

Deliverable 6.4

Recommendations for a deployment roadmap of
the most promising use cases studied in the pilot
tests

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Glossary

Refer to ENTSO-E glossary, <https://www.entsoe.eu/data/data-portal/glossary/Pages/home.aspx>.

Table of acronyms

Acronym	Meaning
ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserve
BRP	Balancing responsible party
BSP	Balancing service provider
DG	Distributed generation
DR	Demand response
EB GL	electricity balancing guideline
EU	European Union
FAT	Full Activation Time
FCR	Frequency Containment reserve
FF	FutureFlow
mFRR	Manual Frequency Restoration Reserves
NC	Network Codes
RES	Renewable resources
TSO	Transmission system operator
VPN	Virtual Private Network
VPP	Virtual Power Plant

The aim of the FutureFlow Project

Four European TSOs of Central-Eastern Europe (Austria, Hungary, Romania, Slovenia), associated with power system experts, electricity retailers, IT providers and renewable electricity providers, propose to design a unique regional cooperation scheme: it aims at opening Balancing and Redispatching markets to new sources of flexibility and supporting such sources to act on such markets competitively. By means of a prototype aggregation solution and renewable generation forecasting techniques, flexibility providers – distributed generators (DG) and commercial and industrial (C&I) consumers providing demand response (DR) – are enabled, to provide competitive offers for Frequency Restoration Reserve (including secondary control activated with a response time of 30 seconds and full activation time of 15 minutes). Retailers act as flexibility aggregators and pool the resource in order to provide the products required by the TSO. A comprehensive techno-economic model for the cross border integration of such services involves a common activation function (CAF) tailored to deal with congested borders and optimized to overcome critical intra-regional barriers. The resulting CAF is implemented as a cloud solution of a prototype Regional Balancing and Redispatching Platform, which makes research activities about cross-border integration flexible while linking with the aggregation solution. Use cases of growing complexity are pilot-tested, going from the involvement of DR and DG into national balancing markets to cross border competition between flexibility providers. Based on past experience with tertiary reserve, participating C&I consumers and DG are expected to provide close to 40 MW of secondary reserve. Impact analyses of the pilot tests together with dissemination activities towards all the stakeholders of the electricity value chain will recommend business models and deployment roadmaps for the most promising use cases, which, in turn, contribute to the practical implementation of the European Balancing Target Model by 2020.

Project Partners

No	Name	Short name	Country
1	ELES DOO SISTEMSKI OPERATOR PREOSNEGA ELEKTROENERGETSKEGA OMREZJA	ELES, d.o.o.	Slovenia
2	AUSTRIAN POWER GRID AG	APG	Austria
3	MAVIR MAGYAR VILLAMOSENERGIA-IPARI ATVITELI RENDSZERIRANYITO ZARTKORUEN MUKODO RESZVENYTARSASAG	MAVIR ZRT	Hungary
4	COMPANIA NATIONALA DE TRANSPORT ALENERGIEI ELECTRICE TRANSELECTRICA SA	TRANS	Romania
5	ELEKTROINSTITUT MILAN VIDMAR	EIMV	Slovenia
6	ELEKTROENERGETSKI KOORDINACIONI CENTAR DOO	EKC	Serbia
7	ELEKTRO ENERGIJA, PODJETJE ZA PRODAJO ELEKTRIKE IN DRUGIH ENERGENTOV, SVETOVANJE IN STORITVE, D.O.O.	EE	Slovenia
8	GEN-I, TRGOVANJE IN PRODAJA ELEKTRICNE ENERGIJE, D.O.O.	GEN-I, d.o.o.	Slovenia
9	SAP SE	SAP SE	Germany
10	CYBERGRID GMBH	CYBERGRID	Austria
11	GEMALTO SA	GTO	France
12	3E NV	3E	Belgium



1 Introduction

Under the H2020 initiative an ambitious project of four European TSOs of Central-Eastern Europe (Austria, Hungary, Romania, and Slovenia), a unique regional cooperation scheme was designed. The aim was to test integrated balancing and redispatching markets of four countries, whereby the new sources of flexibility under the aggregation are tested in real-life situations. By means of a prototype aggregation solution and renewable generation forecasting techniques, flexibility providers – distributed generators (DG) and commercial and industrial (C&I) consumers providing demand response (DR) are enabled, to provide competitive service for automatic Frequency Restoration Reserve (activated with a response time of 30 seconds and full activation time of 5 minutes). Retailers act as flexibility aggregators and pool the resource to provide the products required by the TSO. A solution deals with congested borders and optimize critical intra-regional barriers. C&I consumers and DG were providing close to 70 MW of aFRR for the pilot tests.

The FutureFlow project proved that aggregated DR&DG resources can be very beneficial in the future, where more and more energy will be provided by renewable resources - RES like sun and wind. When the balancing markets will be flexible enough, that means when the procurement procedures are carried out on a short-term basis with short (few hour) products, the new flexibility sources will represent real and healthy competition to the conventional units taking part in the aFRR yesterday and today. The FutureFlow project also shows that a lot of additional effort in overcoming the barriers and obstacles for DR&DG to play an important role in all markets, special in balancing market, will be necessary. The complexity of the integrated aFRR market, which will include also distributed electrical resources as DR&DG, demands investments and development for all stakeholders.

The aim of this document is to elaborate recommendations for the deployment roadmap based on the experimental phase in the project. However, we go even further. As promised in the beginning of the project FutureFlow will not stay on the level of the scientific papers and we kept our promise. This document presents some concrete actions from the TSOs deployment plans. Namely, within the FutureFlow project the partners carried out over 300 hours of real-time tests with prosumers taking part in the aFRR service (detailed reports are available in WP 5). With all those tests, using various technologies, a lot of useful experiences have been gained that will help and serve as a basis to the TSOs when updating rules for future balance service providers and when re-designing their local balancing markets to fit into the cross-border environment. We believe the common goal of all 4 markets and also markets outside of the FutureFlow project is to design flexible balancing markets, with shorter products that enable

integration of prosumers into this services and further the cross-border market integration. It is also important which technologies have the potential and capability to take part in the complex aFRR process. How individual countries cope with this challenges, how they progress and how they structured their deployment plans towards the final target model it will be presented in the continuation of this report.

