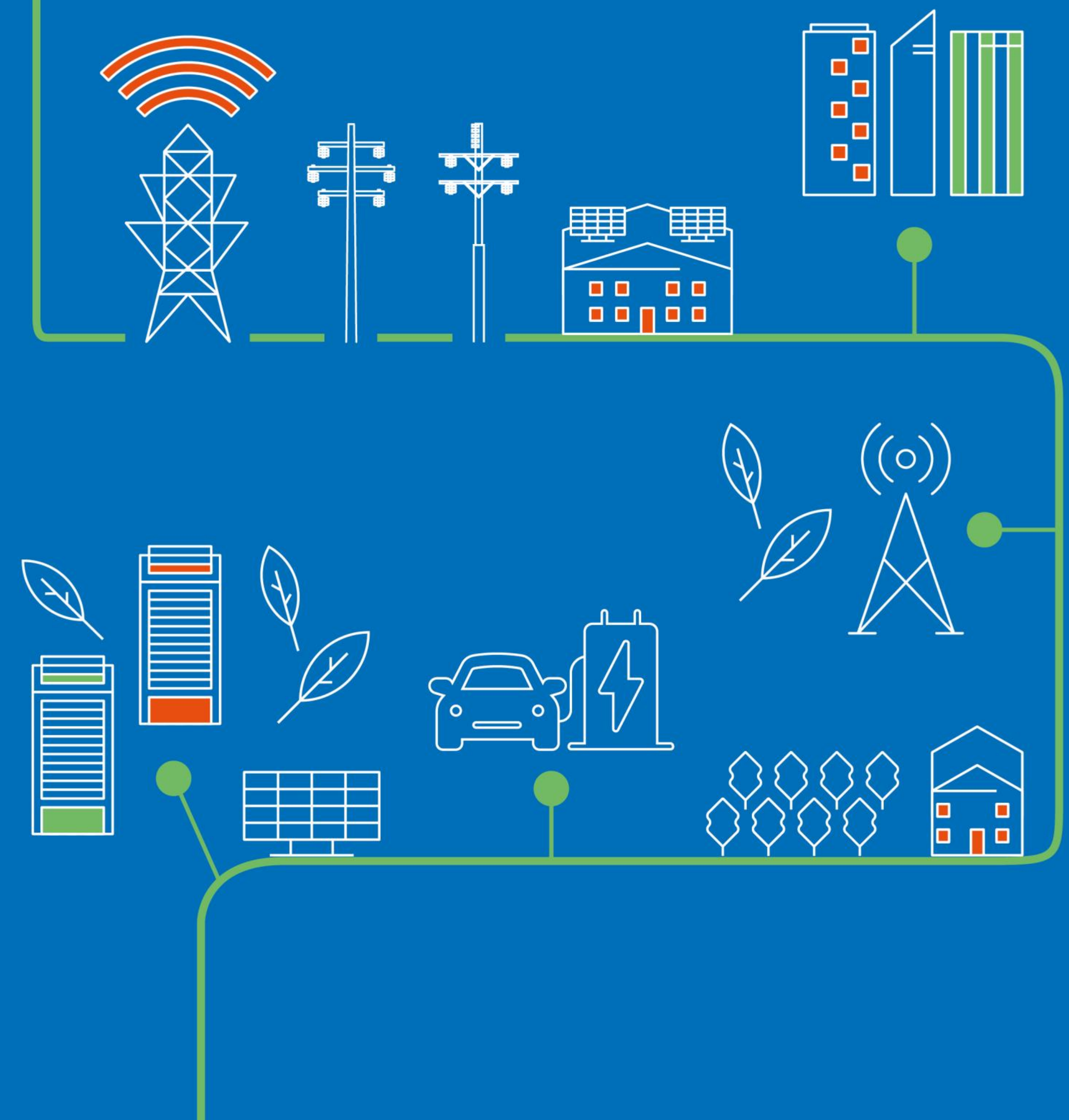
Flexibility Lab White Paper
Executive Summary.



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ABSTRACT

The Flexibility Lab has been launched by Enel to discuss the ongoing rapid changes that the power system is facing, especially at distribution level. 66 companies are part of the initiative, being representative of the diversity of stakeholders involved in the processes of flexibility provision and grid management. The participants had the opportunity to be engaged in one or more of the three Working Groups in which the Flexibility Lab has been organised:

- WG1 – Observability and Controllability
- WG2 – DERMS and Market Platform
- WG3 – e-Mobility

The first step of the work was the identification of the main Innovation Challenges for the distribution grids representing the innovation gaps to be overcome to foster the development and adoption of a flexibility framework. Several challenges were deemed relevant and each one was ranked in terms of importance and urgency to give a better view on where to concentrate Research & Innovation efforts in the near future. Some of the top issues regard cybersecurity, Distribution System Operator (DSO) role, interoperability of devices and platforms, technologies for flexibility management, and market readiness.

The outcomes of this first step established a foundation for identifying a series of use cases key to deploy flexibility solutions. Six of them (two per working group) have been developed in detail, analysing and describing the interactions that the actors of the flexibility value chain should follow to accomplish a well defined goal, e.g. the exchange of data between small scale Distributed Energy Resources (DERs) and DSO platform. This process of developing use cases was done through regular interactions with Flexibility Lab members including working group meetings, on-line shared documents and specific surveys. This made it possible to understand the point of view of the working group members representing actors throughout the power system value chain (such as system operator, aggregator, Charge Point Operators - CPO, e-mobility service provider, HW manufacturer, etc.). The collection of their diverse opinions was key to highlight the needs of each stakeholder in order to deploy effective solutions. The importance of specific technologies has been pointed out as a result of the use case development process and all the actors that are most relevant in this context (e.g., aggregator and DSO) and their interactions has been highlighted.

The use cases developed allowed the set-up of a composite flexibility framework, which is a diagram that depicts the main actors, interfaces and resources that are needed for the procurement and utilization of flexibility. It represents a diagram at a high level with respect to

the use cases and it is intended to clarify the framework in which the use cases can be implemented.

