPs and network requirements. The market model was expected to have lower requirements in terms of communication and technical requirements in comparison with the common market.

Finally, in the case of the Swedish demo, the Multi-Level and Distributed Market Model were selected. The main priority with regard to the selection of coordination schemes was the integration with existing markets and regulation. Emphasis was then laid on time coordination to not disturb the spot market day-ahead and intra-day. Furthermore, the models were selected to fit the ambition of coordinating among small and large size FSPs, Significant Grid Users (SGUs), DSOs, and TSOs while enabling all relevant information exchanges between DSO and TSO on load prognosis and activation time for FSPs.The first demo run in Sweden underlined the importance of putting DSO-TSO markets in the timeframes of the current energy markets without interference. The first demo run in Sweden demonstrated as well that the dialogue between DSO and TSO created new values in understanding how better coordination can lead to a more efficient grid use.

Based on the CoordiNet project experience, all the tested CSs demonstrated to be suitable. However, their choice for application depends on national characteristics, including the grid levels operated between TSO-DSO, the network topology, the impacts of the flexibility activations on the TSO-DSO that are related with the meshed/radial network characteristics, and the characteristics of the flexibility resources.

5.3 INTERRFACE

5.3.1 COORDINATION SCHEMES APPLIED

The coordination schemes in the INTERRFACE project are based on the coordination schemes in the ASM report. Three different options (see Figure 8) proposed by the ASM report discussed earlier in this chapter can be summarised as below:

- **Option 1: Separated TSO and DSO congestion management**

  Local congestion management markets may emerge separated from TSOs congestion management and balancing (which can themselves be separated or merged). This model may be needed to trigger market-based congestion management offers. However, coordination between market processes (CM, BM, ID) should be a focus to avoid market fragmentation on the long run.
- **Option 2: Combined TSO and DSO congestion management, with separated balancing:**

  A specific congestion management market process is created, gathering TSOs' and DSOs' needs, which may overlap. This would contribute to building a congestion management market process, streamlining the needs expressed towards market processes and the rules of the game (time schedule, data exchange, rules of activation, settlement, etc.).

- ## Option 3: Combined balancing and congestion management for all system operators together

  all balancing and congestion management bids and actions are combined in an integrated market-based process. When the current trend is to build a pan-European platform for balancing, an option could be to integrate congestion management and new related needs in the same process as the existing balancing. A single marketplace at national level for collecting and activating flexibility services would allow TSOs and DSOs to access all bids from market parties and to mutually coordinate activations.

Next to the market coordination options, the level of market integration and coordination under each option can be further analysed depending on the treatment and integration of Merit Order Lists as described in Figure 10.

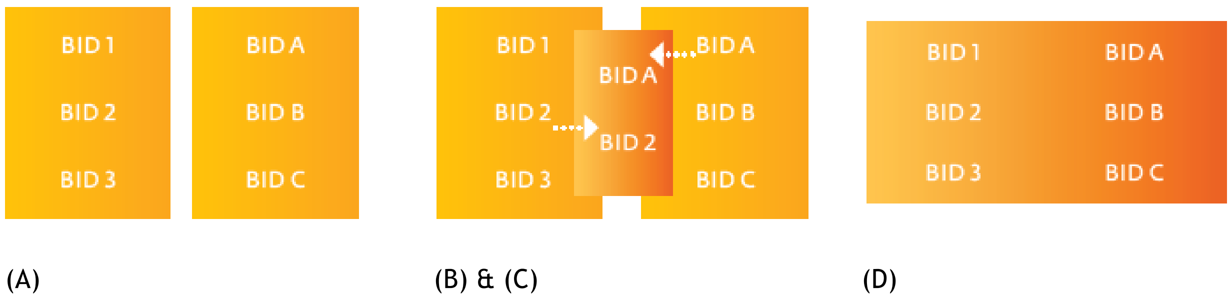

Figure 10: The different level of integration and coordination of Merit Order lists: (A) Separated MOLs with coordination; (B) Overlapping or (C) subset MOLs; (D) Fully integrated MOLs (CEDEC et. al. 2019).

As result, INTERRFACE considered that a closer analysis of various approaches to coordinating or integrating MOLs approaches was necessary to complement the three high-level market design options identified in the ASM report. In doing so, a more coherent approach towards the development of a complete set of market related processes, rules, coordination platforms and data-exchange can be supported across various situations, as reflected in the demo sites. The four degrees of MOL integration are as follows:

- ## Option A: Separated MOLs with coordination

  Which can go from simple notification by the DSO to the TSO after bid activation, to enhanced coordination relying on direct data exchange and sharing of information (e.g., through a datahub and/or flexibility resource register).

- ## Option B: Overlapping MOLs

Bids from one or more lists can be activated for different purposes (can be done through co-optimization, for instance).

- ### Option C: Subset MOLs

  Would effectively bring about the same result as Option B, as bids with additional information (e.g., location) could qualify for other activation purposes.

- ### Option D: Fully integrated MOLs

  Single market platform where TSOs, DSOs, and market parties can buy/sell flexibilities (standardized single products).

As listed above, for each market coordination option indicated in the ASM report, there are varying levels of integration, both with regards to integrating TSO and DSO procurement (e.g., for Congestion management markets) and to integrating several services (e.g., Congestion Management and Balancing). As a result, 9 variations to the level of integration based how MOLs are exchanged/integrated between markets have been derived in-line with ASM report and are summarized in Figure 11.

Market coordination options	Option 1 Separate TSO & DSO CM			Option 2 Combine TSO & DSO CM		Option 3 Combine balancing bids and congestion management			
MOL coordination/Integration between TSO-DSO Congestion Management	Separate CM MOLs			Combined CM MOLs: Overlapping or subset	Combined CM MOLs: Fully integrated	Combined CM MOLs: Overlapping or subset		Combined CM MOLs: Fully integrated	
MOL coordination / integration across services	Separate Balancing and TSO-CM	Combined Balancing and TSO-CM: Overlapping or subset	Combined Balancing and TSO-CM: Fully integrated	Separate Balancing	Separate Balancing	Combined with Balancing: Overlapping or subset	Combined with Balancing: Fully integrated	Combined with Balancing: Overlapping or subset	Combined with Balancing: Fully integrated
	(1A)	(1B)	(1C)	(2A)	(2B)	(3A)	(3B)	(3C)	(3D)

Figure 11: Market Options in INTERRFACE.

Following Figure 11, the market coordination models were described as market options within the INTERRFACE project and represent the range of possible coordination schemes available to demonstration projects. The Option 3D is most advanced in terms of markets integration and coordination, while Option 1A may be the most often chosen option in most countries (namely if congestion management markets exist) and/or demonstration projects today due to the simplicity of design.

The market options in Figure 11, can be represented in a simplified way, as shown in Table 3. Starting from separated markets, meaning that bids are only used on one of the markets, up to a fully integrated market with only one common Merit Order List, all different variations are possible. Nowadays, many pilot projects are working on a combination of CM- and other markets by sharing parts of the bids and adding them on two or more Merit Order Lists of different markets. The same classification can be carried out for the combination of TSOs and DSOs on these markets. Starting from completely separated markets, where the TSO/DSO coordination necessarily needs to take place outside of the market up to integrated markets where TSOs and DSOs can access the same bids on the same Merit Order List. Since the focus of the INTERRFACE project lies in congestion management markets, those markets are specifically highlighted in those market option, though the distinction is suitable for other purposes and can be scaled up to cover other types of markets.

	CM separated from other markets	CM combined with other markets over subset or by overlapping MOLs	CM fully integrated in other markets
TSO	1A	1B	1C
DSO	1A	---	---
TSO & DSO Combined by subset or overlapping	2A	3A	3B
TSO & DSO fully integrated	2B	3C	3D

Table 3: Market Options in INTERRFACE

5.3.2 COMPLEMENTARITY WITH THE ASM REPORT

The main market models considered in the INTERRFACE project are directly based on the options outlined in the ASM Report. D3.2 (INTERRFACE 2020, D3.2) further expands on these options by providing a more detailed mapping of possible design choices. As mentioned above, this directly relates to (a) the level of integration of different markets, from separated markets for congestion management and balancing (and Merit-Order Lists, or MOLs), to fully integrated markets with a single MOL; and (b) the type of coordination between TSOs and DSOs for prequalifying and accessing congestion management and balancing bids. The INTERRFACE project goes even further, by providing more detailed considerations on how different market parties such as BRPs, Resource Aggregators, and Resource providers can actively participate in the considered markets, how the IEGSA platform can support the described coordination functions, and the required interactions with existing tools and platforms to effectively enable the necessary interoperability for the full participation of all grid users wishing to offer their flexibility to the market.

