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Power Transmission &
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Summary of regulatory activities and conclusions of the FlexPlan project

Discussion paper

Gianluigi Migliavacca, Giorgia Lattanzio, Dario Siface (Ricerca sul Sistema Energetico)
Andrei Morch (SINTEF Energi)
Fernando Dominguez Iniguez (VITO)

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Disclaimer

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Nomenclature or List of Acronyms

ACER	https://www.acer.europa.eu/
CBA	Cost-benefit analysis
DSM	Demand-side management
DSO	Distribution System Operator
EC	European Commission
Eurelectric	https://www.eurelectric.org/
ENTSO-E	The European Network of Transmission System Operators for Electricity
RES	Renewable Energy Sources
SO	System Operator
TYNDP	Ten-Year Network Development Plan by ENTSO-E
T&D	Transmission and Distribution grid
TSO	Transmission System Operator
VOLL	Value of Lost Load

Abstract

The FlexPlan Horizon 2020 project (https://flexplan-project.eu/) aims at establishing a new grid-planning methodology which considers the opportunity to introduce new storage and flexibility resources in electricity transmission and distribution grids as an alternative to building new grid elements, in accordance with the intentions of the Clean Energy for all Europeans regulatory package of the European Commission.

FlexPlan created a new innovative grid-planning tool whose ambition is to go beyond the state of the art of planning methodologies by including the following innovative features:

- assessment of the 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 grid years (2030, 2040, 2050),
- incorporation of a 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 renewable energy sources (RES) and load time series through a stochastic optimization approach.

Six regional cases covering nearly the whole European continent were developed in order to cast a view on grid planning in Europe till 2050.

FlexPlan ended up by formulating guidelines for regulators and planning offices of system operators by indicating to what extent system flexibility can contribute to the reduction of overall

system costs (operational + investment) yet maintaining current system security levels and which regulatory provisions could foster such process.

After presenting a short overview of the project motivation and goals, the present report concentrates on the final regulatory reflections and the elaboration of the final regulatory guidelines.

Executive Summary

The FlexPlan project (**https://flexplan-project.eu/**) aimed at establishing a new 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. That is in line with the prescriptions of the directive by the European Commission on common rules for the internal market in electricity, part of the "Clean Energy for all Europeans" package (**https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en**).

In detail, FlexPlan provided the following contributions:

- Development of a new methodology 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 grid years (2030-2040-2050), incorporation of full range of Cost Benefit Analysis criteria into the target function, integrated transmission 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 and analysis of variability of yearly RES and load time series through a stochastic optimization approach.
- Implementation of the methodology in a new toolbox, which was utilized to perform a grid planning analysis over six European regional cases by considering both the mid- and the long-term (2030, 2040, 2050) in one single optimization process. In addition, pan-European scenarios are run as well, in order to establish consistent border conditions for all 6 regional cases.
- Elaboration of regulatory guidelines aimed at providing National Regulatory Authorities with indications on the opportune regulation to be adopted for maximizing the benefits that can be obtained with the new grid planning methodology. These guidelines will be built by considering the potential role of flexibility and storage as a support of T&D planning, resulting from the outcome of the six regional cases.

This report summarizes the main regulatory reflections carried out by the FlexPlan project. Three subactivities are described:

- The first part of the activity was initiated by the beginning of the project and consisted of an assessment of the Pan-European regulatory framework. The intention was to ensure that the project outcomes comply with the overall Pan-European political targets and thereby to set an optimal environment for the real implementation of the planning tool realized by the FlexPlan project. A qualitative evaluation was carried out by using methods based on data collected through literature screenings and survey-based researches.
- The main goal of the second part in the activity was to analyse the outcomes and learnings from the six regional cases and derive conclusions applicable for the national/regional regulations and practices, which could impose limitations for application of the tool. The secondary goal for the activity was to apply the preceding conclusions in evaluation of replicability and scalability potential for the main outcomes of the FlexPlan project.
- The third and final step of the activity provided a comprehensive overview of the present regulatory framework and concluded the analysis by formulating guidelines and recommendations for a proper deployment of flexibility resources. The development of

these recommendations is based on the importance of the role of flexibility resources, demonstrated by the FlexPlan tool, and on the analysis of possible regulatory barriers, identified in European and national regulations.

The third step passed through the analysis of 10 key regulatory factors, the assessment of all regulatory barriers to the adoption of the FlexPlan planning methodology and of the "enabling" factors that could be adopted in order to remove them.