The work proceeded with the identification of the key technologies needed to enable the implementation of the use cases discussed. For each of the identified technologies the readiness level and remaining gaps for their deployment was assessed. Innovative technologies and solutions were addressed by the Working Groups, such as the 5G technology to share close to real-time data, Distributed Energy Resource Management Systems (DERMS) for integrating flexibility with distribution operations, and vehicle-to-grid (V2G) technologies for e-mobility.

Finally, the discussion moved to the assessment of recommended practices to foster the deployment of flexibility solutions. Several have been identified and concrete example of their implementation were proposed by members.

This report summarises the Flexibility Lab activities to-date. Opting for infrastructure investments, particularly in digital technologies, stands out as the preferred strategy for the electrical network. This approach is essential for addressing the challenges of the industry and bolstering the role of electricity distributors. It plays a crucial part in supporting the security and adequacy of the entire energy system. This reportprovides a view of distribution network flexibility and provides a starting point for the development of future activities, projects or pilots in the field of distribution system management with the utilization of flexibility services.

INTRODUCTION

According to the IEA report "Net Zero by 2050" [1], the global electricity demand needs to more than double between 2020 and 2050 with an increase in the share of renewable energy in global electricity generation from 29% in 2020 to over 60% in 2030 and almost 90% in 2050. With reference to EU ambition set in the FitFor55 [2] legislative package by the EC, reinforced by Repower EU plan, almost 800 GW of solar and wind capacity need to be added to the EU power system by 2030. In this view, power systems are pushed to evolve towards a mass electrification of the consumption and a steep increase of renewable sources, which are often variable and distributed. Such deployments would have a strong impact on distribution networks, where the impact of increased electrification and renewables installation lead to several challenges that require modernized infrastructure and new capabilities and tools to be effectively managed. In addition, higher penetrations of electrical loads, variable generators, and storage systems open possibilities for innovative grid management. For example, system operators can make use of such potential to support the security and reliability of the entire energy system.

In this view, Enel launched the Flexibility Lab initiative, with the objective to explore how distribution grids could be made more flexible to address the new DSO's needs. The initiative provided a welcoming environment for interested parties from academia, consulting firms, laboratories, technology providers, as well as representatives from DSOs, TSOs, Flexibility Service Providers (FSP), CPO, and others. The Flexibility Lab initiative was built around three working groups, each with the participation of experts and representatives from a wide range of backgrounds and stakeholder perspectives.

Working Group 1: Observability and Controllability

Observability and controllability are key functionalities to be ensured for the proper management of a flexible power system. WG1 discussed about which are the DSO requirements for monitoring the status of the distributed resources, especially of those that nowadays have low visibility, and how to ensure reliable flexibility service activation.

Working Group 2: DERMS and Market Platforms

DERMS are large-scale software systems needed by the DSO to bring DERs and loads into grid control algorithms alongside conventional controls. Flexibility market platforms enable flexibility providers and aggregators to participate, making competitive offers and being selected to provide services.

Working Group 3: e-Mobility

WG3 is dedicated to identifying the barriers for the adoption of smart charging and V2G, and to define the flexibility potential of Electric Vehicles (EVs). WG2 discussed on which are the case studies most suited to provide grid services by EV charging modulation and about the technological requirements that can allow the optimal integration of EVs into the electrical distribution grid.

INNOVATION CHALLENGES

Supporting society's rising dependency on electricity while reducing carbon emissions requires transformation at all levels from generation to end-use. The Innovation Challenges (ICs), reported in the following figures, have been identified thanks to the interaction with Flexibility Lab members. ICs do not suggest a given technology or solution approach, but rather describe the capability that is needed, and the innovation required to make grids more flexible. Participants in the working groups discussed and reviewed the ICs, ultimately providing comparative rankings of the ICs along two key dimensions/metrics: Impact and Urgency.

