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1. Introduction

1.1 Introduction Bridge Regulatory WG

The BRIDGE Regulatory working group was established at the origin of the BRIDGE initiative with the objective of fostering knowledge sharing among H2020 projects affected or addressing by different regulatory aspects in the Energy domain. The Regulatory WG, as the entire BRIDGE initiative, structures its activities on a yearly basis. In the last years, different topics have been addressed, resulting in most cases on specific reports that can be shared not only within the BRIDGE community, but with a larger audience.

At the beginning of 2021, the BRIDGE Regulatory working group was composed of 52 projects represented by 109 participants. It is a live group where new contributors are always joining and leaving as results of the natural evolution of the projects. This “staff rotation” facilitates a dynamic environment for the introduction of new topics of interest. However, it also creates a continuation challenge when a leading project in one of the topics concludes its engagement with BRIDGE. As a solution, in 2021, the Regulatory WG will not only tackle a number of pre-identified tracks but will also propose a new mechanism to facilitate the continuation of activities by new projects joining the initiative – whenever these activities remain of interest. As part of the action plan of 2021, the Regulatory WG also examined how the best practices and regulatory recommendations from the projects could support the activities of the Action Plan for the Digitalization of the Energy Sector[1].

1.2 Introduction to the main challenges to be addressed

The regulatory working group focusses its efforts on topics related to overall market design. The work has been structured around four tracks that are considered as corner stones for market design. These tracks are expected to stay relevant for the coming years. The four tracks that form the basis of the work of the Regulatory WG are:

1) Products and Services:

   The transition to a high RES system will require new or adapted services for TSOs and DSOs to ensure a stable and secure operation of the system. In addition, these services will be mostly provided by decentralized resources coming from new market players and emerging technologies. This will lead to the design of new flexibility products to facilitate the service provision. The increase in flexibility products in support of a wide range of system services will create a need to address policy questions in relation to harmonization and standardization of services, products, and the related market processes.

2) Cross-border and regional cooperation

   The cooperation between TSOs and DSOs is a fundamental cornerstone in the energy transition. The cooperation should happen within the national context but also cross-border. Questions in relation to improved cooperation address network planning, network operation and emergency measures. This includes for example innovations related to grid observability, information provision, sharing of resources and tools for cross-border system operation.

3) Market integration

   The use of flexibility provided by decentralized resources is in full development. Several flexibility products, mechanisms and market processes have been tested and demonstrated at a small scale and are ready for large-scale implementation. To ensure an efficient upscaling, market fragmentation should be avoided.

[1] Digitalising the energy sector – EU action plan (europa.eu)

Solutions to support market integration deserve attention to increase the efficiency and lower the costs of both market and system operation.

There are multiple dimensions to the challenge of market integration:

1) Several flexibility mechanisms are under development. Next to flexibility markets (= explicit flexibility) also implicit flexibility mechanisms such as dynamic tariffs and dynamic connection agreements are under investigation. The challenge will be to ensure that different mechanisms can co-exist in an efficient way.

2) The procurement and activation of flexibility by system operators should also follow a coordinated approach and might require integration of operational processes, information provision, remuneration mechanisms, …

4) Local markets

The provision of flexibility will come predominantly from decentralized resources. The role of local markets to facilitate participation of flexible resources, mostly connected to low- and medium voltage, is important. The emergence of local markets will give rise to several challenges, i.e. how does the local market relates to existing flexibility markets, how could we integrate multiple carriers beyond energy, what could be role of peer-to-peer, … The specific nature of demand response leads to challenges to address the behavioral aspect of consumers. Also, the technical specifications of the low voltage grid, bring forward the need for new solutions as the solutions applied for high and medium voltage might not necessarily be transposable.

For each of the tracks, on a yearly basis, topics of interest will be determined. For a selection of these topics, a specific action will be determined as part of the yearly work plan.

1.3 Overview Action Plan 2021

Lead topic

Sub-topic

Track 1: Products and Services

Action 1

- **Product standardisation**
- Product design for congestion management
- Product design for voltage control

Action 2

- **Service provision by energy communities**
- Service provision by E- mobility
- Market incentives to support consumer engagement

Track 2: Cross-border and Regional Cooperation

Action 3

- **System Security**
- Regional Coordination Centres
- Geographical islands
- Network Planning

Track 3: Market integration

Action 4

- **Link between different flexibility mechanisms**
- Dynamic tariff design
- Dynamic connection agreements
- Cross-border market integration
- TSO-DSO coordination

Track 4: Local Markets

Action 5

- **Local markets**
- Multi-carrier markets/sector integration
- P2P energy trading

2. Action 1 – Product Design

2.1 Introduction of the Action

The objective of action 1 - Product Design - was to identify good practices when developing flexibility products related to congestion management and voltage control services. Furthermore, in this action are also considered good practices related to the harmonisation of these flexibility products.

To identify Bridge projects' best practices regarding product design, this action received information from several projects participating in the Bridge Regulation WG. The action counted with the input from 13 projects. These projects are:

To collect the relevant information, the action 1 team undertook a combination of desktop research, questionnaires, and workshops. Chronologically, the methodology used in this action was:

- **Desktop review:** Each project was requested to provide the relevant documents they had developed concerning the definition of system services and related products.
- **First workshop:** The kick-off meeting and the 1st action workshop, on September 23rd 2021, where, based on the information in the relevant literature provided by the projects, a discussion was organised on the definitions of system services, flexibility products, harmonisation and standardisation of products. The objective of this workshop was to ensure a common understanding of those definitions to facilitate a coherent response from the different projects.
- **Questionnaire:** A questionnaire was circulated where each project was requested to provide information about the definitions they had used for 1) system services and flexibility products, 2) the congestion management and voltage control products they had developed and 3) the harmonisation process they used to define these products (a copy of this questionnaire is included in Annex-I.
- **Second workshop:** This workshop took place on November 22nd, 2021. As part of this workshop, the team presented the main findings arising from the previous analysis and facilitated the discussion about the main products as well as the process for the harmonisation of the different potential products. As part of

this workshop, the team used a questionnaire in Slido (with the main findings summarised in Annex-II). The information obtained because of these different points of engagement constitutes the basis of our findings in this action as summarised in the following sections.

2.2 Best practices

Based on the information received from the different projects, this section presents the main good practices that have been identified in the development of system services and flexibility products and their possibility for harmonisation. From the information received of the 13 projects during the time of this action, EU-Sysflex, CoordiNet, INTERRFACE and OneNet were the most advanced projects on the topics in discussion.

Definition of system services and flexibility products

Most projects developed their own definitions of systems services and/or flexibility products. This aimed at achieving a consistent understanding across the members of the project. These definitions differed between projects as their projects' objectives are different. However, in this action, we propose the definitions used in OneNet as a base.

- **System service definition:** System service is defined as the action (generally undertaken by the network operator) which is needed to mitigate a technical scarcity or scarcities that otherwise would undermine network operation and may create stability risks.
- **Flexibility product definition:** A product is a **tradable** unit that the network operator acquires from flexibility providers and that entails the option to deliver a service in case of activation (this activation can be automatic). The characteristics of the technical scarcity mitigated by the relevant service will determine the attributes of the tradable unit.

To achieve the definition above, OneNet undertook a literature review of the different definitions used in several H2020 projects. Furthermore, in this action, when other projects were asked whether their definitions were consistent with those in OneNet, they indicated that they were in line.

In addition to the use of flexibility products, procured via explicit flexibility markets, other flexibility mechanisms are also available, such as dynamic tariffs, dynamic connection agreements, curtailment, redispatch measures, etc. In addition to several options of implicit and explicit flexibility, grid reinforcements are also a possible option.

Classification of system services

EU-Sysflex undertook an analysis of the future system needs to identify the relevant system services that SOs will need to deliver going forward. This allowed to identify both the current and future needs that SOs will face to ensure the stability and reliability of the operation of their grids as identified in the table below:

Table 2-1: List of Generic System Services identified in EU-SysFlex

High-level System Service	Generic System Service	Aim
Frequency control	Inertia response	Minimising Rate of Change of Frequency
	Fast Frequency Responses (FFR)	Slow time to reach nadir/zenith
	Frequency Containment Reserve (FCR)	Contain the frequency
	Frequency Restoration Reserves (FRR)	Return frequency to nominal
	Replacement Reserves (RR)	Replace reserves utilised to provide faster products

Congestion management	Fast Product	Emergency congestion management product
	Slow Product	Congestion product for dealing with predictable/forecastable congestion
	Long Term Product	Congestion product with a long lead time for dealing with regular or permanent congestion
Voltage control	Steady State Reactive Power	Voltage control during normal system operations
	Dynamic Reactive Power	Voltage control during a system disturbance.

Definition of attributes for flexibility products

When defining flexibility products, most projects define a set of attributes or characteristics for those products that FSPs will need to deliver if they want to provide this product. Projects for which these attributes have been described explicitly include EU-Sysflex, CoordiNet, ISLANDER, INTERRFACE and OneNet.

When evaluating the main attributes, the answers to our questionnaire are consistent with the findings in OneNet that summarises the main attributes in the figure below:

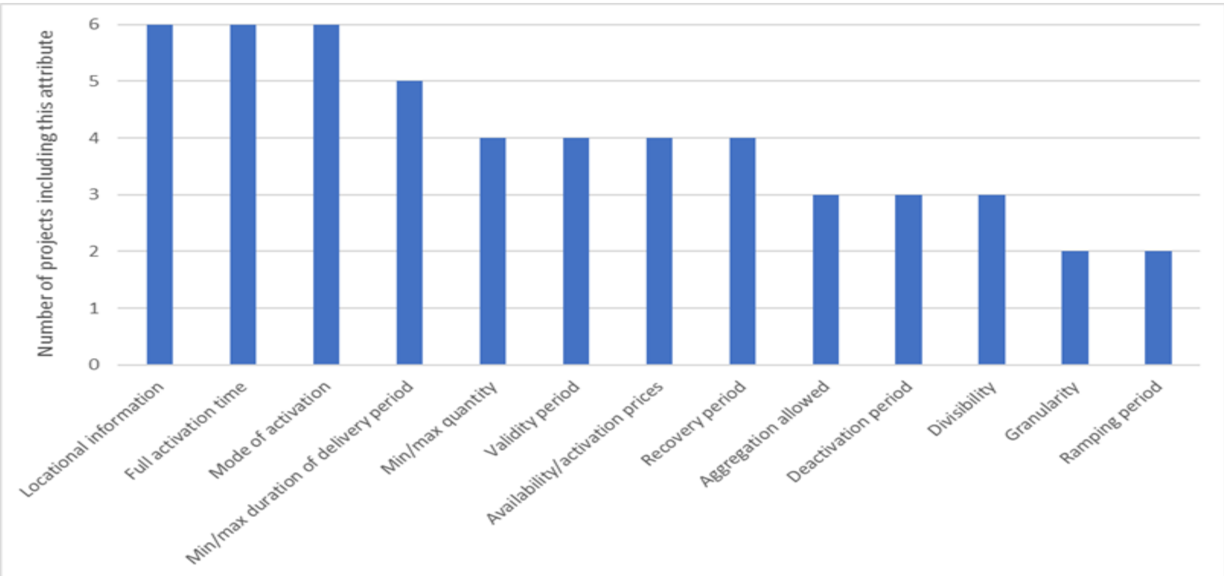

Figure 2-1: Number of projects considering most commonly used attributes (source OneNet Deliverable 2.1).

Expanding on the definitions for attributes included in CoordiNet, OneNet has defined the main product attributes and developed a framework that identifies the decision that a SO needs to undertake about each one of these attributes. This framework provides a structured approach to the definition of flexibility products. Using this framework as the base of future flexibility products would facilitate the comparability between these products and support interoperability and integration when these products are used within multiple countries and/or are offered via multiple flexibility platforms.

Harmonisation versus standardisation

As part of the work in OneNet, the difference between harmonisation and standardisation was considered. Based on the definitions set in that project, harmonisation is a process that reduces the differences between a set of flexibility products but without fully eliminating the potential for differences in values of the different attributes of the product. When these differences are fully eliminated, OneNet refers to a standardised product.

Projects like CoordiNet and OneNet aimed at harmonising flexibility products to develop styled products. These products could improve the TSO-DSO coordination (as well as the coordination of the SOs with other grid stakeholders). By reducing the differences between products, harmonisation would reduce the amount of effort that TSOs and DSOs need to spend to understand each other products. This would facilitate that they can coordinate better their operations once their products are more comparable and, if required, they could participate in the same market (assuming a full standardisation of the product between TSOs and DSOs). Moreover, further standardisation of products could also support possible synergies in case of joint procurement of flexibility by system operators or in case of cross-border cooperation

CoordiNet focusses from the beginning of their product definition on products that could be grouped as standard products. Products that are defined by this project as “harmonised products for the exchange of grid service(s) with common characteristics across Europe (i.e. shared by all TSOs or by all DSOs or by all TSOs and DSOs)”. The products that were considered part of standard products are presented in Figure 2.3 for each service.

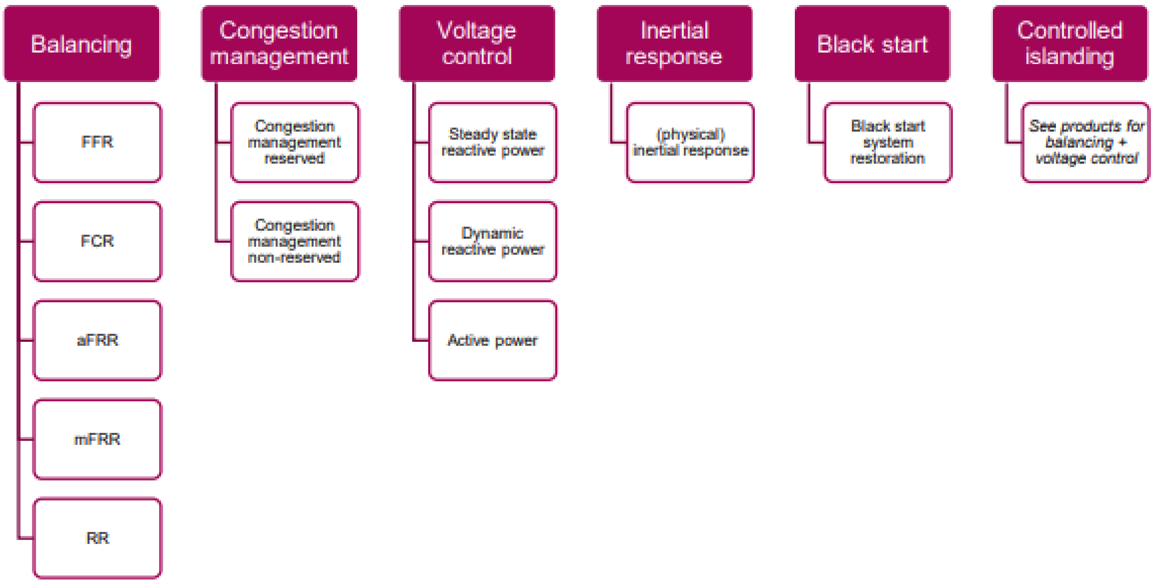

Figure 2-2: CoordiNet’s “standard” product(s) for each service (Figure - D1.3)

On the other hand, OneNet developed an explicit framework that parties considering the design and/or harmonisation of flexibility products should consider. This framework identified potential benefits and sources of costs for harmonisation as shown in the figure below:

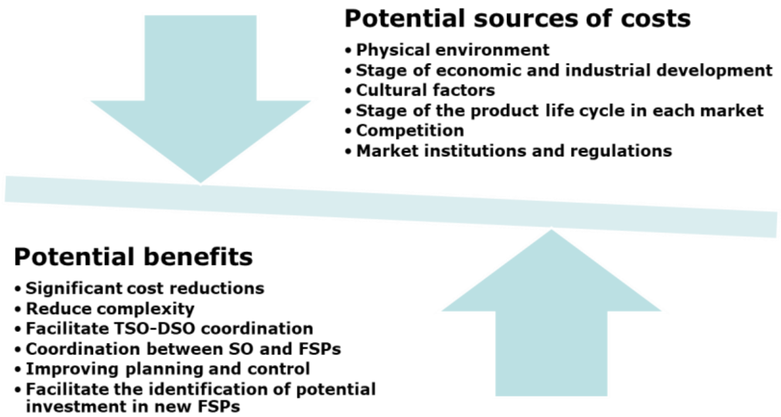

Figure 2-3: Potential benefits and sources of costs from products harmonisation

This framework could constitute the base for any consideration of harmonisation as it allows for a balanced view of the effect of harmonisation. On the one hand, it considers the potential positive effects that an increase in harmonisation could have. This includes potential benefits from reducing complexity and facilitating coordination between parties as well as the reduction in costs this could bring.

On the other hand, when considering harmonisation, it is important to also consider the costs that could arise to develop and implement these harmonised products. The precise costs could vary from case to case, but the potential sources of these costs are summarised in the Figure above. To illustrate how these sources, transform in specific costs, it is possible to consider a case where two TSOs are aiming to harmonising two products they use to address the same need. The cost of that harmonisation could increase due to:

- differences in the technical characteristics of their networks (i.e. physical environment),
- differences in the level of knowledge about the product. If one TSO has superior knowledge about one product, the other TSO would need to invest in increasing its knowledge to ensure the resulting harmonised product would deliver its needs (i.e. stage of the produce life cycle in each market)
- differences in their approach to the management of their network (i.e. pro-active vs reactive, i.e. cultural factors), and/or
- differences in the legal framework where they operate (i.e. market institutions and regulations).

Some of these potential benefits and sources were also identified in the second workshop when asked to the different projects which were the barriers and enablers for harmonisation (Annex I – Part A).

2.3 Conclusions

When considering system services and flexibility products, the main conclusion of this analysis is that there is a good level of convergence in the definitions of system services and flexibility products across projects. This convergence appears to be stronger when considering congestion management products, but it can also be observed in voltage control products.

As indicated above, when considering these system services and products, the first requirement is to ensure that the definitions being used by the different projects are consistent. In our questionnaire, all projects indicated that their definitions of system services and flexibility products were consistent with those published in OneNet. As a result, we are confident to use that definition as the basis of this analysis.

With these definitions, this action started by considering the flexibility products aimed at addressing congestion management. From the information received from our questionnaire, these products can be classified into four large categories:

Table 2-2: List of congestion management flexibility products

Congestion management product	Description
Automatic solutions	Solutions that would allow to reduce congestion without the intervention of tradeable congestion management products.
Corrective CM products	Tradeable product that is activated once congestion arises.
Short-term predictive CM products	Tradeable product that is activated to address congestion that is forecast to arise during M-1 and D-1.

Long-term predictive CM products	Tradeable product that is activated to address congestion that is forecast to arise more than one month later.

The first of these categories is not a flexibility product in the sense of a tradeable flexibility product. However, many technical solutions can be put in place to reduce congestion issues that do not require transactions. Examples of projects considering these issues are Flexitranstore, FLEXIGRID(864579) or Platone.

The other three categories constitute tradeable products and they are mainly differentiated by the use that SOs aim to do with each one of the products. More concretely, two dimensions are used to define these harmonised products. The first one of these dimensions is the capacity the SO must forecast whether the flexibility in the product will need to be used. This allows to split these products between those used to cover unexpected needs of flexibility (i.e. the products are aimed at reacting to unexpected situations) and those that can be used to address forecasted congestion management risks. For this second category, a second dimension is used to differentiate products: time when the SO decides whether these flexibility products are required. This dimension allows to separate between those products that are aimed at addressing short-term congestion management issues resulting from operational actions (e.g. planned maintenance) from those aimed at addressing more structural issues (e.g. substituting or delaying investments).

When evaluating the work being undertaken in voltage control flexibility products, it was observed that at a high level, the same four categories described for congestion management appear to arise. However, with voltage control, the interest in automatic solutions is larger. For example, INTERRFACE identifies flexibility products for congestion management while the products aimed at voltage control are mainly technical solutions.

One point that is worth mentioning is that some projects are considering flexibility products that can be used to address multiple system services (e.g. balancing and congestion management services). Examples of this approach are the evaluation of common flexibility products for mFRR and congestion management in both EU-Sysflex and OneNet and the development of common harmonised products for congestion management and voltage control in OneNet.

To develop these flexibility products most projects undertook a harmonisation process that allows them to identify the main characteristics or attributes for the flexibility products. As part of this process, OneNet introduced a differentiation between harmonised and standardised products using the following definitions:

- **Standardisation:** a process that results in all flexibility products being standardised converging into one single product where no divergence is allowed in both the list of attributes and the values of each one of these attributes.
- **Harmonisation:** a process that results in all flexibility products being harmonised converging into a limited range of potential products that diverge in either required attributes and/or values for an attribute (i.e. a range of values allowed).

To harmonise their products, projects used slightly different approaches, but they all undertook some or all the following actions:

- Literature reviews.
- Reviews of work in demonstrators; and
- Internal workshops.

Harmonisation is a multidimensional process that can result in very different flexibility products depending on the objective of the project. Therefore, when harmonising products all projects should consider the following questions:

- What products (in what countries) do you want to harmonise?
- What are you harmonising in these products (definitions, attributes and/or values)?
- How far do you want to harmonise these products?

With these dimensions in mind, the Slido in the second workshop (Annex I – Part A) shows that 67% of the projects that answered the survey had opted for a partial standardisation (i.e. one single value being set for some of the parameters but ranges for others) for congestion management and 80% for voltage control. Therefore, most of the projects aim for some degree of harmonisation but without arriving to full standardisation of these products.

2.4 Recommendations

In this action, the main recommendation is to follow the best practises identified above to ensure a robust identification and development of system services and flexibility products. These recommendations are:

- Develop definitions of what the project will understand to be a system service and a flexibility product to facilitate a consistent understanding across all stakeholders. Different stakeholders can have very different definitions of what they understand for system services and flexibility products. Therefore, by developing a common definition for all the participants in the project, it is possible to mitigate the risk of missunderstandings.
- When defining the actual system services and flexibility products, it will be important to consider present and future system needs and engage all relevant stakeholders to ensure a robust design that delivers for all parties in the market. This would allow the development of products that are future proof as they consider the potential evolution of these needs while also considering the requirement of the relevant stakeholders. By combining future needs with current ones and considering the reactions of the relevant stakeholders, the new system services and flexibility products would need to be modified less often and they are more likely to be provided successfully.
- When a project aims to harmonise flexibility products it is important to consider potential benefits and costs that that harmonisation could generate. Once that these benefits and costs are going to be case specific, it is difficult to develop a full list of them. However, it is useful to identify high level potential benefits and costs that can be made more concrete when considering specific cases. The benefits could include cost reductions coming from harmonised products or the effect of facilitating the trade of the product between regions (i.e. coordination between these two markets). On the other hand, the costs could take multiple forms including expenses aimed to change the way companies operate their network, the level of knowledge they have about the specific product or costs that would be required to make the two network compatible. Only on those cases where the additional benefits of further harmonisation overcome the costs it would generate, it would be appropriate to go forward.
- The process of harmonisation of flexibility products should start by developing definitions for what each attribute means and, if required, how it will be measured. Only then, it will be possible to consider the possibility to define a value or range of values as part of the harmonisation process.

2.5 Next steps

- One area that is attracting attention is the development of flexibility products to be used for multiple system services. These products could reduce the number of flexibility products that a system operator needs to procure but they could be more complex to define. Therefore, a better understanding of these products would require the evaluation and quantification of the effect that they can have on the liquidity of the market and the overall cost of running those markets.
- Another area where further work would be required is the harmonisation of flexibility products aimed at congestion management and voltage control. Currently more projects have considered a certain degree of harmonisation but it would be important to ensure that there is a clear understanding of the maximum degree of harmonisation that should be implemented as the reasons that would justify potential

differences. This analysis will constitute an important input into the analysis of the potential for harmonisation across markets in the European Union.

3. Action 2 - Service Provision by Energy Communities

3.1 Introduction of the Action

Energy communities were introduced by the European Commission as part of the 'Clean Energy for all European Package' (CEP) in 2016, to place the consumer at the heart of the energy transition. With the recast renewable energy directive (RED II) and the recast electricity market directive (EMD), a legal framework for "citizen energy communities" (CEC) and "renewable energy communities" (REC) was introduced, in order for the above-mentioned to be interpreted and adopted into the member states (MS) national legislation. Although energy communities constitute now a legally defined and recognised entity by the institutions of the European Union, the relevant directives that have been promoted and voted on at a Community level do not appear to have been transposed yet into national law in the majority of the member states. Even in cases where there is a sufficiently defined national legal framework, there are low rates of communities development.