In the ASM report, the flexibility resources register is introduced as a vital part of a flexibility platform since information on flexibility resources that are pre-qualified or are seeking participation in congestion management and balancing services could be shared and available to all parties. The flexibility resources register allows TSOs and DSOs to have visibility on which flexibility resources are connected to their grids, so they know what resources are available to them at all voltage levels. Features can also ensure that the use of flexibility does not jeopardise system stability or does not create local challenges through the implementation of a traffic concept. In the INTERRFACE D3.2 (INTERRFACE 2020, D3.2), a general description of how such a flexibility resources register could interact with existing platforms and tools is provided.

5.3.3 CRITERIA

Choosing the most suitable coordination scheme for their specific purpose is necessary for the demonstrators in the INTERRFACE project. The selection of the respective coordination scheme is mostly based on two separate decisions.

The first decision demonstrators have to make is which of the different congestion management services and eventually further services and markets will be tackled. The second decision then refers to the exact coordination schemes that will be tested.

Regarding the first decision, the results showed that most of the demonstrators focussing on DSOs prefer operational CM markets. This can be due to the fact that a flexibility potential and liquidity in smaller market areas is limited. Reservation in operational CM markets allows for a sufficient amount of flexibility in all situations, whereas in short-term CM market a sufficient amount of flexibility potential is not guaranteed. Looking at the demonstrators that have TSOs within their consortium, short-term CM markets are taken into account in each demonstrator. Some of these Demonstrators comprising TSOs in their consortium include operational CM markets as well.

The decision for specific coordination schemes is, among other things, based on soft criteria like existing markets, regulation in the respective market area and complexity. In contrast to TSOs, Demonstrators that focus on DSO congestion management most often do not have an extensive experience in terms of market-based procurement of services from the past. Furthermore, processes for service procurement i.e. congestion handling, are heterogeneous amongst the different DSOs, especially between different countries. This can be traced back to the distinct regulation in place in different European countries. A common European market process as for TSOs cannot be observed, and therefore alignment with other markets and players becomes complex. The limited prior experience in those pilot projects with market-based procurement of services favours solutions with limited complexity, while alignment with existing markets as well as with other network operators is avoided. In summary, demonstrators focusing on the procurement of services by DSOs tend to choose coordination schemes that foresee separated markets and coordination between TSOs and DSOs taking place outside of the market (if at all). Demonstrators that take into account TSOs tend to be more familiar with the topic of market-based procurement of services and energy markets in general. Therefore, in terms of combination with other markets further concepts are taken into account. In order to increase liquidity and decrease overall costs, coordination schemes that feature combinations with other markets are foreseen in most of the demos. This combination refers to a combination with Intraday as well as Balancing markets. Besides the integration with other markets, TSO/DSO coordination is an important focus for those demonstrators and is further investigated throughout the various stages of flexibility procurement (grid and product prequalification, activation, measurement, validation, and settlement). A usage of those resources makes a coordination mechanism inevitable. As a general conclusion, it can be noted that demonstrators that take into account TSOs flexibility needs, tend to use CM markets that are combined with existing markets in order to increase liquidity while introducing TSO/DSO coordination mechanisms in order to unlock flexibility potentials in the low voltage network.

5.4 SUMMARY OF DIFFERENCES AND COMPLEMENTARITIES

As the previous description of the projects has showed, the ASM report is a central report for both. In Table 4 the proposed models of the two projects are compared regarding the complementarity with the ASM is.

ASM	CoordiNet	INTERRFACE
Option 1	• Multi-level market model, • Fragmented market model, • Central market model, • Local market model	• 1A • 1B • 1C
Option 2	• Common market model, • Integrated market model,	• 2A • 2B
Option 3	• Common market model, • Integrated market model,	• 3A • 3B • 3C • 3D
Out of scope	• Local market model • Distributed market model • Central market model	

Table 4: Coordination schemes in CoordiNet and INTERRFACE compared to the ASM report

As can be seen, the CoordiNet project presents additional and further extensions to the market options presented in the ASM report in terms of market design, also going beyond congestion management. On the other hand, the INTERRFACE project, taking the ASM report as the starting point for work, develops a generalisation of the options defined in the ASM report. This generalisation focuses on the consideration of an integration of different markets (i.e. congestion and wholesale, or congestion and balancing) and the different options of TSO-DSO coordination.

In line with the focus of the ASM report, INTERRFACE gives focus to congestion management, wholesale, and balancing markets. With respect to this, CoordiNet provides a first overarching classification layer that considers general needs at local or central level and looks at coordination schemes that can be adopted for the procurement of all the identified services, including balancing and congestion management.

When it comes to selecting coordination models for the demo activities, it is seen that existing markets constituted a decisive criterion in both projects. Thereafter, INTERRFACE noticed different preferences in criteria depending on whether demos were TSO or DSO focussed or involve both network operators. The DSO focussed demos opted for coordination models with separated markets, while the demos including TSOs took interest in combined markets with the aim to increase the liquidity. In CoordiNet, all demos are led by DSOs in close collaboration with the TSOs and established markets at local level to address some of the DSOs' local needs.

6. Recommendations

In this chapter, recommendations will be presented and discussed based on experiences from both projects. For each of the topics, a short explanation of the background and how the results were achieved in each project is presented, followed by common recommendations.

6.1 ROLES AND RESPONSIBILITIES

The restructuration and modernization process towards an integrated energy market at European level as part of the current energy transition requires simultaneous harmonisation of roles, domains, and resources across EU Countries. The definition of clear and unified responsibilities for each of the actors involved emerges as fundamental to allow for transparent and non-discriminatory coordination among market participants and national authorities as well as to enable the emergence of new business models.

6.1.1 INTERRFACE

The Harmonised Electricity Market Role Model (HEMRM) (ebIX, EFET and ENTSO-E, 2020) developed and maintained by ENTSO-E, EFET and ebIX is proposed to facilitate the dialogue between the market participants from different countries. The INTERRFACE project contributes to this objective through the proposition of new roles to the electricity market to ensure that the use cases cover all the needs that the electricity market demands and to ensure that the effort to improve the flexibility market is proposed with a scientific basis. There are three roles that the project presented to the HRM:

- **TSO-DSO Coordination Platform Operator** (TDCPO): Responsible for performing grid and product qualification of FSPs and to provide the System Operator with access to the flexibility market by gathering and transferring their flexibility needs.
- **Single Interface to Market Operator**: Enables the exchange of data for SO flexibility needs between the TDCPO and the Market Operator (MO) and the exchange of data for market results between the MO and the Flexibility Register Operator (FRO).
- **Flexibility Register Operator**: Among other responsibilities, enables FSPs to provide their flexibility services to the market.

6.1.2 COORDINET

In CoordiNet, the topic of *Roles and responsibilities* was addressed where the different actors and roles involved in the BUCs for each of the demonstration sites were identified. This resulted in a visual representation of these actors and their connections within each BUC, which was presented in a deliverable *Business Use Case: Business Use Case definition*[21]. An example of such a BUC overview is provided in Figure 12 for BUC GR-1a.

