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Smart Energy Europe

The smartEn Map

Ancillary Services 2022

Unpredictable markets require the tools that bring you **certainty**

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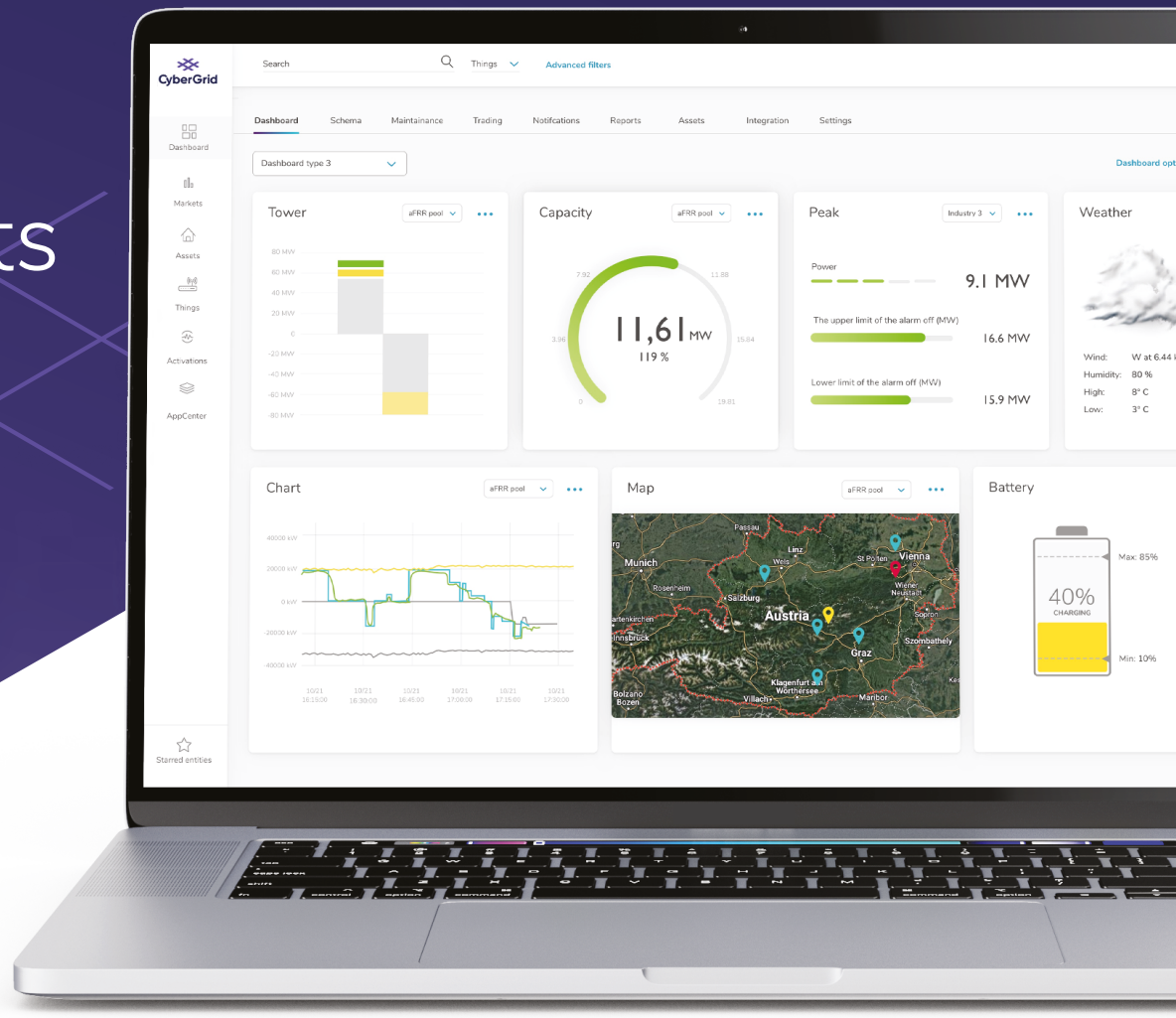

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smartEn is the European business association for digital and decentralised energy solutions. Our members include innovators in services and technology for energy and data management, finance, and research. By taking an integrated perspective on the interaction of demand and supply, our mission is to promote system efficiency, encourage innovation and diversity, empower energy consumers, and drive the decarbonisation of the energy sector.

For further information please visit **www.smarten.eu**

The smartEn Map Ancillary Services, December 2022.

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External Contributors: smartEn would like to thank the following organizations for their cooperation:

ACER, AGEN (Slovenian Energy Agency), APG (Austria), Demand Response Association of Ireland, Energinet (Denmark), ENTSO-E, Elcom (Federal Electricity Commission Switzerland), Elia (Belgium), ERSE (Portugal, Energy Services Regulatory Authority), Estonian Competition Authority, Fingrid Oyj (Finland), MEKH (Hungarian Energy and Public Utility Regulatory Authority), Litgrid (Lithuania), Latvian Public Utilities Commission, RTE (France), Svenska kraftnät (Sweden), TenneT (The Netherlands and Germany), Terna (Italy), Transelectrica (Romania).

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tiko aggregates electrical heaters, heat pumps, boilers, batteries, electric vehicles and other household devices into Virtual Power Plants that stabilize the electrical grid and enable the use of more renewable energy.

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using distributed assets

Specialists in smart charging
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Foreword

Sonya Twohig
Secretary General, ENTSO-E

The net-zero power system will be based on carbon-neutral generation, and a significant part of this generation will be weather-dependent. The future European power system will thus need significant flexibility resources, to efficiently complement the variability of generation and consumption, and to address the increase in overall system complexity.
In this context, Demand-Side Flexibility (DSF) resources will have an increasing critical role to play.

This smartEn report provides very concrete illustrations on how DSF can provide services to the system, while also insisting on the remaining hurdles.

A key aspect for this winter will be the capacity to mobilise consumers demand response to ensure security of supply. Some Transmission System Operators (TSOs) are taking concrete actions in this regard, ranging from voluntary measures to specific demand response auctions. But the possibility to reward consumers for the benefits they provide largely depends on the existence of smart meters or sub-metering devices, hence the importance to ensure smooth, fast and harmonized deployment of such tools across Europe.

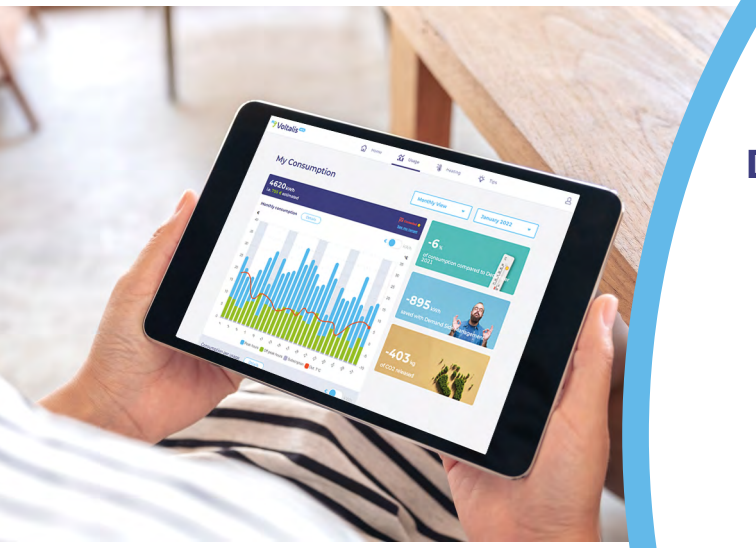
Going forward, if the European Commission requests it, ENTSO-E will work with the EU DSO Entity to draft a network code on demand response in 2023 based on ACER Framework Guideline. A critical aspect will be the delineation of market rules for independent aggregation. These rules should clarify roles and responsibilities between flexibility providers, suppliers, TSOs and Distribution System Operators (DSOs) without discouraging new market players to enter the market e.g., due to high administrative complexity.

In 2023, two important pieces of EU legislation will be on the table that should contribute to further empowering consumers and allowing DSF to play its role fully: Unlocking the potential of DSF should be one of the objectives of the Market Design Reform on one hand and the upcoming new network code on Demand Response should also be drafted in 2023, with the objective to deliver a state of the art set of rules to facilitate a future proof significant participation of demand side resources.

ENTSO-E is looking forward to continuing the constructive cooperation with smartEn and wishes every success to this edition of the smartEn Map on ancillary services.

VOLTALIS' DEMAND RESPONSE ENABLES SMART ELECTRICITY SAVINGS!

We empowers consummers like homes and small businesses accross Europe to save electricity smartly



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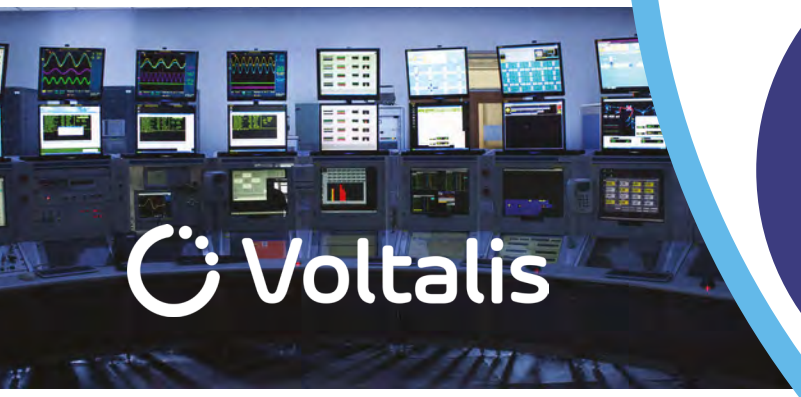
- → 150,000+ homes and buildings already equipped
- → 1,000,000 planned for the next three years
- → Operated in real time to deliver in all markets
- → Already 15 years of operations, now in Europe



Face Energy crisis

- → Avoid high prices for all consumers by flatten the curve and the peak demands
- → Optimize reliability of the grid and better use of renewables
- → Reduce CO2 emissions from traditional power plants to protect planet

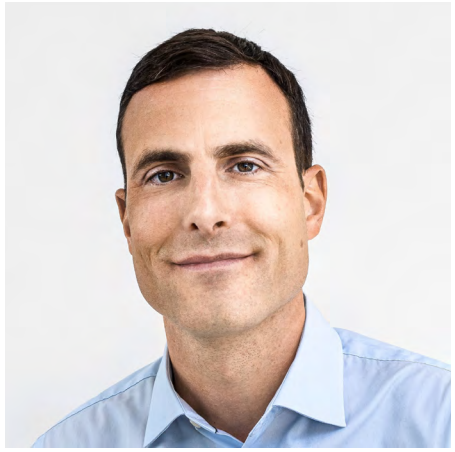
Help European consumers

- → A full free solution for consumers to save energy, manage their consumption and lower electricity bill
- → Consumers participating all together for reducing electricity use at peak hours

Voltalis | **The Leading Residential Demand Response & Flexibility Agregator**

Introduction

Michael Villa
Executive Director, smartEn



Stefan Dörig
Chair, smartEn

Over these past years, the energy sector has been going through a profound transformation heading towards a more decentralised, digitalised and decarbonised energy system. At the same time, current geopolitical events have led to skyrocketing energy prices and supply risk disruptions. In this context, new and smart solutions are required to empower consumers to become active by adapting their consumption and generation patterns based on external signals.

The role that Demand-side flexibility (DSF) can play in the integration of renewable energy sources and in ensuring a stable and resilient energy system is well documented by now, and high in the agendas of European legislators.

In particular, the new Regulation (EU) 2022/1854 for an emergency intervention to address high energy prices includes a mandatory reduction target of 5% of the electricity consumption in peak hours. It is now important to ensure that the implementation of such short-term measures contributes in a sustainable manner and through market-based schemes to activate consumers' flexibility.

Such objective was already enshrined in the EU Electricity Market Design adopted in 2019 and the launch of European coordinated balancing platforms contributed in making important progress towards streamlining market conditions and improving access for DSF technologies to different services.

However, the activation of consumers' flexibility still faces regulatory barriers as the Electricity Market Design is poorly implemented by Member States. Many obstacles to the development and integration of DSF in the ancillary service markets still persist, thus limiting the services offered to help ensure the reliability and availability of energy to consumers.

These barriers could nonetheless be easily overcome by fully and thoroughly embracing true technology inclusivity, ensuring that services and markets are designed with system needs in mind, independent of the technologies providing them.

This present edition of the smartEn Map illustrates the role that DSF plays in the ancillary services in a selection of 21 European countries, providing an update to the 2018 smartEn Map Balancing Markets edition. Overall, the landscape of ancillary services has improved, but given the current energy crisis, and the significant needs for balancing electricity that the energy system will require with further electrification and further deployment of renewables, efforts must be accelerated.

The smartEn Map 2022 allows for the identification of existing barriers to DSF, including those that can be addressed quickly, as well as good practices in integrating new innovative technologies, to achieve a more resilient, decarbonised and affordable energy system with active consumers in the lead.

Mapping Ancillary Services across Europe

OUR SCOPE AND PURPOSE

The *smartEn Map* Ancillary Services 2022 provides a detailed picture of the participation of DSF in the different ancillary services across Europe. It aims at updating and expanding the scope of the smartEn Map Balancing Markets published in 2018. This report considers both frequency and non-frequency ancillary services, when relevant, and it seeks to answer five questions:

1. **What ancillary services are accessible to market players across Europe?**
2. **What are the participation requirements in those mechanisms?**
3. **What are the different technologies participating in each country?**
4. **How advanced is the data transparency of the electricity market in each country?**
5. **Are there any regulatory changes affecting DSF upcoming in the near future?**

The objective of this edition of The smartEn Map is to provide a high-level summary of the conditions for flexible and distributed energy resources (DER) across 21 European countries. We aim to shed light on the regulatory, technical and economic conditions for demand-side participation in the ancillary services market and highlight those countries that have developed inclusive solutions for these technologies. In doing so, we aim to encourage policy makers to set favourable framework conditions for an active participation of the demand-side resources to drive a cost-effective energy transition and contribute to a reliable and efficient energy system for everyone.

The information and grading contained in this report is accurate at the date of publishing (December 2022). However, energy legislation is continuously changing. Hence the reader should understand this report as a snapshot in time, illustrating the path that brought us here, and the possibilities for the future. Finally, this report is not intended as a tool for companies to base their investment decisions on, but as reference material on which to start and support those decisions.

OUR METHODOLOGY AND SCORING SYSTEM

Every year we review our methodology and approach to The smartEn Map. The topics we deal with vary significantly from year to year, and so do our sources and scoring system, to adapt to the specificities of each topic.

For The smartEn Map Ancillary Services 2022, we have collected data from more than 60 sources from across the industry and from a wide selection of countries. We approached TSOs, National Regulators, Economic and Energy Ministries, independent aggregators, energy service and technology providers, and other associations.

To accompany, verify and complete the primary research conducted through the questionnaire, we complemented each chapter with thorough secondary research. The findings of this report were reviewed internally, with the smartEn membership, and externally with a wide range of actors to ensure the quality and accuracy of the outcomes.

The scoring methodology in this report was designed to give an overview and a basis for comparing differing markets and products. Even if the European market for ancillary services foresees a certain level of standardisation, it is still difficult to compare countries, as each have their own idiosyncrasies and different balancing requirements. For this reason, the grade should not be taken as a final judgment of the country as it is accompanied by a text that describes its strengths and weaknesses.

The grading is performed on a high-level assessment based on the outcomes of our research. Not all categories are graded equally, since their importance varies on the overall goal of this smartEn Map. For example, the access to ancillary services and the technical requirements are more important than the data transparency of the country as they determine the inclusion or exclusion of certain technologies from the market. The final objective is to highly score those countries where ancillary services are accessible for all resources and designed in a technology inclusive manner.

OUR RANKINGS

Our ranking is based on five categories: access to ancillary services, participation requirements, market composition, data transparency and upcoming legislative changes. Alongside the aggregated grading of countries, it also allows the mapping of countries per category.

The smartEn Map scoring system

CATEGORY	DESCRIPTION	SCORING SYSTEM
Access to Ancillary Services	Number of services	**0** = Nnon-existing or mandatory product
	Procurement methods	**1** = Market-based procurement not open to DSF
	Aggregation status	**2** = Market-based procurement open to all resources, significant barriers for DSF (e.g., requirement of being a BRP, no possibility of aggregation)
	Minimum bid size	**3** = Market-based procurement open to all resources, some barriers for DSF (e.g., high minimum bid size)
	Requirement to be or assign the role of BRP or have an agreement with a BRP	**4** = Market-based procurement with no barriers for DSF
Participation requirements	Prequalification process	**0** = Requirements exclude DSF
	Testing requirements	**1** = Generation-centric requirements excluding demand-side resources
	Metering requirements	**2** = Technology neutral requirements but some barriers for DSF
	Payments	**3** = Technology inclusive but some barriers for DSF
		4 = Technology inclusive requirements that allow for DSF participation without barriers
Market composition	DSF capacity procured	**0** = No DSF capacity procured
	DSF activated	**1** = Very low procurement and activation of DSF
	Breadth of assets participating	**2** = Medium procurement and activation of DSF
	Number of DSF market participants	**3** = High participation of DSF
		4 = Very high participation of DSF with different types of assets
Data transparency	Generation, load, balancing market data	**0** = No data transparency
	DSF procured	**1** = Limited data, not easily accessible
	Congestion data	**2** = Most data available but limitations (e.g., high granularity, no market composition)
		3 = Complete data available but limitations (e.g., no API)
		4 = Complete, real-time data available incl. volumes procured and activated per technology
Upcoming legislative changes	Status of implementation of EMD	**0** = No upcoming changes
	Strategy to open new markets	**1** = Non-relevant upcoming changes, slow implementation of EMD and market coupling
	Participation in market coupling (MARI, TERRE, PICASSO, FCR cooperation)	**2** = Upcoming changes to open new markets, but long-term or uncertainties in the process
		3 = Upcoming regulatory changes for EMD implementation and market coupling
		4 = Significant upcoming changes for DSF

Main barriers for DSF and how to overcome them

1

BRP agreement for ancillary services

Some European TSOs allow participation in ancillary services only by suppliers/BRPs, while in some countries, direct participation of BSPs is allowed but it is subordinated to the permission of the consumer's supplier (Germany). These are significant entry barriers for independent aggregators and limit free competition between bigger incumbents and new market participants. Some countries have removed this requirement for faster products with a low transfer of energy. In Finland, a BRP agreement is not required for FFR, FCR-N or FCR-D, while in GB, Hungary, Ireland and Italy it is not required for any product. Article 5 of Regulation (EU) 2019/943 states that all market participants are balance responsible, with the option to delegate it to a party of their choice. However, mandatory agreements with the consumer's supplier or BRP should not be expected from the flexibility provider.

2

Symmetrical products

For certain ancillary services, the TSO requires participants to place symmetrical bids. Even if asymmetrical quantities can be offered within the pool, the fact that the overall pool needs to provide a symmetrical product is limiting for certain technologies (i.e., heat pumps, electric boilers, EVs, hydro power plants with limited reservoir). Moreover, there is a complementary aspect between low-carbon technologies overlooked by the mandatory use of symmetrical bids. By combining demand-side technologies that can provide upward services at low availability cost, with variable renewables that can provide downward services at low availability cost, the TSO would obtain the same service and benefits as by forcing symmetrical bids. Hence, removing the requirement for symmetry should enable much wider participation of low-cost resources. Asymmetric bids should be allowed by default for all products, unless the TSO can provide a reasoned justification, including a cost-benefit analysis demonstrating the need for symmetric products. In Finland and Sweden asymmetrical bids are allowed for almost every product, including FCR-N and FCR-D.

3

Availability and accuracy of response requirements

In order to participate in certain markets, providers are required to prove 100% reliability of their availability (Austria) or operate with very small dead-bands (Great Britain). These are different limiting factors for non-dedicated energy assets, like DSF technologies. Availability requirements and equivalent penalties should be proportionate to the required service. A quarantine period to allow time to remedy the situation prior to resuming deliveries should be granted, this is the case for example in Denmark. Assets should also not be required to prove almost continuous accurate response by the product design, if not justified. Aggregated groups of small DERs should be required to perform the services on an aggregate level and not on an asset level.

4

Real-time transmission of data

Most European TSOs require real-time transmission of data (real-time telemetry) to participate in the market for ancillary services, even where this is not proportional to the justified needs of the TSO. Real-time telemetry, especially with high granularity, can quickly overburden the IT systems of aggregated groups. To minimise costs, data should only be required in real-time where it could lead to the TSO changing their actions in real-time on the basis of what they observe in the data. For high granularity services, such as FCR, the correct behavior of the pool can be verified in a prequalification phase. Once successfully prequalified, lower granularity should be required for settling and verification. This happens for example in France, under experimental frameworks, which allow smaller units to provide an estimate of generation or consumption instead of real-time telemetry data. Alternatively, high-granularity data can be required for ex-post verification without the need for it to be delivered in real-time. This greatly reduces providers' costs without affecting TSOs ability to verify performance.

5

Minimum bid sizes

Distributed demand-side resources that can technically participate in TSO markets are often excluded because the required minimum bid size is too high. Some countries across Europe require aggregated capacities higher than 1 MW, up to 5 MW or even 10 MW. While easy for traditional generation, on the demand-side these can only be met by industrial loads, alone or aggregated. Lower minimum bid sizes enable the participation of smaller DSF resources such as EVs and other behind-the-meter assets. This can be seen in Finland and Denmark, where bids for faster products like FCR can be placed starting from 100 kW of capacity. To overcome these barriers, countries need to fully implement Article 6 of the Electricity Market Regulation (EU) 2019/943, in particular paragraph 1, which requires non-discriminatory access to demand response and storage. These considerations should lead to the revision of minimum bid sizes even below 1 MW to lower entry barriers for smaller assets.

6

Prequalification process

Some TSOs require to repeat the prequalification process for already prequalified assets and pools in case of changes in their composition. For example, in some services in France, for each 1 MW increase the complete prequalification tests must be repeated. This is a big effort both on the aggregator and TSO side, it causes loss of revenue and unnecessary delays. This has been overcome for example by Tennet in The Netherlands, where, for a technology already prequalified, a type approval can be obtained and the prequalification tests do not have to be repeated. An alternative would be to not require a new prequalification unless the pool shape and capabilities change significantly.

Overview

The *smartEn Map* Ancillary Services 2022 shows a timid evolution since the last time smartEn assessed the European balancing markets in 2018. The interest remains in opening different markets to demand-side flexibility (DSF) and the innovative solutions it brings to the table. Nevertheless, progress is localised in some countries, home to the more innovative TSOs, while progress in others remains slow.

The most significant change since 2018 is the move towards higher harmonisation at EU level, prompted by the development of the EU platforms PICASSO, MARI, TERRE and the FCR Cooperation. The platforms have introduced standardised products ensuring requirements that are in line with the technology neutrality principles of the 2019 Electricity Market Directive and Regulation. However, a significant number of countries have asked for derogations for the connection, delaying the development of these markets.

Countries that stand out in this year's edition of the smartEn map do so for a variety of reasons. The main ones being having a combination of products that are designed in a technology inclusive way, facilitating non-discriminatory access for DSF providers with a wide variety of technologies in their pools, and transparent and comprehensive data sharing from the system operators.

Following this logic, the most advanced ancillary services markets in Europe are in Belgium, Denmark, Finland, France, Slovenia, and The Netherlands. They all have different products available, that facilitating access to different revenue streams for DSF providers. These conditions have been facilitated through the actions taken on by innovative TSOs like Elia and TenneT Netherlands. They have not only created a good starting point for procuring flexibility services but have also invested in providing transparent data, fostering the activity of flexibility providers.

The biggest barriers are linked to the partial implementation of the 2019 Electricity Market Design. This includes the introduction of the aggregator figure in national legislation as foreseen by Article 17 of the Electricity Directive (EU) 2019/944, high minimum bid sizes or too stringent technical requirements, that we have observed in countries like Austria and Great Britain. Some countries impose even higher barriers for DSF, this is the case of Spain, Romania, Greece and Portugal.

Even in the frontrunning countries, important aspects can still be improved. On the other hand, placing in the lower spectrum does not mean that no improvements have happened, but that they have been insufficient so far and might only require small changes to jump in grading.

For example, Italy is working towards opening the mFRR market, by introducing a new market design with technical requirements open for DR and DERs, which will soon be followed up by a similar market design for aFRR.

Overall, the landscape of ancillary services has improved, but given the current energy crisis, and the significant needs for balancing electricity that the energy system will require with further electrification and further deployment of RES, the efforts made seem insufficient to achieve the EU decarbonisation targets in a cost-effective manner that includes all active consumers.