For the above reasons, as well as due to the important role that the energy communities are expected to play in the integrated energy market of the future, it was deemed appropriate to assess the current situation and the prospects for the future, based on the communities that the projects participating in the H2020 Bridge Initiative are working with. Further research on the issue of services provided to citizens focuses on the search for best practices that can be adopted by more and more communities in the future.

3.1.1 Approach

Following this year changes in the Regulations Working Group workplan, while considering the fact that this action gathers significant interest from the participating projects - with the possibility though of most of them for substantial input offering from 2022 on, it has been decided to work towards building on the element of knowledge sharing, based on an **Input Data Sheet**, which had been specially prepared to serve the needs of the action (depicted in Annex II). The Input Data Sheet has been developed after relevant discussion and suggestions provided by leaders of Regulations WG actions of previous years, with the intention of laying out the foundation for showcasing the best practices regarding the services being provided by the energy communities. An integrated sheet with information related to project pilot activities have been then compiled for the purposes of further analysis of data, utilizing also input from past efforts made within the specific Working Group, e.g. the report on Synergies between demos - ID cards[2] or the report of the H2020 Bridge Initiative Energy Communities task force on Energy Communities in the EU[3], so that any conclusions that will be reached, to be used both by any stakeholders interested and for the introduction of the necessary legislative reforms.

The Input Data Sheet, except from the section regarding the 'current' and the 'future/ideal' state of the service provision element for each one of the energy communities that the projects were working with as part of their activities, it included also data regarding:

- Project and Contact person data:
    - General information for the project (Project description, Demo countries);
    - Basic info for the contact person (name and surname, e-mail, institution);
- Pilot activities – service provision data:
    - Energy Community Organisation structure
    - Energy Community Legal structure
    - Legal framework applied
    - Business models developed

[2]https://ec.europa.eu/energy/sites/default/files/documents/bridge_wg_regulation_synergies_between_demos_report_2020-2021.pdf
[3]https://www.h2020-bridge.eu/wp-content/uploads/2020/01/D3.12.d_BRIDGE_Energy-Communities-in-the-EU-2.pdf

- Social Benefits provided
- Institutional and Regualtory barriers and Recommendations
- Consumer Feedback

The Input data sheet has then been shared with the project representatives during the kick-off meeting of the action, and it was requested to be filled and sent back within a month. An **innovation** in team management and information processing introduced during this period, was the creation of a small group of project representatives, which was named **supporting group**. The purpose of this group was to support all the work of the group, from data collection and analysis, but most importantly, to support the production of conclusions while ensuring impartiality in both the way of analysis and the drawing of conclusions, which reflect the real situation to the extent possible. The supporting group consisted by the following project representatives. With the help of all members of the supporting team, Input Data Sheet from **16 different projects** were collected, from a total of 31 finally interested projects. The projects that provided the action with input this year are the following:

During the **3 action meetings** that were scheduled on a monthly basis for this year working period, the project representatives were able to discuss matters of importance related to the action topic of interest and provide their input within the deadlines set during the kick-off meeting. Then, it was the supporting group that started its work, for the organization of the data, their presentation and their preparation for analysis and conclusions drawing. It is worth noting that out of the 16 projects from which we received information, these concerned **53 pilot applications regarding Energy Communities** in different countries. In fact, some countries show a high concentration of cases of energy communities studied in the context of projects, such as **Greece, Spain, Italy, and Germany.** The following figure presents an overview of the number of Energy Communities we received data about from each of the European countries.

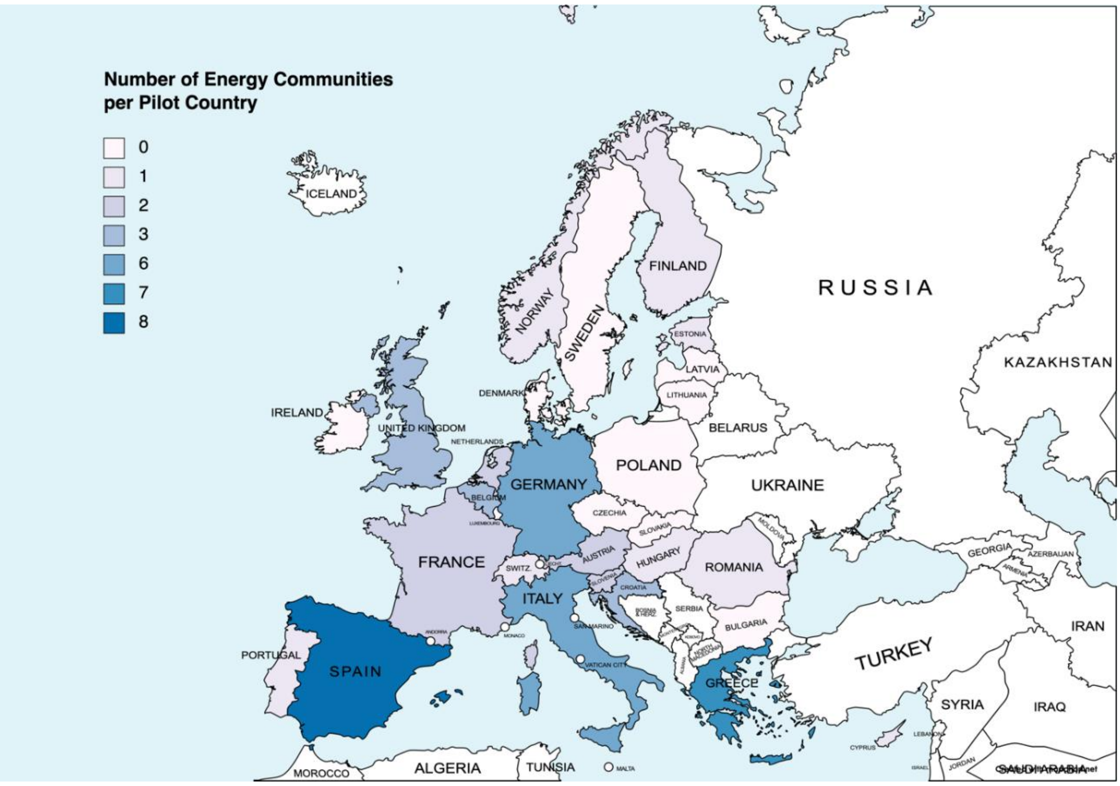

Figure 3-1 Number of Energy Communities per Country with data available

3.2 Best practices

The supporting group work was based on two cycles of data analysis. At the first cycle, the main goal was to analyse the Input Data Sheets and determine which of them can be analysed in combination, in order to present the best practices as well as to be able to reach to some useful conclusions. Therefore, 11 of the project data sheets were decided to be assessed during the second cycle, where the best cases were picked. The projects selected are shown in the following figure along with some important information.

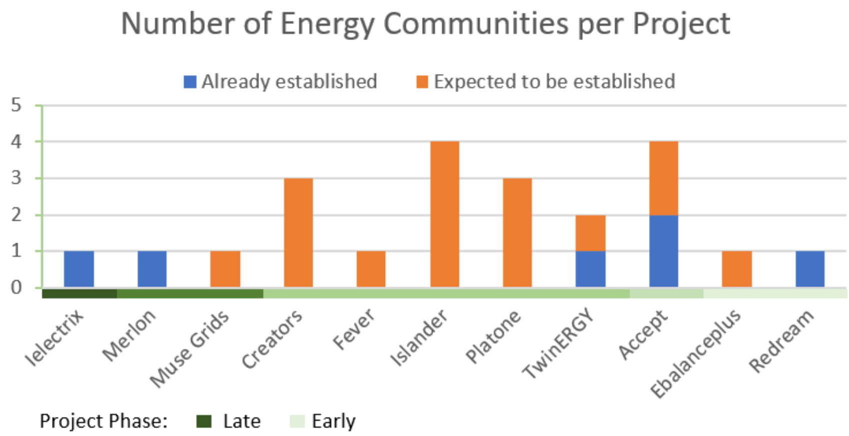

Figure 3-2 Analysis Caption of the project data at a later analysis stage

All of the above-mentioned projects, even though they run during different phases of their lifecycle, with the majority though run through their early stage of implementation of their vision in relation with the service provision element of the energy communities, show interesting practices that could be adopted by future Energy Communities all over the European Union and beyond. The realization of the full value of flexibility through adequate and robust revenue streams is something considered in several BRIDGE projects. It is a key aspect strongly linked with the sustainable development and the prosperous operation of Energy Communities. The business models and the energy-related services envisaged are based either on self-consumption and self-balancing on community level or optimal management, operation, and aggregation for the provision of energy or ancillary services.

More specifically, the most common service that the Energy Communities of BRIDGE projects provide was the **provision of locally generated clean energy to end-users and community members**. One of the main challenges of a Local Energy Community is to provide environmental benefits, as well as economic or social benefits to the partners, members, or local zones where the community operates. In **MERLON**, the Energy Community is framed in a recreational environment that benefits socially and environmentally the site, bringing social cohesion to the demonstration site. The Local Energy Community has decided to install a shared photovoltaic solar installation, with a Battery Energy Storage System that will give flexibility to the distribution grid. Collective self-consumption will be encouraged, increasing the local renewable energy production, minimizing the costs of energy and the decrease of $CO2$ emissions. The LEC will foresee to foster the generation of renewable energy for collective self-consumption without an initial capital investment from the community members. This will facilitate the access of renewable energy to a wider range of citizens. In **REDREAM,** the development of a community solar PV in rooftop and ground mounted systems as well as of one small hydro scheme, are part of a community funded project for the provision of free of charge clean energy to the community members.

Other indicative examples of best practices of services being provided are the following:

Maximization of self-consumption and improved utilization of assets through advanced monitoring and automation. The consumers shall not only know their own total energy consumption, but also have a broader knowledge of energy consumption patterns of themselves and of the community, which enables demand response actions by choice and supports energy behaviour change at a community level. In **ACCEPT** the optimized operation is also enabled for decentralised coordination (P2P trading, implicit demand response), in **iFLEX** the energy end consumption is optimised based on users' preference and the received price signals, while in **MUSE GRIDS** the maximization of self-consumption takes place at household level.

Participation in local energy/flexibility markets (e.g. P2P, marketplace) and in broader energy trading activities (e.g. wholesale market) through the aggregation of local generation. In **ACCEPT** the Energy Community is foreseen in the role of a Retailer, supplying the community members with energy and potentially participate in the wholesale market by offering the locally aggregated energy surplus, while in **MERLON** the participation is envisaged either through the response to the time-varying energy tariffs of electricity retailers or through an established local energy trading mechanism. In **TWINERGY,** blockchain technology and smart contracts are being utilized into facilitating the necessary procedures to cover P2P trading of energy within the community, with the households in the community being interconnected to overcome any legal issues that arise. These technologies make the transactive energy paradigm a reality by allowing customers, either as individuals or in aggregate, to actively engage in energy markets by negotiating and responding to value signals, based on price, demand, time of day, and other grid and market considerations. The transactive energy model used in this project, will turn DERs (from solar to storage to EVs and smart appliances) into grid assets which can also be deployed to solve grid problems.

Provision of balancing services for frequency regulation through the aggregation of flexibility. Aggregation of distributed flexibility resources, a process that the energy community can coordinate or facilitate as in **ACCEPT** and **MERLON**, may enable the participation in balancing markets organised by the TSO (specifically markets for primary, secondary and tertiary reserves) and subsequently provide an extra revenue stream to the community. The project **FEVER** has looked to community ownership of energy storage, which can be an interesting business case especially for energy communities which at the same time generate more renewable energy than they consume. From a societal point of view the case is interesting as storage is still missing to see a mass roll out. It provides RECs with the possibility of enhanced energy independence and a chance to be first movers and perhaps set an example to store further confidence in the business model of storage operations.

Provision of network management services for alleviating network constraints and deferring network reinforcements. In **ACCEPT**, the LEC is considered in the role of a Flexibility Aggregator that provides this service to a System Operator, while in **EBALANCEPLUS** the services aim to increase grid resilience and reliability for the DSO. Carrier coupling with district heating networks is also suggested, while in **CREATORS** the excess heat from the production process of a steel plant beyond of being reused within the process itself is to be fed in the district heating network for the nearby municipality. In **TWINERGY**, The DER management module used at a community level generates a real-time image of the electrical grid that is as accurate as possible. Specially developed and tested algorithms control each storage unit in the grid individually, so that a Virtual Power Plant (VPP) can be operated with the lowest possible storage losses. The maximum storage capacity is optimally used for the integration of RES and foreseeable grid bottlenecks are avoided.

Provision of EV Charging Stations, Community shared EVs and V2G enabled capabilities. In **TWINERGY** high-value services to EV users are provided, such as minimum charging prices and maximum green electricity supply and supporting drivers finding the most suitable station to charge their EV, while addressing issues of payment, security, and quality. The suitability of the charging point is specified based on factors such as dynamic pricing, route cost to the station, amount of the vehicle's battery energy stock and energy that each provider can offer as well as arrival- waiting-charging times. In **ISLANDER**, the community is increasing the number of available charging stations to ease their transportation needs and so the limitation on the available charging infrastructure to not be a deterrent to the choice of electric drive anymore. In **CREATORS**, there is also a very interesting case where the V2G services are coupled with local waste heat network where possible.

3.3 Conclusions

This report is an overview of a series of energy communities from 17 different EU-funded projects under the umbrella of the Horizon 2020 European funded framework. From the above-mentioned projects, 22 demonstration activities in energy communities have provided valuable data regarding Energy Service provision in the countries of the European Union and the United Kingdom. The reality for the countries in which the energy communities operate is that they are governed by different legal frameworks, which in cases where the existence of energy communities is recognized, this is a result of the interpretation of the European directives with minor differences due to adaptation to each member country existing legal framework. Nevertheless, there are interesting indicators regarding the organization and operation of the communities that are worth mentioning.

Regarding the **Energy Community Legal Structure**, the answers distinguished the forms of Energy Cooperative and Partnership (company based), with indications of Not Available, and To Be Decided – TBD also seen among the input), 31% of the investigated communities had the legal structure of a Partnership between stakeholders, 26% had the form of an Energy Cooperative and the others selected either N/A (26%) or To Be Decided (15%) as they run through their initial phase of establishing an energy community.

Despite the fact that from the data we have received, only 47% of the cases studied were provided with a national legal framework for the operation of energy communities, it appears that some energy communities - even while operating in countries that do not have a relevant legal framework, have sought and found ways to take advantage of the available legal framework and continue their operation. In these cases, these communities are mainly based on the development of partnerships between the residents or between the residents and the DSO, to carry out their activities. A typical example is the energy community with which **TWINERGY** project works with, in Germany, where the community relies on the development of partnerships between citizens both for the utilization of public Electric Vehicles and their respective charging stations, while considering the legal coverage that provided in this form of contract for the execution of energy transactions.

An additional encouraging element drawn from the data we have studied is the fact that **74% of the energy communities** under study have **a certain organizational structure**, which implies a certain structure and a defined function. This indicates that most efforts to create energy communities can be considered as organized efforts, which are carried out by stakeholders with relevant experience as well as knowledge of the available operating framework. An interesting example is presented by **MERLON** project, regarding the energy community Enercoop, which it works with in Spain. The energy community, having the structure of an Energy Cooperative with a governing body which forms the decision-making body, consists of a governing council with the president and nine counsellors (vice-president, secretary, treasurer and six vocals), who are renewed by halves every four years. The main purpose of Enercoop energy community, as described above, is to provide electricity to the municipality in a fair, democratic, decentralized, renewable, digital and affordable manner.

The above is mentioned as an example and a best practice due to the fact that the specific community, through its organizational structure as well as its defined goal, has managed to form a structured basis for its operation and thus to focus its operation on issues related to development and delivery of services to citizens. Taking into account also other cases, we conclude that in addition to the existence of a fully defined legislative framework governing their operation, the crystallization of the organizational structure and the purpose of the energy community should be considered as equally key parameters in order to enable the development and delivery of services within the community.

Regarding the issue of **service provision** to citizens based on the analysis carried out, 6 main categories were identified, which are the following:

- Renewable energy production: Production of renewable energy coming from solar PV or other sources
- Automatization: Monitoring application to provide services to the community.
- Demand Response: Application of DR measures
- Electric Vehicle: Services related to EV management, such as installation of communal charging points.
- Heating system: Production of heating system at a community level
- Energy Storage: Implementation of an energy storage solution
- Hydrogen: Generation of green hydrogen

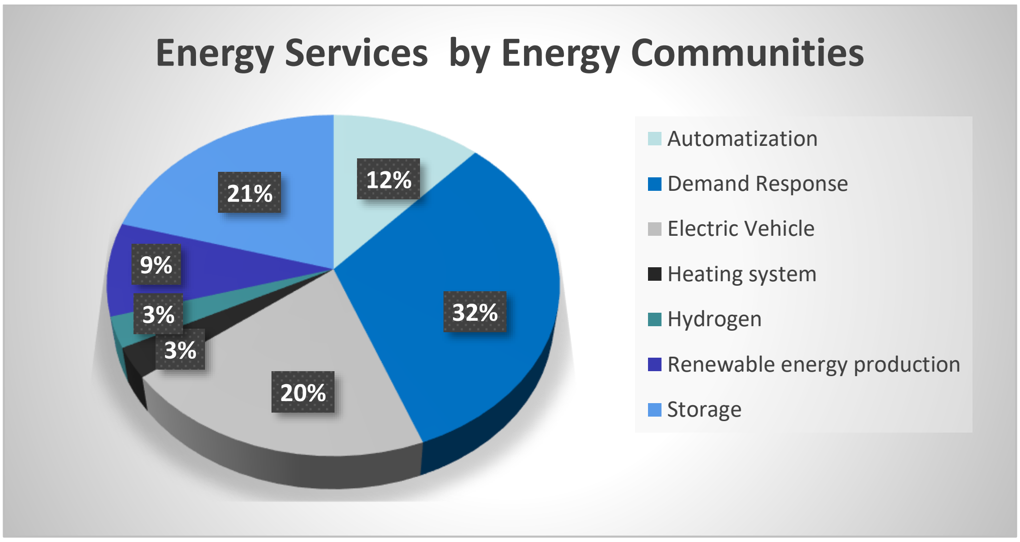

Figure 3-3: Energy Services by Energy Communities

Based on the above, it is worth noting that although the production of energy from renewable sources is one of the main goals of creating energy communities, this is not translated into the corresponding interest in the development of relevant services (such as solar parks built by the community with residents participating as shareholders or communal areas where residents can develop renewable energy systems). The reduced interest may also be justified by the relevant legal framework in most cases, which allows p2p trading of energy within the boundaries of the community, so that the residents of the communities to have an interest in expanding energy production to levels beyond meeting their own needs and as a result, relevant services to be set up.

Another important element is the increased interest and implementation of services related to demand response. Commercial demand response "is technically and economically viable now". Even though multiple trials have demonstrated that demand side flexibility works, and technology roll-out progresses fast enough, with the Smart Home market in EU reducing the gap with the respective US market size volumes, the business-application of residential demand response has been slow to develop. Nevertheless, residential buildings comprise a huge source of flexible energy demand and storage, potentially providing distribution and transmission system operators with the needed services to balance demand & supply and manage power quality.

In this context and considering that the de-facto EC commitment for completing the Internal Energy Market that which is further reinforced by the Winter Package2, will manage to successfully tackle several regulatory barriers for DR and accelerate its full introduction in national markets, there still remain key enablers that need to be satisfied to unleash the huge potential and showcase the commercial viability of Demand Side Flexibility of the residential sector, while maximizing its value for prosumers and energy market stakeholders. Consumers need and seem to be willing to be transformed to active energy market players, towards reducing their energy bills and tackling energy poverty. All in all, social engagement and consumer appreciation lie among the most important lessons learned from projects, which have run under the H2020 umbrella, and more specifically under the relevant Bridge working Group.

Moreover, consumer empowerment can be addressed by enhancing the market role of consumers with the offer of a wide range of services. Consumers need to be able to choose their preferred form of active participation in energy markets, either it has to do with the selection of programs that they will opt-in (implicit or explicit demand response, or both), or by being given the option of direct or indirect participation (through collaborative forms of participation in the form of Local Energy Communities establishment).

For the consumers to be able to make such a choice, however, they must be familiarized and trained in the energy issue. In fact, the energy communities that presented that they offer as social benefits the education of the citizens, compared to the others, presented higher levels of participation of the citizens, as well as a greater variety of services offered. This fact is fully justified as the utilization of most of the services offered within the communities requires a familiarity of the citizens with the energy issue. Consumer empowerment on its own though is not enough. New business models need to be defined and introduced for third parties that will facilitate consumer involvement and represent them in energy market transactions, thus tackling barriers relating to consumers' lack of knowledge about market mechanisms and energy transactions.

3.4 Recommendations

The possibility of cooperation of the participated project teams in this action with active energy communities on their further development and the provision of new services, as well as the implementation of work plans in real conditions, as part of their pilot demonstration activities, results in providing us with important data for the success of the proposed actions. At the same time, the legal framework in force in each Member State is evaluated in practice, in terms of applicability, the possibilities it offers and in terms of whether it meets the generally accepted quality standards.

In fact, the combination of the experience developed through these collaborations, the direct communication with the community managers and most importantly with the final consumers themselves, becomes an important source for making recommendations, which could be taken into account in the future for the modification of the legislative framework, as well as the preparation of proposals for new European legislation.

Based on the above, the projects participating in the action 2 on service provision by Energy Communities, after analysing the full list of recommendations provided by the participating projects, reached at the following key recommendations, which could act as a catalyst for the development of further services and would help EU MS in their efforts towards implementing the European framework regarding the Energy Communities.

3.4.1 Harmonization of definition of Energy Communities and clarification of their interactions with citizens and DSOs

The existence in European directives of definitions for both the Citizen Energy Communities (CEC) and the Renewable Energy Communities (REC) results in room for different (albeit relatively close conceptually) interpretations of the core concept of the Energy Communities by the Member States, which are adopted and attributed to their respective national legal frameworks. This plethora of definitions leads to differences in the regulation covering the relationship of the community with citizens and providers. For example, the existing regulatory framework in Spain (Royal Decree-Law 23/2020) is elaborate regarding certain aspects of community-citizens interactions, such as the right of community members to freely choose a supplier, their practical ability to leave (opt-out) a community they have previously joined, and the impact of the community operation on local / adjacent non-members. Furthermore, the envisaged engagement of energy communities in distribution system operation and / or ownership is far from straightforward for a number of reasons, including the expertise and costs required for the community to bear the standard responsibilities of DSOs, and the incompliance of communities engaged simultaneously in network operation and energy trading with the principles of deregulation and unbundling.

In view of the above, a single comprehensive and consistent legal definition of Energy Communities can be missing from the legal framework of most European Member States. Given the above, the legislative interest will now be able to move from the interpretation of the term and the adaptation to the national data, to the important element of the formation in each Member State of the framework for the provision of services to citizens, their type and conditions that the community must meet to provide them.

3.4.2 Streamlining of the morphology of the services available for provision by an Energy Community

It must be assumed that the best services are those that meet an actual need for a target group. Among the analysed projects, the target group varies from being the end consumers (so the services are mostly related to the energy management element, such as tips to save on the electricity bill, or education/community feeling), to other energy stakeholders, mainly the DSOs, in the form of being offered flexibility/ancillary services. For example, the energy management services offered by the LEC/REC to consumers participating in the same LEC/REC may be benefits derived from membership of the community. Services would then mean, those which are being offered to other actors outside the community, who deal with the community based on market principles. Another point is that most of the cases investigated has pointed out some societal benefits of the community like “education” or “enhanced community feeling”. For those cases it would be interesting to know whether these aspects are indeed factors which drive citizens to participate in REC/LEC and/or can be considered as services being provided in the form of creating a pool of advanced energy market players (consumer preparation for the smooth transition to an integrated energy market), who could be considered as a target group for the DSOs.

Based on the above, it is easily understood that legislative initiative is required on the issue of the morphology of the services offered, the basic rights that communities have as well as the capabilities that derive from their operation and the provision of these services. In fact, special care should be taken in data protection by updating the rules regarding procedures that will take place within the community.

