CROSS-BORDER FLEXIBILITY PREQUALIFICATION OF DER AND EVS BASED ON DECENTRALISED COMMUNICATION MECHANISMS FOR THE DISTRIBUTION SYSTEM OPERATION

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ABSTRACT

The adoption of battery-powered electric vehicles in the EU is expected to grow to 30-40 million by 2030. This, together with the large adoption of other Distributed Energy Resources (DERs), represents a great challenge for Distribution System Operators *(DSOs) in multiple perspectives, such as providing the needed charging infrastructure and ensuring that everyone is served with the expected Quality of Service (QoS), by having a secure and reliable system operation capable of mitigating grid congestion and voltage violation events. One of the mechanisms to mitigate these events can be the usage of these DER, such as* Electric Vehicles (*EVs), as flexibility sources for the improvement of the planning and operation of power distribution systems. This paper proposes harmonising the coordination of the prequalification process for flexibility provision (product and grid prequalification) among System and Market Operators from Portugal, Spain and France, enabling the participation of flexibility providers in multiple markets from cross-border countries through a harmonised and non-redundant prequalification process.*

INTRODUCTION

The continuous growth of distributed renewable generation and energy storage systems, together with the expected increase in active customers engaged in demand response and electric mobility, poses several challenges in system operators' (SO) current planning and operational practices. A key issue to be addressed on the path to energy transition, is how to incorporate the demand flexibility services, derived from these new assets and players into the energy market, using them for operational and ancillary services, that can address different technical issues such as ensuring resilience, efficiency, and reliability for modern electricity grids.

Electric Vehicles have the potential to boost flexibility markets by taking advantage of its batteries as a means of energy storage, hence a resource for up or downwards flexibility provision.

The charging can be done using smart chargers to avoid peak hours, where prices are higher and only charge when the demand is low, or there is a surplus in generation. Storage can be used oppositely by providing energy during peak hours in a vehicle-to-grid (V2G) approach, or be explored as a local resource, supplying electricity to a building known as vehicle-to-building (V2B) or home (V2H).

This creates a great opportunity, not only for the (DER) and EVs, but also for DSOs in matters related to grid operation such as, grid congestions and intermittent energy generation challenges.

This paper aims to present a use case for a cross-border prequalification process, of DER and EVs resources, for flexibility provision, put to proof in the Western Cluster demonstration at the EU funded H2020 OneNet project[1].

1 EU funded H2020 OneNet project: https://onenet-project.eu/

METHODS

In this section, further information will be added as to how the prequalification process of DER and EVs resources will occur, the proposed decentralised architecture approach to the information exchange and, lastly, the use case scenario that translates this same information exchange.

Prequalification

The initial process for flexibility procurement called "Prepare" (in Figure 1), as described in the Active System Management (ASM) report [1], begins with the prequalification of assets, which ensures that the flexibility offered by a particular flexibility service provider (FSP) can be delivered without causing an undesired impact.

This prequalification is a rather complex process involving detailed information and data exchanges, between the system operators, market operators and flexibility providers.

Figure 1 - Flexibility procurement overall process.

The ASM report describes the Preparatory phase, as a crucial stage to enable effective functioning of any flexibility market, because it is a process that ensures that the flexibility offered by a particular flexibility service provider, which has an EV or other DER as a flexibility resource, can be delivered without causing an undesired impact in either of the involved grids. Moreover, once the services and the providers are prequalified, they are registered in a flexibility register. The report splits the prequalification evaluation into product and grid prequalification processes.

On the one hand, the product prequalification is done to determine, whether the unit can perform according to the general requirements set by the system operator, to deliver the product it wants to sell/deliver. On the other hand, grid prequalification is defined as checking whether the grid can manage the delivery of the product. It can be repeated regularly and whenever the technical characteristics of the FSP, or the grid where it is connected to, notably change. However, these prequalifications do not exclude the need for the unit to be examined again, in case of possible activation, already in the market phase, known as qualification.

Finally, after the FSP passes the product and grid prequalification, its information is stored in a flexibility register (the Flex register), a database in which information of all FSPs interested in participating in the flexibility market is stored, and it can be shared.

This process requires a high level of coordination and communication between the system and market operators, which can be achieved using the proposed reference architecture for interoperability and cross-platform interactions from the OneNet project, which is briefly presented next.