WHAT WE LOOKED AT:

- Access to ancillary services
- Participating requirements
- Market composition
- Data transparency
- Upcoming legislative changes

Overview

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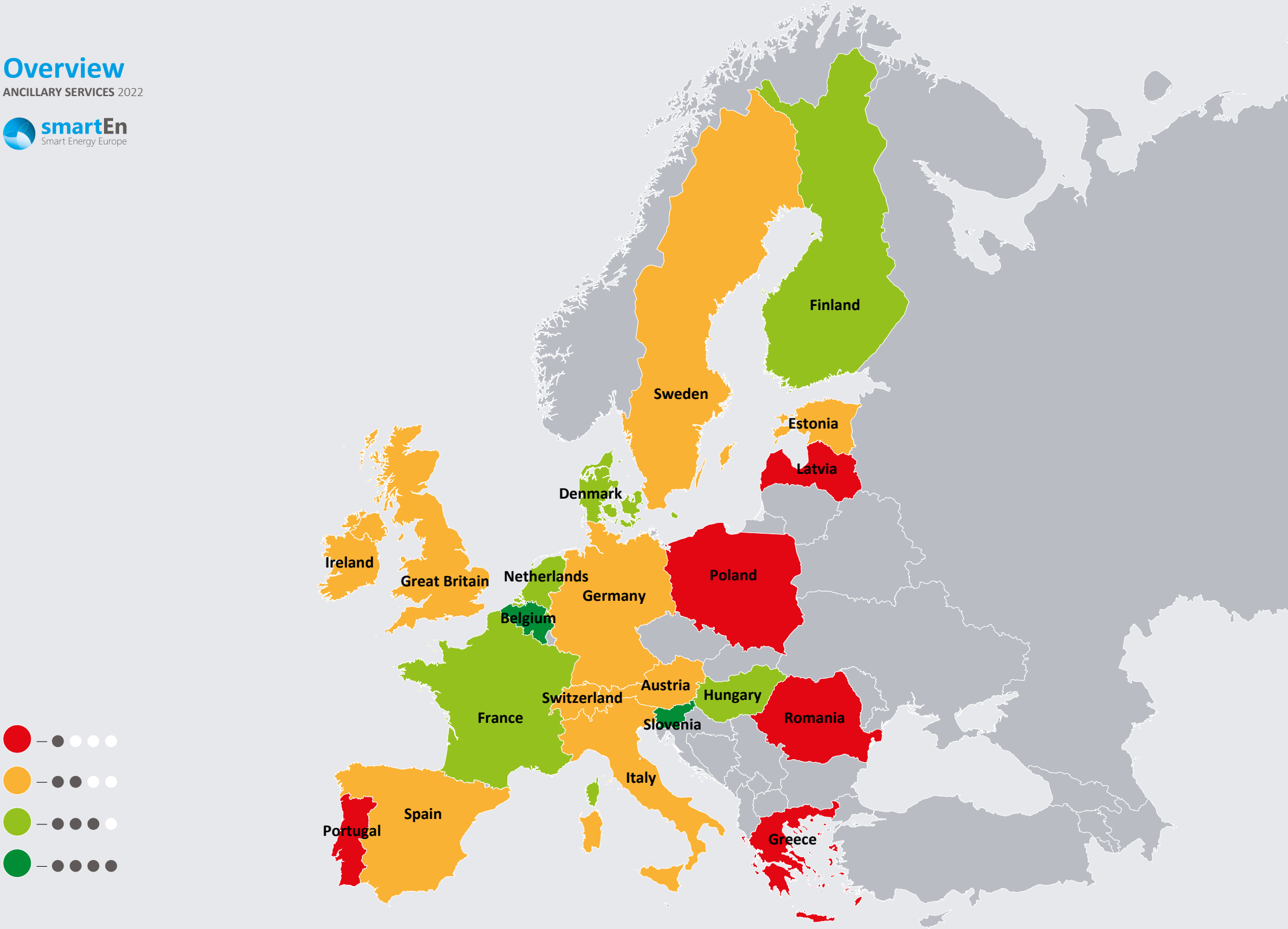

Access to Ancillary Services

The access to ancillary services is split between two types of countries. Those that are part of one of the EU coordinated platforms, the FCR Cooperation, PICASSO (aFRR), MARI (mFRR) and TERRE (RR), and those that are either not part of these platforms or have delayed their synchronisation.

The biggest improvement in the past years comes from those countries that have joined the different platforms. These coordinated platforms guarantee a harmonised procurement method and technical requirements to participate in them. These requirements are in line with the 2019 Electricity Market Design, e.g., a market-based procurement, low minimum bid sizes of 1 MW, allowing the pooling of generation and demand resources.

Countries that have seen a significant improvement in the last years include Hungary, Finland, Denmark, Slovenia.

However, many barriers remain. Some countries still have technical requirements that are too difficult or costly for DSF providers to achieve, de facto excluding them from participation. The main barriers limiting participation of DSF in ancillary services, beyond technical requirements that are covered in the next chapter, are the lack of an aggregator framework implemented in national legislation, the requirement for flexibility providers to delegate or perform the role of a balance responsible party, or even have to reach an agreement with the supplier's BRP, and the limitation for aggregation of generation and demand assets in the same pool.

Countries that are currently still limited by these requirements that could be easily overcome are for example Spain and Sweden.

A special mention is required for some countries that have introduced products to solve specific issues in their grid like Finland, Sweden, Denmark, and Great Britain. These products are addressing needs for ultra-fast products like in the Nordics or are trying to address the current energy crisis and the requirements for demand reduction for the 2022/23 winter, like Great Britain.

As can be seen in the individual country chapters, barriers are still significant in many markets, even in those that have technology neutral requirements. Most of these barriers could be quickly lifted in the current EU regulatory framework and would allow to make a better use of the available demand-side assets and their flexibility.

WHAT WE LOOKED AT:

- Access to FCR, aFRR, mFRR, RR
- Country-specific services
- Procurement methods
- Status of aggregators and aggregation
- Administrative requirements
- Bid size

Access to Ancillary Services / FCR

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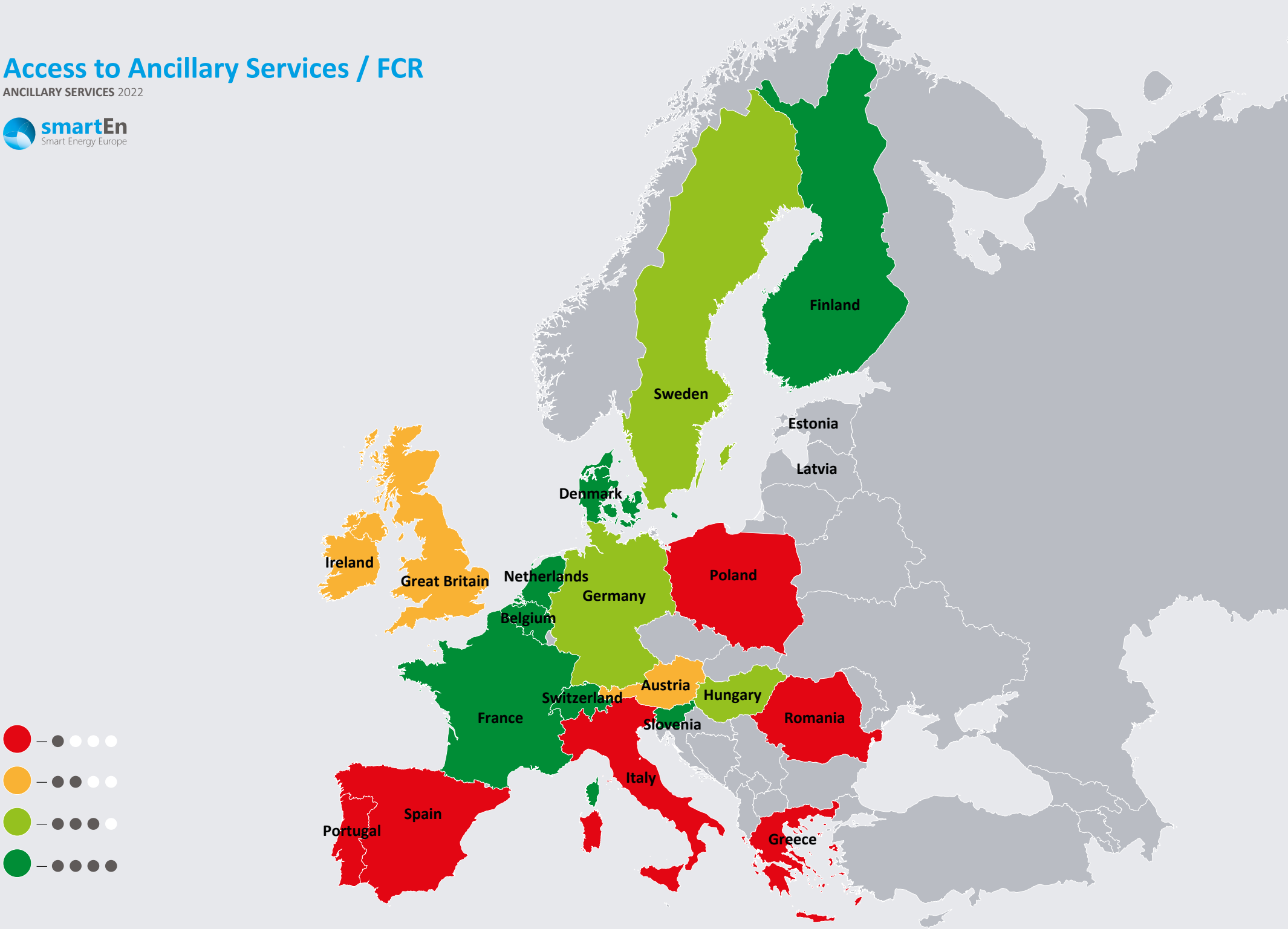

Access to Ancillary Services / aFRR

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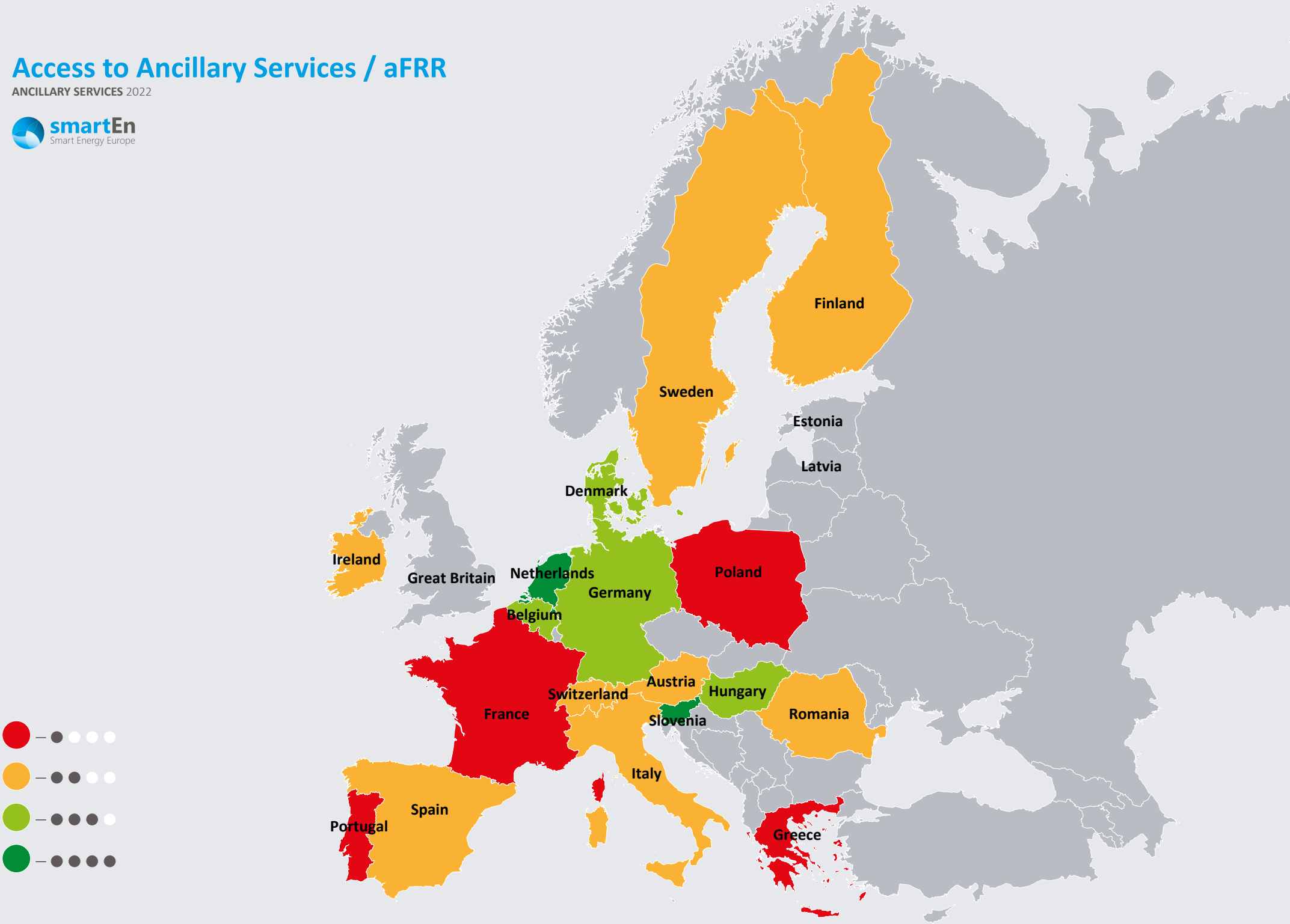

Access to Ancillary Services / mFRR

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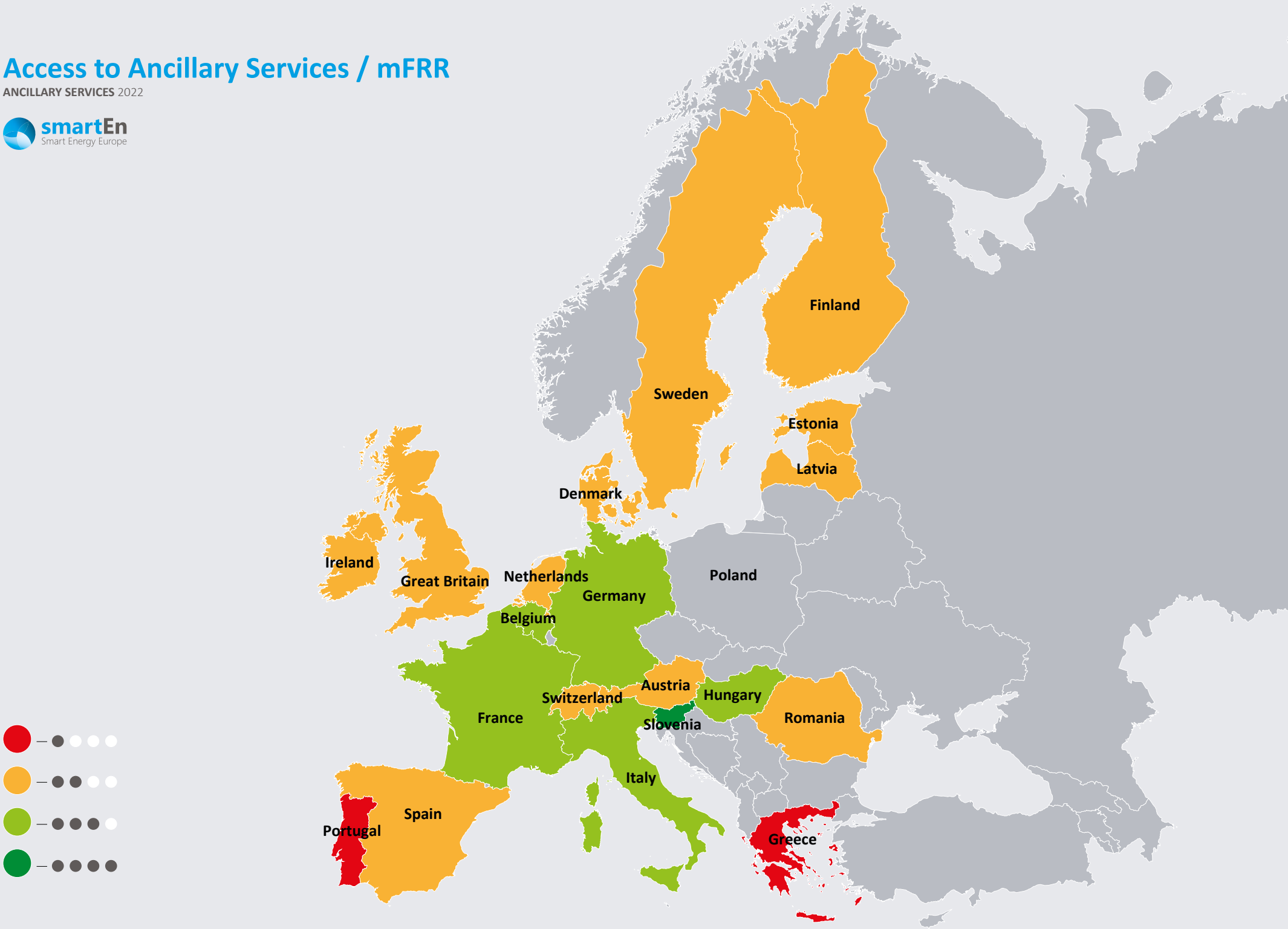

Participation requirements

Participation requirements included in this section can be divided between the prequalification process requirements and the testing and measurement requirements. Most countries have participation requirements that are on paper technology neutral, as they do not explicitly exclude any technology from participating. However, in practice, the elevated requirements are in many cases de facto excluding participation of demand-side resources, even if they could technically and in a secure manner provide the service. Hence, these requirements constitute the main barriers for demand-side flexibility participation in ancillary services.

The prequalification process covers all the requirements that a market participant needs to comply with to be able to deliver a specific product. The main barriers we have observed in this regard are linked to the historical heritage from services being delivered by traditional generation. The most common requirements limiting the participation of demand-side resources are:

- **Minimum bid sizes:** Countries that are already part of one of the EU cooperation platforms for FCR, aFRR, mFRR and RR have usually the same minimum bid size of 1 MW. These are quantities that can be provided if the possibility of aggregation exists. Some countries like Portugal, Ireland, The Netherlands, still have minimum bid sizes in some products that are difficult to achieve even through aggregation, leaving out most demand-side resources from the markets.

- **Aggregation of assets:** Linked to the previous barrier, aggregation is permitted in most countries. However, aggregation of demand and generation units in the same pool is not permitted in some countries (e.g., Spain). It is important to differentiate aggregation from market access for independent aggregators. While aggregation can be performed by suppliers and large energy consumers with their assets behind the meter, an independent aggregator framework is required in national legislation to facilitate access to a wider range of consumers. Our research shows that countries that allow aggregation, but do not have an aggregator framework in legislation, have very little participation of demand-side resources and mostly only that of industrial loads. Countries that stand out for their aggregator framework are France, Belgium, and Slovenia. It is also important to point out that the development of an aggregator framework is mandated by Article 17 of the Electricity Market Directive (EU) 2019/944.

- **Testing and measurements:** In most countries real-time transmission of data is required to provide balancing services, resulting in expensive telemetry connections that are not viable for smaller assets. The accuracy of measuring devices is often not tailored to the type and size of the assets, while the use of sub-metering is usually not allowed.

- **Payments and penalties:** The biggest barrier linked to payments is the lack of capacity payments in some countries to complement activation payments. Activation payments only for balancing products are too low to justify the business case of non-dedicated assets like DSF technologies. Hence the importance of the possibility for the stacking of services, i.e., the possibility to bid into different markets with the same assets, multiplying the possible revenue streams accessible for the flexibility providers. In some countries other financial limitations are preventing the participation of DSF, even if markets are open. This is the case in particular in Italy, which has not adapted the financial conditions of their flexibility procurement to the current electricity prices.

WHAT WE LOOKED AT:

- Prequalification process
- Testing requirements
- Measurement and metering requirements
- Payments and penalties

Participation requirements

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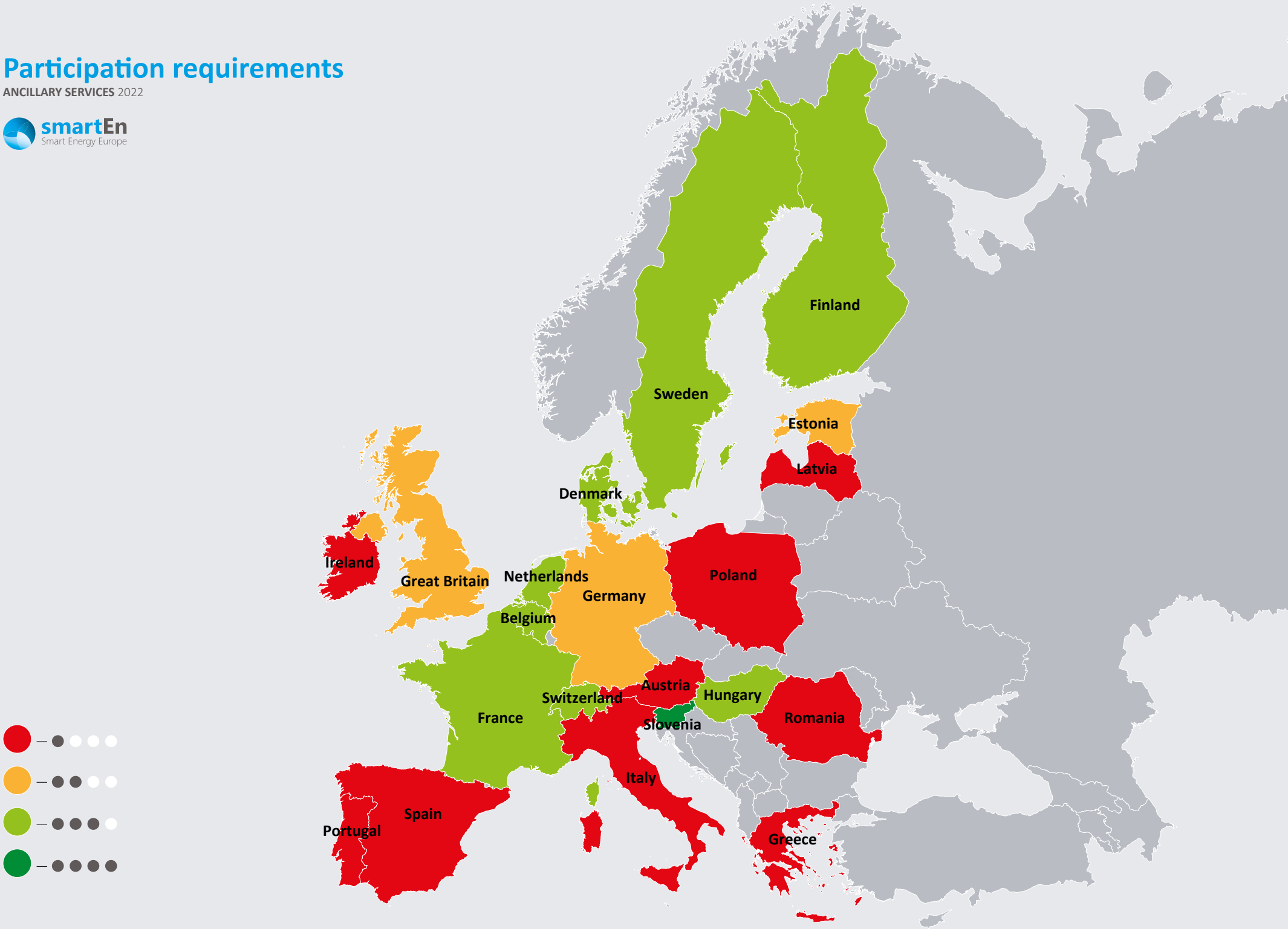

Market composition

Market composition and size are generally a good indication of the openness of the market to DERs in ancillary services. As we will see in the next section, data transparency, not all countries disclose data on the market composition, and technology sources of the activated bids. This makes it difficult in some cases to estimate the participation of DSF in the ancillary services. In these cases, we use prequalified service providers as an indication of the market viability.

Largest markets for ancillary services are dictated by the amounts of those procured by the TSO, those countries include Great Britain, France, Italy, and Germany among others. However, amounts of ancillary services procured does not necessarily translate into ancillary services procured from DSF, and it does not reflect on the openness of the market.

Markets with a higher participation of DSF providers include Belgium, Finland, France, and Slovenia. With between 4 and 13 independent aggregators active in these countries. This translates into 5.3 GW of capacity from DSF bid into the markets in all the countries covered in this map except for the ones that do not disclose this information. The differential between activated and available capacity is another reason why additional capacity payments could be beneficial to foster the entrance of DSF in these markets to ensure system balance. In most countries for which we have data, the provision of balancing services from DSF is very low, at around 10% of the activated bids. The rest of ancillary services are delivered by traditional generation, in most cases gas-fired plants, but also hydro power plants.