3.4.3 Review of operational support tools and enable access to funding programs for further development of energy communities

The current legislation of the EU MS offers several positive features that both enhance the use of technological means and encourage the active participation of citizens. Though there are also some barriers indicated even in MS with updated legislation related to the Energy Communities. For example, in Greece the requirement for at least 50% plus one of the members to be related to the place where the EC has its headquarters, at this early stage of adoption of EC in the country, along with the requirements from financial institutions for a certain percentage of investor's participation with their own funds, in order to provide additional financial support, appear as problems that hinder their development. Therefore, a review of the legislative framework is recommended focusing on the gradual implementation of all prerequisites for the establishment of an EC. Furthermore, further legislative actions are needed to cover the operation phase of energy communities, with the institutionalization of funding programmes, but also the reduction of participation requirements to attract investors and support from financial institutions. This way, the necessary resources for the development and testing of more services within communities are anticipated to become available.

3.5 Next steps

All the actions implemented during the current period, were carried out with the aim of drawing useful conclusions, but also towards forming a solid basis on the issue of services offered by the energy communities, which will be able to be utilized by the next groups to proceed with targeted research on topics of interest (some we will mention below) and thus ensure continuity in the action of the working group.

More specifically, several the projects are currently looking into **P2P energy trading,** which can be interesting as a service to be provided. To this end it would be interesting to research at a greater detail on aspects like the geographical spread or the number of participants that the community should have, for this service to be considered as a viable one and/or to be considered as a better deal than market participation either directly or through an aggregator.

Additionally, most of the projects mention that one of the societal benefits of the community is **"education"** or **"enhanced community feeling".** Therefore, it would be useful to know if the citizens learn anything from the membership in the community. It would also be of great value to receive data from the consumers' point of view regarding the services offered directly by them, through questionnaires that would be distributed to them, so that we have data and direct **consumer feedback**.

4. Action 3 – System Security and Network Planning

4.1 Introduction of the Action

System security is a term used to discuss the stability and strength of the electricity grid, also known as an electric power system. The security of an electricity grid is its technical resilience (or strength), namely its ability to quickly respond and remain stable when unexpected events occur. In modern smart grids with high RES penetration, regional coordination is a key factor to achieve the desired levels of system security, economic efficiency, and CO_2 reduction. Two pillars can drive this transformation:

a. the technical evolution of the developed tools and communication interfaces among the participating actors, and
b. the necessary harmonized market framework at regional level.

Even though the progress of the former is proven to be substantial, the evolution of the latter hinders the development of tools associated with cross-border exchanging of energy and reserves in close to real time intervals.

On the other hand, active distribution network planning is of high importance for utility companies in terms of distributed generation investment, reliability assessment, optimal reactive power planning, substation evaluation, and feeder reconfiguration. The power supply networks are experiencing a dynamic change. The reasons for this change are the technical and economic requirements as well as the political aspirations. A safe and reliable power supply is of the utmost importance for economic success. New tasks are added to the classic network planning tasks. Targeted and flexible network planning is required so that the networks can react successfully to dynamic changes in the electricity network.

To spot best practices regarding System security and Network planning, a questionnaire has been sent to the projects that are involved in those topics, and inputs are collected from 9 projects:

BRIDGE Action 3 aims at researching the system security and network planning solutions and approaches adopted by the Horizon 2020 projects. Therefore, methodology and actions used to procure those information are as follows:

- First, relevant Horizon H2020 projects were contacted that are dealing with system security and network planning topics. They were presented, on the first workshop held on 5th October 2021, the approach to provide us relevant information in the form of a questionnaire.
- Second, questionnaire was defined in that manner to gather all needed information to provide best practices and make high quality recommendations. Questionnaire, also available in Annex III, is based on description of connection of the project with relevant topics of Action 3. Focus of the questionnaire input was to:
    - project to properly describe project,
    - define maturity of project's products/modules/use cases and their affection on improvement of System Security and Network Planning,
    - provide deliverables that support their statements,
    - conclude with lessons learned and potential innovations regarding Action 3 topics.
- Third, questionnaire has been circulated, and after provided inputs, analyses of the answers were made.
- Final step represents the presentation of the recommendations based on project's experiences.

4.2 Best practices

Based on the inputs collected from different projects, this part of the document presents what are the best practices in the development of system security and network planning. Projects that had shown as most advanced in these topics, during the procurement of the questionnaire inputs, were CROSSBOW, X-Flex, FlexPlan and in development phase but with plenty of quality information were FARCROSS, TIGON and TRINITY.
The above-mentioned projects had shown that there are wide range of state-of-the-art approaches and products/tools for improvement of system security and network planning.

4.2.1 System security

When it comes to system security, CROSSBOW is the most 'mature' project. CROSSBOW proposes an integrated approach for the management and the operation of the transmission network in South East Europe. An essential tool towards realising such an integrated approach is the Regional Operation Centre Balancing Cockpit **(ROC BC)** product which will be used for coordinating the cost-efficient and **secure operation** of the whole South East Europe transmission network and enabling the shared use of resources. ROC BC constitutes one of the main products of the CROSSBOW project.

Their product is almost completely done and more than a half of ten below mentioned functionalities have their KPIs available.

The ROC BC product encompasses several functionalities based on algorithms and tools developed in the project and considering existing practices in exchange of data and information, communication infrastructure and requirements from Transmission System Operators (TSOs) and the Regional Security Coordinator (RSC). The ROC includes the following functionalities:

1. *probabilistic regional short-term adequacy assessment (week ahead STA).*
2. *real-time quality check of common grid models (CGMs).*
3. individual grid model (IGM) quality assessment.
4. dynamic line rating (DLR) forecast for overhead lines.
5. enhanced method for preliminary net position estimation.
5. definition of inputs for coordinated net transfer capacity (NTC) calculation.
6. cross-border congestion based on coordinated NTC and on flow-based (FB) algorithm.
7. frequency reserves probabilistic sizing.
8. enhanced transmission system (TS) resilience during emergencies, and
9. over and under-frequency real-time control scheme using phasor measurement units (PMUs).

X-Flex project aims at increasing system resilience in extreme weather events. The objective is to assess and enhance the resilience of the grid against extreme weather events. Two main actions, which are currently in the development phase, have been identified to achieve this objective.

- A tool GRIDFLEX will be developed to assess system resilience considering the spatiotemporal impact of extreme events on the system.
- Then, the tool must provide resilience enhancement measures to mitigate the impact in case of an imminent extreme weather. In addition, self-healing strategies must be developed to minimise the incidents caused by extreme weather conditions.

Related resilience module provides an assessment of distribution system resilience under an extreme weather event. The module can be used to assess the system resilience in case of a forecasted imminent extreme weather or to assess how different operation and infrastructure measures can affect the resilience of the system.

The developed resilience module can assess the distribution system resilience under extreme weather supporting the DSO decisions to enhance distribution system resilience. Through the utilization of appropriate metrics, system operators will be able to evaluate different measures (both operational and infrastructural) and take the right decisions to enhance system resilience both in real time but also for planning purposes.

From the whole package of FARCROSS solutions, the one that is directly addressing the topic of system security is the wide-area measurement, protection, and control system. This solution is currently in the development phase. The philosophy of the Wide Area Measuring, Protection and Control system (WAMPAC) is to control the stability and safe operation of the whole system, thanks to measurements gathered from different points of the transmission network. These measurements are used for distributed or centralised control systems to generate the appropriate response, by means of their control algorithms. The WAMPAC system includes a network of phasor measurement units (PMUs) dispersed throughout the Greek electricity system and phasor data concentrators (PDCs) that collect the information from the PMUs. The PDC exchanges this information with the SCADA and EMS system in the control centre of the Greek TSO. This flow of information is also illustrated in the following picture:

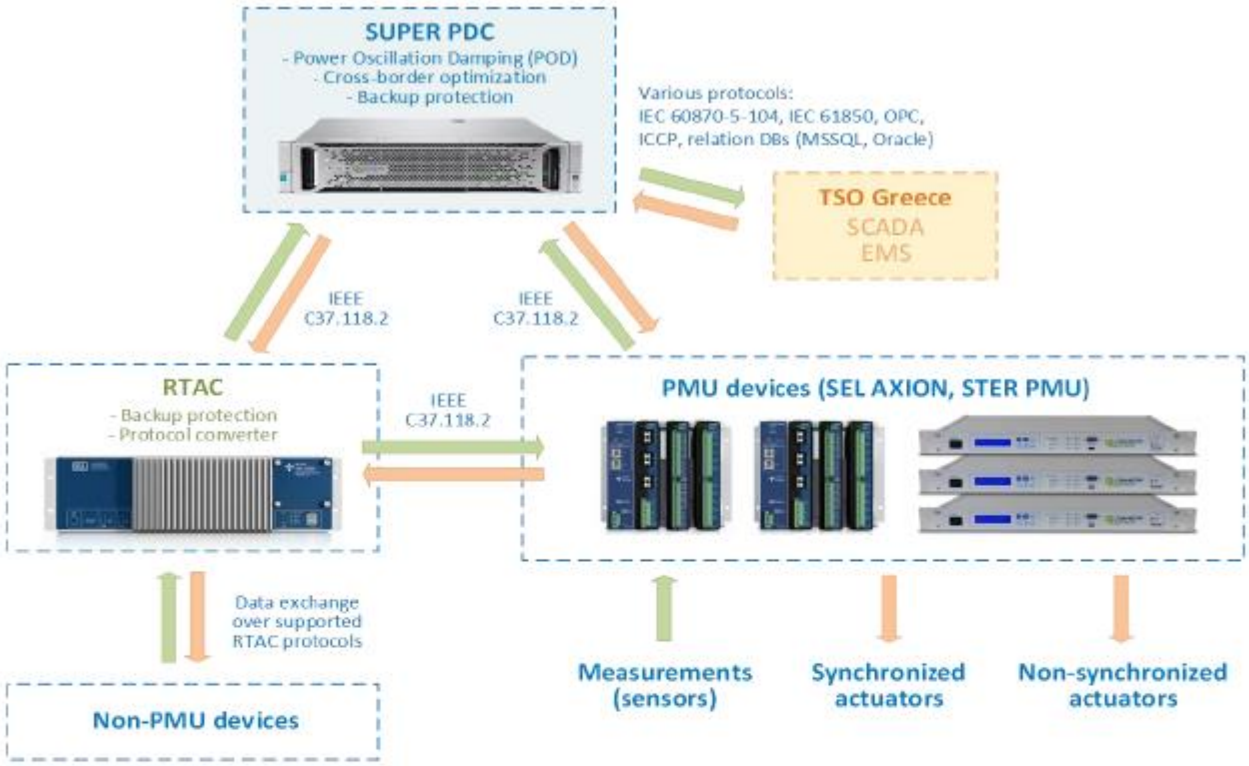

Figure 4-1: WAMPAC flow of information

TIGON project addresses system security issues in the two following tasks that are both currently in the development phase:

1. **Design of protection schemes for DC-based hybrid grids**

The objective of this task is to improve the protection schemes used in MV and LV DC-based grids in a scenario with high penetration of renewables by proposing new configurations at the two demo-sites.

2. **Cybersecurity defence system**

This task will provide a Cybersecurity defence system for the TIGON software-based monitoring, control and energy management applications, adhering to the latest Commission recommendations on cybersecurity in the energy sector of 3.4.2019 (C(2019) 2400 final), which strongly emphasize on cyber-resilience as a priority for energy network operators and technology suppliers. The task aims to propose a fast, distributed security framework that intelligently incorporates the physical state of the defended system and blocks incorrect operation actions. Task's innovations include detection of adversarial manipulation by cross-checking commands and configuration changes for consistency with the physical state of the system, while being deployable and interoperable with communication standards.

The above schemes will significantly contribute to **increasing resilience of the electricity grid to faults and cyberattacks**. Resilience can be defined as the ability of a system to withstand disturbance state and return to a regular state quickly. Nowadays, there is an increased need for addressing the power system resilience following the increasing frequency of occurrence of the natural or man-induced extreme phenomena. In fact, **resilience is one of the characteristics recognized as an essential value of the future energy grids** and the mission orientated goal for Europe is formulated as "A secure, efficient and digitalized European energy system, fully decarbonized by 2050, coupling all energy sectors."

TRINITY project tackles system security issues with providing the concept, algorithm and mathematical set up of close to real time power system security monitoring and redispatching cooperation on regional level with power system security and reliability SENTINEL toolset/ Power system security monitoring and redispatching optimisation. Optimization of coordinated multi-lateral redispatching actions is to be performed when potential overloads are detected, and neither of non-costly measures is successful at resolving congestion problem. It is expected to be performed on D-1, intraday or close to real-time level. The overall concept will include three layers: security monitoring layer and remedial actions optimization layers as well as the cost-sharing layer. The added value of this approach represents the participation of demand response, RES, and storage systems in the process of redispatching.

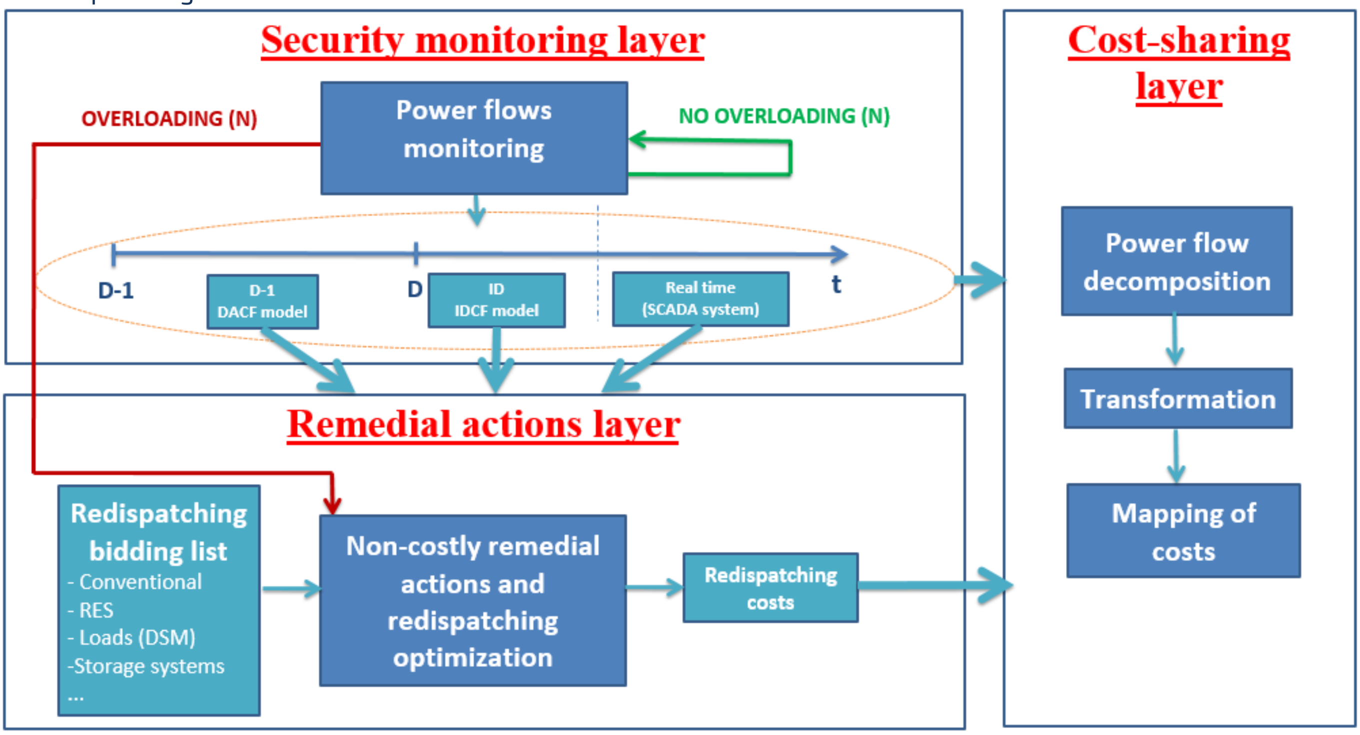

Figure 4-2: TRINITY Power system security monitoring and redispatching optimisation

T-SENTINEL security module includes the development of novel algorithms and corresponding IT solutions related to coordinated security assessment functions performed by regional security centres (RSCs) and transmission system operator (TSOs). The security module is responsible for performing day ahead and intraday power system static security checks and optimization of coordinated multi-lateral remedial actions when potential overloads are detected. The security module aims to deliver advancements in the context of
(1) improved efficiency of solving network congestions through co-optimization of non-costly and costly redispatching actions and
(2) better share the overall costs of redispatching. **All developed T-SENTINEL solutions are tailored to the European electricity guidelines requirements, as well as developed in a way to be replicable in other regions or pan European scale as well.**

4.2.2 Network planning

As for network planning product developments, X-Flex project is in the most advanced stage with their use case (currently in the phase of final demonstration) that has a goal to implement the scenario-based long-term planning and scheduling of the power grid, in order to anticipate problems and incidents of the network based on the prognosis of the network status, using different techniques (e.g. losses reduction, long-term congestion reduction, curtailment reduction/increase RES penetration, technology diffusion, etc.). Main outcome of this use case is the **Grid planning tool** that covers following areas:

- Evaluation of the impact of the integration of flexible assets into the grid.
- Testing long-term scenarios for the pilot sites and testing the capability of the grid to support those scenarios, and
- Identify the weakest feeders and propose upgrades of the grid.

The aim of the Grid planning tool is to offer the grid operator (DSO) the possibility to test and evaluate the impact of different scenarios of demand from users on the network conditions and to identify the measures or upgrades needed for a stable and reliable network operation. Functionality to test the impact of the local flexibility market on the grid conditions will also be added. The aim is to compare the traditional grid reinforcement measures (such as transformer replacement and lines upgrades) with new solutions that take advantage of available flexibility- the establishment of local flexibility market. The goal is to offer the DSO comparison between physical upgrades of the grid and the deployment of a local flexibility market, and assess both approaches from a technical and economic perspective, to show that the use of flexibility can reduce or at least postpone the physical grid upgrades associated with high cost.

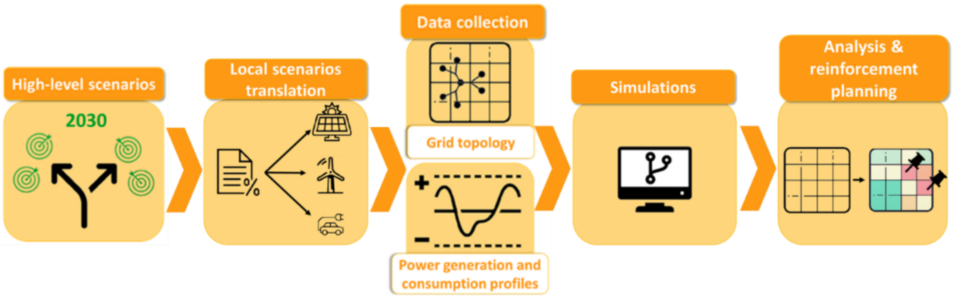

Figure 4-3: Grid planning tool flow

FlexPlan project aims at establishing a new transmission and distribution (T&D) grid planning methodology considering the opportunity to install new storage devices as well as to perform a flexible exercise of some loads located in selected grid nodes as an alternative to building new lines. Local compensation of RES generation spikes could allow to reduce the amount of congestion the grid is exposed to with a less expensive and less environment-impacting intervention. Therefore, not specifically grid security goals but nevertheless, planning and system security are related topics and within the FlexPlan methodology, a probability-based contingency analysis is also incorporated (replacing the traditional N-1 methodology).

FlexPlan aims at providing the following contributions:

- Development of a new methodology and of a new tool optimizing T&D planning by considering the placement of new storage devices as well as the flexible exercise of some loads in selected grid nodes as an alternative to traditional grid planning. This methodology presents several very innovative aspects, among which: assessment of best planning strategy by analysing in one shot a high number of candidate expansion options provided by a pre-processor tool; simultaneous mid- and long-term planning assessment over three time frames (2030-2040-2050); incorporation of full range of Cost Benefit Analysis criteria into the target function; integrated transmission and distribution planning; embedded environmental analysis (air quality, carbon footprint, landscape constraints); probabilistic contingency methodologies in replacement of the traditional N-1 criterion; application of numerical decomposition techniques to reduce calculation efforts; analysis of variability of yearly RES and load time series through a Monte Carlo process.

The full definition and set-up of the FlexPlan methodology is described in details in deliverable *D1.2 Probabilistic optimization of T&D systems planning with high grid flexibility and its scalability.*

Last but not least, TIGON project aims at developing a **Decision Support System (DSS)** (this development is currently in the development phase.) that gathers the specifications of the solutions developed during the project together with the grid configurations and their operation modes and strategies. Therefore, based on the lessons learned during the project demonstration campaigns, this DSS will be able to provide with guidelines facilitating the planning of grid expansions or the development of new DC-based hybrid grids across the EU. On the other hand, this tool will also allow to virtually include additional elements to the grid architectures such us RES generation (PV or wind plants), power electronics or storage systems and simulate the impact that they would have on the system energy efficiency. Moreover, to evaluate the feasibility of including these simulated architectures, this tool will include a module which will take into account not only the energy performance but also the necessary investment and the cost-benefit analysis of the solutions to be implemented.

4.3 Conclusions

Looking over the survey results regarding both system security and network planning topics, the main conclusion of this analysis is that there is a vast number of high-quality reasons and state-of-the-art potential solutions on how to improve both topics.

As indicated above, for system security and network planning main conclusions from the survey results are as following:

SYSTEM SECURITY

- CROSSBOW: In modern smart grids with high RES penetration, regional coordination is a key factor in order to achieve the desired levels of system security. Market development is in general affected from heterogeneous and imponderable causes. However, part of ROC BC demonstration studies clearly unveils that has a direct effect in enabling hidden balancing resources in order to achieve higher system security at regional level, thus more attention should be spent in that front.
- X-FLEX:
    - A key innovation of the developed methodology and the corresponding tool is that will assist monitoring and evaluation of the distribution network resilience towards extreme climate at DSO level.
    - In contrast to the conventional upgrading the infrastructure measures that are usually deployed by the DSOs in order to deal with extreme weather events the deployment of smart operational measures are also taken into account by the developed tool.

    - The developed tool can support DSOs in the planning of the distribution network providing them useful information about the effect of different infrastructure resilience enhancement strategies. The tool will assist DSOs to make adequate and cost-effective resilience investments.
- FARCROSS: The implementation of WAMPAC systems on EU level will increase the grid security, giving more information to operators about the real-time status of the power grid. The outputs of the implemented services will also guide the operators in the decisions making in front of a large-scale perturbation in the power system. Additional services can be developed following the needs of EU, using the capabilities of synchronized measurements in the grid provided by PMUs.
- TIGON: It is expected that great contributions will be made as regards the integration of effective protection schemes into DC operated networks. Furthermore, the development of cybersecurity measures will contribute towards, as explained above, to increasing the resilience of the network.
- TRINITY:
    - The developed methodology and corresponding T-SENTINEL software solution for RAO in the CSA process bring notable improvement in current CSA to practise in the SEE region with the introduction of more flexible redispatching treatment and possibility to perform optimization between costly and some of the non-costly remedial actions.
    - The developed methodology and corresponding T-SENTINEL software solution for RAO in the CSA process can be also suitable for deployment in other European regions as an interim solution.
    - The developed T-SENTINEL software solution represents the first fully integrated solution for Redispatching and Cost Sharing (RDCS), suitable to be deployed in both SEE and other more advanced European regions (such as CORE) in line with ACER Decision on the Common methodology for redispatching and countertrading cost sharing.
    - The developed methodology for RDCS under TRINITY incorporates advanced algorithms for the treatment of HVDC links when conducting power flow tracing and decomposition.

NETWORK PLANNING:

- X-FLEX:
    - In many countries future electricity demand is estimated only at national level. As the distribution of population varies in different parts of the country, as well as the habits and needs of the population in terms of electricity consumption, the preparation of strategies and plans by regions or municipalities should be encouraged in order to facilitate the planning of low voltage grid.
    - The main innovation of the grid planning in X-FLEX is to offer the DSO a clear overview over the future energy needs and the grid conditions that these needs entail. At the same time Grid planning tool will allow the comparison between the traditional grid reinforcement measures and new approaches that use the available flexibility in the grid, from a technical and economic point of view, to help DSO to decide on the future investments and grid development.
- FlexPlan: As stated in D1.2 the tests conducted have shown that the models developed in this deliverable provide coherent results for network expansion problems, both on transmission and distribution grids. Nevertheless, final conclusions are yet to be elaborated in the final stage of the FlexPlan project, when the results become available.
- TIGON: Potential innovation includes the development of a reliable and effective tool for future planning of DC grids and/or integration of DC grids into existing AC grids.