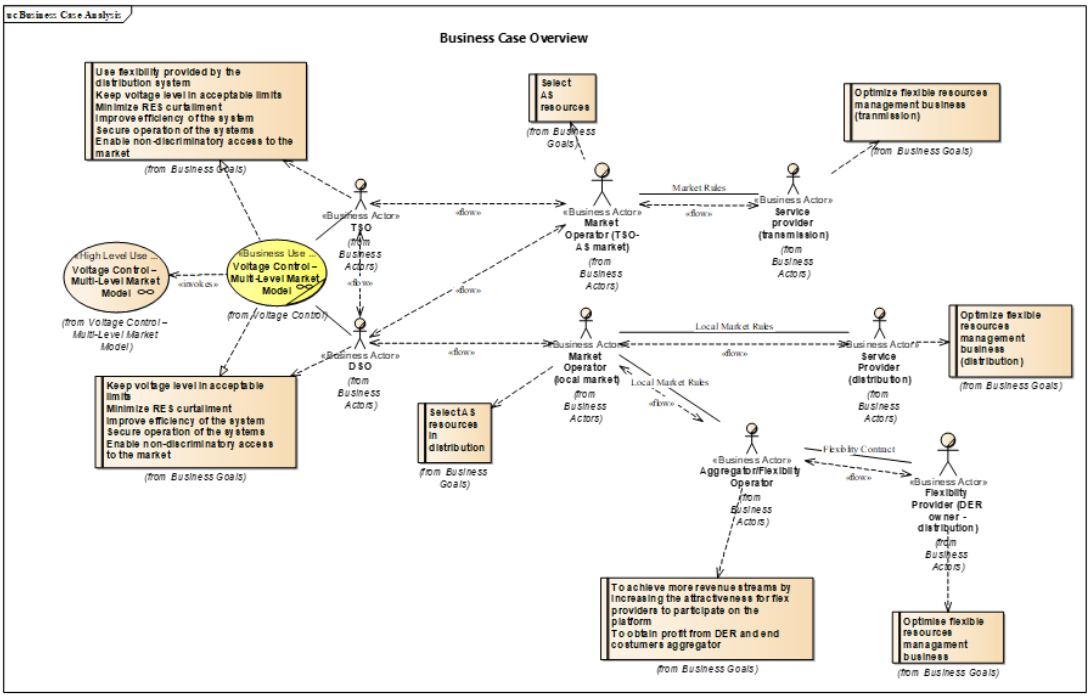

Figure 12. BUC FR- 1a Overview: Voltage Control - Multi- Level Market Model

As shown in Table 3, seven different coordination schemes were defined in the CoordiNet project, each allowing for one or more combinations for the assignment of roles and responsibilities to market stakeholders. The activities conducted in each demo allowed gaining further insights related to the responsibilities of market actors in the context of the different coordination schemes selected for each BUC. The demo findings were gathered and elaborated within the framework of Task 6.7 for the formulation of main barriers and recommendations for action at EU level. In particular, rather than aiming to define the attribution of roles to specific market actors, CoordiNet investigated the fundamental principles behind such a choice, including transparency, timely and secure information exchange, and avoidance of cost duplication depending on the context of application and market structure. Additionally, the participation of CoordiNet in Action 7 of the BRIDGE initiative, Harmonized Electricity Market Role Model (HEMRM), by providing the project's view on the HRM (ebIX, EFET and ENTSO-E, 2020), contributed to the formulation of a common view of EU Bridge projects on roles and responsibilities involved in electricity markets with a focus on flexibility.

[21] CoordiNet 2019, D1.5

6.1.3 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Roles and responsibilities*.

1. A harmonisation of the nomenclature and definition of roles is required to enable flexibility markets across the EU. The attribution of such roles and responsibilities should be based on thorough impact analyses.

Given the differences in local contexts, regulations, and use cases, it is not possible to identify a single one-fits-all coordination scheme and solution for the attribution of roles and responsibilities to stakeholders for the efficient operation of flexibility markets. Nevertheless, a harmonisation of the definitions adopted to identify the full range of roles, eligible entities, and responsibilities in a flexibility market could provide the common ground necessary to enable new business processes for efficient flexibility procurement, the uptake of flexibility markets at EU-level, and the efficient operation of these. The adopted nomenclature should be descriptive of the principles and key characteristics connected to each role, not restricting roles to certain actors. Such a nomenclature should be included in the new Network Codes of Demand Side Flexibility, for which non-binding framework guidelines are currently being developed by the EU Agency for the Cooperation of Energy Regulators (ACER) and undergoing public consultation (ACER, 2022).

In this context, the facilitation of new roles to support the market and underlying communications should also be investigated, especially given incorporating cross-sector flexibility in the energy sector. This includes the effects of procuring flexibility on other voltage levels. The experiences from the demonstration activities of the two projects highlighted the importance of timely and secure information exchange, transparency, and avoidance of cost duplication among the fundamental principles. Hence, when attributing new roles and responsibilities in a flexibility market, the mentioned points should be evaluated by conducting thorough impact analyses.

2. Amidst the rising complexity of flexibility markets, the distribution of costs among procuring entities must be a core element for future regulatory design.

The distribution of costs for delivered services between SOs is a key coordination challenge to solve. The activation of bids by one SO may affect other levels of the system, for example by triggering the need for other SOs to procure services to manage their grid, and thereby create insecurity among market actors. Henceforth, procurement of flexibility by multiple SOs could introduce coordination issues, as the complexity of tracing back each service's cause, effect, and cost increases. The distribution of costs should be made on a clear, transparent and non-discriminatory approach, and always considering the potential trade-offs and interactions of all the involved agents. Best practices for cost allocation mechanisms between SOs when jointly procuring flexibility should be gathered and included in future regulatory frameworks to create certainty among affected market stakeholders.

3. Awareness must be raised considering that there is no one-size-fits-all technical solution supporting decision-making for all flexibility market stakeholders.

Grid decision tools supporting the procurement of balancing products in the transmission system are well defined in EU regulation, established and implemented by TSOs, while guidelines and rules supporting DSOs decision-making are currently lacking. The extension of the already existing tools to all voltage levels are not an easy-to-adopt solution in the short term as the frameworks developed for these tools do not take DSOs specific contexts into consideration. This application was originally not foreseen and therefore comes short of grasping all DSO needs, which are not the same of the TSO needs. Hence, requirements might be different and should be accounted for on various voltage levels. More specifically, interactions between FSPs and TSOs and DSOs may diverge depending on the services considered. However, the emerging information needs for the establishment of flexibility markets should be enabled by common approaches to communication between SOs.

6.2 REQUIREMENTS FOR INFORMATION SHARING

The long-term objective of the work carried out by CoordiNet and INTERRFACE is to facilitate the scale-up of markets and platforms, ultimately paving the way for the creation of a potential pan-European platform. To fulfil this objective, ensuring interoperability between different developed solutions is essential, not least concerning information sharing in the energy market. It should be kept in mind that the digitalisation of the energy system is currently happening at all levels of the value chain with its inherent logic. This produces a somewhat fragmented ecosystem in terms of standards.

6.2.1 INTERRFACCE

In the context of INTERRFACE, the developed IEGSA platform, serving the data and information exchange, adopts following processes:

- Communicate product definition requirements at IEGSA platform,
- FSP registers a flexibility resource unit (i.e., flexible asset) at IEGSA level (on the Flexibility Register) and the resource technical parameters; important note that Balancing Service Provider (BSP) or FSP that registers the resource shall have proper authorization rights/consent from the resource owner,FSP registers a resource group at Flexibity register grouping the resources portfolio and assigning products/services that they are willing to provide,
- Product qualification (request/results) information regarding which resource groups are technically eligible to provide specific product/services,
- Grid qualification (request/results) the process that communicates information which resource groups,
- Bidding process bids are communicated at IEGSA level, including bid modification or bid cancellation,
- Bid qualification (request/results), bid list is sent to qualification algorithm and bid qualification results are made available to SOs,
- Merit order list is communicated to marketplace from IEGSA platform,
- Activation order to FSPs to release capacity/volume,

- Settlement process, where initially FSPs/BSPs upload measurement data regarding the delivery of a product/service which is sent to the Settlement Operator and then results are sent back to FSPs/BSPs/BRPs and the SOs.

All the above cases were deemed essential for the coordinated procurement of flexibility services, where any of them rely on data and information exchange between multiple stakeholders.

TSOs and DSOs can exchange their qualification information with the proposition of these two new CIM-based profiles that ensure replicability since all the profiles are publicly available on ENTSO-E webpage[1] and can receive enhancement proposals by all energy market players through ENTSO-E maintenance request form[2]. This scalable qualification process ensures the security of data exchange between the electricity market.

