edgeFLEX

D6.3 v1.0

Engaging with policy makers, with organizations and experts in regulation and standardization - v1

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Abstract

This is the initial version of the deliverable reporting on the outcome of the actions taken by engaging with policy makers, with organizations and experts in regulation and standardization, to support the implementation of edgeFLEX technical solutions in the first phase of the activities of the project.

It provides the preliminary analysis of potential project results from the perspectives of regulation and standardization, related both to the existing regulatory framework, to trends and as a response to technology challenges. Starting from a series of initial proposals to update and complete the regulatory framework from the perspective of the technical requirements generated by edgeFLEX solutions, this deliverable describes the project work plan for regulatory and standards work and the steps taken in the consultation process with the relevant stakeholders.

Keyword list

edgeFLEX Services, DSOs, Regulatory Framework, Standards and Regulations, Stakeholders Consultations, Policy Makers, Ancillary Services, Providing Inertia, Frequency and Voltage Control, ICT, Innovative Solutions, Network Codes, Workshops.

Executive Summary

The evolution of the power sector is a continuous process, with challenges, but also with answers given by the increasingly complex and effective solutions supported by the technological progress. A variety of distributed energy resources and improving computation, communication, and control technologies create an unprecedented degree of choice for DSOs and power consumers, choices that are poorly guided by incentives and other support measures from the perspective of regulations. Through appropriate regulations and policies, we must address both the technical challenges of the adopted technological solutions, as well as the market challenges that may arise, including the potential waiver of certain types of subsidies.

The edgeFLEX project has the goal of combining hardware and software solutions, supported by research activities in different areas to develop new fast and slow dynamics ancillary services, and a new market for trading them to Virtual Power Plants (VPPs) and grid operators. The scenario is to introduce an innovative way to run VPPs offering increased flexibility, thus developing a new sustainable investment model promoting increased investment and penetration of Renewable Energy Sources (RES).

Beyond regulatory and standardization issues to be considered in the general context of new technologies and technological progress, we aim to identify some specific aspects of dynamically controlled VPP solutions to be supported through an appropriate regulatory and standardization framework. In this sense, we follow a process of identification and analysis of all relevant aspects that can support the implementation of edgeFLEX solutions, carried out in close collaboration and based on a permanent dialogue with all stakeholders.

Once the relevant organizations and institutions have been identified to properly support the ongoing consultation process with all stakeholder categories, in the content of this deliverable we also present the plan and strategy for carrying out our work in this direction.

In a first phase, we aim to initially define and address the regulatory issues responding to the technical challenges of edgeFLEX solutions, which will be widely discussed with all categories of stakeholders, to further substantiate and define them as final proposals for completing the regulatory framework.

Also, the objective of this deliverable includes the presentation of the steps already taken and the preliminary consultations on the initial proposals, either we refer to the simple attendance of the consortium representatives in events having a large participation of stakeholders, or at the organization of debates dedicated to the edgeFLEX project in major international events, bilateral consultation meetings, etc.

The "Conclusions" chapter of this deliverable will highlight the effectiveness of engaging with policy makers and with organizations and experts in regulation and standardization in the first year of project implementation. It also includes lessons learned and recommendations on how we should further carry out our specific activity on standards and regulatory assessment for a better impact and completely reaching the objectives of the task.

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1. Introduction

The edgeFLEX project aims at defining a completely new way to offer flexibility to the grid with a new set of slow and fast dynamic ancillary services. We envisage a new market, an expanded role for VPPs, and the ability to enable active participation of small-scale RES and prosumer assets participating in Energy Communities. The standardization and regulation frameworks are an important lever and a source of concrete support actions both to respond to technical challenges and to those that accompany edgeFLEX solutions in a "go to market" process. The permanent dialogue, the exchange of ideas and the synergies thus created with all categories of stakeholders, help us to validate, substantiate and support the adoption and implementation of impact measures through policies and regulations.

1.1 Objectives of the Report

The main objective of this deliverable is to report on how the potential results of the project relate to the standardization and regulatory framework, by engaging with policy makers, with organizations and experts in regulation, standardization, and other stakeholder categories.

This initial version of the report on regulations and policies relevant to the edgeFLEX context has the following specific objectives:

- To provide brief information on the current context of the regulatory framework - "as is".
- To specify the strategy and the plan for carrying out the regulatory, standardization and policy assessment activity within the project.
- To present a series of initial proposals in regulations, especially from the perspective of the technical challenges raised by edgeFLEX solutions.
- To report on the first consultations with stakeholders, especially those organized in sessions dedicated to the edgeFLEX project.

1.2 Outline of the Report

This first version of the deliverable on stakeholder involvement, with a special focus on the regulatory framework, aims to primarily present the strategy and implementation plan of this specific activity within the project.

The introductory chapter of the deliverable specifies its objectives as well as its positioning within the project works, the relationship with other deliverables belonging to the same work package, as well as the relationship and interdependencies with the other work packages.

Chapter 2 refers to the general context of regulations, the current state and trends regarding the technologies related to the edgeFLEX context, as well as to the relevant institutions we have in mind for engaging with policy makers, with organizations and experts in regulation, standardization, and other stakeholder categories.

Chapter 3 of the deliverable defines the initial proposals as assumptions for updating the regulatory framework, especially those related to the technical challenges of edgeFLEX services. The above-mentioned assumptions are representing the starting point and the object of the initial stakeholder consultations carried out in the first year of project implementation and presented in Chapter 4 of this deliverable.

1.3 How to read this document

The project consists of four technical WPs, strongly interconnected, that will carry out the design, implementation, testing and validation of the hardware/software components. WP1 will develop a new dynamic-phasor driven voltage control algorithm for VPPs, while WP2 will investigate new services for frequency control and inertia estimation. WP3 will cope with the relevant ICT solutions and needs to support such new services and will also develop new VPP optimization approaches, based on advanced spatial-temporal models and forecasts. In WP4, the overall architecture, including data flows, communication protocols, and needed interfaces, will be defined as a reference for the field trial implementation. Finally, WP5 deals with the deployment of the edgeFLEX solution in the pilots and in the laboratory trial.

In addition to the technical tasks, WP6 will define the business models conceivable for the turnkey edgeFLEX services alongside with the regulatory and standardization framework assessment, engaging with policy makers, with organizations and experts in regulation, standardization, and

other stakeholder categories, while WP7 will promote and disseminate the results of the project through the organization of dedicated events in close collaboration with WP6.

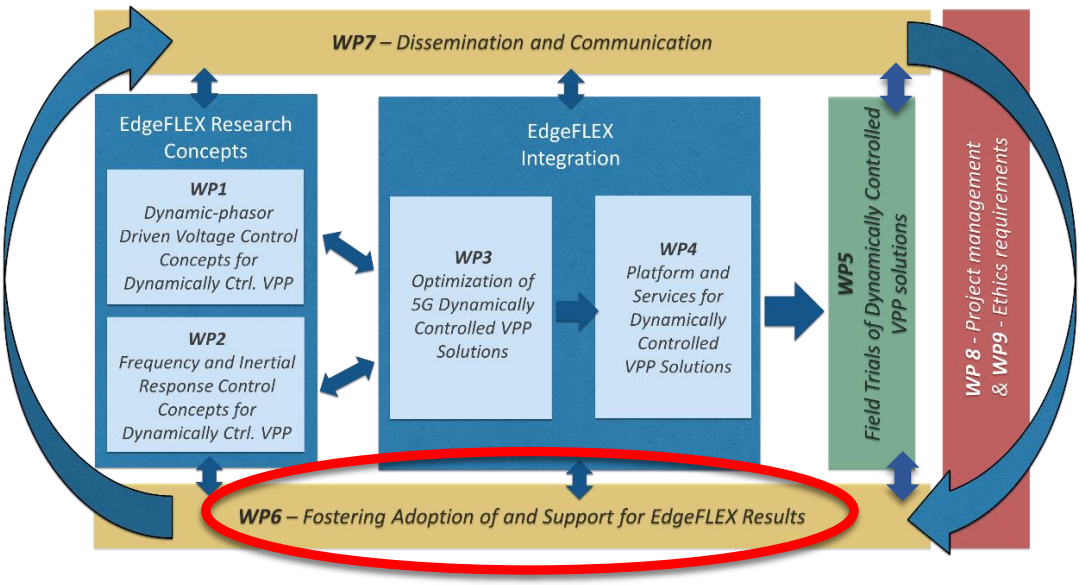


Figure 1.1 – edgeFLEX Work Packages Interconnection

Regarding deliverables, we have the same type of interdependencies and implications, as in the case of the work packages to which they belong.

