Scalability and Replicability Analysis for market schemes and platforms

D11.4

Authors:

Miguel Ángel Ruiz (Comillas)

Rafael Cossent (Comillas)

José Pablo Chaves (Comillas)

Responsible Partner	Comillas
Checked by WP leader	José Pablo Chaves (Comillas), 21/10/2023
Verified by the appointed Reviewers	Luciana Marques (VITO) 18/10/2023 Kinga Biró (BME) 22/10/2023
Approved by Project Coordinator	Padraic McKeever (Fraunhofer), 05/11/2023

Dissemination Level	Public

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

Issue Record

Planned delivery date	31/10/2023
Actual date of delivery	05/11/2023
Version	v1.0

Version	Date	Author(s)	Notes
0.1	30/06/2023	Miguel Ángel Ruiz	Document creation, table of contents
0.2	11/10/2023	Miguel Ángel Ruiz, Rafael Cossent, José Pablo Chaves	Draft for internal review
0.3	26/10/2023	Miguel Ángel Ruiz, Rafael Cossent, José Pablo Chaves	Draft ready for quality check after internal review
1.0	31/10/2023	Miguel Ángel Ruiz, Rafael Cossent, José Pablo Chaves	Final version

About OneNet

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

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

As the electrical grid moves from being a fully centralized to a highly decentralized system, grid operators have to adapt to this changing environment and adjust their current business model to accommodate faster reactions and adaptive flexibility. This is an unprecedented challenge requiring an unprecedented solution. The project brings together a consortium of over 70 partners, including key IT players, leading research institutions and the two most relevant associations for grid operators.

The key elements of the project are:

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

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

Table of Contents

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

List of Figures

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

List of Tables

List of Abbreviations and Acronyms

Acronym	Meaning
BESS	Battery Energy Storage System
BUC	Business Use Case
CM	Congestion Management
D	Deliverable
D-1	Day Ahead
DER	Distributed Energy Resource
DG	Distributed Generation
DSO	Distribution System Operator
EACL	Eastern Cluster
EU	European Union
EV	Electric Vehicle
FSP	Flexibility Service Provider
GRIFOn	Grid Forum
HLUC	High-Level Use Case
HV	High Voltage
ICT	Information and Communication Technology
I-D	Intra Day
KPI	Key Performance Indicator
LV	Low Voltage
mFRR	Manuel Frequency Restoration Reserve
MO	Market Operator
MV	Medium Voltage
NOCL	Northern Cluster
NRT	Near Real Time
P	Active Power
PV	Photovoltaic
PVPP	PV Power Producer
Q	Reactive Power
RES	Renewable Energy Source
RR	Reserve Restoration
SCADA	Supervisory Contro0l and Data Acquisition
SGAM	Smart Grid Architecture Model
SO	System Operator
SOCL	Southern Cluster
SRA	Scalability and Replicability Analysis

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

T	Task
TSO	Transmission System Operator
WECL	Western Cluster
WP	Work Package
WPP	Wind Power Producer

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

Executive Summary

OneNet aims to create conditions for a new generation of system services able to fully exploit demand response, storage and distributed generation while creating fair, transparent and open conditions for the consumer. The project implementation includes demonstrators in four regional demonstration clusters covering over 15 countries which face very different environmental, techno-economic, institutional or regulatory boundary conditions. This raises the question concerning to what extent the outcomes attained within the demo scope would apply when subject to changes in scale of some boundary conditions.

To address this, the Scalability and Replicability Analysis (SRA) presented in this deliverable aims to identify and evaluate the enablers and barriers that would be met when upscaling or replicating the OneNet solutions and Business Use cases (BUCs) and explore the conditions under which the results observed in the demos remain valid and robust. An SRA can be carried out attending to many different dimensions. In order to avoid overlaps with other tasks within WP11, task 11.4 mostly addresses functional aspects affecting scalability and replicability of the demo solutions.

The methodology relies on two main inputs. First, a set of relevant previous EU projects were identified. Then, BUCs in the identified projects were analysed and mapped against OneNet`s BUCs (considering market architecture, KPIs, services tested and demo site characteristics) in order to identify key outcomes from these projects that can be applicable to OneNet as well as to identify some gaps and challenges not fully covered in past projects. Secondly, these gaps were addressed through consultation among OneNet partners and stakeholders via surveys and workshops. Based on all these, this report identified some key barriers when replicating or upscaling the OneNet solutions. These results will serve as an input for the roadmap for an EU wide implementation of market schemes and interoperable platforms developed in Task 11.7.

The mapping of BUCs from previous European projects with OneNet BUCs led to the identification of the following main gaps not covered in previous projects: bias in favour of tackling MV grid constraints with flexibility services rather than LV constraints, focus on short-term and medium-term flexibility procurement but not long-term. In most projects the test/demos are simulated and do not include real data from some of the market participants (e.g. bids of FSPs), resulting in an absence of actual estimations of flexibility costs. Moreover, very few projects incorporate the regional component intrinsic to OneNet regional BUCs.

These gaps were addressed through a consultation both with internal (demo partners) and external stakeholders (GRIFOn) carried out through workshops and surveys. Moreover, regarding actual flexibility costs, publicly available data from the UK was used as a reference to challenge demo views. The results of this process show that there are still some potential barriers to scalability and replicability of OneNet solutions:

- Levels of LV grid monitoring diverge across countries, constituting a barrier for replicability, particularly for BUCs where LV FSPs are considered. There are different steps to cover in the process of LV grid monitoring,

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

from deployment of smart meters and LV supervisors to state estimator tools and sub-metering. Likewise, there is also the need for greater MV grid monitoring in some countries.

- Most OneNet BUCs focus on demand driven constraints, whereas demo partners generally expect more frequent supply-driven constraints in their network. This represents a misalignment between the BUCs tested and the grid conditions for which they were tested, as compared to the grid conditions and flexibility needs most commonly expected by grid operators and is a barrier for scalability/replicability since demo results obtained using flexibility to address a certain type of flexibility need may show a different level of performance under different grid conditions.
- In addition to demand or supply-driven constraints (i.e. congestions and/or voltage issues), there is large agreement between demo partners on the potential of flexibility-based solutions for N-1 scenarios as these are low-probability/high-impact events. Note that this is not a replicability barrier, but a potential driver for flexibility in areas where N-1 scenarios represent a relevant bottleneck for the connection of DER.
- Demo countries reported different levels of FSP availability per type (residential loads, industrial loads, stand-alone storage, controllable DG, non-controllable DG) and voltage level (MV, LV). This is quite relevant as previous projects highlighted the importance of, in terms of scalability and replicability, of engaging the types of FSPs best-suited to the local flexibility need. Thus, the results obtained in terms of the technical and/or cost performance of the FSPs in each project may not be directly replicable in other area with different FSP types.
- In relation to the above, grid operators, when asked about the usefulness of the different types of FSPs, i.e. the ones they deemed more suitable to meet their flexibility needs, stated that stationary storage and controllable DG could be considered the most useful overall, followed by industrial/commercial load. Note that the FSP types deemed as the most useful among the different types of FSPs were not always the ones most commonly available to grid operators. A difference in the expected contribution of different types of FSPs to each system service (balancing, congestion management and voltage control) was observed. In particular, diverging views concerning the expected contribution of non-controllable DG to congestion management and voltage control were found. Various reasons for this were identified of a technical (e.g., high R/X ratio rending Q control ineffective for voltage control, limited capabilities of some inverters), regulatory (e.g., fixed cos phi requirements, minimum bid sizes), or economic (e.g., uncertain flexibility costs) nature.
- Responsibility allocation in case of non-delivered flexibility is a relevant or very relevant concern for most project demos. However, there is a general agreement between most of the project partners that this will become somehow less relevant as experience is gained and trust is built between SOs and FSPs.
- Lastly, the regional aspect (including multiple countries in a demonstration) of some BUCs in OneNet led the partners to identify barriers for cross-border flexibility solutions. First, insufficient harmonization of products and services, unclear governance and coordination among stakeholder, or connectivity and cybersecurity concerns.

1 Introduction

The European Green Deal aims to achieve a carbon neutral economy in the European Union by 2050. Subsequently, the European Climate Law wrote this goal into law and set the intermediate target of reducing emissions by at least 55% by 2030 as compared to 1990. More recently, the revised Renewable Energy Directive set the goal to increase the share of RES in the EU final energy consumption to 42.5% by 2030 (with an additional 2.5% set as indicative). The decarbonization pathways to achieve these targets necessarily imply the electrification of large shares of final energy use and the decarbonization of the electricity mix [2]–[4]. Besides an increase in intermittent generation, an inevitable consequence of decarbonization is the decentralization of the power system, i.e., strong growth of the so-called Distributed Energy Resources (DERs) [5]–[7]. These comprise active customers, distributed generation (DG), electric vehicle (EV) charging infrastructure, or battery energy storage systems (BESS).

In this context, conventional approaches to system operation and grid management where production follows demand and centralized generation is virtually the sole system service provider no longer remain valid. Enhancing the use of flexibility, i.e., the capability to adapt energy injection or withdrawal levels according to system needs, from all available resources regardless of the voltage level at which they are connected, or their nature becomes more and more necessary to ensure a secure and efficient system functioning [3], [6], [8].

In this context, the OneNet project aims to create conditions for a new generation of system services able to fully exploit demand response, storage and distributed generation while creating fair, transparent and open conditions for the consumer. This ambitious view is to be achieved through new markets, products and services and creating a unique IT architecture. The project implementation includes demonstrators in four regional demonstration clusters covering over 15 countries which face very different environmental, techno-economic, institutional or regulatory boundary conditions. This raises the question concerning to what extent the outcomes attained within the demo scope would apply when subject to changes in scale of some boundary conditions.

Therefore, the aim of the Scalability and Replicability Analysis (SRA) presented in this deliverable is to evaluate the enablers and barriers that would be met when upscaling or replicating the OneNet solutions and Business Use cases (BUCs) and to explore the conditions under which the results observed in the demos remain valid and robust.

1.1 Task 11.4

The outcomes from the cluster demonstrators can be strongly affected by the conditions under which the demos are implemented. As a result, the lessons learnt may not be directly applicable to other systems and networks. The SRA aims to fill in this gap by assessing the effect of the implementation of the proposed solutions on a larger scale or under different contexts. The work carried out in this task builds on the SRA methodology

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

that was presented in D2.4 [1] - *OneNet priorities for KPIs, Scalability and Replicability in view of harmonised EU electricity markets*. This methodology is described later in this report. The conclusions from this task will be a relevant input for OneNet implementation challenges developed in T11.7 - *EU wide implementation of market schemes and interoperable platforms*.

1.2 Objectives

This deliverable has been developed within the framework of OneNet WP11 whose main objective is to analyse the results of the different clusters and its demonstrations in order to draw conclusions supporting the EU wide implementation of standardized system products in a coordinated manner through interoperable platforms. Other tasks in WP11 contribute to this goal by addressing aspects such as the technical evaluation of the demo KPIs, the implemented market sequences and products, interoperability of platforms and data exchanges for seamless TSO-DSO-customer coordination, business models and customer engagement.

In this context, the objective of Task 11.4 is to complement the aforementioned tasks by performing a Scalability and Replicability Analysis (SRA) of the proposed BUCs and market schemes, i.e., evaluating the drivers and barriers for implementing the same or similar solutions in different contexts and/or at a larger scale. An SRA can be carried out attending to 5 different layers (i.e. business layer, function layer, information layer, communication layer, component layer). This can be represented through the SGAM model (see Figure 1.1) as proposed by the BRIDGE Task Force on Scalability and Replicability [9].

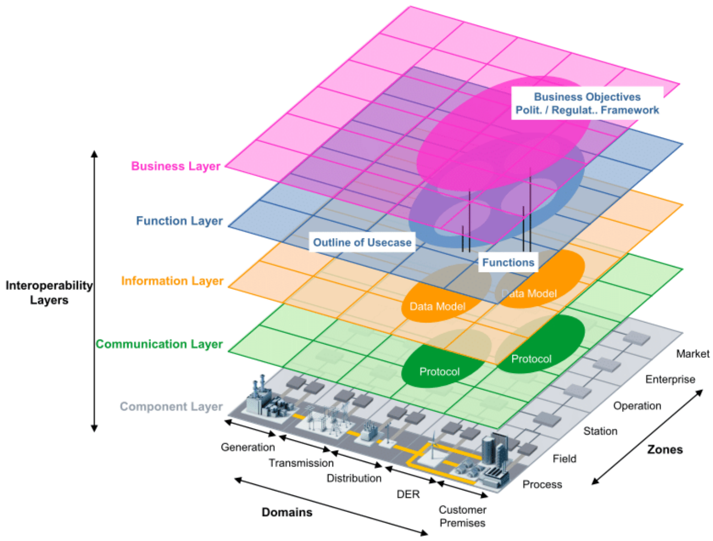

Figure 1.1 SGAM diagram. Source:[10]

Most of the other WP11 tasks can be linked to the business layer (e.g., customer engagement of business models) or the information and communication layers (interoperability and data exchange). On the other hand, task 11.1 focuses on the functional layer but limiting itself strictly to the demo results, i.e., not going beyond in scope or scale. Thus, in order to complement the other WP11 activities, task 11.4 mostly addresses functional aspects affecting scalability and replicability of the demo solutions.

Two main inputs are used to accomplish this. First, a set of relevant previous EU projects were identified. Then, BUCs in the identified projects were analysed and mapped against OneNet`s BUCs (considering market architecture, KPIs, services tested and demo site characteristics) in order to identify key outcomes from these projects that can be applicable to OneNet as well as to identify some gaps and challenges not fully covered in past projects. Secondly, these gaps were addressed through consultation among OneNet partners and stakeholders via surveys and workshops. Based on all these, this report identified some key challenges and barriers when replicating or upscaling the OneNet solutions. These results will serve as an input for the roadmap for an EU wide implementation of market schemes and interoperable platforms developed in Task 11.7.

1.3 Outline

The remainder of this deliverable comprises five main chapters and one appendix:

- Chapter 2 describes the methodology that has been followed to carry out the SRA.
- Chapter 3 enumerates the past and on-going EU projects that were selected based on their similarities in goals and scope to the OneNet BUCs, whose analysis served as a key input to the SRA.
- Chapter 4 provides and in-depth mapping of the OneNet BUCs and KPIs against those defined and demonstrated in the previously short-listed projects. Moreover, the SRA methodology and key conclusions drawn by such projects are presented to the extent that they are applicable to the OneNet BUCs. As a result of all the above, a set of gaps and challenges concerning the BUC scalability and replicability is identified.
- Chapter 5 describes the survey that was carried out among OneNet demo partners in order to fill-in the previously identified gaps and challenges and presents the feedback collected and main lessons learnt.
- Lastly, chapter 6 concludes the deliverable with the main takeaways from this deliverable.
- The appendix presents the questionnaire circulated among the OneNet demo partners aiming to gather additional information so as to address the identified gaps and challenges.

1.4 How to Read this Document

Reading this deliverable requires a certain prior knowledge about the functioning of European electricity markets, power system operation and electricity networks. Likewise, familiarity with some key concepts on local flexibility markets design and TSO-DSO coordination schemes is advisable.

Moreover, this deliverable strongly relies on the results achieved by other work packages (WPs) and tasks of the OneNet project. More specifically, as shown in Figure 1.2, this task builds on BUCs and KPIs defined in WP2

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

and the lessons learnt and outcomes of other tasks within WP11, especially T11.1 and its deliverable D11.1 [11] on the demo characteristics and KPI assessments and D11.2 from T11.2 [12] on the market process and product standardization. Furthermore, this task extracts results from demonstrators' deliverables presenting information on BUC implementation, KPI collection and other results. Therefore, reading these OneNet deliverables is recommended to fully benefit this deliverable.

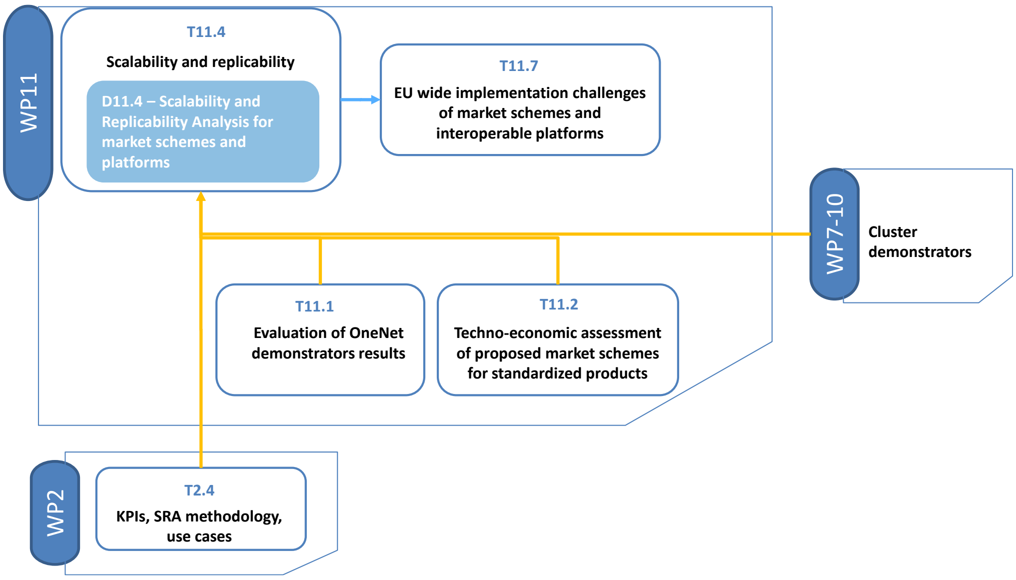

Figure 1.2 Interactions between Task 11.4 and other work packages in OneNet.

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

2 SRA Methodology

Following Task 2.4 and D2.4 [1], Figure 2.1 presents the SRA methodology adopted in this task. This SRA approach is mostly qualitative and relies on two main types of input data sources: i) desk research to identify and analyse relevant SRA results from previous EU projects and ii) feedback from partners and project stakeholders on SRA results and gaps.