4.4 Recommendations

Based on performed analysis of the questionnaire answers, following recommendations could be proposed:

- System security is a key aspect of the Power Sytem. **On top of the System security hierarchy, the TSOs and their respective RSCs are placed. The provision of more inteligent technologies for these actors is of extremely importance for ensuring European System security.** The improvement of the performance of these actors, will have a beneficial waterfall effect that will feed the rest of the electricity system (MV and LV operators, local market operators, RES producers...).
- Due to last natural disasters occuring in 2021 (like floods in Germany or snowfalls in Spain), **the management of extreme weather events** is actually of utmost importance. The climate change will mainstream this events and the power systems need to manage their effects in an effective way. In the report it is possible to find how X-FLEX is developing technologies for MV and LV grids and will be of interest to extrapolate its technoloies to the TSO level.
- To facilitate the management of faults and cyberattacks for the electricity grid. **Cybersecurity have to be tackled at every level of the power system in order to improve the power system resilience** (taking into account the increasing frequency of occurrence of the weather and man-induced extreme phenomena).
- The quick integration of DER into the power grids must be taken into account by grid operators. The **DSOs should be provided with network planning technologies** to face this expansion. These technologies will also facilitate the establishment of local flexibility markets.

4.5 Next steps

In order to progress on the abovementioned recommendations, it is needed further research on the following topics :

- **Regional Adequacy Assessment.** The activities of incorporating high penetration levels of variable and intermittent RES into the power grid prove to be very challenging for TSOs and RSCs across Europe. The risk of supply shortages is tackled through short-term adequacy assessment coordinated on a regional level. The purpose of the short-term Regional Adequacy Assessment (RAA) is to make a week-ahead evaluation if the estimated available generation and cross-border transfer capacities would be sufficient to cover the expected load in the region.
- **Real-Time power security checks and redispatching cost optimization.** Large consumption actors and large RES and storage systems in the process of redispatching are being taken into account and further research in this field (also expanding it to DER - medium and small size-) will be necessary for a Real-Time management of a power system.
- **Self healing and enhanced weather conditions forecasts.** In case of extreme weather events, the prompt anticipation of this incidents and the reconfiguration of the grid will facilitate the security of supply of a larger number of consumers.
- **Cybersecurity for EPES (Electrical Power and Energy System).** A series of technologies for avoiding cyberattacks affecting physical infrastructures are necessary (for example risk assesment analyzers or technologies for predictive maintenance to realize about long term attacks). Distributed security frameworks (that difficult failure of the whole system via an attack of a single point) are intresting in this field.
- **Network reinforecement planning via flexibility markets.** Further research on the prognosis of the network status analyzing the increase of DER and their management via flexibility markets is required. Different techniques (e.g. losses reduction, long-term congestion reduction, curtailment reduction/increase RES penetration, technology diffusion, etc.) have been found interesting for this purpose.

5. Action 4 – Flexibility Mechanisms

5.1 Introduction of the Action

Electricity markets are fundamental for power system operation since they allow defining the schedule for energy production and consumption and determining the support for the system operation in terms of ancillary services and congestion management (i.e. system services). The electricity market architecture is formed by several interrelated mechanisms differentiated in terms of timing, participating actors, related system service, and procurement area [1]. In recent years, climate goals triggered the electricity sector transformation characterised by intermittent energy sources and the need to maximise the use of existing infrastructures. Engaging the connected resources to unlock their flexibility for power system operation is seen as a cost-effective measure for tackling the energy transition maintaining the power supply quality, reliability, and security [2],[3]. Hence, the need for flexibility calls for flexibility mechanisms aimed to procure system operation support and enabling market participation for distributed resources. Since the novelty of the need for flexibility, acknowledged frameworks for designing and integrating flexibility mechanisms are still missing. Many research and development initiatives have been started in Europe to devise and test original flexibility mechanisms and to assess their effectiveness.
BRIDGE track 3 action 4 contributes to electricity market integration by reviewing the flexibility mechanisms developed and tested in the demonstrators of the European Horizon 2020 projects focusing on the analysis of the coordination between different flexibility mechanisms. Action 4 has the objective of fostering knowledge sharing among H2020 projects; the main action 4 activities:

1. analysis of the definition used for the adopted flexibility mechanism.
2. analysis of the relevant design elements of the adopted flexibility mechanism.
3. analysis of the coordination between different flexibility mechanisms.
4. identification and analysis of the approaches for assessing the flexibility mechanisms.
5. formalisation of recommendations from the experience of the analysed project.

Flexibility services can be procured by the system operators (SOs, i.e. Transmission and Distribution System Operators – TSOs and DSOs) from third-party resources by adopting different flexibility mechanisms. Designing the integration of the flexibility mechanisms into the electricity markets requires theoretical knowledge and practical experience on the elements of flexibility mechanisms and the related coordination aspects. The present review is based on 15 Horizon 2020 projects that contributed to the Action 4 activities:

Methodology adopted in Action 4

Action 4 aims at investigating the flexibility mechanisms adopted by the Horizon 2020 projects; hence, Action 4 activities are based on the collection and analysis of the information provided by the working group contributors and public deliverables. Five steps form the methodology adopted in Action 4:

1. Project selection.
2. Definition of the questionnaire.
3. Administration of questionnaires.
4. Analysis of the answers received.
5. Formalisation of recommendations.

As a first step, the relevant projects are selected among all the Horizon 2020 projects to identify the ones dealing with mechanisms for procuring flexibility services. The second step concerns the definition of a questionnaire to collect the relevant information on the flexibility mechanisms adopted and developed by the selected projects. The questionnaire, available in Annex IV, is based on several flexibility mechanisms definitions (i.e., obligation, cost-based, dynamic network tariffs, flexible access and connection agreements, bilateral contracts, and flexibility markets) [4], [5]. In general, each mechanism can be applied standalone or in combination (e.g. a procurement framework can be formed by the joint use of obligation and flexibility markets) [4]. The definitions of these mechanisms are provided in section 1.2.1. The questionnaire focuses on relevant information regarding the design elements of the developed flexibility mechanisms, the coordination among them, the approach used for assessing the effectiveness of the mechanisms, and lessons learnt and recommendations resulting from the project activities. The third step of the methodology concerns the administration of the questionnaires to the project representatives using an online platform and an online workshop. Several bilateral iterations allowed to clarify and refine the information received. The fourth step concerns the analysis of the received information to identify the peculiar aspects and the differences and similarities among the flexibility mechanisms adopted. The preliminary results were presented in an online meeting to the project representatives to collect their feedback. The fifth step of the methodology addresses the formalisation of recommendations and lessons learnt based on projects' experience.

5.2 Best practices

The project review described in this chapter points out the state of the art of the European demonstration activities regarding flexibility mechanisms to procure system services based on the analysis of the panorama of H2020 projects. This section introduces the definitions adopted; then, several project examples describe key aspects of flexibility mechanism coordination and assessment.

A wide range of mechanisms can be used to acquire flexibility from resources owned by other power system players (e.g., distributed generators, prosumers, customers, aggregators). In this review, for clarity, the flexibility mechanisms are classified according to the definition in **Table 5-1** [4].

Table 5-1: Flexibility mechanism definitions

Mechanism	Description
Auction-based market	Auction-based markets are pools in which the offers received from FSPs (i.e., units or aggregated – AGR) are matched with bids for buying the product for the corresponding system service. The market size is limited and depends on arbitrary choices or technical constraints. This report distinguishes the cases of auction-based flexibility markets with one, two, or more buyers since it implies different design choices.
Bilateral contract	The mechanism "bilateral contract" concerns a negotiation process to define a binding agreement between the two parties. The bilateral contract established specifies the characteristics of the service provision.
Peer-to-Peer (P2P) flexibility trading	Peer-to-Peer (P2P) trading refers to a mechanism in which individuals of the same actor category (peers) exchange a product. Product exchange and the corresponding monetary transaction occur directly between the peers or indirectly involving a certified third-party market participant. In P2P flexibility trading the product exchange is a flexibility product. Several mechanisms ranging from

	auction-based to bilateral negotiation-based can be adopted to facilitate the definition of the agreement between the peers.
Dynamic network tariffs	Dynamic tariffs concern time and locational differentiated network tariffs that reflect temporal and spatial cost variations. The grid users are incentivised to change their consumption or production according to the grid operation needs.
Flexible access and connection agreements	Flexible access and connection agreements are agreements between the system operator and the FSPs in which the latter agrees to have connection capacity curtailments in some periods (e.g. during load or generation peaks). This mechanism is referred exclusively for new connections to the electrical grid.
Cost-based mechanism	A cost-based mechanism deals with the remuneration of the FSP based on the actual costs of providing the service. Cost-based mechanisms require auditing the provider's costs and financial margins to determine the remuneration rates.
Obligation	An obligation mechanism defines the mandatory service provision for the FSPs. The service requested by the system operator to the FSPs is not remunerated.

Besides flexibility mechanism type, the key aspects considered in this report for analysing the demonstrated flexibility mechanisms are the procurement timeframe and the buyer's role. The procurement timeframe is classified as short-term (Near-to-real-time - 15 minutes, Intraday, Day-ahead), medium-term (Week-ahead, Month-ahead), and long-term (Seasonally, Annually).

Furthermore, the flexibility mechanisms for procuring system services listed in Table 5.2 can be devised and adopted as a standalone entity or combined. In the latter case, the single flexibility mechanisms are intertwined; two typologies of mechanism coordination are considered in this report:

- Time-based. Time-based coordination exists between two mechanisms that sequentially occur; hence, the one preceding explicitly defines the baseline for the one that follows, which the actors use to adjust the overall mechanism output.
- Bid forwarding. Bid forwarding coordination exists whether the bids submitted to one mechanism can be forwarded and be part of the clearing of another mechanism.

Flexibility mechanisms assessment is a crucial activity to determine the flexibility mechanism viability in view of electricity market integration. Flexibility mechanisms assessment typically concerns the evaluation of the project outcome from different perspectives (e.g., technical, economic, regulatory) considering the project objectives.

5.2.1 Coordination of flexibility mechanisms

This section provides several project examples regarding the flexibility mechanism coordination adopted by the surveyed projects. Among them, X-FLEX and TwinERGY deal with multiple flexibility mechanisms coordinated based on timing; while EUniversal, OneNet, CoordiNet, and Ebalanceplus also demonstrate the coordination based on bid forwarding. **Table 5-2** lists the key features of the flexibility mechanisms addressed by the analysed projects.

Table 5-2: Flexibility mechanisms demonstrated by the analysed projects

Project	ID	Flexibility mechanism name	Flexibility mechanism type	Timing	Actors	
					Buyer(s)	Seller(s)
X-FLEX	**M1.1**	Local capacity (day ahead) market	Auction market (many buyers – many sellers)	Event-based (Day ahead)	AGR	FSP
X-FLEX	**M1.2**	Local capacity (intraday) market	Auction market (many buyers – many sellers)	Event-based (Intraday)	AGR	FSP
X-FLEX	**M1.3**	Local activation market	Auction market (1 buyer – many sellers)	Event-based (NRT)	DSO	AGR, FSP
TwinERGY	**M2.1**	Dynamic network tariffs	Dynamic network tariffs	Day-ahead	DSO	AGR, FSP
TwinERGY	**M2.2**	Real-time Demand Response	Dynamic network tariffs	NRT	DSO	AGR, FSP
TwinERGY	**M2.3**	Bilateral contract	Bilateral contract	Long or medium term	DSO	FSP (storage)
EUniversal	**M3.1**	Local flexibility market	Auction market (1 buyer – many sellers)	Long and medium term	DSO	FSP, AGR

EUniversal	**M3.2**	Local flexibility market	Auction market (1 buyer – many sellers)	Day-ahead	DSO	FSP, AGR
EUniversal	**M3.3**	Local flexibility market	Auction market (1 buyer – many sellers)	Intraday	DSO	FSP, AGR
EUniversal	**M3.4**	Local capacity market	Auction market (many buyers – many sellers)	Intraday	Producer	FSP, AGR
CoordiNet	**M4.1**	Local Flexibility Markets	Auction market (1 buyer – many sellers)	From long to short term	DSO	FSP, AGR
CoordiNet	**M4.2**	Central market model	Auction market (1 buyer – many sellers)	Short-term	DSO	FSP, AGR
CoordiNet	**M4.3**	Common market model	Auction market (2 buyers – many sellers)	Short-term	TSO	FSP, AGR
CoordiNet	**M4.4**	Multi-level market model	Auction market (2 buyers – many sellers)	From long to short term	TSO, DSO	FSP, AGR
CoordiNet	**M4.5**	Fragmented market model	Auction market (2 buyers – many sellers)	From long to short term	TSO, DSO	FSP, AGR
CoordiNet	**M4.6**	Distributed market model	P2P flexibility trading	From long to short term	FSP, AGR	FSP, AGR
OneNet	**M5.1**	Local Flexibility Markets	Auction market (1 buyer – many sellers)	From long to short term	DSO	FSP, AGR
OneNet	**M5.2**	Multi-level flexibility markets	Auction market (2 buyers – many sellers)	From long to short term	TSO, DSO	FSP, AGR
OneNet	**M5.3**	Common flexibility market	Auction market (2 buyers – many sellers)	From long to short term	TSO, DSO	FSP, AGR
Ebalanceplus	**M6.1**	Local Flexibility Markets	Auction market (1 buyer – many sellers)	Intraday	DSO	AGR
Ebalanceplus	**M6.2**	P2P flexibility trading	Bilateral contract	Long-term and mid-term	DSO	DSO
Ebalanceplus	**M6.3**	Power regulating market	Auction market (1 buyer – many sellers)	Intraday	TSO	AGR

The X-FLEX project deals with flexibility and retail markets for the distribution system. The X-FLEX demonstration activities include the development of a local flexibility market platform that allows the local DSO and aggregators to manage the end user's resources to solve grid congestions. The local flexibility market platform enables local capacity trading. **Table 5-2** describes the essential elements of the flexibility mechanisms demonstrated in the X-FLEX project [6]. The three mechanisms are activated depending on the congestion status of the distribution grid; M1.1 and M1.2 are triggered when available capacities are restrained but not critical for the DSO; M1.3 is activated in case of detected congestion or power quality indexes violation. The local capacity market mechanisms (M1.1 and M1.2) that do not entail the DSO intervention, aggregators are the only buyers. M1.1 utilises a day-ahead discrete auction mechanism with pay-as-clear pricing; M1.2 utilises the intraday continuous auction mechanism with pay-as-bid pricing. M1.3 is activated when the DSO requires upward or downward flexibility to solve grid congestion; M1.3 is opened from 45' to 15' before the time of service delivery; it is a discrete auction-based mechanism with pay-as-clear pricing. The flexibility mechanisms M1.1 and M1.2 demonstrated in the X-FLEX project are implicitly time-wise coordinated. M1.1 is followed by M1.2 that serves to adjust the M1.1 output obtained day-ahead (e.g. to correct forecast errors). No coordination concerns M1.3 since being implemented independently in another pilot site.

The TwinERGY project deals with electricity customer awareness and proactive market participation. The TwinERGY tools facilitate the design of customised demand response strategies. The Steinheim (Germany) demonstrator focuses on an energy market that defines demand response programs enabling consumers to bid their flexibility through an aggregator. The flexibility mechanisms in the TwinERGY German demonstrator are illustrated in **Table 5-2** [7]. M2.1 is a dynamic network tariffs mechanism set a day ahead for consumers and aggregators. The beneficiary of the demand response actions is the DSO; hence DSO is considered the generalised buyer. M2.2 is a dynamic network tariffs mechanism that engages prosumers and consumers in system operation; price signals are provided to customers in near to real-time. M2.3 is a bilateral contract-based mechanism dedicated to the local community battery storage and the bidirectional charging station, which provide peak shaving and voltage regulation at the transformer station. The bilateral contract is established in advance with respect to the time of service delivery. The mechanisms M2.1 and M2.2 are tied according to timing-based coordination; M2.1 occurs day-ahead while M2.2 aims adjusting the profile with real-time demand response actions based on the detected forecast errors.

The EUniversal project develops a universal market interface for the DSO use of flexibility. The EUniversal demonstrators deal with local flexibility markets focusing on DSO congestion management and voltage control. The four EUniversal mechanisms in **Table 5-2** enable grid customers to participate in flexibility markets by integrating RES in the energy system [8]. M3.1, M3.2, and M3.3 concern auction mechanisms for procuring active or reactive power. Both continuous and discrete auction types are tested. M3.4 is a local flexibility mechanism for congestion management for trading line capacity permissions defined by a Dynamic Line Rating (DLR) system. Based on the DSO day-ahead power flow calculation and forecasted capacity assessment, the producers can procure additional line capacity from FSPs and aggregators by means of a continuous auction. The coordination between M3.1 and M3.2 is based both on timing and bid forwarding. To illustrate, in M3.1, the FSPs place long-term offers for both active and reactive power flexibility. The offers validated by the DSO are matched in M3.1 and reserved for later activation. In M3.2, which closes 24 hours before activation, reserved offers from M3.1 compete with the new ones submitted in M3.2. In M3.2, the DSO's needs are matched with the FSPs' and aggregators' offers in an iterative process that, after the DSO technical validation, results in traded flexibility to solve the grid constraints. M3.3 and M3.4 are standalone mechanisms since demonstrated independently.

The CoordiNet project focuses on TSO-DSO coordination to use the same pool of resources to procure system services. The CoordiNet demonstrators in Spain, Sweden, and Greece prove the technical and economic viability of system service provision from FSPs. **Table 5-2** shows the flexibility mechanisms addressed in the CoordiNet project [9]. M4.1 describes a single DSO local market not intentionally coordinated with other submarkets. M4.2 is like M4.1; however, it describes a mechanism devoted to procuring TSO system services. M4.3 defines a single market where the TSO and the DSO are buyers of the same set of FSPs; in M4.3, bids include locational information. Unlike M4.3, in M4.4, TSO and DSO procure flexibility by participating as single buyers in different coordinated markets (central and local markets, respectively). Unlike M4.3, in M4.4, the different markets that form the flexibility mechanism are not coordinated. M4.6 represents a local P2P trading mechanism with direct negotiations. In the Swedish demonstrator, the flexibility mechanism coordination within M4.4 concerns bid forwarding from the local to the central market. This coordination occurs considering the day ahead and the intraday timeframes.

The OneNet project focuses on TSO-DSO-Consumer coordination to define a common market design for Europe involving demonstrators of 4 clusters concerning 15 countries. **Table 5-2** shows that the OneNet demonstrators focus on flexibility mechanisms based on auction markets, exploiting different market models (i.e. local, common, and multi-level), covering timing (i.e. long-term, medium-term, and short-term), and different products (i.e. active and reactive power availability and activation) [5]. The OneNet project demonstrators involve flexibility mechanism coordination with bid forwarding. Among the OneNet demonstration activities, the Polish demonstrator entails coordination between the local and central markets, forming the flexibility mechanism M5.2. The coordination regards flexibility mechanisms focused on different system services. In the local day-ahead market, the DSO procures flexibility from FSPs to support network congestion management and voltage control. This market is exclusive for the DSO; however, FSPs bids are forwarded from the local market to the central energy balancing market (exclusive for the TSO). The forwarded bids are a balancing offer at the TSO-DSO interface; in the aggregation process, the distribution grid constraint check prevents endangering the DSO network operation in case of activation. OneNet also demonstrates bid-forwarding in common flexibility market mechanisms (M5.3). In common markets, TSO and DSO are simultaneous participants and potential buyers of the same pool of FSPs. The demonstrated coordination concerns the intraday energy and the short-term congestion management markets; both are common markets. Bid forwarding from the intraday energy market to the congestion management market involves bids with locational information.

The Ebalanceplus project develops an energy balancing platform that integrates production, consumption, and storage. The Ebalanceplus Italian demonstrator concerns a local flexibility market; **Table 5-2** provides the essential description of the considered flexibility mechanisms. M6.1 represents a local flexibility auction-based market in which the DSO procures the aggregators' flexibility to solve grid congestions. M6.2 is a bilateral contract mechanism in which the neighbouring DSOs trade flexibility. M6.1 is cleared depending on the outcome of M6.2; hence M6.1 and M6.2 show time-based coordination. M6.3 represents the market in which the TSO procures frequency ancillary services, flexibility bids not cleared in M6.1 are submitted to M6.3 if there is no distribution grid constraints violation risk. Hence, M6.1 and M6.3 show coordination based on bid forwarding.

5.2.2 Approaches for flexibility mechanism assessment

This section presents the review of the approaches for flexibility mechanism assessment adopted by the surveyed projects.

The CoordiNet project adopts qualitative and quantitative approaches to assess the relevant combinations of flexibility mechanisms using market simulations and analytical, numerical, and qualitative analyses to complement the demonstrators' findings [10]. The quantitative assessment includes the economic analysis from the system and actor perspectives. The system assessment considers a country level cost-benefit analysis (CBA) and the analysis of the impacts of different cost allocations and bidding strategies on multiple mechanisms. Considered indicators are the total cost of flexibility procurement and economic efficiency. The actors' perspective assessment concerns evaluating the business case of the actors involved in the different flexibility mechanisms and the analysis of the allocation of costs and benefits. Moreover, quantitative scalability and replicability analysis involving flexibility market aspects is performed to determine the applicability of the different flexibility mechanisms to different contexts. The qualitative assessment focuses on combinations of flexibility mechanisms to evaluate market adequacy and identify relevant gaps and good practices.

The EUniversal project assesses the demonstrated flexibility mechanisms with quantitative and qualitative approaches [11], [12]. The assessment focuses mainly on regulatory and economic aspects. The regulatory assessment addresses flexibility mechanism integration into electricity markets considering three main elements: flexibility mechanism compatibility, strategic behaviour of FSPs, and regulatory innovation. The flexibility mechanism compatibility analysis concerns the combined use of distribution network tariffs, smart connection agreements and flexibility markets, and then the analysis of the impacts of every single mechanism on other electricity markets. The compatibility analysis provides recommendations on design choices to foster market integration. The impact of different strategic behaviours of FSPs is also evaluated considering different timing and configuration of the flexibility mechanisms coordination with the electricity market architecture. The regulatory innovation assessment is a qualitative analysis of the barriers about the demonstrated flexibility mechanisms. Moreover, the flexibility mechanisms assessment is part of the scalability and replicability analysis that evaluates the market performance considering scenarios that differ in product type, product availability, market-clearing objectives, and network representation.

The X-FLEX project relies on a quantitative market assessment based on estimating the reduction in power losses and improving voltage level, reduction of reinforcement costs for the DSO. SENDER project develops an assessment approach based on technical and social KPIs obtained from the demonstration activities to evaluate the efficiency of the demonstrated solution. FEVER proposes a quantitative approach based on KPIs. PLATONE relies on a quantitative approach based on different KPIs as market liquidity, the ratio between the flexibility offered and required, the ratio between the flexibility provided and required.

INTERRFACE addresses a qualitative assessment based on a combined top-down and bottom-up analysis. The former focuses on services, actors, roles, interactions, and procuring mechanisms, while the latter on the end users’ point of view. The methodology applied to the demonstrators brought to define the interactions between the subjects involved in the services provision. Besides defining market designs, a special focus is set to the common processes (e.g., prequalification and settlement) since the introduction of a flexibility resource register for them will facilitate market coordination.

The Ebalanceplus project proposes a qualitative assessment based on an accurate review of the electricity market structure in each demo site. The focus is on the roles and responsibilities of TSO and DSO, the structure of wholesale and ancillary service markets, and demand-side response through aggregators. Several KPIs are defined to assess the flexibility mechanisms performances of demonstration activities.

Since the projects' maturity, relevant information about the assessment methodology for the OneNet, ISLANDER, FLEXITRANSTORE, CROSSBOW, and TwinERGY projects is not available yet. MERLON and FLEXIGRID do not expect to develop a direct methodology for explicitly assessing the market mechanism's suitability.

5.3 Conclusions

This report presents a review of the activities in Europe that address the demonstration of flexibility mechanism and their coordination. The analysis of the initiatives addressed by the reviewed projects is described in this report considering as key elements the mechanism typology, timing, the buyers' classification, the system service type, and the flexibility mechanism coordination. Moreover, the project review focused on the methodologies proposed for flexibility mechanism assessment.

The overview of the result of the analysis of all reviewed projects considering the flexibility mechanism typology is shown in **Figure 5-1**. The auction-based market is the most widely adopted mechanism. The adopted market-based mechanism typically considers the presence of many potential FSPs (sellers) to allow achieving perfect market conditions. The monopsonist auction-based market (i.e. only one buyer) is majoritarian with respect to the cases in which the market has many buyers (e.g. TSOs, DSOs, aggregators) or only two buyers (i.e., TSO and DSO). Dynamic network tariffs represent one-fifth of the demonstrated mechanisms; bilateral contracts and P2P trading respectively cover 11% of the demonstrated mechanisms. Irrespective of the mechanism typology, DSOs and TSOs are the buyers in most reviewed cases, followed by aggregators. Grid users, prosumers, balance responsible parties (BRPs), and producers play the buyers' role in only a few of the analysed mechanisms.