Specifically, for a better understanding of the work plan and in general of the D6.1 content, the following deliverables are relevant to be consulted in this context:

- D6.5 - A new financing model for RES, to simplify investments in RES beyond subsidy schemes
- D6.1 - Comparative analysis of potential business impact
- D1.1 - Scenario description for dynamic-phasor driven voltage control for VPPs
- D1.2 - Dynamic-phasor driven voltage control concept for current VPPs in large scale deployment
- D2.4 - Inertia estimation concept for low inertia power system
- D2.1 - Scenario description for frequency and inertial response control for VPPs
- D2.2 - Frequency control concept for current VPPs in large scale deployment
- D3.2 - Report on VPP optimization
- D4.1 - Description of edgeFLEX platform design
- D5.1 - Initial report of the phase 1 of all field trials

2. Regulatory and standardization framework assessment – status and trends

To properly support the regulatory and standardization framework assessment approach, we first need to understand the mechanisms of the current regulatory framework, as well as the existing technologies related to the edgeFLEX projects.

2.1 European policy, regulatory and standardization context

In the field of electricity networks there are two main areas:

- Transmission, and
- Distribution.

The power transmission sector is quite advanced on the road to creating a set of common rules and methods at European level for all TSOs from the EU member countries.

The European professional association of the TSOs: European Network of Transmission System Operators for Electricity (ENTSO-E) has been established in 2009, by merging several different organizations and institutions working at that time in different areas (technical aspects, regulatory, market and others) of the power transmission sector, at European level.

From the beginning, ENTSO-E started to implement a sustainable program for developing the regulatory framework and harmonize it at European level.

Each year, the European Commission (EC) draws up an 'annual priority list' of areas to be included in the development of network codes for electricity, with input from a public consultation. The Commission, with further input from the Agency for the Cooperation of Energy Regulators (ACER) and the ENTSO-E, adopts proposals for network codes. The proposals for these network codes are checked by an Electricity Cross-Border Committee of specialists from national energy ministries and then adopted with the approval of the Council of the European Union and the European Parliament, remaining to be implemented by Member States with the EC supervision and help.

Sometimes the new rules are adopted as 'guidelines' rather than 'network codes.' These are adopted under a different provision of the Electricity Regulation but they have the same status – they are both legally binding regulations.

Currently, there are eight network codes in force, grouped in three so called “families”, concerning the activities in the power transmission systems. This is illustrated in the Table 2.1 below, including the status on their adoption and an estimation of the impact level on each code from the edgeFLEX perspective:

Table 2.1 – European network codes currently in force

Network Code family	Network Codes	Status	Impact level of edgeFLEX project on each code
Connection codes	Requirements for Generators	Adopted	Very strong
	Demand Connection	Adopted	Significant
	High Voltage Direct Current	Adopted	Significant
Market codes	Capacity Allocation and Congestion Management	Adopted	Significant
	Forward Capacity Allocation	Adopted	Weak
	Electricity Balancing	Pending	Strong
Operation codes	Emergency and Restoration	Pending	Strong
	System Operations Guidelines	Adopted	Very strong

In the area of electricity distribution, the organizational advances have been more limited mainly because distribution is usually a much more local issue than transmission.

The answer to technical challenges regarding voltage and frequency control comes from a set of ancillary services that are heavily regulated. In a European context, that is even heterogeneous, as previously mentioned with notable differences at the level of national states, especially with reference to voltage regulation.

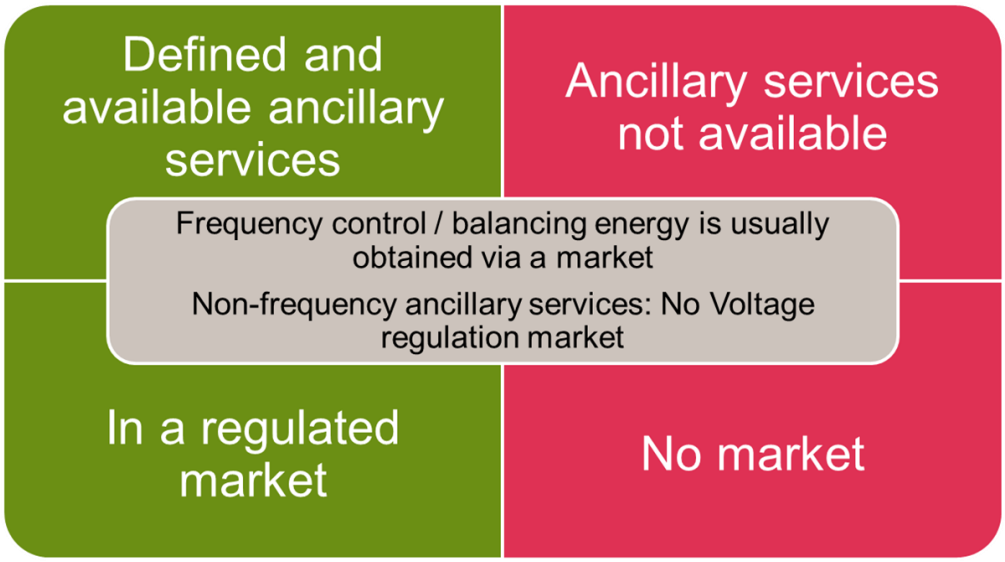


Figure 2.1 - European heterogeneous context regarding ancillary services and markets

In this environment, the regulatory framework concerning the electricity distribution has been developed mainly at national level, reflecting strictly the requirements and characteristics for each country. In Europe, there is a wide range of organizational structures of the electricity distribution activity (service). On one side, for instance, there is only one single company providing the electricity distribution service for the entire country in the Republic of Ireland. On the other side, there are hundreds of DSOs in countries like Germany and France. Obviously, the regulatory framework in the respective countries is developed in accordance with the existing realities and needs.

The lack of regulatory framework harmonization in different countries raises many operational issues especially for the large electricity distribution companies that have subsidiaries in more than one EU member states.

The EC has acknowledged this issue and started a process for improving the organizational aspects by issuing, in 2016, the project: Distribution System Operators Observatory [1]. The aim of this project was to contribute to a better understanding of the challenges that the transition to a new energy system is posing to European distribution system operators and to elaborate solutions to address them.

Based on the results and findings provided by the above-mentioned project and other similar projects, the EC has decided last year to propose the creation of a European professional organization for the DSOs. The proposal was approved by the European Parliament and Council on June 5, 2019. According to that document, the newly created EU DSO entity has the goal to promote the completion and functioning of the internal market for electricity, and to promote optimal management and a coordinated operation of distribution and transmission system [2].