Architecture

The OneNet project, will develop an open and flexible architecture to transform the actual European electricity system, which is often managed in a fragmented country- or area-level way, into a smarter and more efficient pan-European one, while maximising consumer capabilities to participate in an open market structure. This architecture and the Cluster Demonstration approach taken by the project, could provide good insights into the future implementation of this unique pan-European solution, for coordinating a multi-country and multi-stakeholder market and grid operations.

The use of standardised interfaces and mechanisms with a great focus on a decentralised approach, assumes a fundamental importance when tackling the requirements needed to ensure scalability for the near real-time data integration and management, enabling a multi-country and multi-stakeholder near real-time service.

To fulfil these requirements, the OneNet reference architecture introduces three logical levels:
OneNet Participants – base level layer that includes data sources and energy stakeholders.
OneNet Network of Platforms – the middle layer of the system, comprising all platforms that coexist by sharing data and using cross-platform services. It is also here that an important component appears: the OneNet Connector.
OneNet Framework – the core of this architecture holds three main components: the OneNet Decentralized Middleware, the OneNet Orchestration Workbench and the OneNet Monitoring and Analytics Dashboard.

A **OneNet Connector** is a specific instance of the OneNet Decentralized Middleware, will be placed inside each platform and allow easy integration and cooperation among the platforms, maintaining the data ownership and preserving access to the data sources. The OneNet Connector is essential for connecting and integrating a platform within the OneNet ecosystem.

Figure 2 represents the first outcome of a fully decentralised architecture, where the OneNet Connector creates a path to an interoperable network for data providers and consumers.

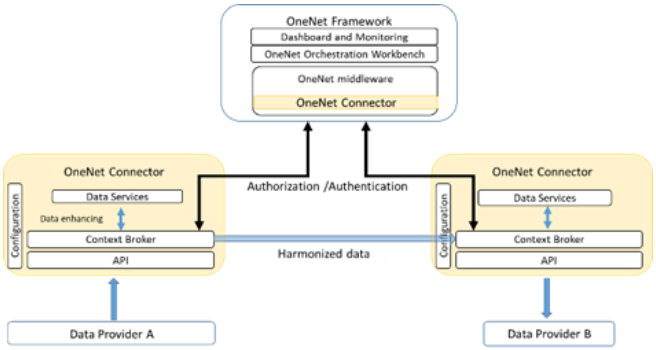

Figure 2 - OneNet Decentralised approach [2]

Regional Use Case

This Regional Use Case aims to advance the interaction and information exchange between the countries in the Western Cluster (i.e. Figure 3) while improving the development of cross-border solutions aligned with the OneNet project goals.

The name of this use case is "Cluster Preparatory Phase: Cross-SO grid prequalification". The use case aims to describe how a FSP can be prequalified to provide flexibility to the SO to whom it is directly connected , or toanother SO, in which the FSP has no direct connection to. This use case leaves the sphere of DSO-TSO coordination to a broader one, where a FSP connected to one SO can be prequalified to a neighbouring SO, if this is physically possible. This type of cross-SO prequalification could be useful, for instance, in places where two DSOs are directly connected or even at two country borders, given that the interconnection characteristics allow for flexibility provision. [3]

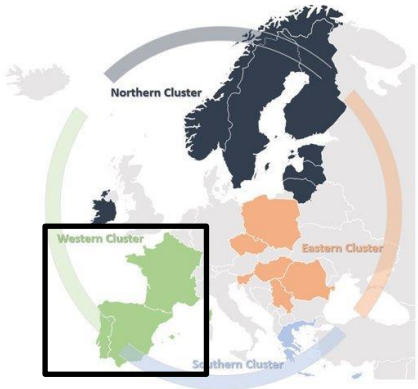

Figure 3- OneNet demonstrator's countries and corresponding cluster [4]

The challenge of this regional use case is, taking into account the particular constraints of each country, to be able to harmonise the main elements of the prequalification processes (product and grid prequalification) and to define the main requirements that FSPs have for their Flex register for all countries in the Western Cluster. Therefore, a "minimum" set of information is agreed among the SOs involved in the Western Cluster for grid and product prequalification. Beyond this information set, SOs can request additional information to complete the prequalification processes if necessary. Coordination between system and market operators from the cluster is needed to carry out this preparatory phase.