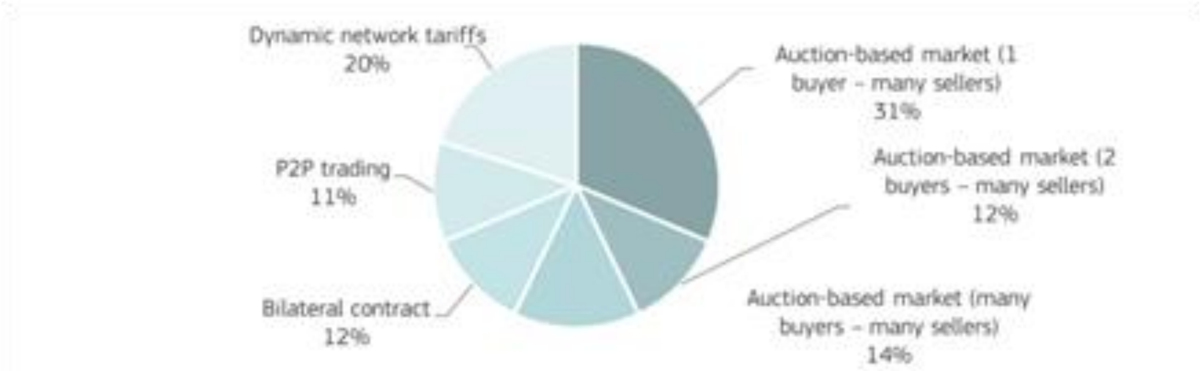

Figure 5-1: Mechanism typology adoption by the reviewed projects

Timing represents a fundamental feature for characterising a flexibility mechanism since it represents the procurement timeframe for the related product and influences mechanism functioning and coordination with the rest of the market architecture. **Figure 5-2** reports the timing of the mechanisms adopted in the surveyed project demonstrators. **Figure 5-2** highlights that most of the demonstrated mechanisms concern a short-term procurement (day-ahead, intraday, near to real-time). Moreover, the surveyed demonstrators also focus on event-based mechanisms, i.e. procurement mechanisms based on a trigger (e.g. system operator request).

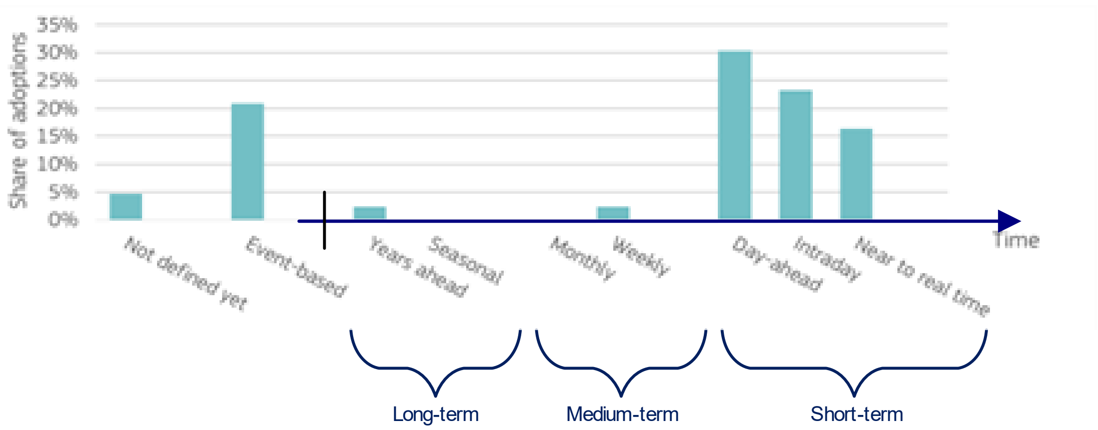

Figure 5-2: Flexibility mechanism timing adopted by projects

The system service of interest for the flexibility mechanism is not a design element; however, it represents an important aspect that influences the mechanism's features (e.g., product, buyers, timing, procurement area) [4]. The flexibility mechanisms of surveyed projects deal with network congestion management (44%), voltage control (27%), balancing (16%), and islanded operation (2%). The 11% of analysed flexibility mechanisms are demonstrated as service agnostic.

Regarding flexibility mechanism coordination, **Figure 5-3** provides the overview of demonstration activities in the reviewed Horizon 2020 projects. Most reviewed projects deal with the coordination of more than one flexibility mechanism. The projects that do not belong to this category focus on a single flexibility mechanism or address an independent demonstration (e.g. the flexibility mechanisms are tested in different demo sites). **Figure 5-3** also highlights the considered type of coordination among flexibility mechanisms; X-FLEX and TwinERGY deal with multiple flexibility mechanisms coordinated based on timing; while EUniversal, OneNet, CoordiNet, and Ebalanceplus also demonstrate the coordination based on bid forwarding.

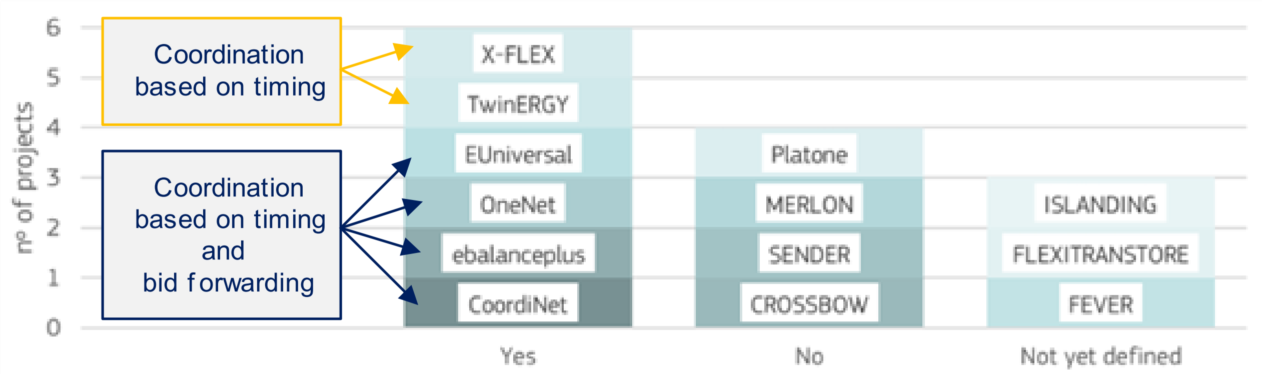

Figure 5-3: Overview of the status of the demonstration activities concerning the flexibility mechanism coordination in the reviewed Horizon 2020 projects

The outcome of the flexibility mechanism assessment contributes to the design of the electricity market integration. As an outcome, the reviewed projects provide regulatory recommendations and general perspectives on the risks and opportunities of several market integration solutions. **Figure 5-4** illustrates the status of the surveyed projects considering flexibility mechanism assessment approaches. Project review reveals that the approaches for flexibility mechanisms assessment can be quantitative, qualitative, or both depending on the scope of the activities, data availability and service under consideration. The flexibility mechanism assessment is addressed, covering several impact areas (e.g. technical, environmental, market, economic, societal). Typically, the flexibility mechanisms assessment requires collecting the demonstration results in terms of key performance indicators (KPIs) on technical aspects related to the flexibility need and provision; market aspects related to products, participation, and exchanged volumes; and economic aspects related to proposed solutions' expected costs and revenues.

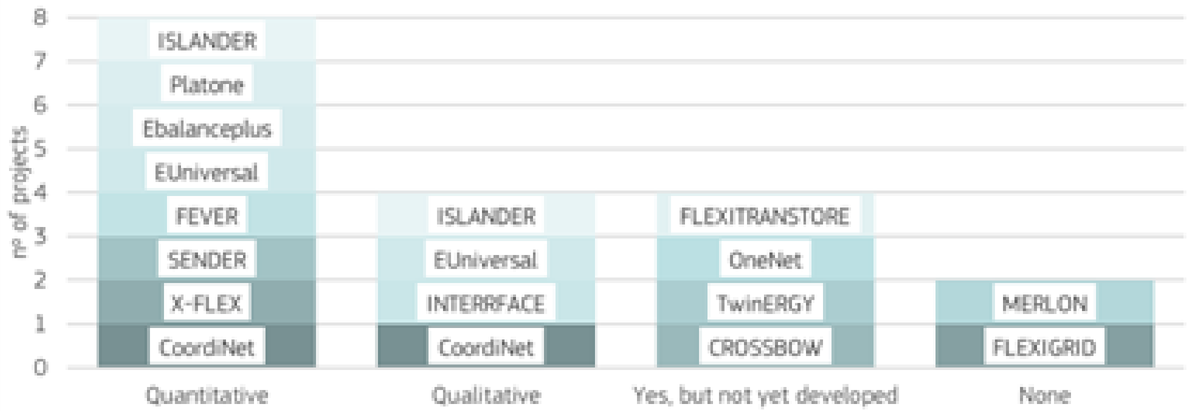

Figure 5-4: Approaches for the flexibility mechanism assessment

The reviewed demonstration activities highlight the pros and cons of exploiting the different flexibility mechanisms considering several scenarios. Auction markets have shown effectiveness in various scenarios enabling various business models and motivating the electricity market participation of network users. The assessment of the demonstrated flexibility mechanism highlights the higher economic efficiency of common markets than other market schemes; however, common markets have a higher implementation complexity and information exchange burden. More decentralised schemes (e.g. multi-level markets) show lower implementation and information exchange requirements and represent a valuable alternative. However, small players may experience entry barriers in flexibility markets; regulatory surveillance is required to lower the possible barriers. The surveyed projects show that the adequacy of the market-based mechanisms depends on the target system service and the technological requirements for providers. The analysis of the surveyed projects identifies coordination efficiency as one of the key aspects for integrating flexibility mechanisms into electricity markets. Coordination efficiency is influenced by several aspects such as the resources allocation that results for TSOs and DSOs, the direct or indirect resource access, the network information sharing. Moreover, the strategic behaviour of participants must be considered to devise coordinated flexibility mechanisms that prevent gaming. The existence of multiple coordinated markets may theoretically increase the risk of gaming; flexibility mechanism timing, participation rules, and regulatory oversight are necessary to limit that risk.

Dynamic network tariffs and connection agreements also represent a valid alternative since the lower complexity also fosters customer engagement. Surveyed projects point out that bilateral agreements, dynamic network tariffs, flexible connection agreements, and cost-based mechanisms may better fit services such as voltage control, black start capability, and controlled islanding. The use of P2P flexibility trading and bilateral contracts may determine the risk of low liquidity as the market size is limited. In P2P flexibility trading, continuous trading is preferred over an auction scheme since able to handle better the bilateral negotiations for establishing the agreements between the peers. Blockchain technology is considered a valuable tool for easing the transaction burden in P2P flexibility trading. However, a dedicated case-based analysis is necessary to determine the mechanism's performance and the flexibility mechanism that best fits the considered scenario.

The demonstration activities highlight that any flexibility mechanisms shall aim for technology neutrality, flexibility mechanisms based on markets should be preferred unless the context makes them not applicable, local characteristics influence liquidity and may create market distortions. Moreover, demonstrators point out that TSOs and DSOs should operate or have a key role in flexibility platforms operation since market outputs are intertwined with the technical aspects of power system operation.

According to the project review, the lack of liquidity is perceived as one of the main concerns regarding flexibility procurement. Liquidity appears critical, especially in local markets since the procurement area is limited and FSP participation can be poor. The flexibility mechanism design solutions proposed by the reviewed projects for increasing liquidity are based on timing and availability procurement. Moreover, flexibility mechanism coordination represents an important tool to allocate potential providers across the electricity market architecture effectively.

5.4 Recommendations

This section resumes the main recommendations that result from the surveyed projects. Most of the analysed projects are still ongoing; therefore, recommendations are based on the available findings considering the actual maturity level. The recommendation provided in this section cover the design of the flexibility mechanisms, their coordination, and the performance assessment.

Considering the design of flexibility mechanism, the surveyed projects make evident that **the "one-fit-all" approach is not fruitful in the context of flexibility mechanisms**. Flexibility mechanism design has to consider the system service and the product to be procured, and the characteristics of the context (e.g. voltage level, timing of the need, volume requested, network type, volume of flexibility potentially available, number of expected FSPs participants, resources types of FSPs). Several principles are pointed out to guide the flexibility mechanism design and integration (e.g. economic efficiency, transparency, equity, implementation concerns, customer engagement and reliability). Even limiting the design exercise to one flexibility mechanism typology, solutions of general validity do not exist; the corresponding design choices (e.g. definition of the dynamic network tariffs or market structures) must be evaluated case by case. Moreover, the analysed flexibility mechanism demonstrations highlight that **local markets may require flexibility dedicated product specifications** that consider the peculiarities of local resources and lower requirements from the products for central markets.

However, bid forwarding between markets can take place as long as products are the same; therefore, a compromise between product specificity and flexibility mechanism coordination must be identified on the case basis.

The surveyed projects investigate the adoption of multiple coordinated flexibility mechanisms; to illustrate; it has been of interest the compatibility of dynamic network tariffs, smart connection agreements, and flexibility markets. However, **the theoretically proven compatibility requires further demonstration of the actual feasibility of coordinated flexibility mechanisms in real contexts.** Due to the complexity of flexibility mechanisms and the related impacts on the electricity sector, the expected performances may not be guaranteed in real applications. Therefore, it is of utmost relevance to carry on further research and large-scale demonstrations to enhance the understanding of the integration of flexibility mechanisms into electricity markets.

The assessment of the flexibility mechanism represents a valuable tool for determining the viability of the adopted flexibility mechanism.

Flexibility mechanism assessment must capture the broad spectrum of economic, technical, regulatory, societal impacts. **The understanding of the impact allocation across the electricity sector can be obtained by a flexibility market assessment from different perspectives (e.g. system, local, and actor based)**.

5.5 Next steps

The analysed experience on flexibility mechanism demonstration allows to identify several priorities regarding flexibility mechanism coordination and electricity market integration:

- Terminology harmonization of flexibility mechanism can ease the comprehensiveness of the proposal and results' comparison among projects.
- Flexibility mechanism coordination and market integration require the accurate design of the timing of flexibility mechanisms to foster liquidity by preventing gaming.
- Good practices for designing the coordination of market phases (i.e., from prequalification to settlement) are required to obtain efficient markets.
- A clear definition of roles and responsibilities of market participants and stakeholders is required to increase transparency and avoid market distortions. Further demonstration activities involving the variety of stakeholders of flexibility mechanisms will support the assessment of regulatory aspects and regulation evolution by identifying the boundaries of each role in the real world.
- The complexity of developing and deploying the different flexibility mechanisms must be assessed considering the context peculiarities. Information exchange burden and the required comprehensiveness of the grid representation must be part of the assessment.
- The deployment of flexibility mechanisms requires a high level of observability and controllability; hence, further efforts on power system digitalisation are necessary.
- There is a lack of a methodology specification to evaluate the suitability of flexibility mechanisms in different contexts and supportive experiences.

The research and development activities on the flexibility mechanism design and coordination are promising. Further research in modelling and large-scale demonstrators are required to fill the gaps concerning the integration of flexibility mechanisms into the electricity market.

6. Action 5 – Local markets

6.1 Introduction of the Action

The decarbonization, decentralization and digitalization provide both challenges and opportunities for distribution grids. The continuous diffusion of growing Distributed Generation (DG) plants for the European decarbonisation objectives, as well as the diffusion of small-sized storage systems connected to electric mobility, make it necessary to revise the distribution system operators (DSOs) that should take on an additional role compared to the classic one:

- role of facilitator for the procurement of global services made available for the security of the system as a whole. It is believed that the role of DSOs as facilitators must find concrete application ever closer to real time on the basis of the real state of operation.
- role of buyer of resources for local services for distribution networks if there is a need.

The implementation of a model useful for enhancing the availability of Consumers, Prosumers and Producers, requires the definition of a local market (LM) model using market mechanisms locally through which the manager (the Aggregator) describes the relations with the Energy Supplier (ES), Balancing Responsible Party (BRP), Balancing Service Provider (BSP), Flexibility Service Provider (FSP) and Prosumers and describes how relationships and responsibilities are organized. It is equally important to know how energy, monetary and information flows are organized, in the balancing process and in the provision of services to grid operators. There are independent local Distributed Energy Resource Management System (DERMS), and even Local Energy Market Systems (LEMS), not connected to the existing market mechanism. Without such an integrated market concept, serving distributed flexibility, the Distribution System Operator's (DSO's) use of flexibility might be very expensive. The wider role that the DSOs are expected to play in the future scenario, pushes the member states to provide an appropriate legal framework to allow and incentivize DSOs to procure regulation services from resources connected to distribution networks. According to article n.32 of the EC Regulation 2019/943, the services procurement process must be conducted in a transparent and non-discriminatory manner. DSOs are also required to define standardized market products, ensuring effective participation of all market participants, including DR. Moreover, appropriate forms of cooperation between DSOs and TSOs shall ensure an effective participation for DERs also in retail, wholesale, and balancing markets.
In this contest, the scope of this section is to provide an overview of the experience related to « local market implementation» developed and tested in the demonstrators of some European Horizon 2020 projects.

Based on the H2020 Bridge Regulations Working Group 2021 work plan and its Track 4 - **Coordinated flexibility markets for system services**, the subtopic that has raised more interest in 2021 refers to the analysis on **P2P energy trading**. However, considering both 2021 and 2022, the most supported topics would be **Local markets**. Therefore, it is proposed to address the subtopic Local Markets, defined Action 5, that could be continued in 2022. The regulation WG has proposed two different types of outcomes for work period 2021-2022:

- A specific report summarising the work performed in each of the tracks.
- The workshops resulting of the Dynamic Knowledge Sharing mechanism.

More specifically, 15 projects actively contributed to the work in this action:

Action 5 has the scope of a dynamic knowledge sharing among H2020 projects, collecting and processing information and the experience of the participating projects; the main goal addressed in Action 5 is to analyse how to proceed for the LM implementation in terms of: identification of the needed services, the activation of the market, the bidding, clearing and settlement mechanisms, and so defining the LM structure, the role of citizens, the technology innovation needed, the market participants and their roles.

To reach the scope of Action 5, it has been decided to work as illustrated in **Figure 6-1**.

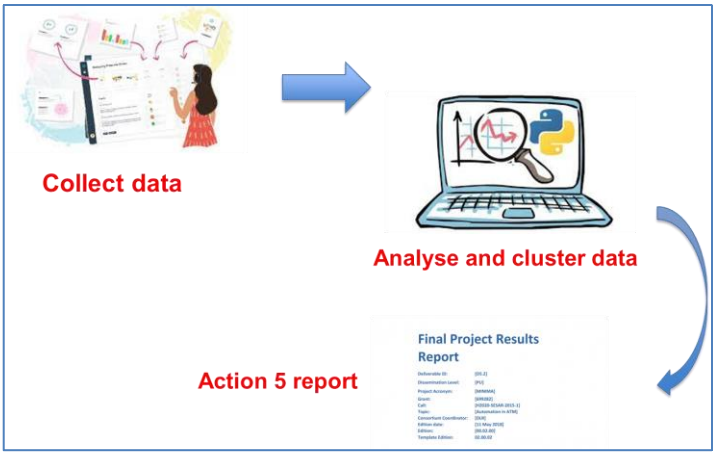

Figure 6-1: How work in Action 5 - **Processes:** Knowledge Sharing; **Tools:** Questionnaire/Collecting database/Meeting/Workshop; **Methods:** Organizing subproject meeting about; Inviting speakers/expertise to SG meetings; Exchanging the ideas with other projects.

To collect the relevant information and sharing the experience provided by the involved projects, the methodology used in this action consists of the following steps:
1. analyzing the background based on results of 2020 year.
2. proceeding with data collection from BRIDGE projects.
3. clustering the information based on the model, the structure, the role of citizens, the technology innovation, the market participants and their roles.
4. Select best practices – existing local market.

5. Identifying relevant applications and issues and formulate recommendations based on scenarios development looking ahead to future challenges.

As a first step, the Bridge Regulation WG report of 2020 year has been analysed to highlight the gaps and the recommendations so to better analyse the information provided in the work period 2021-2022.
The second step concerns the definition of a questionnaire to collect the relevant information concerning the LM implementation in each demo pilot. The questionnaire, available in Annex V – Part A, is based on the following principal points:

- ✓ the regulation context and LM framework;
- ✓ the LM structure and delivery mechanism adopted;
- ✓ the Energy services and LM actors;
- ✓ the LM development barriers.

The questionnaire aims to collect relevant information regarding the LM model and how it has been implemented and integrated in the regulatory framework of each European country.
The third step concerns the administration of the questionnaires and analysing the received information to identify the differences and similarities among the projects and so cluster the information as illustrated in section 6.3.
From the third step results, in fourth step some projects have been selected as main best practices linked principally on the project stage.
The fifth step of the methodology addresses the formalisation of recommendations and lessons learnt from the analysed responses based on the scope of Action 5.

Chronologically, the methodology used in this action was developed by the following work plan:
• Creating a repository to collect research / information / data on MSTeams
• Proposing a questionnaire;
• Collecting data from involved BRIDGE projects;
• Analyzing some specific initiatives organizing a workshop;
• Identifying relevant applications and issues and formulate recommendations;
• Reporting on the Action 5 work results.

This work plan has been implemented following the steps listed in **Table 6-1**.

Table 6-1: Action 5 work plan 2021 – 2022

Step	Date	Responsible
First Action 5 meeting	21/09/2021	Action 5 Leader
Meeting Confirm the project participation	28/09/2021	All
Proposal of questionnarie to collect information from BRIDGE projects	05/10/2021	Action 5 Leader
TOC of Deliverable	05/10/2021	Action 5 Leader
Collecting data sending the Questionnaire	01/12/2021	All
Second Action 5 meeting	02/12/2021	Action 5 Leader
Finalize the first draft version of Action 5 report contribution	18/01/2022	Action 5 Leader
Action 5 Workshop "Dynamic Knowledge Sharing on Local Marteks implementation"	26/01/2022	Action 5 Leader Merlon; Platone; Coordinate; Interconnect; Ebalanceplus

Finalize the first draft version of Action 5 report contribution	18/01/2022	Action 5 Leader

6.2 Best practices

This section provides a consistent overview of the LM implementation by the selected projects relying on essential aspects as regulatory context, delivery mechanism, LM structure and LM implementation barriers. Analysing the questionnaire responses and clustering them in term of above-mentioned essential aspects, five projects have been identified as best practices (see **Figure 6-2**).

Figure 6-2: Bridge projects selected as best practices for Action 5

Regulatory context and LM framework
Merlon: The national legislation at the demo countries does not enable the validation of flexibility marketplaces targeting DSOs. A Blockchain-Enabled Flexibility Marketplace has been designed and developed. Aiming to achieve a more systematic and efficient deployment of flexible resources for distribution network management, dedicated local flexibility markets enable flexibility to be traded according to open market principles. In such markets, the DSO can constitute the demand side, requesting specific levels of flexibility (e.g. ability to reduce or increase power infeed) at specific locations of the network and specific time periods. Flexible resources constitute the supply side, offering their available flexibility at different price levels.
Platone: Currently, in Italy, the ancillary services are provided by the great power plants connected to the HV network. However, in July 2017, ARERA – the Italian Authority for the Electricity market regulation – has launched pilot projects to involve the resources connected in medium and low voltage in the flexibility market. The services (Congestion Management and Replacement Reserves) defined in the pilot projects, are required by the TSO and provided by the BSP, while the DSO assesses the grid constraints only in the creation of the aggregate not in the exercise phase. The transposition of the Directives 2018/2001 (RED II) and 2019/ 944 (IEM) on common rules for the internal market of electricity in Italian regulatory framework is with Decree Law November, 8 th 2021 no 199 and 210.
CoordiNet: the current regulation in the three demo countries within CoordiNet is relevant (https://private.coordinet-project.eu//files/documentos/5cdc65b97fb00COORDINET%20D1.1.pdf):

- In Greece, the regulatory basis for the DSO to procure DER flexibility for local grid management already exists (as part of the Hellenic Electricity Distribution Network Code), but it has not been implemented yet. The main focus is however on bilateral contracts.
- In Spain, DSOs can use DER, more specifically DG, to solve congestions in the same way the TSO does. This process, however, is done through the TSO. It applies to units with a capacity of more than 1 MW (the local market will apply to smaller units not included in the existing market).
- In Sweden, regional and local DSOs can procure flexibility from flexibiliy service providers, but regulation is not specific, leaving freedom of action to the DSO.