EU DSO is scheduled to be fully operational by the end of 2020. It is foreseen that one of the first priorities of the new organization will be the harmonization of the regulatory framework in the EU member states.

2.2 Trends in technology

New public policies and regulations foster and encourage a parallel focus on technological innovations with a rapid rate of change in the electric power system. The power system advances

towards the goal of supplying reliable electricity from increasingly clean and inexpensive resources, and such a revolution demands a dedicated technological development.

The Internet of Things (IoT) facilitates both grid and customers management, either locally, remotely, or automatically, and enables changes in consumer behaviour and expectations. Today, many customers are increasingly using the grid to balance their own generation and demand, and as a backup supplier when their locally sourced generation is unavailable. More and more, customers are becoming prosumers and they expect to flexibly deliver excess generation back to the grid and be paid for it, without restrictions on their production. However, customers still expect the grid to be available to provide power when they need it. These competing interests have dramatically changed the distribution system operation.

The digital revolution also manifests itself through dramatic improvements in monitoring and control equipment in the traditional power system. Additionally, innovative analysis techniques have allowed more rapid situational awareness to grid operators. With the integration of these emergent technologies, grid operators can communicate (unidirectional or bidirectional) with the power grid. A reliable control strategy will be required to manage the power transactions and the network control in real time, especially considering the dynamic and distributed integration of electric mobility.

From the perspective of people who manage the distribution system, this network advancement poses numerous challenges as well as opportunities. For instance, they need network visibility, for which they utilize an intelligent solution known as Advanced Distribution Management System. This solution provides the necessary intelligence and control required for efficient network management, together with new advanced monitoring and metering solutions, such as advanced Phasor Measurement Units (PMU).

At the same time, large amounts of data are being generated at different segments of the power sector, as it is transformed by the ongoing digital revolution. These data have a potential value for power companies, grid operators, and end users. They can be exploited using big data algorithms for different purposes such as power supply and demand forecasting, state estimation and grid control. Additionally, they can be used to foster participation in electricity markets.

Moreover, in smart power systems, it is expected that a significant part of the electrical appliances will have access in real time to some variables of power grids (e.g., system frequency). In addition to the necessary control of the electrical appliances, such parameters can be useful for supervision algorithms to evaluate if the control signals are consistent with the real operation of the power grids.

This goes also hand in hand with the foreseen development of an end-user centric approach, ensuring the dynamic involvement of consumers along with the awareness of the needs of the power grid. For such purpose, the development of increasingly efficient, autonomous, and resilient technological solutions is required that allow to perform the interface between different systems coupled to the power grids, as well as communication systems that enable end-user involvement in a dynamic way. These communication systems will allow to define periods of utilization for the electrical appliances according to power grid operators and end-user's convenience. They are also integrating monitoring systems, to know in real time the energy transactions (for instance, when the end user is a prosumer) and minimize the inefficient and unnecessary use of the electrical appliances. Moreover, by controlling such periods of operation of the electrical appliances, it will be possible to define control strategies to optimize the utilization of the power grid. For example, the load shift, load shedding, and thermostatic load reparameterization mechanisms encompass the concepts of peak shaving and load levelling.

Additionally, the traditional power system has relied on a large number of synchronous generators to provide voltage and frequency control. The penetration of new forms of converter based renewable energy generators is rapidly increasing. In future power systems with 100% RES generation, the need for power electronics interfaced with generation systems to provide active contributions toward grid stability and security will become essential to the operation of these power systems. The energy transition policy that will be followed in Europe will largely increase wind and PV power by replacing conventional thermal generation. This policy will require services such as frequency containment reserve or the provision of synthetic inertia for the system to operate in a robust and secure manner.

With the expected empowerment of prosumers and emergent technologies (such as blockchain) that enable local trading of renewable energy and flexibility, the design of optimization models and new business models to enable prosumers peer-to-peer (P2P) trading or in small Local

Energy Communities (LEC) is fundamental. In fact, the large-scale integration of Distributed Generation will require the adoption of new concepts such as renewable energy communities, and an interaction with traders/aggregators that will serve as interfacing entities that can bid energy and services at local/regional levels or in the wholesale market.

Finally, the sales of Electric Vehicles (EVs) are expected to increase significantly in the coming years and this growth in EVs places new and important challenges to the grid. These challenges are made harder by the tendency to increase both the capacity (with some passenger vehicles exceeding 100kWh and electric buses and luxury vehicles exceeding 350 kWh) and the rate of charge (such as ultrafast charging). However, these vehicles can also have a positive contribution as they can be used to increase the flexibility of the grid through Grid-to-Vehicle (G2V) and Vehicle to Grid (V2G) operation modes. As a contribution for the electric mobility dissemination, policy measures including financial support schemes are necessary to foster the adoption and development of this new paradigm. However, such financial incentives should be adaptable enough to accommodate the large-scale integration of EVs, as well as the new predictable technologies (e.g., new materials and technologies for batteries, new power ratings for EV battery chargers, EV performance, and new operation modes for the EV besides G2V and V2G, such as Home-to-vehicle (H2V), Vehicle-to-Home (V2H) and Vehicle-for-Grid (V4G)).

2.3 Institutions and organizations relevant to the edgeFLEX regulatory and standardization framework assessment

Currently, there are several organizations dealing with different aspects of the electricity distribution activity, at European level. Among those, the most significant ones are the following:

- **The Union of the Electricity Industry** – EURELECTRIC is the sector association which represents the common interests of the electricity industry at pan-European level, plus its affiliates and associates on several other continents. Currently, EURELECRTRIC has over 34 full members, representing the electricity industry in 32 European countries.

- **European Distribution System Operators' Association** – E.DSO is the key-interface between Europe's DSOs and the European Institutions. E.DSO promotes the development and large-scale testing of smart grid technologies in real-life situations, new market designs and regulation. Starting as a Club of 11 CEOs, E.DSO is now gathering 42 leading electricity distribution system operators (DSOs) in 24 countries all over Europe, including 3 national associations, with a well-established secretariat in Brussels. That represents more than 350 million customers and no less than 7 million kilometers of distribution lines.

- **Transmission and Distribution (T&D) in Europe** – T&D Europe is the European association of the electricity transmission and distribution equipment and services. The scope of the organization includes the complete range of products and services necessary to transmit and distribute electricity in high and medium voltages, between the producers and the end users. T&D Europe members provide all types of smart grid technologies, including advanced, smart systems suitable for interaction with renewable energies and ICT. The companies represented by T&D Europe account for a production worth over €25 billion and employ over 200,000 people in Europe.

- **Agency for Cooperation of Energy Regulators** – ACER was established in March 2011 by the Third Energy Package legislation as an independent body to foster the integration and completion of the European Internal Energy Market for electricity and natural gas. ACER is one of the EU decentralized agencies. Distinct from the EU institutions, agencies are set up as separate legal entities to perform specific technical and scientific tasks that help EU institutions and Member States to implement policies and take decisions. ACER's headquarters are in Ljubljana, Slovenia. EU Agencies also support the cooperation between the European Union and national governments by pooling technical and specialist expertise. By fostering cooperation among National Regulatory Authorities (NRAs), ACER ensures that the integration of national energy markets and the implementation of legislation in the Member States are met according to the EU's energy policy objectives and regulatory frameworks.

- **Council of European Energy Regulators** - CEER was established in 2000 for the cooperation of the independent energy regulators of Europe. It seeks to facilitate the creation of a single, competitive, efficient, and sustainable EU internal energy market. CEER's work complements (and does not overlap) the work of the Agency for the

Cooperation of Energy Regulators (ACER). ACER, which has its seat in Ljubljana, is an EU Agency. CEER is a Belgian non-profit association. They share similar objectives. ACER's focus is on what is required in the legislation and CEER does everything else in energy regulation. CEER's motto is fostering energy markets, empowering customers. CEER's work includes international cooperation, smart grids, sustainability, Demand Side Operators, and customer issues.