2 Starting point for the deployment in each country

2.1 Implementation of the EU regulation

TSO's are responsible for the operation and stability of the power systems. Balancing services are one of the most important services in the process. Though the balancing capacity and energy, specially aFRR is something that comes in limited resources, for the TSO's would be most comfortable to stay in the safe zone of classical balancing sources like hydro, gas and thermal power plants. There are many reasons for that, but mainly we can summarise them in the following:

- Fear from unknown
- Investments in IT (applications and security)
- Investments in the prequalification process
- Investments in supervision and control

On another hand, TSO's are strongly regulated, and the European Commission has foreseen bigger role of the electricity market for a future. In 2009 EC implemented Directive 2009/72/EC concerning common rules for the integrated electricity market. Following by Network Codes and a Winter Package. The TSO's are obliged to open their enquiry for balancing services towards new sources as DR&DG, aggregators, RES and enable a transparent and non-discriminatory rule.

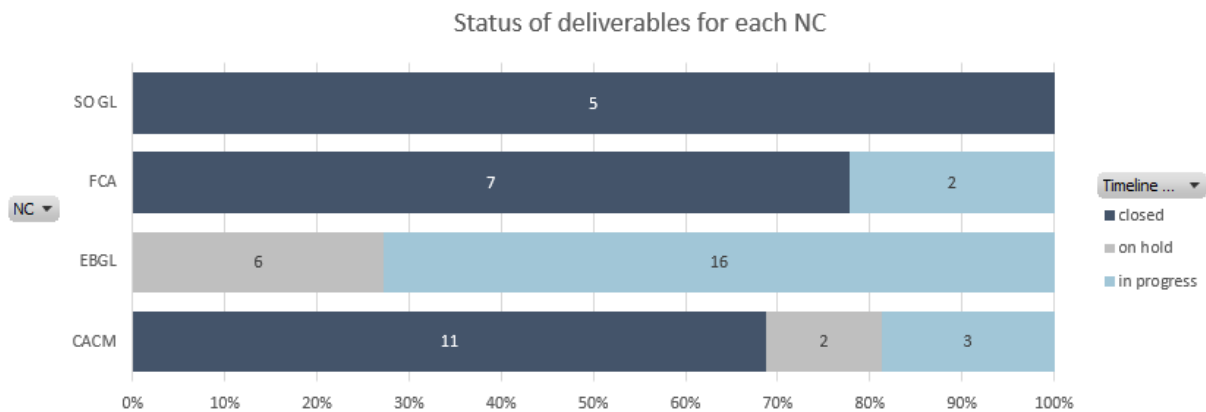


Figure 1: The status of the implementation phase of some relevant Network Codes in October 2019.

2.1.1 Electricity balancing guideline

Network Codes, especially the electricity balancing guideline (EB GL) – published on 23 November 2017 is opening the balancing services to the market. TSO's being fully aware of the responsibilities coming with the new legalisation started to prepare themselves

also through the projects like the FutureFlow. We could say that the coexistence of the Network Code implementation and the FutureFlow project turned out to be extremely useful. Namely, the experiences gained from the FutureFlow project helped a lot the TSOs when preparing update of the balancing market rules for existing and new entrants. The new rules also refer to the connectivity, IT platforms etc. and here the project provided valuable inputs. This finding is especially valid for the countries with less mature balancing market (e.g. Slovenia, Romania, Hungary), but not so relevant for Austria with its liquid and mature aFRR market, already integrated with Germany.

2.1.2 Clean energy Package

Clean energy package goes even further in empowering (active) consumers, distributed generators, aggregators and active customers. It requires non-discriminatory access, level playing field, separation of supply and aggregation, free non-discriminatory access to data, financial balance responsibility for aggregations, no undue payments of consumers' to suppliers, compensation to suppliers is possible subject to conditions[1].

2.2 Are FutureFlow countries ready for deployment

Out of the four participating countries in the FutureFlow project, only Austria has experiences in the participation of aggregators in the aFRR process. However, DR&DGs still present relatively low part of the aFRR resources. Currently, the business case for DR&DG in Austria is still relatively weak (around 10 % of aFRR and mFRR). Partly because the aggregators can only attract customers with large amounts of flexible load or backup generation, partly because aggregator has to have a bilateral agreement with the BRP for BRP's sourcing cost. Also, a wind park, which receives feed-in tariffs is not allowed to participate in ancillary services (and since all imbalance costs are covered by the balance group for green electricity, the operator does not even have to care about forecasts.) The PV has been in the past included into support schemes and receiving fees for each produced kWh and therefore lack the interest to participate in a downward regulation.

All the rest of the countries, Slovenia, Romania and Hungary, do not use any aggregators as aFRR providers and have gathered their first experiences through the FutureFlow project. Despite many incentives that speak in favor of active role of DR&DG in the balancing process, the reluctance towards participation in DR&DG pool is very much present. There are many reasons for this. The responsibility for secure system operation and rather easy handling of this responsibility with conventional sources compared to achieving the same level of security with new flexibility sources. Especially smaller resources present a big challenge. The investments in metering, communication, and security should be made for each participant in the pool. It is not yet clear, who will bear the cost of the investment and how the gains from aFRR sold on the market will be divided. Last but not least, the size of the market and its illiquidity is an important short-

term factor that demotivates TSOs to enter revolutionary changes. No matter what the TSOs do, local markets will not be liquid enough. But this factor will change in the longer term. With the cross-border integration of local aFRR markets, the liquidity will increase significantly, and efforts will be paid.

We have shown in our study of available DR&DG potential; there are already significant resources available. Through the pilot tests, we proved that the contribution of DR&DG is technically and economically justified.¹ DR&DG also bring higher sustainability of the microgrid systems and better security in case of major electricity break downs. Their development contributes to social welfare. We could say that our research brought our idea to the technology readiness level 6 and 7. With some individual, isolated cases we have even reached level 8.



Figure 2: The levels of technology readiness.

For further deployment quite a few more steps are needed:

1. Barriers that had been identified in D6.2. should be eliminated
2. Suitable business models for all players developed

We have described the technical, economic and regulatory barriers with proposed solutions in D6.2.. In this Deliverable we will focus on the step-by-step deployment from the past balancing arrangements towards the future integrated markets with a significant share of new flexibility sources and decreased share of thermo production.

¹ D6.1 Assessment of the pilot tests

3 TSO's deployment recommendations, experiences and plans

For the implementation of the solution proposed by the FutureFlow, the target model proposed by the FF should be implemented in each country. Tables below shows how each participating country situation varies in comparison to the FF target model.