The INTERRFACE project also proposed improvements to the communication level of the Smart Grid Architecture Model (CEN-CENELEC-ETSI, 2014) by applying the ECCo-SP tool to the IEGSA platform. This ENTSO-E tool is MArket Data Exchange Standard (MADES) -based (International Electrotechnical Commission, 2018), implemented in the European electricity market to exchange grid data between TSOs and can be also implemented by DSOs and third parties when a TSO is involved in this implementation.

6.2.2 COORDINET

As part of its tasks, CoordiNet addressed information exchange requirements for the procurement of energy services in an interoperable market framework. Deliverable 2.4 *Interoperable Platforms for procuring system services from consumers, storage, and generators* provided an assessment of the use of information among stakeholders and elaborated data models and formal data exchanges for market communications necessary to deliver the services included in the project BUCs[22]. The analysis resulted in the definition of a service catalogue used as the basis for information exchange in the CoordiNet Platform and directly fed into the work of WP6, focusing on the assessment of lessons learnt during the pilot demonstrations.

In the context of the CoordiNet Roadmap, the *Requirements for information sharing* were addressed both from the perspective of standardisation of data communication protocols and the one of data ownership and accessibility. From the former point of view, requirements for standardisation of data collection and exchange processes necessary for the execution of the different market phases, interoperability of the developed market platform, and facilitation of coordination among SOs were investigated. In line with this focus, additional considerations, and conclusions on the subject of information sharing and its relation to network representation were drawn in D6.2 *Evaluation of combinations of coordination schemes and products for grid services based on market simulations* as discussed in depth in section 6.5[23]. On the other hand, the latter perspective focussed on criticalities such as data access, ownership, confidentiality, and security and explored the relation between data

[22] CoordiNet 2021, D2.4
[23] CoordiNet 2022, D6.2

sharing and attribution of roles and esponsibilities in flexibility markets. Thus, the contribution of CoordiNet to the BRIDGE Initiative, as presented in section 6.1, has been equally relevant to the formulation of conclusions concerning information sharing.

One of the main conclusions of the Coordinet Project was that the selection of the CS, and the corresponding market scheme, depends on the national characteristics such as the grid levels operated between TSO-DSO, the network topology, the impacts of the flexibility activations on the TSO-DSO that are related with the meshed/radial network characteristics, and the characteristics of the flexibility resources. Therefore, at the DSO level it seems more rational creating national platforms than pan-European platforms, especially in the incipient phases of these new flexibility markets at distribution.

6.2.3 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Requirements for information sharing*.

1. Improved data sharing frameworks for all stakeholders are necessary to cover emerging information needs for the establishment of flexibility markets.

Enabling the SOs to procure services such as balancing, congestion management and ancillary services, from assets connected to the network is fundamental to optimise the management of the modern power system and fostering the integration of increasing shares of renewables. To achieve a coordinated procurement and bid activation both at the transmission and distribution levels, it becomes necessary to ensure a seamless and secure data and information exchange among the stakeholders involved in the whole energy value chain.

To this end, an increasing harmonisation of communication protocols and data exchange messages by standard data profiles is crucial as the first step to accommodating and ensuring the effective participation of new actors in the market. A common approach toward a European framework for interoperability is desirable to relieve the need for SOs to perform individual time-consuming and costly processes to manage communications with different types of FSPs and markets. In the long term, where feasible, such communication interfaces should be supported by international data standards (e.g. ESMP documents[3], CGMES documents[4]). This recommendation gains additional importance in light of the future scalability of flexibility solutions. The harmonization of communication protocols and data exchanges should also enable the implementation of innovative solutions and new protocols. Finally, the added value from harmonising the communication between aggregators and flexibility resources should be analysed, as this is part of a private relationship that requires adopting on-going innovative solutions to increase efficiency.

2. The development of increasingly complex frameworks for data sharing between all market stakeholders should be consistently safeguarded via, e.g., GDPR, data privacy and ownership policies.

As flexibility markets grow, different types of data will need to be shared in increasing amounts between SOs and other market participants. Depending on the chosen coordination scheme, this might lead to security issues such as the replication of sensitive network data and privacy protection. To guarantee data privacy and security, data access policies need to be thoroughly defined, by means of, for example, data policy enforcement tools or consent management systems.

Related policies should aim at ensuring confidentiality and data sovereignty utilizing a meaningful and standardized process. As part of the experience of the two projects, it became evident that data ownership, data distribution as well as governance are topics that need to be tackled not only at the payload and data format level, but also at the architectural one. One possible solution to address this need, in accordance with GDPR rules and European level hosted technology, is the creation of an energy data space within the framework of the common European project GAIA-X[5]. As a matter of fact, the GAIA-X concept does not provide another hyperscaler but focuses on the common access to federated data while preserving data sovereignty. To further explore this possibility, a deeper evaluation and use case analysis should be conducted to consistently safeguard flexibility market stakeholders.

6.3 REQUIREMENTS OF PREQUALIFICATION PROCESS

Prequalification is defined in Commission Regulation 2017/1485 (European Commission, 2017b) as the process to verify the compliance of a potential reserve-providing unit or a group with the requirements set by the TSO. The Regulation clearly determines the mandatory minimum technical requirements for the participation in the FCR, FRR, and RR balancing markets, while the Directive 2019/944 (European Parliament and Council, 2019) indicates the necessity of establishing prequalification processes of non-discriminatory nature. Nevertheless, the responsibility of developing the specific processes and making them publicly available remains with the TSOs. As indicated by the call of the two projects, the simplification and automation of prequalification processes have the potential to facilitate the scaling up of flexibility markets. To this end, a minimum level of standardisation and alignment of the process at European level for the different flexibility products for DSOs and TSOs has the potential to relieve market access barriers and ensure the fulfilment of the non-discrimination requirement.

6.1.2 INTERRFACE

The INTERRFACE project contributed to the enhancement of the electric grid reliability in European Union through the continuous improvement of the Common Information Model (CIM[6]), one objective of which consists in an information exchange standard ready to support the integration of Renewable Energy Sources (RES). More specifically, the INTERRFACE project proposed an important increase in data exchange quality through the proposition of new CIM profiles for prequalification processes.

Specifically, in the INTERRFACE project prequalification processes were further distinguished into *product prequalification*, aimed at ensuring that the specifications of the flexibility resource in study are compliant with the product definition, and *grid assessment*, aimed at verifying that the resource activation is technically feasible and will not cause operating problems (voltage, congestions, etc) in any part of the grid. The product prequalification includes tests and should be done way before the bidding process. Thereby, the basic information of resources is collected and tested against the product definition. On the other had, grid assessment depends on the real-time loading and configuration of the grid and cannot be completely performed before the selecting/activating time. Therefore, grid assessment is executed in two phases: a) grid prequalification, which is performed before the trading phase, and b) grid qualification, performed during the trading phase. The grid prequalification uses a static model of the grid and finds out if the activation of the resource can cause congestions at any point in time. In this case, the resource is labelled as "qualified with restrictions" and will be checked further, during the trading phase, using the real-time data. The trading phase includes the determination of the exact impact of activation of each resource on the grid's nodes and branches, using the metering point ID of each resource and the grid topology. Henceforth, the two described aspects of the prequalification process is a complex and challenging task.

To mitigate the practical challenges of prequalification processes, the INTERRFACE project proposes two new roles: Flexibility Register (FR), and TSO-DSO Coordination Platform (T&D CP). On the one side, FR provides the appropriate space for Flexibility Services Providers (FSPs) to streamline their own flexibility portfolio management and provide information on flexibility-availability of assets. On the other side, T&D CP bridges the roles of system operators including TSOs & DSOs towards coordinated grid and bid qualification.

