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Smart Energy Europe

The smartEn Map 2021

Resource Adequacy Mechanisms


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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.

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The smartEn Map Resource Adequacy Mechanisms, January 2022.

Project manager & Lead author: Andrés Pinto-Bello, smartEn.

Market intelligence and research: Cinzia Alberti Mazzaferro, Andrés Pinto-Bello Gómez, smartEn.

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We also thank all smartEn Members for their invaluable contributions and feedback.

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Foreword

As Europe's energy regulators monitor a world where energy prices are high; Covid-19 continues to remain a presence in everyone's lives; and the road to decarbonisation becomes ever-more concrete with the 2020 proposal for a European Climate Law, in July the proposed Fit for 55 package, and just a few days before drafting of this foreword, the proposed Hydrogen and decarbonised gas market package, it is natural to reflect upon resource adequacy.

The Electricity Wholesale Markets volume of the ACER-CEER Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2020 devotes a whole chapter to capacity mechanisms and resource adequacy. Given the Clean Energy Package, EU Member States must firstly strive to ensure an appropriate market functioning through relevant reforms. However, if necessary, temporary and properly designed capacity mechanisms allowing for cross-border participation of resources could be applied under strict conditions. Member States must justify the application of a capacity mechanism based on identified resource adequacy concerns. Importantly, accompanying regulatory distortions or market failures (to the use of a capacity mechanism) must be identified and a plan made to eliminate these distortions and failures. Indeed, such plans are a prerequisite for the approval of new capacity mechanisms or the conclusion of new contracts for existing capacity mechanisms.

ACER-CEER found that, in 2020, four different types of capacity mechanisms are applied in twelve Member States. Out of these twelve, seven have been approved by the European Commission for compliance with State Aid rules.

The Clean Energy Package requires countries to assess whether a strategic reserve is capable of addressing the identified resource adequacy concerns prior to introducing other types of capacity mechanisms.

It will be of particular interest to smartEn's membership that, as of publication of the volume, all currently active capacity mechanisms are open to demand-side response (DSR) participation. However, RES and storage are not eligible in three and four cases respectively. CEER encourages the eligibility of all means allowed by the Clean Energy Package. Looking ahead, it is likely that DSR will become a more important instrument to make the energy system more flexible for the benefit of all users, and in particular, consumers.

Finally, I would like to bring this back to the consumer perspective that is a basis of regulators' objectives. CEER's 2022-2025 strategy commits regulators to **empower consumers for the energy transition,** by:

- Enabling energy system integration: integrating renewables and incentivising innovation;
- Placing consumers at the centre of energy markets with consumer-centric dynamic regulation, empowering consumers to actively contribute to and benefit from a flexible energy system; and
- Ensuring open, well-functioning and resilient markets nationally and in Europe: delivering flexibility and new business models.

We hope that smartEn's membership, and, indeed, the wider European business community, could consider these as worthy goals as well. Enjoy the onward reading!

Dr. Annegret Groebel
President, CEER

Introduction

Michael Villa
Executive Director, smartEn

With the exponential increase of variable renewable energy sources being introduced in the EU over the coming years, resource adequacy assessment plays a key role in ensuring the stability and resilience of the European grids. Climate neutrality and the electrification of the energy system is crucial in the EU's agenda, and to be able to adapt to this transition, European grids will need a systemic change, both in the sources traditionally used to maintain stability and efforts to update system operation. Until now, resource adequacy has been ensured by traditional generation assets, as reflected by the results of this edition of the smartEn Map.

As we move toward this new energy landscape, new smart solutions like decentralised energy resources (DERs), including distributed renewable generation, demand response and energy storage, will play a crucial role in ensuring the resilience of the future energy system due to their Demand-Side Flexibility (DSF) potential.

This has been recognised by European legislators and national regulatory agencies alike. The Commission's Energy System Integration Strategy acknowledges the role of DSF as the bridging solution to support clean electrification and a more efficient energy system. The Electricity Regulation pushes towards a technology neutral environment where DSF can participate on an equal footing with traditional assets. However, ACER observed in its most recent Market Monitoring Report 2020 that some European countries still exclude renewables and storage from their resource adequacy mechanisms (RAMs). To fully integrate DSF in these mechanisms, we need to move further than technology neutrality, and make sure that the product design is technology inclusive, i.e., that no implicit technology bias is embedded in the product design.

Facilitating the entry of demand side resources into different markets, including RAMs, will allow active consumers to monetise their flexible assets, encouraging them to further invest in clean energy resources to the ultimate benefit of the energy system. Having RAMs that are open and actively procuring flexibility is only one part of the puzzle, but without them, the incentives for adopting clean flexible assets decreases and with it the risk of entrenching in long term contracts traditional and polluting technologies increases.

The present smartEn Map illustrates the current roles that DSF plays in different RAMs across a selection of European countries as well as the regulatory conditions for its participation. While resource adequacy is highly dependent on national specificities, like their energy mix or climatic variability, the report allows for the identification of existing barriers and good practices trying to achieve a more resilient, cost-effective and clean energy system.

Mapping RAMs across Europe

Our scope and purpose

THE SMARTEN MAP RAMs SEEKS TO ANSWER 3 QUESTIONS:

1. What are the RAMs used across Europe?
2. What are the different technologies participating in the RAMs in each country?
3. What are the participation requirements in those mechanisms?

The ultimate objective of this edition of *The smartEn Map* is to provide a high-level summary of the conditions for distributed energy resources (DER) across 11 European countries with already established RAMs and 3 countries that are currently designing new mechanisms. We aim to shed light on the regulatory and economic conditions for demand-side participation in those mechanisms and highlight those countries that are at the forefront of developing inclusive solutions for resource adequacy. In doing so, we aim to encourage policy makers to set favourable framework conditions for an active participation of the demand-side to drive the 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 2021). 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. The three "snapshot" chapters are providing insight into draft proposals for new RAMs which might still undergo significant changes before they are approved by the relevant authorities. 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* Resource Adequacy Mechanisms 2021, we have interviewed more than 60 sources from across the industry and from a wide selection of countries. We approached National Regulators, Economic and Energy Ministries, TSOs, DSOs, independent aggregators, energy service and technology providers, and other associations.

To accompany, verify and complete the primary research conducted through interviews, 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 builds on the incentive structures and grid-interaction possibilities for distributed energy resources in the different RAMs. It was designed to give an overview and a basis for comparing otherwise differing markets and products. However, it is still difficult to compare countries, as each have their own idiosyncrasies and different energy mixes and requirements for resource adequacy. 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 types of RAMs used in a country is less important than the prequalification requirements, i.e., various mechanisms are not necessarily better than having a single, technology inclusive one. The final objective is to highly score those countries where RAMs are well designed to address system stability in a technology inclusive manner.

Our rankings

Our ranking is based on the three categories: Resource adequacy mechanisms, technology participation, and participation requirements. Alongside the aggregated grading of countries, it also allows the mapping of countries per category.

The smartEn Map scoring system

CATEGORY	DESCRIPTION	SCORING SYSTEM
Resource Adequacy Mechanisms	▪ Capacity mechanism ▪ Strategic reserve ▪ Interruptibility mechanism	0-4 based on RAMS, procurement methods and other criteria **0** = No RAM (not included in the map) **1** = No DSF participation/Segmented products/ Bilateral contracts/No CO2 criteria **2** = DSF allowed or through Interruptibility schemes / bilateral contracts / tenders **3** = DSR dedicated products and others that allow DSR / tenders or market-based procurement **4** = Market-based procurement with DSR present in all products
Technology participation	▪ DERs (RES, storage, EVs, heat pumps, etc.) ▪ Industrial loads ▪ Nuclear ▪ Coal ▪ Gas-fired	0-4 based on a high-level estimate of DSF monetisation and barriers **0** = No DER or DSF permitted **1** = DER permitted but no activity or only in interruptible loads **2** = Flexible generation and interruptible loads participating **3** = DSF participation in specific or dedicated markets **4** = Widespread participation of DSF
Participation requirements	▪ Testing requirements ▪ Minimum availability requirements ▪ Reaction time and full activation time ▪ Metering requirements ▪ Other requirements	Each category scores in the scale below **0** = If requirements exclude DERs **1** = Technology neutral requirements (but generation-centric design) **2** = Technology neutral, but products designed for DSF exist (i.e, interruptibility schemes) **3** = Technology inclusive but some barriers exist for DSF **4** = Technology inclusive requirements that allow for DSF participation without barriers

Overview

In general Resource Adequacy Mechanisms across Europe are quite limited when offering Demand Side Flexibility (DSF) assets a viable revenue stream. Reasons are various, as we develop in the following chapters, but the lack of distributed technologies present and the overwhelming representation of traditional assets point towards an overall system design that favours the latter. The services required in the different RAMs are sometimes overlapping with existing markets, and are centred around adequacy services, congestion management, contingency reserves and balancing (in particular for interruptibility schemes).

Overall, procurement is mostly done through tenders or bilateral contracts, with a limited market-based approach. This can be a significant barrier for DSF resources, in particular interruptible loads, that are offering similar services to these mechanisms that can be also procured through already existing markets like balancing. This limited market-based approach has kept costs stable over the years (2.6 billion euros in 2020 according to the ACER Market Monitoring Report), even with the higher rate of DSF assets that would be available to provide the same services and potentially reducing costs.

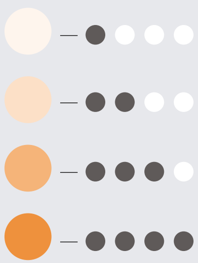
The most common demand-side assets participating are industrial loads through interruptibility schemes, mechanisms specifically designed for them. These often provide an interesting opportunity for large electricity consumers, even though in some cases, like in Germany, these schemes can come in conflict with the tariff design, creating contradicting signals. Nevertheless, Germany's interruptibility scheme stands out as one of the most activated mechanisms across Europe.