There were, or better to say there are very different starting points in each country. But the final goal should be the same; therefore, the actions taken by the TSOs differ. In the following chapter we have prepared an overview that illustrates the evolution of the balancing market in Austria, Slovenia, Hungary and Romania. The tables bellow have been prepared in an attempt to put the most important elements, parameters and indicators on a common denominator. The colours red, orange and green illustrate the maturity of individual important elements of the balancing market. Before 2015, before the so called “era of the FutureFlow”, in some countries plenty of elements were far from the final target model (therefore coloured red), either the FutureFlow target model, either the Picasso model. With time and evolution some of these elements turned orange or green. In any case the process is ongoing, and the deployment plans are a live process.

3.1 ELES

Slovenian TSO has very difficult job in terms of efficient ancillary services management due to very limited balancing resources in Slovenia and on the other hand relatively high needs for reserve power. It should be emphasised that the high need for reserves in Slovenia is connected with large power plants (Nuclear PP 696 MW, Thermal PP 553 MW) compared to peak load (ca 2100 MW). Therefore, ELES is involved in various research projects seeking at new flexibility sources in combination with cross-border exchange of these services. Main goal of the research and development activities within ELES is a step by step transition from the long-term arrangements with BSPs from the “era before FutureFlow” to more flexible balancing environment in the future where DR&DG balancing units play an important role.

The FutureFlow project presents an important leverage for ELES starting the reorganisation and introduction of necessary changes in the field of balancing services. ELES widely uses the experiences from the FutureFlow project at re-designing Slovenian market for balancing services. Products, parameters and other findings from FutureFlow were gathered into the new rules and this is definitely one very important milestone in the deployment roadmap.

ELES re-defined all technical requirements (requirements for units, FAT, tolerances, communication requirements, etc.) as well as market requirements (product definitions

and characteristics, auction procedure, etc.) for each load frequency control action (FCR, aFRR, mFRR) that balance service providers need to be compliant with for successful prequalification procedure and eventually service provision. A prequalification procedure has been established in Slovenia. Such a procedure was not in place in the past and thanks to FutureFlow the procedure has already been implemented. The prequalification concept is identical to the FutureFlow concept and has actually been copy-pasted. Next actions that need to be mentioned are the integration of the Merit Order List into the ELES's Load Frequency Controller and the introduction of separate upward and downward bids replacing obligatory symmetrical offers from the past. Also the portfolio instead of unit based activation is enforced.

Currently, ELES and Slovenian balance service providers are in the process of prequalification and preparations for the year 2020. The year, in which the influence of the FutureFlow on Slovenian local balancing market will already be seen. We believe that with time the percentages of new flexibility sources will increase and that new business models will be applied in practise.

Table 1 shows the evolution of Slovenian balancing market. With colours red, orange and green we tried to illustrate the maturity of individual important elements of the balancing market. Before 2015, before the so called "era of the FutureFlow", all the elements were far from the final target model (therefore coloured red), either the FutureFlow target model, either the Picasso model. With 2020 plenty of elements from the target model will be applied and from the conceptual point of view Slovenian market will be ready for the next step – the cross-border integration. But there is one more step in-between – to gain experience in the local mode operation. In 2020 and 2021 Slovenian balance service providers will operate in a local mode since the integration is not possible yet. However, within the next two years, we cannot expect the full liquidity (because our local market is simply too small), there will be a lot of new entrants, experiences gained and we believe Slovenian power system in a good condition will be awaiting the cross-border integration in about three years from now.

Table 1: Market model development ELES

Parameter	ELES				Justification/comment
	Before FutureFlow (-2015)	Current (2020)	FutureFlow Target model	Future	
Minimum bid to the balancing market, i.e. product resolution (in size) at each product bin (in time).	1 MW	1 MW	1 MW	1 MW	
Is aggregation allowed to reach the necessary product resolution (in size)?	NO	Yes	Yes	Yes	
Are demand response aggregators participating in the aFRR market?	NO	Yes	Yes	Yes	With 2020 the DR aggregators start to participate in the aFRR process
At which timeframe must bids be submitted, i.e. what's the procurement cycle (distance to real-time)?	Annually	In November annually, each month monthly	D-1	till aFRR cooperation (2020) D-1 (till 15:00) – obligatory bids H-2 in D – voluntary bids (aFRR cooperation) (beyond 2020) T-25' – obligatory and voluntary bids	According to national T&C requirements, BSPs are allowed to submit their energy bids in D-1. However, according to PICASSO concept the GCT for BSPs is foreseen T-25'.
Is submitting a symmetrical bid a necessity?	Yes	No	No	No	With 2020, upward and downward bids

At which resolution is the balancing capacity procured, i.e. what's the product resolution (in time)?	Annually	1 year bid, 1 hour activation	1 hour bid 15 min activation	(till aFRR cooperation) (2020) 1 hour bid (aFRR cooperation) (beyond 2020) 15 min bid	
What is the asked full activation time?	15 min	5 min	5 min	5 min	
What is the allowed tolerance limit?	Envelope concept	Envelope concept	Envelope concept ²		The Envelope concept is a dynamic criteria according to which the unit's performance is evaluated
Activation rule	Pro-rata	Merit Order	Merit Order	Merit Order	
Activation rule (type)	Continuos	Stepwise	Stepwise	Stepwise	
Settlement	Pay-as-bid	Pay-as-bid	Marginal pricing	Marginal pricing	
What is the volume [in %] of DG&DR participation of total reserve for aFRR?	0 %	13 %	N/A	25 % (till 2021) Up to 50 % till 2025	Increase of aggregated new flexibility sources expected up to 50 %.
What is the volume [in %] of conventional units (thermo) participation of total reserve for aFRR?	60 %	50 – 60 %	N/A	30 %	Reduction of conventional (thermo) units share for appx. 25%
Prequalification procedure for aggregators participation in aFRR.	No	Yes	Yes	Yes	Developed prequalification procedure for BSPs within FutureFlow has been introduced and adopted on the national level (included in the national T&C).

² The Envelope concept is a dynamic criteria developed within WorkPackage 4. Its purpose is to evaluate the unit's performance in the aFRR process.

3.2 APG

APG started early with the development of the balancing markets. At the beginning of liberalisation process there was only a market for tertiary reserves (mFRR). High costs of balancing reserves and the respective evolution of legislation resulted in the creation of a market for primary control (FCR/2010) and later also for secondary control (aFRR/2012). Nevertheless, the conditions for market participants were mainly elaborated for conventional providers, namely electricity supply companies.

Since there were more and more complaints about the strict rules for reserves – e.g. the rule for BSPs to restrict their reserve pools to one BRP – which limited the possibilities for aggregators remarkably APG decided to establish a completely new set of rules for prequalification in 2014. The goal of these rules was most possible openness for all possible kinds of units and of BSPs. Consequently, there are no limits concerning technology and size of units. Furthermore, the aggregation structure allows BSPs to operate individual strategies.