6.1.3 COORDINET

The topic of prequalification was first addressed within CoordiNet as part of the analysis of the market and regulatory frameworks in the countries hosting the project's demo activities. The outcomes of the task, presented in D1.1 *Market and regulatory analysis: Analysis of current market and regulatory framework in the involved areas*, were taken as input for the market design analysis conducted in WP2 which resulted in a general description of market services, products, dimensions, and coordination schemes that constitute energy markets[24]. The overview, presented in D2.1 *Markets for DSO and TSO procurement of innovative grid services: Specification of the architecture, operation and clearing algorithms* was matched to the practical designs adopted in CoordiNet demos[25]. As such, prequalification was further investigated during the activities implemented on demo level. Lessons learnt and insights from the testing activities on the matter were collected and elaborated in the context of the CoordiNet Roadmap.

6.1.4 COMMON RECOMMENDATIONS

[24] CoordiNet 2019, D1.1

[25] CoordiNet 2021, D2.1

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Requirements of prequalification process*.

1. Prequalification processes of flexibility markets should be harmonised and simplified at product level across flexibility services and market platforms to lower entry barriers for FSPs and increase market liquidity.

The harmonisation of the requirements and processes for prequalification across different flexibility services will at the same time reduce market complexity, lower the barriers faced by FSPs entering the market and allow scaling up of their activities. The harmonisation will also improve the overall procurement process efficiency. In this context, the promotion of automated prequalification processes should be regarded as beneficial, allowing, for instance, to automatically pre-qualify the services with less demanding requirements once a product has already been qualified for services requiring stricter characteristics, thus avoiding duplication of processes.

Nevertheless, the arguments above do not imply that standardisation of prequalification between all the products is recommended or even possible, due to differences in specific product characteristics. As an example, some products might require additional physical testing to prove e.g., the ability to meet the strict demands of balancing services, which is however not necessary for other, less demanding, flexibility services. Therefore, the way forward should be a harmonisation of prequalification processes across services, aligned in common definitions and minimum sets of attributes but allowing for a degree of customisation suitable to each product's characteristics. The harmonised prequalification rules should also address some emerging issues, such as enabling the practical establishment of baselines (e.g. for aggregators), to prevent gaming and undesired arbitrage between flexibility and energy markets. However, the standardization across products should consider differences between flexibility products. Lastly, too strict and data-demanding requirements might increase equipment and management costs for FSPs and therefore prevent them from accessing flexibility markets. Since product requirements are checked every instance when a resource is activated by the SO, providing ex-post validation of flexibility units, prequalification should be simplified to reach a balance between minimisation of requirements for FSPs and safe grid operation.

2. A level playing field should be created to ensure non-discriminatory prequalification processes that grant access to flexibility markets, while a technology-neutral approach is guaranteed.

Prequalification requirements should be designed in a way to ensure non-discriminatory access to the market, according to EU Regulation (European Commission, 2017b). Hence, guidelines for requirements at EU level should guarantee neutrality towards different FSPs and their needs. All providers and all technologies should gain the same opportunities for participation in flexibility markets. Factors to be accounted for including the type of flexibility offered (generation, storage, or demand), resource size (including the cases of small DER and aggregation of small-scale units) and degree of digitalisation. Therefore, future EU requirements should improve a neutral playing field for different types of FSPs and provide all technologies with a non-discriminatory prequalification process. Moreover, actions designed to fulfil the implementation of this recommendation should also ensure technological neutrality prequalification for flexibility services.

6.4 REQUIREMENTS FOR THE SETTLEMENT PROCESS

Settlement processes are essential for the establishment of effective and liquid flexibility markets. The involvement of new flexibility products and the increasing penetration of DERs add complexity to the verification and settlement process required by flexibility markets compared to traditional reserve and wholesale markets. At the same time, the fulfilment of settlement processes requires the monitoring of several grid parameters and the collection of their real-time telemetry measurements or their calculated values, as communicated by each provider with the necessary granularity and frequency depending on the flexibility service in consideration. Consequently, the accuracy of these measurements should be coordinated with the imbalances calculations and the general flexibility procurement process. Although several telemetry requirements are specified at the European level, allowing for a certain degree of standardisation, further harmonisation in the definition of minimum requirements and data access regulations applied at national level can lower the barriers to entering flexibility markets.

6.4.1 INTERRFACE

The INTERRFACE project defined settlement as two separate but interlinked processes: imbalance settlement and financial settlement. Both are based on measurement and validation processes. The processes are coordinated and partly conducted by the FR role. The other essential roles for settlement are MO, Metered Data Responsible (MDR) and Imbalance Settlement Responsible (ISR). In the INTERRFACE project, the role of FR is taken up by the IEGSA system implemented in the project and collaboration is done with the other roles involved in the settlement process (MO, MDR an ISR). On a high level, the FR determines the delivered flexibility amounts and this information is used by the ISR to conclude imbalance settlement and by the MO to carry out financial settlement between the buyer and the seller of the flexibility service. The demonstrated solution of the INTERRFACE project embarked to tackle the questions about the management of distributed resources and independent aggregation that are an essential part of the flexibility market functionality. A centralized process was developed for different products to streamline the settlement process and ease the participation of market parties.

During the development of the IEGSA system, it became evident that a number of questions about the settlement process need to be solved before it will be ready for technical implementation. Two concrete examples of these questions and their solution in the IEGSA system can be highlighted. First, it was realised that a process needs to be in place to handle the modification of resource groups used in the flexibility markets. An existing and product prequalified resource group might change in any phase of the process: after bid placement, selection, or activation. This was solved by maintaining an archive of the resource group and having specific identification codes for the revisions of the resource group. Secondly, an important enabler of independent aggregation is the access to the BRP information of the resources used by an FSP. This information is then needed to be used to automatically handle the Transfer of Energy (ToE) caused by the flexibility actions. An additional achievement of the INTERRFACE project that also supports efficient settlement process is a clear definition of roles and their responsibilities. This is essential for managing the different processes needed to run a multilateral flexibility market with multiple SOs, MOs, and FSPs. Moreover, different governance of the components was enabled when the role of TSO-DSO Coordination platform, FR and MO were kept separate.

6.4.2 COORDINET

CoordiNet approached the topic of settlement first as part of the market and regulatory frameworks analysis, presented in D1.1. This analysis was then further refined to market design in the context of D2.1, which provided an in-depth assessment of baseline calculations for settlement processes considering different factors identified in the CoordiNet project (e.g., type of FSP, product type, TSO-DSO coordination schemes). Settlement processes were further investigated at the demo level and the insights derived from the testing activities were collected and elaborated in the context of the CoordiNet Roadmap. Additional information on settlement processes was described and discussed in D6.3, as part of the economic assessment of proposed coordination schemes and products for grid services proposed in CoordiNet.

6.4.2 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Requirements of settlement process*.

1. Guidelines for telemetry and time-granularity requirements should be harmonised at the European level while considering time characteristics of the flexibility products to ensure the broader harmonisation of settlement processes in European flexibility markets.

To secure a functional market and safe grid operation, minimum requirements on data sharing between market participants and SOs should be established and implemented as part of flexibility products harmonisation. Hence, guidelines regarding real-time telemetry should be harmonised, addressing factors such as data quality and granularity of measurements, to enable the broader harmonisation of settlement processes at the European level.

At the same time, all the flexibility products are characterised by attributes, including preparation time and time activations, which clearly determine the telemetry requirements (i.e. fast flexibility products that should be activated in seconds have different time-granularity requirements than if activated in hours). Therefore, telemetry requirements should not be harmonised across all the products, but rather across all kinds of products.

2. To increase trust among all stakeholders, transparency in data exchanges necessary for the settlement process in flexibility markets should be ensured.

Although there is a clear ambition at European level to foster market-based solutions for the procurement of flexibility and to create a level playing field for all resources and market players (European Parliament and Council, 2019), national legislation transposing the Electricity Market Directive and directing the development of flexibility markets is still lacking in most Member States. In the specific case of settlement processes underlying flexibility markets, two issues need to be addressed. Firstly, how to ensure the non-discriminatory treatment of small and distributed resources for whom the complex settlement and data exchange requirements might pose a disproportionate burden. Secondly, how to enable independent aggregation while managing the responsibilities of different actors, entails and add complexity of data collection. One prerequisite to addressing these concerns is adequate access to flexibility resource information and the availability of granular metering data about their behaviour.