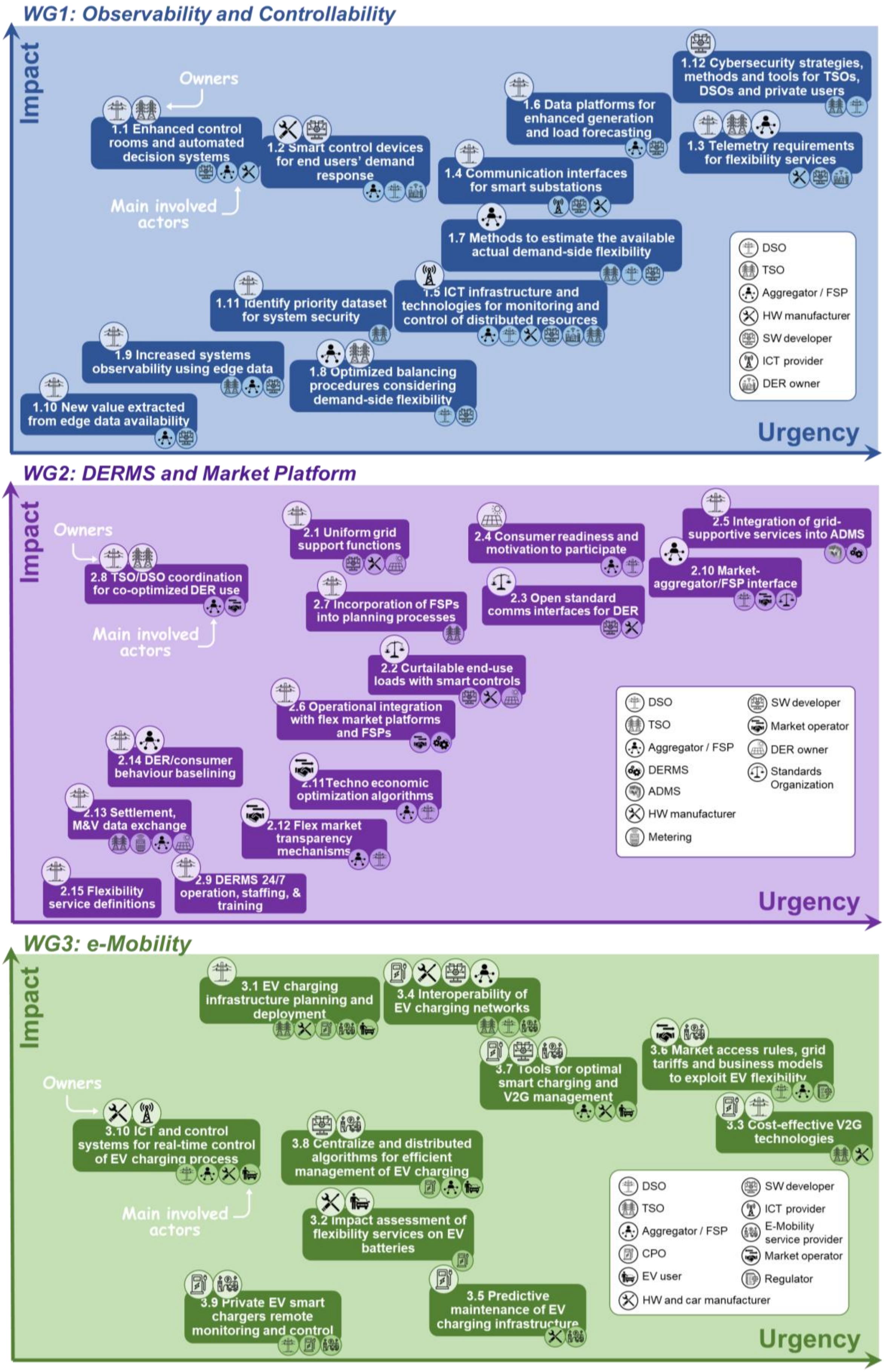

Figure 1: Innovation Challenges

USE CASES, TECHNOLOGY READINESS & GAPS

Through the “use case” methodology a process to achieve a particular goal from the initial trigger to the final feat, the entities involved, the information exchanged, and the capabilities required at each step of the process can be described. Focussing on specific use cases, the working groups identified which specific entities, tools, communication technologies, etc. are involved in the process described and how they might interact towards specific objectives. The work proceeded with the assessment of the maturity level of the technologies identified and with the analysis of the remaining gaps.

Once a use case has been thoroughly defined, its associated list of actors and their interactions can be stitched together with those from other use cases to form a composite architecture. The result of this exercise, performed for the use cases investigated, is reported in Figure 2.

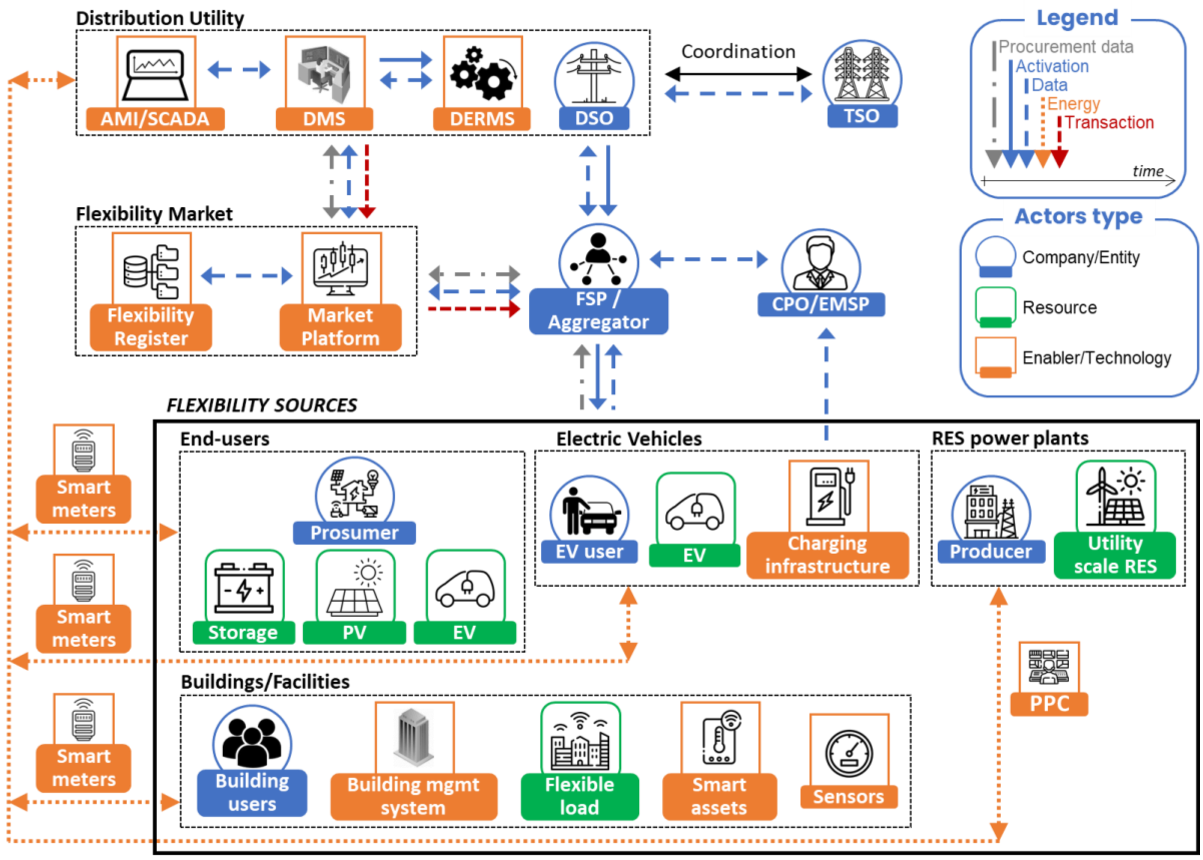

Figure 2: Architecture diagram for flexible grid management according to the use cases analysed.

The following table reports the use cases developed by the Flexibility Lab. Each one is linked with the innovation challenges that need to be addressed to implement it properly in a real environment.