- **National Regulatory Authorities** (i.e., Romanian Energy Regulatory Authority – ANRE, Technical Regulator Organization in Germany - VDE/FNN, etc.)

In Europe, standards are developed and agreed by the three officially recognized European Standardization Organizations: **European Committee for Standardization** (CEN), the **European Committee for Electrotechnical Standardization** (CENELEC), and the **European Telecommunications Standards Institute** (ETSI).

3. edgeFLEX work plan for regulatory and standardization assessment and initial proposals

Within the edgeFLEX project, a series of innovative solutions are going to be developed and tested in the trial sites for a more efficient use of the distributed generation capacities. Based on original algorithms, new services have been defined, as well as new approaches to some existing services. However, to fully take advantage of the results and findings of edgeFLEX, some updates of the existing regulatory and standardization frameworks are necessary.

Both regulatory and standardization activities are largely recognized as very “inertial” sectors of activity. In other words, the process for implementing an update is long and requires many stages. Therefore, to achieve results in the short time frame of a project like edgeFLEX, it is necessary to set up an activity planning, and intermediate milestones.

3.1 Work plan and steps taken

The regulatory and standardization assessment along with any other stakeholder consultation actions regarding the specific market and the solutions outlined in edgeFLEX, are supported by continuous edgeFLEX dialogue activity with practitioners, policy makers and regulators. This activity belonging to the WP6 - Fostering Adoption of and Support for edgeFLEX Results relies on a predetermined plan that aimed at the following:

- To understand the position of the stakeholders, the market needs and to correlate them with the activities carried out in the project.
- To support the implementation of the technical solutions and business models proposed by edgeFLEX through the regulatory framework and standardization.
- To obtain external expertise for validation and assessment of the edgeFLEX concepts, use cases and field trials and their implications (main role: Advisory board).

The process of running the consultations with the involvement of all stakeholder categories follows a repetitive path of successive validation and completion, starting from the commercial assumptions and the input received from the technical work packages that conceptualize the edgeFLEX solutions. It aims to identify all challenges of the “go to market” process and the main benchmarks of the regulatory framework applicable to edgeFLEX services, and to make proposals, as shown in the figure below.

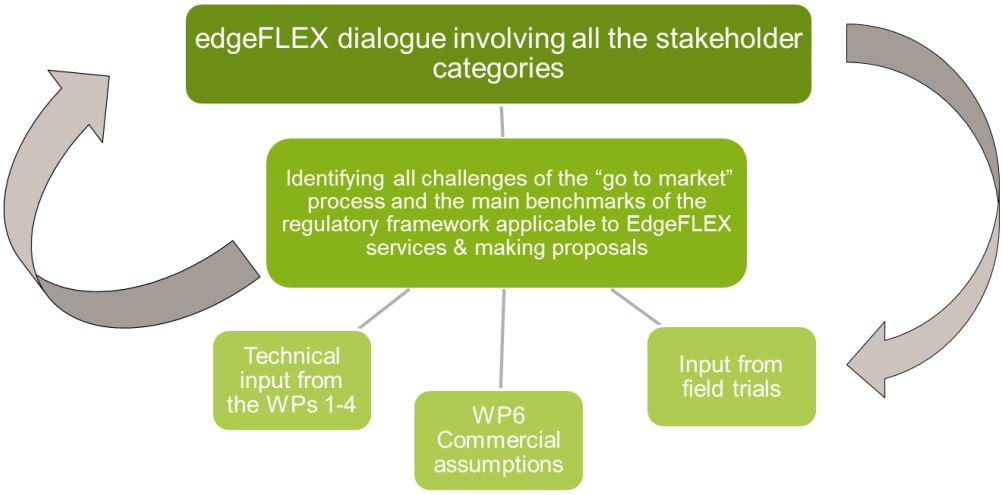


Figure 3.1 - The process of running edgeFLEX dialogue activities

In the first part of the project implementation, our activity focused on addressing the technical challenges of edgeFLEX solutions and their potential impact in regulations. In the next subchapter, we will describe the proposals initially formulated in this regard, that are being already launched in the process of substantiation and validation with stakeholders.

Also, in parallel with the definition of functional and value-added business models associated with edgeFLEX services, we aim to identify the proposals with impact in regulation and standardization from a commercial perspective, of the path of edgeFLEX services to the specific market.

The repetitive approach is especially active in the first phase of the implementation strategy of this regulatory assessment activity within the project, to be able to define a series of final, well-founded proposals, and then in the second phase to go through a series of other necessary steps such as systematic validation with the main stakeholders, and lobbying actions to support the adoption and implementation of proposals both from a technical and commercial perspective.

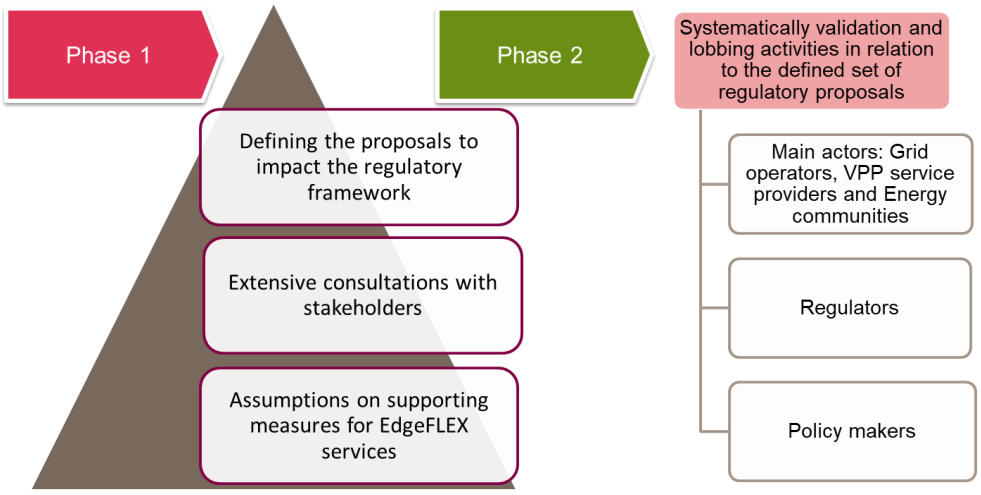


Figure 3.2 - Phases on regulatory framework assessment through stakeholder engagement

3.2 Initial regulatory proposals related to technical challenges

The substantial development of RES-based electricity generation, which we have all witnessed in the last 10 years across Europe, was the basis of relevant changes in the power systems operation. This is a common trend worldwide, but the EU may be considered as the leader in this respect. Distributed electricity generation is having implicitly a major impact on operational requirements, rules, methods, and practices.

In this context, the regulatory framework needs to be updated to provide the proper support to the power network operators, electricity generators, suppliers, and other participants in the operation of the power systems and associated electricity markets. New ancillary services must be defined, and new approaches are required for some of the existing ones. The definition of new components of the electricity markets is identified as necessary, together and in correlation with updates of the existing network codes.

In the following subchapters, the proposals for updating the regulatory framework, based on the initial regulatory assessment within edgeFLEX, are presented. They are subject to consultations with all stakeholder categories for their substantiation and final definition.

3.2.1 New ancillary service – Providing inertia

The replacement of the spinning generators with inverter-based generators has many technical consequences, and one of the most important consequences is the reduction of the power system inertia.