In the last years APG gathered a lot of experience concerning specific concepts of aggregators including baseline concepts for different technologies and different BRP pool solutions (e.g. a smart city concept). The technologies include e.g. heat pumps heating/cooling devices, snow cannons, power-to-heat-units, industrial sites, etc..

In parallel to the development of the Austrian market the cooperation with other TSOs has been developed as well starting with the first cooperation for FCR (2013) which has been enlarged up to now by France, Germany, Belgium, Netherlands and Switzerland.

In 2013 a netting cooperation between APG, ELES and HOPS started. It was very useful both in reducing necessity to activate aFRR and gathering experience with netting cooperations in general.

2014 APG started an imbalance netting cooperation with the German TSOs which was extended shortly afterwards to the first cooperation for aFRR between countries in Europe. This cooperation will be further extended to aFRR procurement in 2020 and will probably be the basis for the future central optimization platforms (PICASSO). This year also the first cooperation in Europe for mFRR between APG and the German TSOs will start.

It can be concluded that the new conditions for BSPs in Austria as well as the far developed cooperations with other TSOs have stimulated the market remarkably resulting in a significant drop of costs for balancing in Austria.

Table 2: Market model development APG

Parameter	APG				Justification/comment
	Before FutureFlow (-2015)	Current	FutureFlow Targer model	Future	
Minimum bid to the balancing market, i.e. product resolution (in size) at each product bin (in time).	5 MW	1 MW	1 MW	1 MW	
Is aggregation allowed to reach the necessary product resolution (in size)?	YES	YES	Yes	YES	
Are demand response aggregators participating in the aFRR market?	YES	YES	Yes	YES	
At which timeframe must bids be submitted, i.e. what's the procurement cycle (distance to real-time)?	W-1	D-1	D-1	D-1	
Is submitting a symmetrical bid a necessity?	No	No	No	No	
At which resolution is the balancing capacity procured, i.e. what's the product resolution (in time)?	5 MW	1 MW 4h-bids	1 hour bid 15 min activation	1 MW 15 min-bids	Goal for PICASSO

What is the asked full activation time?	5 min	5 min	5 min	5 min	Probably 7,5 min in PICASSO
What is the allowed tolerance limit?	3%	3%	Envelope in D4.3	3%	
Activation rule	Merit Order	Merit Order	Merit Order	Merit Order	
Activation rule (type)	Stepwise	Stepwise	Stepwise	Stepwise	
Settlement	Pay as bid	Pay as bid	Marginal pricing	Marginal pricing	
What is the volume [in %] of DG&DR participation of total reserve for aFRR?	App. 1%	App. 8%	N/A	N/A	
What is the volume [in %] of conventional units (termo) participation of total reserve for aFRR?	App.6 %	App. 6 %	N/A	N/A	
Prequalification procedure for aggregators participation in aFRR.	YES	YES	Yes	YES	

3.3 MAVIR

MAVIR had to face quite early with the challenge of establishing the balancing market. At the time of 2005 APG started early with the development of the balancing markets. At the time of 2005 there were 4 types: primary, secondary, minute and hourly types of reserves as a basis of balancing services. By the time it transformed into 3 types: primary (FCR), secondary (aFRR) and tertiary (mFRR). The big milestone in the market of balancing was 2008-2009, when the MAVIR had to introduce the procurement based balancing capacity market. By this time there were several market designs due to the different timeframes of balancing capacity procurement: yearly, quarter-yearly, monthly, weekly, daily. The procurement of balancing capacity from aFRR is quarter-yearly, weekly regularly and daily occasionally (in case there is any additional need identified). From 2020 instead of the weekly procurement the regular daily procurement will be introduced. The next important milestone is 2011, when the aggregators (or virtual power plants) occurred on the aFRR and mFRR markets. By the last almost 10 years, the number and the total installed capacity of aggregators increased. The next milestone expected in the near future is the involvement of renewables and DR in the aggregators' portfolio. The big advantage of aggregators is that they can include smaller units than 1 MW and by their aggregation they can ensure the minimum 1 MW size of bid both on balancing capacity and balancing energy market.

Balancing energy activation is based on merit order list from the very beginning, and settlement is based on pay-as-bid system, but the important change during the last 3 years is that on aFRR market there is no cap for the balancing energy price. The activation is based on the continuous method, which aims at compensating the less quick sources of balancing, this continuous and merit order list based activation enables proving huge amount of unintended exchange in the system.

For the last 6 years, MAVIR has become the participating member of e-GCC imbalance netting cooperation. It involves the Slovakian and the Czech control areas in the coordinated cooperation. Participation in e-GCC resulted in approximately 20% of imbalance netting based energy exchange comparing to the total aFRR balancing energy activation in the Hungarian system.

Table 3: Market model development MAVIR

Parameter	MAVIR				Justification/comment
	Before FutureFlow (-2015)	Current	FutureFlow Target model	Future	
Minimum bid to the balancing market , i.e. product resolution (in size) at each product bin (in time).	1 MW	1 MW	1 MW	1 MW	
Is aggregation allowed to reach the necessary product resolution (in size)?	Yes	Yes	Yes	Yes	
Are demand response aggregators participating in the aFRR market?	No	Partly	Yes	Yes	
At which timeframe must bids be submitted , i.e. what's the procurement cycle (distance to real-time)?	D-1	D-1	D-1	D-1	
Is submitting a symmetrical bid a necessity?	No	No	No	No	
At which resolution is the balancing capacity procured , i.e. what's the product resolution (in time)?	5+2 days long, few hours long, 1 hour long and there is 15 min activation	5+2 days long, few hours long, 1 hour long and there is 5 min activation with 15 min	1 hour bid 15 min activation	Few hours long, 1 hour long bid, and there is 5 min activation with 15	The length of the capacity product depends on the procurement process.