Connected with that, an impact assessment activity was carried out too, by considering the potential impact of the FlexPlan methodology in three different regulatory contexts:

1. the present regulatory context (status quo);
2. status quo (point 1) + some long-term mechanisms in addition to the status quo regulation, capable to provide locational signals to drive new investments in flexibility assets (new storage and flexibilization of existing loads) to be carried out where system operators' studies indicate the maximum profitability for the system;
3. long-term mechanisms (point 2) + real-time-markets reform, so as to create new products and to modify architectures to promote a "level playing field" participation in real-time markets by flexibility providers, for whom such markets were not initially created.

The results of the impact analysis were summarized in three synoptic tables, which are reported in Chapter 4. As a conclusion of the impact assessment analysis, the regulatory context of scenario 3 was strongly recommended for a successful enabling of the provision of services from flexible subjects connected to T&D grids.

Table of Content

1. Overview of FlexPlan motivation and goals

For a successful renewable energy transition, massive network reinforcements are needed at all grid levels to accommodate bulk renewable generation sources on the one hand, and small distributed generation on the other. Additionally, a successful renewable energy transition requires the electrification of other used primary energy sources, mainly for the industry and transport sectors. As such, the increase in the electrical energy demand is expected to put even more stress on transmission and distribution grids, which are being operated ever closer to their limits. According to Eurelectric [1], distribution grids investments between 375 to 425 billion Euro are needed until 2030. Similarly, ENTSO-E states [2] that annual transmission grid investments of 43 billion Euro until 2040 are needed for renewable energy integration.

Massive RES deployment will make future transmission and distribution (T&D) grid planning more complex and affected by uncertainty. To make the energy transition affordable, a holistic grid planning approach is needed, which can assess the trade-offs between classical network investments and flexibility sources across all voltage levels and find the optimal grid expansion strategy for the coming years and decades.

Grid investments are capital-intensive, and the lifetime of transmission infrastructure spans over several decades: due to rapidly changing scenario hypotheses, when a new line is commissioned, the foreseen benefits may no longer justify the corresponding investment. Moreover, variable flows from RES are generating a new type of intermittent congestion which can sometimes be well-compensated with system flexibility, while investments in a new line would not be justified. For these reasons, it would be worthwhile to investigate alternative ways for compensating peak flows and overcome congestions in the grid by exploiting existing or new system flexibility instead of scheduling an expensive and time-consuming system infrastructure expansion. On this pathway, storage can provide a good alternative to building new lines. Indeed, the placement of storage devices in strategic grid locations could prove effective in preventing temporary line overloading, thus constituting a good alternative to building new lines aimed at coping with RES generation peaks. A similar role could be also taken by flexible consumption (e.g., deferrable consumption), especially when considering big industrial loads and tertiary infrastructures. Finally, as storage capacity and flexible load management should be mostly provided by means of private engagement, special regulatory mechanisms should be devised and enforced in order to incentivise building up new flexibility items in opportune locations, wherever consistent advantages are identified.

Flexibility should not be seen as always preferable to building new lines and cables, but the assessment must be led by taking into account the whole structure of the present transmission and distribution grids as well as the scenarios which are adopted to describe the future evolution of the system, from the mid-term (2030) till the long term (2050), which make the whole investigation extremely complex and challenging from the mathematical point of view. Additionally, traditional tools used by transmission system operators (TSOs) and distribution system operators (DSOs) in order to evaluate grid investment needs are not adequate for this kind of analysis. Therefore, a complete methodological re-thinking is necessary.

All these aspects have motivated the activity of the FlexPlan Horizon2020 project (**https://flexplan-project.eu/**, active from October 2019 till March 2023), which established an innovative grid-planning methodology considering the opportunity to introduce new storage and load flexibility resources in electricity T&D grids as an alternative to building new grid elements. FlexPlan created a new innovative grid-planning tool whose ambition was to go beyond the state of the art of planning methodologies by including the following innovative features: integrated transmission distribution planning, environmental analysis, probabilistic contingency methodologies (in replacement of the N-1 criterion) as well as optimal planning decision over several decades. The new tool was used to analyse six regional cases covering nearly the whole European continent (Iberian Peninsula; France and Benelux; Germany, Switzerland and Austria; Italy; Balkan Countries; and Nordic Countries). These regional cases are aimed at demonstrating the application of the tool in real scenarios as well as at casting a view on grid planning in Europe till 2050.

The FlexPlan Consortium encompassed three TSOs (TERNA from Italy, ELES from Slovenia and REN from Portugal); the ENEL Global Infrastructure (also representing the Italian distributor e-distribuzione, present in the consortium as a linked third party); research and development companies and universities from eight European countries (Belgium, Germany, Italy, Norway, Portugal, Serbia, Slovenia, Spain), including the project coordinator RSE; and N-SIDE, the developer of the European market coupling clearing algorithm EUPHEMIA.