Countries that stand out in their resource adequacy mechanism design are few, but many good lessons can be learned from different mechanisms across Europe. In particular France, which stands out with a dedicated demand response (DR) product and technical requirements that can be reasonably met by most DSF assets. But especially the newly designed Belgian capacity mechanism, which provides a good blueprint, with a technology inclusive design, for other countries to follow.

With an expected increase in capacity requirements across Europe, due to the increased volatility of RES and the decommissioning of traditional generation plants, RAMs will play a key role in guaranteeing system stability. DSF and a market-based approach will be consequential in ensuring a stable grid at competitive costs.

Overview

RESOURCE ADEQUACY MECHANISMS 2021



Resource Adequacy Mechanisms

Resource adequacy assessment is subject to significant political influence. Each country decides, according to their needs, on their preferred mechanism to ensure resource adequacy and what quantities they will purchase. Article 21 of the Electricity Market Regulation established that no capacity mechanism should be implemented if the national or European resource adequacy assessments did not identify any resource adequacy concerns. In line with this, numerous countries are redesigning their Resource Adequacy Mechanisms (RAMs), the latest of them being Belgium and Spain, with upcoming products in Portugal, Bulgaria, and Lithuania. Many other EU countries do not have a RAM, relying exclusively on energy-only markets. For that reason, some countries that are usually present in the smartEn Map (e.g. Denmark, Switzerland, the Netherlands) are not included in this year's edition.

Comparing different resource adequacy mechanisms can be challenging. They usually serve different purposes and carry some national baggage, based on the resources traditionally used in each country. However, across the analysed countries we observe RAMs that can be grouped into the following categories: capacity markets, strategic reserves and interruptibility schemes. Those can in turn be market-based or targeted at specific technologies or a specific segment, such as large industrial consumers in the interruptibility schemes. Finally, the procurement method can be price-based, where a specific threshold price is indicated by the system operator, or volume-based, where a specific amount is procured through tenders, bilateral contracts or mandatory participation. The country that has adopted the closest to a pure market-based mechanism is France; a more centralised approach is preferred by the rest of the countries.

In general, RAMs are a useful tool to maintain system stability and address resource adequacy concerns. Resource adequacy services can be provided by many different technologies, including DSF if the product design is appropriate. However, even if theoretically technology neutral, most RAMs observed in Europe are undermined by designs and requirements that treat demand-side technologies unfairly. In some countries, like Bulgaria, Finland, Greece and Portugal, storage is not allowed to participate, contravening the Electricity Regulation[1].

[1] Article 22(1)(h) Electricity Regulation.

Resource Adequacy Mechanisms

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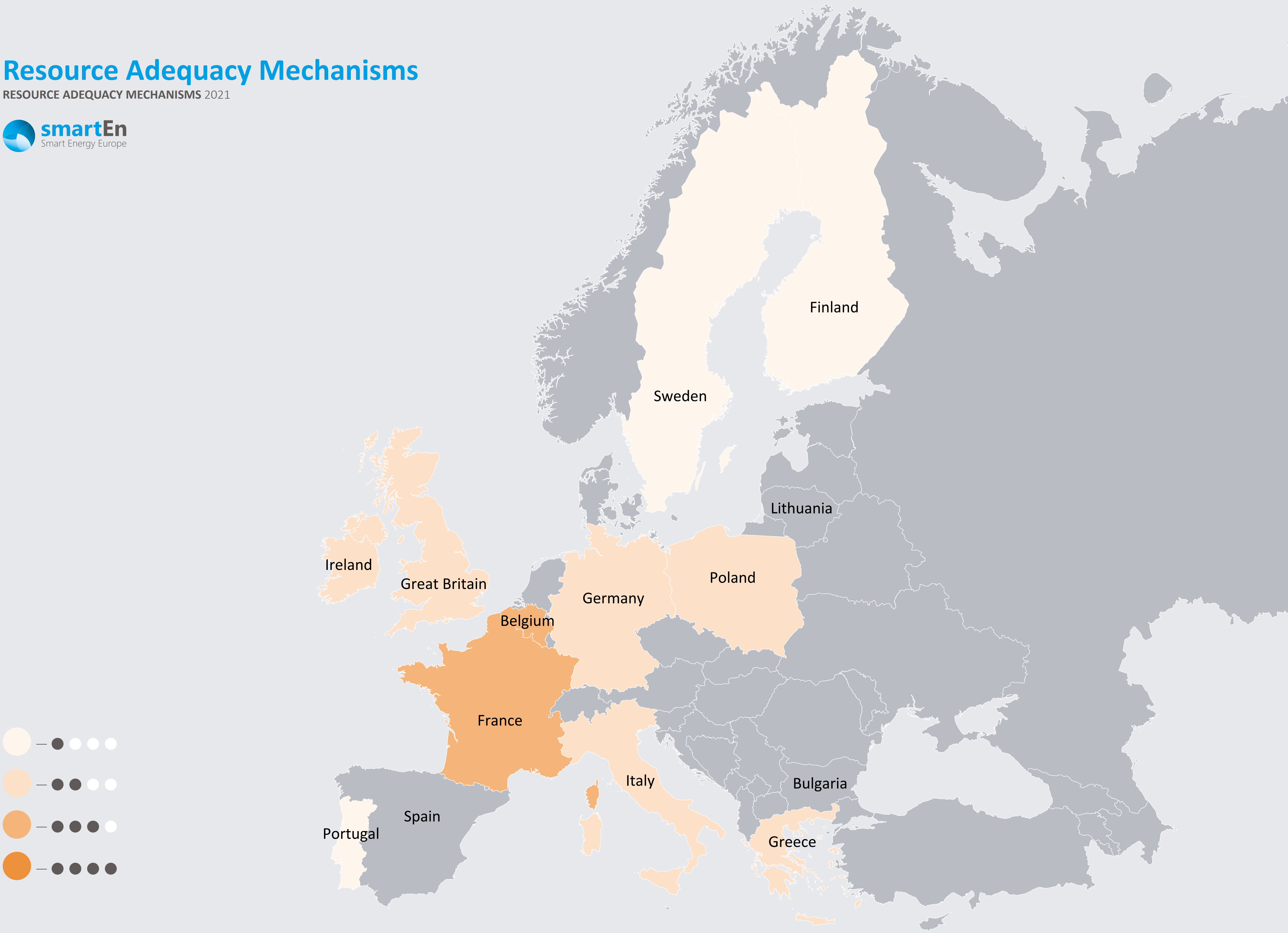

Participating assets

Resource adequacy is one of the largest untapped business opportunities for demand-side resources. However, the various RAMs across Europe currently accommodate only a narrow range of technologies, with a surprisingly low participation of demand-side resources. In the cases where there is demand-side participation, it is mostly confined to larger assets and large industrial consumers. Few countries allow aggregation of demand-side units to participate in RAMs. This is limiting the development of the business case for demand-side flexibility.

Most countries continue to base their programmes on the generation units that traditionally provided the same services in the past decades. The largest share (up to three quarters of the total capacity[2]) of technologies participating in RAMs are natural gas, nuclear, and coal/lignite. DR and battery storage provide a very small percentage – around 3% in 2021 – and only in a small number of countries.

Countries with the largest DR participation are France and Great Britain, mostly through aggregation and battery storage. But in both cases the levels are almost anecdotal, e.g., 3% of total contracted capacity in France. As seen in the previous section, some countries also have interruptibility schemes active, but these only allow participation by large industrial consumers.

The main causes for the low participation of demand-side resources are the limiting participation requirements, as highlighted in the next section. The new Electricity Market Regulation raises expectations by providing clear requirements for the participation of demand in any newly approved RAM. However, as we can see in some of the most recent proposals, like the one being developed in Spain, participation of demand is still not being taken fully into consideration in the product designs and so is likely to remain very limited.

The Electricity Market Regulation and State Aid Guidelines have also introduced limitations on the CO2 emissions permissible for RAMs, which will further encourage countries like Poland and Sweden to update their legacy programmes, which are heavily reliant on fossil fuel generation.

[2] ACER Market Monitoring Report 2019, figure 45, page 75.