	Use Case	Related ICs
WG1	Data flow between small scale DERs and DSO platform	*1.3; 1.4; 1.12*
	Consumers' demand side flexibility forecasting and management	*1.5; 1.6; 1.7*
WG2	Operational utilization of flexible resources to mitigate grid and energy supply constraints	*2.5; 2.6; 2.10*
	Distribution planning inclusive of flexibility	*2.4; 2.7*
WG3	Smart charging / V2G schemes for EV company parking slots	*3.3; 3.4; 3.6; 3.7*
	Prosumer self-consumption optimization and flexibility services by EV and other DERs	*3.3; 3.8; 3.6; 3.7*

In the next chapters will be presented the use cases developed within each working group and a summary of the main outcomes from the technological readiness and gap analysis conducted.

WG1 - Observability and Controllability

UC 1: Data exchange between small scale DERs and DSO platform.

Scope and objective: DSOs full observability of the low voltage grid to maintain high quality of service and to monitor the delivery of flexibility services.

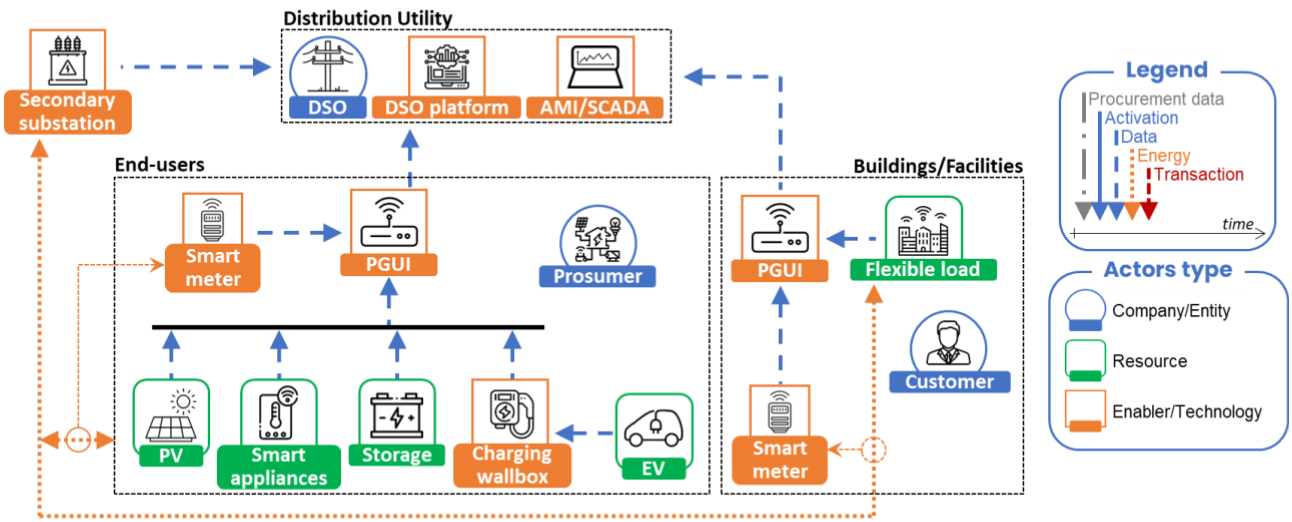

Figure 3: Diagram of UC 1 - Data exchange between small scale DERs and DSO platform

This use case describes the data flow between small scale DERs and the DSO to monitor the grid and the activation of flexibility services. The DSO platform receives (in close to real time) power measurements and data coming from the DERs that provides flexibility services. Different solutions can be adopted for this purpose, for example rely on the cloud interfaces embedded in end user appliances, exploit only on smart meters data or use innovative devices like the Power Grid User Interface (PGUI). This last option has been considered very promising to get close to real time data from flexible DERs and further discussion on the PGUI is reported in the technology section below.

UC 2: Consumers' demand side flexibility forecasting and management.

Scope and objective: Demand side flexibility forecasting and end user's consumption optimization within flexibility service provision schemes.

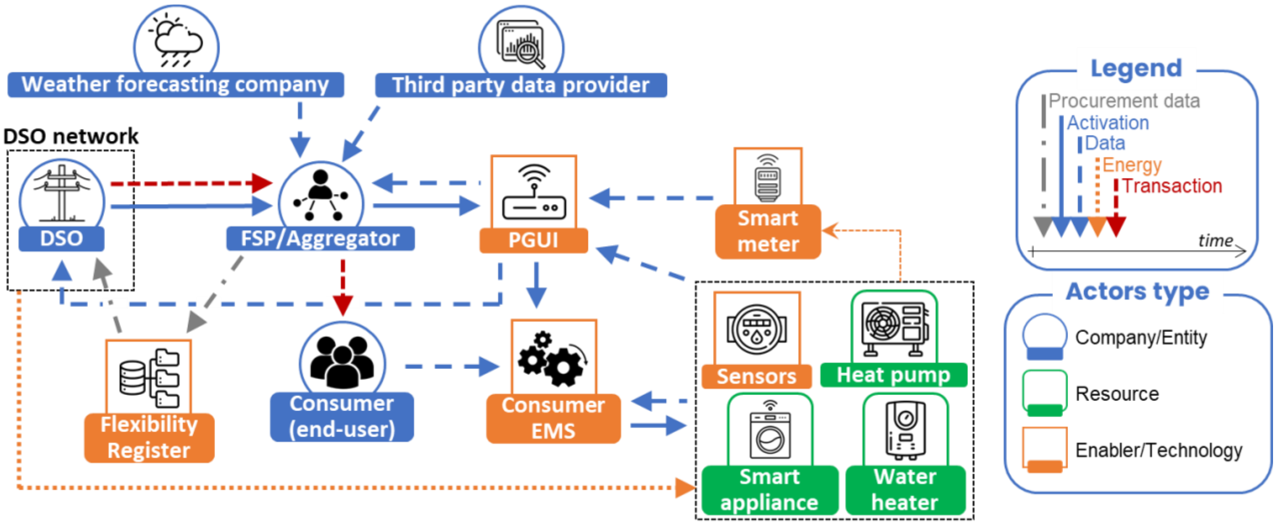

Figure 4: Diagram of UC 2 - Consumers' demand side flexibility forecasting and management.