The main sources of balancing from DSF comes from industrial loads. Countries that stand out using smaller distributed assets like electric vehicles, heating, and behind the meter storage include France, Denmark, Finland, and Austria. In most countries providers of DSF work together with generation in order to ensure reliability, in particular in countries that allow pooling of generation and demand for their bids.

It is worth mentioning that smartEn member companies are currently managing around 13 GW of capacity from demand-side assets that are bid into different markets (including ancillary services), the equivalent capacity of 27 of the largest gas-fired peaking plant in Belgium (Zandvliet, 474 MW).

WHAT WE LOOKED AT:

- Capacity procured by TSOs (total and from DSF)
- Capacity activated by TSOs (total and from DSF)
- Number of market participants
- Assets delivering ancillary services

Market composition

ANCILLARY SERVICES 2022

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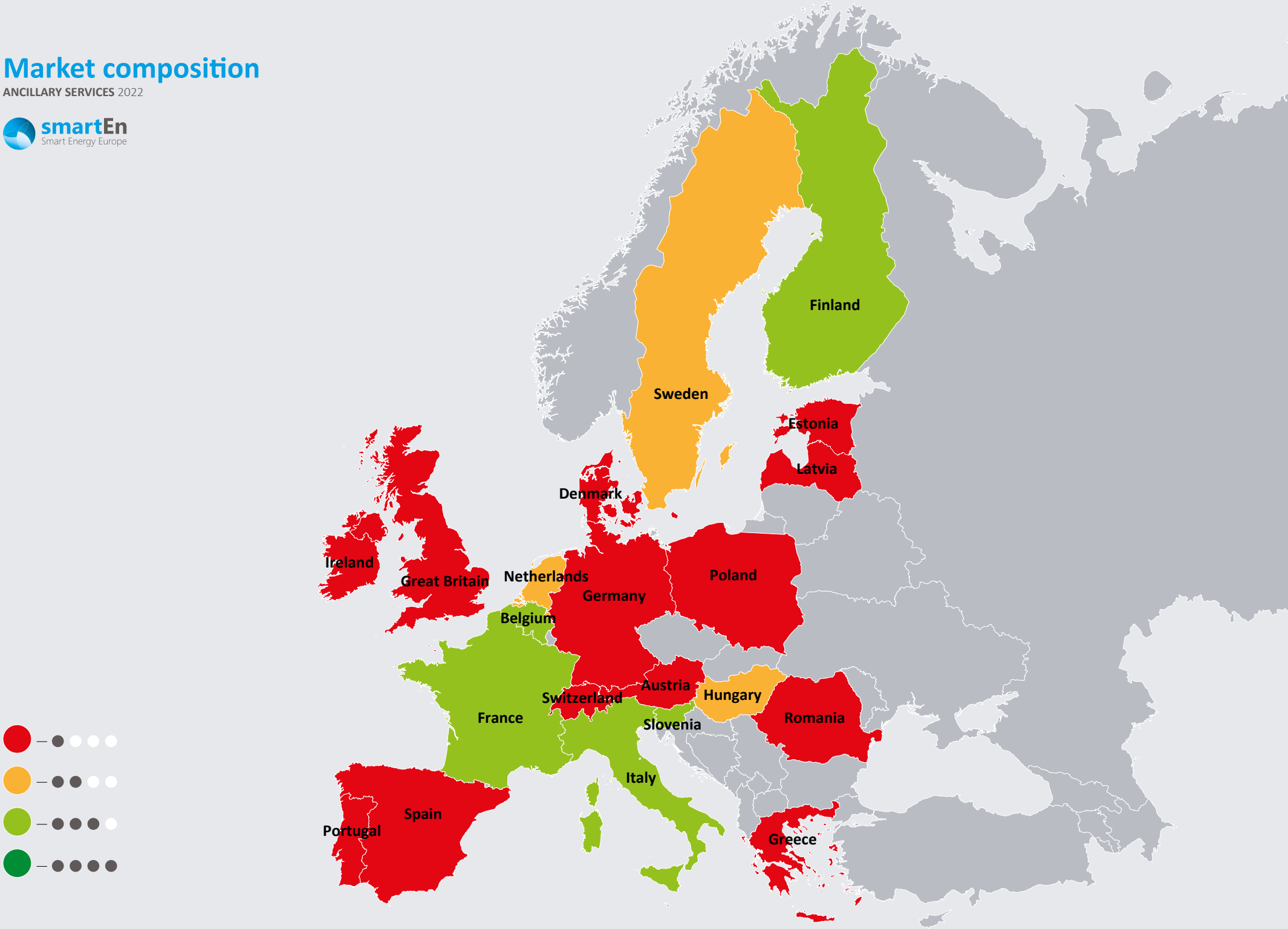

Data transparency

A far-reaching data transparency is imperative for the establishment of innovative market entrants that do not have the established position that incumbents in the energy sector have. The type of data provided by SOs influences the variety of services that aggregators and suppliers can provide to their consumers. For example, CO_2 content or energy sources in the mix at any given moment in time can be translated into special offerings for consumers that want to maximise the use of low-carbon energy through DSF. The creation of these commercial offers depends on harmonised data formats and easy access like for example through open APIs.

ENTSO-E has taken significant strides in data transparency with the Transparency Platform. This online tool allows to access different types of information (i.e., generation and load, balancing services, and cross-border flows) from each European country. However, there are still a significant number of countries for which the data is incomplete, without clarification as to whether the product or the data is not available. This is particularly the case for balancing data and balancing rules and national terms and conditions. It should also be noted that data granularity differs from one country to the other from 15 minutes to one hour due to different imbalance settlement periods. Most TSOs have their own website where they provide similar sets of data, which increases the complexity to retrieve them.

The more glaring lack of data regards the sources procured and activated in each ancillary service. This information is rarely available and can only be found through market parties participating in the services. Providing data on the types of assets available in the market and activated would reflect on the role DSF can play in the ancillary services.

Countries that stand out in their data transparency are Belgium and Finland. Elia provides numerous data sets with high granularity and near real-time information, including on the level of congestion risk per hour in each Belgian electrical zone and redispatching activations and costs. Finland stands out for a great transparency in the volumes and DSF technologies procured for each ancillary service, as well as for market rules.

WHAT WE LOOKED AT:

- Data shared on MW contracted and MWh activated
- Data on types of technologies contracted and activated
- Data on CO_2 content of the grid and energy mix
- Granularity of data provided
- Format of data and platform

Data transparency

ANCILLARY SERVICES 2022

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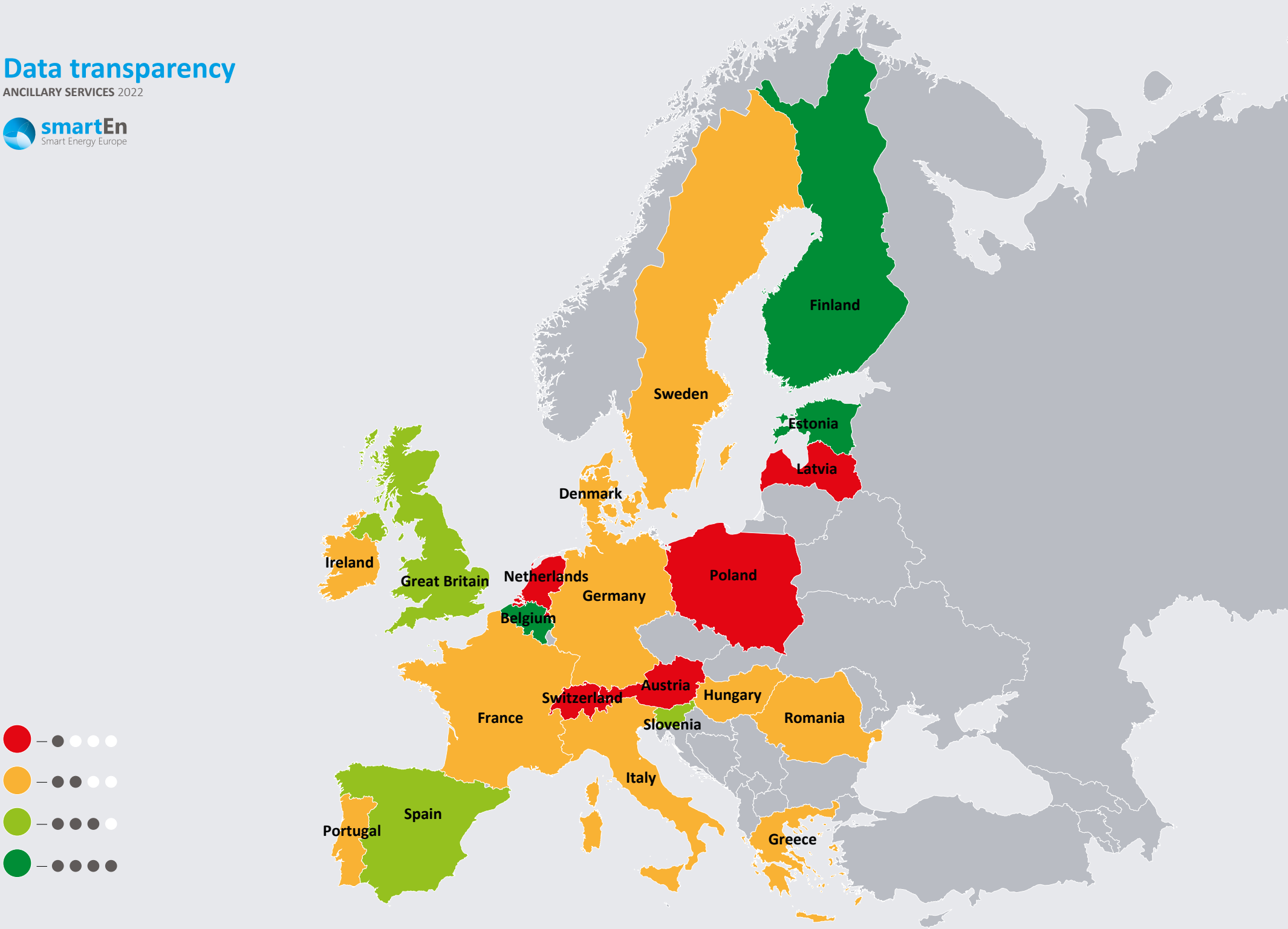

Upcoming legislative changes

The implementation of the Electricity Market Design continues to be one of the main issues since it came into force in 2019. Adoption has been slow in many countries and incomplete in others. Countries that are more advanced in the implementation are France, Belgium, Slovenia, and Hungary, in particular with a fully implemented independent aggregator framework. Countries that are currently planning significant changes in national legislation to implement the Electricity Market Directive in the short-term include Finland, Spain, and Sweden.

The other main legislative process to follow is the implementation of the EB GL and the incorporation into the European balancing cooperation platforms. A significant number of countries are already members of the platforms, however most of them, have asked for derogations or have postponed their connection. Some positive examples in this regard are Germany and Austria, that have already connected and exchanged balancing energy through PICASSO. One country in particular to observe in the coming months is France, with the recent closure of the aFRR market due to high prices and suspected market abuse, the regulator and TSO are currently assessing how and when it will re-open.

In 2022, to address the current energy crisis some countries have introduced or are introducing new services and mechanisms for the winter 2022/2023. Countries that have already introduced new demand reduction products include Great Britain, France, and Ireland. These initiatives are aligned with the Council Regulation (EU) 2022/1854 of 6 October 2022 on an emergency intervention to address high energy prices, which includes a mandatory reduction target of 5% of the electricity consumption in peak hours.

WHAT WE LOOKED AT:

- Implementation of the Electricity Market Design
- Connection to EU platforms (PICASSO, MARI, TERRE, FCR Cooperation)
- Winter 2022/2023 plans to address the 5% peak demand reduction plan

Upcoming legislative changes

ANCILLARY SERVICES 2022

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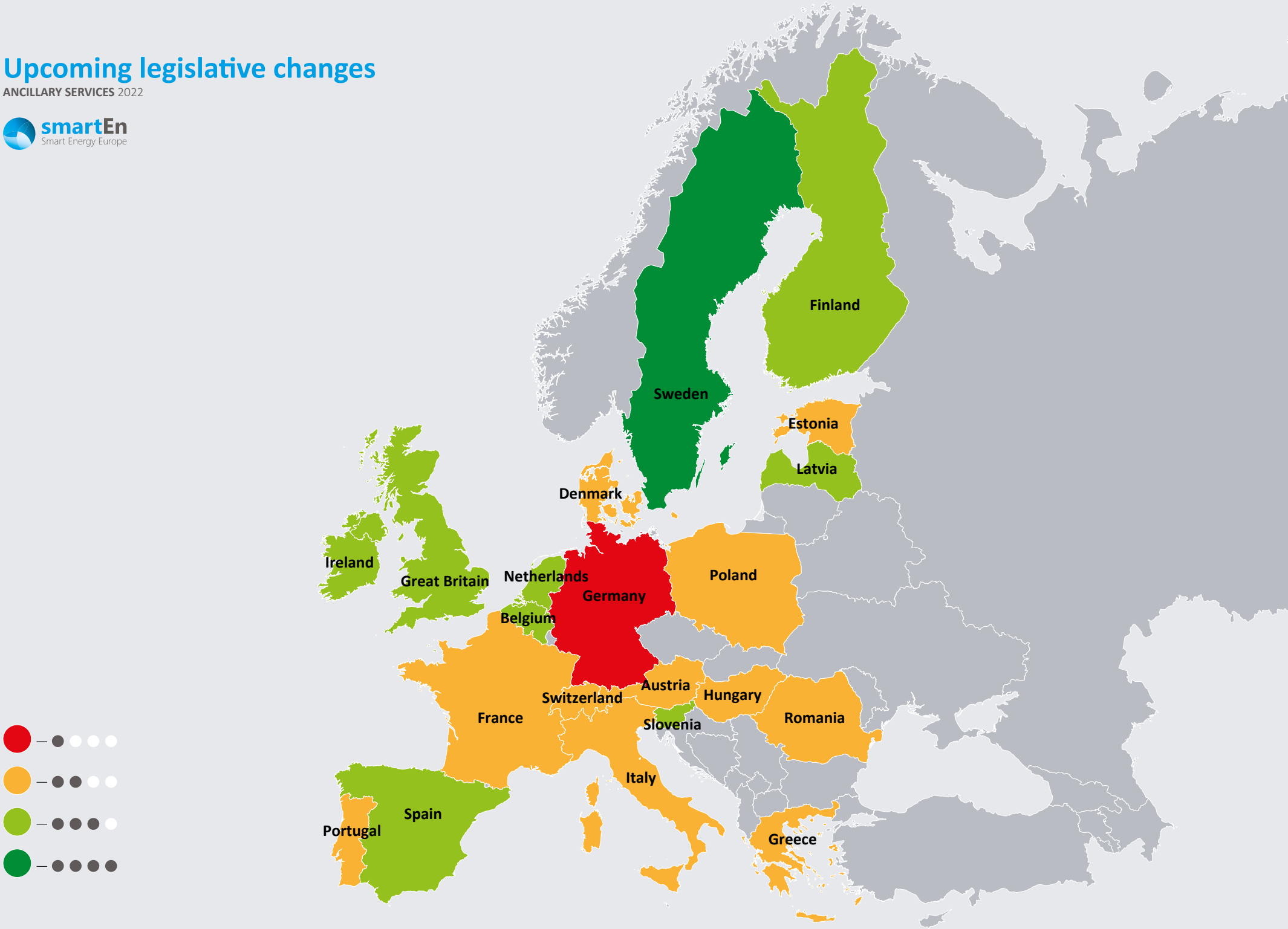
Smart Energy Europe



AUSTRIA

The Austrian ancillary services markets are theoretically open to all resources, but some obstacles still prevent a wide participation of demand-side resources. Notably, assets must prove their capacity to fulfil technical requirements individually, instead of pools, which can be limiting for small scale assets. Independent aggregators are required to have an agreement with a BRP, which places a costly burden on their activity. This results in a market still dominated by generation assets, in particular hydro and gas power plants. The Austrian TSO, APG, has undertaken a big effort in comparison to other European TSOs to increase market coupling through the different ENTSO-E platforms. In particular, Austria was one of the first countries to trade balancing energy for aFRR through PICASSO already in June 2022. This is a positive improvement in terms of harmonisation of market rules and increase in market size for all assets, including DERs.

What changed since the smartEn Map 2018 Balancing Markets?

Participation in the EU FCR Cooperation opened the market to DSF and fostered more favourable conditions like a lower minimum bid size (1 MW), higher auction frequency and shorter duration of delivery.

ACCESS TO ANCILLARY SERVICES

FCR

Since 2019 Austria is part of the EU FCR Cooperation platform opening the market to participation of demand-side assets. APG procures capacity for the primary reserve in the common EU market through daily auctions. In accordance with the rules set by the FCR Cooperation, the reserve can be procured from aggregated demand and generation resources with a minimum bid size of 1 MW in four-hour blocks. Only symmetrical bids for upwards and downwards regulation are allowed, which can be limiting the participation of some DERs which have technical constraints to provide symmetrical products (e.g., heat pumps, non-stationary storage, water heaters) but also run-off hydro power plants without reservoir.

aFRR

The Austrian aFRR market is open to DSF and the recent go-live of the PICASSO platform expands the market, facilitating cross-border trading of balancing energy. aFRR is procured through daily tenders for 4 hours blocks with a day-ahead gate closure. Pooled generation and demand resources can participate in the market; the minimum bid size for the first submitted bid is 1 MW, and 5 MW for each additional offer. Asymmetrical bids are accepted and there is no limit on the ratio between the upward and downward bids that are submitted. On 22 June 2022, APG has successfully exchanged the first balancing bids for aFRR through the ENTSO-E PICASSO platform. The Austrian TSO, together with their Czech and German counterparts are the first to harmonise their national aFRR markets in accordance with the EB Regulation[1].

mFRR

The tertiary reserve, mFRR is open to aggregated generation and demand-side resources. It is procured through daily tenders in four-hour blocks with a day-ahead gate closure. The minimum bid size is 1 MW and asymmetrical bids are allowed without a ratio between upward and downward regulation. APG is among the first European TSOs expected to connect to the ENTSO-E MARI platform in March 2023.

[1] https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/Implementation/picasso/220622_PICASSO_press_release_platform_accession_germany_austria_first_exchange.pdf

PARTICIPATION REQUIREMENTS

The complexity and costs of the telecontrol interface between the assets and the market as well as the requirement of 100% of reliability of availability and activation represent a barrier to the participation of a wide variety of demand-side assets.

• **Prequalification:** The prequalification process is done at asset level, which is costly and unnecessary for smaller assets that will only be active in pools. BSPs have to set up valid concepts of availability, that include an extensive description of the control system, the IT, the asset parameters and the necessary formulars and confirmations that have to be approved by the TSO together with the compliance to an activation test in real operation. The BSP prequalification process takes 10 to 30 weeks, which is longer that what is foreseen by the SO GL (three months), while every additional asset to the pool requires a short prequalification of 6 to 10 weeks. A BRP agreement is still required to enter each market; this is a significant barrier for aggregators facing higher costs and time-consuming procedures.

• **Testing and measurement:** Measurements for prequalification and proof of delivery can be performed at pool level, but measurements of the individual units must be performed and stored by the BSP. The required measurement accuracy is very costly for small scale units. The bidirectional interface is not standardised and the security standards are very hard to fulfil, both of these factors increase the costs. and represent a major barrier for DSF. Depending on the technology providing ancillary services, different types of baseline methodologies are accepted. The Austrian system operator allows the BSP to define the baseline methodology, which is evaluated by independent third parties.

• **Payments:** Availability payments are granted for all reserves, while energy payments for balancing energy are available for aFRR and mFRR. As foreseen by the EU FCR Cooperation, FCR capacity is remunerated following a marginal pricing logic, while aFRR and mFRR are remunerated on a pay-as-bid basis for capacity and energy payments. There is no compensation mechanism to the BRP/supplier foreseen, but the BRP must be informed about the activation schedules of the BSP on monthly basis to ensure a correct imbalance settlement.

• **Penalties:** 100% reliability is required for both availability and activation. This stringent requirement is excluding many demand-side assets from the market.

In case of non-delivery the units lose part of the availability remuneration and can be excluded from the market after three infractions.

MARKET COMPOSITION

The Austrian market for ancillary services remains dominated by generation assets, in particular hydro and gas power plants; in the last years batteries have started to participate in FCR and aFRR.

APG procures balancing reserves for FCR: ±73MW, aFRR: ±200MW and mFRR -195MW, +280MW. There is no publicly available information on the technologies that are covering this capacity, but market parties estimate that DSF is below 10%. Ancillary services are mostly procured from hydro and gas power plants; industrial loads are the main demand-side resource that is procured. Some small assets like BTM batteries, boilers, heat-pumps, and even snow cannons are used to provide these services. There are 16 BSP prequalified in the market, most of which are suppliers.

DATA TRANSPARENCY

The data transparency of the Austrian market is limited.

The TSO provides through a dedicated website[2] close to real-time market information on the energy mix, balancing reserves and energy activated. No information is provided on the carbon content of the grid, congestion, the resources prequalified nor on the amounts of DSF activated in the services procured.

UPCOMING LEGISLATIVE CHANGES

The only relevant legislative changes for the Austrian ancillary services market are related to the European market coupling.

The regulator is adapting the national rules to fulfil the requirements of the MARI initiative based on EB GL and SO GL (e.g., harmonization of the price cap for balancing energy).

[2] https://markttransparenz.apg.at/markt/

BELGIUM

The Belgian market for ancillary services is open and inclusive for all resources. There are no major barriers that hinder participation of DSF and Elia is working on improving its market design, in particular through a consumer-centric approach. The requirement to attempt to reach an agreement with the supplier/BRP for the compensation price can discourage participation of independent aggregators. Unlike what happens in most European countries, services for voltage control are not mandatory but procured through tenders, with the possibility of aggregation behind the same connection point. Belgium is also addressing adequacy concerns for the winter 2022/2023 by increasing the volume of mFRR procured and considering additional short-term capacity auctions for DR and low-carbon technologies.

What changed since the smartEn Map 2018 Balancing Markets?

FCR tenders are now performed daily instead of weekly and fully aligned with the FCR Cooperation rules. aFRR is now open not only to generators but also to demand-side assets and aggregated assets; it is now procured on a daily basis in D-2 instead of on a weekly basis.

ACCESS TO ANCILLARY SERVICES

FCR

Belgium procures FCR through the common European market of the EU FCR Cooperation.

Since 2016 Belgium is connected to the EU FCR Cooperation platform and it procures FCR capacity from day-ahead auctions for four-hour blocks. The procurement is open to all resources, including aggregated demand and generation assets from a minimum bid size of 1 MW. FCR is a symmetrical product with a full activation time of 30 seconds. Balancing energy for FCR is not settled. Unlike the other Belgian frequency ancillary services, assets connected to the low voltage grid can participate in the market, either individually or aggregated.

aFRR

aFRR is procured through daily tenders open to all market players. The upcoming connection with the PICASSO platform is accelerating positive changes such as the reduction of the full activation time.

Elia procures aFRR capacity through daily D-2 tenders from all resources including pooled demand and generation resources from a minimum volume of 1 MW; bids can be asymmetrical. It is mandatory for generation units >25 MW to offer available flexibility as aFRR energy bids. A BSP must at least offer aFRR energy bids corresponding to its aFRR reserved volume, and it has the possibility to offer non-reserved energy bids. Elia activates aFRR automatically by sending a set-point every four seconds and requests to activate within 7.5 minutes. Elia plans to move to a 5 minute full activation time by December 2024 at the latest in order to harmonise its rules with the rest of the European market due to the implementation of the PICASSO platform. The connection to the platform is foreseen by July 2024.

mFRR

The Belgian mFRR market is open to all resources and ensures a level playing field for generation and demand assets. The contracted volume will increase to tackle adequacy issues for the 2022/2023 winter.

The TSO procures only upward mFRR capacity through day-ahead tenders. The

market is open to generation and demand assets with a minimum bid size of 1 MW that can be provided through aggregated pools. Generation units above 25 MW are mandated to offer mFRR energy bids. There is a specific product in Belgium, the mFRR Flex product (previously R3Flex), which is a derated product with a limited number of activations. There are ongoing discussions on the need to maintain this product. Elia activates mFRR from the reserved capacities but BSPs can also freely offer balancing services. The full activation time is 15 minutes. The TSO will increase the procured volume to 915 MW to replace the loss of capacity that was expected from neighbouring countries for the 2022/2023 winter. Elia is part of the ENTSO-E MARI project, with the connection to the platform is foreseen by July 2024.

Voltage Control

The Belgian market is one of the few cases in which the provision of reactive power for voltage control is not mandatory but procured through tenders. Elia procures reactive power for voltage control through yearly tenders open to all resources, nevertheless some units have mandatory provisions to offer it. Aggregation of assets, including demand resources, is possible but only behind the same connection point.