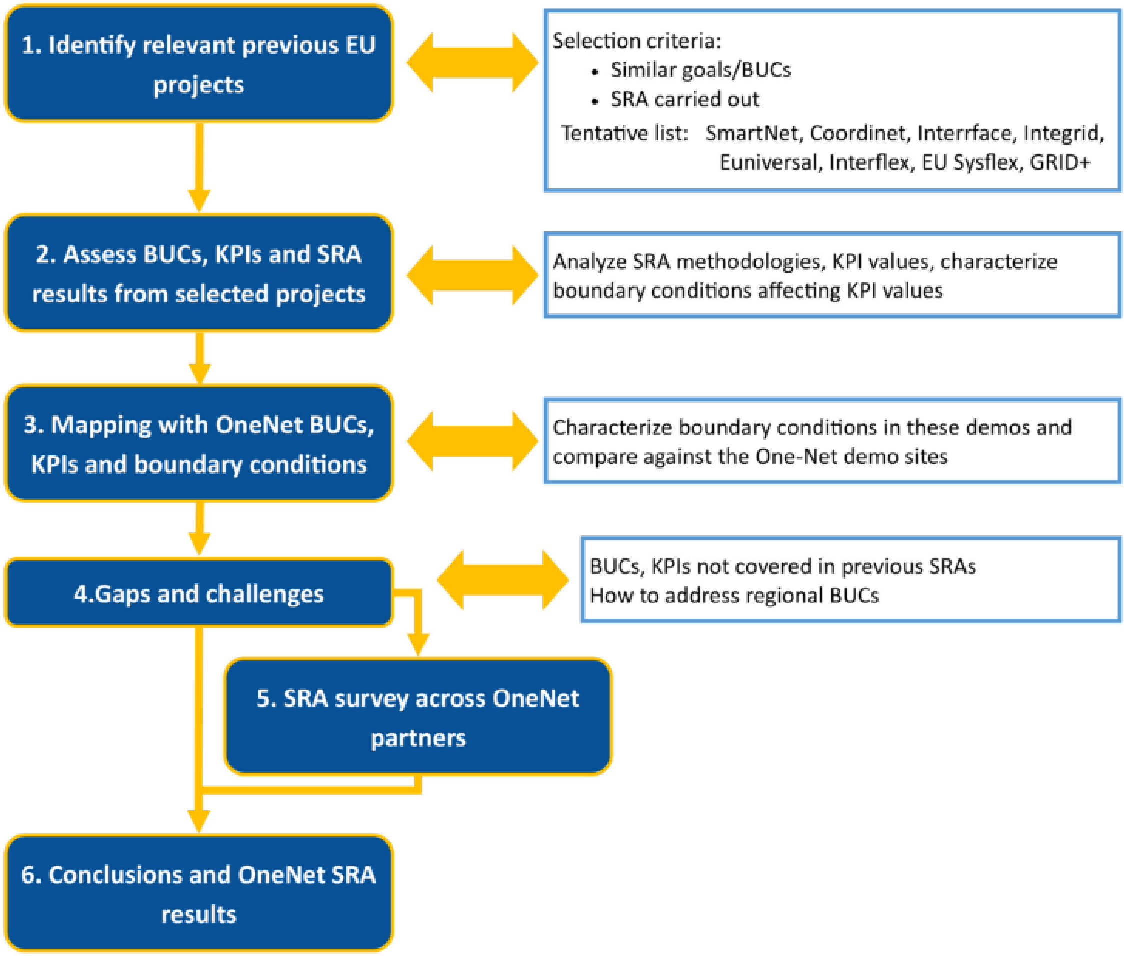

Figure 2.1 - Overview of the SRA methodology

Each of these steps is described in further detail below. It is important to note that, despite its representation, these steps are not fully sequential, as feedback loops exist between them.

1. Identification of previous relevant EU projects. First, a selection of key past and ongoing projects was analysed. This selection identified what projects tested similar use cases and/or measured comparable KPIs. Among these, particular attention was paid to those projects that performed some form of SRA or implementation roadmap. The information from these projects was mostly collected from publicly available reports, but also benefitting from the fact that many OneNet partners have

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

been involved in some of these projects, and through contacts within the corresponding consortiums of these projects in case reports are not available at the time of performing the OneNet SRA.

2. Assessment of the information from selected projects. For every selected project, the relevant information was analysed in detail. The key aspects evaluated include i) the use cases tested and their implementation (e.g. time horizon for flexibility procurement and activation, flexibility products definition, coordination schemes, market sequence, etc.), ii) the SRA methodology and scope (e.g. the layers considered, i.e. functional, market and regulation, economic, social, etc.) iii) the definition of KPIs and the numerical values obtained both from demo activities and SRA studies, and iv) the boundary conditions affecting the KPI values obtained (e.g. grid characteristics, types and number of participating FSPs).
3. Mapping relevant projects against OneNet demos. The characterization of the previous projects obtained in the previous step was compared systematically against the characteristics of OneNet use cases and demo sites. This step aims to assess how comparable or applicable the conclusions of previous SRAs and demos are to the OneNet demonstrators. Differences and similarities on all the aforementioned factors were analysed to extrapolate past results to OneNet contexts.

4. Identification of existing gaps and challenges. The initial desk research, together with the previous step, allowed detecting specific gaps and challenges for assessing OneNet solutions scalability and replicability. These include particularities of some BUCs not covered in previous projects, missing quantification of certain KPIs, or the fact that regional use cases have not been evaluated in past projects.

5. Survey among OneNet partners and stakeholders. In this step, ad-hoc surveys addressed key OneNet partners, particularly those involved in the demos and clusters. The aims of these surveys were i) to validate the results obtained so far and ii) to fill in the gaps identified in the previous step. In addition, other means of consultation were carried out among project stakeholders during a GRIFOn meeting.

6. OneNet SRA results and conclusions. Lastly, the results and lessons learnt from all the previous steps were collected to draw the final conclusions and SRA results.

The results of step 1 of the methodology are presented in section 3 of this report. Next, the main outcomes of steps 2 to 4 of the methodology can be found in section 4. In turn, section 5 describes in further detail the approach followed to carry out the consultation among internal and external stakeholders as well as the feedback obtained (step 5). Lastly, section 6 presents the main conclusions from the whole SRA (step 6).

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

3 Selection of previous relevant EU projects

The SRA methodology starts with the identification of previous projects with similar use cases and comparable KPIs that performed an SRA analysis. The initial list of projects identified in [1] was expanded, then some of the projects were discarded if not fulfilling certain conditions, such as: not being a European project with start and end date; lacking publicly available documentation (e.g. project's web page not functioning, some of the key deliverables for this analysis not being available); BUCs of the project not similar with OneNet BUCs; SRA not performed during the project. Table 3.1 presents the final list and the reasons for not including some of the projects in the analysis. Next, we included a brief description of the projects finally selected.

Table 3.1 – List of European projects and reasons for not considering the discarded ones.
Green fill: Projects finally considered for OneNet SRA.
Orange fill: Criterion not fulfilled.
Grey fill: Project not considered, not necessary to evaluate the criterion.

	European project with start and end date?	**BUC defined based on standards…**	**SRA performed**	**Available documentation in the web (BUC definitions, demo-site descriptions, KPIs, SRA)**	**BUCs are similar to OneNet?**
CoordiNet[1]					
EU-SysFlex[2]					
Interrface[3]					
NODES[4]	No				
Crossbow[5]					
TDX-Assist[6]					
Integrid[7]					
InterFlex[8]					
Piclo-Flex[9]	No				
Enera[10]			Not standard SRA performed		

[1] https://coordinet-project.eu/
[2] https://eu-sysflex.com/
[3] http://www.interrface.eu/
[4] https://nodesmarket.com/
[5] https://cordis.europa.eu/project/id/773430/results
[6] http://www.tdx-assist.eu/
[7] https://cordis.europa.eu/project/id/731218/results
[8] https://interflex-h2020.com/
[9] https://picloflex.com/
[10] https://projekt-enera.de/

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

FARCROSS[11]				Lack of available documentation in the web	
GOPACS[12]	No				
Smartnet[13]			SRA not performed		
Synergy[14]					BUCs focused on ICT, not in testing flexibility solutions
OSMOSE[15]					
Flexitranstore[16]				Lack of available documentation[16]	
Platone[17]					
E-Universal[18]					

The CoordiNet project's objective is to demonstrate cost-efficient models of TSO-DSO coordination for electricity network ancillary services, contributing to a more secure and resilient energy system. The project includes demonstrators in Greece [13], Spain [14] and Sweden [15] where different BUCs where designed to test different market models (e.g. central, multi-level, common, distributed…) for different system services (i.e. congestion management, voltage control, frequency balancing, controlled islanding) [16].

The objective of the EU-SysFlex is to demonstrate flexibility solutions for system services (i.e. congestion management, voltage control, frequency balancing) in close to real time [17] by means of flexibility markets, mandatory services or regulated remuneration. Different pricing mechanisms are tested (market or regulated fee, pay as bid or pay as clear, remunerated quantities).

The objective of the Interrface is to define standardize products (harmonizing CM products into balancing market) and create a market architecture for enabling DERs to provide system services across Europe [18], [19].

TDX-Assist focuses on ICT solutions for data management and information exchange for SOs, enabling enhanced cooperation between SOs, thus facilitating smart grid functions. The project includes demonstrators in Slovenia, France and Portugal.

Crossbow is highly focused on ICT solutions for cross-border information exchange to enable flexibility provision from DERs to provide system services [20].

[11] https://farcross.eu/
[12] https://en.gopacs.eu/
[13] https://smartnet-project.eu/index.html
[14] https://synergyproject.eu/
[15] https://www.osmose-h2020.eu/
[16] Website of Flexitranstore project not available. A search in web archive resulted in most of the deliverables not being accessible due to confidentiality and no SRA documentation https://web.archive.org/web/20221007212145/http:/flexitranstore.eu/Publications.
[17] https://www.Platone-h2020.eu/
[18] https://EUniversal.eu/

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

Integrid focuses on demonstrating how DSOs may enable active participation of different stakeholders in the energy market, allowing DSOs to plan and operate a network with high shares of RES in a secure and cost-efficient manner. The project includes demonstrators in Sweden, Slovenia and Portugal. The project includes different use cases focused on customer engagement, aggregation, solutions for grid users (Home energy management), distribution grid operation with flexibility, and market features (e.g. prequalification, traffic light system for TSO-DSO coordination).

InterFlex focuses on the use of flexibility solutions for a better integration of renewable energy sources, using existing services while improving the current management of energy residuals. The BUCs study the impact of reconfiguration, demand response and energy storage in providing ancillary services [21], the focus is on studying the technical capabilities of DERs to provide ancillary services, not on the design of markets and TSO-DSO coordination schemes. ICT and policy recommendations for enabling flexibility provision are given in the scalability and replicability analysis [22].

OSMOSE focuses in studying how different technologies (BESS, wind farms and industrial loads) can provide system services pointing out what should be the priorities in the future based on the potential of this technologies. It was also highlighted that advanced energy management systems offer opportunities for TSO in optimizing operational costs.

Platone focuses on developing an architecture for operation of distribution networks. The aim is to enable SOs and aggregators data acquisition for smart network management [23]. The solution proposed may receive data from different sources (e.g. weather forecasting, data from smart devices) improving forecasting of consumption and generation patterns. The German demo tested energy management systems for energy communities. The Italian demo tested flexibility market solutions adapted to the Italian and European regulation[19]. The Greek demo tested the provision flexibility by DERs through network tariffs use case included in the SRA [25], [26].

EUniversal focuses on overcoming existing limitations in the use of flexibility by DSOs. The project includes demonstrations of local flexibility markets for congestion management and voltage control in MV and LV networks using active and reactive power. Three demos participate in the project (i.e. Portugal, Germany and Poland) [27].

The next step was to analyse SRA methodologies and l considered in the list of selected projects and map their BUCs against OneNet.

[19] The TSO in the Italian demo was simulated [24], therefore some implementation challenges of TSO-DSO coordination are out of scope (e.g. product harmonization, information exchange between TSO-DSO), this is why we decided to not include BUCs from Platone in the mapping of BUCs presented in section 4.2.

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

4 Assessing and mapping selected projects against OneNet: identification of gaps and challenges

Following the methodology described in section 2, once the project comparators had been selected, OneNet BUCs and demonstrators were mapped against these projects. The outcomes of this process are twofold: on the one hand lessons learnt from these projects relevant to OneNet were identified; on the other hand, gaps in prior results were found. This section presents the process and key results from this mapping analysis.

4.1 SRA methodologies and dimensions considered in previous projects

We reviewed the scalability and replicability analysis of the projects selected in section 3 of this document. Table 4.1 summarizes the gathered information. As discussed in section 1.2, this deliverable focuses on scalability and replicability analysis for the functional layer. Most of the projects address the functional layer SRA through simulations. For example, CoordiNet conducted simulations [28] to assess how the variation of different conditions (e.g. an increase of electricity demand in the demo site, an availability increase of a particular type of FSP) affect market clearing and calculated the resulting amount of Energy non-delivered on different demo sites. INTERRFACE is the only project with a qualitative approach for this analysis. Crossbow did not consider the functional layer in their SRA; therefore, it was not considered for mapping BUCs of OneNet against BUCs from past projects that is presented in the next section. Following the methodology presented in section 2, the conclusions from the functional SRAs along with the mapping of BUCs were used to build the survey presented in section 5.

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

Table 4.1 – SGAM layers covered by SRAs in previous projects.

	CoordiNet	EU-SysFlex	Interrface	Crossbow	TDX-ASSIST	Integrid	InterFlex	OSMOSE	Platone	EUniversal
Did the project formally carry out an SRA?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Business SGAM layer	Qualitative & Simulation	Questionnaire	Qualitative	Questionnaire	-	Simulation & Questionnaire	Questionnaire	-	Simulation	Qualitative & Questionnaire
Functional SGAM layer	Simulation	Questionnaire	Qualitative	-	Simulation	Simulation	Simulation	Simulation	Simulation	Simulation
Information SGAM layer	-	Questionnaire	-	Questionnaire /Qualitative	-	Questionnaire	-	-	-	Questionnaire / Qualitative
Communication SGAM layer	-	Questionnaire	-	-	-	Questionnaire	Questionnaire & Quantitative	-	-	-
Component SGAM layer	-	Questionnaire	-	Questionnaire /Qualitative	-	Questionnaire	-	-	-	-

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

4.2 Mapping relevant projects BUCs against OneNet

As explained in Section 2, the third step of the methodology is to map BUCs and demo sites from previous relevant European projects with OneNet BUCs. The aim of this chapter is to assess how conclusions from previous SRA may apply to OneNet BUCs and identify the main gaps not covered or just slightly covered by previous projects.

First, the business use cases from the selected projects were analysed with special attention to:

1. The market models.
2. The services tested.
3. The KPIs considered.
4. Time horizon for flexibility procurement.
5. The demo site boundary conditions (type of FSPs, considered grid (MV, LV, HV, or any combination)).

Next, we show the results of this comparison.

4.2.1 Northern Cluster

The Northern demo involves four countries (Finland, Estonia, Latvia and Lithuania), testing common markets for TSO-DSO coordination as well as cross-border harmonization in order to move towards an international flexibility procurement.

The flexibility procurement using harmonized market products is demonstrated in each of the participating TSOs and DSOs [29]. The FSPs considered include residential loads, PVs, EVs, commercial loads, and batteries. The BUC (NOCL-01) is service agnostic, so the conclusions may apply for Balancing and Congestion Management. The objective is to ensure availability of near-real-time to long-term flexibility from multiple sources. The basis for the functionalities and architecture of Flexibility Register and TSO-DSO Coordination Platform can be found in previous project (Interrface) [19], [30] and this is the starting point for this demo, thus Table 4.2 shows "Single flexibility platform" from Interrface as a matching use case. The OneNet platform builds on the solution presented in Interrface by including a grid qualification process based on grid information collected from different SO(s) in the TSO-DSO coordination platform, integrating this grid qualification in both the prequalification and activation phases of the market, and allowing jointly procurement of flexibility by SO(s) and value stacking. Further details on the TSO-DSO coordination platform are presented in [31], whilst [12] provides additional information on the assessment of barriers found in the market and product harmonization effort in OneNet.

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

Table 4.2 – Match between BUCs from OneNet Northern Cluster and BUCs from past projects

BUC ID	BUC Title	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement	Matching BUC (ID & Project)	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement
NOCL-01	Northern flexibility market	Market based TSO-DSO coordination	Common Market	Service agnostic (Balancing, Congestion Manageme nt)	Year ahead, Month Ahead, Day Ahead, Intraday, Near-real-time	Single flexibility platform (Interrface)	Market based TSO-DSO coordination	Fragmented and Multi-level	Balancing, Congestion Manageme nt	Day-ahead and Intra-day

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

4.2.2 Southern Cluster

Regarding the Southern cluster, Table 4.3 shows similar business use cases in the reviewed projects.

- SOCL-GR-01 focuses on improving energy predictions at low voltage level for improving the identification of available flexibility resources and improving the prediction of system flexibility needs. FSPs considered include wind power plants, solar power plants, PVs from prosumers and BESS. Special attention to forecasting of loads, RES production, severe weather conditions and as result a forecast of congestions. **Matching BUCs**: A comparable business use case is GR-2a from CoordiNet project, where a local market for congestion management is tested and there are also predictions of loads and RES production but not severe weather conditions. The objective to improve energy predictions is shared between both BUCs.
- SOCL-GR-02 focuses on enhancing storm and icing predictions to prevent dangerous topological or operational state of the system and enhance the outage management process. FSPs considered include wind power plants, solar power plants, PVs from prosumers and BESS. There is no similar business use case found in the previous projects reviewed.
- SOCL-CY-01 tested a multi-level market for active power flexibility providing congestion management and balancing services in the Cyprus island, characterized by high penetration of PVs. This multi-level market includes coordination between TSO and DSO, they share location-based operational limits to ensure that flexibility activation will not cause problems in their grids. The FSPs considered are residential PVs, PVPPs, WPPs and BESS. **Matching BUCs**: SE-1a and SE-3 from CoordiNet jointly study a multi-level market for congestion management services at medium and low voltage level and balancing services for TSO. The context is also an island with increasing penetration of RES.