The flexibility potential from consumer's demand is forecasted by the FSP to offer flexibility services. A PGUI is installed at the user's premises allowing to activate the services in response to signals sent by the FSP and to have close to real-time observability of the energy consumption. To provide grid services, the FSP (acting as an aggregator) forecasts the flexibility potential of the individual resources and computes the aggregate flexibility to be offered in the market (e.g. by techniques such as in [3]). Depending on the methods adopted by the FSP, different kinds of data are needed e.g., ambient sensors measurements, tracking of mobile phone, car traffic data.

WG1 - Technology Readiness and Gaps: Observability & Controllability

The increasing complexity of the distribution grids calls for enhanced digitalization, especially considering a framework where DSOs can purchase local flexibility services. The process of flexibility provision should minimize the direct involvement of end-users and the monitoring infrastructure should allow close to real-time observability of DERs and grids at all voltages. For these reasons the adoption of appropriate communication technologies and control devices is crucial. In this view, WG1 discussed about technology readiness and gaps, and the outcomes are summarised here.

Power Grid User Interface and close to real-time data exchange

The PGUI technology could become a key enabler for the communication between DERs located at end-user premises and platforms at system level, such as the ones managed by the DSO or other actors (aggregator/FSP). In the use cases described above, some of the potential PGUI functionalities such as acquire close to real-time data, forward them to third parties, get activation signals and set points for flexible DERs has been highlighted.

Communication technologies – Network level

To enable the communication channels between end user resources and system level actors (DSO, aggregator, FSP) several solutions are possible, the choice of which depends on several factors and is not unique [4] [5] [6]. The adoption of wired communication (e.g., optical fiber) might be the best option as it guarantees network stability, but wiring networks are often expensive. Wireless communication solutions (e.g., 5G communication [7] [8]) are gaining interest and could also cover remote areas.

Communication technologies – Local level

At the user premises level, the communication between smart devices and the PGUI can be based, as for network-level communication, both on wired and wireless technologies [4] [5]. The applications where wired solutions are the only option are limited since at residential level it is relevant to avoid additional wiring besides the electrical network. Therefore, if cybersecurity and network stability is guaranteed, wireless technologies could be a very valid solution for the communication at the end-user local level. They often result also in lower costs, negligible impact on buildings and they can cover a wide range of applications.

WG1 also assessed a series of barriers towards the implementation of innovative technologies, in the following a summary is provided:

PGUI deployment barriers

Regarding the deployment of the PGUI or a similar technology to monitor and control the flexibility resources, coordination among different actors of the flexibility value chain about its technical specifications needs to be pursued. Actors' responsibilities for its deployment and management should be also defined. Indeed, in a framework of flexibility purchased on local market, the PGUI (or a similar device) need to be in constant communication with system level platforms and therefore adopting standardized interfaces and communication standards is essential. Some of the recommended standards, as widely recognised in literature, are openADR, IEC 61850, IEEE 2030.5 [9] [10] [11] [12].

5G deployment barriers

At the current stage, 5G is no longer an emerging technology but, even if it is mature, some barriers are still hindering its adoption. For example, interoperability issue can arise while integrating communication devices based on 5G networks. Moreover, 5G has been claimed to become attractive to transfer data about flexibility services if the infrastructure is shared with other applications (e.g., mobile networks).

Cloud systems interoperability

Nowadays, almost all smart appliances are able to interact with a cloud platform developed and owned by the manufacturer. This is commonly done through proprietary communication standards and interoperability issues rise when the several smart appliances are aggregated by a FSP to provide demand response services. In fact, the FSP needs to develop different Application Programming Interfaces (API) to communicate with different cloud systems to control single resources. This makes harder and expensive to aggregate different resources, since aggregators need to develop non-standard interfaces to several cloud platforms.

WG2 - DERMS and Market Platforms

UC 3: Operational utilization of flexible resources to mitigate grid and energy supply constraints

Scope and objective: this use case describes the process that takes place when a DSO makes use of a flexibility resource in the operational timeframe. Flexible service providers may be pre-qualified to provide the services that they are offering.

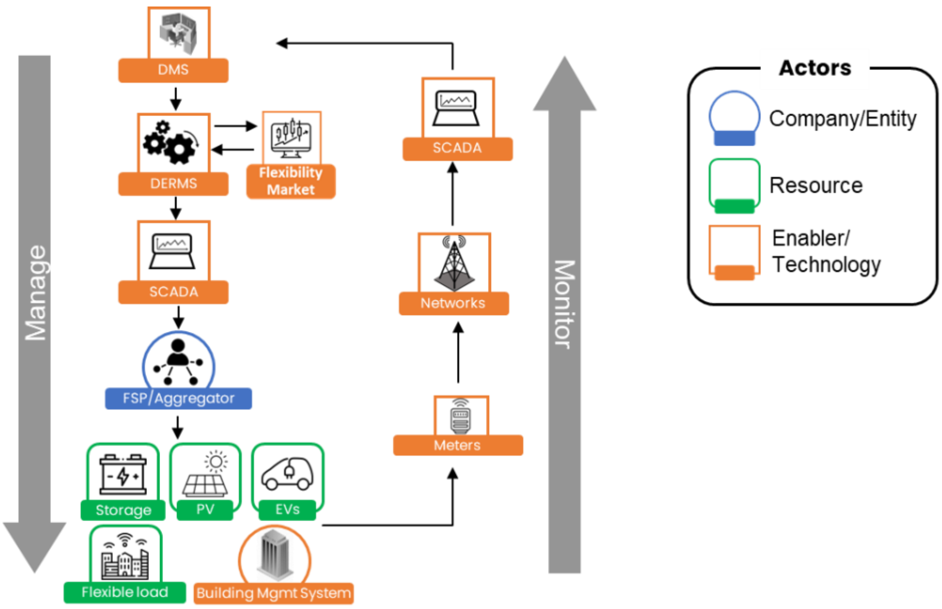

Figure 5, Reference Diagram for Operational Utilization of Flexibility Resources

This use case includes cases in which the service is procured from long-term flexibility markets well in advance (e.g., years) of an operational event as well as cases in which the service is procured within operational timeframes (e.g., day-ahead) from real time markets. The process begins at the distribution management system (DMS) used by the DSO to manage the system. DMS must be improved to include algorithms that can utilize flexible resources in combination with conventional resources (regulators, capacitors, switches) to address potential congestions or voltage issues on the grids. DMS interfaces with DERMS to discover what qualified services are available and to dispatch/request a flex service. Dispatching, depending on the type and size of DER, may involve the utility SCADA system directly communicating to DER sites or may involve DERMS communicating with DER aggregators which then communicate to DER sites using other communication networks. The use case ends when it is verified that the flexibility service was delivered with the timings and quantities needed.