Parameter	MAVIR				Justification/comment
	Before FutureFlow (-2015)	Current	FutureFlow Target model	Future	
		activation settlement		min activation settlement	
What is the asked full activation time?	15 min	15 min	5 min	5 min	
What is the allowed tolerance limit?	Technology and ramprate dependent	Technology and ramprate dependent	Envelope in D4.3	Technology and ramprate dependent	
Activation rule	Merit Order	Merit Order	Merit Order	Merit Order	
Activation rule (type)	Continuous	Continuous	Stepwise	Stepwise	
Settlement	Pay as bid	Pay as bid	Marginal pricing	Marginal	
What is the volume [in %] of DG&DR participation of total reserve for aFRR?	About 20%	About 40%	N/A	-	
What is the volume [in %] of conventional units (termo) participation of total reserve for aFRR?	About 80%	About 60%	N/A	-	
Prequalification procedure for aggregators participation in aFRR.	Yes	Yes	Yes	Yes	

3.4 TRANSELECTRICA

Romanian TSO is faced with changes in the production sources. Till 2014, Romania has fulfilled the 2020 target of renewable integration. In renewables integration process the important role was played by an enough volume of ancillary services. Following the others European targets as decarbonization, some of TPP will limited and the aFRR provided by them will be lost. In those conditions and for preparing for the next challenge regarding renewable integration for 2030, Transelectrica (TEL) develops a diversification of them resources for ancillary services. On the other hand, Transelectrica prepares to put practice European regulations regarding balancing market. In this aim Transelectrica has involved in this project to evaluate the new flexibility sources in combination with cross-border exchange of reserves. FutureFlow created the room for firsts simulations for Romania to use DR&DG balancing units in any type of reserve activation process, including aFRR process.

The FutureFlow project has an important impact for TEL in the process to start changes in balancing services concept. The solutions and simulations provided by the project was taken in account in the issue of market terms and conditions for reserves suppliers, in the technical approach of aFRR activation and in elaboration the first dispatching procedures (for the moment Transelectrica has not those kind of procedures)

Transelectrica has elaborate and submit to NRA, new technical requirements for aFRR including aggregation. Those requirements include requirements for individual units and consumers, FAT, tolerances, communication requirements as well as market requirements including auction procedure. This new prequalification procedure will be in force in 2020, Q2. This procedure includes the FutureFlow concept and use majority of requirements highlighted by Future Flow project. The main change is to change from prorata activation for aFRR and to include the Merit Order List into the Load Frequency Controller, as was the concept has been described into the project. The adoption of the aFRR direct activation has major consequences by changing from symmetrical bits to asymmetrical bits in the FRR process acquisition. In this way, many units can participate the aFRR, including renewables which can provide them reducing availability by separate downward bids.

Table 4 shows the evolution of Romanian balancing market regarding aFRR access to the market. The new rules will apply from 2021 and facilitate the Romanian integration in PICASSO platform.

Table 4: Market model development TRANSELECTRICA

Parameter	TRANSELECTRICA				Justification/comment
	Before FutureFlow (-2015)	Current	FutureFlow Targer model	Future	
Minimum bid to the balancing market, i.e. product resolution (in size) at each product bin (in time).	10 MW	1 MW	1 MW	1 MW	10 MW refer to Regulating Band. From the unit basepoint that means +/- 5MW. We are in process to change to 1 MW as aFRR reserve in up or down direction.
Is aggregation allowed to reach the necessary product resolution (in size)?	NO	Yes	Yes	Yes	
Are demand response aggregators participating in the aFRR market?	NO	Yes	Yes	yes	
At which timeframe must bids be submitted, i.e. what's the procurement cycle (distance to real-time)?	Monthly, weekly	Weekly, daily	D-1	Daily, with minimum interval as t-25 min respecting the platform aFRR exchange requirments	
Is submitting a symmetrical bid a necessity?	Yes	No	No	No	

At which resolution is the balancing capacity procured, i.e. what's the product resolution (in time)?	Monthly, weekly	Daily for 7,5 min full time activation (FAT) and 15 min bid	1 hour bid 15 min activation	15 min bid	
What is the asked full activation time?	15 Min	7,5 min and from 2022 FAT of 5 min	5 min	5 min	
What is the allowed tolerance limit?	+/- 1% Pr	+/- 5% Pr for units less than 20 MW and +/- 1% Pr for larger ones	Envelope in D4.3		Pr – is the rated power of generating unit and if the sum of rated power of entities which are aggregated
Activation rule	Pro rata	Merit Order	Merit Order	Merit Order	
Activation rule (type)	Continuous	stepwise	Stepwise	Stepwise	
Settlement	Marginal Pricing	Marginal Pricing	Marginal pricing	Marginal Pricing	
What is the volume [in %] of DG&DR participation of total reserve for aFRR?	0%	0%	N/A	-	
What is the volume [in %] of conventional units (termo) participation of total reserve for aFRR?	27% are termo TPP and 73 % are hydro HPP	Minor differences starting 2020	N/A	7% will come from others sources	After 1-2 years will expect to have more than 5% aFRR participation from other sources than classical ones
Prequalification procedure for aggregators participation in aFRR.	No	Yes	Yes	Yes	

4 Tentative deployment roadmap in other zones

The roadmap to deploy the most promising use cases in the control zones of all TSOs involved in the pilot tests were extrapolated to other control areas in Europe, paying particular attention to the different regulatory environments and technical constraints faced by TSOs in Europe.

In the final phase of the FutureFlow project, project partners established a closer communication with stakeholders and prepared an analysis of their views on the challenges and opportunities to integrate remotely managed demand and dispersed generation as a source of system services.

Basic and higher levels of stakeholder communication were established, in order to include stakeholder views on the cross-border cooperation of system services markets, regulatory barriers for integration of alternative sources of system services and views on the development of individual markets in the wider region.

At the first stage of the investigation, the current status in the field of the DR&DG as a source of system services was investigated. Investigation tackled two aspects, the one of the providers of specific services as well as users of these services.

At the beginning of the study, a wider set of questions (Appendix 2: Survey) was prepared. The questions were in the second phase, carefully reorganized in the way that all topics were equally covered.

Special attention was given to the selection of the interviewed stakeholders. The problem was in big differences when comparing the stage of development among interviewed countries/systems. For example, there are countries, where there are no market-based system services at all. During discussions with various stakeholders, it was not easy to explain some more advanced methodologies and processes, which are very common and operational in other environments.

4.1 Data acquisition

When choosing participants in the survey, we relied on expert business and research contacts, mostly from the power sector. The selected companies were invited to the study with an email that was focused on the main communication means of the survey.

Most of the participants who were included in the survey defined themselves as familiar with topics presented in the survey, except two who said that they aren't familiar with the topics related to TSOs. Participants¹ were from different countries from Europe; Austria, Bosnia and Herzegovina, Finland, Macedonia, Serbia, Slovenia and Switzerland. There was one company from Austria, Bosnia and Herzegovina, Finland, Serbia and Switzerland; two companies from Macedonia and three companies from Slovenia.