Nowadays, the power system inertia is provided by the kinetic inertia stored in the rotors of the synchronous generators. In case of a perturbation (e.g., a short circuit), the system uses a part of this stored energy by reducing the speed of the rotors accordingly, from all the synchronous generators connected to the grid in that instant, and proportionally with their rated power and electrical distance from the generator to the perturbation location. This wide distribution of efforts helps to maintain the synchronism during the perturbation and after the outage by the protection systems.

The converter-based generators do not have this technical characteristic. Wind turbines have a rotating part but with low speed and reduced mass. Moreover, the connection to the grid is performed using a converter, and there will be no natural reaction to any perturbation in the electricity network.

In these conditions, it is obvious that each replacement of a synchronous generator with a converter-based generator will reduce the kinetic energy stored in the power system. Thus, it will increase the efforts for each synchronous generator to stay connected to the grid and make more and more difficult for them to maintain the synchronous operation after large outages. This effect is called “reduction of power system inertia”. The synchronous generators operating in power systems with low inertia are in danger of losing their stability after an outage. To prevent this, the synthetic inertia needs to be provided by other facilities in case it is needed.

The necessary technical capabilities for providing synthetic inertia have been previously defined and tested in the RESERVE project, and “Providing synthetic inertia” has been proposed as a new ancillary service. This proposal is currently under ENTSO-E consideration. This is a critical measure for allowing increased penetration of RES while maintaining the system stability.

In general, the VPP has a quite complex structure, potentially including wind and/or photovoltaic electricity generation, biomass or/and bio-gas electricity generation, storage facilities, consumption, heat pumping, and others. In these conditions, and with an appropriate coordination of the above-mentioned assets, the VPPs are able from technical perspective to provide synthetic inertia when needed. This potential feature of the VPPs will be further analyzed and tested within the edgeFLEX project.

3.2.2 VPPs – as new participants in the Electricity Balancing Market

The main components of the electricity market are the following:

- the bilateral wholesale market (involving long-term bilateral transactions validated by contracts) [3]
- the day ahead market and/or intraday market (involving stock exchange-type transactions in a time frame of 24 hours or less)
- the balancing market involving stock exchange-type transactions implemented in a time frame of minutes, including two main components: the ancillary services market, and the electricity for balancing.

For a better understanding of the interactions between different markets, please see below a typical (for European countries) daily load curve, as shown in Figure 3.3.

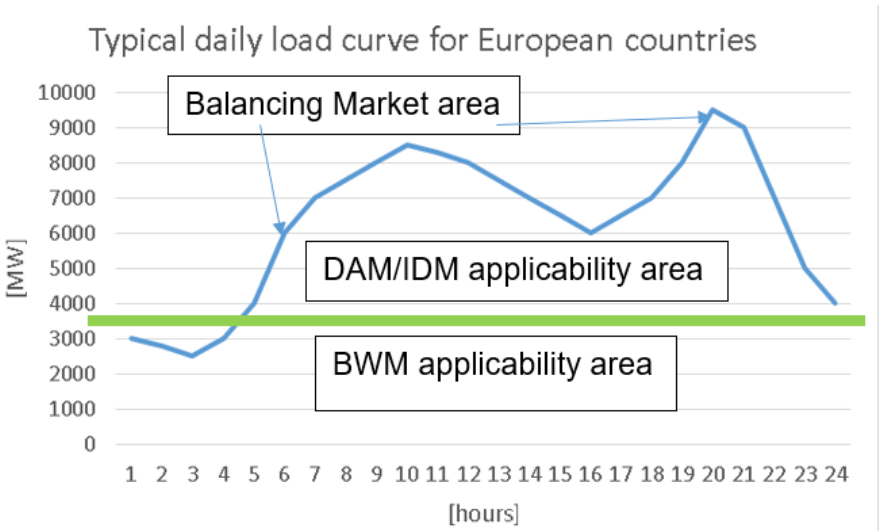


Figure 3.3 - The typical daily load curve and the applicability areas for the electricity markets [4]

Nowadays, the Electricity Balancing Market (EBM) is a very important component of the power systems operation. By the instrumentality of this structure, the power system operators are provided with the necessary tools for controlling the frequency, both in normal operational conditions and in case of outages. This is also critically required to improve the power balance in power systems with high penetration of non-synchronous devices.

Considering the importance of the EBM in current power systems operation, the requirements for acceptance as a participant are very detailed and strict. The status of participant allows the firms to make offers and receive payments on this market. Once a legal entity receives the status of participant on the EBM, its behavior is carefully monitored by the power system operator, which is normally the EBM operator as well. In case the participant is not fulfilling its contractual obligations, the penalties start from financial fines and may go up to the cancellation of the participant status.

Until recently, the VPPs have not been considered reliable enough to be accepted as an EBM participant. However, the developments in the software platforms used for coordination of the VPP's components operation have led to a greater acceptance from this perspective. The findings and results of the edgeFLEX project are aiming to consolidate this acceptance trend and allow the project members to promote VPPs as a valuable participant of the EBM in the power systems where this approach is not yet implemented.

3.2.3 New Voltage regulation market

Currently, the approach for voltage regulation is rather well harmonized among EU member states. The electricity network operators are the only providers of this type of service, and they are remunerated accordingly. The payment is fully regulated, and it is in fact a fixed amount included in the transmission and/or distribution tariff assessed by the national regulatory authority, in order to cover the costs generated by the provision of the service.

The efficiency of the existing system is more and more reduced by the development of the distributed electricity generation, especially in case of LV electricity grids. The continuation of the trend for installing electricity distributed generation, which may be easily foreseen, it is expected to create more difficulties to properly ensuring the voltage control. The solution is to involve other participant profiles, beside electricity grid operators in the process of voltage regulation.

VPPs characterized by a diversified structure (generation, storage, consumption, etc.), scattered over large geographic areas, and with their components mainly connected to LV electricity grid, have the great potential to be a relevant future provider of Voltage Regulation Service. This approach will be further technically analyzed and tested in edgeFLEX, and a proposal for a new market definition will be promoted to the ENTSO-E, ACER, CEER and other relevant similar organizations, for a better harmonization of the implementation at European level.

3.2.4 ICT chapter requirements updates within existing Network Codes

According to Distribution System Operators Observatory [5], "the rapid changes occurring in the distribution segment have brought this sector at center stage of the debate. The increasing penetration of local renewable generation and the emergence of demand response enabling solutions are acting as main transformative forces in the power sector, making the distribution grids the primary recipient of all the new interactions initiated by these numerous distributed units (Glachant, Rious, & Vasconcelos, 2015)." [6]

Distributed energy generation management relies on wireless connections between the generation units' locations and the distribution system control center, which integrates software solutions for data collection and processing to substantiate decisions. The implementation and sustained development of these solutions, which involve a high degree of digitalization, represented the trigger of the requirement to include specific regulations for ICT in the existing regulatory framework at distribution level.

In the specific context of the project, the ICT component is one of the pillars of edgeFLEX solutions, which will act as a powerful enabler:

- It will enable the new technique for voltage stability control in the power grid by connecting a huge number of communication end points in the future.
- It will enable the new technique for online inertia estimation, and provide solutions for synthetic inertia, that will solve the current problems, i.e., decreased system inertia because of penetration of distributed energy sources that do not have inertia. This will be

even more critical in the future and 5G communications will improve the quality of online inertia estimation service by providing superior performance in terms of latency and will ensure data security and integrity.