The development of this use case is important since it addresses some principles agreed between system operators that are described in the ASM Report, such as defining clear needs from an operational perspective to allow the FSPs to develop sound products, facilitate the participation of all market parties, lower entry barriers and enable any service provider to sell its service in all markets. For instance, an Aggregator or an FSP who wants to participate in two Flexibility Markets from different countries could enter using the same rules.

In this regional Business Use Case, the OneNet system is essential to foster the interaction among system operators, market operators and Flexible Service providers.

The main actors to play a role in this use case are described as follows:

Host MO
The Host Market Operator is a role characterised by the operation of the flexibility market in the country/grid to which the FSP is electrically connected. This role can be performed by different actors such as the DSO, the TSO or an Independent Market Operator.

Host SO
The Host System Operator is a role characterised by operating the networks in the country/grid to which the FSP's resources are electrically connected. This role is performed by the DSO(s) and/or the TSO(s). This role may include the connecting DSO, the intermediate DSO (if applicable), and the country's TSO in which the FSP's resources are physically located.

Foreign MO
The Foreign Market Operator is a role characterised by the operation of the flexibility market in the foreign country/grid to which the FSP is being prequalified to provide the cross-SO flexibility service. This role can be performed by different actors such as the DSO, the TSO or an Independent Market Operator.

Foreign SO
The Foreign System Operator is a role characterised by the operation of the networks in the foreign country/grid to which the FSP is being prequalified to provide the cross-SO flexibility service. This role may include the DSO to which flexibility will be provided, the intermediate DSO (if applicable), and the foreign country's TSO.

OneNet System

The OneNet System is the IT solution developed within the OneNet project that allows the integration and collaboration of the OneNet Participants (platforms, applications, services), facilitating the cross-platform market and network operations, ensuring scalability and interoperability while maintaining the data ownership. More in detail, the integration of the OneNet Participants will be done through the OneNet Decentralised Middleware, composed by the OneNet Connectors.

FSP

It is defined as any legal entity that offers flexibility services in the market.

The interactions between these actors when performing a cross-border flexibility prequalification, are well defined in the sequence diagram of Figure 4. This use case assumes that the prequalification requirements are comprehensively defined among the stakeholders beforehand and that the FSP is already prequalified in its origin.