SOCL-CY-02 tested a local market for congestion management and voltage control, by using reactive power flexibility, and phase balancing services. The flexible resources considered include PV parks, large energy storage systems and prosumers. The FSPs considered are residential PVs, PVPPs, WPPs and BESS. Matching BUCs: DE-RP from EUniversal consists of a local market for voltage control and congestion management by using reactive power flexibility in the LV grid, where residential customers with PVs provide reactive power flexibility, residential customer loads and commercial where also considered as FSPs for reactive and active power flexibility (separation between active and reactive power flexibility was difficult from a technical perspective in the case of loads). HLUC01 from Integrid implements a local flexibility market to solve MV grid constraints and to optimize MV network operation using active and reactive power flexibility [32]. The FSPs consist of different industrial customers (Slovenian demo) [33]. FI-RP from EU-Sysflex studies a local flexibility market for reactive power flexibility in the LV and MV grid, the objective of the DSO is to avoid penalties coming from operating outside the allowed PQ-window defined by the TSO. The FSPs include PV power plants and industrial sized BESS.

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

Table 4.3 – Match between BUCs from OneNet Southern Cluster and BUCs from past projects

BUC ID	BUC Title	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement	Matching BUC (ID & Project)	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement
SOCL-GR-01	Enhanced Active/Reactive Power Management for TSO-DSO coordination	Technical based TSO-DSO Coordination	Common Flexibility Market	Congestion Management, Forecasting, Voltage Control	Day Ahead, Intraday	GR-2a (CoordiNet)	Market based TSO-DSO coordination	Local[20]	Congestion management	Day ahead, I-D, NRT
SOCL-GR-02	Enhanced severe weather condition management and outage management for TSO, DSO	Technical based TSO-DSO Coordination	N/A Out of scope	Forecasting	N/A Out of scope	NA				

[20] Despite having a different market model, local in the case of GR-2a from CoordiNet and common in SOCL-GR-01 from OneNet, this is a match because The objective to improve energy predictions is shared between both BUCs.

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

	and micro grid operator									
SOCL-CY-01	Active power flexibility	Market based TSO-DSO coordination	Multi-level Market	Balancing, Congestion Management	Intraday and Near Real Time	SE-1a (CoordiNet)	Market based TSO-DSO coordination	Multi-level Market	congestion management	Long term to intraday
						SE-3 (CoordiNet)	Market based TSO-DSO coordination	Multi-level Market	balancing	NRT
SOCL-CY-02	Reactive power flexibility and power quality	Market based DSO coordination	Local Market	Congestion Management, Voltage Control, Phase balancing	Intraday and Near Real Time	HLUC01 (Integrid)	Market based DSO coordination	Local	Congestion management , voltage control	Week-ahead to hours ahead
						DE-RP (EUniversal)	Market based DSO coordination	Local	Congestion management , voltage control	Day-ahead and intra-day
						FI-RP (EU-SysFlex)	Market based DSO coordination	Local (Market + bilateral)	Voltage control	Weeks ahead

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

4.2.3 Western Cluster

Regarding the Western cluster, Table 4.4 shows similar business use cases in the reviewed projects.

- WECL-ES-01 tested a local market for long-term congestion management. The objective is to procure products to ensure the MV network remains secure and does not go beyond its firm capacity at times of peak demand. FSPs include residential and industrial customers. **Matching BUCs:** As described before, HLUC01 from Integrid implements a local flexibility market to solve MV grid constraints and to optimize MV network operation. The FSPs consist of different industrial customers (Slovenian demo). The main difference between this BUC and WECL-ES-01 from OneNet is that the market horizon in the OneNet BUC is greater (years ahead to weeks ahead) than in HLUC01 from Integrid (week ahead to hours ahead) and not including residential loads as FSPs. ES-1b from CoordiNet presents a local flexibility market for congestion management in MV grid. In one demo the FSPs considered are mainly demand-side, Industrial loads, EV charging points, municipality facilities, and some distributed generation. In the second demo there is cogeneration, demand side flexibility and storage.
- WECL-ES-02 tested a local market for short-term congestion management in MV/LV grid, with a market horizon of D-1 and intraday. The FSPs include demand response from industrial loads, municipality facilities and EV charging points, as well as flexibility from industrial generation (biogas power plant). **Matching BUCs:** ES-1b from CoordiNet presents a similar case where a local market for congestion management in MV network is tested with a similar market horizon (D-1 and intraday). The FSPs include industrial loads, EV charging points and municipality facilities and PV generation in one demo and cogeneration, demand side flexibility and storage in the other demo.
- WECL-FR-01 focused on the information exchange between TSO, DSO and FSPs for monitoring renewable production curtailment. The STAR platform is developed for these monitoring purposes. The FSPs considered include PVPPs and WPPs. Given the scope of the BUC, WECL-FR-01 may be included as part of any BUC with renewable generation as FSPs and congestion management as service tested. In conclusion there is no specific matching to this BUC.
- WECL-FR-02 is focused on TSO-DSO information exchange. Since the activation of flexibility by the TSO can generate contingencies in the DSO network and vice versa, this BUC proposes that TSO and DSO agree in advance on a set of curtailment activations that are safe for each other (similar to traffic light system). The FSPs considered include PVPPs and WPPs. Similar to WECL-FR-01, given the scope of the BUC, WECL-FR-02 may be included as part of any BUC implementing a 'traffic light system' between TSO and DSO for renewable energy curtailments. In conclusion, there is no specific match to this BUC.
- WECL-PT-01 focuses on TSO-DSO information exchanges to enable flexibility provision in the short term. A multi-level coordination strategy is considered for congestion management services, covering

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

prequalification, plan/forecast, market phase, monitoring and activation[21]. EHV/HV/MV are considered in the demonstrator. The FSPs considered are industrial and commercial loads. **Matching BUCs:** SE-1a from CoordiNet presents a multi-level local flexibility market for congestion management purposes in HV and MV grid. The market horizon considered goes from long term to intraday. The FSPs considered include industrial, residential and commercial loads as well as BESS and district heating.

- WECL-PT-02 The main difference between WECL-PT-01 and WECL-PT-02 is the timeframe considered for the market horizon. WECL-PT-02 considers the long term (years ahead)[22]. The FSPs considered are commercial loads. **Matching BUCs:** Similarly, to WECL-PT-01, SE-1a from CoordiNet also represents a match, because it covers long term to intraday market horizon, please refer to the description above.
- WECL-PT-03 focuses on information exchange (expected evolution of the transmission and distribution network and their associated supply, consumption and flexibility services 'bidirectional', capacity and availability for load connection at TSO-DSO interconnection points 'from TSO for DSO', forecast of load and generation 'from DSO to TSO') for improving TSO and DSO operational planning. The resources considered comprise the entire list of connected resources within the selected areas (wind, solar, hydro, pump storage, thermal, load P and Q, others). **Matching BUCs:** BUC 7 from TDX-Assist 'Coordination of operational planning activities between TSO and DSO' also focuses on TSO-DSO information exchange (forecast of load and distributed generation) in order to improve operational planning activities.

[21] For the actual demonstration purposes, only the steps related to the prequalification and plan/forecast were considered in the Portuguese demonstration.

[22] WECL-PT-02 was not specifically addressed within the Portuguese demonstration, as an initial filtering of the most crucial System Use Cases for the parties involved was deployed. A complete list and description of the selected use cases can be found in OneNet's D9.2.

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

Table 4.4 – Match between BUCs from OneNet Western Cluster and BUCs from past projects

BUC ID	BUC Title	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement	Matching BUC (ID & Project)	Coordination scheme	Market Model	Services tested	Time horizon for flexibility procurement
WECL-ES-01	Long-term congestion management	Market based DSO coordination	Local Market	Congestion Management	Years ahead to Week-Ahead	HLUC01 (Integrid)	Market based DSO coordination	Local	Congestion management, voltage control	Week-ahead to hours ahead
						ES-1b (CoordiNet)	Market based DSO coordination	Local	Congestion management	Day ahead, I-D
WECL-ES-02	Short-term congestion management	Market based DSO coordination	Local Market	Congestion Management	Day-Ahead and Intra-Day	ES-1b (CoordiNet)	Market based DSO coordination	Local	Congestion management	Day ahead, I-D
						DE-RP (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	short term

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

WECL-FR-01	Improved monitoring of flexibility for congestion management	Technical based TSO-DSO coordination	N/A Out of scope	Information Exchange (for enhanced Congestion Management)	NRT	HLUC07 (Integrid)	Market based DSO coordination	local	generic service	week-ahead to real time
WECL-FR-02	Improved TSO-DSO information exchange for DER activation	Technical based TSO-DSO coordination	N/A Out of scope	Information Exchange (for enhanced Congestion Management)	N/A Out of scope					
WECL-PT-01	Exchange of Information for Congestion Management – Short Term	Technical based TSO-DSO coordination	Multilevel Market (the market model is considered in the design, but not developed in the demo)	Information Exchange (for enhanced Congestion Management)	Day-Ahead and Intra-Day	SE-1a (CoordiNet)	Technical based TSO-DSO coordination	Multi-level	congestion management	Long term to intraday

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

WECL-PT-02	Exchange of Information for Congestion Management – Long Term	Technical based TSO-DSO coordination	Multilevel Market (the market model is considered in the design, but not developed in the demo)	Information Exchange (for enhanced Congestion Management)	Years Ahead	SE-1a (CoordiNet)	Technical based TSO-DSO coordination	Multi-level	congestion management	Long term to intraday
WECL-PT-03	Exchange of information for operational planning	Technical based TSO-DSO coordination	N/A Out of scope	Information Exchange (for enhanced Operational Planning)	N/A Out of scope	BUC 7 (TDX-Assist)	Technical based TSO-DSO coordination	N/A Out of scope	Information Exchange (for enhanced Operational Planning)	N/A Out of scope

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

4.2.4 Eastern Cluster

Regarding the Eastern cluster, Table 4.5 shows how BUCs from OneNet share similar characteristics with BUCs in the reviewed projects.

EACL-CZ-01 focuses on nodal area congestion management at LV level [34], using a local market for long term procurement of active power flexibility. The FSPs considered in this BUC are EV charging stations. **Matching BUCs**: DE-AP tested a local flexibility market for congestion management and voltage control using active power flexibility. DE-AP includes more types of FSPs considered include heat pumps, electric heating systems, batteries, EVs and PVs. The main difference is the time horizon considered, while DE-AP from E-Universal considers short-term flexibility market, EACL-CZ-01 considers long-term procurement of flexibility. Es-1b from CoordiNet also tested a local market for congestion management, the difference is that the CoordiNet BUC considers congestions on the MV grid and not on LV, and the time horizon being long-term for EACL-CZ-01. The FSPs considered in ES-1b include Industrial loads, EV charging points and municipality facilities, cogeneration and storage.

EACL-CZ-02 focuses on reactive power overflow management at the connection points between TSO and DSO (HV levels) using a long-term local flexibility market. The FSPs considered include small hydro generation and CHPs. **Matching BUCs**: PT3 from EUniversal tested a local market for congestion management and voltage control during planned maintenance using active and reactive power, the time horizon considered was from some days in advance up to 2-3 weeks in advance. DE-RP from E-Universal tested local flexibility market for voltage control and congestion management on the short-term (unlike the OneNet BUC: EACL-CZ-02), considering flexibility needs in the MV and LV network [35], the FSPs considered include heat pumps, electric heating systems, batteries, Electric vehicles and photovoltaic installations. PL-RP from E-Universal tested a local flexibility market for reactive power, the services considered include congestion management and voltage control and time horizon goes from day-ahead to intra-day, this time Horizon differs from the one considered in OneNet BUC EACL-CZ-02. The FSPs considered include wind farm, biogas plant and Battery Energy Storage.

- EACL-CZ-03 focuses on voltage control at DSO level through market-based procurement of reactive power flexibility. The FSPs are located in the MV and HV network level. The objective of the BUC is to keep voltage in given limits in terms of quality of supply. **Matching BUCS**: Like the previous OneNet BUC (EACL-CZ-02), this BUC matches with PT3, DE-RP and PL-RP from E-Universal (please refer to the descriptions above). DE-RP and PL-RP main difference with EACL-CZ-03 is that they consider a short-term market horizon.

EACL-HU-01 focuses on voltage control at MV through market-based procurement of active and reactive power flexibility. The FSPs considered include household PVs, PV power plants, BESS, and residential loads. Week ahead and day ahead market horizons are considered. These BUC includes a

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

Traffic light system for TSO-DSO coordination designed to communicate grid status between SOs. **Matching BUCs**: HLUC01 from Integrid implements a local flexibility market to solve MV grid constraints (congestion management and voltage control) and to optimize MV network operation. The market horizon considered goes from week ahead to hours ahead, similar to EACL-HU-01 from OneNet. The FSPs considered are industrial loads in contrast with EACL-HU-01 from OneNet that considers batteries, distributed generation and residential loads. FI-RP from EU-Sysflex tested a local flexibility market for voltage control at the TSO-DSO interface by the use of reactive power. The FSPs considered include EVs, batteries, electric heating loads and PVs [36], similar to the OneNet case. The time horizon considered is weeks ahead. PT3 from EUniversal, as described previously, tested a local market for voltage control and congestion management, the main difference with OneNet BUC is the time horizon considered (some days/ 2-3 weeks in advance) while OneNet EACL-HU-01 covers week-ahead and day-ahead time horizon, but the day-ahead is covered by E-Universal in PT2 BUC.

- EACL-HU-02 focuses on congestion management at HV/MV transformer through a local flexibility market. The FSPs considered include household PVs and PVPPs, BESS, and residential loads. Week-ahead and day-ahead time horizons are considered. **Matching BUCs**: HLUC01 from Integrid and PT3 described in the paragraph above are a match to this OneNet BUC. PT3 diverges by not covering the day-ahead market horizon. And HLUC01 in the FSPs considered (industrial loads). ES-1b from CoordiNet tested a local flexibility market for congestion management. The FSPs considered include mainly demand-side, industrial loads, EV charging points, municipality facilities, cogeneration and storage. The main difference is the market horizon, ES-1b considers day-ahead and ID market horizon.

- EACL-PL-01 focuses on prequalification and this is often considered as a phase inside a BUC, this is why this BUC is not included in the table as many BUCs from other projects may include this prequalification phase and therefore match EACL-PL-01.

- EACL-PL-02 focuses on using flexibility resources connected to MV and LV network to provide frequency services to the TSO with a central coordination scheme, where it is verified that TSO activations would not cause a problem in the distribution network and those bids are not offered to the TSO. The FSPs considered include commercial load, gas power plants, residential load (including heat pumps) connected to the LV & MV level network. **Matching BUCs**: FI-AP1 and FI-AP2 from EU-SysFlex and HLUC05 from Integrid test DERs participating in the balancing market with a central coordination scheme, the main difference is the FSPs considered not including distributed generation.

EACL-PL-03 focuses on local market for congestion management and voltage control at HV, MV and LV level [37]. The market horizon considered is day ahead and week(s) ahead. The FSPs in the demo include commercial load, gas power plants, residential load (including heat pumps), PVs and storage. **Matching BUCs**: ES-1b from CoordiNet presents a local flexibility market for congestion management

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

in MV grid. The FSPs considered are mainly demand-side, industrial loads, EV charging points, municipality facilities, cogeneration, demand side flexibility and storage. The main difference is that LV congestions are not considered in ES-1b and the market horizon does not include medium term. HLUC01 from Integrid implements a local flexibility market to solve MV grid constraints and to optimize MV network operation using active and reactive power flexibility [32]. The FSPs consist of different industrial customers (Slovenian demo) [33]. The main difference is that LV congestions are not considered in HLUC01. The market horizon goes from week-ahead to hours ahead, similar to EACL-PL-03 from OneNet.

- EACL-PL-04 focuses on registration for balancing services. Similarly to EACL-PL-01 this is often considered as a phase inside a BUC, this is why this BUC is not included in the table as many BUCs from other projects may include this registration phase and therefore match EACL-PL-04.

EACL-SL-01 focuses on a local flexibility market (short term) and bilateral contracts (long term) for congestion management in the LV network using active power flexibility and prove the concept of the usage of the flexibility services in the distribution grid as an alternative to the traditional grid reinforcement. Heat pumps are the flexibility assets tested [37]. **Matching BUCs**: DE-AP from E-Universal tested a local flexibility market for congestion management and voltage control using active power flexibility. DE-AP includes more types of FSPs i.e. heat pumps, electric heating systems, batteries, EVs and PVs. The main difference is that EACL-SL-01 aims to solve LV grid constraints, while DE-AP focuses on solving MV grid constraints, and the time horizon considered, while DE-AP from E-Universal considers short-term flexibility market, EACL-SL-01 adds the possibility of contracting long-term flexibility through bilateral contracts. PT4 from E-Universal partially covers the time horizon gap, by testing a long-term flexibility market (years ahead time horizon), with the aim to support grid planning, congestion management and voltage control services included. This BUC assess the possibility of using flexibility as an alternative to grid reinforcement and considering a wide variety of FSPs. However, this BUC considers MV grid constraints while EACL-SL-01 from OneNet considers LV grid constraints.