- It will enable the new technique for frequency stability control that will solve the existing power grid challenge, i.e., to reduce the frequency variance. Frequency control will consider the information gathered from the energy market. 5G will be able to support the stringent communication requirements of the technique that are not possible to meet with 4G.
- ICT, specifically 5G and edge cloud computing, will enable the new concept of low-cost PMU devices that request extremely high sampling data rates and ultra-low latency communications performance.
- It will enable the advanced technique for optimization of VPP operations that will improve current energy market trading. Currently, energy distribution and dispatch are planned in intervals of 1 hour that will be shorten to 15 minutes. Central point of failure will be avoided by service logic deployment in distributed edge cloud.
- ICT will enable the advanced energy flexibility aggregation and trading system, i.e., the new interactions between energy market and DSO fast dynamics techniques that will further improve stability of the power grid. Furthermore, ICT will enable reactive power trading. 5G communications will enable reactive power management that is started 1 minute or less before the problem occurs. This flexibility management puts stringent communication performance requirements towards 5G.

The regulatory framework in the communication field is strongly developed, but the content of the regulation is focused on the specific needs of the communication itself with limited corroboration with the needs and requirements of the electricity distribution system operation. The edgeFLEX project team has a very well-balanced structure from the point of view of the expertise, grouping specialists from the electricity sector and information and communication sector. By running the project activities and comparing with the context of other similar projects, it became clear that including specific requirements for information and communication in the regulation for electricity distribution would be a major facilitator for further development of the distributed generation/ integration of RES powered electricity generation.

The initial proposal for including ICT requirements within existing Network Cods have been developed in SOGNO, and it will be completed with specific updates related to VPPs operation.

3.2.5 Update of Renewable Energy Law

In addition to the regulatory framework, it is useful to introduce updates to the legislative framework. For instance, a new release of Renewable Energy Law become active as of January 1st, 2021 in Germany, which contains several relevant changes as presented below.

There were included new requirements for new PV installation in combination with open-air installations and solar installations on buildings or noise barriers, solar installations in waterways, car parks and farmed arable land as well as systemic combinations with storage and tenant electricity supply solutions.

Biomass with a maximum value of remuneration for new installations, Section 39b of Renewable Energy Act (EEG) 2021, increase to 16.4 cents/kWh and a maximum value of remuneration for existing installations, Section 39g (5) No. 3 EEG 2021, increase to 18.4 cents/kWh.

New rules for citizen participation to the construction of the electricity generation based on Wind, have been introduced to increase the public acceptance of this technology.

RES generation assets out of subsidy are permitted to continued electricity purchase and remuneration by the grid operator, with no full feed-in obligation, i.e., self-supply is allowed, and the RES are entitled to grid connection and priority purchase, transmission, and distribution of electricity.

Rules for smart metering were introduced for allowing the grid operators to remotely controlled RES generation, by applying remote control schemes to all installations (existing and new plants) for all activities related to electricity market.

According to the EEG 2021, Energy Community shows some early opening clauses but does not sufficiently implement the requirements in the EU Directive or even in contradiction to the EU Directive in some cases. Such updates on the Renewable Energy Law are need in most of the European countries, and the specific legislation and provisions should be properly harmonized at the European level.

3.2.6 New rules for the management of RES electricity generation

Starting from the example of such an initiative in Germany, where there are extensive changes ahead for grid operators in terms of redispatch and feed-in, the legislature has extensively revised the requirements for the curtailment of generation plants in the event of grid bottlenecks and voltage problems with effect from 01.10.2021. It refers to the management with the passing of the Network Expansion Acceleration Act 2.0 (NABEG 2.0).

In the future, all grid operators will be in position to solve their grid congestions using market-oriented actions, by providing financial compensations. In addition, new contracts will have to be drafted, negotiated, and concluded. The burden on each grid operator is expected to be high. Reimbursement of costs, on the other hand, has only been clarified for implementation costs up to October 2021.

All generation facilities, including RES plants and Combined Heat and Power (CHP) plants from 100 kW installed power, as well as plants that can be remotely controlled by a grid operator at any time (this essentially concerns controllable PV plants up to and including 100 kW installed power), will be included in the redispatch. According to initial assessments, this includes more than 100,000 plants. The implementation mechanisms for the redispatch of RES and CHP plants have also been redefined. In the future, the balancing group manager of the generation balancing group will be entitled to perform balance adjustments. In addition, the plant operator is entitled to receive financial compensation for the lost revenue, as has been the case in the past. In the future, shutdowns will be based on planned values and forecast data.

In the event of a grid bottleneck or voltage problems, the grid operator having this problem in the grid, must decide which generation plants in its grid or in other grids are to be curtailed to eliminate or avoid the problem. In addition to the effectiveness of the measure, the grid operator must also consider the costs caused by the curtailment (on both sides of the bottleneck, if applicable) as part of an overall assessment and form a "merit order" (deployment sequence) for the redispatch on this basis. The measures that are "expected to cause the lowest costs overall" are then to be selected. For Renewable energy plants and CHP plants, imputed (i.e., fictitious) costs are used as a reference in this respect. These imputed costs are determined with the help of a factor to be defined by the Federal Network Agency (BNetzA), which is to be selected in such a way that RES and CHP plants are only derated if otherwise five to fifteen times the non-priority generation would have to be curtailed. The factor can be determined differently for RES plants on the one hand and CHP plants on the other.

By applying this type of rules, adapted to the requirements of VPPs and standardization at European level, a new source of income is effectively created for VPPs and its components.

All these aspects will be subject to a more detailed analysis regarding the potential positive impact, and in what terms, which these new legislative provisions regarding RES generation may have in support of edgeFLEX solutions.

4. Engaging with policy makers, with organizations and experts in regulation and standardization

The above-mentioned stakeholder consultation strategy represented the starting point of our activity to engage with policy makers, with organizations and experts in regulation and standardization.

Depending on the calendar of events attended by representatives of the target segment, we have adapted our concrete actions of feedback collection and consultations, considering several levels of involvement:

- Attending events where topics from the edgeFLEX area of interest have been potentially addressed.
- Collaborations with different organizations and participation with dedicated edgeFLEX sessions in their events.
- Active involvement in organizing our own consultation events (targeting minimum 2 large consultation events involving all stakeholder categories).
- Bilateral consultations.

4.1 Participation in specific events

Especially in the first phase of consultations with stakeholders, we aimed at participating in events in which to better understand the technological and market context related to the services and solutions we build in edgeFLEX.

In this regard, representatives of the edgeFLEX consortium participated in the following specific events:

- Integrated Approach in the Management and Operation of Electricity Transmission and Distribution Networks
  - April 30, 2020
  - 100 registered participants
  - International videoconference

- Europe in Transition: How can we accelerate the shift to an integrated, renewables-based energy system?
  - October 22, 2020
  - 50-100 registered participants
  - International videoconference

- Asset Brussels Roadshow
  - October 28, 2020
  - 50-100 registered participants
  - International videoconference

- Global DSO Event - 1st Global Platform of Leading Electricity Distribution Operators
  - January 26-27, 2021
  - Organized by E.DSO.
  - International videoconference

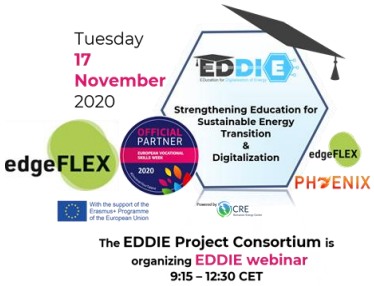
- Cybersecurity Standardization Conference – European Standardization in support of the EU Cybersecurity Act
  - February 2-4, 2021
  - Organized by European Union Agency for Cybersecurity
  - Online conference

4.2 Engaging with relevant stakeholders in dedicated bilateral workshops and meetings

In the framework of our WP6 specific activity, we conducted a series of awareness activities and consultations with the main stakeholders at the higher level of involvement by organizing dedicated edgeFLEX sessions within events and bilateral meetings, and by organizing the first Advisory Board meeting within the project.