Figure 3: Participants³

4.2 Initial stage of the study

In the first part of the study, the questions were directed into participant's experiences with prequalification tests. Some participants showed a great experience with these tests while others answered as "other", which we treated as lack of experience.

Next, we asked participants to express an opinion on what is most important to them during the execution of the prequalification test. Answers have exposed the following important topics:

- the market model of selecting the most favourable service provider,
- clear process and relevant features to be tested, compliant with service

³ The list of respondents is attached at the end of this document

requirements, which are relevant for the service provider,

- clear requirements related to metering devices and communication with the metering point
- control mechanisms for actual service delivery,
- ability and responsibility of BSPs to deliver aFRR products,
- planning aspects of a TSO, their transparency during the definition of quality and quantity of the service,
- opportunities for new entrants (balancing markets should be open for all potential providers).

Additional conclusions that were drawn from the answers:

- in order to fulfil the requirements given by the BSP and prevent an eventual negative effect on the Power system stability, the DSO is recognized as an important stability stakeholder, that should be properly included in the process if the flexibility is used and controlled by the TSO.
- it should be mandatory that DSO approves the possibility of the use of flexibility for the balancing services if it is connected to the DSO grid like it is mandatory in Austria.
- Special attention should also be put to the quality of the tests, where a transparent criterion should be established by the TSO and fulfilled by the provider.

In the next step, the participants had to expose their positive or negative opinion related to their experience with the prequalification tests. For the negative part, all groups suggested an improvement in communication as the main challenge. The second suggestion was given towards better transparency and overall determination of a clearer process.

The positive answers appraised selection processes where service providers are:

- selected through a process of a public tender,
- technical conformity criteria are defined in advance (business risk assurance),
- the procedures follow a clear and transparent process.

Additional negative opinions were related to:

- the issue of energy usage during the prequalification tests, which is typically not reimbursed,
- additional costs with the prequalification test, which disfavour distributed service providers against providers of centralized services (power plants),
- Unnecessary high extent of technical analysis and examination of the provider's ability to prove the actual provision of its aFRR product.

- period of testing is too extensive,
- testing protocols are lacking clearness,
- in general, the prequalification tests are running against new entrants.

In-depth analyses on the troubles with pre-qualification tests and other aforementioned problems showed the following opportunities for improvement:

- TSOs have trouble to gain any information whether service provider has the capacity and experience of providing the requested service,
- new participants should gain more practical experience from the existing participants, more details to be provided to new and potential participants
- balancing market should be fully open for all potential providers with minimal technical preconditions (equipment, communication).
- TSOs should design more customized products for aFRR, some of which should be linked with the capacity payment (strong conditions, system security oriented, stronger prequalification procedure and capacity payment) and some without these strong conditions.
- TSOs should better standardize the testing procedure.
- Improvements should be also related to a clear set of rules, decreasing of the testing time and keep anonymity during testing.
- methodology of test procedures should be further developed and tailored to the new entrants.

4.3 The quantitative part of the study

A survey included some quantitative elements; here the questions required from the participants to answer with a choice from 1 – 4, in which 1 meant no impact at all, 2 – minor impact, 3 - major impact and 4 – necessary.

The average numerical answer given by the participants was 3 points. This could be interpreted in the way that questions asked in the survey were important for participants and they all provided answers spanning from extremely neglecting to very positive impact.

Table 5: Table of answers to the quantitative part of the survey⁴

Questions	Participants										Average
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
Q7	2	4	4	1	4	3	3	4	4	2	3
Q8	4	3	4	4	4	3	4	4	4	2	4
Q9	3	3	3	2	3	3	4	3	3	2	3
Q10	2	4	2	2	3	4	1	3	1	3	2
Q11	3	4	3	4	4	4	3	1	4	3	3
Low prices	3	4	3	3	3	2	1	2	4	3	3
Good delivery services	3	4	4	3	4	4	2	4	4	3	4
Quality of services or quality of products	4	4	4	3	4	3	2	4	4	3	4
Relationships	2	2	3	2	2	3	3	2	2	2	2
Communication	2	3	3	3	3	2	4	3	3	2	3
Data exchange	2	3	3	3	4	1	4	4	4	3	3
Long term contracts (more than one year)	2	4	3	1	1	3	2	2	1	3	2
Other	*	*	*	*	*	*	3	*	*	*	*
Low network charges	3	4	3	3	3	4	3	4	4	3	3
Simple apply procedures	3	4	4	4	4	4	3	3	4	4	4
Data transparency	2	3	4	4	3	3	2	4	3	4	3
Long term contracts (more than one year)	4	2	3	2	1	2	3	4	4	3	3
Other	*	*	*	*	*	*	*	*	*	*	*
Q15	1	1	2	4	1	4	3	1	3	3	2
Q16	1	1	1	4	1	1	1	1	2	2	1
Q17	3	1	3	2	4	2	4	3	1	3	3
Q18	3	4	3	3	4	3	4	3	4	3	3
Q19	3	2	1	3	3	3	3	3	4	3	3
Q20	3	1	3	1	3	2	3	3	4	4	3
Q25	3	1	4	3	3	2	1	4	4	2	3

Table 5 provides the answers of the participants. From the results, we can draw another conclusion that the participants selected in the survey arrive from the appropriate sector and area and can identify and suggest resolutions for the mentioned issues.

The highest ranked was Question 8, which evaluated how important is In the that NRA request explicit provision to enable DR&DG participation in the national aFRR market and make sure that they are treated equally and were marked with 4 points - necessary.

Next group of answers that found claims under number 10 and 15 ranked as important is this group of claims related to the need of additional provisions in the grid connection rules and about the establishment of independent aggregator in a specific market.

As no impact at all was ranked question 16: “How much do you agree with the thesis that customers and aggregators do not need a contract with supplier / BRP to provide flexibility?”

4.4 Effect of electric vehicles

Next part of the questionnaire dealt with the most controversial topic of the survey. This question was about the relation between the power grid and the electric vehicles charging. It is extremely important for the FutureFlow project to get the feedback on the question “Electric vehicle charging will become one of the most promising demand that has the potential to be included in demand response services. What do you see as a problem on the power grid side in relation to Electric vehicles charging?”, since EV will be a huge user of electricity in future, but can be a source of aFRR too.

This question raised a lot of interest and was answered by all participants. They agreed

⁴ Questionnaire in the table is specified in attachment

charging will have a great impact on the required peak generation.