EACL-SL-02 focuses on a local market (short -term) and bilateral contracts (long-term) for voltage control in the LV network using active power flexibility, and proves the concept of the usage of the flexibility services in the distribution grid as an alternative to the traditional grid reinforcement. PVs and batteries are the flexibility assets tested [37]. **Matching BUCs**: As described in the previous paragraph, DE-AP from E-Universal tested a local flexibility market for congestion management and voltage control using active power flexibility. DE-AP includes more types of FSPs i.e. heat pumps, electric heating systems, batteries, EVs and PVs. The main difference is that EACL-SL-01 aims to solve LV grid constraints, while DE-AP focuses on solving MV grid constraints, and the time horizon considered, while DE-AP from E-Universal considers short-term flexibility market, EACL-SL-01 adds the possibility of contracting long-term flexibility through bilateral contracts. PT4 from E-Universal partially

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

covers this gap, by testing a long-term flexibility market (years ahead time horizon), with the aim to support grid planning, congestion management and voltage control services included. This BUC assess the possibility of using flexibility as an alternative to grid reinforcement and considering a wide variety of FSPs. However, this BUC considers MV grid constraints while EACL-SL-01 from OneNet considers LV grid constraints.

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

Table 4.5 – Match between BUCs from OneNet Eastern Cluster and BUCs from past projects

BUC ID	BUC Title	Coordination scheme	Market model	Services tested	Time horizon for flexibility procurement	Matching BUC (ID & Project)	Coordination scheme	Market model	Services tested	Time horizon for flexibility procurement
EACL-CZ-01	Nodal area congestion management	Market based DSO coordination	Local Market	Congestion Management	Long term (Not specified)	DE-AP (EUniversal)	Market based DSO coordination	Local, interaction with TSO is out of scope	Congestion management, voltage control	Day ahead and intraday
						ES-1b (CoordiNet)	Market based DSO coordination	Local	Congestion management	Day ahead, I-D (Not long term)
EACL-CZ-02	Reactive power overflow management	Market based DSO coordination	Local Market	Congestion Management	Long term	PT3 (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	Days/weeks ahead
						DE-RP (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	short term

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

						PL-RP (EUniversal)	Market based DSO coordination	Local	Congestion management & Voltage control	short term
EACL-CZ-03	Voltage Control	Market based DSO coordination	Local Market	Voltage Control	Long term (Not specified)	PT3 (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	Days/weeks ahead
						DE-RP (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	short term
						PL-RP (EUniversal)	Market based DSO coordination	Local	Congestion management & Voltage control	short term
EACL-HU-01	MV feeder voltage control	Market based DSO coordination	Local Market	Voltage Control	Week-Ahead & Day-Ahead	HLUC01 (Integrid)	Market based DSO coordination	Local	Congestion management, voltage control	Week-ahead to hours ahead

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

						FI-RP (EU-SysFlex)	Market based DSO coordination	Local (Market + bilateral)	Voltage control	Weeks ahead
						PT2 (EUniversal)	Market based DSO coordination	Local	Voltage control	Day-ahead
						PT3 (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	some days/ 2-3 weeks in advance
EACL-HU-02	HV/MV transformer overload	Market based DSO coordination	Local Market	Congestion Management	Week-Ahead & Day-Ahead	HLUC01 (Integrid)	Market based DSO coordination	Local	Congestion management, voltage control	Week ahead to hours ahead
						ES-1b (CoordiNet)	Market based DSO coordination	Local	Congestion management	day ahead and ID
						PT3 (EUniversal)	Market based DSO coordination	Local	Congestion management, voltage control	some days/ 2-3 weeks in advance

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

EACL-PL-02	Managing flexibility delivered by DER to provide balancing services to TSO.	Market based TSO coordination	Central Market	Balancing	Day-Ahead	HLUC05 (Integrid) Small batteries, EVs and commercial loads	Market based TSO coordination	Central (Traffic light system)	Balancing, mFRR and RR	
						FI-AP1 (EU-SysFlex)	Market based TSO coordination	Central	Balancing	Day ahead, FCR
						FI-AP2 (EU-SysFlex)	Market based TSO coordination	Central	Balancing, mFRR y RR	
EACL-PL-03	Event-driven Active Power Management for Congestion Management and voltage control by the DSO	Market based DSO coordination	Local Market	Congestion management, voltage control	Day-Ahead and Medium term	ES-1b (CoordiNet)	Market based DSO coordination	Local	Congestion management	day ahead and ID
						HLUC01 (Integrid)	Market based DSO coordination	Local	Congestion management, voltage control	Week ahead to hours ahead

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

EACL-SL-01	Congestion management in distribution grids under market conditions	Market based DSO coordination	Local Market	Congestion Management	Long-term (scenario 1, bi-lateral contracts) & short-term (scenario 2, flexibility market)	ES-1b (CoordiNet)	Local		Congestion management	day ahead and ID
						DE-AP (EUniversal)	Market based DSO coordination	Local, interaction with TSO is out of scope	Congestion management, voltage control	Day ahead and intraday
						PT4	Market based DSO coordination	Local	Congestion management, voltage control	Years ahead
EACL-SL-02	Voltage control in distribution grids under market conditions	Market based DSO coordination	Local Market	Voltage Control	Long-term (scenario 1, bi-lateral contracts) & short-term (scenario 2, flexibility market)	DE-AP (EUniversal)	Market based DSO coordination	Local, interaction with TSO is out of scope	Congestion management, voltage control	Day ahead and intraday
						PT4	Market based DSO coordination	Local	Congestion management, voltage control	Years ahead

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

4.3 Identification of existing gaps and challenges

The aim of the mapping of BUCs from OneNet with BUCs form previous projects presented in Section 4.2 was to identify gaps and challenges not addressed in previous project but covered in the OneNet project. We covered these gaps and challenges by asking demo partners in the survey about the identified topics to gather their insights based on the experience gathered during OneNet demos.

One of the gaps identified is that previous projects when addressing DSO needs focused mainly on MV grid constraints, while some BUCs from OneNet focused on solving LV grid constraints (e.g. EACL-01, EACL-02, EACL-CZ-01). This is why, in the survey submitted to the demonstrators, when covering the topic of grid monitoring, we focused on LV grid monitoring. We also included separate questions on grid constraints and FSPs availability between MV grid and LV grid. A second gap is that BUCs from previous projects are focused on short-term or medium-term time horizon when procuring flexibility services, while some BUCs from OneNet focus on long-term procuring of flexibility (ES-01, EACL-SL-01, EACL-CZ-01 and EACL-SL-02).

An additional gap is that most European projects tests/demos are simulated and/or do not include real data from some of the market participants (e.g., bids of FSPs). Therefore, analysing the cost of flexibility solutions is difficult or out of scope. This is why in the survey we asked partners what flexibility prices they expect, and what prices of flexibility would they find attractive. Then, we compared the results with the most advanced flexibility market in Europe (UK flexibility market).

Finally, one of the differential characteristics of OneNet is to address regional use cases where information is shared between SOs from different countries, making an effort on product and market harmonization aiming for a future international market of flexibility that includes DERs as FSPs. Previous projects have focused on improving the cross-border management of energy resources. For example, Crossbow focused on ICT solutions and did not include the functional layer on the SRA [38]. The Northern cluster demonstration in OneNet uses as a basis the Interrface single flexibility platform, including a grid qualification process based on grid information collected from different SO(s) in the TSO-DSO coordination platform, and allowing jointly procurement of flexibility by SO(s) and value stacking. Further details on the TSO-DSO coordination platform are presented in [31]. The results conclusions of the regional BUCs in OneNet allowed to identify barriers to the product and market harmonization, please see [12] for additional information.

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

5 SRA survey across OneNet partners and lessons learnt

After mapping BUCs of OneNet with BUCs from past European projects we review their SRA results and conclusions. The questionnaire aims to assess to what extent the conclusions from previous projects may apply in the OneNet context and address the identified gaps and challenges presented in section 4.3. Next, we discuss the previous lessons learnt from SRAs of the selected past European projects.

A. On grid monitoring

Previous projects, such as Integrid, highlighted in their SRA the importance of grid monitoring as an enabler of local flexibility exploitation (particularly for flexibility need estimation, grid prequalification and activation), particularly in the MV and LV grids. Integrid concluded that the lack of observability of the MV network results in inaccurate network optimisation. Under this uncertain scenario, and to preserve system security, grid operators could resort to conservative and unnecessary measures such as grid reinforcements (in a long-term framework) or contracting/activating more flexibility than needed.

Another relevant insight is that even with sufficient monitoring devices deployed, advanced monitoring tools for state estimation or flexibility forecasting may be hindered by lack of access to complete relevant data. According to the findings of Integrid or Interrface, limitations may arise due to the inability to access data in (quasi) real time, the existence of information silos within DSO systems (no SCADA connection), insufficient time granularity (e.g. hourly vs. 15-min data), or sub-metering requirements for an accurate baselining and settlement. In the survey, we asked demo partners about the status of their grid in terms of MV and LV monitoring as well as whether they faced similar limitations to the ones described above.

B. On FSPs

The CoordiNet project SRA [28] concluded that the presence of different types of FSPs is important for the SOs to be able to solve grid constraints with flexibility solutions. For example, PVs and wind generators will not be able to provide active-power upward flexibility. Additionally, it is important to consider the location of FSPs and how different types of FSPs are usually available at different voltage levels. For example, flexibility assets located at the MV grid will not be able to help in solving demand driven congestions in the LV network. The location of FSPs is even more crucial for solving voltage issues due to the specific locational characteristic of voltage control as concluded in [28]. This is why we asked demo partners in the survey questions regarding the availability of different types of FSPs at the MV and LV networks. FSPs' availability is not only important from a technical perspective but crucial for market liquidity, a fundamental aspect for scalability and replicability of flexibility solutions as highlighted in previous projects (e.g. EU-SysFlex).

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

C. On the type of constraints

CoordiNet project [28] highlighted how different types of grid constraints (congestions vs voltage issues) and its causes (demand driven vs. supply driven)[23] need specific types of flexibility. For example, a network area dominated by PVs experiencing congestions at peak generation hours would benefit from downward flexibility. This is why we included in the survey a question regarding the constraints tested in the demos and the constraints which are actual or expected in distribution network in general, since a misalignment between those may constitute a barrier for scalability and replicability of the BUCs tested in OneNet. We also asked about the usefulness of the different types of FSPs providing different grid services (i.e. balancing, congestion management and voltage control).

D. On the allocation of responsibilities for non-delivered flexibility

The draft proposal for Network Code on Demand Response [39] establishes the roles and responsibilities for market parties and system operators in Article 21. According to this draft proposal, the service providers would pay penalties for deviations in delivered services according to national terms and conditions. Therefore, national regulations can define these penalties and responsibilities, but it is indicated that a penalty for service providers should exist in case of non-delivered services.

5.1 SRA survey across One-Net demo partners

Based on conclusions from previous projects' SRAs, and the identification of gaps and challenges, we designed an initial questionnaire to gather information from project partners (see the Appendix). Given that a contextualized discussion around these gaps and challenges required additional background information on the grid characteristics or flexibility service, the survey included additional questions beyond the four gaps/challenges described in section 4.3, but all of them are covered, nonetheless[24].

After analysing the survey responses from demo partners, a preliminary analysis was presented in the WP11 demo workshop held during the General Assembly in Florence (June-2023), where additional feedback from project partners was gathered concerning the preliminary conclusions of the SRA. After receiving feedback, we updated the analysis and designed a second questionnaire to fill-in some minor gaps (full questionnaire also included in the Appendix). The updated analysis was presented in the workshop to the demo partners in October and the second questionnaire mentioned above was circulated in order to deep dive into some open issues.

[23] Demand driven constraints are grid constraints caused by the connection of new loads or increase of the existing ones (e.g., EVs or data processing centers). Supply driven constraints refer to those caused by the increase of renewable and distributed generation.

[24] Note that, despite the fact that One-Net addresses TSO-DSO coordination and flexibility needs from both SOs, the questionnaire mostly addressed DSO-related aspects as the gaps and challenges identified, besides the regional dimension of the BUCs, mostly refer to local flexibility utilization.

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

Finally, during the GRIFOn workshop, we presented the final conclusions of the SRA to receive feedback from external stakeholders.

5.2 Survey results evaluation and lessons learnt

Next, we present the main takeaways based on the questionnaire responses and demo feedback received during the workshops conducted in the project.

5.2.1 On the current state of the grid and the need for additional grid monitoring

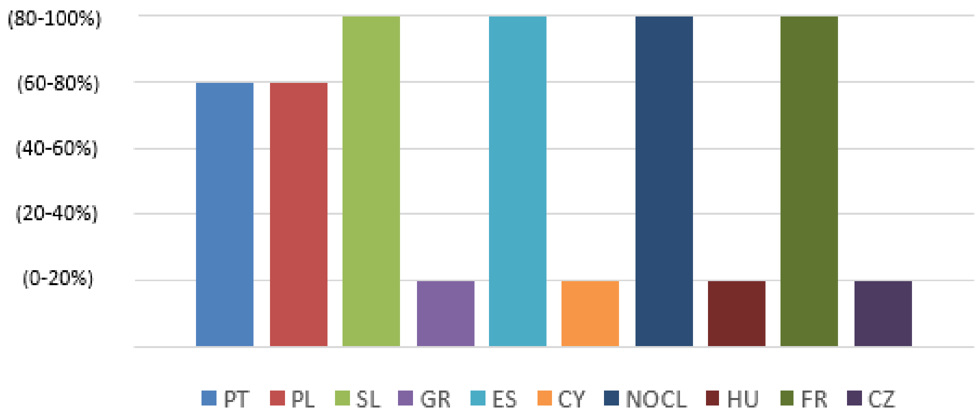

Figure 5.1 – Smart meter deployment: Percentage of LV grid consumption points with smart meters in the demo countries.

An important aspect regarding the provision of flexibility services by DERs to SOs is the monitoring of the LV and MV grid as well as metering devices. These are fundamental technical needs to take advantage of flexibility. Previous projects like Integrid and Interrface have highlighted the need for monitoring for grid prequalification and settlement purposes. Figure 5.1 shows a summary of the answers to question 3.1 of the survey (see page 64), indicating the percentage of smart meter deployment in the grid of the different project partners. The results show very divergent levels of smart meter deployment in the countries of the demo partners. Partners from Portugal (PT), Poland (PL), Slovenia (SL), Spain (ES), France (FR) and from the Northern cluster (NO) countries[25] indicated high levels of smart meter deployment (60%-100% of consumption points) in their countries, while partners from Greece (GR), Cyprus (CY), Hungary (HU) and Czech Republic (CZ) indicated very low levels of smart meter deployment (0-20% of consumption points). Similarly, Figure 5.2 shows a summary of the answers to question 3.2 of the survey. This question aims to gather information about the percentage of MV/LV substations monitored. In a similar way to the previous question on smart meters, the answers by the partners in the different countries also show very dissimilar levels of LV supervision deployment. Partners from Greece (GR), Cyprus (CY), Hungary (HU) and Finland from the Northern cluster (NO)[25] show the lowest levels of LV supervision deployment (between 0-20% substations are monitored).

[25] Note that northern cluster value contains the average value of the answer from the countries in the Northern cluster.

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

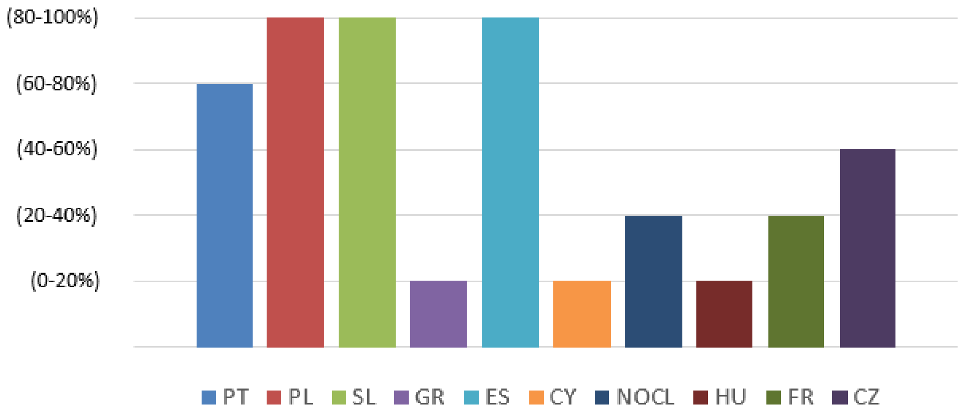

Figure 5.2 – LV supervision deployment: percentage of secondary substations (MV/LV) monitored in the demo countries

We then asked demo partners, in survey question 3.3, if they would need additional LV grid monitoring in order to scale up the tested solutions across their country. Figure 5.3 presents the answers to this survey question. There, Cyprus and Greece pointed out their necessity for additional LV grid monitoring for scaling up their BUCs. This is not a surprise, since previous answers showed low levels of smart meter deployment and low voltage supervision in both countries. The case of Poland is interesting, while having high levels of smart meter and LV supervision deployment, they need LV network power-flow tools to increase grid observability and scale-up the BUCs within their grid. Another interesting insight rises from the Czech demo in which, as it has low levels of smart meter deployment and just over 50% LV supervision, the tested traffic light scheme does not require additional LV monitoring. Hungary, France and Portugal do not consider the LV grid in their demo, this is why this question is not applicable to their BUCs. As a general conclusion, progressive enhancement of LV grid monitoring would enable more advanced BUCs, this includes smart meter deployment, LV supervisors, state estimation tools and sub-metering.

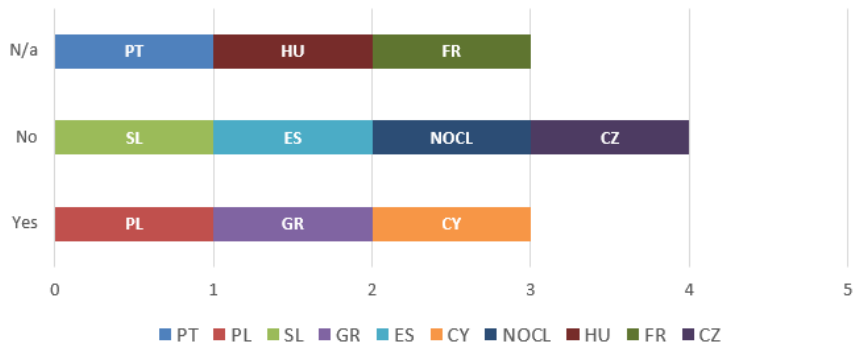

Figure 5.3 – Additional LV grid monitoring needed for scaling-up the tested BUCs?