Participating assets

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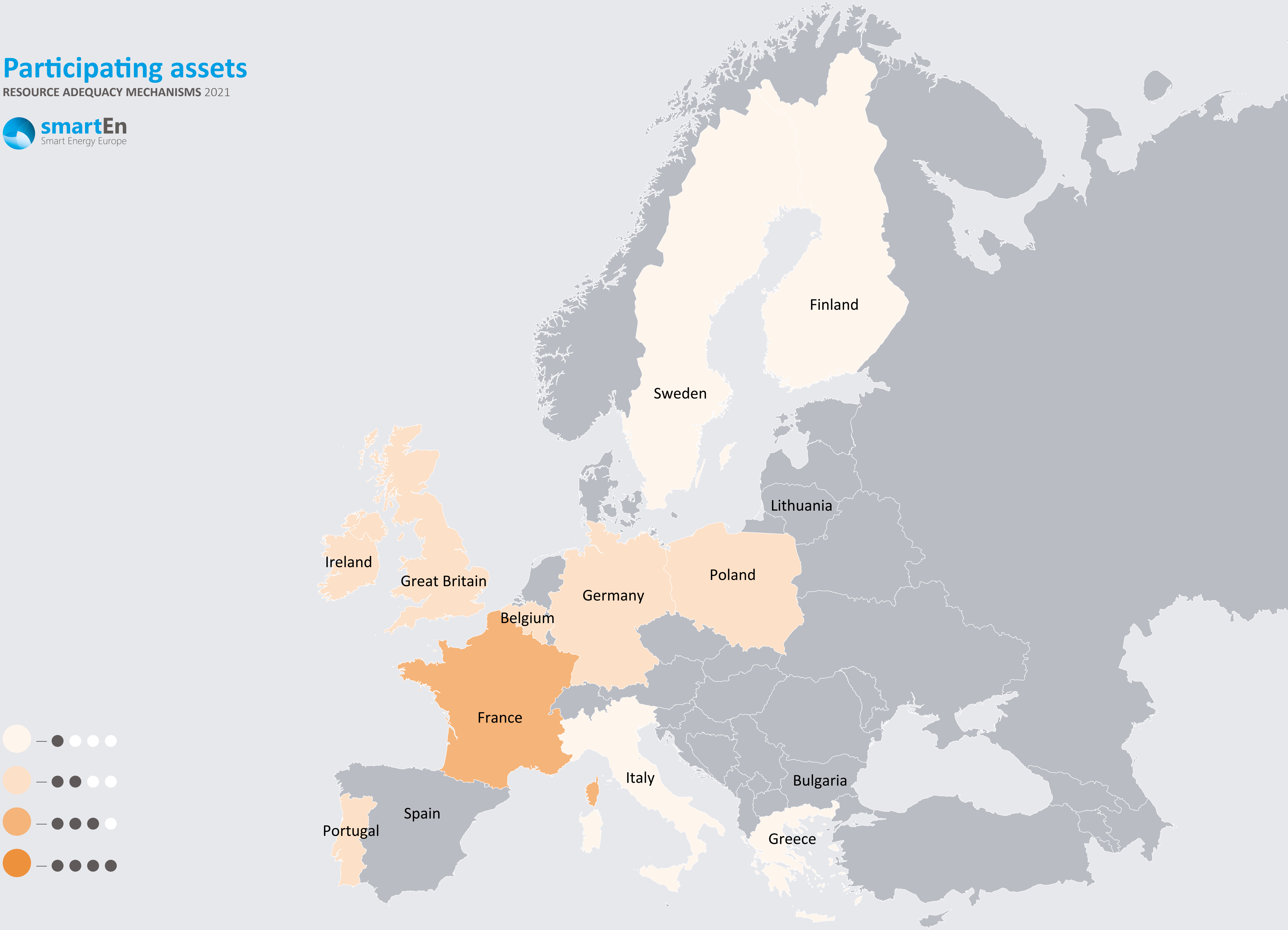

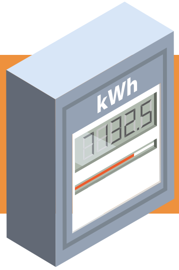

Participation requirements

Participation requirements for RAMs have historically been tailored to the specific technologies intended to provide them. As a result, prequalification requirements are usually the main barrier for demand-side units. No Member State has succeeded in providing a truly level playing field in their RAMs. The most common requirements that limit participation of demand-side resources include:

- Telemetry and measuring requirements: Some system operators require real-time telemetry over SCADA instead of settling on the basis of more manageable metering data. In other cases, for example in Germany, capacity providers need to communicate their exact load curves, with 15-minute resolution, 24 hours in advance – something that is achievable for generators, but not for most customer loads.

- Testing requirements: Most countries impose demanding prequalification tests where full activation must be maintained for long periods. For example, activation in Poland has to be maintained for four hours uninterrupted. While this is straightforward for generation units, it is not viable for most demand-side assets, in particular ones with a limited energy reservoir (LER) like storage. These tests are also not remunerated, which can be very costly for aggregators that have to compensate their customers for the opportunity costs they incur in this forced downtime.

- Aggregation of assets: Aggregation is rarely permitted, which makes even a 1 MW minimum bid-size impossible for all but the largest storage facilities. France, Belgium, GB, and Ireland are among the few that permit aggregation, and the new Lithuanian mechanism and the Finnish reserve allow aggregation of generation and demand in the same pool providing capacity reserves.

- Minimum bid sizes: Most countries have minimum capacity requirements above 1 MW, surpassing what many demand-side resources can provide by themselves. Countries like Belgium, Finland, France, Greece, and Italy, stand out with 1 MW minimum bid sizes, which are more easily manageable, particularly if aggregation is permitted.

Many of these requirements are completely unachievable for most demand-side units, and the need for them has not been justified for these mechanisms. The Electricity Market Regulation mandates a truly technology-neutral approach to new RAMs; with the upcoming revision of existing mechanisms, it should be expected that many of these requirements will be changed. This is already the case with the Spanish government's capacity mechanism proposal, which was significantly amended by the regulator with the intention of making the requirements more technology-neutral.

Participation requirements

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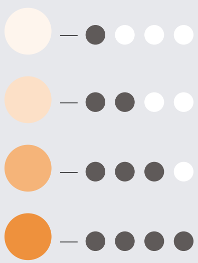
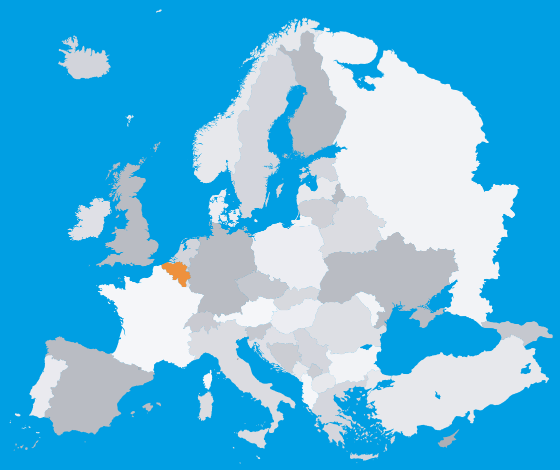




BELGIUM

In April 2021, Belgium introduced a new Capacity Remuneration Mechanism (CRM) based on reliability options intended to guarantee security of supply from 2025. The CRM is designed to be technology-neutral and initial assessments position it as one of the more inclusive European mechanisms for DSF. Participation of DR and storage in the first T-4 auction was significantly lower than conventional power plants. Nevertheless, it is reasonable to expect a greater participation of demand-side capacity in the auction that will be held one year before delivery, much better suited for the characteristics of these technologies.

Resource Adequacy Mechanisms

Security of supply in Belgium is secured through a technology neutral CRM that was approved in August 2021 by the European Commission under State Aid legislation, for a maximum duration of 10 years.

Capacity is procured though tenders with a social welfare optimisation. The default duration of a capacity contract is one year, but some projects can ask for a longer contract duration (three, eight or fifteen years maximum) if they exceed certain investment thresholds. Since demand-side units have significantly lower investment costs than generators, it is more difficult for them to obtain long-term contracts. This is also confirmed by the results of the first T-4 auction held in 2021.

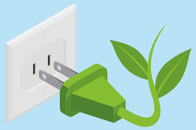
Procurement takes place twice for each delivery year. One auction is held four years in advance, for around 75% of the capacity, and one held one year in advance (e.g., for the 2025/26 delivery period, the first auction was held in 2021 and another will be held in 2024).

The mechanism includes two CO2 requirements. In alignment with the EU Electricity Regulation, participation in the CRM is not allowed for assets with CO2 intensity greater than 550 g of CO2 of fossil fuel origin per kWh. As a tie break rule in the auction, if required to choose between assets with the same price, the one with the lowest CO2 emissions is favoured. Moreover, any thermal capacity awarded with long-term contracts has to commit to develop a plan to become carbon-neutral by 2050 with intermediate steps in 2035 and 2045.

The CRM is compatible with the energy and balancing market, demand-side units can participate in those markets using the same loads committed to the CRM. The mechanism foresees pay-back obligations, which require market parties to repay the difference when the wholesale price is higher than the strike price. In other European markets with similar reliability option products (i.e. Ireland), there is usually one single strike price that applies to all market participants, which can be a disadvantage for demand-side units. However, in the Belgian CRM a special provision applies to demand-side units, which have the possibility to replace the one single strike price with their declared market price. This provision aims at avoiding that units have to pay back forrevenues that were not received in the first place in the energy market (in case the wholesale price exceeds the strike price, but would be below their declared market price).

In the first CRM auction, in October 2021, the Belgian TSO procured around 4.4 GW of capacity for the delivery period 2025/26. This was done on a pay-as-bid basis, with an average price for the selected bids of 37167.35 €/MW/year for units not subject to an intermediate price cap (which is applied to units that are only eligible for one-year contracts), and 19901.60 €/MW/year for those subject to the price cap.

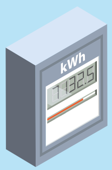
Participating assets



In the first auction of the Belgian CRM, which took place in October 2021, most of the capacity was awarded to gas-fired power plants: they obtained 81% of the total assigned capacity.

In the first CRM auction held in October 2021, 40 capacity market units were selected, representing 13 participants. Traditional generation was the dominant technology, with 3.6 GW[3] combined cycle gas turbines (81% of the total capacity), followed by 362 MW of CHP and 287 MW of demand-side management (mostly industrial loads from the paper and steel industry) and 41 MW of storage (both small- and large-scale storage). Participation of DSF in the CRM so far has been limited. This can be attributed to restrictions on assets that receive subsidies and to the fact that the T-4 auction is better suited to traditional generation, while 25% of the capacity for the delivery year 2025 will be auctioned only in 2024, where demand-side units are expected to shine.

Participation requirements



The Belgian CRM was developed to be technology neutral and has one of the fairest prequalification designs from the existing European mechanisms. However the derating factor design could limit participation of some demand-side technologies.