UC 4: Distribution Planning Inclusive of Flexibility

Scope and objective: This use case describes a distribution utility planning process that takes flexible resources into consideration. This use case augments traditional planning, which focuses on infrastructure upgrades, with plans that include the use of flexible resources.

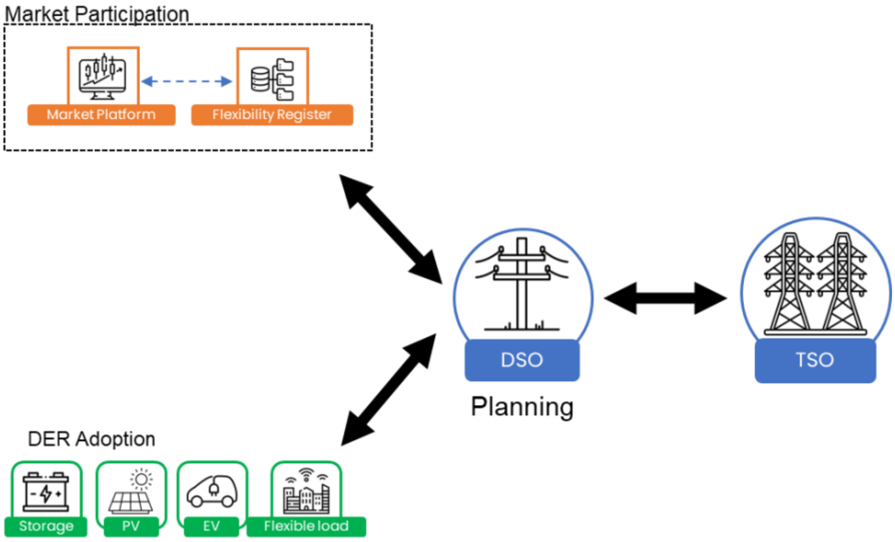

Figure 6 Reference Diagram for Distribution Planning with flexibility

Planning is inherently conservative with actions determined that will guarantee that needs are met under worst case conditions. The inclusion of flexible resources in such deterministic processes is a challenge due to the utility requirement that capabilities are guaranteed when needed. A key question for planning with flexibility is whether it is used in a dependent way or only for economic optimizing. If a DSO plans in such a way that they are dependent on flexibility services when called-upon, and the lack thereof would cause outages or equipment damage, then the flexibility service is mission-critical and considerations such as redundancy, backups, online availability and communication system reliability are important. On the other hand, if the planning process merely uses flexible resources to reduce line losses, then a failure to respond is not concerning.

WG2 - Technology Readiness and Gaps: DERMS & Market Platform

DERMS

There are many products referred to as DERMS but differing in capabilities and new services. Most products connect to individual DER and aggregate them to perform services for distribution and/or bulk power systems. To provide these system services, DERMS technologies depend on readiness of distribution management systems to use optimal combinations of flexibility and traditional controls.

DERMS products that are presently available organize DER into logical groups and manage their device-specific settings to produce grid services like Watt and Var offsets. The ability to instead communicate to a flexibility market that is served by other entities performing aggregation is less common among DERMS products.

Flexibility Markets

Flexibility market platforms are nascent and evolving to meet the needs of projects in various regions. Some platforms have been deployed and operational for 5+ years with moderate levels of participation and use. Providers of flexibility market platforms generally believe that their products have the scalability needed, but demonstration of this capability has been limited by available market participants and, crucially, clear guidance/intent from DSOs.

Flexibility markets depend on the definition of a fixed set of "flexibility services", for example, defining minimum and maximum quantities of Watts, up/down ramp time, accuracy of control, advance notification needed, and telemetry for operational verification. The nature of these service definitions currently varies by region according to the needs of grid operators.

Flexibility Register

In addition to their core market function, flexibility market platforms could have a role in providing a registry of available flexibility. Such a registry would contain data such as unique DER/flexibility resource identifiers/IDs, nameplate DER power/capacity ratings, and active contractual limits of each device, among other information. Where this registry resides, if it gets shared by multiple markets, who maintains it, and precisely what the interfaces with the registry look like are still to be defined, but the information it contains is expected to be critical to decisions made by at least DERMS, TSO's, and of course flexibility market platforms.

DMS and DERMS Interface

The interface between DMS and DERMS is of critical importance and yet, as noted by working group participants, it has not yet been standardized sufficiently. The IEC 61969-5 (CIM for DER) aims to address this interface but is a work in progress and has not been field-tested. Until it is available, ad-hoc solutions are being used. In the interim, some technology providers are beginning to incorporate DERMS functionalities into the DMS offerings, effectively combining DMS and DERMS into one software and internalizing this key interface. Regardless of whether products come from separate vendors or just one, exposure of a standardized interface is preferred for the opportunity it provides for system sustainability and inclusion of DERMS products not necessarily tied to a DMS vendor.

WG3 - eMobility

UC 5: Smart charging / V2G schemes for EV company parking slots.

Scope and objective: Management of a charging infrastructure owned by a company and hosting employees' EV to provide flexibility services (V1G or V2G).