Regarding MV grid monitoring, Latvia from the Northern Cluster, Hungary, Cyprus and Greece indicated the need for additional grid monitoring for scaling-up their BUCs across their grid. Extending the MV/LV measurements can increase the accuracy of state calculation in the case of Hungary, while Latvia and Greece

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

would need additional monitoring of MV lines for scaling-up their BUCs. This question does not apply to the French demo (FR) as the solution presented for RES curtailment is a back-office treatment. Portugal (PT), Poland (PL), Slovenia (SL), Spain (ES), and Finland from Northern cluster (NOCL-FI) indicated that they would not need additional MV grid monitoring for scaling up their BUCs. Please see Figure 5.4.

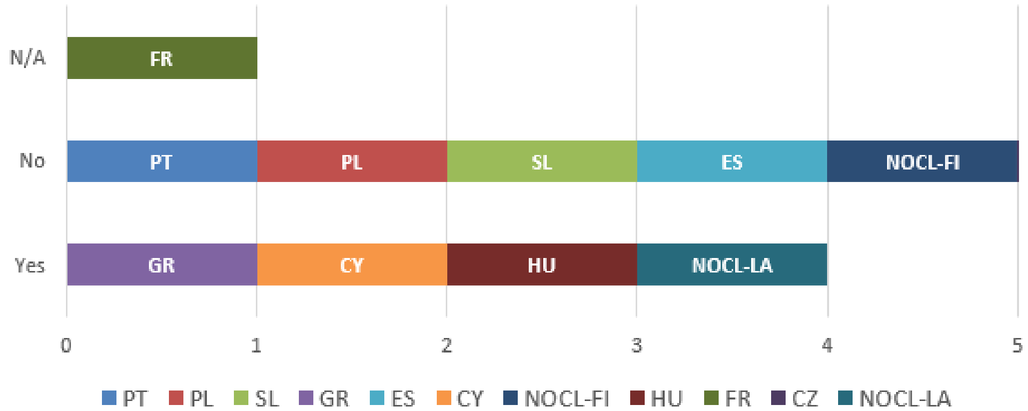

Figure 5.4 – Additional MV grid monitoring needed for scaling-up the tested BUCs?

In summary, previous European projects highlighted the importance of LV and MV grid monitoring for the provision of flexibility solutions, and survey responses of OneNet showed very dissimilar levels of grid monitorization across projects partners. This may be a barrier for replicability of the tested solutions, as low levels of smart-meter deployment would make difficult baselining and settlement, and low levels of LV grid supervision deployment will affect the quality of network state estimations and may lead to unnecessary measures when procuring flexibility damaging the business case for flexibility solutions. Even scalability of some of the solutions across the whole grid at national level, would be difficult without additional grid monitoring for some of the partners as shown in Figure 5.3 and Figure 5.4. Greece and Cyprus indicated the need for additional LV and MV grid monitoring. Poland indicated the need for additional LV grid monitoring, to be more specific they need network power-flow tools. Hungary and Latvia indicated the need for additional MV grid monitoring.

5.2.2 On the type of constraints tested in the demos

Some regions in Europe (e.g. The Netherlands, Norway, Germany and The United Kingdom) are experiencing increasing congestions due to peaks of renewable generation and the uptake of EVs [40]. As highlighted by the scalability and replicability analysis from CoordiNet project [28], different network constraints (demand driven vs supply driven) may benefit from different types of FSPs. For example, a network area with supply-driven constraints (due to peak-hour generation of RES) may benefit from downward flexibility provided by batteries and demand response. On the contrary, an area experiencing demand driven congestions would benefit from upward flexibility of DERs located in the same area. This is why we asked demo partners about the type of constraints tested in their BUCs and the type of constraints they expect in their whole distribution network. Figure 5.5 shows the type of constraints tested in each demonstrator. Figure *5.6* shows the frequency of

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

constraints, actual or expected by demo partners in their distribution network. Comparing both figures, demand-driven constraints are more present than supply-driven ones in the demos (Figure 5.5). DSOs expect more supply-driven constraints common across their whole grid (Figure *5.6*) which indicates a potential misalignment between demo conditions and actual grid conditions of the whole grid, which may represent a barrier for scalability. Still both demand-driven and supply driven constraints are expected in most countries. Other drivers of constraints (e.g. scheduled maintenance) are also expected by the demo partners, and Figure 5.7 shows that most demo partners (>90% of responses from the DSOs) consider flexibility as moderately useful or very useful for N-1 scenarios. In line with conclusions from previous projects, partners highlight the potential of flexibility solutions for N-1 scenarios. Flexibility is particularly valuable for these scenarios with low probability of occurrence that would otherwise require reinforcements.

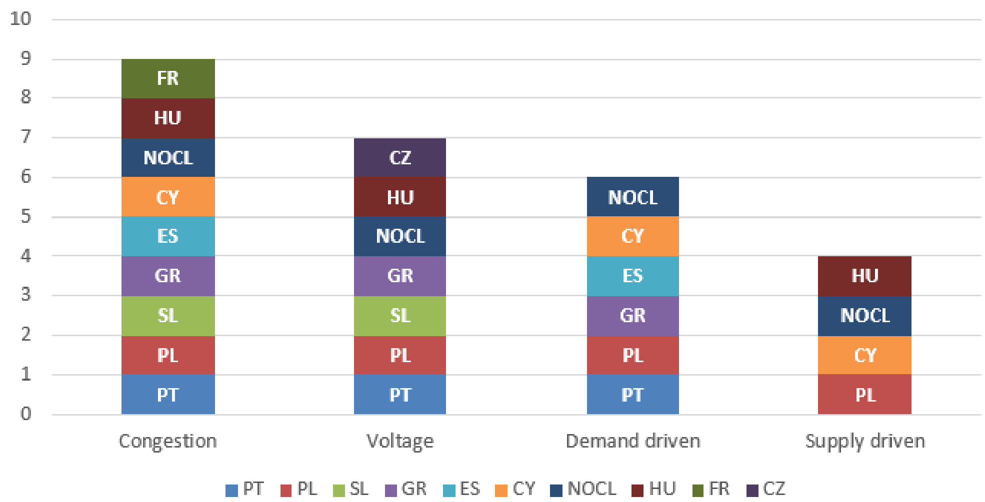

Figure 5.5 – Type of constraints tested in the demos

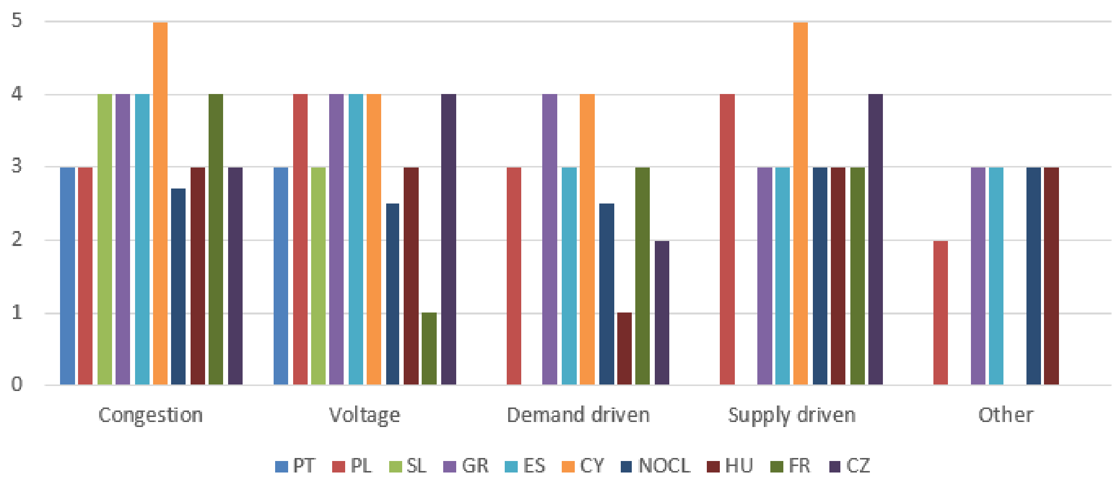

Figure 5.6 – *Frequency of constraints* (actual or expected) in the demos across the distribution network (1-*Never*, …, 5-*Constantly*, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

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

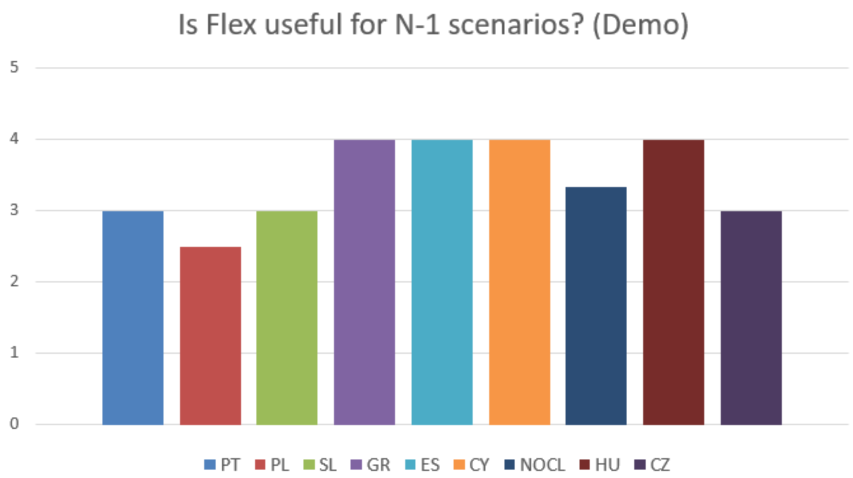

Figure 5.7 – Usefulness of flexibility solutions for N-1 scenarios (1-useless, …, 5-extremely useful, 0-No response/Do not know)

5.2.3 On FSPs' availability, contribution to system needs and flexibility cost

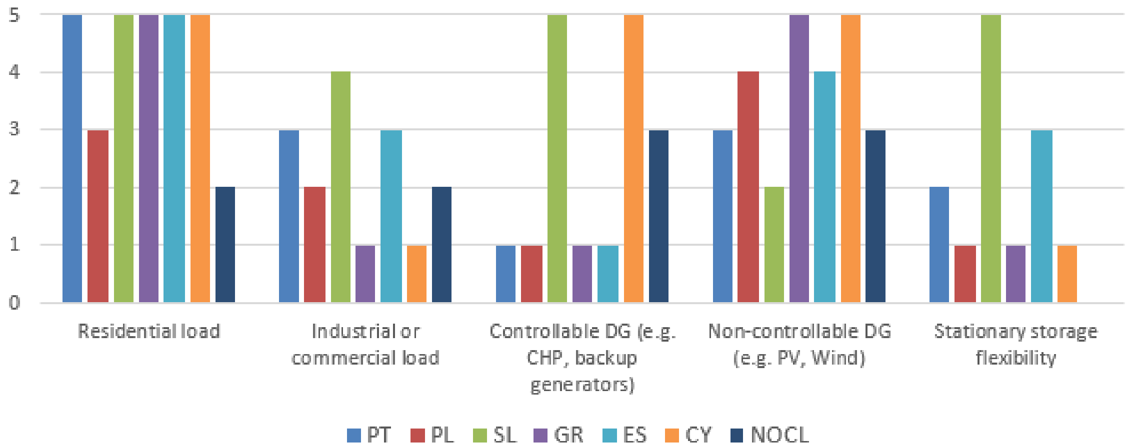

Figure 5.8 – FSPs availability per country in LV grid (1- Not available, …, 5-highly available, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

As motivated before, different types of grid constraints (e.g. supply driven, demand driven) may benefit from different types of FSPs (distributed generation, batteries, etc.). Therefore, depending on the grid conditions of each region, SOs may require different types of FSPs to solve grid problems. This is why we asked partners in question 5 of the survey to identify what type of FSPs are available in their LV and MV grid. Figure 5.8 and Figure 5.9 show responses from partners on FSPs' availability at country-level in MV and LV grid. As expected, residential load and non-controllable DG are more available in the LV level while industrial/commercial load and controllable DG are more available in the MV level. Some differential issues between countries are that Cyprus and Slovenia have high availability of controllable distributed generation in the LV grid (e.g. CHP, backup generators). In the case of Slovenia, the network structure presents a different ratio of LV and MV networks compared to other European countries, LV networks are much longer, this may explain the high availability of

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

controllable distributed generation in the LV grid. Additionally, based on the responses, Slovenia is the country that presents higher availability of FSPs overall and the only country with high availability of stationary storage flexibility.

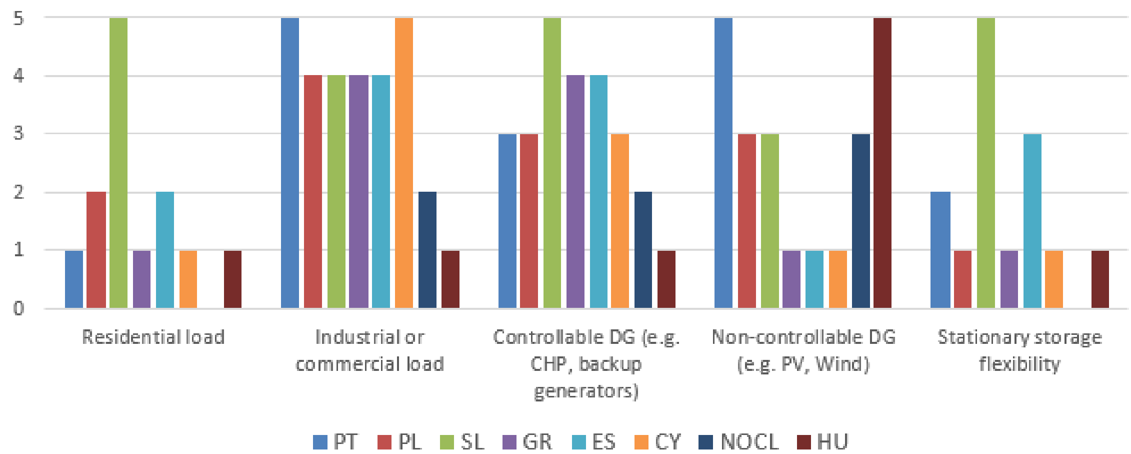

Figure 5.9 – FSPs availability per country in MV grid (1-Not available, …, 5-highly available, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

Since different types of FSPs may be useful for different system services, we asked partners to what extent they consider that different types of FSPs may contribute to different system services. Figure 5.10, Figure 5.11 and Figure 5.12 present the responses regarding the usefulness of the different types of FSPs in contributing to each system service (i.e. balancing, congestion management, and voltage control). Results show that SOs consider stationary storage and controllable distributed generation as the most useful FSPs, followed by industrial/commercial load. Responses show diverging views between partners when asked about usefulness of non-controllable distributed generation for congestion management and voltage control (Figure 5.11 and Figure 5.12). Hungary and the countries from Northern cluster (Latvia, Finland and Estonia) indicated that non-controllable DG may have critical or relevant contribution in congestion management while Portugal, Poland, Slovenia, Greece, Spain, Cyprus and France expect negligible or minor contribution from this type of FSPs for congestion management, please see Figure 5.11. The case is similar regarding the contribution of non-controllable DG for voltage control, please see Figure 5.12, where Slovenia (SL) and Hungary (HU) indicated that non-controllable DG may have critical contribution for solving voltage issues while Portugal (PT), Poland (PL), Greece (GR), Spain (ES), and Cyprus (CY) considered expect negligible or minor contribution from non-controllable DG in solving voltage issues. This difference between responses may be due to various reasons. As suggested by [28], [41], there may be technical and economic reasons limiting the potential of FSPs, or even regulatory reasons. We included a question to deep dive in the reasons behind this in the survey for demo

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

partners, question 2 of the second survey included in the appendix, where they indicate in a Likert scale[26] whether a particular aspect represents a barrier for the use of flexibility from non-controllable DG (1-Not a barrier, …, 5-Strong barrier). Next, we comment the results.