Participants also expressed their ideas on how to solve the challenges on the side of the power network in relation to the Electric vehicles charging:

- Starting time of the charging - this will have a large effect on the required peak generation in a country.
- Through the price of electricity for charging electric vehicles, it is possible to ensure the balancing of the power system.
- The price of electricity for charging electric vehicles should be adjusted depending on the momentary load of the power system.
- Increasing EV fleet of business enterprises and households will increase their electricity peak demand, which based on the actual network tariffs means an increase of their electricity bills.

Furthermore, the feedback provided the following ideas:

- The power system should ensure adequate electric power and energy consumption.
- Consumer's behaviour should be measured and checked.
- Grid connection Rules are tailored to the operation of centralized units. Requirements need to consider that resources of flexibility from EVs will be located in multiple places.
- if requirements are too tight, this will kill the EV business and no distributed resources will arise from EVs.
- Provision of ancillary services from EV is based on the probability that EVs are indeed connected to the grid at the very moment of the need for balancing. If there are not enough EVs connected to the grid at certain point in time (when balancing energy is needed), TSO will have to activate other units which means that TSOs would probably have to reserve more capacity than needed because of the uncertainty of EV.
- important to notice the charging speed of EV, number of vehicles and intensity of charging.
- Unclear ways and organization of EVs charging can be another challenge. In the case of individual EVs it should not be a problem, but in the case of commercially organized charging, special connection rules (contracts) should apply.
- Commercially organized charging should clarify between two options: representation of EVs through many aggregators or one single market entity
- DSO (TSO) should enable both of the above options, and the users should decide which one to use and consequently pay the appropriate connection charge.

- Some of the participants also expressed that one of the most influential factors will be the penetration rate of EV integration into the power system. If it's stable and will take a lower rate (about 2-3% per year), then large problems should not occur.
- EV hourly load should be properly forecasted in the energy balance on the intraday and day ahead level and secured upfront by the market participants.
- A positive effect coming from the EVs is that the power system will face less problems with the positive reserve.
- Stability and the operation of the DSO grid could be endangered if TSO would include too many charging stations simultaneously for the balancing purposes for negative reserves. At this point, grid operators should take more care for weak network areas.

4.5 Last part of the survey

In the last part of the survey, we have been dealing with more qualitative questions. Based on the previous discussion, this part contributed to the service provision in relation to the actual national legislation. By this, we have investigated eventual barriers for the cross-border aFRR energy exchange.

The response on this part of the survey was moderate, which means that half of the participants provided an answer to the questions. Most of the answers expressed that legislative barriers are not the most critical element compared to other elements.

Next question was tackling with the issue of double network fee charges that apply to the energy storage and what could be done to resolve it? All respondents expressed their negative opinion related to this issue. A consensus of the answers is: "Double network fee charges are not a good solution to the problem; it also makes no sense to insist on double fees and on the other hand expect investments to the storage solutions."

If a BSP is charged for drawing and injecting the power back to the systems, this will necessarily limit BSP interest in providing such type of service. Consequently, if such a system will be implemented, all additional costs will be transferred to the consumers.

Energy storage will play a significant role in distributed energy markets/networks, especially in the future when larger inclusion of EV on the grid is expected. In order to make energy storage more attractive for investors and BSPs, proper tariff system should be implemented.

Answers regarding proper tariff system differentiate. Some of the participants were in favour of implementation of the netting mechanisms for injection and withdrawal of electricity to/from the network. Others were proposing zero fees for energy storages which will be included in ancillary services scheme.

Followed by the previous question next survey question deals with the problems related

to the deficiencies for energy storage integration into the flexibility services.

The common opinion is that the use of energy storage for the flexibility services represents a serious challenge. At the moment, most of the available energy storages are not economically competitive in comparison to other available resources. This means that providers of electric mobility services, who are not traditional Utility companies, does not see enough commercial incentive to make any progress in this direction

Other challenges are also the high cost of technology and high grid costs.

Thus, the lack of predictability, investors are reluctant to invest in such services.

4.6 Identifying barriers and key stakeholders

As the stakeholders who could mostly participate in the process of overcoming identified barriers, participants expose “Ministry”, followed by the “National Regulatory Authority”. In the middle of all groups was the “TSOs”. “Parliament and Government” and “Others” have only one vote each. At the end of the line was “Market operator” group with no vote.

The last question in the survey was about describing new opportunities that Companies can carry out without amending the legislation. Legislation could accelerate development in some cases, but usually, it is quite slow and rigid for new business.

Some participants believe that without changes in the legislation, there is no opportunity for new market players. On another hand, there is a lack of classic production facilities which can cope with the requirements (minimum bid 1 MW, FAT 5min).

In the last part of the survey, participants presented their ideas about the opportunities in the framework of the existing legislation. Many of them have pointed out that there is no such opportunity within existing legislation, they did not recognize it, or they have not confronted with it yet. They agree that legislation itself can accelerate business opportunities.

The complete Questionnaire is available in Annex 2

4.7 Conclusion of the survey

attention Throughout the survey, participants mostly agreed with the given arguments and expressed similar sentiment regarding certain issues raised. This shows us that the survey was well designed and generated important information needed for this sector/spectrum group.

In the results, we highlight question 12, as we received the most substantive answers to this question. This question generally stands out in the survey. It shows how important this topic for the respondents to the survey is.

At this point, we can summarize that survey helped us collect important information reading the future deployment possibilities. It also brought toward the achievements

of the FutureFlow towards the participants in the survey and raised the interest in new possibilities of the future integrated aFRR market.

5 Conclusions

The deployment of the most promising results of the FutureFlow project has already started and is undergoing. There are several reasons for this and honestly speaking probably the most important is the regulatory incentive. The TSO's would be most comfortable to stay in the safe zone of classical balancing sources like hydro, gas and thermal power plants; however, the energy transition strongly supported by the changing legislation made TSOs proactive. ACER representative in the FutureFlow's final conference in Vienna summarized the three main elements which ACER and the national regulators expect from TSOs, i.e.:

- **To allow and enable new, environmentally friendly sources to enter balancing markets** and became important players offering TSOs their flexibility.
- **To decrease the need for system reserves.** This is expected to be achieved by regional dimensioning of system reserves.
- **To integrate local markets into the regional cross-border balancing/flexibility markets.**

These three requirements are actually a big compliment to the FutureFlow. Namely, the structure of the project, in particular the structure of the Use Cases, show that already in 2015, the project was designed in way oriented towards this objective.