PARTICIPATION REQUIREMENTS

The technical requirements for ancillary services do not limit the participation of demand-side resources. However, the compensation mechanism to the BRP/supplier that is currently implemented limits participation of independent aggregators.

- **Prequalification:** Market parties must submit the relevant documentation for each technical unit and perform a prequalification test. The BSP can decide to perform the prequalification at asset or pool level for FCR. For mFRR and aFRR, units below 25 MW can decide to perform it at pool level, while units above 25 MW are always prequalified at asset level. For voltage control the prequalification process is always performed for the individual units. The prequalification process usually takes between two and six weeks.

- **Testing and measurement:** he prequalification test and the measurement requirements do not hinder participation of specific resources. Measurement is usually performed at the connection point, but sub-metering can be used to isolate certain assets. The accuracy of the measuring devices is adapted to the asset size. Nevertheless, specific procedures to facilitate and accept embedded sub-metering devices, not only for balancing but also for energy allocation, should be further improved.

- **Payments:** For FCR, only availability payments are granted. For aFRR and mFRR there are both availability and energy payments, while for voltage control there are only energy payments. For aFRR, the BSP, BRP and supplier of the asset need to reach an agreement for its participation and compensation mechanism. For mFRR, under the current "Transfer of Energy" model, the supplier is compensated by the BSP at an agreed price, or, if such agreement is not reached, at a regulated price applied by the regulator. In both cases, the conditions can discourage participation of independent aggregators.

- **Penalties:** In case of unavailability, financial penalties are imposed based on the power or energy discrepancies for all products expect for mFRR, for which the suspension of the delivery point can be applied.

MARKET COMPOSITION

The favourable requirements allow for a high participation of DSF in different products, especially from small scale batteries and industrial loads.

From the overall FCR capacity procured by Elia (87 MW), 28 MW are provided by small/medium scale batteries (household batteries and batteries up to 20 MW), with the remainder mostly coming from CCGT plants. 40 MW out of 117 MW of aFRR are procured from small/medium scale batteries as well as CHP plants. In mFRR, 350 MW out of 650 MW of total capacity is procured from DR providers, mainly industrial loads. Voltage control is provided mainly by CCGT, hydro, nuclear and wind power plants. Activation of DSF capacities is also quite high, for FCR almost 100% of the capacity is activated, for aFRR up 42 GWh (6%), aFRR down 105 GWh (18%) and for mFRR up 8 GWh (1%). Three independent aggregators are providing their services in the market, with a fourth is expected to be prequalified shortly.

DATA TRANSPARENCY

The data transparency of the Belgian electricity market is one of the most advanced in Europe. In 2021, Elia launched its Open Data Platform[3] where different datasets on power generation, demand, congestion and balancing are published with a granularity of 15 minutes or less. All information is easily accessible from Elia's website and through an open API. It is worth highlighting that it is particularly interesting for market parties to access information on the level of congestion risk per hour in each Belgian electrical zone, as well as redispatching activations and costs. On the other hand, the platform does not provide information on the CO_2 content of the grid.

UPCOMING LEGISLATIVE CHANGES

In the short-term, the Belgian market is responding to security of supply issues with an increased procurement of mFRR capacity, including from DSF providers. In the medium-term, harmonisation of the market rules through the ENTSO-E platforms and a consumer-centric market design promise more opportunities for active consumers.

To respond to the adequacy issues for the winter 2022/2023, the Belgian Ministerial Cabinet asked Elia to increase the mFRR volumes to be contracted with 250 MW. In addition, Elia will investigate an additional low-CO_2 capacity winter auction for 2023/2024. These initiatives could provide demand response, batteries and other CO_2 efficient technologies additional incentives to be available to the market in response to the energy crises.

In the medium-term, Elia is conducting a pilot project that aims at opening the redispatch products to DERs. This will be on a voluntary basis for demand facilities, but mandatory for production and storage units ≥1 MW. In 2021, the TSO launched a Consumer-Centric Market Design that should help to unleash the flexibility held in assets like EVs and unlock better services for consumers. Notably, the introduction of the 'Exchange of Energy Blocks' hub would allow energy to be exchanged between consumers and other market parties on a fifteen-minute basis. This is meant to address the administrative complexity that is currently discouraging new market players from entering the market.

[3] https://opendata.elia.be/pages/home/

DENMARK

Denmark has a wide range of ancillary services that are procured through market-based mechanisms. Generation and demand assets can compete on equal footing and aggregation is allowed. Nevertheless, aggregated units must be part of the same BRP, which limits the possibilities for market players to form their portfolios. The participation of EV batteries in ancillary services is particularly common in Denmark due to favourable conditions to access the fastest products, FFR and FCR. The TSO requires local measuring systems with 1 second resolution that are particularly costly for smaller assets and can limit the business case of residential aggregators. Finally, the transparency of the market is limited due to the unavailability of market composition data.

What changed since the smartEn Map 2018 Balancing Markets?

In recent years, the Danish market for ancillary services has seen some positive evolutions, in particular the introduction of the new FFR product common to all the Nordic countries, and the opening of the aFRR market, which was previously procured through bilateral agreements with the Norwegian TSO.

ACCESS TO ANCILLARY SERVICES

FFR

The Fast Frequency Response (FFR) product has technical requirements very well suited for demand-side assets like EV batteries, making it one of the most accessible products in the Danish market.

In line with the other Nordic countries, in 2020 Denmark introduced a Fast Frequency Response product (FFR). This service is used in situations with low inertia when frequency-controlled disturbance reserves (FCR-D) in the Nordic synchronous area cannot maintain frequency above a certain threshold in the event of major outages. Usually the need for FFR is non-existent in the winter months and it is highest on summer weekend nights, so the capacity procured by the TSO varies throughout the year from 0 to 45 MW. The reserve is procured through daily national auctions open to all resources, including pooled generation and demand units from a minimum bid size of 0.3 MW. Unlike other ancillary services, as outlined below, for FFR it is not required that the units belong to the same BRP. Balancing energy for FFR is settled as imbalances, as often happens for very fast products. These conditions make the product particularly well suited for DSF technologies, in particular distributed EV batteries that can ramp up fast enough. While this is currently not possible with the V2G CHAdeMo protocol, it will eventually be with the adoption of the CCS standard.

FCR

Denmark procures different FCR products in its two synchronous areas; conditions for DSF technologies are more favourable in the Eastern Denmark area (DK2).

The Western Denmark area (DK1) is part of the EU FCR Cooperation, so Energinet's requirements are aligned with the other European countries that are part of the cooperation. In DK1, FCR capacity is procured through daily auctions that are open to aggregated demand and generation assets with the condition that the same BRP has balance responsibility for both the demand and generation units. Moreover, FCR can be delivered from independent BSPs. The minimum bid size is 1 MW and bids must be submitted in four-hour blocks. The total capacity

procured in DK1 is 22 MW. In addition, Danish providers can export up to 100 MW to continental Europe. FCR balancing energy is settled as imbalances.

The Eastern Denmark (DK2) area is synchronised with the Nordic area. Energinet procures three FCR products in coordination with Sweden:

- FCR-N for normal operation for a total capacity of 18 MW
- FCR-D upwards for disturbances for a total capacity of 44 MW
- FCR-D downwards for disturbances for a total capacity of 38 MW

For all products the minimum bid size is 0.1 MW and they are procured through daily auctions. The FCR-N product is symmetrical and this could constitute a barrier for technologies that cannot cost-effectively place symmetrical bids (i.e., heat pumps, batteries, boilers). Balancing energy for upward and downward regulations in connection with FCR-N are settled with the respective regulating power prices. These services are an interesting value stream for DERs, especially EV batteries, whose participation in the Danish FCR market is particularly advanced.

aFRR

Denmark procures aFRR through monthly auctions. The requirement for demand and generation assets to be within the same BRP's balancing perimeter does not attract demand-side resources.

aFRR capacity and balancing energy are procured in DK1 through monthly auctions. Generation and demand assets can be pooled but aggregations have to be separated for each BRP. The minimum bid size is 1 MW and bids need to be symmetrical. aFRR is the only product for which the bids have to submitted via email to the TSO and not through a centralised portal. Energinet procures ca. 100 MW of aFRR capacity for upward and downward regulation. Demand-side resources active in Denmark, mostly EV batteries and electric boilers, prefer to participate in markets for faster products. In DK2, aFRR is procured through the common Nordic market. The planned connection to the PICASSO platform is estimated for Q1 2024.

mFRR

mFRR is procured through market-based mechanisms but requirements such as the high minimum bid size hinder participation of DSF.

Denmark procures manual reserve in both DK1 and DK2. In DK1, the full required volume is procured at daily auctions, while DK2 procures 40% of required volume at daily auctions and 60% at monthly auctions. The minimum bid size is still high, 5 MW, and aggregation of generation and demand units is allowed only within the same BRP's perimeter. Denmark is part of the ENTSO-E MARI platform but the go-live has been delayed to Q1/Q2 2024.

PARTICIPATION REQUIREMENTS

The prequalification process for pooled resources is performed for portfolios of maximum 3 MW, which can be a limitation for certain aggregators. The requirement to use local measuring systems with high resolution is particularly costly for smaller assets.

- **Prequalification:** The prequalification procedure is the same for generation and consumption assets and it is performed at pool level for portfolios of maximum 3 MW. This could be a burden for aggregators with bigger portfolios that have to fulfil multiple prequalification procedures. Each ancillary service has a different prequalification test, depending on the requirements of the service. Independent aggregators can deliver FCR and FFR without an agreement with a BRP/supplier. In contrast, for aFRR and mFRR an agreement must be reached and this is a barrier for participation of aggregators in the market.

- **Testing and measurement:** Metering requirements are particularly stringent for FFR and FCR because the TSO requires the installation of local measuring systems with a resolution better than 1 second. This can be particularly costly, and unjustified, for small scale resources and limit their participation in the market. For aFRR and mFRR, each individual generation and consumption unit must be connected to the Energinet's Control Centre, but this can be implemented through the control software and does not require installation of measuring devices on each unit.

- **Payments:** The same payments are granted to generation and consumption units. Availability payments are settled for all the reserves and energy payments are also available for all services except for FFR and FCR in DK1.

- **Penalties:** In case of non-delivery of the service, the payment made to the provider is reduced proportionally to the period of non-delivery. Energinet may also quarantine

the provider for up to 30 days to allow time to remedy the situation prior to resuming deliveries.

MARKET COMPOSITION

The detailed market composition of Danish ancillary services is not disclosed by the TSO. From information collected from market parties, the main demand-side resources that are participating, especially in FFR and FCR products, are electric boilers, batteries and EV batteries.

DATA TRANSPARENCY

The data transparency of the Danish market is advanced in terms of grid data but, as highlighted before, the market composition is unknown and this is a limiting factor.

Energinet publishes real-time data on the generation mix, CO_2 content of the grid and information on grid congestions through an online portal[4]. The data is available through downloadable files and an open API. In addition, the TSO is developing a system to incorporate geographical tags in the regulating power market to mitigate internal congestions, this should allow market participants to incorporate this information into their commercial offerings.

UPCOMING LEGISLATIVE CHANGES

The main legislative changes are related to the harmonisation projects in the Nordics and continental Europe but there are uncertainties over the implementation timelines.

Denmark is part of the Nordic Balancing Model (NBM) cooperation as well as the Continental Europe harmonisation projects. Nevertheless, the implementation timeline of the common aFRR and mFRR capacity markets foreseen by the NBM is still uncertain and the connection to the ENTSO-E platforms has been postponed to 2024. The only short-term legislative change that it is worth highlighting is the development of a compensation model that might facilitate independent aggregators' participation in all ancillary services markets.

[4] https://www.energidataservice.dk/

ESTONIA

Estonia, like the other Baltic countries, is synchronously interconnected with the IPS/UPS (Integrated/Unified Power System) and plan to synchronise with the CESA (Central European Synchronous Area) by the end of 2024. Therefore, the Estonian market for ancillary services is quite different from the rest of Europe. The only ancillary service available is mFRR, which is procured in a market open to demand-side resources. Nevertheless, low profitability and challenging measurement requirements make participation of DSF almost non-existent.

What changed since the smartEn Map 2018 Balancing Markets?

No significant changes have happened since 2018.

ACCESS TO ANCILLARY SERVICES

FCR

Not available.

aFRR

Not available.

mFRR

mFRR balancing energy is the only ancillary service procured in Estonia. It is open to aggregated demand and generation but participation of DSF is very low. Balancing energy for mFRR is procured through daily auctions for a maximum duration of delivery of 60 minutes. There is no procurement of capacity for this reserve. The minimum bid size is 1 MW and aggregated demand and generation resources can participate in the market. A basic aggregation framework has been introduced into national law, but certain barriers prevent a real participation of DSF in the market. For example, aggregators must sign bilateral contracts with energy suppliers in order to participate. This results in very low volumes of balancing energy provided by demand-side resources.

PARTICIPATION REQUIREMENTS

The need to provide real-time data through high-cost measurement devices is the main technical barrier that limits participation of demand-side resources in the mFRR market.

- **Prequalification:** The prequalification process is performed at pool level. The aggregator has to sign a balancing agreement with the TSO and to demonstrate ex-post that it has actual DR resources to provide balancing energy for mFRR once real-time data from the first activation is available.
- **Testing and measurement:** The aggregator is required to provide real-time of its delivery to the TSO. The high cost of the control logic and data exchange system is a barrier to the participation of demand-side resources in this market.

There are no strict requirements on the devices for the real-time data collection. The data is verified during the monthly settlement process, where metering data is used to verify and finalise the metering points data.

BSPs can uses their own baseline methodology. Elegrid does not provide nor pre-approve any methodology. If the TSO considers that the activated energy calculated by the BSP is not reasonable, the volumes can be attributed to the BSP's imbalance. Since each BSP has to sign a BRP agreement, the imbalance is then settled through the imbalance price.

- **Payments:** Energy payments are settled on a marginal price logic with a maximum price of 5 000 €/MWh. There are no capacity payments and this can limit the economic viability of DSF participation in the market.
- **Penalties:** There are no specific penalties for non-delivery.

MARKET COMPOSITION

The Estonian market has a very low participation of demand-side resources.

Only four BSPs are prequalified in the market. The amount of DSF energy bids in mFRR market is ca. 2 MW, which are mainly provided by industrial and commercial loads.

DATA TRANSPARENCY

The transparency of the Estonian market is very advanced.

Elering provides information on production and consumption, cross-border flows and imbalances per bidding zone border and per market time unit[5]. In addition, data on the Estonian balancing market are published through the Baltic Transparency Dashboard[6] which provides real-time information and transparency of the Baltic Coordinated Balance Area. Both platforms are accessible through open APIs.

UPCOMING LEGISLATIVE CHANGES

The synchronisation with the CESA will open new markets for ancillary services in Estonia.

Baltic countries aim at establishing a Baltic Load Frequency Control (LFC) block by the end of 2024 due to the desynchronization of IPS/UPS synchronous area and synchronization to CESA. The establishment of the LFC block will open the possibility to offer FCR and aFRR capacities to the market and harmonise market rules with Continental Europe.

Finally, it is expected that between the end of 2022 and 2023 the Estonian government will establish a demand response market settlement model for the day-ahead market. This is part of the implementation process of the EU Electricity Market Directive 2019/944.

[5] https://dashboard.elering.ee/en
[6] https://baltic.transparency-dashboard.eu/

FINLAND

Finland has a wide variety of ancillary services, the majority of which are open to all resources and ensure a level playing field for generation and demand assets. The aFRR market is also undergoing positive changes, with the removal of the requirement to be or assign a BRP. Some barriers for demand-side resources (e.g., minimum bid size, obligation to be a BRP) still remain for mFRR. However, the lack of a comprehensive aggregator framework for all services represents a major barrier. The technical requirements ensure fair competition among the different resources; this is shown by high participation in the different reserves from storage, industrial and commercial loads. The Finnish market benefits from a high level of transparency. Finally, the upcoming legislation for the definition of the aggregator framework will likely widen the access of DSF to the different markets.

What changed since the smartEn Map 2018 Balancing Markets?

A new FFR product was introduced in 2020, open to DSF including through independent aggregators. Participation of DR and storage is significant. The same applies for the FCR-D Down market that opened in 2022. An increase in the capacity procured from demand-side resources for the different reserves can also be observed. The reduction of the minimum bid size and the upcoming opening to independent aggregators of the aFRR market is also a positive improvement in the Finnish ancillary services market.

ACCESS TO ANCILLARY SERVICES

FFR

FFR is a new fast product introduced by the Nordic countries; in Finland it is fully open to DSF and particularly suitable for batteries and DR providers.

Since May 2020, the Nordic Synchronous area has introduced a Fast Frequency Reserve (FFR) to handle low-inertia situations. Finland procures it from a national hourly market. FFR is procured only in upward direction and, depending on the inertia of the system, only for some hours of the year and with variable volumes. Fingrid publishes a procurement forecast one week ahead. FFR is a very fast product with maximum activation times of 0.7, 1 or 1.3 seconds depending on the activation frequency. The minimum duration of activation is 5 seconds if the power deactivation rate is no more than 20% of the FFR capacity per second. If the deactivation rate is higher, the minimum duration of activation is 30 seconds. The maximum activation period is 15 minutes. The market is open to aggregated demand and generation assets with a minimum bid size of 1 MW and a BRP agreement is not required. These conditions result in high participation of DR and storage in the market, as detailed in the following sections.

FCR

The Finnish FCR market is inclusive for all demand and generation resources.

Finland procures two different FCR products: one for Normal Operation (FCR-N) and one for Disturbances (FCR-D):

- FCR-N aims to keep the frequency within the standard frequency range of 49.9-50.1 Hz. It is a symmetrical product with a minimum bid size of 0.1 MW.

- FCR-D aims to limit the frequency deviation to 49.5 Hz or 50.5 Hz when the frequency goes outside the standard range. Upwards and downwards bids can be submitted separately and no ratio is applied between the bids.

Both products are procured through yearly and hourly markets and have the same technical requirements and terms & conditions. A BSP that has a yearly agreement may participate in the hourly market only if it has supplied the reserve amount specified in the yearly agreement in full. There is the possibility of flexible bidding for capacities that are suitable for both FFR and FCR-D upward

regulation. Finland also procures FCR from the other Nordic countries, Russia and Estonia.

aFRR

The aFRR market is open to aggregation but it is still required for service providers to be or assign a BRP. This barrier will be removed in 2023.

aFRR is procured nationally through hourly markets. The minimum bid size to participate is 1 MW. Aggregated demand and generation resources can participate but providers are required to be or assign a BRP. This barrier will be removed from May 2023. A BSP can submit bids to the hourly market separately for up-regulation and down-regulation capacities. A common aFRR capacity market for the Nordic area is under discussion. The implementation of the PICASSO platform is expected by Q2 2024, since all Nordic TSOs have requested a derogation to ENTSO-E.

mFRR

mFRR is the least inclusive market in Finland due to high minimum bid sizes and BRP requirements.

Fingrid procures mFRR capacity through weekly tenders and mFRR balancing energy through an hourly market (they are referred to as balancing capacity and balancing energy markets). The minimum bid size is 10 MW. Pooled generation and demand resources can participate only if they are part of the same BRP. The opening of the market to independent aggregators is under consideration, following the results of a pilot project ended in 2021[7], but the timeline for implementation is uncertain. The implementation of the MARI platform, to exchange balancing energy for mFRR with the Continental Europe area, has been derogated to Q1/Q2 2024.

PARTICIPATION REQUIREMENTS

The technical requirements for the different ancillary services ensure a level playing field for all resources.

• **Prequalification:** The prequalification process varies between products and it is in principle performed at asset level. However, for FRR and FCR, both asset-level and pool-level prequalification are accepted and type-approval can be applied. The technical requirements for prequalification are the same for all technologies and usually the prequalification tests are faster to perform for demand than generation assets.

• **Testing and measurement:** Metering requirements for FFR and FCR are not particularly taxing for DR resources, and smaller units (< 2MW) are allowed to have lower measurement accuracy. Nevertheless, real-time telemetry is required to monitor the state of charge of batteries in FCR products. For aFRR and mFRR, there are no particular measurement requirements to fulfil. Nevertheless, the new technical requirements for FCR, agreed upon all Nordic TSOs, that will be implemented from 2023, could lead to an extension of real-time telemetry requirements to all resources and more stringent tests especially for entities with limited energy reservoirs (LER).

• **Payments:** For FFR, like most fast products, only capacity payments are granted. The same applies for FCR-D, while FCR-N, aFRR and mRR are also remunerated with energy payments. A marginal price logic is applied to all the products. FCR-D down and aFRR are the most profitable markets. In general, the economic viability of balancing products for smaller demand-side units is quite low, making revenue stacking especially important.

• **Penalties:** Currently there are different sanctions in case of non-delivery for all reserve products apart from aFRR. From May 2023 they will be harmonised between products and will be equal to three times the capacity remuneration received for the non-delivered reserve.

MARKET COMPOSITION

The accessibility to DSF of the Finnish ancillary services market shows in the relatively high volumes of capacity procured from DSF providers across the different products.

The FCR-D Up market is particularly interesting for DR, with over 40% of the prequalified capacity assigned to them. All the FCR markets are suitable for storage, almost 19% of the prequalified capacity of FCR-N, 4% of the prequalified capacity of FCR-D Up, and 21% of the prequalified capacity of FCR-D Down is from batteries. Overall, the shares of DR and storage in the reserve procurement are increasing over the years. In absolute terms, 80

[7] https://www.fingrid.fi/en/electricity-market/market-integration/the-future-of-the-electricity-markets/aggregation-pilot-project-in-the-balancing-energy-markets/

MW of FFR, 10 MW of FCR-N, 410 MW of FCR-D Up, 10 MW of FCR-D Down, up to 530 MW of mFRR up and up to 100 MW mFRR down were procured from DR providers at the beginning of 2022. Traditionally, hydro power units have produced most of the reserve capacity in Finland. DR capacity comes from a vast variety of industrial and commercial loads with a good potential for heating and cooling technologies. There are ca. 46 prequalified BSPs in Finland, 5 of which are independent aggregators which participate in FFR and FCR markets.

DATA TRANSPARENCY

The Finnish market has high transparency not only in terms of grid data shared but also market rules and participants.

Fingrid provides data through its Open Data[8] platform. This includes real-time data on composition of the energy mix, CO_2 content and grid congestions for disturbances and planned outages each 5 days. Data can be retrieved through different formats and an open API. The TSO also provides comprehensive data on the sources used in different products.

UPCOMING LEGISLATIVE CHANGES

The main short-term legislative change for ancillary service is the opening of the aFRR market to independent aggregators from May 2023.

The connection to the ENTSO-E balancing platforms will also widen the possibilities for DSF providers to participate in a bigger market. By the end of 2022 it is also expected that the proposal for the introduction of the independent aggregator framework will be presented to the Finnish parliament.

[8] https://www.fingrid.fi/en/electricity-market-information/

FRANCE

The French market has a wide variety of ancillary services, which are relatively open to DSF providers. However, negative evolutions in some markets in 2021 and 2022 have limited viability of investments in DERs. Notably, the decision by the French Regulator to suspend the aFRR market due to suspected market abuse. This step back harms DSF providers, limiting the value streams they have access to. Moreover, not all markets allow equal participation of generation and consumption units and some DERs can only participate under experimental frameworks. France has adopted several measures to tackle the energy crisis of winter 2022/2023. A new provision obliges all DR resources to be available on the balancing market when the system is particularly at risk (in "red EcoWatt" moments) with the possibility of receiving only energy payments. Aggregators also face high penalties if consumers are unavailable. This represents a big risk for them and disincentivises consumers from participating in explicit DSF markets.

What changed since the smartEn Map 2018 Balancing Markets?

Aggregated demand, storage and generation resources are now fully allowed to participate in the FCR market. The aggregation of demand and generation resources has also been allowed in aFRR and mFRR but within an experimental framework. The aFRR market was open to all resources for a short period of time in 2021 but suspended on the regulator's request due to suspected market abuses.

ACCESS TO ANCILLARY SERVICES

FCR

FCR is the main product for DSF due to its procurement method and the beneficial technical requirements. It is procured through the EU FCR Cooperation and open to aggregated demand-side resources. Aggregation of generation and demand units in the same pool is allowed. Through the FCR cooperation platform, capacity for primary control is procured with market-based auctions on a daily basis. The minimum bid size is 1 MW. From July 2020 the duration of product delivery has been reduced from one day to four hours. While this change is positive, it could be further improved to a reduction to 1 hour to foster participation of smaller assets (e.g., EVs and small stationary storage). Only symmetrical bids are accepted, this requirement hinders participation of many decentralised assets, which have technical constraints to offer symmetrical products (i.e., heat pumps, batteries, electric boilers).

aFRR

The secondary reserve is mandatory for historic generators above 100 MW and any new generation or storage capacity above 75 MW. It is accessible to every other actor, including DSF providers, via a secondary market. However, the aFRR market was open for a short time during 2021 and then suspended. At the moment of writing, the minimum capacity to participate in aFRR is 1 MW. Any BSP can sell their aFRR capacities through a secondary market, with a minimum duration of 30 minutes. This condition severely limits aggregators, which have to negotiate bilateral agreements and disclose their available capacities with obligated parties that are also future competitors in the market. The activation is pro-rata rather than through the merit order and the remuneration is based on SPOT prices. Nevertheless, the merit order activation and a pay-as-clear remuneration should be introduced by half of 2023.