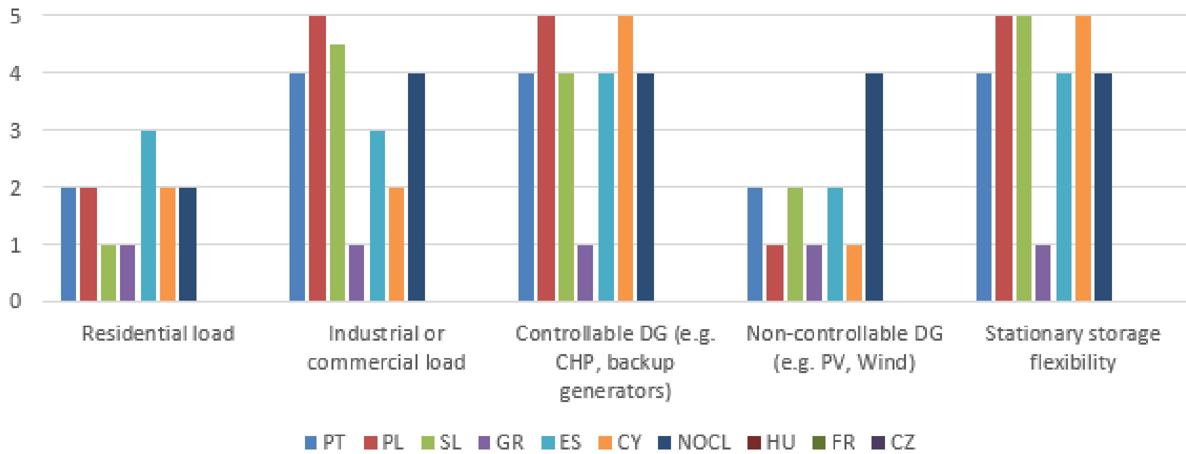

Figure 5.10 – FSPs contribution to balancing (1-Negligible contribution, …, 5-Critical contribution, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

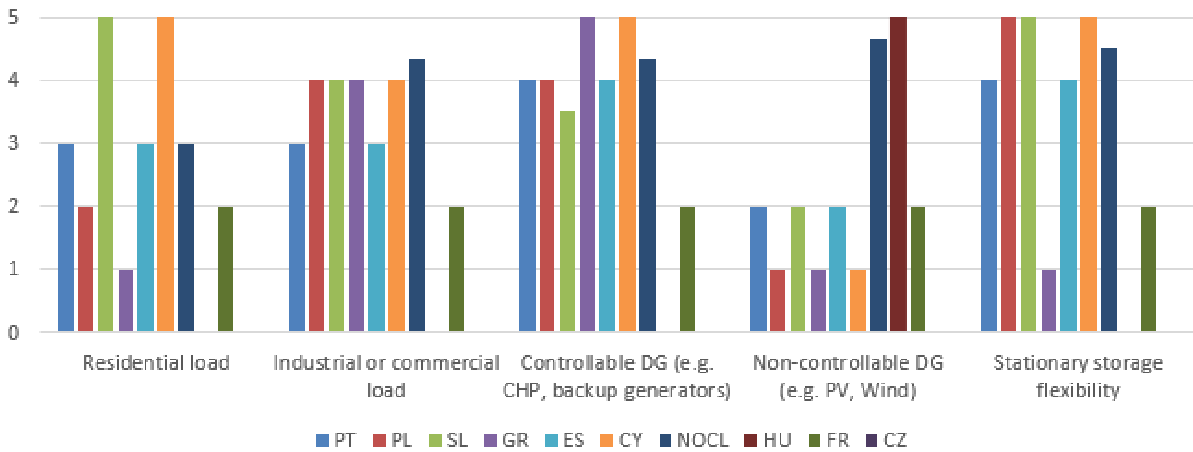

Figure 5.11 – FSPs contribution to congestion management (1-Negligible contribution, …, 5-Critical contribution, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

[26] Likert scale: An approach to gather the opinion of respondents by a unidimensional scale, in this particular case the scale was designed to gather the opinion of DSOs on wether a particular aspects represent a barrier to the use of flexibility from non-controllable DG (1-Not a barrier,…,5-Strong barrier).

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

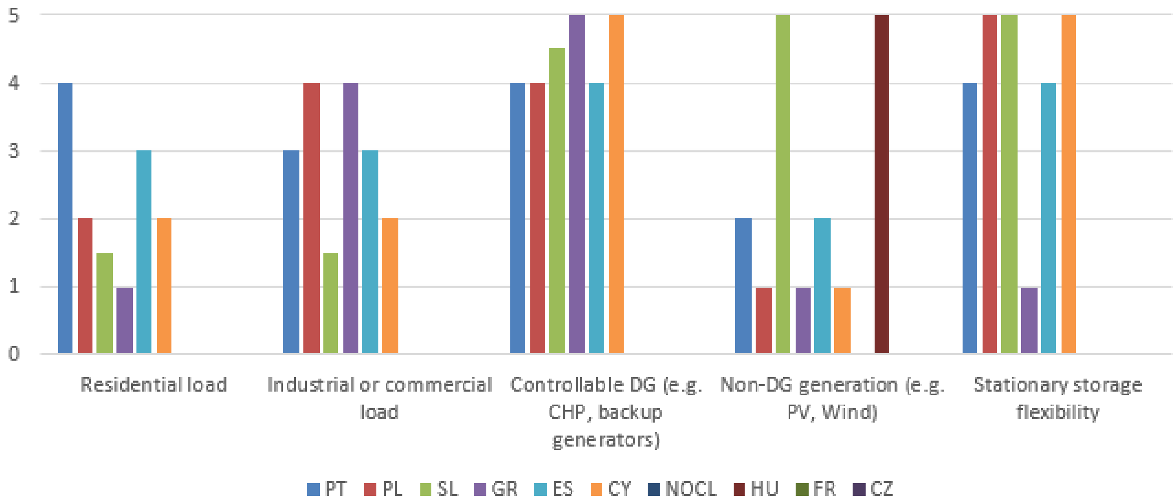

Figure 5.12 – FSPs contribution to voltage control (1-Negligible contribution, …, 5-Critical contribution, 0-No response/Do not know).
**Note That 0 responses do not appear as bars in the graph*

From the technical perspective, 71% of respondents indicated that "Grid R/X ratio limits the potential of Q for voltage control" represents a moderate or significant barrier. This limits the use of flexibility from non-controllable DG in BUCs where LV grid constraints are considered. One of the respondents indicated that for LV grids and rural MV grids the R/X ratio is large; therefore, Q has little impact on voltage control. For HV networks and urban MV networks Q can be used to control voltage.

A second barrier from the technical perspective is "Non-controllable DG is not located in grid areas where voltage control is needed" that represents a moderate or significant barrier for 63% of the partners. The influence of the FSPs' location for voltage control was already highlighted as crucial by CoordiNet project scalability and replicability analysis [28] and the responses to the survey are in line with that conclusion. However, the respondents that indicated higher availability of non-controllable DG in the LV network (Cyprus and Greece, see Figure 5.8) indicated that this is not a barrier or that it is a minor barrier. In conclusion, the location of non-controllable DG is an important factor when contributing to voltage control and we expect this barrier to diminish in some cases as more non-controllable DG is deployed across the network.

As a third technical barrier, 43% of the partners indicated that the FSPs' technical limitations (e.g. asynchronous generation unable to provide Q control) is a significant or strong barrier for the use of flexibility from non-controllable DG. A high variability was observed in the answers to this third barrier, this makes sense as we would expect some of the countries where investors have deployed old versions of non-controllable DG, and some others have deployed more advanced versions due to connection agreements or having deployed most of non-controllable DG during recent years. This would result in a barrier for replicability of some BUCs where non-controllable DG is used for voltage control.

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

From the regulatory perspective, 38% of respondents indicated that "DSO is not allowed to use flexibility" represents a strong barrier, this is the highest share of respondents indicating a strong barrier from any of the topics of the survey. This make sense as there is still a lack of regulation for flexibility markets in many European countries, in some others, flexibility use by the DSO was only recently regulated and therefore the DSO is taking the first steps in using flexibility. There is still not an established market or methodology regarding local flexibility markets.

As a second topic from the regulatory perspective, 83% of respondents indicated that a connection agreement forcing a fixed cos(phi)[27] represents a moderate to strong barrier. This was already noticed by some regulators as a respondent from Portugal indicated, where current legislation enforces a fixed cos(phi); however, the Electricity system Supervisor has pointed out this will change to allow a DSO controlled Q injection. In conclusion, it may be valuable if regulation were to evolve in some countries to soften these requirements to unveil more potential from FSPs.

As a third regulatory topic, high bid size minimum requirements may also represent a barrier for the provision of flexibility from non-controllable distributed generation, while 63% of respondents indicated that high bid size minimum requirements represent a moderate to significant barrier, none of them designate this as a strong barrier. Previous studies highlighted the impact that a low minimum bid size may have on enabling the participation of DERs in flexibility markets and increase liquidity of the market in both local and wholesale markets [42], [43]. This is a relevant topic, that may affect non-controllable DG but also other types of FSPs and should not be overlooked by regulatory authorities.

Finally, the DSO may not be allowed to control voltage. This was not signalled as a strong or significant barrier by any of the respondents, this suggest that at least some form of voltage control is allowed to the DSOs in the countries of the respondents.

From the economic perspective, there was only one respondent mentioning the high price of flexibility as a significant barrier for the use of flexibility from non-controllable DG. As a preliminary conclusion, the price of flexibility from non-controllable DG may not represent a major issue for most countries. However, 38% percent of respondents indicated this as a moderate barrier. Next, we discuss the economic aspect of flexibility solutions.

As local flexibility markets are at early stage or still not present in many countries, one open issue for the business case of local flexibility solutions is the cost. In question 12 of the survey, we asked DSOs participating in the demos about the expected cost of flexibility (€/kWh) and what would be an attractive price for flexibility solutions (€/kWh). Figure 5.13 (left side) shows the responses of DSOs to question 12 of the survey regarding flexibility costs. This question was particularly difficult for the DSOs to answer due to the lack of experience with

[27] A fixed cos(phi) at the T-D interface represents a limitation for the DSO in the use of reactive power flexibility because modifying Q will affect the cos(phi).

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

real flexibility markets. Still, results show attractive prices for DSOs varying between 0.5 €/kWh and 0.8 €/kWh for short term and between 0.1 €/kWh and 0.8 €/kWh for long term. For comparison, we looked at the flexibility prices in UK Piclo-flex tenders ("Piclo flex confirmed bids" report downloaded from https://data.piclo.energy/ on Sept-21-2023). Pre-fault and Post-Fault products were excluded from the analysis as they do not fit most of the BUCs tested in OneNet. Moreover, 1 £ = 1,15 € exchange rate was considered, and bids with no £/kwh price were excluded. Figure 5.13 (right side) shows the average price of accepted flexibility bids during 2020 in Piclo-flex markets in the UK (0.36 €/kWh). Thus, the average price of accepted flexibility bids in Piclo-flex markets in the UK for 2020 is within the range of attractive prices for DSOs in OneNet (0.1-1 €/kWh). Prices in Piclo-flex market decreased as markets evolved during 2021 (0.16 €/kwh) and increased for 2023 (0.51 €/kWh). 2021 prices are below the range of attractive prices for DSOs in OneNet, the only response indicating an attractive price lower than the Piclo-flex is the Latvian response for attractive price in the long term (0.1 €/kWh). The increased prices during 2023 may be related to high energy prices experienced, but looking at the evolution of prices during 2023, the average price of accepted bids in August 2023 has decreased to 0.22 €/kWh as energy prices have also diminished during the year, so the high prices earlier in the year may be attributed to a particular disruptive event of the energy market and we may assume that based on the UK experience, price of flexibility tend to decrease as local flexibility markets evolve. Figure 5.14 shows that prices of all flexibility bids, not only accepted ones, have also diminished over time. Most DSOs indicated in a following survey that they expect flexibility prices higher than Piclo-Flex markets due to less mature and/or less liquid flexibility markets, and some of the DSOs (close to 30%) indicated they expect intrinsically higher flexibility costs (e.g. due to FSP characteristics, energy prices, etc.). These prices from Piclo-flex in the UK would not necessarily replicate across other European countries, but this is the most developed European flexibility market and it shows potentially attractive prices based on responses from the DSOs participating in OneNet. Moreover, we may expect decreasing prices as markets develop and experience and liquidity increase.

Regarding flexibility price, another reference data point serving as an upper bound is the value of lost load (VoLL). There is a study prepared by Cambridge Economic Policy Associates Ltd for the Agency for the cooperation of energy regulators [44] estimating the domestic VoLL for different European countries and the values range from 6.19 €/kWh to 15.90 €/kWh, well above the expected and attractive flexibility prices shown and the average flexibility prices of Piclo-flex markets in the UK, see Figure 5.14. In conclusion, flexibility price is not expected to be a major issue based on the scarce information available at this moment.

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

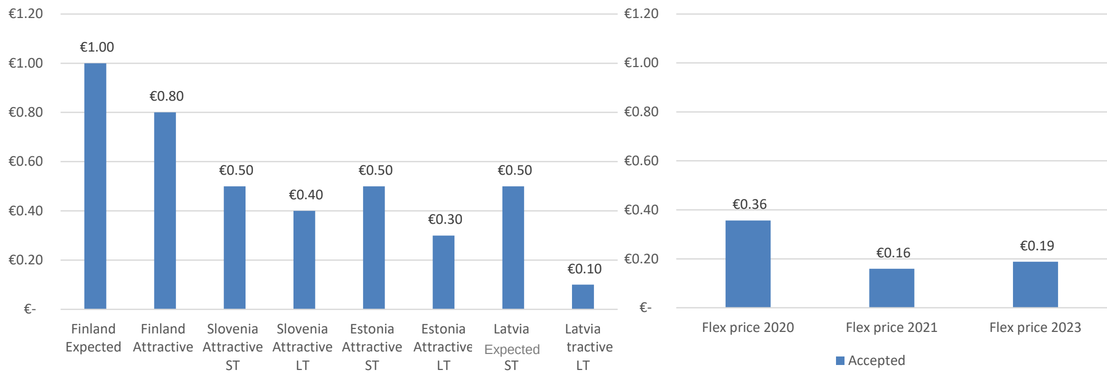

*Figure 5.13 – Left-side figure: Expected and attractive flexibility price by demo partners. Right-side figure: Average prices for accepted flexibility bids in Piclo-flex auctions (United Kingdom) pre-fault and post-fault products excluded, bids without a £/kWh price excluded, ('Piclo flex confirmed bids' report downloaded from https://data.piclo.energy/ on Sept-21-2023) *1 £ = 1,15 € Exchange rate considered*

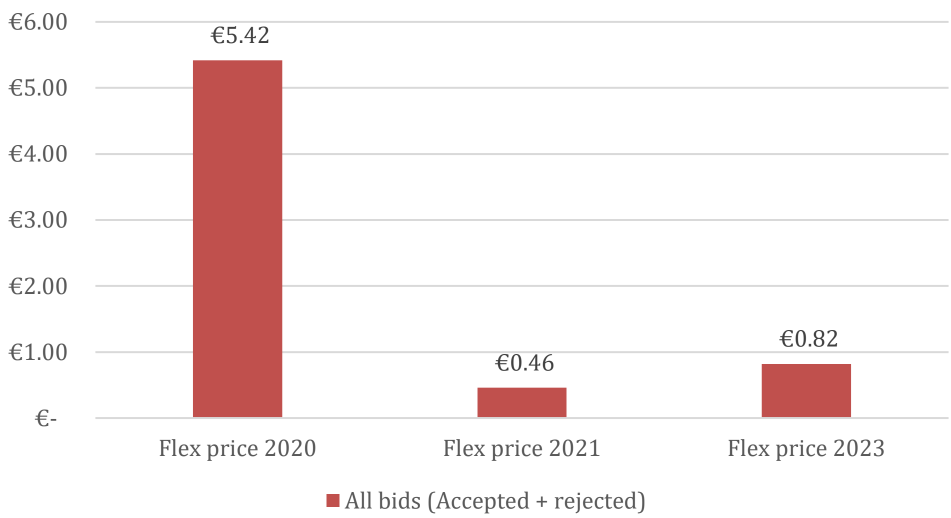

*Figure 5.14 – Average prices for all flexibility bids (accepted + rejected) in Piclo-flex auctions (United Kingdom) pre-fault and post-fault products excluded ('Piclo flex confirmed bids' report downloaded from https://data.piclo.energy/ on Sept-21-2023) *1 £ = 1,15 € Exchange rate considered*

5.2.4 On the allocation of responsibilities for non-delivered flexibility

Figure 5.15 presents the demo partners answers to survey question 13 of the first survey included in the Annex. Most of the partners consider the allocation of responsibilities for non-delivered flexibility as a very relevant or extremely relevant topic for the scalability (broader implementation in their own country) of the flexibility services tested in their demos. The only divergent response comes from Slovenia: they consider this topic as somehow relevant or moderately relevant for scalability. Further conversation with Slovenian partners indicated that they have already experience and an established relationship of trust with FSPs. This led to an additional question for demo partners and more than 70% of respondents either agree or strongly agree that: "the importance of responsibility allocation may diminish as more experience is gained and reliable relationships

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

with FSPs develop”. In conclusion, while this topic will still be relevant, there is a strong agreement that this potential barrier would probably soften as flexibility markets mature. This is completely aligned with the recently published draft proposal for a network code on demand response [39], where Article 21 establishes that the service providers should pay penalties for deviations in delivered services according to national terms and conditions. When establishing these penalties, there is a tradeoff between lowering entry barriers for new service providers and giving certainty or security to system operators. Based on the results of the survey, it may be appropriate to establish harder penalties at the beginning and then, as relationships of trust between FSPs and system operators develop, soften these penalties in order to promote market liquidity. This is why giving room and flexibility for national regulation in this topic, as the draft proposal for network code on demand response does [39], in this topic seems reasonable based on the survey results.

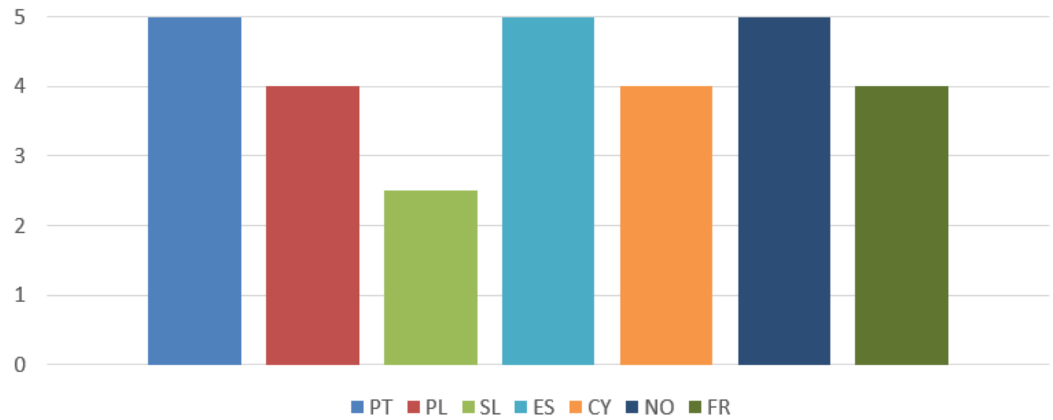

Figure 5.15 – Importance of the allocation of responsibilities for non-delivered flexibility when scaling-up the solutions tested in the demonstration (1-not relevant, ..., 5-extremely relevant, 0-Do not know)

5.2.5 On the regional use cases and the OneNet platform

One of the main objectives of OneNet project is to design an ICT architecture, enabling DERs to provide system services at European level. This solution aims to achieve further cost-efficiencies in the European electricity system and facilitate the integration of RES. There is a focus on facilitating the participation in the energy markets of prosumers and other FSPs connected to LV and MV networks and improving the cooperation between system operators [45].