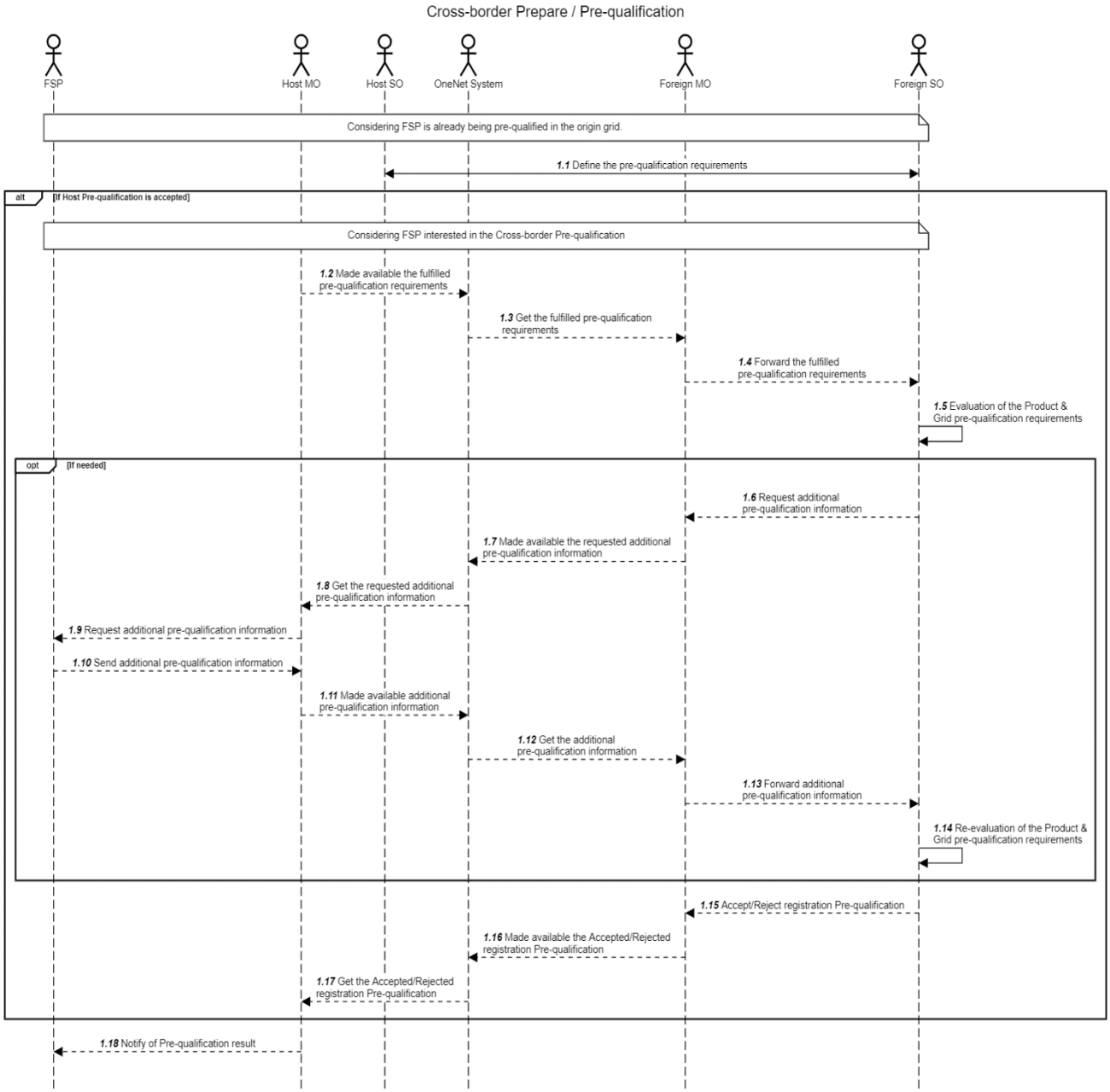

Figure 4- Regional Use Case sequence diagram

The Host MO makes available the fulfilled prequalification requirements through the OneNet System flowing down the chain, until it reaches the desired Foreign SO. Then the Foreign SO can evaluate the product and grid prequalification.

At this stage, the Foreign SO can either request furtherinformation from the FSP pushing the request down the chain or, if all is in conformation to the requirements, send an Accept/Reject of the prequalification result.

For this use case, the following information is proposed to be exchanged taking into consideration previous analyses: ID, Name, Type of resource, which could be an EV or other appropriate DER, Mode of activation [manual/automatic], Flexibility direction, Locational information and SO connected, Single or Aggregated portfolio, Maximum Quantity, Maximum full activation time and Grid Prequalification Result, as shown in Table 1 [5].

Table 1- Exchanged Information Example

Fields	Example
ID	PT-FSP30
Name	António Silva
Type of Resource	EV + Smart Charger
Flexibility Direction	Up and Down
Locational Information	Lisboa
SO Connected	E-REDES
Single or Agreggated Portfolio	Single
Maximum Quantity	22 kW
Maximum Full Activation time	2 min
Grid Prequalification Result	Accepted

CONCLUSION AND EXPECTED RESULTS

This Regional Use Case wants to achieve a seamless data exchange between all the stakeholders in the Western Cluster countries, with well-defined actors and the required communication. They are contributing to harmonising and standardising the prequalification process and requirements among cluster members and the data that is being exchanged. These achievements could be a positive step in realising a pan-European energy market, where DER and EVs will be the new reality in flexibility provision.

This demonstration expects to deliver some KPIs (Key Performance Indicators) stated in the OneNet public deliverable D2.4 [6]. One example is the rate of acceptance in FSPs, willing to be prequalified across country borders or across an SO border, or the measurement of the prequalification execution time, which can be very relevant when determining the feasibility of an implementation in a production environment, among others.

In the future, the next steps in the flexibility procurement process as presented previously should be addressed at a cross-border level. For now, the Planning/Forecasting and Market Phase process will be demonstrated at a national level in the Portuguese and Spanish demonstration.

ACKNOWLEDGEMENTS

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