2. Regulatory analysis: How to enable the flexibility resources for network planning?

The FlexPlan activity dedicated to "Regulatory Analysis" consisted of three sub activities, that looked into regulatory aspects related to the topics of the FlexPlan project.

2.1. Analysis of the regulatory *status quo* and strategies in Europe

The first part of the activity was initiated by the beginning of the project and consisted of an assessment of the Pan-European regulatory framework. The intention was to ensure that the project outcomes comply with the overall Pan-European political targets and thereby to set an optimal environment for the real implementation of the planning tool realized by the FlexPlan project.

The first step applied qualitative evaluation methods, based on data collected through literature screening and survey-based research. The activity followed a stepwise approach, which is presented in Figure 1, where the activity was divided into two parallel streams: one carried out a screening of a set of documents selected by the project group, while another complemented by means of a survey aiming at investigating existing practices of both Transmission and Distribution System Operators (TSO and DSO). The survey involved three European TSOs and four DSOs.

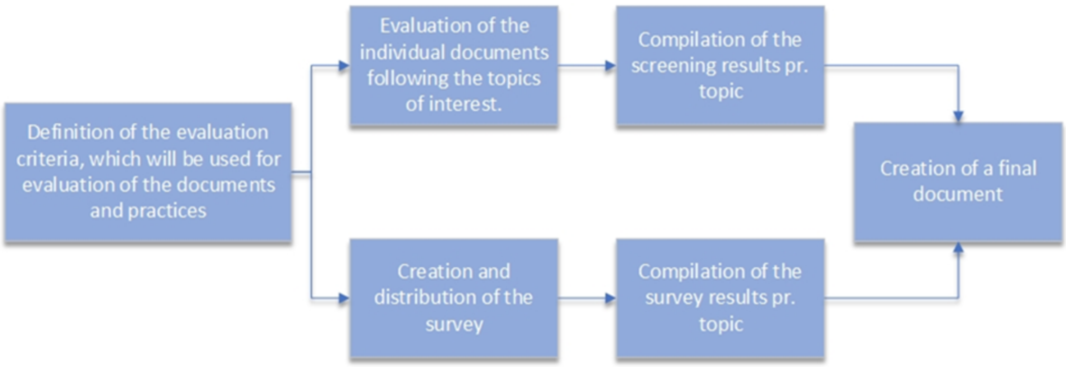

Figure 1: Steps in the regulatory assessment methodology

The screening covered a selection of the relevant documents, issued by several types of stakeholders, including the European Commission (EC), ENTSO-E and the interest organisations representing DSOs. The study focused on a pre-defined selection of issues, which have critical importance for FlexPlan project and are called "topics of interest". These topics represent either some key assumptions that will have to be made within the project activities, or/and some attributes, which can be directly or indirectly decisive for the development and later for the implementation of the project outcomes.

Some of the main conclusions from the analysis of the regulatory status quo and strategies in Europe are presented below.

Requirements related to consideration of flexible resources in planning: Summarising the results of the screening process above, the importance of the flexible resources was clearly stated in the Internal Electricity Market (IEM) Directive [3]. The document includes a specific section (Art.32) dedicated to incentives for use of flexibility sources in distribution, stating that the distribution network development plan shall also consider demand response, energy efficiency, energy storage facilities or other resources that the DSO has to use as an alternative to system expansion. Furthermore, the same document defines that when elaborating the Ten-Year Network Development Plan (TYNDP), TSOs shall fully consider the potential for the use of demand response, energy storage facilities or other resources as alternatives to system expansion. The EC Regulation 2019/943 on the internal market for electricity [4], which is linked to the above-mentioned Directive, states that in order to integrate the growing share of renewable energy, the future electricity system should make use of all available sources of flexibility, particularly demand side solutions and energy storage. In ENTSO-E's 3rd Guideline for Cost Benefit Analysis (CBA) of Grid Development Projects [5], flexibility of demand is considered as a consistent part of the estimation of the socio-economic welfare.

The project concluded that there was a clear indication from the present regulatory framework, supported by a broad agreement across different stakeholders, that flexible resources should be used as a viable resource for the operation of the power system and thus it should be considered in the planning procedures of the power grid.

Ownership and operation of energy storage: The study specifically highlighted the importance of this issue with regards to the establishment of a regulation to support a future planning methodology taking into consideration the role of storage and flexibility in the FlexPlan methodology. The most recent version of IEM Directive presented the official position of the EC regarding ownership of energy storage facilities by respectively DSOs and TSOs. The document reaffirmed the position stated in the previous drafts of the Directive, which, as a general rule, does not allow SOs to own, develop, manage, or operate energy storage facilities. However, both Art. 36 and Art. 54 of the same document, dedicated respectively to DSO and TSO, refers that SOs are allowed to own, operate or manage such devices, among other conditions, if these devices are "are fully integrated network components and the regulatory authority has granted its approval".