Difficulties in ascertaining an accurate baseline, especially in the case of small FSPs and aggregators, constitute a barrier to flexibility market development. When it comes to independent aggregation, the definition of an accurate baseline is strongly connected to the determination of proper correction and compensation models related to BRP imbalances caused by the aggregator's actions, which clearly depends on the terms and conditions of the balancing services that are defined at national level. In the future, the definition of a set of best practices for verification and compensation processes (i.e., Transfer of Energy), currently differing across acountries, should be pursued at the EU level to facilitate the management of flexibility markets with multiple SOs, MOs, and FSPs and to enable cross-border market participation. These best practices should address both information exchange needs among market players (e.g., BRPs access to FSP resource information), as well as means of verification of actual flexibility delivery for SOs.

6.5 GEOGRAPHICAL SCOPE AND NETWORK REPRESENTATION

The reliable and secure operation of power systems needs to consider the technical constraints imposed by TSOs and DSOs on energy trading, such as line flow and voltage limitations. At the same time, the cost-effectiveness of the provided flexibility in solving a specific market clearing problem depends on the network topology and the system state. As a result, the optimal procurement of flexibility requires a critical assessment of network constraints and resource location through the adoption of an adequate network model, whose type and geographic scope influence the complexity of the market-clearing problem.

6.5.1 INTERRFACE

Network representation is an important element that needs to be thoroughly addressed when discussing flexibility services, especially when considering spatial aggregation of local flexibility. Concurrently, the need to render coordinated operation among SOs, including interactions among TSO-DSO, DSO-DSO, TSO-TSO, which implies versatile information and data exchange. Such information might refer to flexibility information (e.g., flexibility needs, or available flexibility connected in the grid accompanied with spatio-temporal details) and grid topology exchange. For this purpose, in INTERRFACE context when common grid and bid qualifications set in place, common grid representations were necessary to assess grid states properly. Network representation from this perspective is an essential element that has to be thoroughly addressed to enable the coordinated operation of SOs utilizing standard model profiles such as CGMES and/or CDPSM.

To deal with this topic, INTERRFACE has come up with several solutions on different layers. To enable the aforementioned qualification processes, the IEGSA platform developed by the project introduces a model for grid representation. This includes topological information which presents the connections of grid nodes on different grid levels, including the connection points of the TSO and DSOs. The temporal grid state is presented using two alternative models. The more rudimentary model includes available up and down regulation capacity for each node. The more sophisticated model utilizes Power Transfer Distribution Factors (PTDF) matrices, which represents the effect of flexibility activations over a larger network of grid nodes to reveal possible grid violations in the whole examined system.

Another approach was applied on the EFLEX blockchain ledger platform. This was developed in the context of the project to allow the market players to indicate their needs and offering, eFlex allows them to trade flexibility services with each other through smart contracts and smart billing solutions. Regarding the contribution on the network representation leveraged with flexibility information that helps TSOs and DSOs to immediately see how the local grid reacts to the trading and how it affects the grid congestions, into the following layers.

1. **Introduction of network layer.**

On the EFLEX platform, INTERRFACE has developed a network layer which shows the list of substations and lines for a specific region in the form of a table and map. The list of substations shows the name, the peak load value, the connection status and the exact latitude and longitude of the substation. This list can be filtered based on the voltage level. Likewise, the list of lines shows the connection points (from, to), the operating status and the distance. With these data, the DSO and TSO can view demand and availability of flexibility.

2. Matching layer.

INTERRFACE has developed a matching algorithm on the EFLEX platform which automatically matches users' requests to offers. The matching algorithm takes into consideration the location, volume and price of the request and provides a list of offers for the users to choose from and proceed to procurement. The preference is first given to the DSOs when compared to the TSO'. The offers can also be combined and procured for larger volume requests.

3. Peer to peer energy trading powered by Blockchain.

The EFLEX platform makes use of blockchain technology to make the transaction process secure and instant. The flexibility providers can receive the payment made immediately since this technology provides instant finality.

6.5.2 COORDINET

The subject of network representation was addressed in CoordiNet as part of WP2 both in the context of Task 2.1 and Task 2.3. The former task, reported in D2.1, described the main characteristics and key dimensions of market design and mapped selected concepts to the three demo countries, including network representation in their overall system architecture definition. At the same time, D2.2 *Advanced network monitoring and operation tools: Specification for improved DSO-TSO collaboration to increase observability and optimise operations*, presented the outcomes of Task 2.3. The analysis of functionalities and requirements, of tools for monitoring and operation of power systems identified for the implementation of CoordiNet demonstration campaigns, touched upon the topic of network topology and representation.

In line with the other topics discussed in this position paper, lessons learnt from the demo activities were collected and elaborated to produce the CoordiNet Roadmap. The analysis provided by the demonstration campaigns was further complemented and supported by the evaluation of coordination schemes and products for grid services conducted in Task 6.2, which were based on the analysis of mathematical models derived from the outcomes of WP2. Additional considerations regarding this topic that contributed to this position paper can be found in D6.3, *Economic assessment of proposed coordination schemes and products for grid services*.

In general, the CoordiNet demonstrators did not share detailed network information with the markets or between DSOs for market clearing, mainly to ensure grid security. According to the level of observability of the grid under investigation, network information was incorporated in the demo tests using static and dynamic impact factors or anonymized simulations of the real network. In the Coordinet Spanish demo, a certain extent of grid topology information was included in the local market platform. However, the experience showed that it could be more efficient to share some “contribution factors”, linked to each bid, instead of sharing all the structural grid information to the market platform. The reason behind this is that new electricity assets are commissioned every day, especially at the MV and LV level.This would require updating the dataset with the same frequency and, in turn, result in higher burden of administrative processes.

6.5.3 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Geographical scope and network representation*.

1. Adequate requirements for network information sharing should be chosen to ensure the optimal operation and selection of bids in flexibility markets while those must not hinder grid security and the core responsibilities of SOs.

When designing a network topology representation for the market clearing process, a balance should be found between high accuracy, which can ensure the optimal selection of bids and an increased provision of flexibility from DERs without incurring in the violation of network constraints, and a manageable level of complexity in terms of computational time requirements, which might compromise the safe and secure operation of the overall power system. The selection of bids, by means of merit order lists, should take into consideration the location of sources and the impact of bid activation on grid management. At the same time, it should be kept in mind that detailed structural grid information is confidential and underlies the core business of SOs. Sharing such structural information implies an important administrative burden for SOs and risks undermining grid security and quality of supply, of which both TSO and DSOs are responsible agents. Moreover, structural data should be always updated, which is challenging when new assets are commissioned every day.

Also, the technical assessment of bids requires knowledge of the grid topology at all points in time, which in turn demands the knowledge of multiple unforeseen events, scheduled manteinance activities, etc. All thes events are only known by the SO and cannot be considered by the market operator. As alternative, the SO is the unique responsible to validate the non-violation of network constraints.

2. Guidelines on observability requirements should be developed to promote an accelerated deployment of monitoring and measurement tools to improve digitalisation and grid observability.

As flexibility markets grow, with higher numbers of participants and bids involved, it will become increasingly challenging to guarantee safe grid operation following the activation of bids. Maintaining optimal market operation while integrating more flexibility resources and DERs will require the inclusion of additional network information in the market clearing process. Improved grid observability at the LV level will play a key role in the detection of technical constraints, and congestion issues, in the impact of FSPs activation, and in the overall determination of flexibility needs. Therefore, large-scale installation of smart meters in the distribution system should be promoted by means of investment plans for rollout by SOs and regulatory incentives. Moreover, to ensure the accessibility and usability of smart meters data, standards for processes and power of attorney should be developed for establishment between SOs and the FSPs.

6.6 CONSUMER ENGAGEMENT

An important part of the project's scope has been to demonstrate how consumers of different kinds and sizes can use their assets/devices connected to the electricity network to deliver flexibility services to TSOs and DSOs. This is also supported by the CEP, which aims to enable an active role for consumers in the energy system. To facilitate this, the projects have used cascading funds made available under the call to incentivize the participation of third parties to be able to gain more insights into the consumer perspective.