Participation in the CRM prequalification process is mandatory for capacity holders that fulfil a set of eligibility criteria, but there is no obligation to bid in the auction. The eligibility criteria do not allow the receipt of other subsidies during the delivery period. This excludes from participation CHP plants and renewable assets that will receive governmental generation subsidies during the CRM delivery year (if subsidies finish before the delivery year, participation is allowed. To participate in the prequalification process and auction, assets must be grouped into capacity market units (CMU) of at least 1 MW of derated capacity. The CMU can comprise a single delivery point or multiple aggregated delivery points. Physical units that are not yet deployed or in planning stages can also be prequalified as virtual CMUs if associated with delivery points prior to the delivery period. Out of caution, the system operator limited virtual CMUs to a total of 200 MW in the first auction; but during the auction no capacity was awarded to virtual CMUs.

For demand-side technologies, derating factors are based on the number of hours for which the unit can decrease its demand. Preliminary assessments by market participants suggest that the derating factors could be limiting the participation of demand-side units because the calculation methodology used by the system operator led to an overestimation of available capacity, based on the federal government 2025 technology deployment plan, and therefore higher derating factors.

Assets can be tested during the prequalification phase and at the discretion of the TSO once they have an availability obligation. The TSO is entitled to test the assets within 24 hours for an expected duration of 15 minutes or, in case of energy contained units, the full duration declared in their Service Level Agreement. The tests evaluate the consumption data of the previous year: if the demand-side unit has a consumption reduction for 24 hours of at least the offered volume, the test is fulfilled.

[3] This capacity and the following ones are volumes of derated capacity.

FINLAND

To ensure resource adequacy, especially during the winter period from December to February, Finland adopts a strategic reserve. The size of the reserve is decided at least every four years (and in practice typically every two years) by the Finnish NRA, the Energy Authority, based on an assessment of their resource adequacy needs. It is contracted through public tenders, recently covering two-year periods. The strategic reserve is open to both demand-side and generation units, but some requirements, such as the long activation times necessary for the reserve, limit the participation of DERs and aggregated loads if not supported by large-scale storage. At present, the contracted reserve consists entirely of traditional generation units because demand-side units were not able to satisfy the tendering criteria. This comes in contrast with previous years where demand-side units, such as heat pumps for district heating, were also contracted.

Resource Adequacy Mechanisms

Finland employs a strategic reserve, without active DR participation, to ensure security of supply in its system. The Finnish government is revising its regulations; in 2020 it submitted its implementation plan to be aligned with the EU Electricity Regulation.

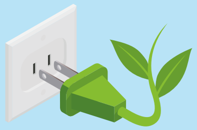
The Finnish strategic reserve was introduced in 2007, when State Aid regulations did not require approval of the EU Commission. In 2019, the Finnish Energy Authority acquired a total of 611 MW of strategic reserve for the 2020–22 delivery period. The reserve is divided between the summer and winter periods. Demand response (DR) facilities are included in the design of the strategic reserve only in the winter period. However, DR was not competitive enough in 2019 and no capacity was awarded to it. Finland is currently revising the strategic reserve regulation to be in line with the EU Electricity Regulation, which we can hope might lead to a mechanism that is more inclusive for DERs. The Finnish implementation plan has been submitted and initial recommendations have been issued by the Commission.[4]

The procurement of strategic reserve is performed through public tenders, organised at least every four years. The governmental regulation on strategic reserves (11.2.2011/117[5]) states that environmental requirements can be considered during the public tenders, but a specific emission benchmark is not set.

Procurement decisions and capacity payment amounts are published by the NRA. The transmission system operator publishes the cost breakdown of the strategic reserve service and shares the cost that is passed to final consumers during the winter period to maintain the reserve. In 2020, for the period from January to February, the cost of the reserve passed to consumers was around 1-1.5 €/MWh.[6] When activated, generators are paid the operational costs of the unit (fuel costs and ETS-related costs). Demand-side units, if part of the reserve, can be activated through the balancing market and remunerated at the price cap of the day-ahead market.

[4] https://ec.europa.eu/energy/sites/default/files/adopted_opinion_finland_en.pdf
[5] https://finlex.fi/fi/laki/ajantasa/2011/20110117
[6] https://www.fingrid.fi/en/grid/peak-load-capacity/fees/peak-load-capacity-2020/

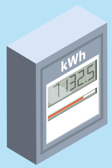
Participating assets



Even if in principle the Finnish strategic reserves are open to demand-side units, at present only traditional generators are part of the reserve.

The current strategic reserve consists of three generation units: one coal and two natural gas power plants. Although loads, in particular large heat pumps for district heating, were contracted in the past, demand-side units were not competitive enough in the most recent 2019 tender: they were outbid by conventional power plants.

Participation requirements



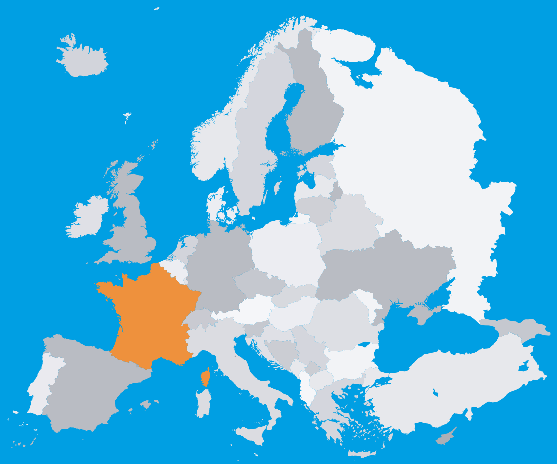
To participate in the strategic reserve, both generation and consumption sites have to fulfil similar requirements which essentially exclude small DERs from participation (even if aggregation is possible). The suitability of traditional generators to meet these requirements indicates that the programme was designed with these technologies in mind.

Three main requirements have to be fulfilled by flexible consumption units in order to be part of the strategic reserve:

- During the winter months, the load must be capable of at least 200 hours of operation at its full capacity. There can be recovery periods between the activations.
- The minimum capacity to participate is 10 MW, with a ramp-up time of 10 minutes.
- The load must be ready to activate its capacity in no less than twelve hours from the order issuance from December to February and in one month during the rest of the year.

These requirements exclude participation of small DERs and aggregated loads, because few can commit to such long activations. For DERs to actively participate, pools would require large long-term storage as support or to aggregate a very large pool of loads to be viable. Requirements for generators are similar, but they much more closely match generators' capabilities.

A State Aid decision is expected in early 2022, after which these rules will be changed, with the expectation that the minimum bid size will be lowered to 1 MW and aggregation will be allowed both for demand-side units and generation units.



FRANCE

Participation of demand-side resources in French RAMs is advanced compared to other EU countries, but still quite limited compared to traditional generation. Resource adequacy in France is guaranteed through a market-wide capacity mechanism. A call for tenders for interruptible loads is also organised to ensure system security. While the first mechanism is designed to be technology-neutral and is open to both generation and demand-side units, the latter is focused on large industrial consumers. In addition, the French system operator contracts capacity through an annual call for tenders from demand response. As of today, around 3% of the total certified capacity in the French market is represented by DR. The participation requirements for the capacity mechanism are technology neutral. The interruptibility scheme instead foresees limiting requirements (e.g., only units above 25 MW of capacity can participate).

Resource Adequacy Mechanisms

France guarantees resource adequacy through a market-wide capacity mechanism, which is complemented by yearly calls for tenders dedicated to DR. It also relies on interruptible loads for highly energy-intensive users as emergency resources. Overall the French system provides several good opportunities for demand-side units to access capacity payments.

Capacity Mechanism

For the French capacity market's 2020 delivery year, 33.5 GW (of which 2.1 GW auctioned during the delivery year) of capacity guarantees have been already auctioned, while the volume certified by the system operator was 86.6 GW. The 2021 DR call for tenders contracted around 1.5 GW, almost double the capacity contracted in 2020.

The French capacity mechanism was approved by the European Commission under the State Aid legislation in 2016, for a duration of 10 years. The annual DR call for tenders was approved in 2018 until 2023.

The capacity mechanism is market-based. Capacity operators (generators and demand-side units) certify their capacity to the system operator, obtaining capacity guarantees that can be sold to obliged parties (suppliers) through over-the-counter (OTC) trades or organised market sessions. The dedicated DR product, *appel d'offres effacements*, is procured through yearly tenders.

Generation capacity operators are required to certify their capacity four years in advance of the delivery year. DR operators may choose to certify their capacity up to one year in advance. This is not mandatory, but very convenient for DR pools which might not have certainty over their pools four years in advance.

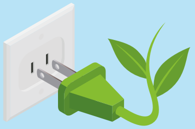
Pursuant to the EU Electricity Regulation, the French capacity mechanism does not allow for the participation of generation capacities emitting more than 550 g of CO_2 of fossil fuel origin per kWh. The DR call for tenders also forbids the participation of DR actions that involve fossil fuel generators. There are special provisions under the capacity mechanism for new low-carbon capacities (e.g. RES, DR, storage), which are eligible for long-term calls for tenders and are rewarded with seven-years long procurements.

In the capacity mechanism, capacities are paid based on their availability during the peak periods of a delivery year. The average price resulting from the market for the 2021 delivery year was around 31 k€/MW. On average, the remuneration in the 2021 DR call for tenders was 55 k€/MW. Resources can participate in both energy markets and capacity mechanisms at the same time, although some reasonable limitations exist between the DR tender and the interruptible loads programme. The remuneration obtained through the DR call for tenders complements that from the capacity mechanism (based on a contract for difference) but is not compatible with interruptible contracts.

Interruptible loads

The interruptible load programme tenders a rolling reserve of 1.5 GW. The interruptible contracts have a maximum duration of two years for every technology and the procurement is done through calls for tenders. For the 2021 delivery period the maximum awarded prices were 35 k€/MW for lot n°1 and 15 k€/MW for lot n°2. The programme has never been approved by the European Commission under State Aid regulation.