Rules for allocation of costs and incomes between TSOs and DSOs in new common investment projects: From the Transmission side, following the requirements of the EU Regulation 347/2013 on guidelines for trans-European energy infrastructure [6], ENTSO-E has developed a CBA of Grid Development Projects, ensuring a common framework for multi-criteria CBA for TYNDP projects. However, there are no commonly agreed rules for allocation of costs between TSOs and DSOs in common investment projects.

The survey results indicated that the present practice is based on a split of costs at transmission system level. However, this practice may be reconsidered in case flexibility resources from distribution networks will be actively employed and coordinated for the provision of system services to TSOs. For that time there was no regulatory framework, applicable to this case.

Multi-criteria vs. cost-based approach for evaluation of new projects: The ENTSO-E's 3rd CBA guideline describes the common principles and procedures for performing combined multi-criteria and cost-benefit analysis using network, market, and interlinked modelling methodologies for developing Regional Investment Plans and the EU-wide TYNDP. There are several reasons for selection of this combined approach. It is important to repeat the point made by ENTSO-E in its CBA guideline: costs mostly rely upon scenario-independent factors like routing, technology, material, etc., while benefits are strongly correlated with scenario specific assumptions.

Costs functions representing reliability in Cost and Benefit Analysis: The study indicated that the main challenge is to represent reliability in monetary terms. The commonly used key indicator for reliability is the lost load, which is monetised via the Value of Lost Load indicator (VOLL). According to ENTSO-E's CBA guideline the value for VOLL that is used during project assessment should reflect the real cost of outages for system users, hence providing an accurate basis for investment decisions. It is also stated that the experience has demonstrated that estimated values for VOLL vary significantly in dependency of geographic factors, differences in the nature of load composition, the type of affected consumers, and the level of dependency on electricity in the impacted geographical area, differences in reliability standards, the time of year and the duration of the outage.

Priorities for sharing flexible resources between TSO and DSO: The IEM Directive defines that DSOs shall cooperate with TSOs for the effective participation of market participants connected to their grid in retail, wholesale and balancing markets. Delivery of balancing services stemming from resources located in the distribution system shall be agreed with the relevant TSO.

However, further screening and survey of the present practice indicated that at present there is no common regulatory or practice background allowing to draw clear conclusions on this topic. The necessity of defining this is clearly highlighted both at the institutional level and by the stakeholders.

Responsibilities for congestion management and balancing: According to the IEM Directive while performing its main tasks (the efficient, reliable and secure operation of the distribution system), the DSO shall procure the non-frequency ancillary services needed for its system in accordance with transparent, non-discriminatory and market-based procedures, unless the regulatory authority has assessed that the market-based provision of non-frequency ancillary services is economically not efficient and has granted a derogation. According to the same document, TSO is responsible, in that context, for ensuring the availability of all necessary ancillary services, including those provided by demand response and energy storage facilities. Several ENTSO-E's documents, including the 3rd CBA Guideline and "European Power System 2040: Completing the map" [7] clearly presume that responsibility for balancing and congestion management is TSOs' responsibility. Regarding the evolution of roles and responsibilities, in a 10-20 years' timeframe it is reasonable to suppose that TSOs will remain responsible for system balancing and congestion management in their respective networks, while DSOs will be allowed to deal with congestion in their own distribution networks.

The first step concluded that there were strong regulatory signals prompting European system operators to consider flexible resources as a new important active subject in the grid expansion planning process. This strengthened once again the importance and proper timing of FlexPlan project, both for testing new innovative grid planning methodologies coping with the present challenges, for the comprehensive scenario assessment up to 2050 and for the final synthesis of the results into regulatory guidelines brought to the attention of National Regulators and the Commission.

The complete results summarized in section 2.1 are described in detail in **deliverable D6.1** (**https://flexplan-project.eu/wp-content/uploads/2020/04/D6.1_20200429_V2.0.pdf**).

2.2. Learnings from the regional cases and regulatory implications

The main goal of the second part of the activity was to analyse the outcomes and learnings from the six regional cases and derive conclusions applicable for the national/regional regulation and practices, which could impose limitations to the application of the tool. The secondary goal for the activity was to apply the preceding conclusions in the evaluation of replicability and scalability potential for the main outcomes of the FlexPlan project.