4.2.1 Workshop dedicated to the edgeFLEX project within EDDIE webinar under EVSW (European Vocational Skills Week)

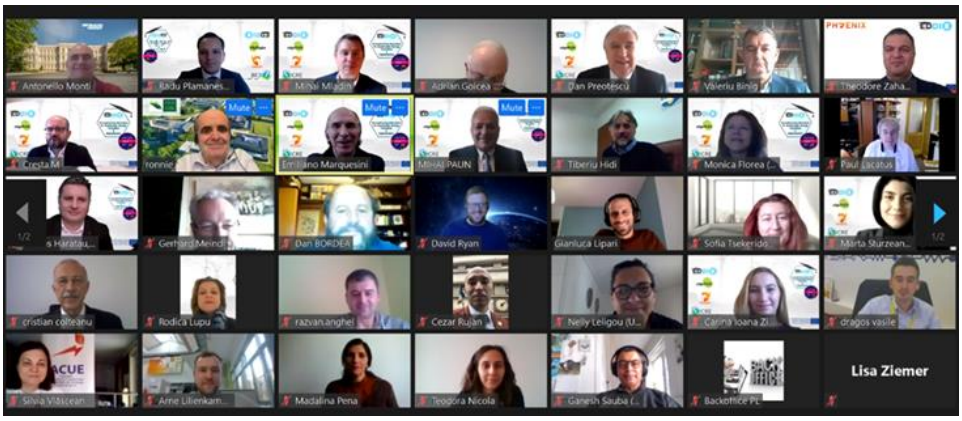
During the event organized by the Romanian Energy Centre "Strengthening Education for Sustainable Energy Transition and Digitalization", under the auspices of EVSW, we had the first dedicated session to present the edgeFLEX project, with emphasis on regulatory issues.



The event organized on November 17, 2020 had a large international participation, with over 150 registered participants.

The discussions in the panel dedicated to the edgeFLEX project were attended by experts in the field of regulation both at European and local level, as follows:

- Representatives belonging to European organizations in the field of energy and energy regulation: E.DSO and ENTSO.E
- Representatives of DSOs and TSOs in charge with regulations from CEZ, ENEL, and Transelectrica (Romanian TSO)
- High-level representatives belonging to national regulatory authorities, such as Flemish Regulator VREG and the National Energy Regulatory Authority in Romania



The discussions confirmed that there is a concern at European level, but also specifically at local level, to support through appropriate regulations the context of Dynamically controlled VPP solutions proposed by edgeFLEX:

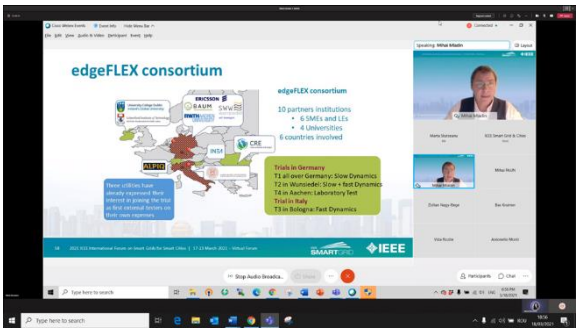
- It was pointed out that in 2020 there were relevant local initiatives in the context of VPPs, more precisely it was updated the secondary legislation on VPPs.

- The Aggregator has been specifically defined as a key factor in the process of supporting flexibility, and based on this, a significant impact on the balancing market is expected.

4.2.2 EdgeFLEX project in the session "Regulatory measures supporting Smart Grids" - 2021 IEEE International Forum on Smart Grids for Smart Cities

The edgeFLEX consortium partners organized on March 18, 2021 the session dedicated to the relevant aspects in regulation towards supporting Smart Grids solutions, within the "2021 IEEE International Forum on Smart Grids for Smart Cities".

This session was attended by experts in regulation and standardization, both at European level and at the level of national regulatory and standardization bodies.



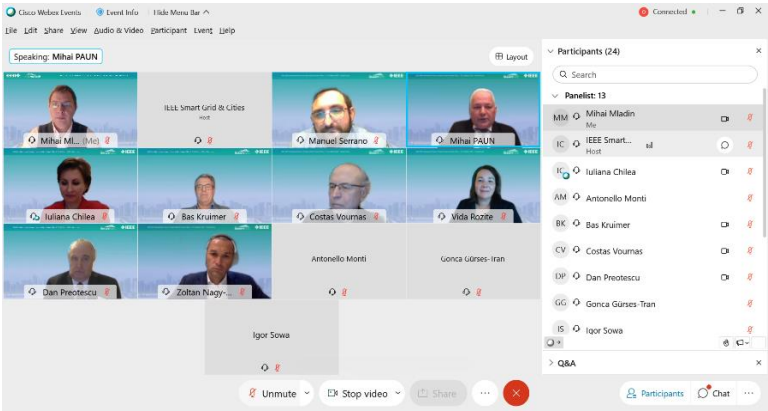
Following the presentation of the edgeFLEX project, we discussed in the panel on 4 of the 6 initial proposals for updating / completing the regulatory framework, which were formulated within the project and are addressing the context of Smart Grids:

- New ancillary service providing inertia
- VPPs as new participants in the Electricity Balancing Market
- New Voltage regulation market
- ICT chapter requirements update on existing NCs

Our proposals on the regulatory framework were appreciated as relevant in the context of Smart Grids, and we were encouraged to further substantiate them, to promote them to stakeholders who can further support their adoption.

In this context, the following emerged from the discussions:

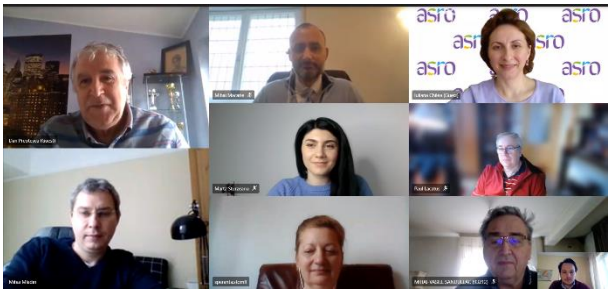
- It is critical to explore the synergies that may be created between regulation and standardization for supporting Smart Grid solutions.
- As a trend and at the same time as one of the main factors supporting the energy transition, digitalization strongly requires special attention to regulations to properly integrate and harmonize the ICT component in the energy context; once such provisions are included in the NCs, it is needed a continuous updating process in accordance with the technological evolution and new requirements.
- To overcome the paradigm of regulations in force at the local level by reference to cross border coordination and harmonization at regional and European level, in support of providing services with a wide impact in the context of Smart Grids.
- Especially at the level of national regulators, there are concerns and actions in support of VPPs and their associated functionalities; with reference to the proposal "VPPs as new participants in the EBM", the representatives of the regulatory authorities are involved in a continuous process of consultation with the participants in the above-mentioned specific market and depending on the evolution and maturity of the market they will propose and new participants.



4.2.3 Bilateral meeting with The Romanian National Standardization Body

Our activity of analysing the standardization framework and determining the potential measures in this area related to the context of edgeFLEX services and solutions, started with the bilateral online meeting on February 3, 2021 with the Romanian National Standardization Body (ASRO).

Reference projects belonging to ASRO were brought into discussion, as benchmarks to refer to and take them into account in the analysis of the standardization framework associated with edgeFLEX services and solutions.