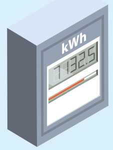
Participating assets



A variety of technologies, both generation and demand-side units participate in the various French mechanisms. However, the lion's share of capacity is still provided by traditional generation units. DR stands out in particular thanks to the dedicated product, unique in Europe, and the interruptible loads programme.

Currently 235 obligated parties and 85 capacity portfolio managers, which are the legal entities financially responsible for the overall imbalances of their certified capacities, participate in the capacity mechanism. In line with France's current generation mix, the certified capacity in 2021 was mainly assigned to nuclear, hydro and conventional fossil fuel generators. RES that receives public support under a purchase obligation regime, mainly solar and wind, cannot participate in the capacity mechanism. 2.8 GW of DR capacity was also certified (only 3% of the total certified capacity): this mirrors the DR volume that is currently available in France during peak times, as stated by the government's multi-year energy plan. Twenty-two sites, all industrial loads, were selected during the 2021 interruptible load call for tenders.

Participation requirements



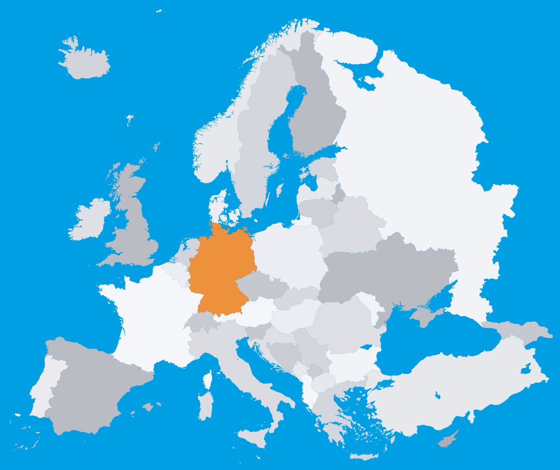
Participation requirements for the capacity mechanism are quite positive and straightforward, without specific requirements that could significantly limit the participation of some technologies: all capacity holders above 1 MW (with aggregation allowed for smaller resources) can compete for the same product. The interruptible loads contract on the other hand is appropriately designed to suit energy intensive industries and as such has higher minimum bid sizes.

Capacity Mechanism

Generation and DR units above 1 MW, including aggregated pools, can participate in the capacity mechanism. There are no technical barriers that explicitly limit certain technologies. There are no availability requirements built in the mechanism, nor specific metering requirements. Nevertheless, every certified capacity resource must be tested during peak winter days but no more than three times during the delivery year. If DSF operators offer the same capacity in the wholesale market (through the Notification d'Échange de Blocs d'Efacement [NEBEF] mechanism) or in the balancing market, they have the possibility to choose the mechanism through which they can be tested. Only tests performed through the balancing mechanism lead to a specific remuneration.

Interruptible loads

The interruptible load call for tenders is open to capacity units above 25 MW, with no possibility of aggregation. The scheme requires fast responses (5 seconds for lot n°1 and 30 seconds for lot n°2) and long availability (3 750 hours over the 1 July 2021 to 31 December 2021 period for lot n°1 and 2 250 hours over the same period for lot n°2).



GERMANY

Germany contracts a wide variety of resource adequacy mechanisms, most of which are very rarely activated. Overall, RAMs in Germany do not incentivise the participation of demand-side resources, as their product designs de facto exclude DSF, with the exception of interruptible loads for industrial consumers. Even if in theory demand-side resources are permitted to participate in every product, most of them are designed with a specific technology in mind, with the result that only those technologies participate. Currently none of the procurement is done through a full market-based approach, with tenders and bilateral contracts being the main procurement methods.

Resource Adequacy Mechanisms

Germany has numerous active resource adequacy mechanisms that vary in capacity, duration, procurement methods and activation rates. However, all, except the interruptibility scheme, have limited or non-existent participation of demand-side resources.

Strategic reserves

Germany currently contracts a 1056 MW capacity reserve, 6 GW of network reserve and 2.7 GW of emergency preparedness. There is also 1.2 GW of special technical grid resources, a scheme dedicated to four gas-fired power plants that will be active from the end of 2022, after the shutdown of the last nuclear power plant in Germany. Of these, only the capacity reserve and the network reserve fall under the State Aid legislation. The network reserve and the special technical grid resources address system security rather than resource adequacy issues.

The procurement methods vary between products. Only the capacity reserve is procured through open tenders; the others are bilateral deals.

The capacity reserve is procured in 24-month periods, with the possibility to extend. Three of these periods have been approved already by the EU until September 2025.

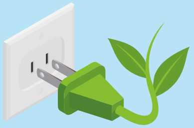
None of the RAMs consider CO2 emissions in their tenders or product design, as is evident from the participating technologies outlined in the next section.

Not only is participation limited to certain technologies, but the actual activation of most of these products is very limited, as situations have not yet occurred where they would be necessary. In particular, the capacity reserve and the emergency preparedness have never been activated. The 2020 tender for the capacity reserve resulted in availability payments of 68000 €/MW-year.

Interruptible loads

Around 1200 MW of interruptible loads are currently procured on a weekly basis by the German system operator. The interruptibility scheme is approved under State Aid regulation until June 2022, its potential extension is still uncertain. Interruptible loads were activated more than 40 times in 2020 after a record of 130 times in 2019. The reason behind the high activation rate is that interruptible loads are used in case of imbalances, once the usual balancing instruments are exhausted. In 2020 the interruptibility scheme remunerated capacity holders with 500 €/MW-week for capacity price and 400 €/MWh for the energy price in case of activation.

Participating assets



Most resource adequacy mechanisms are geared towards traditional generation and only the interruptibility scheme is in practice open to demand-side participation, in the form of large industrial consumers. There are clearly limitations to DSF participation in German RAMs.

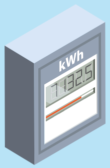
Strategic reserves

The main actors in the capacity reserve and the technical grid resources are 12 gas power plants. In the network reserve, the main participants are coal and gas power plants, while in the emergency preparedness programme, only lignite power plants are active.

Interruptible loads

Industrial loads can only participate in the interruptibility scheme, which currently includes 30 industrial loads. In theory, flexible loads are allowed to participate in different products, but technical requirements prevent this in practice, as explained in the next section. The clear differentiation of technologies in products is by design: each of the different reserves is designed with a specific technology in mind, with no competition between technologies for the same product.

Participation requirements



While participation of DSF is in theory permitted in some of the mechanisms, it is not technically feasible due to the imposition of requirements that cannot be met by DSF.

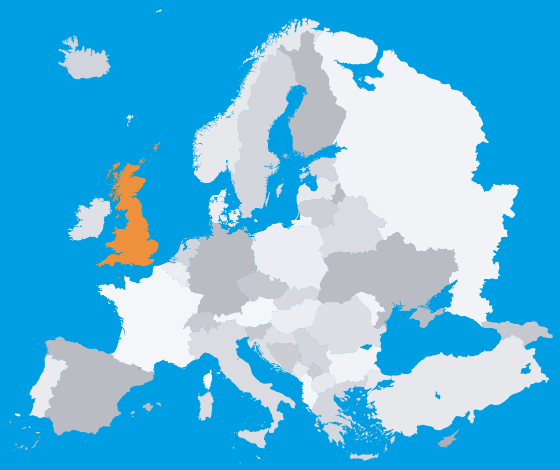
Strategic reserves

The participation of the demand side in the capacity reserve, is limited due to different requirements, mainly:

- Data required by system operators. The exact load curve must be communicated on a 15-minute basis the day before, with an allowed deviation of only 5% of the projected load. This requirement is impossible for most DERs, which cannot predict their demand with that accuracy so far ahead of time.
- No participation in other markets, such as balancing energy, in the past three years. This requirement prevents flexibility providers from stacking services to guarantee a diversified activity portfolio, severely limiting the DSF business case.
- Long dispatch durations. In the capacity reserve it is 12 hours, which cannot be sustained by demand-side resources.

Interruptible loads

The sole representation of the demand side is in the interruptibility scheme, a product specifically designed for the industrial loads. The required response time is 15 minutes for quickly interruptible loads and 350 ms for immediately interruptible loads. The minimum availability requirements of 120 quarter-hour blocks of unavailability in one week are also suitable for demand-side units.



GREAT BRITAIN

The main resource adequacy mechanism in Great Britain (GB) is a capacity market based on competitive auctions. However, the scheme´s requirements do not ensure a level playing field for demand-side units, and capacity is thus mostly provided by generation. The contract duration, the lack of an effective dispatch regime, and the testing requirements make demand-side participation not competitive with generation units. Ongoing discussion driven by an industry-led proposal on the energy payments for independent aggregators and revision of the current resource adequacy scheme could introduce more favourable conditions in the near future.

Resource Adequacy Mechanisms

A capacity market has been active in GB since 2017. It has specific provisions for demand-side units and allows independent aggregators. Nevertheless, some requirements limit the participation of DSF to a small percentage (2.6%) of the total contracted capacity and make it eligible for only 1-year contracts reducing investment certainty.

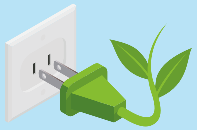
The British capacity market was approved under the State Aid legislation in 2014 and reapproved in 2019 with amendments after the Tempus legal challenge, which argued that the scheme discriminated against demand-side market players. It is authorised until 2024. In the most recent capacity auction, for the 2024-25 delivery period, 51981 MW of derated capacity was pre-qualified and 40819 MW cleared. In the same auction, 1066 MW of DR units were contracted, corresponding to 2.6% of total contracted capacity.