2.2.1. Regulatory practices in the light of outcomes from the regional cases

Despite the high computational complexity of nodal models including both transmission and distribution (T&D) networks, some features of the FlexPlan approach (Benders' decomposition and T&D decomposition [10]) made it possible to retain the numerical tractability of the models. In particular, the T&D decomposition represents one of the main improvements brought by FlexPlan.

Indeed, the results of the six regional cases, if compared to the present practices highlighted:

- **the importance of the interaction between planning procedure of TSO and DSOs.** Indeed, in many cases it is demonstrated that overall system costs which arises due to the presence of congestions in the transmission system are reduced thanks to the settlement of resources connected to the distribution network.
- **the necessity to use a nodal network model in order to avoid underestimation of the curtailment of renewable energy production.** A zonal approach would provide too optimistic results in systems characterised by high RES penetration and many binding network constraints.

2.2.2. Evaluation of replicability and scalability potential

The assessment of the main outcomes of FlexPlan project was divided into two separate parts:

- The FlexPlan methodology i.e., combination of different methods and techniques assembled together in the project, allowing to make estimations of the optimal system expansion considering use of flexible resources.
- The FlexPlan tool i.e., project-specific implementation of the FlexPlan methodology in a set of software codes and data.

The present study refers to scalability and replicability terms and definitions, which were established in the framework of EU project Grid+ specifically for the SmartGrids domain [8]. These terms and definitions are not novel, but based on several technical studies and modified, whenever it was necessary, in order to function appropriately within the domain.

- Scalability is the ability of a system to maintain its performance (i.e., relative performance) and function, and retain all its desired properties when its scale is increased without having a corresponding increase in the system's complexity
- Replicability denotes the property of a system that allows it to be duplicated at another location or time.
- A system is understood as a set of interacting elements with similar boundary conditions.

Several other factors should be considered:

- The ability of a system to scale or/and replicate does not necessarily imply that the scaled-up system performs well
- Scalability is often design-dependent: it must be tackled from the very beginning
- Scaling-up and replication might be interlinked, scalability and replicability are independent. The former is rather system dependent, whereas the latter depends on the expected change of the boundary conditions

Although scalability and replicability of each system depends on specific factors, common and sufficiently generic factors should be sought.

- Technical factors determine whether the solution developed in a particular project is inherently scalable and/or replicable, i.e., whether it is feasible to scale-up and/or to replicate.
- Economic factors reflect whether it is viable to pursue scaling up or replication.
- Regulation and acceptance of stakeholders such as end users, regulators, authorities, etc., reflect the extent to which the current regulatory and social environment is ready to embrace a scaled-up version of a project or whether a new environment is suitable for receiving a project.

The stipulated factors were evaluated separately for the FlexPlan methodology and the FlexPlan tool. In this way the study wanted to assess whether a more refined implementation of the methodology may improve any potential shortcomings identified in the study. The assessment was made, by assigning scores, similar to standard Likert-scale, for each factor and estimation of average values (see the results in FlexPlan D6.2).

In general, the assessment showed very high scalability level, with some minor limitations related to computational power, required for upscaled versions of the tool. At the very same time it must be considered that the accomplished regional studies have already a realistically big scale, covering whole regions and countries. The same applies to replicability potential of both the methodology and the tool.

The complete set of results described in section 2.2 are presented in **deliverable D6.2** (**https://flexplan-project.eu/wp-content/uploads/2023/03/D6.2_20230327_V1.0.pdf**).

2.3. Regulatory Guidelines from the FlexPlan project

The third and the final step of the activity provided a comprehensive overview of the present regulatory framework and concluded the analysis by formulating guidelines and recommendations for a proper deployment of flexibility resources. The development of these recommendations is based on the importance of the role of flexibility resources, demonstrated by the FlexPlan tool, and on the analysis of possible regulatory barriers, identified in European and national regulations. The analysis reviewed the previously identified regulatory acts and documents and, starting from the delineated "topics of interest" described in Section 2.1, a total of ten key factors were selected to analyse recent changes in the regulatory landscape and the possible barriers encountered when implementing the FlexPlan methodology in the present EU end national regulatory context.

Incentives for settling new flexibility resources: The deployment and development of flexibility resources must be accelerated and guided by means of mechanisms dedicated to support private investors. These supporting mechanisms can be of different nature (e.g.: a proper market design to involve flexibility resources; dedicated tariffs; etc.) but should all reflect the identified system needs, favouring the deployment of new flexibility resources where the system has shown weakness and bottlenecks, in order to ensure a safe operation of the grid avoiding unnecessary investments.