The regional BUCs are focused on the OneNet platform objectives. The Northern cluster makes an effort on harmonization between countries participating in the demo (i.e. Latvia, Estonia, Lithuania and Finland), presenting one BUC and a harmonized solution for market architecture, flexibility register, roles and responsibilities and settlement. This facilitates future scalability of system services at European level, see [29]–[31], [46] for more detail. The eastern cluster regional BUC focuses on sharing key flexibility market/utilization data between countries. This data sharing will serve as a basis for establishing further communication and learning from other countries’ experiences as flexibility markets develop in Europe. The western cluster regional

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

BUC focuses on harmonizing the product prequalification process and grid prequalification process, ensuring that the flexibility offered by a particular flexibility service provider can actually be delivered without causing an undesirable situation in either of the involved grids, thus facilitating the FSPs' participation into the various flexibility markets within the western cluster.

It is relevant to note that the most relevant bottlenecks when implementing these regional BUCs are not those related to the functional aspects. In fact, the key barriers identified by the demo partners when implementing these solutions, therefore relevant to replication, are essentially related to the following issues:

- Insufficient harmonization of market products and services (see D11.2 [12] for a deeper analysis).
- Missing clear framework for governance and coordination among stakeholders, particularly regarding service procurement cost allocation, grid data sharing, etc. For a more extensive evaluation of business model and governance aspects, the reader is referred to D11.5 [47].
- Connectivity and cybersecurity challenges when connecting IT systems from different SOs (interoperability and data exchange aspects are covered in D11.3 [48]).

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

6 Conclusions

This deliverable D11.4 presented the scalability and the replicability analysis of solutions proposed in the OneNet project from a qualitative perspective. The analysis focused on techno-economic aspects more closely related to the SGAM functional layer, i.e. those affecting the BUCs and KPI values and not focusing on regulatory, information and communication aspects. The work was carried out on two stages. Firstly, an analysis of past demonstration projects and mapping of their BUCs and KPIs against the ones defined and tested in OneNet was carried out. Secondly, based on the lessons learnt in the previous step, a consultation among demo partners was performed to either confirm or rebut those conclusions, and answer to questions not addressed by past projects.

Analysis of selected past projects and mapping against OneNet

This process comprised an assessment of BUCs tested, KPIs measured, and SRA carried out by a set of selected relevant past EU projects. This exercise allowed for the identification of gaps or missing inputs for the evaluation of replicability and scalability of OneNet solutions. The main findings of this exercise are the following:

- A first gap identified is that previous projects, when addressing DSO needs, focused mainly on MV grid constraints, while some BUCs from OneNet focused on solving LV grid constraints.
- A second gap is that BUCs from previous projects test short-term or medium-term time flexibility procurement, while some BUCs from OneNet focus on long-term procurement.
- An additional gap is that most EU projects demos are simulated and/or do not include real data from some of the market participants (e.g., bids of FSPs), therefore a clear analysis of the cost of flexibility is generally missing.
- Finally, the regional feature of OneNet BUCs is something not covered in previous projects and the difficulties encountered in these BUCs are additional insights for the SRA.

Identification of key barriers for scaling-up and replication

Combining the results from the previous mapping and gap analysis and those of the consultation process with OneNet demo partners, which included two questionnaires and two workshops, the following outstanding barriers to the scalability and replicability of OneNet solutions were identified:

- There are very diverging levels of LV grid monitoring across the different countries, this constitutes a barrier for replicability of BUCs where FSPs at LV are considered. There are different steps to cover in the process of LV grid monitorization, from deployment of smart meters and LV supervisors to state estimator tools and sub-metering. Regarding MV voltage grid monitoring, there is also the need for greater MV grid monitoring in some countries, and this represents a barrier for both scalability and replicability of the presented solutions.

- Most of the BUCs conducted by OneNet demos focused on demand driven constraints, while demo partners expect more frequent supply driven constraints in their network. the BUCs tested and the grid

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

conditions for which they were tested, as compared to the grid conditions and flexibility needs expected by grid operators, This represents a potential barrier for scalability/replicability since demo results obtained using flexibility to address a certain type of flexibility need may show a different level of performance under different grid conditions.

- Additionally, there is large agreement between demo partners on the potential of flexibility solutions for N-1 scenarios, as these events are not frequent and therefore flexibility solutions offer a clear advantage over fit and forget type of solutions (i.e. traditional network reinforcement).
- OneNet demo partners reported markedly different levels of FSP availability per type (residential loads, industrial loads, stand-alone storage, controllable DG and non-controllable DG) and per voltage level (MV and LV) in their countries. One of the most notable differences is that Cyprus and Slovenia have high availability of controllable distributed generation in their LV grid. Another notable difference is that Slovenia has high availability of all the types of FSPs across the grid. Previous projects highlighted the importance of, in terms of scalability and replicability, of engaging the types of FSPs best-suited to the local flexibility need. Thus, the results obtained in terms of FSP technical or cost performance in a given project may not be directly replicable in another area where different types of FSPs are available.
- When examining responses of DSOs about the usefulness of the different types of FSPs, stationary storage and controllable distributed generation were the ones considered most useful overall, followed by industrial/commercial load. We noticed a difference in the expected contribution of different types of FSPs to congestion management and voltage control. There was a high difference in the responses of DSOs regarding expected contribution of non-controllable DG to congestion management and voltage control. This led to additional iteration, finding various reasons for this phenomenon (technical, economic and regulatory barrier). From a technical perspective, first a high Grid R/X ratio limits the potential of reactive power for voltage control, therefore limiting the potential of non-controllable DG for voltage control, this is the case of LV networks and some rural MV networks. A second aspect from the technical perspective is the crucial locational characteristic of voltage control, already noticed in past projects. In this sense, project partners pointed out a barrier in not having non-controllable DG where needed for voltage control. It is worth mentioning that the partners with highest non-controllable DG availability across their grids do not consider this location issue as a barrier. Therefore, we may expect this second barrier to soften as more non-controllable DG becomes available and there is higher probability of finding an FSP where needed. As a third technical barrier for non-controllable DG in providing flexibility some partners pointed out the technical limitations of FSPs (e.g. asynchronous generation unable to provide Q control). From a regulatory perspective, DSO not being able to use flexibility and DSO being forced to a fixed cos(phi) at the TSO-DSO interface and a high minimum bid size are the main barriers. From the economic perspective, there is not much consensus among partners on the expected price of flexibility in the future. Based on Piclo Flex bid

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

data in the UK, historical flexibility prices in the country are in the range of attractive prices indicated by partners. Still, this is an issue difficult to foresee before flexibility markets develop and these are only preliminary conclusions on the topic of flexibility costs.

- Regarding the allocation of responsibilities for non-delivered flexibility, this is a relevant or very relevant concern for most project partners. However, there is an agreement between most of the project partners that this will become less relevant as experience is gained and relationships of trust are built between SOs and FSPs.
- The regional, i.e. trans-national, aspect of some OneNet BUCs led to the identification of barriers for cross-border flexibility solutions, including lack of harmonized products and services, missing governance and coordination framework for the procurement cost allocation, or grid data sharing, and connectivity and cybersecurity challenges.

Limitations and outlook for upscaling and replication

Several of the conclusions drawn from the SRA presented in this report in terms of existing gaps and barriers to upscaling and replication reflect the current situation of distribution networks and the intrinsic limitations faced by demonstration projects in terms of regulatory conditions or time horizon. Thus, enhancing the scalability and replicability potential would require overcoming these.

For example, the analysis presented herein found few prior pilots testing the use of flexibility in the LV. This can be a result of the lack of deployment of monitoring capabilities in this voltage level as well as the low liquidity achieved by demos in local markets as they usually face important challenges for end-user engagement. Likewise, regulatory constraints, in the absence of enabling regulation or the possibility to run the pilots under regulatory sandboxes, oftentimes prevent DSOs to engage in actual economic transactions with end users; hence the limited data on actual flexibility costs found. Furthermore, demonstration projects generally have a duration of a few months, or a few years at most; this prevents them from integrating the contribution of flexibility as an alternative to grid reinforcements and explains the lack of long-term flexibility procurement in past projects.

Lastly, it is relevant to note that this SRA report mostly considered technical boundary conditions affecting the potential performance of implementing the OneNet BUCs as measured by their KPIs. However, upscaling and replication is also affected by other aspects outside the scope of this report, such as customer engagement, interoperability and data exchange, business models and regulation, or the harmonization of services, products and market processes. Therefore, readers are advised to read other OneNet deliverables for further information about these topics.

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

References

[1] OneNet, 'D2.4 OneNet priorities for KPIs, Scalability and Replicability in view of harmonised EU electricity markets'. 2021. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2022/10/OneNet_Deliverable_D2.4_v2-28122021.pdf

[2] Ipcc, *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, 1st ed. Cambridge University Press, 2022. doi: 10.1017/9781009157940.

[3] International Energy Agency, 'Net Zero by 2050 - A Roadmap for the Global Energy Sector'. 2021. Accessed: Oct. 31, 2023. [Online]. Available: https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

[4] European Comission, 'A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy'. 2018. Accessed: Oct. 31, 2023. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773

[5] International Energy Agency, 'Unlocking the Potential of Distributed Energy Resources'. 2022. Accessed: Oct. 31, 2023. [Online]. Available: https://iea.blob.core.windows.net/assets/3520710c-c828-4001-911c-ae78b645ce67/UnlockingthePotentialofDERs_Powersystemopportunitiesandbestpractices.pdf

[6] I.J. Pérez-Arriaga *et al.*, 'Utility of the future: an MIT Energy Initiative response to an industry in transition'. Project: UOF-MIT. Funded by Massachusetts Institute of Technology (MIT), 2016. Accessed: Oct. 31, 2023. [Online]. Available: https://energy.mit.edu/research/utility-future-study/

[7] N. Rosetto and V. Reif, 'Digitalization of the electricity infrastructure: a key enabler for the decarbonization and decentralization of the power sector', in *A Modern Guide to the Digitalization of Infrastructure*, J. Montero and M. Finger, Eds., Edward Elgar Publishing, 2021. doi: 10.4337/9781839106057.00015.

[8] E. Hillberg *et al.*, 'Flexibility needs in the future power system', 2019, Accessed: Oct. 31, 2023. [Online]. Available: https://www.iea-isgan.org/wp-content/uploads/2019/03/ISGAN_DiscussionPaper_Flexibility_Needs_In_Future_Power_Systems_2019.pdf

[9] European Commission. Directorate General for Energy., *Guidelines for implementing the prescribed technology: additional subroutines and requirements, scientific background and state of the art, scalability & replicability task force.* LU: Publications Office, 2023. Accessed: Oct. 10, 2023. [Online]. Available: https://data.europa.eu/doi/10.2833/48123

[10] CEN-CENELEC-ETSI Smart Grid Coordination Group, 'Smart Grid Reference Architecture'. 2012. Accessed: Oct. 26, 2023. [Online]. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

[11] OneNet, 'D11.1 Evaluation of OneNet demonstrators' results'. [Online]. Available: OneNet H2020 EU Project. To be published in the future on the OneNet website: https://onenet-project.eu/public-deliverables/

[12] OneNet, 'D11.2 Techno-economic assessment of proposed market schemes for standardized products'. [Online]. Available: OneNet H2020 EU Project. To be published in the future on the OneNet website: https://onenet-project.eu/public-deliverables/

[13] Coordinet, 'D5.1 Greek Demonstrator Analysis & Planning'. 2019. Accessed: Oct. 31, 2023. [Online]. Available: https://private.coordinet-project.eu//files/documentos/5e4c2778aea24D5_1%20coordinet.pdf

[14] Coordinet, 'D3.1 Report of functionalities and services of the Spanish demo'. 2020. Accessed: Oct. 31, 2023. [Online]. Available: https://private.coordinet-project.eu//files/documentos/5e4c274e8190dD3.1%20Coordinet.pdf

[15] Coordinet, 'D4.1 Site specific product portfolio to be used in Swedish demo (including contracts, routines and business models)'. 2020. Accessed: Oct. 31, 2023. [Online]. Available: https://private.coordinet-project.eu//files/documentos/60379e43b9d9aD4.1%20products%20in%20the%20Swedish%20demo%202020-12-21.pdf

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

[16] Coordinet, 'D1.5 Business Use Case: Business Use Case definition'. 2019. Accessed: Oct. 31, 2023. [Online]. Available: https://private.coordinet-project.eu//files/documentos/5cdc65b97fb00COORDINET%20D1.1.pdf

[17] EU-SysFlex, 'D3.3 Business Use Cases for Innovative System Services.' 2018. Accessed: Oct. 31, 2023. [Online]. Available: https://eu-sysflex.com/wp-content/uploads/2019/03/D3.3_Business-Use-Cases-for-Innovative-System-Services.pdf

[18] Interrface, 'D1.7 Final Project Report 2'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: http://www.interrface.eu/sites/default/files/publications/INTERRFACE_D1.7_v1.0.pdf

[19] Interrface, 'D5.6. Congestion Management demonstration: Final Evaluation report and lessons learnt'. Accessed: Oct. 31, 2023. [Online]. Available: http://www.interrface.eu/sites/default/files/publications/INTERRFACE_D5.6_FINAL_PUBLIC.pdf

[20] Crossbow, 'D2.2 Use cases scenarios and KPIs identification'. 2018. Accessed: Oct. 31, 2023. [Online]. Available: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bd730075&appId=PPGMS

[21] InterFlex, 'D2.1 Use case detailed definitions and specifications of joint activities in the Demonstrators'. 2017. Accessed: Oct. 31, 2023. [Online]. Available: https://interflex-h2020.com/wp-content/uploads/2018/06/D2.1-Use-case-detailed-definitions-and-specifications-of-joint-activities-in-the-Demonstrators.pdf

[22] InterFlex, 'D3.8 Scalability and replicability analysis SRA for all use cases'. 2019. Accessed: Oct. 31, 2023. [Online]. Available: https://interflex-h2020.com/wp-content/uploads/2020/02/D3.8-Scalability-and-replicability-analysis-SRA-for-all-use-cases_AIT_InterFlex.pdf

[23] Platone, 'D1.1 General functional requirements and specifications of joint activities in the demonstrators'. 2020. Accessed: Oct. 31, 2023. [Online]. Available: https://platone-h2020.eu/data/deliverables/864300_M12_D1.1.pdf

[24] Platone, 'D3.9 Report on main results achieved in the field test'. Accessed: Oct. 31, 2023. [Online]. Available: https://www.platone-h2020.eu/data/documents/864300_M48_D3.9.pdf

[25] Platone, 'D4.1 Report on the definitions of KPIs and UCs'. 2020. Accessed: Oct. 31, 2023. [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M12_D4.1.pdf

[26] Platone, 'D7.6 Main findings and recommendations'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M48_D7.6.pdf

[27] EUniversal, 'D2.2 Business Use Cases to unlock flexibility service provision'. 2019. Accessed: Oct. 31, 2023. [Online]. Available: https://euniversal.eu/wp-content/uploads/2021/05/EUniversal_D2.2.pdf

[28] CoordiNet, 'D6.4 SRA methodology and results'. 2022. Accessed: Oct. 31, 2023. [Online]. Available: https://private.coordinet-project.eu//files/documentos/62cc728e10495COORDINET_WP6_D6.4_SRA%20METHODOLOGY%20AND%20RESULTS_V1.0_27.06.22.pdf

[29] OneNet, 'D7.3 Report on market functionality'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2023/05/OneNet_D7.3_v1.0-1.pdf

[30] OneNet, 'D7.2 Flexibility register description and implementation'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2023/10/D7.2_OneNet_v1.0.pdf

[31] OneNet, 'D7.4 Northern Cluster Demonstrator: TSO-DSO Coordination module description and implementation', 2022, Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2022/12/OneNet_D7.4_v.1.0.pdf

[32] Integrid, 'D1.2 Use Cases and Requirements'. 2017. Accessed: Oct. 31, 2023. [Online]. Available: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5b72ec0d5&appId=PPGMS

[33] Integrid, 'D4.1 Detailed specification and guidelines for field testing in SL'. 2018. Accessed: Oct. 31, 2023. [Online]. Available:

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

https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bbdd37b5&appId=PPGMS

[34] OneNet, 'D10.2 Report on selection of services'. 2022. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2022/10/D10.2-Report-on-selection-of-services.pdf

[35] EUniversal, 'D8.2 Specifications of test scenarios within the German Demonstrator'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://euniversal.eu/wp-content/uploads/2023/07/Deliverable-D8.2-Specifications-of-test-scenarios-within-the-German-Demonstrator.pdf

[36] EU-SysFlex, 'D6.1: Demonstrators' system use cases description'. 2019. Accessed: Oct. 31, 2023. [Online]. Available: https://eu-sysflex.com/wp-content/uploads/2019/03/EU-SysFlex_D6.1_Demonstrators-system-use-cases-description_v1.0_final.pdf

[37] OneNet, 'D10.4 Report on demonstrations', 2023, Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2023/10/OneNet_D10.4_V1.0.pdf

[38] Crossbow, 'D16.1 Scaling up and replication roadmap'. 2022. Accessed: Oct. 31, 2023. [Online]. Available: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5eb6bf8e7&appId=PPGMS

[39] EUDSO and ENTSO-E, 'EUDSO Entity and ENTSO-E Draft proposal for a Network Code on Demand Response'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://consultations.entsoe.eu/markets/public-consultation-networkcode-demand-response/supporting_documents/Network%20Code%20Demand%20Response%20v1%20draft%20proposal.pdf

[40] E. Beckstedde and L. Meeus, 'From "Fit and Forget" to "Flex or Regret" in Distribution Grids: Dealing With Congestion in European Distribution Grids', *IEEE Power and Energy Mag.*, vol. 21, no. 4, pp. 45–52, Jul. 2023, doi: 10.1109/MPE.2023.3269545.