6.6.1 INTERRFACE

INTERRFACE is a customer-centric project focused on generating an architecture and associated solutions for integrating multiple system players into new energy markets in a transparent, secure, and democratic manner, promoting cooperation among DSOs, TSOs and consumers related to flexibility and procurement of services through the electricity market.

To promote customer engagement in the development of the project's solutions, WP2 addressed the definition of stakeholders' needs, including customers, grid and system operations and market players' perspectives. A series of structured surveys were conducted among focused groups in operational roles, with the representatives of the partner stakeholders, focusing upon the perspectives and the perceived needs. Such interviews engaged customers in a co-creation process, focused on generating engineering knowledge to create a list of tangible, measurable and testable requirements for the project's solutions. This way, the blockchain-based local market platform developed in the project, along with the use of "smart" contracting and billing system, allowed engaging consumers in cost-efficient electricity trading that unleashed local flexibility potential, while exploiting the existing familiarity of end-users in using peer-to-peer technologies in mobile apps. Moreover, WP5 of the project, devoted to pilots' deployment, demonstration and evaluation, examined customer acceptance of the architecture and solutions developed in the project. Data were collected from the pilots and indicators between the specification set in WP2 and the project results were compared. Statistical analysis of this data provided a clear picture of customer acceptance, as well as other efficiency and reliability aspects. Eventually, WP8 of the project aimed at developing business cases, promoting start-ups and involving external stakeholders within the project to accommodate innovative energy services, in particular for household consumers. In this manner, an open call for third parties, based on cascading funding mechanisms, was enabled to stimulate further engagement of customers and spread the accomplishments of INTERRFACE and its technological framework. As a result, several SMEs and start-ups were reached through the project dissemination activities and involved in the generation of cascading solutions for providing flexibility services in dedicated markets with the support of all consortium partners covering the energy value chain. Thus, the INTERRFACE project established conversion of public funding into socio-economic benefits as a priority, promoting project outcomes commercialisation and customer engagement, with a strong commitment to the participation of stakeholders across the energy value chain, including, but not limited to, network operators, aggregators, producers, consumers and policy makers, which required a collaborative analysis of customer needs and existing barriers, as well as working at different activity levels, ranging from technological to political levels.

An example to provide some specific insight, comes from a selected Italian demo “DSO-Consumer alliance” that is related to congestion management. The goal of this demo is to demonstrate how flexibility of different FSPs can improve the quality of DSO network and at the same time maximize the self-consumption of RES produced locally. Four types of FSPs have been identified and tested: i) a large prosumer with a 1.2 MWe CHP-generation unit; ii) a Battery Aggregator; iii) a large building with several flexibility resources; iv) a Local Energy Community with residential consumers and prosumers. In the Italian demo, a platform to monitor FR and assess FSP flexibility potential has been developed and tested.

6.6.2 COORDINET

The customer engagement plan of CoordiNet was laid out at the beginning of the project and reported in D1.2, *User and Customer-engagement plan*. Based on this input, engagement activities were planned at demo-level and were iteratively adjusted over the course of the demo runs. In the specific case of the Greek demonstration, the analysis of interactions with customers and consumers was consolidated in D5.5, *Report on Customer and Consumer Support Activities*. On the other hand, the interaction with stakeholders organized as part of the Swedish and Spanish demonstrations and their outcomes are described in D4.5, *Report on lessons learned, bug fixes and adjustments in products and routines within the Swedish demo,* and D3.5, *Evaluation of preliminary conclusion from demo run,* respectively.

The final evaluation of the engagement activities carried out over the course of the CoordiNet project was realized through Task 6.6 and reported in D6.6, *Ex-post customers’ perception and engagement assessment of the demonstrations*. The task methodology involved the collection of information on FSPs’ perception of the project and the demonstrations through a series of interviews with participants of the project, national workshops targeting local stakeholders, questionnaires directed to external FSPs and other relevant parties, and through the CoordiNet forum. The evaluation activities tackled different aspects of the customers’ experience including drivers, barriers, user-friendliness of the proposed technical solution, and economic incentives. The analysis of the collected material resulted in the assessment of CoordiNet engagement strategies, and the formulation of recommendations taken into account in the drafting of this position paper.

In the context of the CoordiNet Roadmap, specific focus was reserved for the concrete barriers faced by new entrants in flexibility markets and their impact on the willingness and ability for market participation, evaluated in barriers influencing the FSP viability of business case as well as social aspects. The main input to the roadmap on this topic came directly from the demonstrations and fed in from T6.6.

6.6.3 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Consumer engagement*.

1. Clear and reliable information for FSPs and independent aggregators on markets, including services, products, and coordination schemes, should be promoted.

A low level of awareness and understanding of grid-related issues and the potential benefits of flexibility service provision are important barriers to tackle to increase FSPs' market participation. Moreover, consumers' acceptance of potential impacts on comfort levels or the perceived ease of use and integration in everyday life will have a significant impact on flexible service implementation.

FSPs reached by the two projects remarked on the importance of clearer information in the process of entering a flexibility market and for placing bids. They indicated that a clear regulatory framework for participation in the markets could motivate the provision of flexibility while a lack of knowledge acts as a deterrent to their participation. On the same line, interest has been shown in receiving particular training on, e.g., business needs and flexibility capacities, before entering a market if they already are aware of relevant flexibility markets. Successful programmes are usually featured by the easiness of implementation for the final prosumers and the provision of valuable economic returns which should be supported by clear and reliable information.

2. Measures should be taken to ensure transparency in and across flexibility markets, including market operations and bid selection processes, to increase the confidence and interest of FSPs and future independent aggregators in emerging business use cases.

It is important to communicate to the FSPs what incomes a company can expect when participating in a flexibility market. In an environment with significant uncertainties, like the energy sector, it is important to understand how to evaluate flexibility in a company and grasp the opportunities that it entails. Due to the current volatility of energy costs, any action that leads to economic savings, such as energy flexibility, increases value for the company. Therefore, clear and transparent signals from the markets are important to increase the interest of FSPs and aggregators.

This goes in the same direction with the harmonisation of the configurations of co-existing flexibility markets. They should be streamlined to simplify access and strengthen the participation of FSPs and independent aggregators in different flexibility markets.

3. Policies tackling flexibility markets should consider incentives to attract new FSPs, strengthen their role, and endorse long-term planning to safeguard business sustainability and security of operation for FSPs and interacting stakeholders.

An ideal customer engagement plan should provide enough certainty on incentives to involve new participants in an economically sustainable way. However, the effort of implementation at small prosumers levels is often not cost-efficient regarding the achievable flexibility capacity. In this context, the implementation of Local Energy Communities with monetary and/or non-monetary incentives could be a solution for exploiting flexibility for small-scale users. An additional solution could be to automatise prosumer participation which, however, adds an additional layer of complexity. For instance, improving energy monitoring systems could allow for better Demand Response (DR) programs leading to an increased awareness of prosumers' electrical consumption and consumption patterns. Thereby, by automating prosumer input, grid services could be strengthened while the impact on the core business of customers such as industrial consumers should be considered. This includes differences in flexibility demand between seasons/year-to-year. It is often difficult to attract new FSPs as their supply would create profits with high variability across time. Overall, incentives should be considered as a means to involve more market participants.

Of course, such measures have to be taken in light of long-term planning to ensure the sustainability of core and flexibility market business of all stakeholders. The mentioned aspects are particularly relevant for the scalability and replicability of the projects in other contexts, as will be discussed in the following section 6.7.

Finally, when designing strategies to attract new FSPs, it should be considered that the types of flexibility products involved have a clear influence on market effectiveness as their capability and attributes (e.g., upward and downward regulation volume and activation time) vary considerably. In CoordiNet, some DSO flexibility markets are tested in LV, demand-driven radial grids, while other DSO markets take place on HV (sub-transmission) meshed grids, with high-RES penetration, sometimes exporting power to the transmission grid rather than withdrawing it. In such diverse scenarios, different types of FSPs proved to be complementary, providing more capabilities for the SOs to solve network violations through flexibility procurement and activation.