Storage ownership and operation: The main reasons that justify why SOs are not allowed to own and operate storage facilities are 1) the risk for market distortion because SOs as natural monopolies are not subject to competitive pressure as investments are spread across final users; 2) generation of conflict of interests because SOs would act as market participants; 3) part of the resource value would be lost because storages would not be allowed to participate in markets in case they are owned by SOs; and 4) an increase of network tariffs would be expected to cover SOs investments. Thereby, the proved importance of storage facilities in contributing to the security of energy supply drives toward the necessity of new actors which can participate in network investments.

Responsibilities and data exchange between TSO and DSO in planning: Some changes in the defined roles and responsibilities of TSO and DSOs are required in order to consider the integration in the framework of DERs and active consumers. A clear regulatory framework should well define where and when responsibilities of TSO end and the ones of DSOs start. Furthermore, guidelines for the cooperation of the network development plans are necessary in order to coordinate planning procedures, grids expansions and development flexibility assets.

CBA updates and internalization of environmental costs: The uptake of flexibility resources requires an update of the present CBA approach which should consider every benefit brought by flexibility resources. Two main aspects should be considered while performing a CBA: first the coordination between TSO and DSOs in defining required investment for the network reliability and secondly the monetization of every factor should be strained. In the FlexPlan approach, environmental aspects and carbon-footprint are monetized and a Transmission and Distribution (T&D) decomposition is developed in order to allow a coordinated CBA between different SOs.

Services that can be provided by flexibility resources: market and non-market dispatch: The present regulations impose limitations (mainly technical) on the technologies which are allowed to provide flexibility services. To integrate non-conventional flexibility resources many methodologies can be investigated as for example: 1) rules-based approach, modifying the present flexibility resources requirements; 2) dedicated network tariffs, use of Static Time-Of - Use tariffs; 3) connection agreements, to procure flexibility from new providers able to offer the service; and 4) market-based procurement, to acquire short- and long-term flexibility.

Markets flexibility resources can participate in: Flexibility resources should be encouraged to provide services to both balancing and congestion management purposes. Demand Side Management (DSM) is a powerful resource for solving network issues, anyway DSM is not always allowed to participate in electricity markets. In the proposed Guidelines on Demand Response [9] target markets for flexibility resources are mentioned as a possible solution for the integration of flexibility resources in the present regulatory framework. Bids should be locationally connotated and the markets should allow for the participation to all kind of technologies I.e. technology-neutral.

Products tailored for flexibility resources in Realtime-markets: Some specific markets already exist for the provision of flexibility services, but their configuration mainly supports bidding from conventional technologies. Ad hoc products should be developed looking at what services can be provided by storage facilities and demand response For example, the use of block-bids could facilitate flexible loads which are able to move electricity consumption from one time-frame to another by adopting different production chain schemes, but which become inflexible, once the actual scheme is determined, for the remaining part of the production chain.

Regulation on aggregators and possibility to include flexibility in their basket: Aggregation is a very resourceful process because, not only it reduces the amount of bids on the market, but also favours the integration of resources characterized by small capacities which would not be allowed to participate in the electricity market in other ways. Roles and responsibilities of aggregators are not yet clearly defined, neither at the European level nor, often, at national one. This creates a sense of fuzziness that often prevents subjects even to participate in the sandbox experiments promoted by the national Regulators.

Interactions with Capacity Markets: Capacity remuneration mechanisms represent a mean to promote long-term investments. Their structure should favour the development of flexibility resources increasing the system reliability: capacity remuneration mechanisms could be a viable solution in order to provide incentives for the development of flexibility resources and to assure system operators the availability of flexible resources at a suitable price for congestion management.

How proposed market reforms could affect flexibility remuneration: Several market reforms have been proposed in recent years, mainly aiming at monitoring and counteracting the steep increase of energy prices. Anyway, most of them do not distinguish flexibility resources which should be treated separately, taking into account that one of the scopes of these resource is to facilitate network management, thus having as an effect the one of reducing electricity prices.

The activity was concluded by development of a comprehensive set of Regulatory Guidelines, which are reported in chapter 3 of the present report.

The complete set of results of section 2.3 is presented in **deliverable D6.3** (**https://flexplan-project.eu/wp-content/uploads/2023/03/D6.3_20230308_V1.0.pdf**).