The CoordiNet project focuses on the procurement of network services by TSOs and DSOs. Various market models are proposed, some of which include local markets for DSOs. The development of local markets for DSOs within the Coordinet project can be framed within the European regulation.

Interconnect: The regulatory context for the Italian pilot is that described for Platone project. For the Belgian pilot, current flexibility markets are limited to the high voltage grid where the Belgian TSO (Elia) has access to flexible assets that provide frequency regulation. A market participant must meet strict conditions to be able to offer frequency regulation services (high capacity and availability). As citizen energy communities are not recognized as a legal entity, they cannot participate directly into the high voltage flexibility market, instead they must rely on aggregators to enter the market.

Ebalanceplus: electricity markets can show differences across EU countries. In view of this, the present subsection provides a short description of the electricity markets in the countries with demo sites in the ebalance-plus project: Denmark, France, Italy and Spain. In **Denmark** power generators are obligated to provide voltage regulation and reactive power ancillary services. Aggregators are partially active. In theory, demand response can enter the energy and ancillary services markets, but this is very limited due to little demand from the TSOs and DSOs. Low economic benefits for end users and regulatory issues like minimum bid size in reserve markets, online measurement capability, and symmetric bids also affect the participation of demand-side and aggregators in the markets. However, the aggregators are allowed to participate in the energy and ancillary service markets, but they should have bilateral agreements with consumers BRPs and retailers. At the moment, it is mostly the BRPs and retailers that provide the aggregation services. **France** is one of the leading countries in the participation of demand-side of the system in ancillary service markets. Industrial, commercial and residential consumers can offer their flexibility to the markets through the aggregators. Aggregators are allowed to bid into all markets without any pre-determined arrangements between aggregators and suppliers/BRPs. In Italy and Spain the scenario is defined in Platone and Coordinet projects.

<u>Market mechanism</u>

Merlon: Beyond the business perspective of the flexibility marketplace, the following 3 core functionalities have been distinguished and indicatively presented in **Figure 6-3**: visibility of available flexible asset, marketplace operation and contract notification, settlement and remuneration (Merlon – Deliverable D7.3).

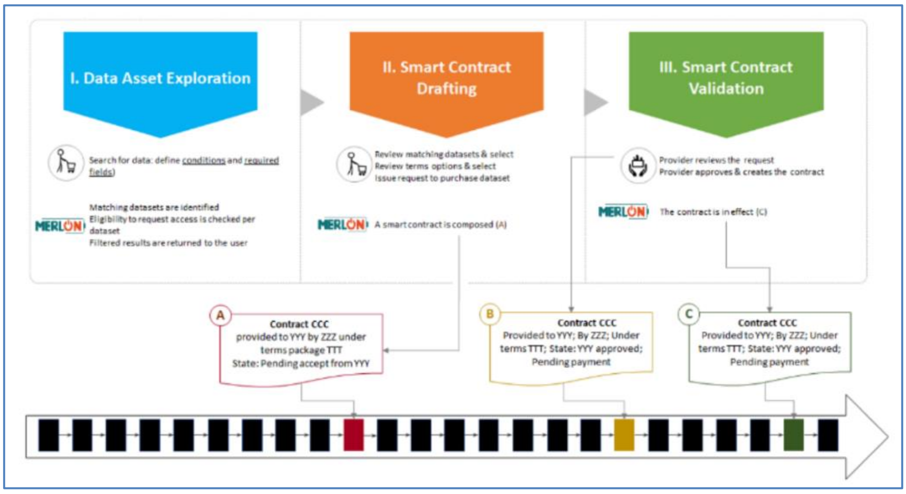

Figure 6-3: MERLON Marketplace Distributed Ledger

Platone: The Market Platform (MP) is a blockchain-based platform that enables the management of wide geographical area flexibility requests from TSOs and local flexibility requests from DSOs. The flexibility requests are matched with offers coming from Aggregators according to pre- defined rules and dispatching priorities, in order to solve grid issues. All the market operations are registered and certified within the blockchain service layer, ensuring a high level of transparency, security and trustworthiness among all the market players. The first prototype of the Platone Market Platform was integrated in the Italian

Demo Architecture and includes : Only Day-Ahead Market Flexibility Services; Clearing Market Tool based on price priority; Settlement Outcomes and validation; Blockchain and Smart Contract services for Settlement and Customer Incentivization; First prototype of the Web Dashboard for Market Participants.

CoordiNet: Explicit local flexibility markets for DSOs have been / are being implemented in the three demo countries. The local markets in the different demo countries have made some own design choices, depending on local needs. These design options include:

-The local DSO markets are integrated within the timing of the already established energy and balancing markets, considering the specific timings of the markets within each of the demo countries.

-Different time frames are considered: week-ahead, day-ahead, intraday and near real-time for the procurement of flexibility;

-The services procured via local markets within CoordiNet include congestion management, voltage control and controlled islanding; Energy only and a combination of capacity and energy products are tested; In addition, reactive power products are used.

-Most local markets tested consider a closed-gate auction, but in the Swedish demo also a continuous market is tested aside from a closed-gate auction.

-Both pay-as-cleared and pay-as-bid pricing schemes have been implemented.

Interconnect: For the Italian pilot a delivery mechanism based on dynamic tariffs (time of use tariffs) is adopted. On the contrary, for the Belgian pilot, Continuous participation to a LEM requires a clear and efficient redistribution of revenues and costs among participants (e.g., community members). The redistribution may be enforced by the market organizer (e.g., community manager). The value the participation brings to e.g., community members should be such that they are doing better than action on their own. A high enough market price (clearing price) provides incentives to flexibility providers (prosumers). If the market price is not high enough, subsidies might be necessary to incentivize participation of prosumers.

Ebalanceplus: ebalance-plus aims to exploit the flexibility of distributed energy resources (DERs) and end-users using different market mechanisms in the power system. One hour before power delivery, aggregators estimate their available flexibility at the next hour. The Aggregator submits a flexibility power and price bid for the next operating hour to the LFM. The DSO receives the aggregators' flexibility bids, considers the ability of peer to peer flexibility trading with neighboring DSOs, and clears the LFM market focusing on congestion management in the distribution grid. If there are upward and downward flexibility bids that are not traded in the LFM and do not impose congestion to distribution grid, they are transmitted to the RPM by the DSO. The accepted upward and downward flexibilities in RPM are informed to aggregators and are settled by RPM prices. In this case, aggregators should keep the capacity available and let the TSO use them in case of power imbalance in the system (Capacity and energy trading). The cleared bids are scheduled for the next hour, i.e., some aggregators will reduce the consumption of their consumers and some other will increase the consumption of their consumers (Energy trading).

LM structure

Merlon: In the flexibility marketplace of the MERLON project, two key stakeholders are involved: the flexible asset owners as the actors to access the marketplace and make their flexible assets available (PV, EV, charging point, Battery owners etc.) and the aggregators searching and demanding for flexible assets. A conceptual architecture, defined in Merlon Deliverable D8.6, is given in **Figure 6-4**.

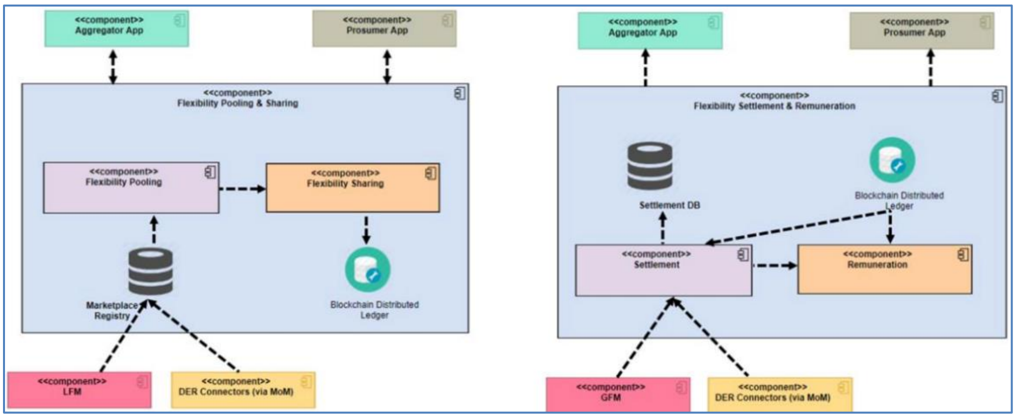

Figure 6-4: MERLON flexibility marketplace – Conceptual Architecture Overview

Platone: a new flexibility market with a relevant role of the DSO has been designed. It defines a context where **all the customers**, connected to the distribution grid, can supply flexibility services to the TSO and DSO in a **Common Ancillary Service Market** (see **Figure 6-5**), in which the players can interchange their flexibility products. In the project, the aggregator has a key role, because it is the only interface between the distribution grid users and the market for selling flexibility, so it has to be able to gather and place the customer flexibility.

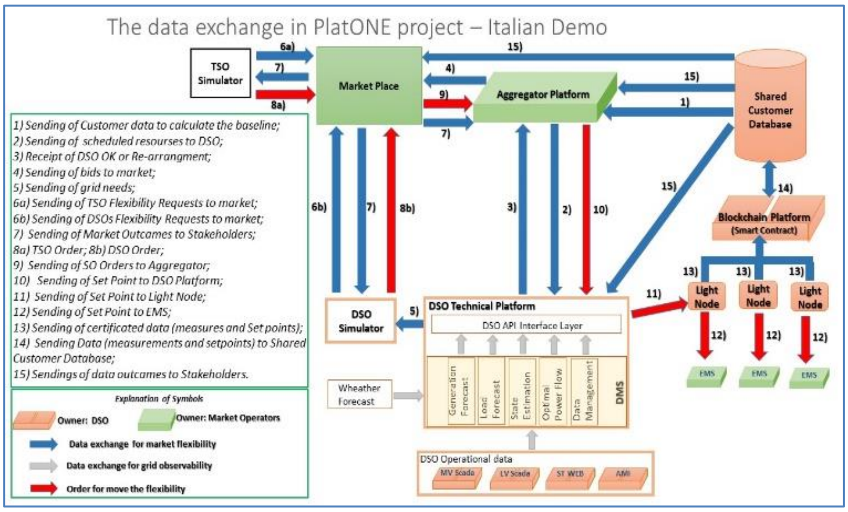

Figure 6-5: Platone **Common Ancillary Service Market** – Conceptual Architecture data exchange Overview

CoordiNet: The Local DSO markets within CoordiNet mostly have a traditional, centralized market structure. In addition, a decentralized market structure, i.e. a local P2P market, is also being implemented as part of the Swedish demo. The market structure and elements developed in the SE-1a BUC is illustrated in **Figure 6-6**. The goal of the market is a coordination between two market session: the local flexibility market and the regional flexibility market in order to prevent critical congestion problems between the regional and the local DSOs and the TSO and the regional DSO.

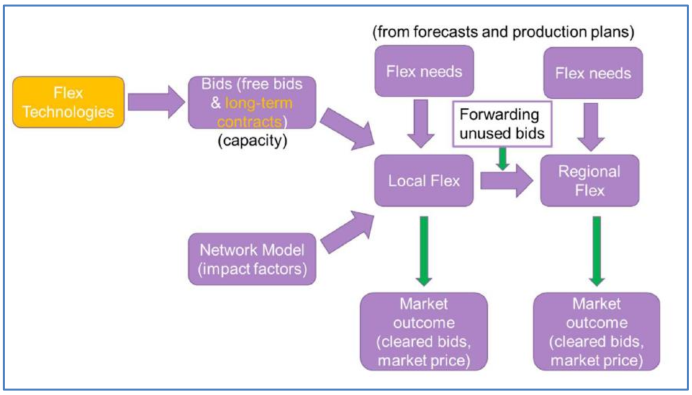

Figure 6-6: Coordinet **market structure** in the SE-1a BUC (Coordinet Deliverable D2.1)

Interconnect: The LM structure supposes a more diversified approach to FSPs that the regulation provides for.

activation through 3rd party aggregator/BSP, organizing the market through a platform that allows direct trade between DSO <-> communities and community <-> community. For the Italian pilot, DSO should be assuming the following roles:

- Neutral facilitator for the provision to TERNA (TSO) of global ancillary services provided by BSPs for the secure operation of the overall power system ;
- Buyer of resources for the provision of local ancillary services (e.g. voltage regulation, power quality and distribution network congestion), necessary for the secure operation only of the distribution network or of its portions (dedicated pilot projects are necessary).

For the Belgian pilot, the DSO (stakeholder), operates/maintains/develops/recovers optimally the grid, maintains balance at interconnection, facilitates flexibility trading and buys flexibility (responsibilities).

Ebalanceplus: The ebalanceplus project aims to increase the use of flexibility and resilience of energy networks through an energy balancing platform, which integrates smart production, storage and consumption technologies. The main goal are to provide: a market place for trading the available flexibility of end-user consumers, benefiting end-user consumers from providing ancillary services and the DSOs from the available flexibility of their consumers for removing the transmission system congestion; provide the possibility of trading the flexibility in a distribution grid with other markets like regulating power market. A Local Flexibility Market (LFM) is defined for each DSO. The LM structure is different based on flexibility mechanism: explicit demand side flexibility or implicit demand side flexibility. Explicit demand side flexibility, or incentive-driven demand side flexibility, is the one traded on the different energy markets (wholesale, balancing, system support and reserves markets). This is usually facilitated and managed by an aggregator that can be an independent service provider or a supplier. Renumeration for the prosumer can be in the form of a direct payment or savings on the electricity bill. Implicit demand side flexibility, or price-based demand side flexibility, is the prosumer's reaction to electricity or network price signals. When prosumers have the possibility to choose ToU or dynamic tariffs that reflect the variability on the market or network, they can adapt their behaviour (through automation or personal choices) to reduce energy expenses. Renumeration for the prosumer is mostly in the form of savings on the electricity bill. From the above mentioned cases the LM structures illustrated in **Figure 6-7** are implemented.

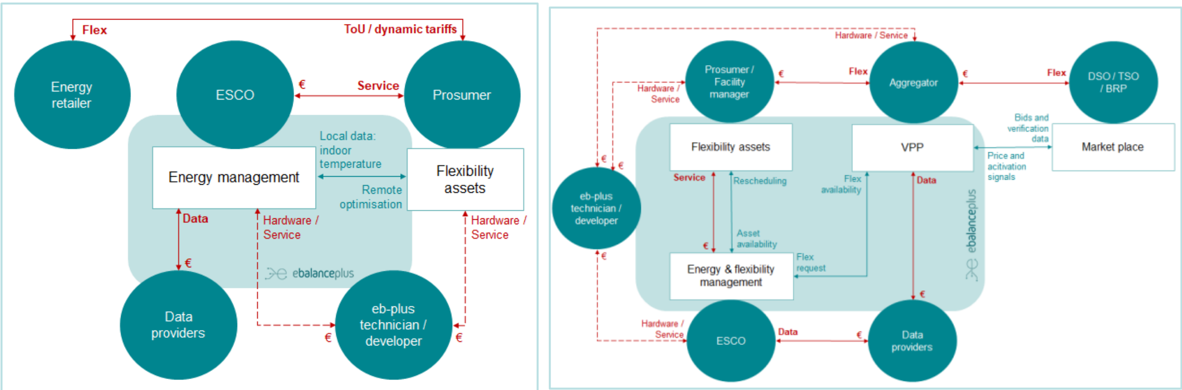

Figure 6-7: Ebalanceplus **LM structure** (Ebalanceplus Deliverable D1.2) – 1) Flex based on implicit demand flexibility: using ToU or dynamic tariff; 2) Flex based on combined EE and explicit DR

LM implementation barriers

Merlon: The principal barrier investigated is the national legislation that does not enable the validation of flexibility marketplaces targeting DSOs, giving rise to the the impossibility of the DSO to procure flexibility.

Platone: The no standardization on the definition of flexibility resources (in the area of flexibility) stand as a barrier to harvesting the full potential of the active participation of customers, aggregators and Energy communities into the electricity market. The missing flexibility markets stand again as a barrier limiting the potential of the business case for storage. The lack of a business case allows, in principle, the DSOs to own and operate storage for a time limited to when the business case is possible. The uncertainties regarding the reward of such investment appears to be a barrier for DSOs to kick-start this deployment. The energy transition will require great investment into the DSO grid to integrate the new technologies. So, the principal barriers individuated are: regulatory and technical.

CoordiNet: Some preliminary barriers have been collected:

- A national, regulatory framework which truly supports the procurement of flexibility by DSOs via markets from all types of grid users is currently not available yet, although first steps have been taken (see above).
- There is no framework yet to incentivize and adequately remunerate DSOs to procure flexibility. Financing of grid operators must support the use of flexibility.
- There are market liquidity concerns in case of local DSO markets; Linked to this, the risk that certain FSPs can exercise market power is higher with low liquidity.
- FSPs might be quite risk-averse when participating to these new DSO markets; The inclusion of a capacity product seems an important factor to convince some FSPs to participate in the market.
- Accounting for network characteristics and computation of impact factors will be key to properly remunerate the provision of grid services and might need further investigation.
- The activation of local flexibility can create energy imbalances. To account for this, different alternatives are possible either to have strong coordination with the TSO to account for such imbalances or to counter-activate a bid to keep the balance unaltered. This imbalance risk could also be managed as FSP responsibility. These options should be further investigated.
- Quantifying the amount of flexibility that has been delivered by FSPs is not straightforward, certainly for new types of smaller FSPs, which are very often aggregated. Appropriate measurements and a suitable methodology for baselining are needed.

Interconnect: the barriers encountered at this stage of the project's development for the Italian pilot concern especially the regulation :

- Demand Side Management and Local Flexibility Market are not yet implemented in the Italian network code, but they are highly debated at Regulation Authority and Government levels, as well as in EU-funded research projects
- Local Energy Market: Not yet opened. As in most European countries, trials run by the DSOs are still limited or in a pilot phase.

- Local Ancillary Services Market: not yet opened. The huge development of distributed resources connected to the Italian distribution network requires the institution of a local Ancillary Services Market in the next years.
- Regulatory barriers for load participation to the energy market: access to the balancing market only permitted to generation units bigger than 10 MVA.
- Time of use tariff has been implemented but the design does not give strong incentive to consumers to shift their demand away from the highest peak hours due to the limited price difference.

Ebalanceplus: Different structures can be defined for implementing LMs, but in anycase some barriers and so challenges have to be faced:

- **Regulation**: Actual market regulation is one of the main barriers to local market access for DER, as the access rules are not well defined.
- **Complexities of trading in the LM**: Participating in LMs needs understanding of some requirements such as being familiar with the structure of the LM, rules, and regulations, the ability to estimate the available flexibility, and being an expert in bidding strategies in the markets. Obviously, **most end-users are not qualified in these aspects** and these complexities will create challenges for them to participate in the LM.
- **Evolution of the DSO's role**: Changing the role of the DSO dictates that the ICT infrastructures of the distribution grid should be developed for providing a proper environment to enable data exchange and automatic control between involved LM parties.
- **Conflict of interests between different market players' operations**: Economic conflicts between retailers/BRPs and aggregators; the market rules and therefore the remuneration at the level of each operator are not well defined
- **SOs coordination**: coordination between the operation of TSO and DSOs such that the requirements of both sides for the stable and secure operation of transmission and distribution grids are satisfied;
- **Social acceptance**: The flexibility market concept is based on adapting end-users' loads to the flexibility needs in the grid. While most discussions in this field are concentrated on the technical aspects of procuring flexibility from end-users, end-users' perspective on LFM is not taken into account. Flexibility market designers should pay attention to how end-users see and react to different pricing structures and direct control of their appliances.

6.3 Conclusions

Considering the principal points on which the survey has been developed, the main conclusion of this analysis is that actually the regulatory framework is not prompt to guarantee the technical and economic sustainability of a LM implementation. This is considered the principal barrier for the real-life implementation of LM in many countries of the involved projects.

From the point of view of **the regulatory context**, not all demo countries have existing regulatory requirements for local markets. European regulation is considered as the baseline: Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC; Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (CACM); Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. Limits in terms of power and type of connection network, established by some regulatory framework, represent constraints for economic sustainability of the LM implementation. Based on the collected information, the main regulatory barriers are illustrated in **Table 6-2** for a selection of European countries.

Table 6-2: Actual regulatory context in some demo pilot countries

Country	Regulatory context principal characteristics
Belgium	Current flexibility markets are limited to the high voltage grid where the Belgian TSO (Elia) has access to flexible assets that provide frequency regulation

Germany	Based on a cost-based redispatch system for generators with a nominal power lowered to 100 kW
Greece	The regulatory basis for the DSO to procure DER flexibility for local grid management already exists (as part of the Hellenic Electricity Distribution Network Code), but it has not been implemented yet; Based on bilateral contracts.
Italy	The Authority with the resolution 300/2017/R/eel has promoted pilot projects aimed to initial opening of Ancillary service market to small demand and production units. Legislative Decrees n. 199 of 08/11/2021 and n. 210 of 08/11/2021 for the implementation of the European directives RED II and IEM.
Slovenia	Draft law provides that the DSO shall foster a flexibility market by 2030.
Spain	DSOs can use DER, more specifically DG, to solve congestions in the same way the TSO does. This process, however, is done through the TSO. It applies to units with a capacity of more than 1 MW (the local market will apply to smaller units not included in the existing market).
Sweden	Regional and local DSO procure flexibility without any regulation.

Aiming to achieve a more systematic and efficient deployment of flexible resources for the distribution network management, from the point of view of the **LM framework**, dedicated local flexibility markets have to be developed enabling flexibility to be traded according to open market principles. In such markets, the DSO can constitute the demand side, requesting specific levels of flexibility (e.g. ability to reduce or increase power infeed) at specific locations of the network and specific time periods. Flexible resources constitute the supply side, offering their available flexibility at different price levels. The same concept also applies for the aggregators, where there is an emerging need for establishing marketplaces that will facilitate contractual processes among aggregators and prosumers.
Actually, the interest is focused on the development of dedicated market clearing platforms, blockchain-enabled flexibility markets, DSO local Markets for congestion management and voltage control, local energy communities and P2P markets with dynamic pricing.
The critical issue of DSO-TSO coordination still remains open.
In order to overcome this issue, some projects have designed and implemented **the LM structure** based on a Common Ancillary Service Market, both the DSO/TSO as buyer in the same market, while more projects adopt a decentralized market structure, i.e. a local P2P market or a local DSO flexibility market.

Several delivery mechanisms, in terms of trading and price mechanisms, energy services and LM participants role, can be individuated from the responses analysis as reported in **Table 6-3**.

Table 6-3: List of Market mechanisms, energy services and LM participants roles

Market mechanism	energy services	LM participants role
Contract negotiation	congestion management (capacity and real time)	Procurer (e.g. aggregator, DSO), Resource Aggregator (RA), Aggregator
a closed-gate auction	voltage control (active / reactive power control) (Capacity, Real-time and in emergency)	Grid Operator
pay-as-bid pricing		Producer, Prosumer, Consumer/ End Customer
pay as cleared pricing	controlled islanding	Flexibility Operator, Flexibility Market Operator (FMO), Market operator
Dynamic net usage tariffs	minute reserve, frequency reserve, tertiary reserve	Transmission capacity allocator
Intraday Market Coupling Auction	energy flow balance	Resource Provider (RP)

Capacity Reserve Auction	capacity reserve for balancing purposes	Neutral facilitator for the provision to TSO of global ancillary services provided by BSPs
Guarantees of origin		Platform provider
Over The Counter Trade (bilateral trade)		Community manager
		Supplier
		Balance responsible party
		Balance service provider for distribution resources
		Flexibility Services Provider (FSP)
		Service provider
		Resources owner

Analysing the **Table 6-3** it is evident that the first issue is to ensure that the definitions of delivery mechanism, energy services and LM participants role are consistent with each other and do not differ according to the local context.
Regarding the **LM development barriers**, unfortunately, there appear to be many barriers that hinder the implementation of a LM that is both economically and technically sustainable; the barriers can be classified into: Regulatory and Legislation; Technical, Standardization and other barriers, as reported in **Table 6-4**.