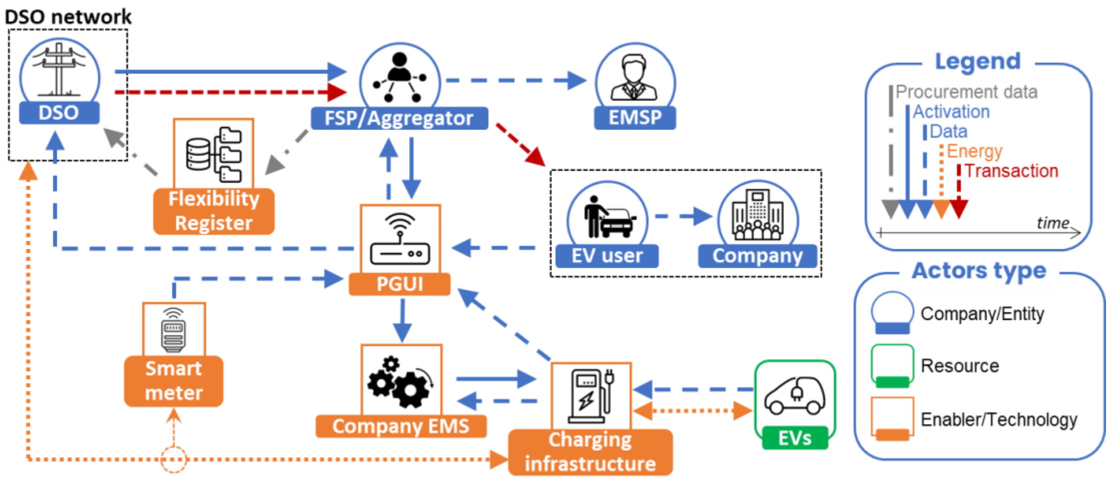

Figure 7: Diagram of UC 5 - Smart charging / V2G schemes for EV company parking slots

This use case covers the activation of grid services from company parking slots by means of smart charging and/or V2G schemes where the EVs are owned by the employees (e.g. as developed by [13]). Following the request of the aggregator, the activation and management of the flexibility service is performed by an EMS. It coordinates the charging points according to different requirements and constraints. In this view the EMS continuously monitors the status of charge of EV batteries and, also considering the employees' necessities in terms of EV availability, manages the charging process. This would guarantee the provision of flexibility services without impacting the possibility for the users to utilize their EVs. The PGUI technology acts as the communication bridge between FSP/DSO and the DERs and permits the service activation and monitoring.

UC 6: Prosumer self-consumption optimization and flexibility services by EV and DERs.

Scope and objective: Optimizing prosumer self-consumption and grid services delivery through the management of EV charging process in coordination with other resources.

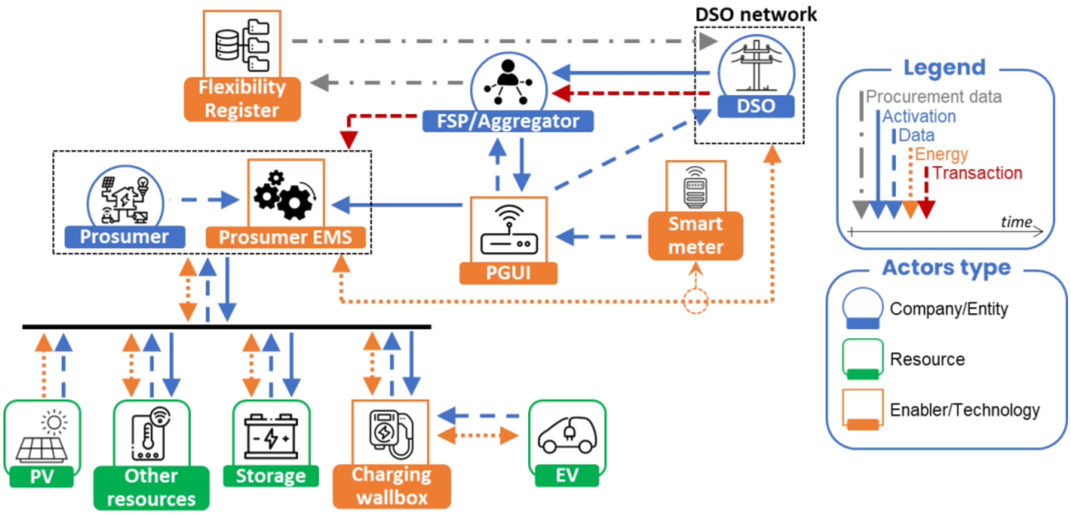

Figure 8: UC 6 - Prosumer self-consumption optimization and flexibility services by EV and DERs.

All resources of a generic end-user (e.g. EV, PV, storage, other smart appliances) are used for optimizing both the flexibility service delivered and self-consumption in order to obtain the highest economic benefit possible. Smart charging and V2G in this use case are part of this optimization and their management will be granted by the adoption of an EMS that coordinates the EV charging with the consumption and production of all the other assets. For the activation and provision of flexibility service, the EMS needs to continuously monitor the status of the charge of the EV battery, and all the other resources mentioned before. Moreover, it needs to be aware of the PV production forecasts as well as the users' activities and comfort constraints such as the EV's needed availability.

WG3 - Technology Readiness and Gaps: eMobility

Trying to map which are the charging options that provide the highest potential in terms of flexibility, and which are the technological requirements in terms of control and observation of the charging process, the discussion within WG3 revolved around the main topics presented in the following:

Charging technologies to provide flexibility

Different kind of business models for flexibility services by EVs are possible [14], generally they rely on sufficiently long charging times, to allow a relevant modulation of the energy drawn by the vehicle, and a sufficiently high charging power to provide a relevant modulation. With a focus on electric light-duty vehicles, WG members indicated the slow charging (<7.4 kW) and the quick charging (<22 kW) as the top suited charging powers for flexibility services provision thanks to charging times in the range of 1-8 h [14].

Charging connections for vehicle-to-grid

V2G was originally studied for Direct Current (DC) chargers. Nevertheless, bidirectional charging connected to AC is getting interest nowadays, as it has been pointed out by different case studies and by acknowledged entities [15]. In fact, the large majority of chargers relevant for V2G applications that are placed at residential and workspaces level are connected in AC.