The TSO opened a national tender for aFRR, including also aggregated demand

[9] https://www.cre.fr/content/download/25770/file/220630_2022-88_Derogation_appel_offres_reserve_secondaire.pdf

response providers, for a few weeks in 2021 and then suspended the service on the regulator's request due to suspected market abuses and scarce liquidity[9]. The market is suspended according to article 6 of the EU Electricity Market Regulation 2019/943, until four conditions are met: 1) additional capacities are certified by RTE, 2) commitments by market parties to bid according to their opportunity costs, 3) additional competitors (including in particular DR aggregators and storage assets owners) enter the market, 4) RTE improves its algorithm to select the most competitive bids. The access to the ENTSO-E PICASSO platform, which will likely increase energy payments introducing a pay-as-clear remuneration, has been derogated to 2024.

mFRR and RR

The mFRR/RR market sees a high participation of DSF technologies, but some barriers (i.e., high minimum bid size, the impossibility of aggregating demand and generation in the same pool) still persist. Capacity for the tertiary and replacement reserves are procured through national yearly and daily tenders. Energy for these reserves is procured through the national balancing mechanism with a pay-as-bid logic or TERRE (European platform to exchange energy for RR) with a pay-as-clear logic. In 2022, 66% of volumes were procured annually and 33% through daily tenders. Demand units can in theory be contracted for these reserves but with a minimum bid size of 10 MW without the possibility of aggregation of generation and demand. An experimental framework allows lower minimum bid sizes but participation is still limited. Nevertheless, a dedicated yearly tender for DR ("AOE", Appel d'Offres Effacement) gives additional availability remuneration to DR, also with units < 1 MW, for providing mFRR/RR. This mechanism is approved under State Aid with strict conditions (i.e., price cap, participation limited to some years depending on the type of consumers). The AOE shall be replaced by another mechanism from 2024. This legal uncertainty is slowing down investments in load flexibility. The overall share of mFRR and RR procured from demand-side resources is high (circa 50%) but activation is very low. The connection to the ENTSO-E MARI platform is expected between 2024 and 2025.

PARTICIPATION REQUIREMENTS

Technical requirements for the participation in the ancillary services do not limit DSF but telemetry measurement requirements can limit the use of some distributed resources.

- **Prequalification:** The prequalification process is performed at pool level and it is a transparent and fair process. Prequalification for FCR and aFRR foresees ex-ante technical tests to demonstrate the dynamic response of the units, while there is immediate prequalification for mFRR and RR and ex-post checks. Storage and limited energy units are asked to provide more data upfront than other participants and a thorough description of the charging strategy. A BRP agreement is not required for DR providers, but it is required for storage.

- **Testing and measurement:** The measuring requirements do not limit demand-side resources per se, but some specifications, like the obligation to transfer data in real-time (10s telemetry measurements) to the TSO, can prove cumbersome for smaller distributed assets. Nonetheless, these specifications are waived under experimental frameworks, which allow smaller units to provide an estimate of generation or consumption instead of telemetry data. Tests are remunerated at the marginal balancing price.

- **Payments:** Capacity and energy payments are equally guaranteed to all resources, generation and demand-side.

- **Penalties:** Penalties expose BSPs to high risks due to price volatility. A set of penalties are foreseen for FCR and aFRR: in case of loss of capacity, there is a loss of the availability payment and penalisation at the hourly spot price. In case of repeated non-activation, part of the availability payments are lost. For mFRR the penalty is based on the maximum between the capacity payment and the spot price.

MARKET COMPOSITION

The French market for ancillary services is still dominated by conventional generators, but there is good participation of industrial loads and CHP plants. Assets connected at low voltage level are allowed to provide ancillary services individually or aggregated. Around 13 independent aggregators are currently participating in the balancing market. Currently 489 MW are procured for FCR, 700 MW of aFRR (upward and downward), 1 GW of mFRR and 500 MW of RR. Of this capacity, circa 20% of FCR and 50% of mFRR and RR are provided by demand-side resources. For 2023, 2700 MW have been rewarded in the AOE, the amount of this total capacity that is allocated to mFRR/RR is unknown.

DATA TRANSPARENCY

The data transparency of RTE is quite advanced. The system operator provides hourly data on the energy mix and the CO_2 content of the French system via the éCO2mix[10] website. The tool intends to help consumers to better understand their electricity consumption and it is accessible through an open API. Information on grid congestions is not provided in a real-time manner but regularly published by the TSO. It is important to highlight that RTE has recently introduced a new digital tool, EcoWatt[11], to forecast the status of the electrical system ahead of the winter 2022/2023. The tool will signal if the status of the electrical system is critical and power cuts are inevitable. The objective is, through a simple message, to call on individuals, companies, and communities to voluntarily reduce their consumption during peak periods. Even if this is an interesting information tool put forward by the TSO, currently it does not incentivise or facilitate the automatic activation of flexible consumers to react to grid constraints.

UPCOMING LEGISLATIVE CHANGES

The most relevant upcoming regulatory change would be the re-opening of the aFRR market, but it will not happen in the short-term. France is also introducing multiple measures for DSF to tackle high energy prices and ensure security of supply in the 2022/2023 winter. Some of these measures could be counterproductive to the commercial viability of DSF. The re-opening of the aFRR market it is not expected before 2025. As of November 15th, the national terms and conditions allows aggregation of all type of assets (and in any combination) for FCR and aFRR, nevertheless, this change won't be relevant for demand-side resources in aFRR, if the market remains closed. This will also be granted to assets connected to the low voltage grid by the first semester of 2023. France is one of the first countries in Europe to introduce measures, that leverage the potential of DSF to reduce gas consumption during peak hours, to tackle the energy crisis. In particular, RTE launched a new call for tenders of 500 MW for implicit DR[12] to encourage suppliers to allow consumers to achieve load reductions when receiving a peak signal through their mobile phones. On the other hand, RTE introduced a requisition measure for DR capacities participating in any market[13]. This measure is raising concerns among market participants due to its economical non-viability. Consumers will be obliged to offer their capacity in the balancing market (for maximum 300h) while receiving only energy payments. An administrative fine could be applied to the aggregators that do not submit offers, increasing the risk of consumers leaving the market of explicit DR.

[10] https://www.rte-france.com/en/eco2mix
[11] https://www.monecowatt.fr/
[12] https://www.services-rte.com/en/learn-more-about-our-services/benefit-from-a-support-mechanism-for-the-demand-response-inextricably-linked-with-supply.html
[13] (articles L.321-17-1 and L321-17-2 of French energy code).

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GERMANY

The German market has seen limited improvements in the access of DSF in the different ancillary services. The FCR, aFRR and mFRR are open through market-based mechanisms, but significant barriers still prevent substantial participation of demand-side assets. Notably the limitation to form pools within one balancing area, the requirement of a BRP certificate issued by the consumer's supplier and the high administrative efforts to participate. Frequent changes in regulation and market requirements do not guarantee certainty to market players. Moreover, the weak digitalisation and data transparency of the German electricity market is greatly limiting the proliferation of innovative offers for active consumers. Finally, the German TSOs have made great efforts towards the European harmonisation of the balancing market through the connection to the ENTSO-E platforms.

What changed since the smartEn Map 2018 Balancing Markets?

Germany fully joined the EU FCR Cooperation platform, which guarantees a level playing field for all resources within the Cooperation. No major changes can be noted for the other frequency ancillary services.

ACCESS TO ANCILLARY SERVICES

FCR

Germany procures FCR through the EU FCR Cooperation, which allows equal access to demand and generation assets.

Germany is part of the FCR Cooperation and procures FCR capacity from 1 MW through daily auctions for four-hour blocks. Pooled assets are allowed to offer asymmetrical FCR as long as the pool offers symmetrical FCR. This can be a limitation for the formation of a pool of demand-side resources with technical constraints to offer symmetrical products. Nevertheless, pooling is only allowed within the same TSO area (Germany has four different balancing areas, corresponding to four different TSOs).

aFRR

The aFRR capacity and energy markets are open to all resources. The German TSOs have already successfully connected and traded energy through the European PICASSO platform.

Capacity for secondary control is procured through day-ahead tenders from a minimum bid size of 1 MW with a product length of 4 hours. Aggregation of demand and generation in the same pool is allowed, but only within the same balancing area. Since 2020 the balancing energy market was introduced to separate procurement of balancing capacity and balancing energy. Asymmetrical bids are allowed. aFRR balancing energy is procured for 15 minutes blocks and the full activation time is five minutes. In June 2022, the German TSOs, together with the Austrian and Czech ones have been the first to connect to the ENTSO-E PICASSO platform. This is a significant step for the harmonisation of their national markets for balancing energy in accordance with the EB Regulation.

mFRR

Germany procures mFRR capacity and energy through a market-based mechanism open to all resources.

The German TSOs procure capacity for tertiary reserve through day-ahead tenders open to all providers from 1 MW, including pools of demand and generation.

As for the other frequency ancillary services, pooling is only allowed within the same balancing area. Since 2020 an energy market for mFRR balancing energy was introduced. Asymmetrical bids are allowed and the full activation time for this product is 12.5 minutes. The connection to the ENTSO-E MARI platform was established in October 2022, this means that the German TSOs were among the first to connect.

PARTICIPATION REQUIREMENTS

A series of technical requirements create undue barriers for DSF providers, in particular a requirement for BSPs to have an agreement with the consumer's supplier, and the limitation to offer ancillary services within the same TSO area.

• **Prequalification:** A pool is defined as the aggregation of Reserve Providing Groups (RPG) and Reserve Providing Units (RPU). A RPU is formed by single and/or aggregated demand and generation assets connected to the same connection point, an RPG is formed by aggregated demand and/or generation units connected to multiple connection points. The prequalification process is performed at RPU or RPG level. For all ancillary services, pooling of assets is only allowed within the same balancing area (the area connected to one of the four German TSOs). If a provider offers technical units in several control areas, a framework agreement has to be concluded with each respective connecting TSO. Aggregators are therefore limited in their possibility to form pools. The prequalification process foresees many steps, including performing an operating test, the submission of a technical concept and pool concept, the written confirmation of the consumer's supplier/BRP and the confirmation of the connecting DSO in case of assets at distribution level. According to SO GL, the prequalification process may take up to three months. The complexity of this process can also be flagged as a barrier for smaller service providers.

• **Testing and measurement:** The BSP must submit real-time data to the connecting TSO. In general, the metering requirements are not adapted to the size and capabilities of the assets and this can be particularly taxing for small units. Units of less than 100 kW can use an internet connection for data transmission, bigger units need connections via leased lines.

• **Payments:** Except for FCR, all ancillary services are remunerated through availability and energy payments. BSPs obtain a price for reserving FCR capacity (in €/MW) which already includes inherent costs for energy.

• **Penalties:** In case of non-delivery, German TSOs use a two-step process. In general, the payment for availability and/or provision is reduced to the available and/or delivered capacity. In a second step, the TSO can impose a penalty or other restrictions such as the withdrawal of the prequalification permit. For FRR the non-delivered energy is multiplied with the maximum of either the cross-border marginal price or the wholesale market price. The baseline methodologies are proposed by the providers and approved by the TSO.

MARKET COMPOSITION

Germany is one of the biggest markets in Europe in terms of procured capacity for ancillary services. Nevertheless, the market remains dominated by conventional generation assets; only 2% of the total procured capacity comes from DSF assets.

Germany procures up to 555 MW for FCR from the FCR Cooperation, ±2 GW of aFRR capacity and 600 MW upwards and 1 GW downwards of mFRR. Since the bids can be performed at pool level, the actual capacity procured from demand-side resources is unknown. Nevertheless, the German TSOs disclose the amount of prequalified capacity for each technology. Demand resources account for 120 MW in FCR, ca. 500 MW for aFRR and ca. 700 MW for mFRR. Hydro power plants and traditional generation from gas and lignite are the main technologies procured for ancillary services. Battery storage, mainly from front-of-the-meter assets but also from EVs, is used almost exclusively for FCR. Due to the aforementioned barriers, only three providers out of the 54 prequalified BSPs[14] are independent aggregators.

[14] https://www.regelleistung.net/ext/

DATA TRANSPARENCY

Germany is lagging in terms of digitalisation and data transparency of its energy system.

While data transparency on market rules and tenders of the balancing market are well described in a central hub for all German TSOs (Regelleistung.net), the transparency on generation, CO_2 content and congestions of the grid is limited. This is due to the fact that each TSO publishes data for their own balancing area with different levels of granularity and different platforms. The ENTSO-E transparency platform aggregates data from the different TSOs, but granularity remains too high (yearly). Data on the CO_2 content of the grid are not available, while information on congestion management and redispatch are published through a central platform[15] and yearly reports of the NRA.

UPCOMING LEGISLATIVE CHANGES

Legislative changes in the last two years limit the participation of DERs and industrial loads in the market. The BNetzA, The German regulatory authority, is considering introducing a competitive mechanism for voltage control.

Germany ended the sheddable loads scheme that was greatly participated by aggregated industrial loads without the implementation of alternative markets really open to demand-side assets. These loads are now encouraged to participate in existing balancing markets via an aggregator, but as described before, some barriers still need to be removed. It should also be noted that under the new Redispatch 2.0 regime, the responsibility of procuring the necessary balancing energy in the event of constraints shifts from the BRPs to TSO/DSOs. This constitutes a derogation for market based redispatch foreseen by the Electricity Market Regulation and it is a great limitation for many DERs. Germany is considering creating a market for voltage control, which is currently mandatory, nevertheless, the implementation timeline of this project is uncertain.

[15] https://www.netztransparenz.de/EnWG/Redispatch

GREAT BRITAIN

A great variety of ancillary services is procured in the British market. Although most services are defined in technology-neutral terms, the actual product designs make participation by DSF almost impossible, with the exception of FFR and short-term operating reserves (STOR). The major barriers stem from the design of the dynamic products, in particular the baseline approach that is impossible to be fulfilled by demand-side assets, and the use of very small dead-bands, meaning that accurate response must be delivered almost continuously. Ancillary services are mainly procured from conventional power generators and large batteries. GB is one of the first European countries that implemented measures to tackle scarcity of supply for winter 2022/2023 through an ad-hoc Demand Flexibility Service to reduce demand during peak periods, with day-ahead notice.

What changed since the smartEn Map 2018 Balancing Markets?

A set of new fast ancillary services (dynamic containment, moderation and regulation) has been introduced, but these products are mainly designed for utility scale batteries. Since Brexit, the British TSO markets are no longer coupled with the continental Europe market, so British DSF providers cannot access to the bigger European balancing market.

ACCESS TO ANCILLARY SERVICES

The British TSO procures three products with fast reaction times from daily auctions that are theoretically open to all assets from demand and generation resources, but in practice participation can only be possible for large front-of-the-meter batteries.

• Dynamic Containment

This product is designed to restore frequency after a significant frequency deviation, the FAT is one second and the maximum duration 15 minutes. Aggregation of assets from demand and generation from 1 MW of pooled capacity is in principle allowed, but due to the technical requirements outlined below, this product in practice is accessible only to large front-of-the-meter batteries. Procurement is done through daily auctions that are simultaneous with the other two fast products that are described below. However, the markets clear independently without any optimisation between these three products. Therefore, providers must choose one service to participate in during each period. However, they can provide both high and low variants of the same service together, and asymmetrical bids are allowed.

• Dynamic Moderation

This fast service is designed to help the TSO to keep frequency within operational limits when there are sudden large imbalances between demand and generation such as due to erroneous wind forecast, by responding quickly when frequency moves towards the edge of the operational range. The FAT is 1 second, with a maximum ramp start of 0.5 seconds and a maximum duration of 30 minutes. As is the case for Dynamic Containment, aggregation of demand and generation assets is allowed from a minimum bid size of 1 MW; nevertheless, only batteries are currently participating in the daily auctions.

• Dynamic Regulation

Dynamic Regulation is a pre-fault service designed to slowly correct continuous but small deviations in frequency. The FAT is 10 seconds, the maximum ramp start is 2 seconds and the maximum duration 60 minutes. This last requirement can be particularly difficult to meet for energy-limited assets. Nevertheless, the TSO is evaluating the reduction of the duration requirements from these assets. In line with the products described above, Dynamic Regulation is procured through

daily auctions open to stand alone and aggregated assets from 1 MW of capacity. Currently only batteries have been rewarded.

FCR

GB procures two ancillary services that are similar to the standard European FCR product: FFR and MFR. The first is market-based and fully open to DSF providers, while the latter is only open to large generators, for which participation is mandatory.

• Firm Frequency Response (FFR)

The TSO has a statutory obligation to maintain the frequency of the National Electricity Transmission System between 49.5 and 50.5 Hz. The control room normally controls frequency within a tighter operational limit of 49.8 to 50.2 Hz, which it does through the FFR and other products. FFR is open to generators connected to the transmission and distribution networks, storage providers and aggregated demand side response. Two types of FFR are procured: dynamic and static frequency response. The first one is a continuous service, while the second is discrete, triggered at a defined frequency deviations and particularly suitable to be provided by demand-side resources. The dynamic service has to be provided within 10 to 30 seconds, while the non-dynamic has a FAT of 30 seconds and a maximum duration of 30 minutes. The minimum offer size is 1 MW. Historically, these services have been procured through pay-as-bid monthly tenders, but to comply with the Clean Energy Package, they are moving to pay-as-clear daily auctions from April 2023. The dynamic product is intended to be replaced by the new products described above, but the static product will continue to be procured "for the foreseeable future," as it is more cost-effective than the new products[16].

• Mandatory Frequency Response (MFR)

Mandatory Frequency Response is an automatic change in active power output in response to a frequency change. The service is used by the TSO to maintain the frequency within statutory and operational limits. All large power stations connected to the transmission network are obliged to have this capability. The TSO chooses which ones to instruct to be available and pays them on a pay-as-bid basis, as well as making energy payments. There are three response services with different reaction times from 10 seconds to 30 seconds and a maximum duration time up to 30 minutes. It is a generator-only programme that makes all the other services much less investable because a provider cannot know whether the TSO will procure any services from the other markets, or just rarely on MFR. According to the latest Annual Balancing Services Spend Report[17], the TSO's spending for MFR is greater than the one for FFR. Since a lot of capacity is procured through this mandatory service, other resources are severely disadvantaged.

aFRR

There is no product in GB that corresponds or is similar to the standard aFRR.

mFRR

GB procures short-term operating reserves (STOR), which is a product similar to the standard European mFRR. These reserves are procured through tenders that are open to single or aggregated demand resources from 3 MW of capacity.

The TSO procures short-term operating reserves to access sources of extra power when actual demand is greater than forecasted or unforeseen generation unavailability is occurring. This can be achieved through additional generation or demand reduction. The reserve can be procured from aggregated demand resources from a minimum pooled capacity of 3 MW. Historically, STOR has been procured on a pay-as-bid basis through seasonal tenders, but to comply with the Clean Energy Package, committed STOR is now procured through day-ahead auctions on a pay-as-clear basis for availability payments and pay-as-bid for energy payments. Non-Balancing Mechanism (NBM) providers can also offer their assets on an energy-only basis via the Optional STOR service. Response must be provided within 20 minutes and maintained for at least 2 hours. Providers need to be able to deliver at least 3 times a week, with a recovery period of no more than 20 hours. These requirements are quite stringent for DSF providers and limit their participation.

[16] https://www.nationalgrideso.com/document/267901/download
[17] https://www.nationalgrideso.com/document/266016/download

PARTICIPATION REQUIREMENTS

Some technical requirements severely limit participation of demand-side assets, in particular for dynamic containment, moderation and regulation. The baseline approach and the measurement requirements are the most limiting factors.

- **Prequalification:** each individual asset (called eligible assets) within an aggregated unit must pass pre-qualification and testing at its own meter point. This applies for all products except for FFR, for which prequalification is done at pool level. Each product foresees different steps for the prequalification process, but in general each participant must register as a Registered Service Provider, submit relevant documentation, and perform a series of tests carried out by the TSO. Eligible assets are allocated to Response Units, which can bid into the auctions.

- **Testing and measurement:** The new dynamic services require a small dead-band, so an accurate response must be provided almost continuously, even though the frequency events that the Dynamic Containment service is meant to contain occur only rarely. This is a major barrier for demand-side assets that cannot cost-effectively provide a continuous response. The minimum sample rate for these services is 20 Hz. All the products include metering requirements that add administrative burden and costs to DSF providers; this is particularly the case for the three dynamic reserves. The new services require real-time telemetry either through SCADA or a new MQTT-based data concentrator.

- **Payments:** The dynamic products are remunerated only with availability payments, while STOR includes utilisation payments. No BRP agreement is required to provide ancillary services. There is no compensation from the BSP to the supplier, but there is a correction of their perimeter.

- **Penalties:** The dynamic products include error limits from 7% to 25%, for which the penalties are 100% of the availability payments. STOR providers must deliver a minimum of 95% of the offered MW throughout the instructed period. Failure to deliver will trigger an Event of Default at which the unit will lose availability payments for most, or all, of the relevant committed window. One of the most challenging requirements for DSF providers is the baseline approach for the dynamic products. The baseline must be submitted at gate closure (1 hour ahead), which cannot be done with sufficient accuracy by non-dedicated assets. It would be better if baselines were allowed to be submitted closer to real time.

MARKET COMPOSITION

The fast reserves procured in GB seem to be designed only for large batteries and this is confirmed by the actual participation in these markets that come 100% from this technology. The other two products that in theory are accessible to DSF providers see very limited participation.

GB procures 1 279 MW of dynamic containment, 160 MW of dynamic moderation and 160 MW of dynamic regulation. Due to the barriers highlighted before, only front-of-the-meter batteries are participating in these markets. Apart from these, the majority of frequency response capacity seems to be procured through the mandatory product, which is only open to large generators. In FFR, there is participation of DR for 4 MW, distributed generation for 208 MW and batteries for 344 MW. For STOR, National Grid procures between 1.8 GW and 2.3 GW. The majority of STOR capacity is procured from CCGT, OCGT and gas reciprocating engines, there is no significant participation of DR in this market; some DERs are procured but they are mostly generation assets.

DATA TRANSPARENCY

The data transparency of the British market is advanced.

The British TSO, in partnership with Environmental Defense Fund Europe, University of Oxford and WWF developed an online tool[18] to publish data on GHG emissions in the energy mix for each region (DSO areas). It is a Carbon Intensity API that allows market participants to access real-time information on generation, demand and GHG content of the grid as well as forecast data. The goal of the service is to allow consumers with smart devices to optimise their behaviour based on CO_2 emissions. For transmission congestions, the TSO issues notifications[19] to invite potential service providers to submit services and price offers to support solving the constraints.

[18] https://carbonintensity.org.uk/
[19] https://www.nationalgrideso.com/balancing-services/system-security-services/transmission-constraint-management?market-information

UPCOMING LEGISLATIVE CHANGES

In the short-term, the GB market will introduce two new ancillary services and a demand flexibility service to help managing the grid during winter 2022/2023.

There are two new ancillary services that the TSO is currently defining: quick reserves and slow reserves. The first one aims at reacting to pre-fault disturbances to restore the energy imbalance quickly and return the frequency close to 50.0 Hz. The latter is designed to operate post-fault and aims to provide the TSO with access to firm, bi-directional energy to displace large losses on the system and recover frequency to ± 0.2 Hz within 15 minutes. Aggregated units from 1 MW of capacity can bid into the daily auctions for these services but are excluded from participating in other services if they do. The design of these new products includes metering requirements that are too stringent and costly for demand-side assets. In particular for the slow reserve, the requirement of 1 Hz metering with a latency of no greater than 5 seconds is unnecessary for a service with a 15-minute response time. GB was one of the first countries to implement an emergency measure to reduce peak demand during winter 2022/2023. The TSO, building on a positive trial conducted with Octopus Energy[20], has implemented a Demand Flexibility Service[21] to help manage the electricity grid over winter through flexibility from customers of any size who are not already contracted to provide any form of flexibility. The service is procured through aggregators or suppliers in 30-minutes blocks day-ahead from minimum 1 MW of capacity. All participating assets require half-hourly metering and they have to be available for at least 30 minutes.

[20] https://www.nationalgrideso.com/news/national-grid-eso-and-octopus-energy-launch-trial-unleash-demand-flexibility-winter
[21] https://www.nationalgrideso.com/industry-information/balancing-services/demand-flexibility

GREECE

Greece procures FCR, aFRR and mFRR through a market-based mechanism. In June 2022 the Greek TSO, IPTO, announced the market opening to demand-side resources[22]. However, at the moment of writing the market is de facto not active due to various delays, and it is hard to estimate when actual procurement of balancing reserves and energy from DSF will begin. The technical requirements are generally not limiting for demand-side resources but the prequalification phase, for which pools of assets will have to repeat the test if new assets are included in the portfolio, is significantly taxing for DSF providers.