Table 6-4: List of LM developments barriers

Regulatory & Legislation	Technical	Standardization	Other (economic, consumer)
A national regulatory and legislation framework which truly supports the procurement of flexibility by DSOs via markets from all types of grid users is currently not available yet	Local markets may create energy imbalances that need to be properly accounted for and communicated to the TSO	Standardize the voltage level and new safety regulations, in particular for the DC grid	Customer attractiveness, engagement and maintenance of engagement to guarantee the economic sustainability
No framework yet to incentivize and adequately remunerate DSOs to procure flexibility	Installation of the control equipment on the prosumer side	Existing standards for trading electricity in local markets are not numerous and not applicable to all possible use cases of local trading	Liquidity concerns
Properly remunerate the provision of grid services	Integrate new different enabling technologies	The lack of definition of flexibility services and products for DSOs maintains the relation between the DSOs and the stakeholders in a unidirectional exchange	Internal group conflicts which may occur within the community
Different legislative and regulatory framework in different countries, that can hinder the implementation of regional products being	Participating in LMs needs understanding of some requirements such as being familiar with the structure of the LFM, technical rules,, the	Device/product standardization for local flexibility services	Lack of expertise and skills (and motivation) and risk-aversion of citizens to participate in new energy market and regulatory matters which

developed in one specific project	ability to estimate the available flexibility, and being an expert in bidding strategies in the markets.		may jeopardize the creation of a local energy community
Establishment of minimum flexibility bids for participation in energy markets	Conflict of interests between different market players' operations	Unlocking flexibility, through a DSO standard solution for users connected to the distribution grid	Finding a clear business model with incentives large enough for prosumer motivation
Some deviation could arise between the actual flexibility utilization from aggregators and forecasts from the Balance Responsible Parties (BRPs)	TSO-DSO coordination: technical constraints can limit the participation; activation of local flexibility can create energy imbalances; validation of flexibility		Social acceptance of demand response programs
Small market size established by regulatory framework can lead to low revenues, as well as to low liquidity of the local market	Observability and controllability for islanded operation		Behavioural barriers
Regulatory barriers for load participation to the energy market in terms of power	Limited flexibility availability. Overcome of flexibility boundaries and availability constraint		Lack of awareness
Regulatory framework based on the time of use tariff does not give strong incentive to consumers to shift their demand away from the highest peak hours due to the limited price difference	Technical and digital solutions to increase the trust and the transparency in the LM mechanism		Privacy/security measures (GDPR)
Different regulatory frameworks can have a direct and indirect impact on research and innovation and the link is complex and sometimes difficult to demonstrate because various forms of regulation do not have the same impact on the innovation process in different contexts.	Synergy between long-term and short-term market and integration with balancing market mechanism		Permissions needed for data gathering (scaling up)
The regulatory framework of DSOs' responsibilities in the distribution grid should be changed	Risk for gaming between markets		Long and complex prequalification process

One important step of Action 5 has been surely the Workshop "Dynamic Knowledge Sharing on Local Markets implementation" organized in January 26th 2022 (the agenda is depicted in Annex V – Part B). The scope of this workshop has been to provide an overview of the experience related to «local market implementation» developed and tested in the pilots of some European Horizon 2020 projects. It has been a moment of sharing interesting experiences, and in particular of the following lessons learned and opportunities that are of help to formulate the recommendations reported in section 6.4.

Lessons learned:
- Smartification of buildings is fundamental for the LM operation;
- Interoperability should be ensured (open standards, OpenADR);
- Digital tools/solutions (tools for aggregators, retailers, DSOs, and customers) have to be implemented dealing with vulnerable population;
- End-user level requirements (user-centric, friendly UI, prosumer app);
- Definition of KPI to evaluate the performance and so the reliability of the tools and solutions;
- DERs location is crucial (the LM is closely connected to the physical network);
- SOs coordination to improve the impact on the electrical system;
- The flexibility demand and offers borders (i.e. secondary or primary substation) have to be clearly defined ;
- The habits, nudgning techniques to promote behavioural changes.

The opportunities to exploit by accelerating the LM implementation process :
- Further revenues for the users and for the other operators (aggregators, flexibility providers, Sos, retailers…) ;
- New DSO roles: like buyer of flexibility services and local flexibility enabler;
- Correct trade-off between grid reinforcements and the use of flexibility;
- The increase of resources to solve local and system issues, can bring a decrease of costs (market liquidity).

6.4 Recommendations

In this section the main recommendations that result from the information analysis of the surveyed projects to ensure a LM implementation technically and economically sustainable are reported. These recommendations are:

- Act locally (i.e. at the neighbourhood, city level, municipality) for a greater involvement of local authorities to define a regulatory framework that accelerates and appropriately incentivises and does not hinder the LM implementation.
- Involve and engage the citizens and the stakeholders in the first phase of definition and design of LM model; so, finding and animating the users for the participation through larger incentives and benefits for their motivation.
- Standardize the role of LM participants to overcome possible deviation between the different roles (for instance between Aggregator and BSP).
- Evolve the actual regulatory and market framework so that it can: provide the possibility to easily switch between aggregators fostering competition and avoiding customer locking phenomena; reduce the investment of the players (DSO in terms of network infrastructure and the aggregators in terms of measurement technologies and telecommunication on customer); guarantee liquidity and impartiality of the market; alike TSO, enable the DSO to request (locally) flexibility resources (this increases the liquidity of the market and, through the marketplace (third party), its neutrality with respect to the network operators (TSOs and DSOs)); link the revenue from tariffs to the costs incurred by the DSOs in a dynamic manner do not hamper grid investments further.
- Create an incentive system that allows to cover the digitalization investments. Investment in digital technologies by energy companies has risen sharply over the last few years. Digitalisation can facilitate the development of distributed energy resources, such as household solar PV panels and storage, by creating better incentives and making it easier for producers to store and sell surplus electricity to the grid. New tools such as blockchain could help to facilitate peer-to-peer electricity trade within local energy communities. Policy and market design are vital to steering digitally enhanced energy systems onto an efficient, secure, accessible, and sustainable path.

It is recommended to design a practical guidelines document to provide a harmonization of definition of delivery mechanism, flexibility services and products and of participants' role. Moreover, a regulatory framework should thus further evolve to truly support the development of market-based procurement of flexibility by DSOs.

6.5 Next steps

The work developed in Action 5 has been carried out with the aim of examining the past and future direction of European market design and identifying relevant applications and issues and formulate recommendations based on scenarios development looking ahead to future challenges which can be a guide for future projects and maintain the stability of the working group. Further research will focus on the following aspects to be explored in the coming years :

- A regulatory and market framework which truly supports the procurement of flexibility by DSOs via markets from all types of grid users should be established.
- A common database collecting data and information of the best practices in terms of LM implementation that have been successful – a Dynamic Knowledge Sharing Platform to find and share knowledge about the Local Markets.
- An harmonization of delivery mechanism, energy services and LM participants definitions is fundamental to avoid market failure and distortions.
- A business model that assures the customer motivation and so the LM economic sustainability.
- Define a specific digitalization roadmap to support the LM implementation (data management, information flow) to enhance energy management and control capabilities of enabling technologies.

7. Recommendations

<table>
<tr><td>R1.1 (action 1)</td><td>Key Message: The development of standard definitions for what it is understood as a system service, a flexibility product and each product attribute is a minimum requirement for an efficient communication between grid stakeholders</td></tr>
<tr><td colspan="2">Recommendation: To ensure a common understanding and better communication between all stakeholders, when considering system services and flexibility products, they should start with developing definitions for, at least, what it is understood for system service, flexibility product and each product attribute.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: This recommendation supports the development of European data-sharing infrastructure as data transferring and data sharing would only be meaningful if the data being shared is consistent and comparable (i.e. it is based on the same definitions) across different jurisdictions.</td></tr>
<tr><td>R1.2</td><td>Key Message: When developing new flexibility products, it will be necessary to consider the requirements of all grid stakeholders to ensure the product will deliver for all the involved parties (e.g. FSPs, SOs and regulators)</td></tr>
<tr><td colspan="2">Recommendation: System services and flexibility products should be developed in a cooperative way between the different stakeholders to ensure that they deliver for both SOs and flexibility providers. If the product were not to deliver the needs of the SO or it would include requirements that (some/all) FSPs cannot deliver, it would not be possible to develop an efficient procurement of these products.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: This recommendation supports the empowerment of citizens by integrating them on the process for the design of the flexibility products to ensure these products deliver for them, and not only for the SOs.</td></tr>
<tr><td>R1.3</td><td>Key Message: How far to bring harmonisation is an exercise of balancing potential benefits and costs</td></tr>
<tr><td colspan="2">Recommendation: Harmonisation is a range where the decision-maker in each case (e.g. SO, regulators or policy markets) should decide how far to define the attributes and their relevant values. When harmonising or integrating products, it will be important to balance the potential benefits and costs that the process would bring. The benefits could include cost reductions coming from harmonised products or the effect of facilitating the trade of the product between regions (i.e. coordination between these two markets). On the other hand, the costs could take multiple forms including expenses aimed to change the way companies operate their network, the level of knowledge they have about the specific product or costs that would be required to make the two network compatible. These benefits and costs will be case specific and, in some cases, difficult to quantify other than qualitatively. Only on those cases where the additional benefits of further harmonisation overcome the costs it would generate; it would be appropriate to go forward.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: This recommendation will support most of the areas on the digitalisation roadmap since, for example, increasing the harmonisation of products would facilitate the exchange of information between the different jurisdictions once the products are more comparable as well as it would facilitate the comparison of the different products across countries which would facilitate that FSPs and consumers can get empowered.</td></tr>
</table>

R2.1	**Key Message**: Harmonization of the definition of Energy Communities and Streamlining of the morphology of the services provided by an Energy Community
Recommendation: A single comprehensive and consistent definition of Energy Communities can be considered to be missing, while if existed, it would help towards moving the legislative interest from the interpretation of the term, to the important element of the formation of the framework for the provision of services to citizens, their type and conditions that the community must meet to provide them. In addition, novel legislative initiative is required on the issue of the morphology of the services offered, the basic rights that communities have as well as the capabilities that derive from their operation and the provision of these services. In fact, special care should be taken in data protection by updating the rules regarding procedures that will take place within the community.	
Link to digitalisation of energy action plan/policies: This recommendation is in complete agreement with the roadmap for digitization. It supports the focus being given for citizen empowerment, the enhancing uptake of digital technologies for the provision of state-of-the-art services by the Energy communities along with the requirement for enhanced cybersecurity of the energy sector	
R2.2	**Key Message**: Enabling access to funding programs for further development of energy related tools and services to be provided within the Energy communities
Recommendation: A review of the legislative framework is recommended focusing on the gradual implementation of all prerequisites for the establishment of an Energy Community. Furthermore, further legislative actions are needed to cover the operation phase of energy communities, with the institutionalization of funding programmes, but also the reduction of participation requirements to attract investors and support from financial institutions. This way, the necessary resources for the development and testing of innovative tools and services within communities are anticipated to become available.	
Link to digitalisation of energy action plan/policies: This recommendation supports the empowerment of citizens by securing resources towards the development of services to be provided by the energy communities.	

R3.1	**Key Message**: The provision of more intelligent technologies for RSCs and TSOs.
Recommendation: System security is a key aspect of the Power System. On top of the System security hierarchy, the TSOs and their respective RSCs are placed. The provision of more intelligent technologies for these actors is of extremely importance for ensuring European System security. The improvement of the performance of these actors, will have a beneficial waterfall effect that will feed the rest of the electricity system (MV and LV operators, local market operators, RES producers…).	
Link to digitalisation of energy action plan/policies: It is aligned with the digitalization roadmap. The intelligent technologies to be provided to RSC and TSOs rely on a previous digitalization of the main elements of their grids.	
R3.2	**Key Message**: Management of extreme weather events

<table>
<tr><td colspan="2">Recommendation: Due to last natural disasters occurring in 2021 (like floods in Germany or snowfalls in Spain), the management of extreme weather events is of utmost importance. The climate change will mainstream these events and the power systems need to manage their effects in an effective way. In the report it is possible to find how X-FLEX is developing technologies for MV and LV grids and will be of interest to extrapolate its technologies to the TSO level.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: The digitalization of as much historical weather data and the utilization of big data technologies will be essential for the development of new technologies to manage extreme weather events (like events forecast and risk assessment).</td></tr>
<tr><td>R3.3</td><td>Key Message: Cybersecurity must be tackled at every level of the power system</td></tr>
<tr><td colspan="2">Recommendation: To facilitate the management of faults and cyberattacks for the electricity grid. Cybersecurity must be tackled at every level of the power system to improve the power system resilience (taking into account the increasing frequency of occurrence of the weather and man-induced extreme phenomena).</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: Digitalization of the main elements of power systems will need a higher level of cybersecurity in their daily operations.</td></tr>
<tr><td>R3.4</td><td>Key Message: DSOs should be provided with network planning technologies</td></tr>
<tr><td colspan="2">Recommendation: The quick integration of DER into the power grids must be considered by grid operators. The DSOs should be provided with network planning technologies to face this expansion. These technologies will also facilitate the establishment of local flexibility markets.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: In this context, it is important to provide more advanced digital technologies for DSOs, but also to small and medium prosumers in order to facilitate their management on the management of their new energy sources/storage.</td></tr>
</table>

<table>
<tr><td>R4.1</td><td>Key Message: the "one-fit-all" approach is not fruitful for designing the flexibility mechanisms to be adopted in a particular context (e.g. due to specificity related to the interested country, power system, grid, or area).</td></tr>
<tr><td colspan="2">Recommendation: Flexibility mechanism design must consider the specificities of system services, the products to be procured (see also recommendation R1.3), and the characteristics of the context. Principles such as economic efficiency, transparency, equity, implementation concerns, customer engagement and reliability should guide the flexibility mechanism design and integration. The effectiveness of the design choices has to be evaluated case by case based on KPIs to capture the broad spectrum of economic, technical, regulatory, societal impacts and their allocation across the actors of the electricity sector.</td></tr>
<tr><td colspan="2">Link to digitalisation of energy action plan/policies: This recommendation relies on the empowerment of citizens since tailored flexibility mechanisms should be based on a consumer-centric approach that ensures the highest social acceptance, also by preserving data confidentiality. Different flexibility mechanisms have diverse</td></tr>
</table>

digitalization requirements in terms of network observability, controllability, and data sharing among actors (i.e. the adoption of a fragmented market model implies lower digitalisation requirements than a common market).	
R4.2	**Key Message**: Good practices for coordinating the phases (i.e., from prequalification to settlement) of different flexibility mechanisms part of the same market architecture are required to obtain efficient electricity markets.
Recommendation: Flexibility mechanisms with coordinated market phases contribute to the overall electricity market efficiency; hence, the design of the future electricity market architecture must maximise the coordination of flexibility markets phases. For example, a flexibility register shared among flexibility mechanisms will enhance interoperability, market liquidity, Furthermore, a settlement phase coordinated among flexibility mechanisms will reduce the number of transactions. Both examples mentioned contribute improving the economic efficiency of the overall market architecture.	
Link to digitalisation of energy action plan/policies: This recommendation supports the development of a European data-sharing infrastructure accessible to all eligible market actors allowing increasing market integration, common processes and, thence, market effectiveness.	
R4.3	**Key Message**: Flexibility mechanism coordination and market integration require technical and digital solutions to foster liquidity by preventing gaming and frauds.
Recommendation: Further efforts are required from the regulatory and technical perspective to define market structures, participants' roles and responsibilities, and digital tools which foster transparency and avoid market distortions by design. Demonstration activities with multiple stakeholders are needed to support the regulation evolution identifying the role boundaries in the real world. Novel and robust digital tools (e.g., market platforms, energy management systems, ICT infrastructures and solutions) are required to implement secure flexibility mechanism enabling the services necessary for the future customer-centric electricity system.	
Link to digitalisation of energy action plan/policies: This recommendation relies on the required enhanced cybersecurity of the energy sector; due to the high digitalisation level of electricity markets and their close relationship with power system operation, the security of the power system is intertwined with the security of the digital market platforms and support fraud detection and the markets integration through interoperable platforms.	

R5.1	**Key Message**: Act locally (i.e. at the neighbourhood, city level, municipality) for a greater involvement of local authorities and customers.
Recommendation: Involve and engage the citizens and the stakeholders in the first phase of definition and design of LM mode providing information on the purpose, on the economic and environmental benefits, on the method of implementation, on what the interaction will be; so, finding and animating the users for the participation through larger incentives and benefits for their motivation.	

Link to digitalisation of energy action plan/policies: This recommendation relies on the digital tool/solutions (i.e. web-application, collaborative platforms, virtual workspaces, living-lab) implementation that facilitate access for all actors (for aggregators, retailers, DSOs, and customers).	
R5.2	**Key Message**: Evolve the actual regulatory and market framework, considering best practices with respect to harmonisation and market organisation (see also R1.3 and R4.1).
Recommendation: (1) provide the possibility for end consumers to easily switch between aggregators fostering competition and avoiding customer locking phenomena; (2) reduce the investment of the players (DSO in terms of network infrastructure and the aggregators in terms of measurement technologies and telecommunication on customer); (3) guarantee liquidity and impartiality of the market; i.e. increase the liquidity of the market through the marketplace (third party) and ensure its neutrality with respect to the network operators (TSOs and DSOs); (4) link the revenue from tariffs to the costs incurred by the DSOs in a dynamic manner**.**	
Link to digitalisation of energy action plan/policies: The digitalisation can facilitate the development of distributed energy resources, such as household solar PV panels and storage, by creating better incentives and making it easier for producers to store and sell surplus electricity to the grid. New tools such as blockchain could help to facilitate peer-to-peer electricity trade within local energy communities. Policy and market design are vital to steering digitally enhanced energy systems onto an efficient, secure, accessible, and sustainable path. The possibility for end users to easily switch between aggregators should be supported by making the consumer-data accessible (after consent of the consumer) to the relevant market parties. This recommendation relies on the development of a European data-sharing infrastructure accessible to all LM operators to support and accelerate the LM implementation (data management, information flow) to enhance energy management and control capabilities of enabling technologies.	

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Annex I – Part A Questionnaire template answered by Action 1 projects

Questionnaire for BRIDGE - WG Regulation - Action 1 - Product Design

As part of the BRIDGE Regulation Working Group Action 1 aims to work on flexibility product design and harmonisation with a special emphasis on **congestion management and voltage control services**.

In this context, your responses to this questionnaire aim to collect information about the **flexibility products** being considered in your H2020
project.
The questionnaire is divided into 4 sections: General information; Congestion management products, Voltage control products and the Harmonisation process. Please fill in the information of these 4 sections.

For any doubt you may have regarding the questionnaire, please write to:
- Fernando Dominguez - fernando.dominguezziniguez@vito.be
- Catarina Augusto -
catarina.augusto@edsoforsmartgrids.eu
The information collected will be used for the analysis on the BRIDGE Regulation Working Group and will be included on this WG's final report of 2021-2022. Therefore by answering this questionnaire you are allowing us to use the information shared in the mentioned
report.
Thank you for your collaboration.

Background information

Name of the project	
Starting date	
Finishing date	
Name of the person answering	
E-mail	

Definition of system services and flexibility products

To facilitate completing this questionnaire we are using the OneNet project definitions of system services and flexibility products. These definitions could be adapted to reflect other projects

System service is defined as the action, generally undertaken by the network operator, which is needed to mitigate a technical scarcity or scarcities that otherwise would put the stability of the operations of the network at risk.

Flexibility product is a **tradable** unit that the network operator acquires from flexibility providers and that entails the option to deliver a service in case of activation (this activation can be automatic). The characteristics of the technical scarcity mitigated by the relevant service will determine the attributes of the tradable unit.

Are these definitions of **system services** and **flexibility products** in line with the definitions used in your project? If not, please provide alternative definitions.	

Congestion Management products

OneNet Project Example

Name of the product	Corrective local active
Description and expected use of the product	This product would be used to react with active power to an unexpected incident that requires correction in less than one hour (i.e., FAT should be under one hour). This product will include information about the location of the flexibility.
Main attributes of the product:	Capacity/energy
	Location required (Y/N)
	Maximum full activation time
	Minimum required duration of delivery period
	Maximum deactivation period
	Maximum recovery period
	Maximum number of activations (per day, week…)
	Required mode of activation
	Minimum quantity
	Divisibility (Y accepted / Y required /N)
	Granularity
	Maximum and minimum price
	Availability price (Y/N)
	Activation price (Y/N)
	Symmetric/asymmetric product (Y/N)
	Aggregation allowed (Y/N)

Your Project Products:

[please add the additional columns as required]

Name of the products	

Description and expected use of the product	
Main attributes of the product	

Voltage Control products

OneNet Project Example

Name of the product:	Corrective local reactive
Description and expected use of the product:	This product would be used to react with reactive power to an unexpected incident that requires correction in less than one hour (i.e., FAT should be under one hour). This product will include information about the location of the flexibility.
Main attributes of the product:	Capacity/energy
	Location required (Y/N)
	Maximum full activation time
	Minimum required duration of delivery period
	Maximum deactivation period
	Maximum recovery period
	Maximum number of activations (per day, week…)
	Required mode of activation
	Minimum quantity
	Divisibility (Y accepted / Y required /N)
	Granularity
	Maximum and minimum price
	Availability price (Y/N)
	Activation price (Y/N)
	Symmetric/asymmetric product (Y/N)
	Aggregation allowed (Y/N)

Your Project Products:

[please add additional columns as required]

Name of the product	

Description and expected use of the product	
Main attributes of the product	

Harmonisation or standardisation of flexibility products

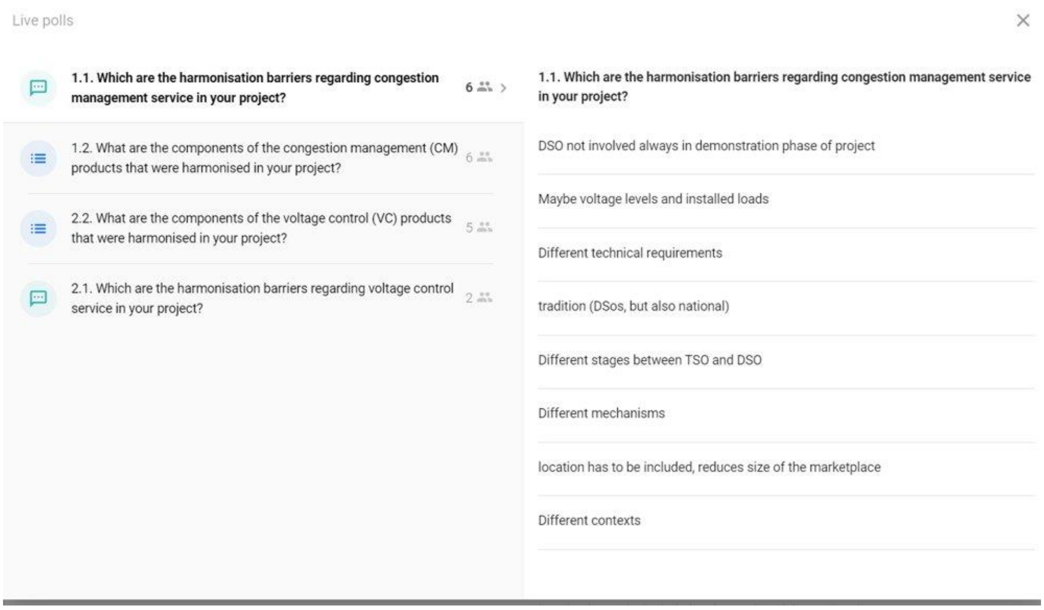
To facilitate completing this questionnaire we are using the following definitions for harmonisation and standardisation. These definitions are based on OneNet project, but they could be adapted if required.	
Standardisation: no divergence is allowed in the list and values for an attribute (i.e. one set value allowed) **Harmonisation:** limited divergence is allowed for the list and values for an attribute (i.e. a range of values allowed)	
Did your project undertook (or will undertake) a **process to either develop harmonised/standardised products** (i.e. reduce the variability across the relevant parameters of a number of products)?	
If yes,	
Please describe the **process used to define** the **relevant products**, the **relevant parameters** and the **values for those parameters**	
Methodology for products harmonisation/standardisation	
Did you developed a **methodology to develop harmonised products**? If yes, which one? Please provide a description of the methodology.	
If you did not developed a new methodology in your project, please provide a description of the methodology used, if the case.	
Harmonised/standardised products' attributes	
Did you identify a list of attributes for each product?	