In this initial phase of consultations with ASRO, the following directions of analysis were established regarding the potential impact in the field of standardization:

- Data transmission and cyber security issues.
- Standards for computer programs, at the user interface level; these are generally provided by International Organization for Standardization (ISO), and CEN-CENELEC takes them as such.
- The internal structure of the computer programs, both at the level of the component modules and at the level of the integration platforms.

4.2.4 1st Advisory Board meeting

The Advisory Board (AB) will meet 2 times to assess the edgeFLEX concepts, use cases and field trials and their implications. AB meetings will also serve as an opportunity to identify changes in the external framework and new challenges and opportunities. In addition, the AB will advise in the communication of results to stakeholders in preparation for exploitation. At the same time, the AB will help communicate the project results and insights and thereby help ensure European-wide acceptance and usability of the edgeFLEX project outcomes.

Discussions with the members of our Advisory Board will enhance our impact by regularly reviewing our plans and giving us the benefit of their considerable insight to improve the effectiveness of our actions.

EdgeFLEX has established a focused AB of leading representatives of the Critical Energy Infrastructure and ICT sectors which will meet annually to advise the project on strategic directions in the sector:

- **Dr. Ralf Levacher**, CTO, Stadtwerke Saarlouis GmbH
- **Prof. Mario Paolone**, Chair of the Distributed Electrical Systems laboratory and Head of the Swiss Competence Center for Energy Research (SCCER) FURIES (Future Swiss Electrical infrastructure), Swiss Federal Institute of Technology
- **Marcus Törnqvist**, Accountable Manager and Business Developer in ICT Ericsson
- **Dr. Davide Della Giustina**, Head of Networks and Systems Operations, Unareti
- **Andreas Kiessling**, CEO energy design & management consulting,
- **Dr. Werner Friedl**, Head of the research field "Integrated Energy Systems", AIT Austrian Institute of Technology

On January 21, 2021, we organized the first meeting with the Advisory board in the online environment, which was attended by all 6 AB members, asking several questions related to both the implementation plan and the steps taken, with a series of preliminary suggestions. The focus of the discussions was on the way of organizing the activity in edgeFLEX, the overall architecture issues, specifically pointing out the following:

- If we have considered and how we follow the cyber security aspects.

- The role of the network operator and where are the expected DSO or Transmission System Operator (TSO) interaction and boundaries between them within edgeFLEX context.
- Clarifications on edgePMU functionalities at lower voltage levels.
- Why not to consider active power from batteries to avoid congestions within our research work.
- Why 5G when 4G latency may be good enough.
- If the data flow for each of the presented scenarios (for centralized and decentralized services) was or may be properly estimated.
- Clarifications on the use of term “services” within edgeFLEX: one as an ancillary service and two as “function offered as a service”.
- The importance of regulations and how we manage the analysis of relevant aspects from this perspective both in terms of national specificity, but also how we ensure communication and exchange of ideas with relevant organizations at European level to have an impact.

The questions were especially oriented towards understanding the context of project implementation, the way of organizing and the actions taken so far were appreciated and validated by the AB members.

5. Conclusions

In a European context where the electricity networks regulatory and standardization framework is described by an advanced power transmission sector, with eight network codes currently in force (see Table 2.1) and a distribution system which faces local adaptations due to national structures, needs and limitations, the new public policies and regulation foster and encourage a parallel focus on technological innovations with a rapid rate of change in the electric power system. Technologies and concepts like IoT, the digital revolution, Advanced Distribution Management System and PMU, big data, synchronous generators, P2P trading, EVs, G2V, V2G, H2V, V2H and V2G, are key elements in defining standards and regulations.

The edgeFLEX strategy to fully take advantage of the project results and findings targets three main directions. First, the consortium focuses on the understanding of stakeholders' position and the market need for a precise correlation with the activities performed and scheduled in the project. Then, the attention goes on supporting the implementation of the technical solutions and business models proposed by edgeFLEX regarding regulatory framework and standardization. Equally important is also the last direction of obtaining external expertise for validation and assessment of the project concepts, use cases and field trials. Public consultations were carried out until present and will continue to be part of the strategy. As a result, the initial activity addressed the technical challenges and their potential impact in regulations, as well as defining functional business models which will bring added value.

Engaging with policy makers, with organizations and experts in regulation and standardization is an ongoing and complex activity, carried out throughout the project implementation period, and involves interactions and consultations with all stakeholder categories. We refer to a process that involves first the organization of the above-mentioned planning of the assessment activity in regulation and standardization, considering the technical conditions and aspects related to a "go to market" process associated with the proposed services and solutions within edgeFLEX.

This first version of the deliverable, which refers to the first year of the project implementation, has primarily the role of presenting the existing situation and the Task 6.3 specific action plan. This task provides input to both versions of this deliverable, D6.3-v1 and D6.4-v2.

Also, this version of the deliverable summarizes the initial proposals of edgeFLEX in terms of updating the regulatory framework:

- "New ancillary service – Providing inertia".
- "VPPs – as new participants in the Electricity Balancing Market"
- "New Voltage regulation market
- "ICT chapter requirements update within existing Network Codes".
- "Update the Renewable Energy Law".
- "New rules for the management of RES electricity generation"

Considering the above proposals, during the first year of edgeFLEX project activity, the process of engaging with policy makers, with organizations and experts in regulation and standardization materialized in several relevant actions like: participation in specific events and workshops; initiating meetings with standardization bodies and organizing the AB meeting. Each action presented opportunities both at European and local level to support through appropriate regulations the context of Dynamically controlled VPP solutions proposed by edgeFLEX.

As result of all these interactions a set of suggestions was gathered. ASRO recommended the field of data transmission and cyber security issues as important topics to be analysed, as well as standards for computer programs focusing on the component modules and integration platforms levels. The AB members indicated through their questions the segments which demand for specific attention from edgeFLEX consortium. Cyber security, the role of network operators and expected interactions and boundaries of DSOs and TSOs at the project level and edgePMU functionalities were address during the conversation. Furthermore, recommendations for establishing a clear differentiation between the service as an ancillary service and the service as a function offered like a service were also pointed out. The constant communication and ideas exchange at European level with relevant organization will be an important task of edgeFLEX project, as the regulations and standardization need improvements correlated with the new changes that the power system is facing.

6. List of Figures

7. List of Tables

8. References

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9. List of Abbreviations

AB	Advisory Board	E.DSO	European Distribution System Operators' Association	NRA	National Regulatory Authorities
ACER	Agency for the Cooperation of Energy Regulators	EEG	Renewable Energy Act	P2P	Peer to Peer
ASRO	Romanian National Standardization Authority Body	ENTSOE	European Network of Transmission System Operators	PMU	Phasor Measurement Unit
ANRE	Romanian Energy Regulatory Authority	ETSI	European Telecommunications Standards Institute	RES	Renewable Energy Sources
BNetzA	Federal Network Agency	EU	European Union	T&D	Transmission and Distribution
CEER	Council of European Energy Regulators	EURELECTRIC	Union of the Electricity Industry	TSO	Transmission System Operator
CEN	European Committee for Standardization	EV	Electrical Vehicle	VPP	Virtual Power Plant
CENELEC	European Committee for Electrotechnical Standardization	G2V	Grid to Vehicle	V2G	Vehicle to Grid
CHP	Combined Heat & Power	H2V	Home to Vehicle	V2H	Vehicle to Home
DSO	Distribution System Operator	ISO	International Organization for Standardization	V4G	Vehicle to Grid
EMB	Electricity Balancing Market	IoT	Internet of Things	WP	Work Package
EC	European Commission	NABEG	Network Expansion Acceleration Act		