What changed since the smartEn Map 2018 Balancing Markets?

This is Greece's first appearance in the smartEn Map for ancillary services.

ACCESS TO ANCILLARY SERVICES

FCR

Primary reserve is procured through a market-based mechanism but, at the moment of writing, only open to generation assets.

The Greek TSO, IPTO, procures FCR through a market currently open only to generators with a minimum bid size of 1 MW. Capacity and energy are procured through daily auctions, for activation of the balancing energy there are also intra-day auctions. Balancing energy for FCR is not settled. FCR procurement in Greece does not require symmetrical bids for any providers. According to the latest ENTSO-E annual survey on ancillary services[23], this happens only in Greece and Ireland and, when demand-side resources will be allowed to participate in the market, it could be interesting for certain assets that have technical constraints to place symmetrical bids (i.e., boilers).

aFRR

aFRR is procured through a market-based mechanism currently open to generators only. The minimum bid size to participate in the market is 1 MW and both reserve and balancing energy are procured through daily and intra-day auctions. Asymmetrical bids are allowed and balancing energy for aFRR is compensated at a marginal price with a resolution of 15 minutes. The full activation time (FAT) is between 5 and 7,5 minutes, which is longer than what usually happens in the rest of Continental Europe. Greece is part of the PICASSO project, a derogation for the connection was asked to the regulator but the exact date for the platform go-live is unknown.

mFRR

mFRR is procured through daily and intra-daily auctions open only to generators.

The procurement method of mFRR is the same as for aFRR. The minimum bid size is 1 MW and both reserve and balancing energy are procured through daily and intra-day auctions. Asymmetrical bids are allowed and balancing energy is compensated at a marginal price with a resolution of 15 minutes. The full

[22] https://www.admie.gr/nea/anakoinosi/symmetohi-tis-apokrisis-zitisis-stin-agora-exisorropisis
[23] ENTSO-E Survey on Ancillary services procurement- Balancing market design 2021 (page 13)

activation time is between 5 and 10 minutes, which is shorter than the usual FAT for mFRR in the rest of Europe. IPTO has requested an extension for the connection to the MARI platform, which is expected by July 2024.

PARTICIPATION REQUIREMENTS

Certain technical requirements, in particular the repetition of the prequalification process for the pool if new assets are connected, are very taxing and can limit the participation of demand-side resources.

- **Prequalification:** The prequalification process consists of three tests that are performed at pool level. One test aims to verify the connection between the TSO and the BSP, one to evaluate the limits of the portfolio and one to verify that the activation is being transmitted and performed correctly. In case new assets that exceed a certain limit are added to a portfolio of DR or DER assets, this is required to perform additional tests, leading to unnecessary tests for already pre-qualified units.

- **Testing and measurement:** The TSO requires both real-time monitoring and ex-post checks, no metering requirements that could penalise DSF have been identified.

- **Payments:** Reserves are remunerated following a pay-as-bid logic with a resolution of 30 minutes, while balancing energy follows a marginal price logic with a resolution of 15 minutes. Availability and energy payments are granted for aFRR and mFRR, while FCR is only remunerated with availability.

- **Penalties:** In case of non-delivery, a bigger penalty is applied to the availability remuneration and a smaller one to the energy payments. Two baseline methodologies are allowed by the TSO. This is limiting for DSF providers that should be allowed to propose their own baseline methodology, approved by the NRA. Post real time the imbalance settlement process takes place to compensate or charge any imbalances of the participants in the balancing market for every 15-minute settlement period. Greece applies the uncorrected model so there is no compensation between the aggregator and the supplier.

MARKET COMPOSITION

At the moment of writing, no capacity nor energy for ancillary services is procured from DR, storage or distributed energy resources. Market parties estimate that, when the market will open, the potential size for DSF providers will be around 800 MW. The current size of balancing reserves, which are mostly procured from generators, are: FCR ±1 059 MW, aFRR upwards 3 898 MW and downwards 3 906 MW, upwards mFRR 4 717 and downwards 4 657 MW[24].

DATA TRANSPARENCY

Data transparency of the Greek energy system is good, but data is provided with a too high granularity. From the TSO website, data on generation mix, evolution of demand and interconnection loads is provided on a monthly basis. Data is accessible through downloadable files and an open API.

UPCOMING LEGISLATIVE CHANGES

In the upcoming months, it is expected that Greece will certify demand-side resources and allow them to take part in the market, as already foreseen by the national regulation.

[24] ENTSO-E Balancing Market Report 2022

HUNGARY

The Hungarian market for ancillary services has seen positive developments in recent years thanks to the introduction of the aggregator framework and the removal of obligations for generators. FCR, aFRR and mFRR are procured in hourly blocks through tenders with different timeframes. The market is open to demand and generation assets, alone or aggregated, and circa 20% of the overall capacity procured comes from DSF technologies, they are mainly industrial loads. Some barriers still persist in the technical requirements for smaller scale assets, in particular the relatively high minimum bid sizes and some technical requirements (i.e., gradients, delivery durations).

What changed since the smartEn Map 2018 Balancing Markets?

Generators no longer have an obligation to provide FCR nor FRR products, so now these products are procured through competitive markets. A new aggregator framework introduced in 2021 has opened the market to independent aggregators.

ACCESS TO ANCILLARY SERVICES

FCR

Hungary procures FCR capacity through yearly and monthly tenders open to all market parties.

The Hungarian TSO procures FCR capacity in hourly blocks through yearly tenders open to all resources from 1 MW of capacity and monthly from 5 MW of capacity. Aggregation of generation and demand assets in the same pool is allowed but the possibility to change sign of the schedule is still under development. The product is symmetrical and this can be a limitation for certain demand-side assets that have technical constrains to deliver symmetrical capacity (i.e., boilers, and EV batteries). FCR capacity is remunerated through a pay-as-bid logic, while FCR balancing energy is not remunerated.

aFRR

The Hungarian aFRR market guarantees access on equal footing to all resources from 1 MW of capacity onwards.

aFRR capacity is procured in hourly blocks through monthly, weekly and daily tenders open to generation and demand units, individually or aggregated, from 1 MW of capacity (except for monthly tenders where the minimum block size is 5 MW). aFRR balancing energy is procured through daily auctions. aFRR is procured for upward and downward regulation and the bids can be asymmetrical. The full activation time is between 10 and 15 minutes, which is higher than the average FAT of aFRR in the other European countries. Activation of balancing energy bids for other purposes (i.e., congestion management) is possible, this is a positive feature of the Hungarian market that fosters interoperability between markets. MAVIR is part of the ENTSO-E PICASSO[25] project and its derogated connection date is foreseen for 2024.

mFRR

mFRR capacity and energy are procured through competitive process open to all resources.

Similarly to aFRR, the Hungarian TSO procures mFRR in hourly blocks through monthly, weekly and daily tenders open to all resources from 1 MW of capacity (except for monthly tenders were the minimum block size is 5 MW). mFRR balancing energy is procured through daily auctions, the product is not symmetrical and remunerated through a pay-as-bid logic. The full activation time is 12.5 minutes, in line with the product design of the other European countries

[25] ENTSO-E- Survey on Ancillary services procurement Balancing market design 2021

that procure mFRR. Activation of energy bids are possible for other markets that are not balancing (i.e., congestion management). The connection of Hungary to the ENTSO-E MARI platform is foreseen for 2024, like the majority of derogations guaranteed to the other European countries.

PARTICIPATION REQUIREMENTS

The prequalification process that has to be performed at asset level for FCR, the ramping requirements and the delivery duration are barriers for a wider participation of DSF.

- **Prequalification:** The prequalification process foresees the signing of an accreditation agreement and the performance of a series of tests to fulfil the data connection requirements, the signal transmission tests and the service tests that are different for each product. The prequalification process might take between 1 and 3 months, in line with what is prescribed by the SO GL. It has to be performed at asset level for FCR, while for FRR products, both asset and pool level prequalification is possible. In case of pool level prequalification, if the group composition changes several times within 3 months and these expected changes are recorded in the prequalification agreement, a renewed prequalification has to be carried out only for the final composition. A BRP agreement is not required for participating in the market.

- **Testing and measurement:** Assets have to be equipped with a certified metering unit of class 0.5. Some potential barriers for participation of small-scale assets have been identified. In particular, the activation/deactivation time (for FCR, activation has to be achieved after 15 seconds and full activation after 30 seconds), the ramping requirements (e.g., aFRR 2 MW/minute, mFRR 5 MW/15 minute, mFRR 12,5 1 MW/minute) and the delivery duration (for capacity products, the duration has to be 16 or 8 hours for high-tariff or low-tariff products, respectively) and the fact, that for 1 time unit only 1 bidding price can be offered.

- **Payments:** Ancillary services are remunerated through a pay-as-bid logic, both capacity and energy payments are foreseen for aFRR and mFRR, while FCR is only remunerated through capacity payments, this is often the case for faster products. There is no compensation model between the BSP and the BRP.

- **Penalties:** For products that are remunerated with capacity payments, the penalty is equal to the payment itself and the surplus costs required to restore system balance. For energy products, the penalty is the price of the imbalance. In case of repeated non-performance, the TSO might require the renewal of the prequalification. There are no baseline methodologies defined by the TSO, BSPs are settled based on their provided schedule and metered data.

MARKET COMPOSITION

The Hungarian market sees a moderate participation of DSF, circa 25% of the procured capacity comes from demand-side assets, mainly industrial loads.

Hungary procures ±38 MW of FCR, of which between 10 and 14 MW come from DSF, ±250-320 MW of aFRR, of which between 40 and 80 MW come from DSF and 500 MW of mFRR upward and 140-280 MW for mFRR downward for which there is no procurement from DSF technologies. Activation of demand-side assets depends on the market prices but it might reach 30% of the overall capacity. Ca. 30 BSP are prequalified, of which only one is an independent aggregator. From the demand-side the market remains dominated by big industrial loads. Distributed storage is also participating in FCR, while solar PV is used for downward products.

DATA TRANSPARENCY

The transparency of the Hungarian energy system is limited.

The TSO publishes data on the generation mix and load mainly through the ENTSO-E Transparency platform. Other data (incl. more granular information on the energy mix, balancing data etc.) are available through the TSO website but through basic interfaces and not accessible through open APIs. Data on congestions are shared also through the ENTSO-E platform, but congestions occur rarely in the Hungarian system.

UPCOMING LEGISLATIVE CHANGES

The are no significant legislative changes that are foreseen by the Hungarian regulator.

Since 2021 Hungary has introduced an aggregator framework[26] as established by the European Electricity Market Design. At the moment, the NRA does not foresee any primary legislative update that will influence the Hungarian electricity market. The continuous development of secondary legislation is ongoing.

[26] Act XLVIII of 2007 on Electric Energy

IRELAND

Ireland and Northern Ireland jointly procure through their TSOs (EirGrid and SONI) 14 different ancillary services, seven of which are similar to the standard products procured in continental Europe. Aggregated demand-side assets are allowed to take part, but the high minimum bid size and the long duration that must be guaranteed limit participation only to industrial consumers. Most of the procurement process is not market-based: tenders take place every six months, but remuneration is regulated. There is a separate, "volume capped" tendering process for multi-year fixed contracts to provide bundles of ancillary services, targeted at new-build batteries. The regulator is considering a move to true market-based mechanisms, but the timing for this is currently unclear.

What changed since the smartEn Map 2018 Balancing Markets?

No significant changes have been observed since 2018.

ACCESS TO ANCILLARY SERVICES

All ancillary services are procured through a tendering process open to Demand Side Units (DSUs) and Aggregated Generation Units (AGUs) but from a minimum portfolio capacity of 4 MW and minimum delivery of 2 hours.

FFR

Ireland procures 14 different DS3 Services (ancillary services). Fast Frequency Response is the fastest one, with a FAT between 0.15 and 10 seconds. It is procured, like all the other ancillary services, through tenders that take place every 6 months that are referred to as "gates" and usually start in April and October of each year. The gate process consists of prequalification and tenders. When a provider has qualified through the gate tendering process it receives a contract which enables it to provide the service. Demand Side Units (DSUs) and Aggregated Generation Units (AGUs) are allowed to participate in the tenders with a minimum portfolio capacity of 4 MW. Although this is not part of the product design, DSUs must demonstrate in a test that they can deliver for a minimum of 2 hours. This applies to every Irish ancillary service (including the ones described below) – even those where responses need to only last for seconds – which de facto limits the participation to industrial loads.

FCR

Primary control is provided though two products: Primary Operating Reserve (POR), with a FAT between 5 and 15 seconds and Secondary Operating Reserve (SOR), with a FAT between 15 and 90 seconds.

aFRR

Tertiary Operating Reserve 1 (TOR1) is the closest product to aFRR, with a FAT between 90 seconds and 5 minutes.

mFRR and RR

Ireland procures three products that are similar to mFRR and RR: Tertiary Operating Reserve 2 (TOR2), Replacement Reserve – Synchronised (RRS) and Replacement Reserve – Desynchronised (RRD). The FAT of these products ranges from 5 minutes to 1 hour. Irish and Northern Irish TSOs are observers for the ENTSO-E MARI platform, so their participation in the project is not yet defined.

PARTICIPATION REQUIREMENTS

The obligation to provide real-time data can hinder participation of demand-side technologies, and the profitability of these services is limited by the regulated tariffs that providers can receive.

- **Prequalification:** Prequalification is part of the gate procedure that takes place every six months. The prequalification test is performed at pool level for aggregated units (DSU or AGU) but a set of information must be provided for each asset composing the portfolio. A BRP agreement is not required to participate in the tender procedure. In addition to the prequalification test, the DSU must fulfil the 2-hour test even for the provision of a short-duration ancillary services. This is a significant barrier to participation and discriminatory because AGUs, front-of-meter batteries, and generators do not have this requirement.

- **Testing and measurement:** Aggregators are required to provide real-time availability and performance data of the units to the TSO, which can be particularly costly for small assets. The minimum data resolution is 1 second and measurement devices of Class 0.5 and Class 0.2 should be installed respectively on current and voltage transformers at the connection point. If a provider has several individual sub-components behind a connection point, the measurement device should disaggregate the response from each of the individual components or technologies providing the service.

- **Payments:** Only availability payments are rewarded to tender participants. For further detail on the 2022 tariffs please refer to the smartEn member's exclusive database. The total pool of remuneration is subject to an annual cap of €235 million, and prices are revised periodically with the aim of keeping total spending within that cap.

- **Penalties:** There are performance scalars built into the services, each service has its own scalar[27], as well as TSO performance monitoring. In case of non-delivery the received payment changes in a proportional manner to the non-delivered energy. There is no compensation for imbalances to the suppliers.

[27] https://www.eirgridgroup.com/site-files/library/EirGrid/OPI_INN_DS3-System-Services-Scalar-DesignFinal_231017.pdf
[28] https://www.eirgridgroup.com/site-files/library/EirGrid/Procurement-Summary-Gate-7.pdf [29] https://smartgriddashboard.com/#all [30] https://www.semcommittee.com/sites/semc/files/media-files/System%20Services%20Future%20Arrangements%20High%20Level%20Design%20Decision%20Paper.pdf [31] https://www.cru.ie/wp-content/uploads/2022/08/CRU202281a-ESBN-Recommendation-Paper-NNLC-Demand-Reduction-Schemes-1.pdf

MARKET COMPOSITION

Due to various market and technical barriers, amongst DSF technologies only industrial and commercial sites are currently providing services.

The TSO procures more than 1 GW of capacity for each of the balancing products[28]. Due to the technical limitations, demand-side participation in ancillary services consists mainly of industrial (e.g., pharmaceutical, manufacturing, data centres and mining) and commercial assets. Behind-the-meter assets, batteries, process control and interruptions are also procured.

DATA TRANSPARENCY

The transparency of the Irish market is rather limited.

The system operator shares data on the grid through an online dashboard[29]. Data on energy mix, CO_2 content and imbalances are published with a granularity of 15 minutes. Information on grid congestions is not available and there is no open API to retrieve data automatically. The amount of prequalified or procured capacity from demand-side resources and the service providers are not disclosed.

UPCOMING LEGISLATIVE CHANGES

A major revision of the System Services to introduce a competitive process is currently under consultation, but it is expected to be implemented by 2026.

The SEM Committee is consulting on the new design of the ancillary services procured in Ireland and Northern Ireland[30]. The proposed framework entails daily (day-ahead) auctions and long-term contracts up to 12 months to reserve the necessary capacity. Providers will be able to apply without waiting for the gate procedure. In addition, system services will be procured locationally where there are locational requirements. While this represents a positive evolution, the removal of the barriers for DSF is still important to allow broader participation by lower cost resources. It is worth highlighting that Ireland is implementing some positive changes to tackle supply shortages with DSF in the winter 2022/2023. Notably, the Irish DSO has introduced the "Beat the Peak" programme, which includes initiatives to exploit the flexibility of all consumer-types, to reduce consumption during peak hours[31]. The product designed for commercial users foresees the participation of aggregators and market remuneration through availability and energy payments.

ITALY

The access of demand-side resources to the Italian ancillary services market improved since the launch of the UVAM pilot project for mFRR and RR in 2019, and its extension to aFRR in 2021. However, in the context of high energy prices, UVAM participants in mFRR services are incurring substantial losses due to the static strike prices envisioned in the programme that are currently below energy prices. This is forcing many participants to leave the market and hampering the creation of a real market for ancillary services where generation and demand resources can compete on equal footing. A new fast reserve product was procured in 2020, but this was targeted only at large scale batteries. The pilot project nature of these initiatives and the short-term perspective of the regulatory framework creates uncertainty for DSF providers.

What changed since the smartEn Map 2018 Balancing Markets?

The UVAM project opened the markets of aFRR, mFRR and RR to DSF providers on a pilot basis.

ACCESS TO ANCILLARY SERVICES

Fast Reserve

In 2020, Terna launched a new pilot project for a fast reserve with activation within 1 second. At the time of writing, it is unclear if the TSO will launch another auction or implement a full market for the procurement of this reserve.

The product was procured through an auction for the delivery period 2023-2027 and it was open to stand-alone and behind-the-meter production units, DR assets (if they were not already contracted as interruptible loads) and storage devices both stand-alone and behind-the-meter. Aggregation was allowed only within the same bidding zone with a minimum bid size of 5 MW. These conditions narrowed the possibility of participation of smaller demand units for which this product would be particularly suitable (e.g., decentralised storage). Moreover, assets that were already qualified for the capacity market were barred from offering the same capacity for this reserve to avoid double remuneration.

FCR

FCR product is currently not open to market participants.

Conventional generation units and co-generators with a capacity of 10 MVA or above must provide this reserve. Italy is not part of the EU FCR Cooperation.

aFRR

Secondary reserve has been accessible to demand-side resources since December 2021, but its energy-only market design limits the commercial viability for DSF providers.

Through this pilot, project assets with a limited energy reservoir (such as storage) and aggregated resources from 1 MW of capacity are allowed to participate in the aFRR market. This aims to test the relaxation of some of the current grid code requirements related to aFRR provision (e.g. symmetrical reserve) to facilitate the participation of new resources. This is a positive development for demand-side resources, which have new accessible value streams. Nevertheless, Terna remunerates secondary reserve only with energy payments, which can represent an entry barrier for smaller demand units that have to cover upfront investment costs (e.g., measurement equipment). The Italian TSO is expected to join the PICASSO platform in July 2023.

mFRR and RR

mFRR and RR are the main value streams for DSF in Italy, these two products are historically open to aggregated generation and demand assets under the UVAM pilot project.

Terna procures circa 1 GW of these reserves through annual tenders (70% of the total capacity) and monthly tenders (30% of the total capacity). Participants can offer their services up to three hours for an afternoon product and up to four hours for two evening products. The minimum bid size for these products is 1 MW. Terna is already part of the TERRE platform, while the connection to MARI is foreseen for July 2024.

PARTICIPATION REQUIREMENTS

Participation in the ancillary service market by aggregated demand resources is limited by the requirement of installation of costly measurement devices and limited profitability due to static strike prices (currently lower than the energy prices) foreseen under the UVAM project.

• **Prequalification:** The prequalification is performed at pool level and consists of one test per direction for the duration of two hours for the mFRR and of eight hours for the RR and one test for the duration of thirty minutes for aFRR. For mFRR and RR, tests the tolerance is 10% and in case of failure the test can be performed again up to three times within 90 days; otherwise it is not possible to apply for a new prequalification for the next 6 months. A BRP agreement is not required for any of the products, this gives independent aggregators easier access to the markets.

• **Testing and measurement:** After prequalification, the system operator, at its discretion, can also perform up to four tests of UVAM resources. After three failed tests (even non-consecutive), the units are excluded from participation. At the beginning of 2022, a large number of tests was performed, which caused numerous participants to leave the project. A technical measurement device (UPM) costing ca. €400 is required for each point of connection. This requirement is particularly taxing for small scale resources, particularly since such high accuracy measurements should not be necessary from these types of assets.

• **Payments:** Awarded units in the mFRR and RR tenders receive availability payments up to a reference price of 30 k€/MW/year and energy payments up to 200 €/MWh and 400 €/MWh depending on which product they offer in the tertiary reserve. The low energy strike prices limit the profitability of these products, especially in the current context of high energy prices. For many months during 2022, the spot price (PUN) has been much higher than the strike price, obliging dispatched UVAM to compensate BRPs with the difference between the PUN and the strike price for the energy provided, which is higher than their remuneration. UVAM operators are facing losses and this is de facto forcing them to leave the market during the energy crisis, when the system would greatly benefit from greater availability of DSF resources. For aFRR the remuneration consists only of energy payments without applying a strike price. These remunerations are often not sufficient to cover the costs of the measurement devices.

• **Penalties:** In case of non-delivery, penalties depend on the market price, with exclusion foreseen after a certain number of non-deliveries or partial deliveries. Settlement is performed considering the baseline that each BSP communicates to the TSO by 17:00, and then can update during the communication sessions of the day of delivery. Terna corrects ex-post the baseline considering the deviation in the quarter-hour before delivery and the accepted quantity and penalises BSPs for these forecasting errors.

MARKET COMPOSITION

Technical barriers (i.e., high cost of measurement devices) and low profitability of some products limit the participation of demand side resources in ancillary services to industrial loads.

In first half of 2022, there was 1 104 MW of qualified capacity (31 BSPs) in UVAM. Nevertheless, ancillary services are still mainly provided by conventional generation plants. In the first five months of 2022, 3 400 MWh of DSF were activated.

DATA TRANSPARENCY

The data transparency of the Italian TSO is rather limited.

Hourly data on the energy mix and load curves are shared through interactive dashboards and a smartphone app[32], while the carbon contents of the grid are communicated through monthly and yearly reports. Data on grid congestions are not publicly disclosed.

UPCOMING LEGISLATIVE CHANGES

No major legislative changes for ancillary services are currently under consideration by the Italian regulator, which increases market uncertainty among DSF providers.

Market parties hope for a positive evolution for the FCR market, but, at the moment of writing, there is no publicly available information from the Regulator nor TSO. There is also uncertainty on the renewal of the UVAM pilot projects. Terna has recently launched:

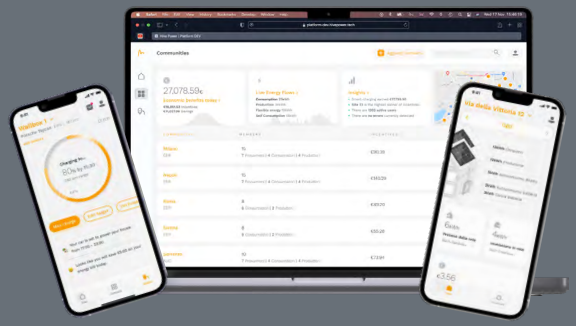
- a consultation of the grid code related to rules for participation in the MSD and technical requirements for frequency regulation services[32].
- a new framework, Energy System Innovation[33] (ESI), to foster the participation of new resources in the MSD, in particular electric vehicles.

[31] https://www.terna.it/it/nostra-app
[32] https://www.terna.it/it/sistema-elettrico/codici-rete/consultazioni-operatori
[33] https://www.terna.it/en/electric-system/system-innovation/spotlight-energy-system-innovation

DEMAND-SIDE FLEXIBILITY MANAGEMENT

MEET SWISS-ITALIAN STARTUP HIVE POWER

STARTUPS ARE PLAYING A PIVOTAL ROLE IN EMPOWERING & INCENTIVISING END-USERS TO DECARBONISE THE EU ENERGY SYSTEM.