[41] D. Davi-Arderius, M. Troncia, and J. J. Peiró, 'Operational Challenges and Economics in Future Voltage Control Services', *Curr Sustainable Renewable Energy Rep*, Jul. 2023, doi: 10.1007/s40518-023-00218-1.

[42] F. Gonzalez Venegas, M. Petit, and Y. Perez, 'Can DERs fully participate in emerging local flexibility tenders?', in *2019 16th International Conference on the European Energy Market (EEM)*, Ljubljana, Slovenia: IEEE, Sep. 2019, pp. 1–5. doi: 10.1109/EEM.2019.8916343.

[43] U. D. Team, 'Flexibility Deployment in Europe'. 2021. Accessed: Oct. 31, 2023. [Online]. Available: https://www.usef.energy/app/uploads/2021/03/08032021-White-paper-Flexibility-Deployment-in-Europe-version-1.0-3.pdf

[44] Cambridge Economic Policy Associates Ltd, 'CEPA study on the Value of Lost Load in the electricity supply'. Agency for the cooperation of energy regulators, 2018. Accessed: Oct. 31, 2023. [Online]. Available: https://www.acer.europa.eu/en/Electricity/Infrastructure_and_network%20development/Infrastructure/Documents/CEPA%20study%20on%20the%20Value%20of%20Lost%20Load%20in%20the%20electricity%20supply.pdf

[45] OneNet, 'D5.1 OneNet Concept and Requirements', 2021, Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2022/10/D51-OneNet-Concept-and-Requirements.pdf

[46] 'OneNet D7.1 Report on Flexibility Availability'. 2020. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2022/12/OneNet_D7.1_v1.0.pdf

[47] OneNet, 'D11.5 Recommendations for customer engagement strategies'. 2023. Accessed: Oct. 31, 2023. [Online]. Available: https://onenet-project.eu/wp-content/uploads/2023/07/OneNet-Deliverable-D11.5_v1.0.pdf

[48] OneNet, 'D11.3 Recommendation of interoperability platforms and data exchange for TSODSO-customer coordination'. [Online]. Available: OneNet H2020 EU Project. To be published in the future on the OneNet website: https://onenet-project.eu/public-deliverables/

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

Annex A SRA survey circulated among demo partners

A.1 1st survey for demo partners on scalability and replicability

The questions related to T11.4 are divided into four topics: Grid characteristics, FSPs characteristics, Product/Service and market architecture.

Distribution Grid characteristics

- **Q1 [DEMO]:** What is the grid topology/characteristics of your demonstration?

Please indicate the name of the demo site, filling as many rows as demos site you have

		Topology & type/location			
Demo site 1	Grid topology	☐ Meshed (meshed operated)	☐ Meshed (radially-operated)	☐ radial	☐ Other (Please specify)
	Grid type/location	☐ Rural	☐ Urban		☐ Other (Please specify)
Demo site 2	Grid topology	☐ Meshed (meshed operated)	☐ Meshed (radially-operated)	☐ radial	☐ Other (Please specify)
	Grid type/location	☐ Rural	☐ Urban		☐ Other (Please specify)
Demo site 3	Grid topology	☐ Meshed (meshed operated)	☐ Meshed (radially-operated)	☐ radial	☐ Other (Please specify)
	Grid type/location	☐ Rural	☐ Urban		☐ Other (Please specify)
Demo site 4	Grid topology	☐ Meshed (meshed operated)	☐ Meshed (radially-operated)	☐ radial	☐ Other (Please specify)
	Grid type/location	☐ Rural	☐ Urban		☐ Other (Please specify)

Comments:

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

- **Q2 [DEMO]:** Previous project highlighted the potential contribution of flexibility services to alleviate criticalities in N-1 scenarios. How useful do you consider flexibility services are for N-1 scenarios?

Please indicate the name of the demo site, filling as many rows as demos site you have

	Usefulness of flexibility for N-1 scenarios					
Demo site 1	☐ useless	☐ somehow useful	☐ moderately useful	☐ very useful	☐ extremely useful	☐ Do not know
Demo site 2	☐ useless	☐ somehow useful	☐ moderately useful	☐ very useful	☐ extremely useful	☐ Do not know
Demo site 3	☐ useless	☐ somehow useful	☐ moderately useful	☐ very useful	☐ extremely useful	☐ Do not know
Demo site 4	☐ useless	☐ somehow useful	☐ moderately useful	☐ very useful	☐ extremely useful	☐ Do not know

  - **Q2.1 [DEMO]:** What is the alternative for alleviating criticalities in these N-1 scenarios (e.g. grid reinforcement, service interruption)?

Comments:

- **Q3 [COUNTRY]:** Does a low visibility of LV grid and the quality of historical data represent a barrier for the use of flexibility?

DSO 1 (please include your company name as you answer the question):

DSO 2 (please include your company name as you answer the question):

DSO 3 (please include your company name as you answer the question):

DSO 4 (please include your company name as you answer the question):

  - **Q3.1 [COUNTRY]:** What percentage of your LV grid consumption points have smart meters?

    DSO 1 (please include your company name as you answer the question):

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

DSO 2 (please include your company name as you answer the question):

DSO 3 (please include your company name as you answer the question):

DSO 4 (please include your company name as you answer the question):

- **Q3.2 [COUNTRY]:** What percentage of your secondary substations (MV/LV) is monitored? (i.e. low voltage supervisors)

DSO 1 (please include your company name as you answer the question):

DSO 2 (please include your company name as you answer the question):

DSO 3 (please include your company name as you answer the question):

DSO 4 (please include your company name as you answer the question):

- **Q3.3 [COUNTRY]:** For the large-scale deployment of the BUCs in your demonstration, would additional grid monitoring in LV be required with respect to those currently in place?

DSO 1 (please include your company name as you answer the question):

DSO 2 (please include your company name as you answer the question):

DSO 3 (please include your company name as you answer the question):

DSO 4 (please include your company name as you answer the question):

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

Comments on LV monitoring:

- **Q4 [COUNTRY]:** Do limitations in the monitoring level of MV grid and the quality of historical data represent a barrier for the use of flexibility?

DSO 1 (please include your company name as you answer the question):

DSO 2 (please include your company name as you answer the question):

DSO 3 (please include your company name as you answer the question):

DSO 4 (please include your company name as you answer the question):

  - **Q4.1 [COUNTRY]:** For the large-scale deployment of the BUCs in your demonstration, would additional grid monitoring in MV be required with respect to those currently in place?

    DSO 1 (please include your company name as you answer the question):

    DSO 2 (please include your company name as you answer the question):

    DSO 3 (please include your company name as you answer the question):

    DSO 4 (please include your company name as you answer the question):

Comments on MV monitoring:

FSPs

- **Q5 [COUNTRY]:** What flexible resources are more available per voltage level?

Please rate from 1 to 5: being 1 - not available, 5 - highly available Or N/A

DSO1 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
LV						
MV						

DSO2 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
LV						
MV						

DSO3 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
LV						
MV						

DSO4 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP,	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:

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

			backup generators)			
LV						
MV						

Comments:

- **Q5.1 [COUNTRY]:** Considering your demonstration's experience, to what extent may the different flexibility sources contribute to:

Please rate from 1 to 5: being 1 - negligible contribution, 5 – critical contribution. Or N/A

DSO1 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
Balancing (Frequency services)						
Congestion Management						
Voltage Control						

DSO2 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
Balancing (Frequency services)						

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

Congestion Management						
Voltage Control						

DSO3 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
Balancing (Frequency services)						
Congestion Management						
Voltage Control						

DSO4 (Fill your company name please):

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
Balancing (Frequency services)						
Congestion Management						
Voltage Control						

Comments:

- **Q6 [DEMO]:** What type of FSPs **from other demos (currently not available in your demo)** do you think would be useful to your Business use case/s?

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

Please rate from 1 to 5: being 1 – not useful, 5 - highly useful. Or N/A

	Residential load	Industrial or commercial load	Controllable distributed generation (e.g. CHP, backup generators)	Non-controllable distributed generation (e.g. PV, Wind)	Stationary storage *flexibility*	Other *(please specify)*:
BUC-ID-1						
BUC-ID-2						

Comments:

- **Q7 [DEMO]:** Imagining a future commercial deployment of your BUC(s) in the networks considered in the demo, which level of FSP availability would be necessary for the deployment to be technically and commercially successful?

Please indicate the name of the demo site, filling as many rows as demos site you have

Demo site	Level of FSP availability needed				
Demo site 1	☐ 1x (same number/volume as the demonstrator)	☐ 1.5x (50% more FSPs)	☐ 2x (twice the number of FSPs)	☐ Other (please specify)	☐ Do not know
Demo site 2	☐ 1x (same number/volume as the demonstrator)	☐ 1.5x (50% more FSPs)	☐ 2x (twice the number of FSPs)	☐ Other (please specify)	☐ Do not know
Demo site 3	☐ 1x (same number/volume as the demonstrator)	☐ 1.5x (50% more FSPs)	☐ 2x (twice the number of FSPs)	☐ Other (please specify)	☐ Do not know
Demo site 4	☐ 1x (same number/volume as the demonstrator)	☐ 1.5x (50% more FSPs)	☐ 2x (twice the number of FSPs)	☐ Other (please specify)	☐ Do not know

Could you provide additional insights? (e.g. additional FSPs could increase market liquidity, reduce uncertainty to the SO, etc)

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

Comments:

Product/Service

- **Q8 [DEMO]:** *Pasts projects highlighted that grid characteristics and FSPs characteristics play an important role in the usage of flexibility by SOs. For example: A region characterized by RES type flexibility (unable to export its maximum energy generation at peak hours) may benefit from demand shifting and storage systems providing downward flexibility. While a demand driven area would benefit from added renewable capacity (not only as flexibility providers but mainly as distributed generation reducing the needs for energy imports from the transmission grid).* What type of constraints (demand driven constraints or supply driven constraints) are you experiencing or expect to experience in your demo area?

Please indicate the name of the demo site, filling as many rows as demos site you have

	Type of constraints		Driver		
Demo site 1	☐ Congestion management	☐ Voltage control	☐ Demand driven	☐ Supply driven	☐ N/A
Demo site 2	☐ Congestion management	☐ Voltage control	☐ Demand driven	☐ Supply driven	☐ N/A
Demo site 3	☐ Congestion management	☐ Voltage control	☐ Demand driven	☐ Supply driven	☐ N/A
Demo site 4	☐ Congestion management	☐ Voltage control	☐ Demand driven	☐ Supply driven	☐ N/A

Comments:

- **Q9 [Country]:** Beyond the demonstration. How common each type of constraint is or will be more common according to your experience in the broader distribution area?

  DSO1 (Fill your company name please):

Type of constraints	Frequency					
Congestion Management	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Voltage Control	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

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

DSO2 (Fill your company name please):

Type of constraints	Frequency					
Congestion Management	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Voltage Control	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO3 (Fill your company name please):

Type of constraints	Frequency					
Congestion Management	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Voltage Control	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO4 (Fill your company name please):

Type of constraints	Frequency					
Congestion Management	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Voltage Control	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

Comments:

- **Q10 [Country]:** Beyond the demonstration. How common each type of constraint driver is or will be more common according to your experience in the broader distribution area?

DSO1 (Fill your company name please):

Cause of the constraints	Frequency					
Demand Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Supply Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Other (resiliency, scheduled maintenance)	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

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

DSO2 (Fill your company name please):

Cause of the constraints	Frequency					
Demand Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Supply Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Other (resiliency, scheduled maintenance)	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO3 (Fill your company name please):

Cause of the constraints	Frequency					
Demand Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Supply Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Other (resiliency, scheduled maintenance)	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO4 (Fill your company name please):

Cause of the constraints	Frequency					
Demand Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Supply Driven	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know
Other (resiliency, scheduled maintenance)	☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

Comments:

- **Q11 [COUNTRY]:** When DERs are providing balancing services for the TSO (in the next 5-10 years). How often you expect local constraints in the distribution network to limit the flexible assets in providing this service?

DSO1 (Fill your company name please):

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

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO2 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO3 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

DSO4 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

TSO1 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

TSO2 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

TSO3 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

TSO4 (Fill your company name please):

Frequency					
☐ Never	☐ Rarely	☐ Sometimes	☐ Frequently	☐ Constantly	☐ Do not know

Comments:

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

- **Q12 [COUNTRY]:** A key challenge for the use of distributed flexibility is its cost, which is still unknown given the incipiency of local flexibility markets. On the one hand, TSO and DSOs may need to procure local flexibility at a certain cost so that it is economically more interesting than the alternative solution (e.g. reinforcing the grid). On the other hand, consumers may have a different perception of flexibility value (e.g. the discomfort for shifting consumption or the cost of changing a production schedule). In this context, please consider the following question:
    - Imagining a future commercial use of distributed flexibility for congestions in MV/LV in short/medium term, what would be an attractive price of active power/energy flexibility for the TSO or DSO?

Attractive price:
DSO1 (Fill your company name please):

	Long term	**Short term**
MV (e.g. industrial consumer)	_________€/kWh	_________€/kWh
LV (e.g. residential consumer)	_________€/kWh	_________€/kWh

Attractive price:
DSO2 (Fill your company name please):

	Long term	**Short term**
MV (e.g. industrial consumer)	_________€/kWh	_________€/kWh
LV (e.g. residential consumer)	_________€/kWh	_________€/kWh

Attractive price:
DSO3 (Fill your company name please):

	Long term	**Short term**
MV (e.g. industrial consumer)	_________€/kWh	_________€/kWh
LV (e.g. residential consumer)	_________€/kWh	_________€/kWh

Attractive price:
DSO4 (Fill your company name please):

	Long term	**Short term**
MV (e.g. industrial consumer)	_________€/kWh	_________€/kWh
LV (e.g. residential consumer)	_________€/kWh	_________€/kWh

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

- Moreover, what price do you expect to see FSPs to request/bid? Please give (price or interval, N/A or do not know)

Expected price:
DSO1 (Fill your company name please):

	Long term	Short term
MV	_________€/kWh	_________€/kWh
LV	_________€/kWh	_________€/kWh

Expected price:
DSO2 (Fill your company name please):

	Long term	Short term
MV	_________€/kWh	_________€/kWh
LV	_________€/kWh	_________€/kWh

Expected price:
DSO3 (Fill your company name please):

	Long term	Short term
MV	_________€/kWh	_________€/kWh
LV	_________€/kWh	_________€/kWh

Expected price:
DSO4 (Fill your company name please):

	Long term	Short term
MV	_________€/kWh	_________€/kWh
LV	_________€/kWh	_________€/kWh

Comments:

- **Q13 [COUNTRY]:** Regarding the scalability (broader implementation in your country) of the flexibility services tested in your demo. How relevant do you think the allocation of responsibilities/liabilities for non-delivery of flexibility after being contracted?

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

Please indicate the name of the demo site, filling as many rows as demos site you have

	Relevance of responsibilities/liabilities allocation					
Demo site 1	☐ not relevant	☐ somehow relevant	☐ moderately relevant	☐ very relevant	☐ extremely relevant	☐ Do not know
Demo site 2	☐ not relevant	☐ somehow relevant	☐ moderately relevant	☐ very relevant	☐ extremely relevant	☐ Do not know
Demo site 3	☐ not relevant	☐ somehow relevant	☐ moderately relevant	☐ very relevant	☐ extremely relevant	☐ Do not know
Demo site 4	☐ not relevant	☐ somehow relevant	☐ moderately relevant	☐ very relevant	☐ extremely relevant	☐ Do not know

Comments:

Market Architecture

- **Q14 [COUNTRY]:** What barriers do you expect in the broader implementation (country-level) of the market architectures tested in your BUCs? Check if the market architecture is correct for each BUC or modify it otherwise.

	Market architecture							
BUC-ID-1	☐ Local market	☐ Central market	☐ Common market	☐ Integrated market	☐Multi-level	☐ Fragmented market	☐ Distributed market	☐ Do not know

please indicate barriers for each market architecture (e.g. implementation barriers, governance, ICT, economic, etc).

Answer:

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

A.2 2nd Survey for demo partners about some key open issues for scalability and replicability

Main open issues in Onenet SRA

1. Please indicate the country of your demo

2. Big differences across demos concerning potential contribution of **non-controllable DG** to solve congestion and voltage issues. Why?
Do the following aspects represent a **barrier** for the use of flexibility from **non-controllable DG** in your country? (1: does not represent a barrier,...,5-represents a strong barrier)

	1	2	3	4	5
DSO is not allowed to use flexibility.	○	○	○	○	○
High price of P flexibility	○	○	○	○	○
Technical limitations by FSPs (e.g. asyncronous generation unable to provide Q control)	○	○	○	○	○
DSO not allowed to control voltage	○	○	○	○	○
A connection agreement forces a fixed cos(phi)	○	○	○	○	○
Non-controllable DG is not located in grid areas where voltage control is needed.	○	○	○	○	○
Bid size minimum requirements are too high.	○	○	○	○	○
Grid R/X ratio limits the potential of Q for voltage control	○	○	○	○	○

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

3. Why do you expect flexibility prices well above the ones observed in UK?

- ☐ Less liquid markets
- ☐ lack of experience with flexibility markets
- ☐ intrinsically higher flexibility costs (e.g. due to FSP characteristics, energy prices)
- ☐ Otras

4. Do you think the importance of responsibility allocation may diminish as more experience is gained and reliable relationships with FSPs develop?

	Strongly disagree	disagree	Not sure	agree	Strongly agree
Level of agreement	○	○	○	○	○

5. Regional use cases and One-Net platform: additional barriers to replication?

6. Any additional comment:

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