3. Final regulatory guidelines

As explained in the previous chapter of the present report, the FlexPlan project carried out a comprehensive overview of the present regulatory framework, This brought to the formulation of the following set of guidelines and recommendations for a proper deployment of flexibility resources:

- Investments in storage and flexibility will remain mostly in the hands of private investors, municipalities and other subjects (excluding SOs). **National Regulatory Authorities should translate the suitability of deploying new storage or flexibility in strategic network locations into opportune incentivization/support mechanisms for potential investors.** This complicates the traditional scheme, where System Operators after carrying out planning analyses were the only subject entitled to invest.
- Such incentivization mechanisms should contain a locational element able to drive potential investors to prefer an investment in critical nodes, identified on the basis of the studies led by the System Operators. **This could be carried out by means of locational capacity markets.** However, the development of a long-term incentivizing framework able to attract investments towards critical locations could reveal regions with high potential for the exercise of market power. In these cases, **market-based mechanisms for the procurement of flexibility services should be combined with long-term contracts with a pre-established strike price**, so as to disincentivize investors receiving long-term incentivisation to apply significant bid-up strategies. In alternative, **a cap on bid prices** could be explicitly established. Finally, a **"must-run" situation**, in which the SO bids the asset on behalf of the owner can also be acceptable, but just in extreme cases.
- **Real-time market should be reformed by defining products that allow "flexibility" providers to compete with traditional resources on a "level playing field" basis.** Of course, SO needs should be taken into account too, as buyers of these services. Operative constrains of storage and demand side management should be fully considered.
- Despite some significant yet incremental steps done in 2019/944 Directive**, active use of Demand Response has been inhibited due to lack of a comprehensive regulatory framework for the subject**. In that sense it is difficult to underestimate the importance of the forthcoming Network Code for Demand Response. The FlexPlan Consortium acknowledges the significance of the presented ACER's Framework Guideline for the Code, which presents an outline for the main subjects to be stipulated. The final document shows a great improvement after the public consultation accomplished in autumn 2022. It also creates a logical connection between network development planning as described in Art. 32 and demand response, as an alternative to system expansion.
- Despite recognising the importance of aggregation for demand response, Directive 2019/944 failed to define role and responsibilities of the Aggregator, the key element in the puzzle. By contrast, we believe that **role and responsibilities of the aggregators should be accurately designed at a common European level.** In the final version of the Framework Guideline more details have been specified, but the future role of Aggregator still remains somewhat unclear and probably has to be properly addressed at another legal level (e.g. in a new version of the 2019/944 Directive). Here, the FlexPlan consortium assumes that an aggregator should act by compensating positions with opposite risk exposures, thus favouring real-time markets operation. However, the business case of the aggregators must also be considered so that their operation is capable to provide them with the needed

revenues, without which no real subject, even in presence of a specific regulation, will ever volunteer to take such responsibility.

- **In future energy systems, TSO and DSOs should coordinate their planning activities.** In fact, most of the potentially flexible loads as well as most distributed generation are being connected to distribution systems. However, it is not thinkable to allow a really integrated planning of transmission and distribution: on one side the optimization problem would be too complex and on the other system operators are not allowed to exchange private data with other subjects, be they even other system operators. Therefore, a coordinated approach can be suggested in which by means of an exchange of data at the border between different systems, DSOs can, in case advantageous for the system, oversize their network so as to get fit to provide services to transmission. The T&D decomposition approach proposed by FlexPlan can be, in our opinion, a good starting point for reasoning on this approach.
- Cost-benefit analysis must take into account positive effects of flexibility resources. Key importance must be attributed to the Green House Gases (GHGs) and other pollutant reduction. **Environmental aspects should be put in monetary terms so that they can be co-evaluated with more traditional ones (social welfare, etc).**
- **Market reforms are now investigated in Europe, so as to decouple market prices from gas prices (possibility of price-caps or two-stage markets). These reforms, while considering the role of generators and loads, usually don't consider explicitly the role of flexible resources (e.g. arbitrage between market prices at different times).** Taking into account the fact that storage and DSM will be two major players in the future provision of ancillary services, a clarification on the nature of the service provided by these subjects would bring to more forward-looking reform of market mechanisms.

4. Impact assessment

The regulatory guidelines reported in the previous chapter of the present report summarize the regulatory thought of the project.

The present regulatory context, prompts to consider flexibility as a full-fledged candidate for system refurbishment in System Operators grid planning procedures:

- according to Directive (EU) 2019/944 (Art. 32, Art. 40) storage and demand response should become full-fledged grid planning candidates;
- according to Regulation (EU) 2022/869 (Art. 13) ENTSO-E's infrastructure gap analysis must consider with priority "all relevant alternatives to new infrastructure".

However, some barriers do remain to this process. **Deliverable D7.6** (https://flexplan-project.eu/wp-content/uploads/2023/03/D7.6_20230306_V1.0.pdf) performed an impact assessment analysis by considering the potential impact of the FlexPlan methodology in three different regulatory contexts:

1. the present regulatory context (status quo);
2. status quo (point 1) + some long-term mechanisms in addition to the status quo regulation, capable to provide locational signals to drive new investments in flexibility assets (new storage and flexibilization of existing loads) to be carried out where system operators' studies indicate the maximum profitability for the system;
3. long-term mechanisms (point 2) + real-time-markets reform, so as to create new products and to modify architectures to promote a "level playing field" participation in real-time markets by flexibility providers, for which such markets were not created.