In order to support corporates with agile solutions for prosumers and EV users, startups have been working behind the scenes to innovate and bring new ways to provide demand-side flexibility benefits to energy retailers and automotive players. Passing these benefits along to end users gives energy companies a competitive advantage in a market with few possibilities for differentiation. One of Europe's leading actors on this scene is Hive Power, a Swiss-Italian startup working on flexibility since 2011.

Their FLEXO solution provides companies with white label software that allows them to manage any flexible asset, from energy communities to EV smart charging points.

How does that work?

Energy communities and prosumers have been around for decades in niche markets, but they are now moving to the forefront of energy retailer and governmental strategies for implementing renewables, such as solar, in residential and industrial settings.

Hive Power provides an interface for monitoring community members and pods, as well as an app for single prosumers to view their monthly savings and projected renewable outputs. The app, ideated by an Apple designer, offers an intuitive, modern user experience which eliminates the frustration many users undergo when navigating outdated utility software or new concepts.

The same technology can be used for optimising time of use (ToU) flexibility for charging EVs and household appliance usage.

Taking the EV example, FLEXO uses insights on charging profiles, usage timing, and hourly energy market prices to automate charging to the least costly time of day. In doing so, it also contributes to grid stability by optimising charging for non-peak periods.

Hive Power is available for new partnerships with energy, automotive, and appliance manufacturing companies looking to explore intelligent flexibility management.

WWW.HIVEPOWER.TECH

LATVIA

Latvia, like the other Baltic countries, is synchronously interconnected with the IPS/UPS (Integrated/Unified Power System) and plan to synchronise with the CESA (Central European Synchronous Area) by the end of 2024. Latvia has common rules for procurement of ancillary services with the other Baltic countries. The only ancillary service available is the mFRR balancing product, which is in theory open to all market participants, including demand-side resources. Nevertheless, there is no participation of demand-side resources in the market mainly because the role of the independent aggregator has not been defined.

What changed since the smartEn Map 2018 Balancing Markets?

This is Latvia's first appearance in the smartEn Map for Ancillary Services.

ACCESS TO ANCILLARY SERVICES

FCR

Not available.

aFRR

Not available.

mFRR

Balancing energy for mFRR is the only ancillary service procured in Latvia, but there are no DSF providers participating in the market because the independent aggregator role has not been defined and the market size is small.

Latvia is part of the common Baltic balancing market, that started operating from January 2018. Balancing energy for mFRR is procured through daily auctions for a maximum duration of delivery of 60 minutes. Balancing services can be provided by a market participant whose portfolio includes power plants or demand facilities from a minimum bid size of 1 MW. Nevertheless, there is no participation of demand-side resources in the market. The full activation time is 15 minutes. Latvia is expected to join the ENTSO-E MARI platform in 2024, as the majority of the other EU countries.

PARTICIPATION REQUIREMENTS

No aggregator framework exists in Latvian legislation, preventing independent flexibility providers to participate in the market. In theory there are no technical requirements that limit participation of demand-side resources. Nevertheless, measuring device requirements can increase the cost of participation for smaller scale assets.

- **Prequalification:** The prequalification process can be performed at pool level. Providers with a valid declaration of prequalification can participate in the market, this entails compliance with the measuring requirements. The prequalification process does not need to be repeated if there are changes in the portfolio without changes in its capacity.

• **Testing and measurement:** or BSPs with aggregated demand or generation units, the installed electricity control meters shall have the ability to register load profiles for each one-minute interval. Aggregated demand and generation portfolios do not need to transfer real-time data. The accuracy class should not be lower than 0,5.

• **Payments:** Energy payments are settled on a marginal price logic. There is no procurement of reserves, therefore no capacity payments. This limits the economic viability of DSF participation in the market.

• **Penalties:** There are no specific penalties for non-delivery nor a specific baseline methodology defined by the TSO. BSPs have to submit baselines that indicate the amount of electricity consumption and/or generation in MWh with an accuracy of no lower than 0.1 MWh and at least the resolution of the interval of trade.

MARKET COMPOSITION

The Latvian market for ancillary services is small and does not have participation of demand-side resources.

Procurement of the total amount of mFRR reserve (100 MW) is done every 2 years to ensure that there is security of availability of such service, a single emergency reserve provider (generator) is contracted. There is one BSP with qualified resources located in Latvia participating in Baltic balancing energy market. Nevertheless, there is no procurement of balancing energy from these resources.

DATA TRANSPARENCY

The transparency of the Latvian market is very limited.

AST, the Latvian TSO, publishes data on generation and consumption through its website[35], but data are not updated regularly and the granularity is high. In general, the TSO relies on the data published through the ENTSO-E Transparency platform.

UPCOMING LEGISLATIVE CHANGES

The synchronisation with the CESA will create new markets for ancillary services.

Baltic countries aim at establishing a Baltic Load Frequency Control (LFC) block by the end of 2024 due to the desynchronization of IPS/UPS synchronous area and synchronization to CESA. It is foreseen that aFRR will be introduced and, starting from 2025, it is planned that aFRR and mFRR capacity will be procured commonly in the Baltic countries. From 2026, FCR capacity will also be commonly procured. The Latvian government is working on the implementation of the EU Electricity Market Directive and the definition of the framework for independent aggregators, but this is not expected in the short-term. Finally, the expected transition in the coming years to 15 min market time units in both day-ahead and intraday timeframes could have positive implication for participation of demand-side resources in the wholesale electricity market. This will allow to bid in shorter timeframes and closer to real time operation.

[35] https://www.ast.lv/en/electricity-market-review

NETHERLANDS

The Dutch market for ancillary services is mostly technology neutral and the TSO is continuously reviewing requirements to ensure that any undue barriers for DERs are identified and removed. The high minimum portfolio size of 20 MW to participate in the mFRR market is excluding smaller consumers that could potentially provide this service; this barrier will be removed from 2023. Small scale and industrial loads are participating in the market for ancillary services but the TSO does not disclose the amount of capacity procured. The main legislative change expected in the medium-term is the connection to the ENTSO-E balancing platforms but the timeline for legislative changes is still unclear.

What changed since the smartEn Map 2018 Balancing Markets?

Since 2018, a positive tendency to decrease the procurement times of the tenders can be observed. In particular, FCR is now procured daily (formerly weekly), aFRR weekly and daily (formerly monthly), and mFRR daily (formerly monthly). The minimum bid size to participate in aFRR market was also decreased to 1 MW.

ACCESS TO ANCILLARY SERVICES

FCR

The Dutch FCR market is accessible and open to all market parties thanks to harmonised rules of the EU Cooperation.

The Netherlands is part of the EU FCR Cooperation, therefore it procures FCR capacity through daily auctions of four-hours blocks from single or aggregated demand and generation units in 1 MW bids. These must be symmetrical, which can be a limitation for certain demand-side technologies. There is no settlement for FCR energy procurement.

aFRR

The requirements for the aFRR market guarantee access to demand and generation.

TenneT procures aFRR through weekly and daily tenders. From the second half of 2022 the FAT of aFRR was reduced to 5 minutes, to meet the requirements of the EB GL. The definition of standard products will be finalised in parallel with the connection to the PICASSO platform, foreseen in 2024. aFRR capacity and energy can be procured from all market participants, including aggregated demand and generation assets from a minimum bid size of 1 MW. The BSP can bid with assets at different BRPs, TenneT does an imbalance adjustment at the BRPs behind the activated assets with ex-post information of the BSP.

mFRR

The mFRR market is open to all resources, but due to a high minimum bid size, from the demand-side only industrial consumers participate.

mFRR is procured daily through tenders that are open to all market participants, including pools of demand and generation assets. However, the participation to this market for a broad range of DSF technologies is particularly challenging due to the very high minimum bid size of 20 MW. This will be lowered to 1 MW from January 2023. The service is mainly provided by industrial loads. TenneT procures around 1 GW of mFRR capacity, the bids for upward and downward regulation can be asymmetrical. TenneT performs an imbalance adjustment at the BRPs through 5-minute allocation data received from the BSP.

PARTICIPATION REQUIREMENTS

There are no identified technical requirements that create undue barriers for certain technologies.

- **Prequalification:** Prequalification is performed at pool level for aFRR and mFRR and at group or unit level for FCR, once obtained it is valid for 5 years. A change in the BSP portfolio triggers a new prequalification process to communicate the new connection points, but the prequalification tests do not have to be repeated. A BRP agreement is not required for participation in any of these services.
- **Testing and measurement:** During the prequalification process, each BSP has to explain how the measurements at asset level are aggregated. For FCR and aFRR a four-seconds aggregated signal has to be provided, but this can be built up with measurements with a lower data granularity.
- **Payments:** Payments are equal for generation and consumption units, all ancillary services guarantee availability payments, balancing energy for aFRR and mFRR are also remunerated.
- **Penalties:** In case of non-availability, which is communicated beforehand, there is a penalty for FCR equal to five times the compensation (proportional to the time interval and capacity). Instead, there are no penalties for aFRR and mFRR but if the overall availability is below 99%, the qualification is withdrawn. In case of under-delivery, there are different penalties for each product. For FCR and aFRR, it is up to the BSP to formulate a baseline methodology according to the requirements. For mFRR the 5-minutes period before the activation are used for the baseline.

MARKET COMPOSITION

Demand-side assets, small scale and industrial loads, are participating in the Dutch market but the quantification of their capacity is not publicly available.
The Dutch TSO procures 111 MW of FCR capacity, 300 MW of aFRR capacity and circa 1 GW for mFRR. The amount of demand-side capacity or balancing energy that are procured for the different ancillary services is not disclosed by the TSO.

Currently there are 25 BSPs prequalified for ancillary services in the Dutch market. In terms of assets participating, both small scale assets and industrial consumers are participating. Some market players have proven that EV batteries can be used for delivering aFRR and FCR services, even if barriers still persist for a wider participation.

DATA TRANSPARENCY

The TenneT data transparency is currently lacking depth and ease of centralised access. The TSO does not provide data on the amount of DSF capacity procured or activated.

TenneT does not disclose directly information on the Dutch energy mix and CO_2 content of its grid, but it collaborates with other companies to make this information available online from different tools[36]. Nevertheless, the data are not retrievable directly through an API. Imbalance positions and prices are published on real time on TenneT's website, while information on congestion issues is only published as operational massages or through the ENTSO-E Transparency platform.

UPCOMING LEGISLATIVE CHANGES

From 2023 the mFRR market will allow minimum bid size of 1 MW. In the medium term the main legislative changes are related to the market coupling and product standardisation.

The connection to the ENTSO-E market platforms MARI and PICASSO are foreseen in 2024, this will foster harmonisation of requirements with other European countries. From January 2023, the minimum bid size to participate in mFRR market will be lowered to 1 MW, allowing a broader participation of DSF technologies.

[36] https://energieopwek.nl/ and https://co2monitor.nl/

POLAND

The Polish market for ancillary services remains non-competitive and not accessible for demand-side flexibility. Despite this, Poland is considered to be one of the most prominent emerging markets due to the planned opening of value steams and its high needs for system flexibility[37]. The TSO currently procures FCR and aFRR balancing energy through bilateral contracts with generators. It is expected that the market will allow participation of DSF by the end of 2023 at the earliest. Nevertheless, market parties have raised some concerns that the TSO will introduce tight area restrictions for aggregation, limiting their possibilities.

What changed since the smartEn Map 2018 Balancing Markets?

No relevant changes can be observed in the Polish market. Balancing energy is still procured through bilateral contracts or obligations on generators.

ACCESS TO ANCILLARY SERVICES

FCR

Balancing energy for primary control is procured through a market in which generators with capacity above 100 MW are obliged to participate.

The Polish TSO does not procure balancing capacity for FCR nor for any other ancillary services. It procures FCR balancing energy from a day-ahead market, which is in theory open to all resources. Nevertheless, conventional generators and hydro power plants connected to the transmission grid are obliged to bid. Therefore, only these resources are participating. Power plants above 100 MW must be equipped with primary control systems with specific parameters to provide balancing services. The TSO optimises the use of these reserves in terms of the lowest costs and safety criteria. Standby and activation rules are defined through bilateral contracts between the TSO and generators. Poland is not part of the EU FCR Cooperation nor does it plan to join it in the near future.

aFRR

Balancing energy for secondary control is procured through a market in which generators with capacity above 100 MW are obliged to bid.

Generators above 100 MW must also be equipped also with secondary control systems and provide balancing energy for secondary control. Balancing energy is procured from generators through a day-ahead market in which centrally dispatched generation units are obliged to participate. Even if in theory the participation of other providers, including demand-side resources, is possible, the market is saturated by generators and the price volatility is too limited to allow a real competitive process. Poland is part of the ENTSO-E PICASSO project and it plans to go-live in July 2024. This would likely lead to the definition of standard or specific products, as defined by the EB Regulation.

mFRR

Not available.

[37] smartEn/Delta-EE- European Market Monitor for DSF (2021)

PARTICIPATION REQUIREMENTS

A low price cap for balancing energy limits the profitability of the market.

- **Prequalification:** Large generators are obliged to provide primary and secondary control, so a real prequalification process is not defined.
- **Testing and measurement:** Balancing energy providers must have meters and transformers with appropriate accuracy and the ability to transmit remote hourly electricity measurements to the TSO. Even if details are not yet known, the reform of the market that is currently under discussion foresees the obligation of a SCADA system and high accuracy of forecasted demand which would be costly and limiting for smaller DSF assets.
- **Payments:** Poland does not procure balancing reserves but only balancing energy, therefore only activation payments are granted. The maximum offer price in the balancing market used to be around 10 000 EUR/MWh, but it was never achieved (in practice the maximum price observed was 800-900 EUR/MWh in summer 2022). Recent regulation developments capped the maximum balancing market offer price for hard coal and gas power plant according to a cost-based formula, resulting in a maximum price of ca. 150-200 EUR/MWh, limiting opportunities for other participants in case of capacity shortages. Energy-only payments are often not sufficient to cover the investment costs for non-dedicated assets, therefore a reform of the market should also take this aspect into consideration.
- **Penalties:** In case of non-delivery, 25% of the offer price is deducted from the remuneration.

MARKET COMPOSITION

The Polish balancing products are procured from generators and hydro power plants.

Poland procures ±170 MW of FCR and ±500 MW of aFRR. In 2021, 26 entities were registered as BSPs, including two entities with storage capacity and one DR provider[38]. The Polish ancillary service market sees participation only of conventional generators and hydro power plants, due to the fundamental barriers highlighted previously.

DATA TRANSPARENCY

The data transparency of the Polish energy market is limited.

PSE discloses data on the Polish energy mix, volumes and prices of the wholesale and balancing markets and grid constraints. Nevertheless, the granularity of the data (hourly) is low and the GHG content of the electricity system is not officially disclosed.

UPCOMING LEGISLATIVE CHANGES

It is expected that the Polish market will allow participation of DSF, including from independent aggregators, by the end of 2023. Market players have expressed concerns that the reform will not practically allow for the activity of aggregators.

The Polish regulator is working on the implementation of the EU Electricity Directive to allow participation of all resources, including demand-side resources, in the balancing market. The planned reform will separate the roles of BSPs and BRPs. This is expected by the end of 2023. Nevertheless, market players are concerned that area restrictions for aggregation will be introduced, allowing aggregation only to individual high-voltage stations and with a minimum power of 1 MW, which may make the provision of these services impracticable.

[38] ENTSO-E Balancing report 2022

PORTUGAL

The Portuguese market for ancillary services remains closed to DSF. The aggregator framework was introduced into national legislation in January 2022. However, it was not accompanied by the necessary practical improvements in the accessibility of DSF to the different ancillary services markets. Not all ancillary services are procured through market-based mechanisms (FCR is a mandatory product). Only mFRR allows the participation of consumption units, i.e. industrial DR, but without the possibility of aggregation. Technical requirements are mainly tailored to the characteristics of generators, which is the technology that predominantly participates in the market.

What changed since the smartEn Map 2018 Balancing Markets?

The aggregator framework was introduced in national legislation in 2022. No other significant changes in the markets to allow access to DSF providers can be noted.

ACCESS TO ANCILLARY SERVICES

FCR

FCR is not procured through a market but a mandatory provision for generators.

aFRR

Balancing energy for secondary reserve is procured through a market, which remains closed to demand-side units.

aFRR is procured through a market from resources with a minimum capacity of 1 MW. Aggregation is not allowed and the product is procured from thermal and hydro power plants. The reserve is asymmetrical with a ratio of two between upward and downward regulation. This would constitute a barrier for some demand technologies, like small batteries, that have technical constraints to provide symmetrical load variations. Portugal is part of the PICASSO project, which would harmonise the rules for the procurement of aFRR across the EU and it is expected to allow greater participation of DSF. The connection to the platform is expected for the middle of 2024.

mFRR and RR

mFRR and RR are procured through a market mechanism but without the possibility of aggregation, the only demand participation comes from industrial consumers.

mFRR or “Reserva de regulação” is procured from balancing areas that include conventional generators and consumption units. Balancing areas are obliged to offer mFRR capacity in daily markets. Aggregation is not allowed so only single demand units above 1 MW of capacity can technically be procured. The remuneration of the daily mFRR auctions is based on activation, and no availability payment is foreseen. REN introduced a pilot project to allow the participation of DSF in mFRR from April 2019. The project showed that technical requirements for data communication could be a barrier to DERs[39]. REN is part of the ENTSO-E MARI platform but, as many other participating countries, a derogation for the connection to the platform was asked to the Regulator.

[39] https://www.erse.pt/media/zwfhzifs/relat%C3%B3rio-erse.pdf

RR are also procured by the Portuguese TSO from a market-based mechanism for thermal and hydro generators from 1 MW of capacity. Similarly to mFRR, remuneration is based on activation and aggregation is not allowed.

PARTICIPATION REQUIREMENTS

The technical requirements are built around technical capabilities of generators and would need to be adapted to demand-side technologies to allow their participation in the future.

- **Prequalification:** Prequalification is performed at asset level and it foresees a series of tests. It evaluates different parameters, like the capacity to communicate with the TSO, the real generation or consumption in a fixed load regime, a gradient of continuous variation in generation or consumption and the response to requests for random variations in generation or consumption, including reversing the direction of the of the request.
- **Testing and measurement:** The TSO requires transmission of real-time data for providing ancillary services. This constitutes a barrier and a high cost for smaller scale assets and it was also proven from the experience of the pilot project for participation of DSF in mFRR.
- **Payments:** Availability and energy payments are granted for aFRR, only energy payments for mFRR and RR. Energy payments only are usually not sufficient to make the business case economically viable for non-dedicated assets like demand-side resources.
- **Penalties:** Deviation penalties are applied in aFRR, mFRR and RR, except for the DSF technologies that participate in the pilot project on mFRR. For DSF, it is assumed that the contracted RR service is dully provided. The deviations measured in the consumption are attributed to the supplier imbalances.

MARKET COMPOSITION

Different regulatory constraints make participation of demand-side resources almost non-existent.

Conventional generators and hydro power plants are contracted for aFRR 180 MW (up) and 90 MW (down), for mFRR and RR the quantity procured considers a dynamic rule corresponding to the sum of the biggest generation asset (400 MW) plus 2% of the forecasted demand (max of 200 MW) plus 10% of wind forecasted generation (max of 540 MW). Circa 30 MW of industrial loads are contracted for mFRR. Currently, 10 BSP are prequalified but no independent aggregators.

DATA TRANSPARENCY

Data transparency of the Portuguese market is limited.

REN provides data on the Portuguese generation mix with a granularity of 15 minutes through a Data Hub[40]. No information is provided on CO_2 content of the grid, but the ERSE, the Regulator publishes average emission coefficients to determine CO_2 emissions. There is also no open API to access such data and this further limits usability of the data. No information on the sources of the activated bids is made available.

UPCOMING LEGISLATIVE CHANGES

The role of aggregator, as foreseen by the EU Electricity Directive, has been introduced but it is unclear if this will lead to relevant legislative changes for ancillary services.

In January 2022, the legal framework[41] that transposes the EU Electricity Directive provisions, including the aggregator framework, was introduced and it is currently under implementation. ERSE will develop the implementation of this framework from 2023, nevertheless, it is not clear when the new legal framework will enable actual participation of DSF in the ancillary services market.

[40] https://datahub.ren.pt/en/
[41] https://dre.pt/dre/detalhe/decreto-lei/15-2022-177634016

ROMANIA

Romania procures ancillary services for aFRR, mFRR and RR from market-based mechanisms theoretically open to all resources. However, in practice only generators offer ancillary services due to low maturity of the market and various barriers (e.g., 5 MW minimum bid size for aFRR, requirement of a BRP agreement, and impossibility of aggregating generation and demand assets in the same pool). The minimum bid size for aFRR will be lowered to 1 MW in 2023, once the transition from pro-rata to merit order activation is implemented.

What changed since the smartEn Map 2018 Balancing Markets?

This is Romania's first appearance in the smartEn Map Ancillary Services.

ACCESS TO ANCILLARY SERVICES

FCR

The provision of FCR capacity is currently mandatory for generators.

aFRR

aFRR is procured through a market mechanism but the market design excludes DSF providers.

Transelectrica, the Romanian TSO, procures capacity for aFRR in hourly blocks through a market open to demand and generation assets but without the possibility of aggregating them in the same pool. The minimum bid size is very high (5 MW upward and 5 MW downward) direction and bids have to be symmetrical; these conditions exclude most of the potential DSF providers. As a result, there is no participation of demand-side assets in the market. Balancing energy for aFRR is also procured through the same mechanism. Access to the ENTSO-E PICASSO platform is foreseen for 2024. Romania has undertaken different steps to create standard products in line with the EB GL and the access to PICASSO will further harmonise the current rules with the other European countries.

mFRR and RR

mFRR and RR are procured from a market open to all resources but there is no participation of DSF providers in the market.

Capacity for mFRR and RR is procured through a market similar to the aFRR one. The market is open to demand, generation, and storage facilities but aggregation of different sources in the same pool is not allowed. The minimum bid size is 1 MW. The procurement of balancing energy for mFRR and RR follows the same rules. Romania is part of the ENTSO-E MARI project and its connection to the platform is foreseen for 2024, as it was granted a derogation.

PARTICIPATION REQUIREMENTS

The technical requirements are mainly tailored to the characteristics of generators, which are the only technologies participating in the market.

- **Prequalification:** The prequalification tests are performed for ramping down and up for four power values: 25%, 50%, 75% and 100% of the maximum capacity for the product. Prequalification can be performed at pool level and each type of balancing reserve has a different prequalification procedure as well as each type of assets: generating units, demand and storage units. A BRP agreement is required to participate in the market, which further limits the entrance of independent aggregators in the market.
- **Testing and measurement:** Real-time monitoring is required to provide aFRR ancillary service and this can be particularly costly for smaller demand-side units.
- **Payments:** Contracted capacity payments are guaranteed for the FRR and RR products, there are no energy payments.
- **Penalties:** Penalties for non-delivery are particularly stringent. The penalty corresponds to 100% of the availability payment for that time interval.

MARKET COMPOSITION

The Romanian market for ancillary services has no participation of DSF.

There is no central easily accessible information on the amount of capacity that the TSO procures for ancillary services. At the moment there is no capacity nor balancing energy procured from demand-side technologies for any ancillary service.

DATA TRANSPARENCY

The data transparency of the Romanian energy system is limited.

The TSO provides real-time data on the energy mix. Other information is provided (i.e., balancing market data, ancillary services market, capacity forecast, metering operator data, committed transactions for congestion management) but granularity of the data is generally low and information is not easy to access. Transelectrica provides information on the Terms & Conditions of the balancing market through the ENTSO-E Transparency platform, which is mostly unavailable for other EU countries.

UPCOMING LEGISLATIVE CHANGES

The main upcoming legislative changes are related to the access to the ENTSO-E balancing platforms.

Starting in October 2022, all Romanian balancing products are standard and in line with the EB Regulation. The new Terms & Conditions for BSPs and BRPs have been approved by the NRA and entered into force on 1 October 2022. The main upcoming legislative changes are related to the access to the ENTSO-E balancing platforms, this might trigger the elimination of the major barriers for DSF.

SLOVENIA

The Slovenian market is relatively small but since 2019 many regulatory improvements have made the ancillary services products open to demand-side resources. The technical requirements do not prove to be cumbersome for demand-side assets and the accuracy of the metering devices is tailored to the size of the assets. DSF participation from batteries, industrial loads and distributed generation varies from 48% of total aFRR capacity to 26% of total mFRR capacity, proving that the conditions for participation allow competition of demand and generation on equal footing.

What changed since the smartEn Map 2018 Balancing Markets?

FCR is not a mandatory product anymore and since 2021, it is procured through the FCR Cooperation. As of December 2020, the TSO's Terms and Conditions for BSP allow aggregated resources with limited energy capacity such as storage units to provide FCR alongside traditional generator and demand units. aFRR is procured through a market fully open to all resources and not through bilateral agreements, the auction frequency for procurement of mFRR has also increased and the market is open to all providers.

ACCESS TO ANCILLARY SERVICES

FCR

FCR is open to all market participants and Slovenia is part of the EU FCR Cooperation, which guarantees equal conditions for demand and generation units.