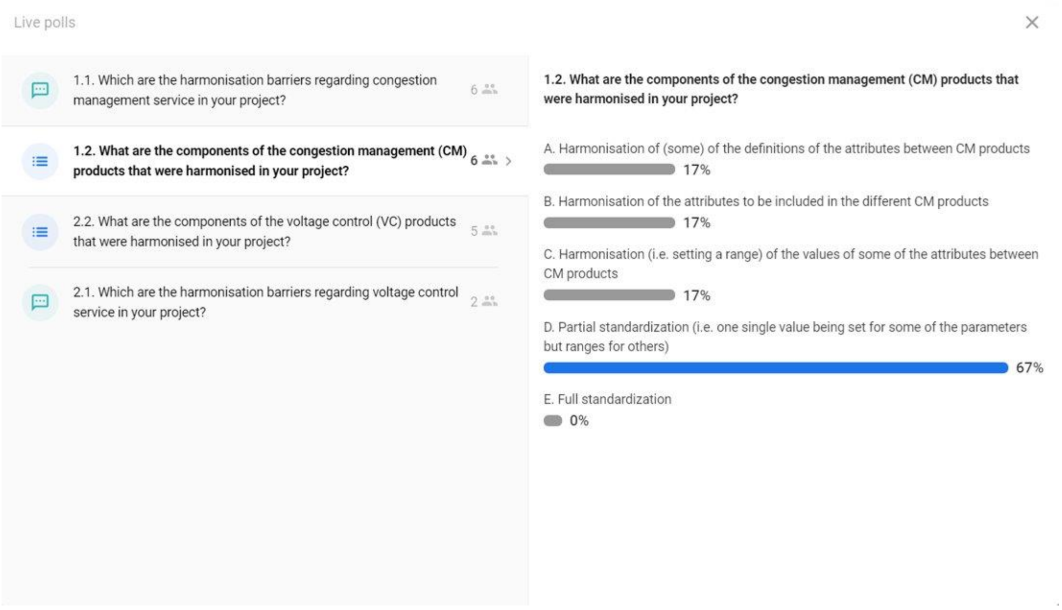
Annex I- Part B: Slido results from 2nd Worshop

Action 1 – Product Design 2nd Workshop – 22/11/2021

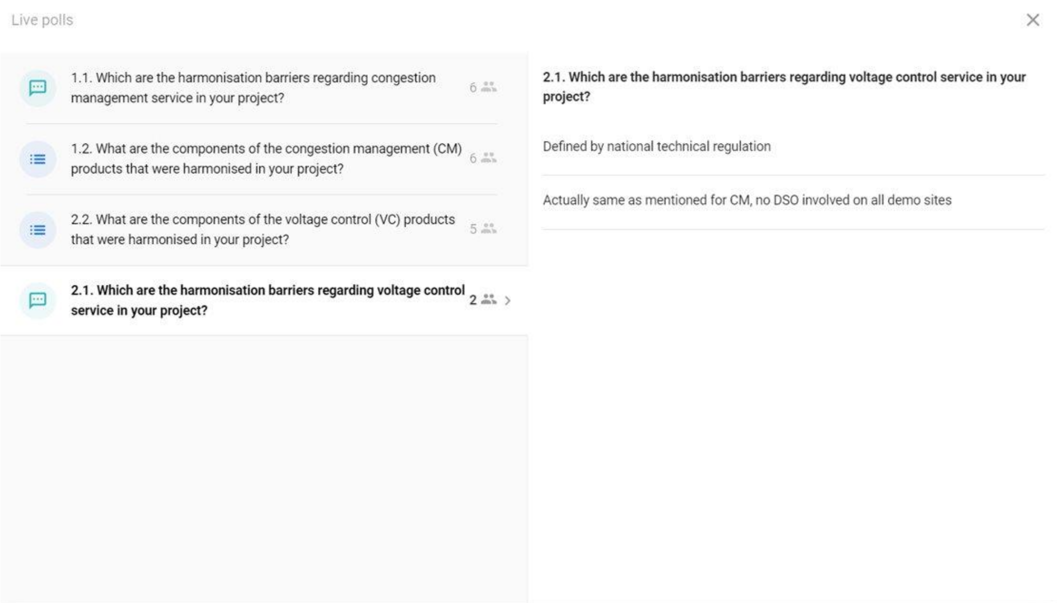
Answers from the survey made during the workshop focus on flexibility products harmonisation. The workshop counted with the participation of XX. Slido was the tool used to collect the information of the live survey as support of the discussion.

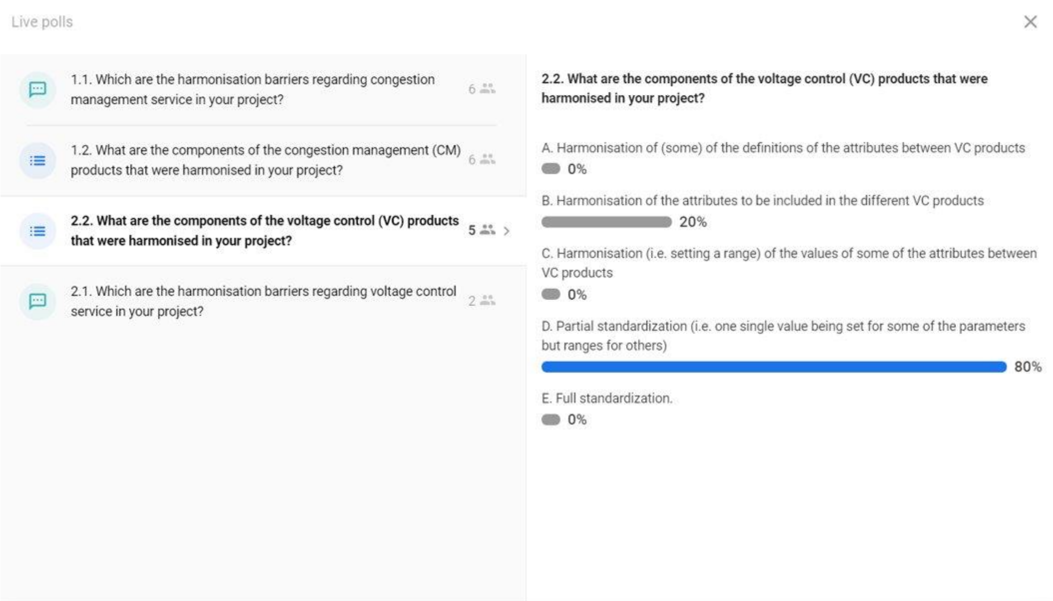
Congestion Management' Products Harmonisation:





Voltage Control' Products Harmonisation:





Annex II – Questionnaire Template shared to the Action-2 projects

Input Data Sheet

This questionnaire aims at assessing the current state of service provision by the Energy Communities related to the H2020 Bridge Initiative projects pilot demonstration activities. Projects are also encouraged to provide information about use cases they are investigating as background research as part of their work towards designing and developing the service provision elements for their energy communities. This is the first part of the research that will be conducted for this action under the Regulations WG activities for the period 2021 – 2022.

Name of the Project:	[Project Name]	
Project Start – Finish Dates:	Start mm/yyyy End mm/yyyy	
Pilot Activities Period	Start mm/yyyy End mm/yyyy (duration mm months)	
Project Description:	[Provide a short description of the project overall goals and the related to energy communities activities]	
Demo Sites (country):	[1. Pilot demo site name, Country, Stage (early or middle or Late or Finished)]	
Project Contact person for this action	Full Name:	
	Email:	
	Project website:	

Demo No. 1 Information Card [For each one of the Demo sites indicated above, where Energy communities are investigated]

Demo Name	Demo site name, Country

Demo Description	Demo information (population, households, RES capacity, Use cases etc.)
Energy Community Organisation Structure	Information about the following sub sections: • organisational model • purpose • how can someone participate • its decision-making bodies and • how it is controlled (which is the responsible authority / how it is controlled)
Energy Community Legal Structure	Please state the legal structure if the Energy Community of reference; choose from the following options: • Energy cooperatives • Limited partnerships • Community trusts and foundations • Housing associations • Non-profit customer-owned enterprises • Public-private partnerships • Public utility company • Other [state the structure type]
Legal Framework applied	Provide an overview the National Regulations followed by the Energy Community
Business Model	Provide information about the business model used [if related info available]
Services Provision by the energy Community (current State)	e.g. related to production, storage, sharing of self-produced renewable electricity (provide some short description) / Benefits description
Social Benefits **(current State)**	e.g. Indication of the social benefits that LEC can also bring: • Local value (energy independency, reduce carbon emissions, creation of local jobs…) • Energy citizenship and democracy • Generating financial returns to community (associated to Business Model part) • Education and mobilisation of citizens • Social cohesion (provide short description)
Services Provision by the energy Community (Ideal State)	Provide information about services that have been proposed for application, but end up not being provided in the country of the pilot due to any kind of barriers (note the type e.g., regulatory barriers (if any)
Institutional and Regulatory barriers	Provide information about the barriers that are faced due to the current regulatory framework applied in the country the energy community is established

Regulatory recommendations	Provide suggestions for changes at a regulatory level towards safeguarding the energy community's smooth operation
Consumer Feedback*	Provide information/feedback received by the consumers that are users of the services provided
Photos	Include some photos of the demo and maybe by the processes related to the services provided as part of the Energy community activities

***** Consumer Feedback will be provided if available at this stage

Annex III – Questionnaire Template shared to the Action-3 projects

BRIDGE Initiative, WG Regulations, Track 2 survey – PROJECT_NAME

Short description of the project (no more than 2 pages):
• **Web site address,** • **Main objectives and scope of the project,** • **Short description of the products and scenarios,** • **Structure of the project (figure describing connection between innovation challenges, objectives, work packages and products),** • **Project achievements and outcomes.**
Connection between the project and Track 2 topic System security (no more than 2 pages):
• **Describe how your product/module/use case is related to this topic,** • **Define maturity of the product/module/use case related to this topic (L1 – defined only concept, L2 – development phase, L3 – preliminary demonstration done, L4 – final demonstration done, L5 – KPIs available),** • **Explain how your product/module/use case improves this topic on EU level,** • **Underline which deliverables could support previous claims (include links if they are online),** • **Conclude with lessons learned and potential innovation regarding this topic.**
Connection between the project and Track 2 topic Network planning (no more than 2 pages):
• **Describe how your product/module/use case is related to this topic,** • **Define maturity of the product/module/use case related to this topic (L1 – defined only concept, L2 – development phase, L3 – preliminary demonstration done, L4 – final demonstration done, L5 – KPIs available),** • **Explain how your product/module/use case improves this topic on EU level,** • **Underline which deliverables could support previous claims (include links if they are online),** • **Conclude with lessons learned and potential innovation regarding this topic.**

Annex IV – Questionnaire for flexibility mechanisms

Flexibility mechanisms definitions

Obligation The obligation mechanism represents a non-market solution in which third parties are obliged to provide the system service when required by the system operator and without any remuneration. It is a non-market-based mechanism.

Cost-based Within a cost-based mechanism, the service providers are remunerated for the actual cost of providing the service. In general, cost-based mechanisms require auditing the providers' costs and defining an adequate margin for providers' return. It is a non-market-based mechanism.

Dynamic network tariffs The dynamic network tariffs mechanism is characterised by the differentiation of network tariffs on temporal and spatial bases. Consequently, the third parties provide system services by adapting their electric behaviour according to the received price signal. It is a non-market-based mechanism.

Flexible access and connection agreements The flexible access and connection agreements (or dynamic grid connection agreements) concern the formalisation of an agreement between the system operator and the service provider. Flexible connection means that the power exchange at the network interface can be reduced according to the grid operator's needs. Generally, flexible access and connection agreements are reached for new connections. The flexible access and connection agreements mechanism is a non-market-based mechanism.

Bilateral contract The bilateral contract mechanism involves achieving a binding agreement between two parties, the TSO or DSO and the service provider. The contract states the agreed terms for the service provision defined during the bilateral negotiation process. Generally, the bilateral contract mechanism is implemented for existing connected resources and constrained situations. The bilateral contract mechanism is a market-based mechanism.

Flexibility market The flexibility market mechanism concerns the definition of a marketplace dedicated to the exchange of flexibility. Flexibility markets consist of an auction procedure characterised by a tendering process in which the sellers offer their flexibility by submitting bids. The related market can be local or system-wide according to the type of flexibility traded. The flexibility market category, considered for the project survey described in this section, includes both the auction and exchange market mechanism, as defined in section 3.1. Flexibility markets are auction markets characterised by the presence of a unique buyer or few buyers (e.g., TSO, DSO, FSP, any other commercial party) and multiple sellers (e.g., FSPs and any other commercial party). Flexibility markets are exchange markets if exist a centralised market where the bids specify price and quantity or a supply or demand curve and price negotiation is not possible since many buyers and sellers participate; thus, a market operator is involved. The flexibility markets that have been of interest for the reviewed projects have a monopsonistic and weak oligopsonistic structure [25]. In monopsonistic markets, the sellers offer their flexibility to a unique buyer (the TSO or the DSO), while in the weak oligopsonistic markets, the buyers are few (in general, the TSO and DSO, or a system operator and several FSPs) [25]. The flexibility market mechanism is a market-based mechanism.

Questionnaire

The present questionnaire is part of the BRIDGE Regulatory WG - Track 3: market integration - Action 4: link between different flexibility mechanisms.

The objective of the Action 4 is fostering the knowledge sharing among the H2020 projects to:

1. Define flexibility mechanisms

2. Analyse the relevant design elements of each mechanism

3. Improve the understanding of the links between different flexibility mechanisms
4. Present the evaluation /suitability of multiple mechanisms
5. Make recommendations from lessons learnt of the project results

This questionnaire aims at gathering the necessary information to map the set-up of the market mechanism concepts among the H2020 projects. Within each project, the different demos approach different scenarios, methodologies and designs, therefore it's expected for the market design of the different demonstrations to be in a non-identical development phase.

We are aware that the different projects have a different level of deployment, therefore some mechanisms would be not deployed yet. In this regard, we would like to collect your answers considering what is expected when your project will be completed.

- Please highlight the answers related to aspects **not yet deployed but already fixed with an asterisk (*).**
- In case some aspect is not already defined yet, please provide the preliminary thoughts **highlighting these answers with the dollar symbol ($)**.
- In the cases in which preliminary thoughts are not available yet, please answer to the corresponding question stating: **Not Defined Yet**.

This questionnaire is intended for demonstrators. Therefore, for each project:

1 demonstrator: 1 questionnaire

To answer this questionnaire, a defined market structure should be already defined. If this is not the case, please provide additional information, in the section 1 of the questionnaire, regarding:

- If the scope of the demo foresees the definition of a market design.
- When will the market design be ready?

For any doubt you may need regarding the questionnaire, please write to:

José Pablo Chaves Ávila: jose.chaves@iit.comillas.edu

Matteo Troncia: matteo.troncia@iit.comillas.edu

Joao Falcao: Joao.Falcao@edp.pt

By answering to this questionnaire, you agree that the data you provide here can be used by the BRIDGE initiative for the related activities and to communicate with you. The data you provide will be used in compliance with the GDPR, data protection principles in Regulation (EC) 2016/679. We do not sell, trade, rent or otherwise share your Personal Information with third parties without your consent. The full text of the BRIDGE privacy policy is available at this link: www.h2020-bridge.eu/privacy-policy/. If you have any questions regarding the Privacy Policy, or wish to withdraw your consent for the continued collection, use or disclosure of your Personal Information, please contact us by sending an email to admin@h2020-bridge.eu

For each question please provide the links to the references regarding the deliverables that describe the adopted market mechanisms. You can also list them below.
1. .

2. .
3. .
4. .
5. .

	1 – Background information	
Q. 1	Please provide you name and surname	
Q. 2	Please provide your Email address	
Q. 3	Which is your project?	
Q. 4	Which is your organisation?	
Q. 5	Which is the Demo Country?	
Q. 6	Which is the name of your Demo?	
Q. 7	What is the **objective of the demo**? [provide a brief explanation of the main objectives of this demo] *[e.g. Unlock the flexibility of the resources connected to the distribution system to contribute to the congestion management at the distribution level. Local markets in which the DSO is the buyer (of the flexibility services) and the FSPs are the seller (of the flexibility services) will be tested.]*	
Q. 8	Provide your **definition for the market** mechanisms you consider in the demo. Provide a name for the different market mechanism and a brief description of the **key characteristics**.	[e.g. Dynamic tariffs, Dynamic connections, Local flexibility markets, TSO-DSO coordination, cross-border integration]
Q. 9	Have you adopted a **methodology to assess the suitability of the market mechanism** (e.g. with respect to demo context, providers' perspective, economic efficiency, etc.). Is your methodological approach **Qualitative or Quantitative**? Please provide a description and references.	

	2 – Market composition				
Q. 10	**How many market mechanisms** are applied in your Demo?				
Q. 11	What types of procurement mechanism do they represent?	Type/Market mechanisms[4]	Market mechanism 1 [market mechanism name]	Market mechanism 2 [market mechanism name]	Market mechanism 3 [market mechanism name]
		Cost-based (Regulated)			

[4] See the Appendix for definitions

		Obligation (Regulated)			
		Bilateral contract			
		Auction market (1 buyer – more sellers)			
		Auction market (2 buyers – more sellers)			
		Auction market (more buyers – more sellers)			
		Dynamic network tariffs			
		Flexible access and connection agreements			
		Other (please specify)			

	Attribute	***Market mechanism 1***	***Market mechanism 2***	***Market mechanism 3***
Q. 12	Market mechanism name			
Q. 13	Market mechanism type[5]	[e.g. Auction market; Cost-based; Obligation; Bilateral contract]		
Q. 14	Timing of the market mechanism clearing (GTC)	[e.g. Week(s)-ahead, Day-ahead, Intraday; Near-to-real-time]		

[5] See the Appendix 0 for definitions.

Q. 15	Procurement frequency: • More than Annually, • Annually, Monthly, • Weekly, • Day-ahead (daily), • Intraday, • Near to real time (15 min), • Event-based[6]	[e.g. Daily, Intraday, Event-based]		
Q. 16	Market clearing type[7]	[e.g. Discrete; Continuous]		
Q. 17	Remuneration scheme[8]	[e.g. Pay-as-bid, Pay-as-clear, other]		
Q. 18	Service	[e.g. Balancing, Frequency control, Voltage control, Rotor angle stability, Network congestion management, System restoration, System adequacy, Islanded operations, Others]		
Q. 19	Generalised Product procured	[e.g. Active and reactive power availability; Active and reactive power activation]		
Q. 20	Level of spatial granularity	[e.g. Zones at distribution level - Several substations, Zones at distribution level - A substation]		
Q. 21	Voltage Level where resources are located	[e.g. HV, MV, LV]		
Q. 22	Who is the buyer(s)	[e.g. TSO, DSO, Aggregator]		

[6] The procurement will always be called upon at the request of a DSO or TSO, who at any given time considers that it needs the resources distributed in an area of its network to provide some flexibility for the proper management of the network.
[7] Continuous market: in this type of market, a market participant can buy and sell assets at any given time. Traders who react first to a certain trading opportunity have a comparative advantage. Consequently, continuous trading generates incentives for each trader to become marginally faster than the competition.
Discrete market: Market clearing following a discrete auction refers to a frequent batch auction market where the respective market is cleared at discrete intervals (e.g., each quarter-hour) through a uniform auction.
[Source: CoordiNet D1.3] https://private.coordinet-project.eu//files/documentos/5d72415ced279Coordinet_Deliverable_1.3.pdf
[8] Pay-as-bid: each seller receives a payment for the offered good or service equal to the actual selling price asked. Therefore, each accepted bid of the auction is remunerated differently.
Pay-as-clear: all the sellers receive the same unitary payment for the offered homogenous good or service. All sellers are paid according to the same per unit price that is equal to the lowest accepted bid, regardless of the actual selling price asked by each of the sellers.
[Source: EUniversal Deliverable 5.1] https://euniversal.eu/wp-content/uploads/2021/02/EUniversal_D5.1.pdf

Q. 23	Who is the seller(s): • FSP (single resources) • FSP (aggregated)	[e.g. FSP, Aggregator]		
Q. 24	Who is the MO	[e.g. IMO, TSO, DSO]		
Q. 25	Participation in market mechanism for sellers[9]	[e.g. Optional, Hybrid, Compulsory]		
Q. 26	System operators order (for the procurement of flexibility within a market mechanism)[10]	[e.g. Priority for DSO; Priority for TSO; Exclusive use for TSO; Exclusive use for DSO; No priority nor exclusivity for TSO and/or DSO]		
Q. 27	Please motivate your answer			
Q. 28	Methodology to represent the grid[11]	[e.g. Comprehensive grid data, Partial grid data, Empirical rules]		
Q. 29	To which market mechanism is this one linked to? Fill each cell corresponding to a market with the name of the linked market, as in the example.	[market mechanism nº 2]	[market mechanism nº 1]	[no one]
Q. 30	Link type (Which links between different flexibility mechanisms are explored and how these links are defined)	[e.g. explain the link between the tariffs and local flex markets]	[e.g. explain the link between the tariffs and local flex markets]	

Market mechanism evaluation		
Q. 31	Which are the recommendations and lessons learnt regarding the implementation of **each single market mechanism?** Moreover, highlight which of the provided answers concern not yet developed aspects, preliminary thoughts, possible alternatives.	

Market mechanisms coordination

[9] **Optional**: sellers are free to choose if participating in the market or not **Compulsory**: the sellers are obliged to participate in the relevant market (e.g. obliged to submit bids) **Hybrid**: some principle exists that may oblige a seller to participate

[10] Priority means that the one system operator is the one that choose first. Exclusive means that there is only a buyer. [Source: OneNet Deliverable 3.1] https://onenet-project.eu/public-deliverables/

[11] Comprehensive grid data (e.g. power flow calculation), Partial grid data (e.g. use of sensitivity indexes), Empirical rules (e.g. ZIP codes) [Source: OneNet Deliverable 3.1] https://onenet-project.eu/public-deliverables/

Q. 32	Have you implemented the different market mechanisms **independently**? Which ones?	
Q. 33	Have you implemented the different market mechanisms in **combination**? Which ones?	
Q. 34	Which are the **recommendations and lessons learnt regarding** the implementation **of the market mechanisms?**	

Final Information		
Q. 35	Please provide **general comments** in case of additional clarification required. Highlight which of the provided answers concern **not yet developed aspects**, **preliminary though**ts, **possible alternatives**.	
Q. 36	For each question **please provide the links to the references regarding the deliverables that describe the adopted market mechanisms**. You can list them below.	

Annex V – Part A: Questionnaire shared to the projects participating in Action-5

General Information

Name		**Organization:**	
Project Title:			
Project Website:			

1. Regulatory context and LM framework
Provide some short description about the policy and the regulatory context for Local energy market and the proposed LM framework developed in the project

2. Ownership
Provide some short description about type of ownership is provided by the regulatory scheme and which has been implemented.

3. Delivery mechanism
What trading and price mechanism can be implemented and/or have been implemented?

4. LM size and structure
Provide a short description about the LM size and structure proposed or implemented and how the regulatory framework has determined it.

5. Energy services in LM
What and how energy services can be implemented by the regulatory scheme?

6. Role of LM participants /actors
What is the role of each participants/actors?

7. LM barriers
What LM development barriers (type technical, economic, environmental, policy and regulatory and so on) have been analyzed/encountered and how they have been faced

Annex V – Part B: Agenda of the Action-5 Workshop on January 26th 2022

bridge

26th January
3:30 - 5:30 (CET)

Bridge WG Regulation WorkShop – Action 5

"Dynamic Knowledge Sharing on Local Markets Implementation"

3:30 - ***Welcome addresses and Opening Session***
Anna Pinnarelli (University of Calabria – DIMEG)
Project name: Ebalanceplus

3:40 - ***"Value stacking of LES and prosumers' engagement through a local flexibility marketplace"***
Nikolaos Chrysanthopoulos (Imperial College London); *Kostas Tsatsakis* (Suite5)
Project name: MERLON

4:00 - ***"The Local Flexibility Market in the Platone Project"***
Gabriele Fedele (Platone's Technical Coordinator)
Project name: PLATONE

4:20 - ***"Local flexibility markets for DSOs and their coordination with TSO markets - experience from CoordiNet"***
Kris Kessels (VITO), *Carlos Madina* (Tecnalia)
Project name: CoordiNet

4:40 - ***"Facilitating consumer participation into local energy markets"***
Stefano Fava (Innovation Technology Senior Specialist – Unit R&D), *Diana Moneta* (RSE)
Project name: Interconnect

5:00 - ***"Smart-Energy OS for linking flexibility to electricity markets"***
Henrik Madsen (University of Denmark - Department for Applied Mathematics and Computer Science, Technical)
Project name: Ebalanceplus

5:20 - ***Closing session***

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