Control and monitoring of the charging process

Regarding EVs charged at residential level, there is the need of a local charging controller, even for those wall boxes that are not enrolled in flexibility programs, to not overcome maximum allowable power while the consumption of the other appliances changes. An option would be to install in the wall boxes a charging controller that is already able to receive modulation setpoints by an external actor thus with the possibility to be enrolled in flexibility programs. This would be relevant to foster the use of EVs as a source of flexibility.

Within WG3 the following technological barriers limiting flexibility by EVs were also discussed.

V2G deployment barriers

Bidirectional charging still has big gaps to be overcome to enable its commercial deployment as a flexibility service. The most hindering technological barriers underlined by WG2 members are here provided in order of importance: (i) lack of V2G-ready electric vehicles, since at market level very few models available have V2G capabilities [16] [17] [18], (ii) deployment of V2G-ready EV supply equipment, (iii) control systems, (iv) communication technologies, and (v) interoperability.

EMS for e-mobility

EMS technologies has been claimed as suited to perform V2G, even if small gaps have been identified for EMS algorithms, which could be improved to enhance the charging process optimisation. Also, the lack of tested V2G case studied (and therefore tested EMS functionalities for V2G) makes it difficult to understand the operational requirements and eventual gaps that current technologies will experience when performing V2G. A side issue identified for EMS today is that they are not interchangeable and therefore doesn't open to the possibility of substituting the EMS by maintaining the same devices and resources.

BEST PRACTICES AND RECOMMENDATIONS

Technology developments and demonstrations worldwide have shed light on what the future, more-flexible power system may look like. From these efforts, a number of best practices and suggested technology features have become evident. Such experiences and learnings were brought to the Flexibility Lab by working group stakeholders and shared during meetings and through surveys.

In this context, best practices are recommended courses of action that, if implemented/utilized, have the potential to accelerate the process of making grids more flexible. As working group stakeholders acknowledged, recommended practices are sometimes not the easiest or fastest path but are instead those that tend toward sustainable, scalable systems and minimize stranded assets and optimized investments along the way.

Adopt a standard and practical means for quantifying the level-of-service provided.

Measurements both before (baselines) and during flexibility events are needed to calculate flexibility-driven response estimates and counterfactuals that enable settlement.

Assess the EV owners' willingness to modulate the charging power.

Pilot projects, analysis of data from charging infrastructure, surveys and other tools can deepen the understanding of EV owners' willingness to modulate charging under different circumstances.

Develop DSO-TSO & DSO-FSP coordination interfaces at the inception of flexibility service.

To prevent flexibility services established by different system operators from negatively affecting the others, direct coordination between TSO & DSO is recommended. Moreover, DSO-FSP coordination during flexibility provision enable the FSP to modify its strategies dynamically.

Consider the end-users needs in the definition of flexibility services.

It is essential to consider end-user needs to ensure that flexibility services are well-received and enticing enough to the public (especially at time of adoption) to foster broad adoption.

Ensure the scalability of the monitoring and controlling infrastructure with respect to the growing number of resources connected to the grid.

A scalable infrastructure supports optimal resource utilization and the successful integration of renewable energy and EVs. It can ultimately contribute to a more stable and reliable grid.

Establish a small number of very clearly defined and standardized flexibility services.

Details such as min/max quantity, advance notification, ramp up/down time, hold-duration, etc. should be publicly documented for each service.

Make flexibility markets as transparent as possible.

Flexibility market platforms should provide a public mean for stakeholders to verify fair market operations. This should include anonymized lists of offers made for each service and the identification of what was selected and at the relative marginal price.

Promote the sharing of results coming from demo projects with regulatory bodies.

Pilot and demonstration projects are key to evaluate the performance, scalability, and effectiveness of flexibility services and solutions. Share projects' results with regulatory bodies fosters the needed evolution of the regulatory framework.

Standardize communication protocols for the activation and monitoring of flexibility.

Standardizing communication protocols for flexibility activation and monitoring is crucial for ensuring semantic interoperability, scalability, cost-effectiveness, and widespread adoption of flexibility resources.

CONCLUSIONS AND FINAL REMARKS

The Flexibility Lab initiative, launched by Enel in 2022 and carried on by RSE and EPRI, is a discussion forum for experts from the power system value chain. The initiative is organised in three working groups to focus members' activities on key R&I topics for the evolution of distribution systems, namely "Observability and Controllability", "DERMS and Market Platform" and "e-Mobility". The main goal of the initiative is to discuss on how to meet the challenges raised by key trends such as the increasing penetration of renewable sources, the electrification of energy consumption and the e-vehicles uptake.

Through workshops, technical meetings, surveys, shared documents and other tools, the Flexibility Lab working group members had the opportunity to share their views and perspectives on the different topics under discussion. This made possible to reach a consensus about the identification of the main innovation challenges (either technical or not), the development of relevant use cases, the assessment of innovative technologies and the definition of recommendations to enhance the integration of DERs within distribution grids finding common solutions which will strength the role of distribution operators in bolstering the security and reliability of the entire electricity system. This report is a tangible outcome of the Flexibility Lab, and it summarises all the discussions and results obtained to date.

To conclude, Flexibility Lab proposes the following final remarks about innovative technologies, flexibility enablers and recommended approaches to boost grid flexibility and prepare distributions systems to host increasing shares of DERs and further electrification of energy end uses.

Innovative technologies

- PGUI technology for real-time monitoring and control of DERs
- 5G communication technology
- DERMS
- Flexibility market platforms
- Technologies for bi-directional charging of EVs
- EV charging controllers with communication capabilities

Flexibility enablers

- Development of standards
- Cybersecurity methods and tools
- Market transparency and rules
- Interoperability between devices and resources
- Develop technologies that comply with DSO requirements
- Algorithms for demand-response and EV charging management

Recommended approaches

- User-centric approaches
- DSO-TSO coordination
- DSO-FSPs coordination
- Stakeholders' involvement in development processes
- Flexibility services as a resource to solve grid contingencies
- Information exchange among all actors in long & short time frames

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