FCR symmetrical capacity is procured through daily auctions in four-hour blocks from bids with a minimum size of 1 MW. Balancing energy for FCR is not procured through a market: BSPs are obliged to provide the amount of balancing energy corresponding to a 15-minute activation of the maximum amount of the provided balancing capacity. In 2021 the market coupling though the FCR Cooperation led initially to a more liquid market and lower prices, but high wholesale energy prices have influenced FCR prices as well.

aFRR

aFRR is open to all providers and procured through different auctions with different timeframes.

aFRR is procured through monthly and daily auctions. Aggregation of demand and generation in the same pool is allowed and the minimum bid size is 1 MW. Balancing energy is also procured through a market-based mechanism. If a qualified BSP successfully clears the balancing capacity auction they are obliged to submit a corresponding balancing energy bid. If a qualified BSP failed at the balancing capacity auction they may submit voluntary balancing energy bids. Capacity and energy bids can be asymmetrical, without a ratio between the upward and downward regulation. ELES, the Slovenian TSO, has submitted a request for derogation in the connection to the PICASSO platform until July 2024.

mFRR

mFRR is open to all providers and procured through different auctions with different timeframes.

The procurement of mFRR follows the same logic as the aFRR auctions, but it is characterised by a multi-annual contract for upward mFRR that expires at the end of 2023. All other mFRR are procured through daily auctions. A BSP can participate simultaneously in all balancing services. The planned connection to the ENTSO-E MARI platform is expected in Q3 2023.

PARTICIPATION REQUIREMENTS

The technical requirements are fair for all providers and certain conditions such as the accuracy of metering devices are proportional to the size of the assets.

• **Prequalification:** The prequalification for FCR is performed at asset level, while pool level is used for aFRR and mFRR. The process consists of an application for the recognition of the technical qualification and then the verification, which entails a test of the communication and ICT system, and a successful implementation of the test activation. There are no particular conditions of the prequalification test that limit participation of demand-side resources in comparison to other providers.

• **Testing and measurement:** The metering requirements differ for accuracy class, data acquisition interval and data recording interval according to the service provided and the size of the connection point's rated load. In particular, the connection points with a rated load higher or equal to 1 MW must be equipped with meters of at least 0.5 or C accuracy class, for connection points with rated load higher than 43 kW, the accuracy class should be at least 1 or B, and for connection points with a rated load less or equal to 43kW, at least 2 or A. Nevertheless, the TSO requires the transmission of data in real-time, which could be an excessive requirement for smaller assets.

• **Payments:** Equal payments are granted to generation and demand-side resources when they are allowed to participate in the market. A marginal price logic is applied for FCR, through the FCR Cooperation, and a pay-as-bid logic for aFRR and mFRR. Slovenia has implemented a combination of the contracted and uncorrected model for independent aggregators, which does not demand mandatory compensation to the suppliers for the energy not used as a consequence of providing explicit DR.

• **Penalties:** In case of non-delivery, penalties are based on the non-delivered volume and the price of the most expensive accepted BSP's balancing capacity bid. The baseline methodology is defined by the TSO.

MARKET COMPOSITION

Good market conditions have fostered participation of demand-side resources in aFRR and mFRR markets.

There is good participation of DSF in the markets: for aFRR demand-side technologies provide 57 MW out of 120 MW of the total reserve (48%), and for mFRR 85 MW out of 321 MW needed (26%). In terms of activated energy, in 2021 38 600 MWh (equal to 36% of all activated aFRR) and 149 MWh (equal to 25% of all activated mFRR) were DSF activations. In terms of assets, mostly batteries, industrial consumers and diesel generators participate in the different ancillary services.

DATA TRANSPARENCY

The data transparency of the Slovenian TSO is good but could be improved.

The Slovenian TSO provides information on the total capacity contracted and contrary to other countries also provides information on the activated resources and quantities. It only provides basic hourly information on the generation mix and the load profiles through its website[42]. A newly defined KPI[43] incentives the TSO to provide to consumers and market parties access to 15-minute interval data of extended datasets in real-time or near-real-time (with maximum 15-minute delay).

UPCOMING LEGISLATIVE CHANGES

New Terms and Conditions for BSPs are going to be approved by the end of the year. The main legislative change expected for the ancillary services market is going to be new Terms and Conditions for BSPs, which are currently in final stages of the approval process at the Energy Agency and will presumably be effective by the end of 2022. It is also possible that there may be modifications of the independent aggregator model following a cost benefit analysis performed by the market operator in 2023.

[42] https://www.eles.si/en/load-and-generation
[43] https://www.uradni-list.si/files/RS_-2022-123-02907-OB~P011-0000.PDF

SPAIN

Despite its high share of variable renewable energy generation, limited interconnections with continental Europe and size of the market, Spain remains virtually closed to DSF. Not all ancillary services are procured through market-based mechanisms and, even where they are, a level playing field for demand and generation assets is not guaranteed. The minimum portfolio size of 200 MW for aggregated units in aFRR and the limited profitability of mFRR and RR markets make participation of DSF resources non-existent. A clear implementation timeline for the transposition of the Electricity Directive's provisions (e.g., the aggregator framework) into the Spanish market design is also missing, leaving market parties with high uncertainty. In order to deal with scarcity of supply for winter 2022/2023, the TSO introduced in October 2022 a new fast frequency reserve for consumption units of minimum 1 MW of capacity, but, participation is limited to BRPs.

What changed since the smartEn Map 2018 Balancing Markets?

Since 2021 the mFRR market opened to demand-side assets but aggregation of demand and generation in the same pool is not allowed.

ACCESS TO ANCILLARY SERVICES

FCR

FCR is a mandatory service for generators and not remunerated.

aFRR

The Spanish aFRR market is open to resources from a portfolio of minimum 200 MW, de facto excluding the participation of DSF.

Spain procures aFRR through D-1 auctions open to demand and generation resources from 1 MW of aggregated capacity. The resources providing the service must belong to the same regulated zone with a minimum portfolio size of 200 MW without the possibility of aggregating demand and generation in the same pool. Participation of independent aggregators is not allowed by regulation, only BRPs can provide the service. The Spanish TSO, REE, procures and remunerates also balancing energy for aFRR. Spain is member of the PICASSO project and it is expected to connect to the platform by July 2024.

mFRR and RR

mFRR and RR balancing energy markets are open to aggregated demand and generation assets, but without the possibility of mixing the two in the same pool. Having only energy payments limits the profitability for DSF providers.

The TSO procures balancing energy for mFRR and RR through daily auctions, with a gate closure every 15 minutes, open to generators and demand resources from 1 MW capacity. Aggregation of generation and demand in the same pool is not allowed. There is no procurement of capacity for these reserves and this is an important limitation for DSF providers, for which the profitability of energy only payments is too low. The full activation time of mFRR is 15 minutes and 30 minutes for RR. Spain is part of the MARI project; its connection has been derogated and is now expected by July 2024 at the latest. Since 2020 Spain is part of the TERRE platform and it procures RR balancing energy through the common European market.

PARTICIPATION REQUIREMENTS

A series of barriers for DSF can be identified in the technical

requirements for ancillary services, from the telemetry measurements to the limited profitability due to energy-only payments for mFRR/RR.

- **Prequalification:** The prequalification process can be performed at asset or pool level and it is the same for generation and demand-side assets. The prequalification test for mFRR and RR is not particularly taxing. Nevertheless, the administrative process is too long for demand-side assets, for whom the market opening is relatively recent.

- **Testing and measurement:** The measurement requirements are too stringent, since telemetry is necessary at the boundary point, which includes not only the flexible assets but also all the other resources connected on that site. A major issue on the verification is the different time granularity between energy and balancing products. Since energy retailers are the only possible participants in the market using demand side resources, the baseline is calculated on the energy traded in the day ahead and intraday markets.

- **Payments:** Payments for mFRR and RR are one of the major barriers for DSF providers. Unlike for generators, the provision of energy through ancillary services has an opportunity cost for demand-side providers since it is not part of their core business, therefore energy-only payments and the compensation to the BRP limit the revenues to the spread between the balancing market price and the day-ahead price. In Spain, that is usually around 10-40 €/MWh, which is not sustainable for the business model of DSF providers. For aFRR capacity payments are foreseen, but other barriers highlighted before limit the participation of DSF.

- **Penalties:** Penalties are calculated based on the performance of the contract point; they are usually equal to 1.5 times the remuneration.

MARKET COMPOSITION

Due to technical and regulatory barriers, there is almost no participation of DSF in the ancillary services market.

Spain procures around 800 MW of capacity for aFRR, of which none is procured from demand-side assets. Overall, the activation of ancillary services was equal to 2000 GWh in 2021, the only DSF provider (with 1 MW of capacity) was activated in the RR market only for one hour in the whole year. Ancillary services are mainly provided by conventional generators, renewables and hydro power plants.

DATA TRANSPARENCY

The data transparency of the Spanish market is fairly comprehensive but could increase its granularity.

The Spanish TSO shares data through its portal[44] on the energy mix, CO_2 content and imbalances of the grid. Nevertheless, the granularity of the data is low, hourly or daily, and there is no information available on congestions. Data on balancing services instead are provided with a granularity of 15 minutes. An open API is available to retrieve the data from the portal.

UPCOMING LEGISLATIVE CHANGES

Changes in the Spanish market design have been long awaited, in particular the definition of the aggregator framework, but a real implementation timeline is still uncertain.

The full transposition of the 2019 EU Electricity Market Design is still to be completed, in particular the definition of the role and responsibilities of an independent aggregator. The definition is currently contemplated in the national law but the implementation of the proper regulatory framework is foreseen for Q1 2024[45]. In the short term, it is also expected that a market for procuring reactive power for voltage control will be open. Spain is introducing emergency measures to tackle adequacy issues during winter 2022/2023. From October 2022, the TSO has introduced a product similar to a fast frequency reserve or interruptibility scheme for consumption units of minimum 1 MW of capacity, procured through an annual tender[46]. This is more an emergency measure rather than a structural scheme for DSF providers and only BRPs can participate, excluding independent aggregators. REE is changing the regulation to allow aggregation of generation and demand assets, but the timeline for implementation is still unclear.

[44] https://www.ree.es/es/datos/aldia
[45] smartEn – The Implementation of the EMD to drive demand-side flexibility (March 2022)
[46] https://www.boe.es/buscar/act.php?id=BOE-A-2022-15354

SWEDEN

Sweden has a wide variety of ancillary services procured through market mechanisms and harmonisation efforts in regulation and technical requirements are ongoing both at Nordic and European level. Nevertheless, Sweden has not introduced the definition of the independent aggregator in their national legislation. Hence, BSPs must operate in ancillary services through a BRP (e.g., a supplier) and cannot join independently. This constitutes a significant barrier for the development of DSF in Sweden. Batteries and DR providers widely participate in the FFR, a fast product recently introduced in the Nordics, but the other ancillary services are still mainly provided by conventional thermal generators and hydro power plants.

What changed since the smartEn Map 2018 Balancing Markets?

This is Sweden's first appearance in the smartEn Map Ancillary Services.

ACCESS TO ANCILLARY SERVICES

FFR

FFR is currently the most accessible product to demand-side esources in Sweden.

FFR stands for Fast Frequency Reserve, it is a very fast product common to all Nordic countries and used in case of low rotational energy in the grid. Svenska kraftnät, the Swedish TSO, usually procures around 100 MW of FFR capacity, which is responsible for covering 35% of the total need in the Nordic power system. FFR is procured through annual tenders and it is called off twice a week, during the time period from 1st of May until 30th of September. Aggregation of demand and generation in the same pool is allowed and the minimum bid size is 0.1 MW. These are favourable conditions for DSF and the product is particularly suitable for demand-side technologies like batteries and electric boilers. Independent aggregators can participate in the market, without the involvement of BRPs.

FCR

FCR is an interesting product, requirements-wise, for demand-side resources but collaboration with a BRP is needed in order to access the market.

Sweden is part of the Nordic FCR Cooperation, so the technical requirements of this service are harmonised between the Nordic countries (at least between Sweden, Finland and Denmark to this date). Nevertheless, unlike Finland, Sweden has not yet defined the BSP role in their legislation, so a collaboration with a BRPs is needed in order to access the market. This limits access and increases costs for independent aggregators. The development of the BSP role is ongoing, but it's not clear when it will come into place. The TSO procures two types of FCR products:

- FCR-N, which is used during normal operation, is automatically activated if there is a frequency deviation within 49.90-50.10 Hz. Capacity is procured D-2 and D-1 through auctions. The minimum bid size to participate in the market is 0.1 MW, which is very well suited for small scale demand-side assets, however, it is also a symmetrical product which can be detrimental for some technologies like storage.

• FCR-D upward and downward regulation are activated in case of disturbances. The minimum bid size to participate is the same as for FCR-N, but in this case the product is asymmetrical without any ratio between the bids. FCR-D up is activated between 49.50-49.90 Hz and FCR-D down is activated between 50.50-50.10 Hz.

aFRR

The participation in the Swedish aFRR market would be feasible for demand-side resources but the lack of an independent aggregator framework and the short contracts do not attract DSF providers.

The Swedish TSO introduced in 2022 a new national market design for the procurement of aFRR capacity with day-ahead auctions and marginal pricing. This is a first step for the implementation of a common aFRR capacity market through the Nordic Balancing Model cooperation, which should go-live by the end of 2022, but the implementation timeline is still very uncertain. The minimum bid size for participating in the market is 1 MW and aggregation of demand and generation is allowed. When activated, aFRR is settled at the mFRR balancing energy price. Sweden is also part of the EU PICASSO platform and plans to connect between Q1 and Q2 2024.

mFRR

mFRR is the least accessible product for demand-side resources in Sweden due to high minimum bid size of 10 MW, the impossibility of aggregation and the lack of an independent aggregator framework.

Sweden procures mFRR from voluntary bids in the balancing energy market, mFRR is called continuously when needed and bids must be submitted no later than 45 minutes before the operating hour. High minimum bid sizes of 10 MW (5 MW in the bidding zone SE4) and the lack of capacity payments limit the accessibility of this market for smaller demand-side resources. The minimum bid size will be lowered to 1 MW by the end of 2023. mFRR is also in the scope of the Nordic Balancing Model cooperation, which will introduce a common mFRR capacity market, but the timeline of its implementation is still unclear. Sweden is also part of the MARI platform, the planned connection will be Q2 2024.

PARTICIPATION REQUIREMENTS

There are no particular technical requirements that limit DSF providers and exceptions are granted or under development for small scale resources.

• **Prequalification:** The prequalification is performed per application, even for aggregated resources. The same requirements apply for all technologies, the tests depend on the ancillary service they apply for. Some of the ancillary services require longer activation times (up to an hour), limiting the potential participation of some demand resources. The Swedish TSO tends to perform the prequalification process rather quickly and it has up to 8 weeks to complete the process. Units with a maximum capacity less than 0.1 MW can be type-qualified and simply added to a pre-qualified group, as long as the maximum capacity is not increased. The BSP can also expand the pool with type-qualified units and thereby increase the maximum capacity from the group in steps of 0.1 MW, up to a maximum of 1 MW, without the need for a new pre-qualification.

• **Testing and measurement:** All ancillary services require real-time measurement values. Nevertheless, it is possible to have centralised metering if local metering is impossible. This enables easier handling of metering for aggregated demand-side resources. Svenska kraftnät plans to introduce a new communication solution that should be able to function as an alternative for smaller players by the end of 2022, but it is likely that this will be prolonged further into 2023. There are no baseline methodologies defined for resources with variable production or consumption, but they are currently under development in a pilot study with market participants.

• **Payments:** The same type of payments are granted to generation and demand units. All ancillary services, except mFRR, grant availability payments while FCR and FFR do not foresee activation payments. aFRR grants both an availability payment and an activation payment.

• **Penalties:** Each product contemplates a different penalty in case of non-delivery.

MARKET COMPOSITION

Due to the lack of recognition of the independent aggregator in national legislation, participation of DSF in the Swedish ancillary services is quite limited, with the exception of FFR, where DSF plays an important role.

Batteries and electric boilers are the main technologies prequalified for FFR, representing 72.5% of the total capacity procured. Small volumes of DR participate also in FCR-D (around 10%) and mFRR (ca. 1%). Industrial loads and batteries are participating but the market remains dominated by thermal generation and hydro power plants, in particular 100% of aFRR and 90% of mFRR capacities are procured from hydro.

DATA TRANSPARENCY

The data transparency of the Swedish TSO is limited to generation and demand data.

Sweden publishes real-time data for production and hourly data for consumption on its website[47]. It doesn't provide information on the GHG content of the grid nor congestions. The TSO also discloses information on the market composition.

UPCOMING LEGISLATIVE CHANGES

A series of positive legislative changes will make the ancillary services market more accessible to DSF in the short-term. The Swedish TSO is also involved in innovative projects to connect local flexibility markets with the mFRR market.

The Swedish Regulator is working on the definition of the BSP role, that will open the market to new players and independent aggregation. Nevertheless, the implementation of this new role is not expected before 2024. The main short-term legislative changes will be related to the Nordic Balancing Model cooperation. In particular:

- The introduction of the Nordic aFRR capacity market in Q3 2022 that will make the market more attractive for DSF providers.
- The reduction of the minimum bid size to 1 MW for mFRR that will allow easier access for smaller assets and is currently planned for Q4 2023.
- The reduction of the imbalance settlement period to 15 minutes from May 2023 that allows market participants to react easier to changes and divide more accurately the cost of imbalances between the participants, therefore allowing greater participation of DSF.

Finally, the Swedish TSO is part of the Sthlmflex project and the Coordinet project, which fosters procurement of flexibility on NODES' local flexibility markets[48]. Thanks to a sandbox environment, the local market platform will aggregate FSP orders by BRP and transmit the orders to the TSO for participation in the mFRR market with a minimum bid size of 1 MW. The go live is planned for November 2022.

[47] https://www.svk.se/en/national-grid/the-control-room/
[48] https://nodesmarket.com/sthlmflex-shortflex-registration-form-membership-agreement-and-rule/

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SWITZERLAND

The Swiss market for ancillary services is open to all participants from generation and demand assets. In addition to the frequency ancillary services that are usually procured through markets across Europe, Swissgrid also procures energy to compensate active power losses through tenders. FCR is the most accessible product for DSF providers, while the aFRR and mFRR would be more accessible if tenders would be more frequent and minimum bid sizes lower. The requirement to be or assign the role of BRP remains a barrier for independent aggregators. In addition, the barrier of low profitability is often mentioned as a high obstacle for market players, depending on the product. Revenue stacking is not always easy to implement due to increased technical requirements to offer different products.

What changed since the smartEn Map 2018 Balancing Markets?

The only substantial change that can be observed since 2018 is an increased frequency of FCR procurement from weekly to daily auctions, in compliance with the rules of the FCR Cooperation.

ACCESS TO ANCILLARY SERVICES

FCR

The FCR market is well established in Switzerland that is part of the EU FCR Cooperation.

Swissgrid, the Swiss TSO, procures FCR through daily tenders for four hours blocks from the FCR Cooperation. The reduction from daily to four-hour blocks was implemented in 2020 and ongoing discussions in the Cooperation seem to promote a further reduction to one-hour blocks. The minimum bid size, according to the harmonised rules of the Cooperation, is 1 MW and the market is open to aggregation of demand and generation assets. Switzerland procures circa 61 MW from the overall capacity of the Cooperation. FCR balancing energy is not settled.

aFRR

aFRR is procured through weekly tenders open to all resources but a hight minimum bid size and low granularity of the tenders hinder participation of DSF.

The secondary reserve is procured through weekly tenders open to all market players, including aggregated demand and generation assets, from a minimum bid size of 5 MW. The change to daily tenders that was foreseen in 2019 was not implemented and the minimum bid size remains quite high in comparison to other EU countries. Asymmetrical bids are allowed, making this product flexible for different types of technologies and consumer sizes. aFRR balancing energy is also tendered and remunerated with a pay-as-cleared logic as foreseen by the PICASSO platform.

mFRR and RR

mFRR and RR, which are products with similar requirements, are procured from all market players, but the minimum bid size of 5 MW still remains a barrier for a wider participation of smaller assets.

mFRR is procured through weekly tenders and, during the weekends, through daily tenders in four-hour blocks. The minimum bid size is 5 MW, aggregation of demand and generation in the same pool is allowed and the product is asymmetrical. Swissgrid also organises energy tenders, in which all bidders, who receive a contract in the capacity tendering process, must submit bids for three different products: TRE, RR and RR_TRE up to the awarded volume of tertiary control power. TRE is a specific national tertiary control energy product, RR is a standard replacement reserve product and RR_TRE a combination of the national tertiary energy and the standard replacement. Additional TRE and RR bids can also be offered voluntarily, independently of the results of the power tendering process. Swissgrid is part of the ENTSO-E TERRE platform, while the access to the MARI platform is currently subject of litigation.

Active Power Losses

Switzerland procures energy to compensate for active power losses through tenders open to all resources, this is a unique case across Europe.

To compensate active power losses in the transmission grid, Swissgrid launches call for tenders of baseload products of 1 MW. This product is procured yearly, quarterly and monthly from all balance groups in the Swiss control area. As for the other Swiss ancillary services, aggregated demand and generation pools can offer the product only if they are BRPs. Switzerland, Belgium and The Netherlands are the only countries that procure such product through a market-based mechanism.

PARTICIPATION REQUIREMENTS

The prequalification process and the measurement requirements to participate in the ancillary services market are technology neutral and leeway for pooled resources are foreseen, when necessary.

- **Prequalification:** The prequalification process is performed at pool level. Each ancillary service has different minimum technical requirements that a portfolio must fulfil. Once obtained, prequalification is valid for five years. In case of pooled resources, if the assets belonging to a connection point change configuration, the prequalification test must be performed again by the pool. The obligation to have a BRP agreement constitutes a barrier for a wider group of service providers to participate in the market.

- **Testing and measurement:** The TSO guarantees a certain flexibility for the measurement requirements and there are no particular requirements that hinder participation of demand-side resources. At least one measurement device is foreseen for each unit, but a power measurement at the connection point is allowed if the measurements of the single units can also be tracked. The maximum permissible deviation between measured and actual frequency is 10 mHz.

- **Payments:** All products guarantee availability payments, for aFRR, mFRR and RR energy payments are also settled.

- **Penalties:** In case of non-delivery, the penalties foresee a reimbursement equal to the difference, if positive, between the price at which the TSO purchased the non-supplied volume of energy on the market or from another source, and the agreed contract price.

MARKET COMPOSITION

The amount DSF capacity procured for ancillary services is not disclosed by the TSO.

Switzerland procures ±61 MW of FCR, ca. ±400 MW of aFRR capacity and ca. ±500 MW of mFRR capacity. For the active power loss, the TSO runs forecast to determine the necessary volumes. There are 21 prequalified bidders for ancillary services in Switzerland, the majority of which use hydro power plants. The amount capacity procured from DSF or other technologies is not disclosed by the TSO.

DATA TRANSPARENCY

The transparency of the Swiss market is very limited.

The TSO provides consumption and generation data on a monthly basis in graphic format on its website and data with a higher granularity through downloadable Excel files. Information on the CO_2 content and congestions of the grid are not publicly available, neither is the market composition for ancillary services.

UPCOMING LEGISLATIVE CHANGES

While no specific changes are foreseen for the ancillary services market, broader legislative changes will affect DSF providers.

In 2021 the Federal Council proposed the revision of the Energy and Electricity Supply Act, which is currently discussed by the parliamentary commissions. This revision will create the legal basis for end consumers and storage operators to use their flexibility to support the grid and ensure a more user-friendly tariff system. This is seen as a step forward to obtain a clearer ownership and roles for the use of flexible assets.


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List of Acronyms

aFRR	Automatic Frequency Restoration Reserve
BRP	Balance Responsible Party
BSP	Balance Service Provider
BTM	Behind-the-meter
CCGT	Combined Cycle Power Plant
CESA	Continental Europe Synchronous Area
CHP	Combined Heat and Power
DER	Distributed Energy Resource
DR	Demand Response
DSF	Demand-side Flexibility
DSO	Distribution System Operator
EB GL	Electricity Balancing Guideline
EV	Electric Vehicle
FCR	Frequency Containment Reserve
FCR-D	Frequency Containment Reserve Disturbances
FCR-N	Frequency Containment Reserve Normal
FOTM	Front-of-the-meter
GHG	Greenhouse Gases
MARI	Manually Activated Reserves Initiative
mFRR	Manual Frequency Restoration Reserve
MSD	Mercato dei Servizi di Dispacciamento (Ancillary Services market)
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation
PUN	Prezzo Unico Nazionale (Unique National Price)
RR	Replacement Reserve
SO GL	System Operation Guideline
TERRE	Trans European Replacement Reserves Exchange
TSO	Transmission System Operator
V2G	Vehicle-to-Grid

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