The impact analysis was carried out by highlighting the following aspects:

- overview: outline of the reference regulatory context,
- advantages and drawbacks of the FlexPlan methodology in this context,
- technical issues and barriers encountered in applying the FlexPlan methodology,
- enabling factors to overcome the barriers.

The result of this analysis can be summarized by the following synoptic tables:

Regulatory framework 1: "Status quo" regulation	
Key impact	**Enablers**
This scenario proposes to apply the FlexPlan methodology and provide flexible resources (new storage devices and flexibilization of existing loadsd) with the possibility to bid in ancillary services markets without modifying the current European and national regulations.	No enablers are requested, as the regulation would stay as it is. However, this scenario would highlight several barriers for an efficient deployment of the flexibility from storage and demand-side management.

Regulatory framework 2: Capacity Markets become open for flexible resources	
Key impact	**Enablers**
This scenario resolves the limited availability of flexible resources (e.g. demand response and electric storage) in specific well-defined places, where they will be needed for provision of services for network operation. The scenario proposes modifications to the existing capacity mechanisms to incentivise investments into flexible assets in the right place and period of time by facilitating investment recovery. This will make flexible assets a more reliable and attractive alternative for a more efficient planning of transmission and distribution grids.	The existing technical requirements for participation in capacity mechanisms, should be redesigned in order to accommodate flexible resources. Considering experience from the existing markets, FlexPlan suggests: (i) Reduction of min bid size. The forthcoming Demand Response Guideline indicates reduction of min bid size granularity for balancing energy products to 0.1 MW, the figure could be adapted for capacity mechanisms as well. (ii) Minimum duration of the bid, with timeframes allowing participation of flexible resources. (iii) Ramp requirements, to fully exploit resources that can ramp up and down quickly. (iv) Compulsory inclusion of locational information into the bids to ensure correct allocation of the resources. These terms should be considered for specification of detailed demand response pre-qualification requirements, which are suggested in the above-mentioned Guideline.

Regulatory framework 3: Full integration of all technologies	
Key impact	**Enablers**
By assuming a removal of barriers for the participation on ancillary services markets, this scenario facilitates the implementation of the FlexPlan methodology. The access to these markets opens the potential for obtaining additional revenue streams that will increase the potential profitability of new investments. Furthermore, since congestion products include a location component, investors will face a local price which would facilitate the delivery of the FlexPlan methodology.	To enable this scenario, it will be crucial to remove any barrier still in place in the current procurement process for other flexibility resources providing these products (e.g. reduction on bidding size or information requirements) Furthermore, incentivising the provision of aggregation services will improve the overall performance as it will allow smaller providers of flexibility to participate in these markets.

As a conclusion of the impact assessment analysis, the regulatory context of scenario 3 is strongly recommended for a successful enabling of the provision of services from flexible subjects connected to T&D grids.

5. Conclusions

After three-and-a-half years of work within the FlexPlan project, we can state that a first cornerstone has been laid down for the creation of a new grid planning methodology able to cope with some important challenges of the next years: increasing RES penetration, need to provide flexibility for the system, need to coordinate transmission and distribution planning so as to make possible for the flexible resources connected to distribution grids to provide services to the transmission system.

The FlexPlan project has analysed several aspects tied to the synergy between flexibility resources (storage and flexible demand) and grid reinforcement interventions. A new grid planning methodology has been created, a new toolbox applying this methodology has been deployed (as well as a set of open access libraries), regional studies have been developed to demonstrate the feasibility to apply such methodology to problems that have the same level of complexity as those coped with by the System Operators. Finally, the regulatory framework has been analysed, by locating barriers to the application of the FlexPlan methodology and ways to remove them.

The present report summarized the main regulatory reflections carried out by FlexPlan and a set of regulatory guidelines aimed at facilitating the adoption of the methodology and, with that, the possibility for flexible resources (storage devices and DSM) to be considered as entities able to contribute to grid planning and to provide services to the system. As shown as a result of the impact assessment activity, **a regulatory scenario featuring, in addition to the status quo, both long-term mechanisms capable to provide locational signals to drive new investments in flexibility assets and a real-time-markets reform, so as to create new products and to modify architectures to promote a "level playing field" participation in real-time markets by flexibility providers is strongly recommended for a successful enabling of the provision of services from flexible subjects connected to T&D grids.**

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