Capacity is procured through auctions with an upper price cap (usually £75/kW-year). Capacity auctions are in theory equally competitive for all the participating technologies, and they should ensure that capacity is procured at the lowest price possible. Nevertheless, demand-side units are only eligible for shorter contracts than new-build or refurbishing generators, but this difference is disregarded in the merit order of the bids, which considers only the price per kW for the procured year, ignoring the costs and risk transfers associated with longer contracts (e.g. a bid of £21/kW-year for a one-year procurement is considered more expensive than one for £20/kW-year for a 15-years procurement).

Main auctions are organised 4 years ahead of delivery date (T-4), with supplementary auctions held a year ahead of delivery (T-1) at the Secretary of State's discretion. New-build units with CAPEX above a certain threshold are eligible for 15-years contracts, refurbishing units with CAPEX above a lower threshold are eligible for 3-years contracts, and all other units are eligible only for 1-year contracts. Due to this condition, even if in theory new demand-side resources can apply for multi-year contracts, the scheme is slanted towards traditional generation that relies heavily on CAPEX because demand-side resources have a higher proportion of OPEX to CAPEX. In practice, these requirements make DR units only eligible for 1-year contracts, putting them at a disadvantage compared to new-build and refurbishing generation.

The capacity market imposes a limit of 550 g of CO_2 of fossil fuel origin per kWh on post-2019 resources, in alignment with the EU Electricity Regulation.

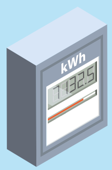
Since the mechanism has been introduced, there has not yet been a system stress event requiring capacity to be activated. The remuneration for capacity holders is equal to the auction clearing price multiplied by a technology-specific derating factor. The most recent T-4/T-3 auctions cleared at £6440/MW (2022/23), £15970/MW (2023/24), and £18000/MW (2024/25). T-1 auctions have been even more volatile: £770/MW (2019/20), £1000/MW (2020/21), and £45000/MW (2021/22).



Participating assets

The British capacity market awards mainly generators, in particular gas-fired power plants. Demand-side units participate in small numbers due to the barriers previously mentioned. The main demand-side participants are industrial consumers and storage developers that participate either through aggregation or with utility-scale assets.

In the most recent T-4 auction, for the delivery period 2024/25, 491 capacity holders were contracted, from around 120 companies. Participants are either stand-alone or aggregated generators, industrial consumers, storage developers, and interconnectors. Gas is the primary fuel with the greatest capacity awarded (26446 MW), followed by interconnectors (6874 MW) and nuclear power plants (2039 MW). DR provides 1066 MW of capacity and 252 MW of battery storage has also been contracted. RES with a subsidy under the "contract for difference" scheme are excluded from the capacity market.



Participation requirements

The capacity market imposes some requirements that are much harder for demand-side units than for generators, such as the testing requirements and the need to deliver the capacity obligation in absence of an efficient dispatch mechanism. The requirements benefit traditional generators and do not ensure a level playing field to all technologies.

Some technical barriers and requirements of the capacity market hinder participation of the demand-side:

- The absence of an effective dispatch mechanism. The capacity market design only provides a firm notification about a system stress event after it has occurred. Capacity market notices are automatically issued whenever a forecast margin falls below a certain level and at least 4 hours in advance of the potential event, but this has the potential to result in a great number of notices, almost none of which might turn into real system stress events. Notices may also be in effect for several hours before an actual stress event occurs. This system works well for CCGT operators, as whenever a notice is issued, energy prices are likely to be high enough to run the power plant at a profit for as long as necessary. On the other hand, for DR it is important to minimise dispatch hours because the cost of dispatch can be very high, there are no energy revenues to offset dispatch costs, and there may be hard limits on the duration of response that some customers can provide. DR providers are forced to guess whether and when a system stress event will actually occur. Access to the wholesale market would reduce dispatch costs for independent aggregators and provide a somewhat more level playing field in the capacity market.
- Testing requirements are easier for generators to satisfy. During the winter of each delivery year, three satisfactory performance days (SPDs) are required. Generators can satisfy this simply by nominating three days on which they delivered their nominal capacity as part of their normal operations. DR units instead deliver only when dispatched for some purpose and they do not receive energy payments, so they typically have to explicitly carry out three tests without receiving any remuneration. The consequences of failing the SPDs are costly both for the supply and demand side: if a unit does not demonstrate at least 100% performance in three SPDs by the end of April, it stops receiving capacity payments and three further SPDs are required. If these new tests are not 100% satisfied, its capacity agreement is terminated, and all capacity payments received for that delivery year must be paid back. If a resource can only deliver 99.9% of its nominal capacity, there is no leeway to reduce its capacity obligations and payments.

GREECE

Participation of demand-side resources in the Greek resource adequacy mechanisms is possible in theory, although with significant hurdles depending on the type of asset and mechanism. The two main RAMs in Greece are the Transitory Remuneration Flexibility Mechanism (TRFM) and an interruptible loads scheme, however they are both being phased out in 2021. A Permanent Capacity Remuneration Mechanism (PCRM) is being evaluated by the European Commission at the time of writing. Stringent technical requirements have forced DR and storage out of the TRFM, and only large industrial consumers satisfy the requirements for participating in the interruptible loads programme. The development of the PCRM is an opportunity to move to a new product design more inclusive of distributed flexibility.

Resource Adequacy Mechanisms

The TRFM and interruptible loads are the two mechanisms that ensure security of supply in the Greek electricity market, but they are both being phased out at the time of writing. The TRFM remunerates the availability of flexible generation capacity, while interruptibility contracts are open only to large single loads.

TRFM

Greece contracted 9 GW of capacity for the 2020 delivery period through the TRFM. The mechanism has been approved by the European Commission under the State Aid legislation. The TFRM was approved until March 2021, however in the last auction the TSO only procured capacity until December 2020.

Procurement is done through pay-as-bid auctions, they consist of blocks of capacity, each having a 1 MW minimum capacity. Each unit can submit up to 10 blocks, but there is no possibility of aggregation.

Capacity used to be contracted every two months until the last auction in October 2020.

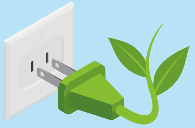
Emissions limits are in place for generation units and fully aligned with the mandatory standard of 550 g of CO_2 of fossil fuel origin per kWh imposed in the EU Electricity Regulation.

The TRFM includes a mechanism to avoid over-compensating generators: each month, they receive the maximum out of the revenues from the balancing capacity market and the capacity mechanism. The TRFM auction price is capped to 39000 €/MW, and the average remuneration in 2020 was 33818.41 €/MW.

Interruptible loads

In 2020 and 2021, 2.6 GW were procured through interruptible loads contracts. The interruptibility scheme was approved under State Aid regulation until September 2021. The frequency of procurement was every three months and done through pay-as-cleared auctions. The average prices in 2021 were 63775 €/MW/year for type 1 (5 minute reaction time, maximum duration of 48 hours) and 44912.5 €/MW/year for type 2 (1 minute reaction time, maximum duration of 1 hour). At the time of writing, demand-side participants that receive interruptibility payments cannot benefit from revenue streams from other markets.

Participating assets



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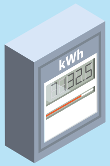
Only generation units, mainly gas and hydro power plants, are participating in the current TRFM. DR and storage are allowed to participate in the mechanism, but they have not been contracted so far due to various barriers. DR participation is limited to interruptibility contracts for unaggregated industrial consumers.

In the two auctions held in 2020, around 28 participants, which can be traced back to 6 companies, were contracted in the TRFM. They are mainly CCGT, OCGT and hydro power plants.

In 2021, 37 industrial consumers participated in the interruptibility scheme.

Participation requirements



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The TRFM in principle allows participation of demand-side units, but some technical requirements have discouraged their participation in the auctions.

TRFM

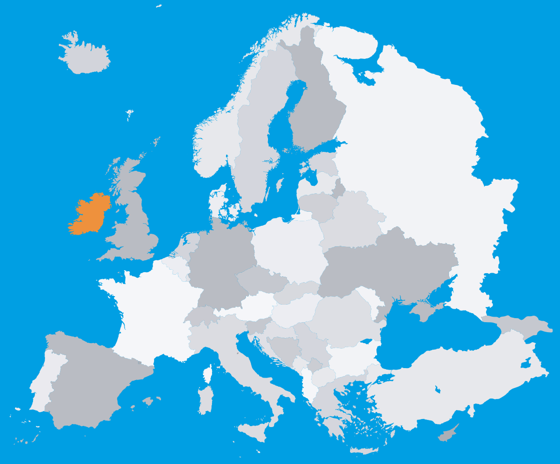
Greece allows participation of DR and storage capacity units greater than 1 MW in the TRFM. It requires a ramp of at least 8 MW/min and for response to be maintained for at least three hours. Fast ramping can be achieved by most DR and storage, but the long durations limit the participation of units with a limited energy reservoir (LER) like storage.

The TRFM includes a prequalification process only for demand-side units, whereas generators need only to provide their annual maintenance schedules.

To participate in the TFRM, real-time remote control and telemetry are required for both generation and demand-side units, which increases the costs of participation for small sites.

Interruptible loads

Interruptible contracts impose a minimum capacity of 2 MW, limiting them to large industrial consumers. The registered capacity for the scheme is based on historical data. Tests take place once per semester and they are not remunerated, which can be costly for demand-side units. There are two types of interruptible contracts, with different availability requirements. For type 1, the reaction time is 5 minutes, the duration of each power reduction order is 48 hours and the maximum duration of load shedding per year is 288 hours. For type 2, the reaction time is 1 minute, the duration is 1 hour and the maximum duration per year is 36 hours.