The ambitious goal to engage 35-45 MW of flexibility coming from DR&DG supports the first bullet above. We have even exceeded the initial goal by cca 50 %. Together with the objective to decrease the need for system reserves by enhanced TSOs regional coordination these new entrants will make a strong pressure on conventional, in particular thermal units currently having a big share in the aFRR and mFRR markets. The Use Case (UC) nr. 2 was dedicated to the experimentation and exploitation of all kind of flexibility sources suitable primarily for aFRR services in the local markets. At the same time, within UC2, the changes of the local market design tailored to the new rules under establishment have been tested and are now under implementation.

Use Case nr. 3, the real-time tests in a cross-border environment has been designed as an experiment able to demonstrate functioning and potential benefits of integrated local markets. All new local DR&DG sources have been, in addition to local activations also tested in a cross-border situation. With the help of IT infrastructure, developed within FutureFlow, Hungarian, Romanian and Austrian sources have been used for balancing of the Slovenian power system and vice versa. On top of this real-time field experiments, the simulation of existing conventional sources and new flexibility sources has been carried out. As a result, in average 23 % less aFRR energy needs to be activated

in case of integrated markets compared to the local operation of four power systems. And this is an additional strong push and motivation for TSOs and regulators to integrate balancing markets asap.

In this conclusion, it can be summarized that the balancing markets are ready for new entrants. Based on the findings of the FutureFlow and other changes in power systems of Slovenia, Romania, Hungary, and Austria new rules have been adopted and the implementation is undergoing. DRs, DGs, and other flexibility sources such as storages are getting more and more involved in the balancing markets. Their increasing share is a proof that FutureFlow did not stay on the level of scientific papers but went further by introducing new business models on the level of flexibility sources and the deployment on the level of system operation.

The good thing of the customers recruited in the FutureFlow is that, even if not all new sources are suitable for taking part in a complex aFRR process, these sources can and will be used in the mFRR processes. In this way the share of CO₂ free sources is increasing.

6 Appendix 1: List of Respondents

	Country	Name of Company
1.	Austria	Energienetze Steiermark GmbH (DSO)
2.	Bosnia and Herzegovina	ASA Energija Sarajevo (Supplier, Representative of a significant number of major industrial customers in BIH)
3.	Finland	VIRTA Ltd.
4.	Macedonia	Toplifikacija AD Skopje Production
5.	Macedonia	Faculty of Electrical Engineering, University "Goce Delcev", Stip, Macedonia
6.	Serbia	PE EPS: Mining-Generation-Supply/Trading-Distribution value chain
7.	Slovenia	IPPS Invalidsko podjetje Pošte Slovenije, proizvodnja in storitve, d.o.o.
8.	Slovenia	D2S d.o.o.
9.	Slovenia	Holding Slovenske elektrarne d.o.o.
10.	Switzerland	Energy Financing Team (Switzerland) AG

7 Appendix 2: Survey



Everyday life, everyday tasks and habits of people are those who can contribute to a good environment and society. Through the concept of sustainable development we can talk about the development of energy efficiency and the assumption of electricity as the concept of a successful green future. Energy is an interdisciplinary field that includes energy resources and technologies and the use of energy in the economy. In modern energy, there are important environmental, economic and social issues related to technical energy use.

The questionnaire below consist from questions related to the delivery, supply and electricity consumption, but mostly is intended to Future Flow Project founding from European Union Horizon 2020 research and innovation Program, which explores the development of the balancing market for automatic Frequency Restoration Reserve (aFRR). Part of the project addresses the regulatory barriers which might prevent optimal development of the aFRR market. It is important to note that the regulatory barriers include both: the rules that prevents market development and the rules which are necessary for market development but are not in place. This questionnaire seeks for information about regulatory barriers in the national legislations. The objective is to further explore the existing regulatory framework and propose more effective aFRR market design.

The project primarily covers the market for balancing energy (not the capacity). The goal of the project is to establish the platform which would enable cross-border exchange of the balancing energy and integration of demand response and distributed generation.

Providers, clients, customers, agencies and others will face in the future problems with the electricity grid. For this reason, we are interested in how you evaluate, see and how you define the state of the currently installed energy network. The questionnaire is structured in a way that you can define and answer the questions precisely. That will be great help to us to improve the energy network. The information from this questionnaire will be used solely for the purpose of the Future Flow project. We appreciate your inputs. They will be valuable assistance for further development of this project.

For an easier understanding of the questionnaire, here follows the interpretation of the terms used:

Definition of used terms:

- **TSO: Transmission Service Operator**
- **DSO: Distribution Service Operator**
- **NRA: National Regulatory Authority**
- **BRP: Balancing Responsible Party**
- **BSP: Balacing Service Provider**
- **Agregator**
- **FRR:Frequency Restoration Reserve**
- **DG: Distributed Generation**
- **DR: Demand Response**
- **BSP: Balance Service Provider**

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Questionnaire:

1. Please provide the following information Company/Organisation?

Enter your answer: _____

2. BSP has to pass prequalification tests, to be able to offer balancing services. Who is executing the prequalification tests in your country?

- TSO
- External service provider chosen by TSO
- I am not familiar with the topic

3. If prequalification tests are done by external provider, please explain how do you choose them (with a tender every X years or any other way).

- One month
- One year
- More than one year
- Other

4. What is most important to you when the prequalification tests are made?

Enter your answer: _____

5. Expose a positive or negative point for you when prequalification tests are made?

Enter your answer: _____

6. What would you suggest improving the prequalification tests?

Enter your answer: _____

In the following questions from 7. to 11. please provide your opinion on how would the following initiatives help to achieve better integration of DR & DG in the national aFRR market.



-1

-2

-3

-4

19. Baseline is a steady state of consumption of particular BSP. Do you think baseline methodologies should be available for public review and subject of consultation?

-1

-2

-3

-4

20. The process of balance provision control, measurement and verification shall be established on the level between TSO - aggregator and not on the level of individual flexibility provider

-1

-2

-3

-4

21. Is there a provision in the current national legislation which presents a barrier for the cross-border aFRR energy exchange? If yes, please describe the barrier.

Enter your answer here: _____

22. What is your opinion on double fees issue for the energy storage? What could be done to resolve this issue?

Enter your answer here: _____

23. What problems do you face and where do you see deficiencies related to energy storage integration into the flexibility services?

Enter your answer here: _____

24. Identify the stakeholders who could mostly participate in the processes to overcome identified barriers (please mark two)

- Parliament
- Government
- Ministry
- TSO
- National Regulatory Authority
- Market Operator
- Other

25. Are legislative obligations and services important to you and do you think it is possible to find business opportunities without amending legislation on the field of flexibility?

-1

-2

-3

-4

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26. Please describe in your case new opportunities that you can carry out without an impact on the legislation?

Enter your answer here: _____