6.7 SCALABILITY AND REPLICABILITY

According to the inter-project agreement presented in Chapter 2, one of the main focuses of the collaboration between INTERRFACE and CoordiNet was the discussion of strategies for scalability and replicability at EU level of the solutions developed and tested by the two projects. As the scaling up of platforms and flexibility markets is an integrating part of the challenge addressed by the two projects, Scalability and replicability was chosen as the last focus for the joint recommendations of this paper.

6.7.1 INTERRFACE

The INTERRFACE project proposed a methodology to ensure the scalability and replicability of the results at European Union level, which is the SGAM – Smart Grid Architecture Model. Through the SGAM, the project used cross-border congestion and balancing schemes, which were tested through 3 demo areas with different countries of European Union. The scalability of such schemes across Europe was assured through the implementation of the CIM profiles, ensuring that a different number of actors could exchange the information through this data model, accordingly to the specific use cases, at different levels such as TSO or DSO level.

As discussed in Deliverable 9.13 of INTERRFACE project, the scalability and replicability aspects are considered for the results of the project at Pan-European level, through a roadmap with technical, regulatory and stakeholder-oriented aspects to ensure the IEGSA (Interoperable pan-European Grid Services Architecture) scalability and replicability at Pan-EU level. The implementation of ECCo SP (ENTSO-E Communication & Connectivity Service Platform), one of the components presented at IEGSA platform, ensured scalability, as the tool is designed to exchange a large amount of data between the use cases' actors. It is important to mention that IEGSA is not a market platform, but a middleware architecture in a distributed system which acts as the binder that puts together many different hardware and software entities.

6.7.2 COORDINET

In CoordiNet, the Scalability and Replicability Analysis (SRA) of the CoordiNet BUCs included two distinct components:

i. A quantitative analysis focusing on the functional aspects of the BUCs which analysed how changes in certain technical and market boundary conditions affect the results obtained, as measured by the relevant Key Performance Indicators (KPIs), particularly those related to flexibility activation amount and costs. The most relevant technical and market conditions include, among others, the following: number/size/type of FSPs providing the services, grid characteristics, TSO-DSO coordination schemes, or type/frequency/amount of flexibility requirements.
ii. A qualitative analysis that identifies the key barriers for upscaling and replication that may be found in current power system regulation.

The detailed methodology and outcomes of the SRA performed for the CoordiNet project are reported in D6.4, *Scalability and replicability analysis of the market platform and standardized products.*

6.7.3 COMMON RECOMMENDATIONS

Based on the experiences of the CoordiNet and INTERRFACE projects and the outcomes of the joint discussion, the following policy recommendations were elaborated regarding the topic of *Scalability and Replicability*.

1. Product and process harmonisation should be regarded as means to facilitate the emergence of tailored business cases and models.

As highlighted by the experience of the large-scale demonstrations led by the two projects, local and national contexts, influenced by factors such as climate, geography, network topologies, location of production and consumption sites, have a direct impact on the applicable use cases. Consequently, different resulting grid needs will require different business models. This consideration does not lessen the importance of product standardisation but rather brings an additional argument to support it. Harmonisation of flexibility products and attributes concerning grid services would highly benefit their tailoring to specific business use cases. At the same time, the co-existence of different tools developed by different stakeholders for application in their respective areas of operation can be expected. In this respect, the critical point to ensure scalability stands in achieving a level of cross-platform integration that allows for adaptation to specific data requirements and use cases' needs. The promotion of public standards available to all energy market participants should be regarded as beneficial for the encouragement of integrated communication.

Moreover, the conducted SRAs highlighted that under some scalability assumptions, flexibility might only partially solve emerging grid criticalities. In such cases, other complementary solutions could be considered, such as network reconfiguration, control of OLTCs, or resorting to new FSPs.

2. Knowledge sharing and cooperation between TSOs and DSOs should be promoted as enablers of the scaling up and replication of flexibility solutions.

The continuous collaboration between TSOs and DSOs, both in terms of knowledge sharing and data information exchange, is a key action to enable the refinement of market roles and processes, lower access barriers to attract higher numbers of market participants, and altogether efficiently implement scalable flexibility solutions. Current and future developments of SOs roles following the evolution of energy markets, should always be accounted for in the context of this cooperation.

Moreover, the results of the conducted SRAs highlighted how, from an economic point of view, joint TSO-DSO markets can lead to lower flexibility costs. At the same time, market-based procurement of reactive power support for voltage control proved to be beneficial for both TSOs and DSOs.

3. Barriers posed by national regulation to the implementation of market-based flexibility solutions should be addressed with paramount importance.

The regulatory SRAs performed by the projects highlighted barriers that current national regulatory frameworks still pose to the implementation of the proposed flexibility solutions. Among the identified ones are the lack of harmonisation and market-oriented definitions for congestion management and voltage control, the need for enhanced TSO-DSO coordination for certain market models, and the lack of a DSO regulatory framework enabling flexibility procurement. Specifically, regarding the latter point, the provision of a regulatory basis with adequate incentives and remuneration schemes for SOs is necessary to foster the practice of flexibility service procurement as an alternative to the reinforcement of grid infrastructure.

As hinted in previous recommendations, it can be foreseen that in the early stages of flexibility market implementation, several different platforms will co-exist at the EU level due to local circumstances, different regulations, and different maturity levels. Further, the harmonisation of platforms and processes will become possible with higher market maturity, allowing for the replication of best practices in different locations. However, regulators should consider that the accomplishment of such maturity levels will require time, and the early stages of markets' development will entail high incurring setup and operation costs together with low remuneration potential for involved stakeholders. Therefore, there is a remarked need for the inclusion of adequate incentives for all stakeholders when designing frameworks supporting the establishment of market-based flexiility solutions.

7. Conclusions

This common position paper represents the successful conclusion of the bilateral collaboration between the INTERRFACE and the CoordiNet projects, both selected under the LC-SC3-ES5-2018-2020 Horizon 2020 program call "TSO – DSO – Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale generation". The commitment demonstrated by the two projects since the beginning of their operation, and continuously maintained during their implementation, allowed them to bring together their common and complementary learnings, consolidated into the policy recommendations presented in this deliverable.

The experiences of the large-scale demonstrators of the two projects disclosed several barriers that are still impeding the uptake and upscale of harmonised flexibility markets across Europe. The differences in national and local contexts, in terms of climate, geography, energy systems, and economies, create a fragmented panorama that entails specific needs and the definition of tailored business models. In this context, the low level of understanding of the impacts and benefits entailed by flexibility service provision and the lack of confidence shared among market actors hinders the successful implementation of the investigated flexibility solutions. At the same time, regulation is still lacking behind in many Member States, coming short to relieve the identified issues and urging action at the European level.

To overcome these barriers, INTERRFACE and CoordiNet have worked together to formulate a set of shared policy recommendations addressing the topics of *Roles and Responsibilities*, *Requirements for information sharing*, *Requirements of prequalification process*, *Requirements of the settlement process*, *Geographical scope and network representation*, *Consumer engagement*, and *Scalability and Replicability*. The following points aim at summarising and highlighting the fundamental, common stances of the two projects, while Table 1 presents a more extensive overview of the recommendations:

- Firstly, it is of utmost importance to strive for **coordination among energy system stakeholders**, characterised by seamless information exchange and clear definitions of responsibilities, fostering efficiency of the overall energy system operation and enhanced benefits for all market players.
- Secondly, the **harmonisation of definitions, processes, and best practices across the EU**, with the end goal of simplifying the setup and operation of market-based flexibility solutions, supporting the design of interoperable and yet tailored systems, and altogether enabling their scaling up and replication is needed.
- Lastly, it is crucial to **empower current and new potential market actors** by providing them with the tools necessary to understand the opportunities offered by flexibility markets, strengthen their role within them, and overall increase their trust, by guaranteeing transparency as one of the fundamental principles in the design of future electricity markets.

Stemming from the fruitful collaboration and knowledge-sharing process led by INTERRFACE and CoordiNet, the joint recommendations presented in this paper, particularly in Chapter 6, constitute a powerful tool to tackle the barriers identified through the experience of the two projects and facilitate the deployment of the solutions they have tested, all in all paving the way towards harmonised flexibilities markets in Europe.

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