IRELAND

Ireland has opted for a capacity market based on reliability options to guarantee security of supply. Both generators and demand-side units (DSUs), mainly industrial consumers, participate. The mechanism, even if in theory technology-neutral, does not guarantee a level playing field for DSF. Certain requirements for participation, like metering and testing, hamper participation of small sites and DERs. The lack of a clear dispatch order particularly harms DSUs, which do not generally have revenues from energy payments.

Resource Adequacy Mechanisms

Ireland has adopted a capacity market that is open to all types of assets, but in practice most capacity is provided by generation units.

Procurement is done through capacity auctions based on reliability options. These are intended to provide a hedge against high prices, acting as a form of insurance, while incentivising capacity providers to ensure their resources are available when needed. The price of the “reliability premium” is set during the auction. If the price in the wholesale market exceeds the strike price (which depends on fuel cost indices and DSU opportunity costs), capacity providers must pay the difference between the market price and the strike price. At other times, when the wholesale price is below the strike price, capacity providers receive their energy revenues as normal, unaffected by the capacity market.

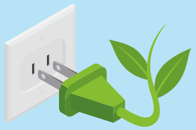
Under the current “State Aid Compliance Interim Approach”, DSUs are only paid for the energy they deliver when dispatched if the price is above the strike price: if the system operator chooses to dispatch them at other times, they run at a loss. This means they are not on a level playing field with generators, who are always paid for their energy.

Auctions are held twice for each delivery period: four years and one year in advance. New-build generators with CAPEX above 300 €/kW are eligible for ten-year contracts, while existing generators and demand-side units are eligible only for one-year contracts, which limits investment security.

The CO_2 requirements are aligned to the standards of the EU Electricity Regulation, with a threshold of 550 g of CO_2 of fossil fuel origin per kWh. The current mechanism has been approved under State Aid regulation until 2028.

The strike price is typically exceeded a few times per year. In principle, every time the reference price exceeds the strike price, capacity market units will deliver energy to earn revenues to meet their pay-back obligations. However, if they are not dispatched, they don’t receive energy payments but still have to fulfil their pay-back obligations. Dispatch is at the system operator’s discretion, but they seem to dispatch generators much more consistently than DSUs during times of high prices. This leaves demand units potentially exposed to huge losses, even when they are fully available. This was a cause of contention during a period of high prices in early September 2021, with uncovered obligations worth millions of euros.

Participating assets

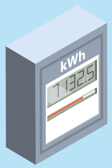


The Irish Capacity Market awards mainly traditional generators, especially gas turbines. Participating demand-side units are mainly industrial consumers.

During the most recent auction, for 2024-25 delivery year, 7437 MW of derated capacity was prequalified and 6138 MW cleared at a price of 47820 €/MW-year, coming from 28 normal participants and two interconnectors. The main technology awarded was gas turbines (4782 MW), followed by interconnectors (421 MW) and demand-side units (420 MW, i.e. 6.84%).

Demand-side participants are mainly industrial consumers, which participate directly or through aggregators. The mechanism sets a minimum bid size of 4 MW. Certain participation requirements hinder participation of the demand side, as explained in the following section.

Participation requirements



The Capacity Market imposes excessive metering requirements and onerous testing procedures that hinder participation of demand-side units, and the lack of a reliable dispatch merit order disproportionally penalises them.

Participation requirements that hinder participation of demand-side units are:

- Excessive metering requirements. SCADA data readings are required. These need specific industrial control systems, rather than cheaper meter data, with the data used both for real-time visibility purposes and for settlements. This hampers participation of small sites.
- The testing procedure is onerous, especially for small sites. Before joining a demand-side unit, the site must demonstrate its ability to ramp up and down on instruction and deliver its registered capacity for the required duration (currently a minimum of 2 hours), and the correct functioning of the real-time telemetry, in a test witnessed by the system operator. This level of non-remunerated commissioning testing is particularly onerous and precludes the participation of small sites.
- Availability requirements. The resources must be available every hour of the year. But, due to the load-following factor, the capacity that has to be available to meet the obligation is lower at off-peak times.
- Lack of a real merit order for dispatching. The minimum requirements are: response time not longer than an hour, ramp rate of at least 1.67% per minute and duration of sustained response for at least 2 hours. If a demand unit can ramp faster, it is more likely that it will be dispatched by the system operator. The system operator does not follow a merit order during a capacity event: if the demand-side unit is not dispatched when the reference price is above the strike price, it is still obliged to make difference payments, even though it is not earning any energy revenues in that moment. This hinders disproportionately demand-side units that might not be dispatched but still have to pay a penalty as if they had failed to deliver their capacity, posing a serious risk to the financial stability of these capacity providers.

ITALY

Italy relies on a capacity market as a resource adequacy mechanism. When faced with insufficient supply in the short term, a load shedding plan can be activated in close coordination with DSOs. In addition, but not considered as a RAM by the Italian system operator, interruptibility contracts are in place as emergency resources. This programme is specifically dedicated to demand-side resources but is used to manage security issues (e.g. frequency stability), rather than for adequacy planning. The capacity market is designed to be technology-neutral and to include both generation and demand-side resources. Nevertheless, certain participation requirements limit the ability of demand-side units to participate in practice. This resulted in no demand response and only very limited storage capacity contracted in the first two auctions that have been held.

Resource Adequacy Mechanisms

Italy opted for a capacity market based on reliability options as a resource adequacy mechanism and an interruptible loads programme that acts as emergency resources for frequency stability. No DSF capacity has been contracted so far. This is due to a combination of barriers to participation and the presence of a more profitable, but incompatible, market.

Capacity market

In the capacity market auctions held in 2019, Italy contracted 40.9 GW for delivery in 2022 and 43.4 GW for 2023. The mechanism has been authorised until 2028 under the State Aid legislation. The procurement method is market-based, through auctions with marginal pricing.

In the capacity market, the main auctions are held up to four years before the delivery period. Additional year-ahead adjustment products can be procured through dedicated auctions. New capacity resources are eligible for 15-year contracts, and existing ones for one-year contracts.

CO2 requirements are aligned to the standards of the EU Electricity Regulation, and based on expert certifications.

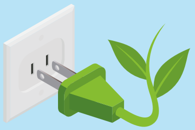
Apart from the barriers to participation discussed below, the capacity market's failure to attract demand-side resources can also be attributed to the existence of the more profitable ancillary service UVAM project. The two programmes are not compatible, so demand-side units are forced to choose.

Existing and new production units receive a premium equal to the lower value between the declared marginal price and their respective cap price. Participants in the 2019 auction, mainly thermal generators, have cleared at their respective cap prices: 33 k€/MW-year for existing resources and 75 k€/MW-year for new ones.

Interruptible loads

Interruptible loads, dedicated to demand-side units, are in place as emergency resources (e.g. for frequency stability) but not used for adequacy purposes. 3.5 GW of interruptible loads have been contracted for the period 2021–23 and an additional 800 MW for 2021. They are normally secured with three-year contracts, but the TSO can also enter into monthly or multi-monthly contracts for extraordinary needs. They have been contracted, through pay-as-cleared auctions, on average for 80 k€/MW-year for period 2021–23 on the mainland, and 126 k€/MW/year in Sicily and Sardinia. Interruptibility contracts also pay per disconnection based on the spot price offered by the operator.

Participating assets

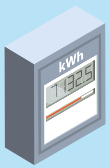


The current capacity market rewards only generators: mostly thermal units, but also renewables and storage in lower quantities. Demand-side assets, even if in theory included in the market design, are not currently participating.

For the 2022 and 2023 auctions, thermal generators make up 78% of the 40 generation units contracted. The greatest part (from 75% to 87.6%) of new capacity has been awarded to CCGT and OCGT units.

Loads above 1 MW can participate in the interruptibility contracts, which currently include around 200 industrial consumers, some of them with behind-the-meter generation.

Participation requirements



The capacity market is designed to include participation of demand-side units, including a specific remuneration method for them. However, even if the mechanism is technology-neutral on paper, in practice certain requirements make participation of DSF highly unattractive.

Capacity market

The main requirements that limit participation of demand-side units in the capacity market are:

- Remote load disconnection requirements. Demand units must guarantee the availability to be remotely disconnected by the TSO within 5 mins.
- Remuneration scheme. Demand-side resources are remunerated based on their availability to reduce the load in specified critical hours and the participation is rewarded in the form of a partial exemption from the adequacy fees that customers should otherwise pay to the TSO. Since they do not receive direct capacity payments, demand-side units are not subject to a strike price based on their reliability option, which could be perceived as an advantage. Nevertheless, the lack of a direct payment seriously limits the types of assets that will participate in the mechanism.
- Participation is only allowed through the Balance Responsible Party (BRP). Independent aggregators are excluded.
- Obligation to offer in the ancillary services market (Mercato per il Servizio di Dispacciamento, MSD) the minimum between the contracted capacity and the baseline for each 6-hour/day peak period. These hours vary at the discretion of the TSO and there is no flexibility on the number of hours to offer – i.e. customers cannot choose to offer higher availability in order to be de-rated less harshly.
- Load resources and generation resources cannot be located on the same site.

Interruptible loads

Interruptibility contracts also include requirements that could exclude certain participants. The ability to be remotely interrupted within 200 ms by the TSO can be fulfilled by many industrial loads but they cannot benefit from aggregation because each individual site has to guarantee monthly availability.

POLAND

Poland relies on a capacity market and an interruptible loads programme (IRP) as resource adequacy mechanisms. The capacity market is designed to be technology-neutral, but the actual participation of DSF is still only 4% of the total contracted capacity. The reasons for the low participation include limiting technical requirements, shorter contract durations, and the impossibility of receiving energy payments when dispatched. The IRP scheme is contracted through public tenders for capacity from both aggregators and industrial end-users. The programme is open to participation of small assets and aggregators, but assets that participate in the capacity market are excluded from the IRP.

Resource Adequacy Mechanisms

Resource adequacy in Poland is guaranteed primarily through an auction-based capacity market. There is also an interruptible loads scheme (IRP), intended to ensure security of supply in extreme situations.

Capacity market

In the auctions for the 2021 delivery year, around 23 GW of capacity was contracted in the capacity market. The mechanism is compliant with State Aid regulation and has been approved until 2030. In the capacity market, procurement is made though capacity auctions.

The main auction is organised in the fifth year before the delivery year, with an additional auction one year ahead of delivery. Although the capacity market is intended to be technology-neutral, contract duration differs based on the unit type and CAPEX level. New generation units are eligible for 15-year contracts, refurbished units may apply for 5-year contracts, demand-side units that incur substantial modernisation expenditures may apply for 5-year contracts and every other unit is only eligible for 1-year contracts. Aggregated loads usually fall in the last category.

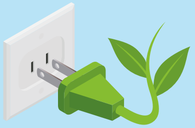
The CO_2 requirements in the Polish capacity market are aligned to the standards of the EU Electricity Regulation. New and old generation units that emit more than 550 g of CO_2 of fossil fuel origin per kWh are excluded from participation. However, units that were already granted with capacity contracts before December 2019 can remain part of the capacity market until the end of their contract. There are additional emission requirements: if bids with equal prices are submitted, the bids are ordered based on the lowest CO_2 emissions. Additionally, new low-emission generating capacity market units may apply for capacity agreements that are two years longer.

Since the capacity market came into force, no system stress event has occurred. The main auction for delivery year 2021 cleared at 240.32 PLN/kW-year, while the additional auction for the same year cleared at 286.01 PLN/kW-year. In case of activation, DSF capacity units do not receive energy payments and cannot offset the cost of being dispatched. This limits participation of certain consumers.

Interruptible loads (IRP)

In the last tender of the IRP, six participants were contracted for the period April 2021 to March 2022. The IRP did not need State Aid approval, but has been approved by Polish NRA. The mechanism works through public tenders, with a price cap, the frequency of tenders for the IRP scheme is based on resource adequacy assessments. In the IRP tenders for 2021/22, max prices offered by the contractors varied from 12900 PLN/MWh to 13121 PLN/MWh, the awarded price resulting from the bidding phase, which, as explained in the next section, takes place the day before delivery, could be lower.

Participating assets

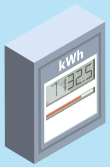


Participating technologies are mostly traditional fossil-fuel generation, with some DR and storage participating, even if in small numbers.

There are currently 389 capacity market units. 79% of participating capacity comes from coal and lignite power plants, followed by 10% natural gas power plants and 6% pumped-hydro storage. Technologies that provide demand response are only 4% of the total. The IRP contracts have been assigned to six participants so far: five aggregators and one industrial end-user.

This mix of participants might change from the delivery year 2025, when most conventional technologies will be excluded due to emission restrictions.

Participation requirements



The capacity market is in principle technology-neutral but technical requirements, like the long activation time and the impossibility of having sub-metering points, limits participation of certain flexibility sources. Demand-side units, whether standalone or aggregated, must have a capacity greater than 2 MW but no more than 50 MW.

Capacity market

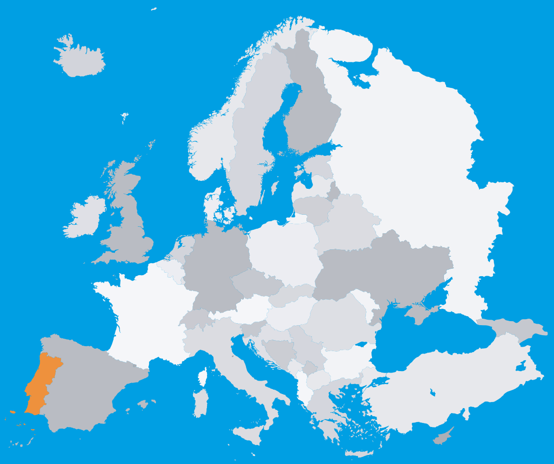
The market includes some participation requirements that in practice limit flexibility providers. In particular, the capacity market units are obliged to provide net attainable capacity for a continuous period not shorter than four hours. This requirement, although arguably necessary for the purpose of resource adequacy, might limit participation of units with a limited energy reservoir (LER), such as storage.

Units are required to provide remote acquisition of hourly metering data, but this must come from the site boundary: sub-metering is not allowed. This is particularly problematic because a CMU cannot include sources with high emissions, so, if a DSF asset shares the site with a high emitting source, even if the latter does not participate in the providing the service, the DSF is excluded from participation.

The capacity market requires one pre-season test and 4 tests in each delivery year. These tests are not remunerated and therefore can be very costly for some flexibility providers. Assets participating in the capacity market cannot be contracted through the IRP.

Interruptible loads (IRP)

The IRP scheme is a voluntary service. It is open to small assets that can participate through aggregation, and has more lenient technical requirements than the capacity market. The day before delivery a request for bidding is issued by the TSO and at that point of time the products and the available capacity become known to the system operator. On activation day, service providers provide capacity based on the reaction time declared during the bidding process, which may vary from 30 minutes to 4 hours. The minimum bid size to participate in the scheme is 1 MW, which can be achieved also through aggregation. There are no testing requirements to participate, and metering requirements can also be easily fulfilled by participants.



PORTUGAL

The Portuguese electricity system ensures resource adequacy through an interruptibility scheme. The procurement method is not competitive. Rather, it is based on bilateral contracts, which are awarded only to big industrial consumers and renewed automatically. DERs and aggregators are not allowed to participate in the scheme. This mechanism was never approved by the European Commission under State Aid regulation and the Portuguese government decided to phase it out by December 2021. At the time of writing, the government is preparing a new flexibility product to procure by auction from large consumers, but it is still unclear whether this new mechanism will be more inclusive for independent aggregators and small loads.

Resource Adequacy Mechanisms

Portugal currently maintains interruptible contracts to ensure resource adequacy in its system. This mechanism is planned to be phased out by December 2021. There is uncertainty about what mechanism will be introduced afterwards.

In 2020, a total of around 700 MW was secured through interruptible contracts. There is concern among the industrial consumers that the phasing out of the interruptibility programme would increase the risk of uncontrolled blackouts in Portugal, even though the contracted capacity was rarely activated. A new competitive product will be introduced in the near future. The replacement of this mechanism could be an opportunity for the introduction of a competitive and technology-neutral capacity mechanism, even if the first available information suggests that a similar scheme for industrial loads will be introduced. The interruptible scheme has been active since 2006 but was never submitted to the approval procedure for State Aid regulation.

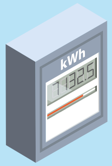
The procurement of interruptible loads is done through bilateral contracts rather than a competitive procedure. The contracts last one year, with automatic renewal. The average price in 2020 was 148 k€/MW-year.

Participating assets

The Portuguese interruptibility service is by design available only to large industrial consumers.

The minimum load reduction allowed to participate in the mechanism is 4 MW. Aggregation of loads is not allowed: the scheme is designed only for single large industrial consumers connected at medium or high voltage. In 2020, there were 48 participants, but the system operator's annual report on the scheme does not provide information on the type of technologies that are participating.

Participation requirements



The participation requirements for the interruptibility scheme can be easily fulfilled by large industrial consumers, for whom the scheme is designed.

To participate in the interruptibility scheme, demand-side units must be connected in MV or HV, offer a minimum capacity of 4 MW, and not perform essential activities that, in case of disconnection, can jeopardise the safety of people or goods. The capacity holders have to perform a yearly availability test, which is not remunerated, with the possibility of retaking it in case of failure. Participants have to deliver the capacity reduction for a duration which depends on the notice period (if the notice period is two hours, the maximum duration of interruption is twelve hours; if the notice period is five minutes, the maximum interruption is two hours; for instant response resources, the maximum interruption is one hour). Participants have to comply with metering requirements (i.e., telemetry).

SWEDEN

In the Swedish electricity market, security of supply is guaranteed through a strategic reserve, intended to ensure that enough capacity is available in winter periods. The strategic reserve was adopted as a temporary measure, with the intent of phasing it out to leave the capacity resolution to the market, but nevertheless the programme has been extended until 2025. A certain amount of capacity in the reserve is meant to be guaranteed to demand-side units, but technical requirements de facto exclude any demand participation. At present, the reserve only comprises a single oil-fired generation plant. The last tender procedure for generation was meant to be held in 2019, contracting for delivery between 2020 and 2025, but was cancelled due to lack of competition. The last procurement of demand response was in 2019, and no tender has been arranged since then.

Resource Adequacy Mechanisms

Sweden guarantees resource adequacy in its electricity market through a strategic reserve purchased through separate public tenders tailored for generation and demand response units. The mechanism was introduced in 2003. It is not compliant with the current State Aid regulation, but will be in place until 2025.

Currently the Swedish strategic reserve has a size of 562 MW, significantly downgraded from the initial volume of 2 GW established in 2003. The mechanism was introduced as a temporary measure until 2008, but it has been extended many times, most recently until 2025. The Swedish strategic reserve is not approved by the European Commission under State Aid legislation. It is expected that the Swedish strategic reserve will be adapted to the EU Electricity Regulation, in particular Article 22(2), but a formal procedure to revise the scheme has not yet been initiated.

The procurement is done through public tenders held six months before the winter period. The strategic reserve is active only during the winter period from November to March. Tenders are held separately for generation and demand-side units.

The last successful tender for generation was in 2017, resulting in a four-year contract for the period 2017–21, with the option of extending until 2025. In late 2019, this option was exercised. In the same period, the system operator tendered for a further 188 MW of generation capacity, to reach the cap of 750 MW, but the tender was cancelled due to lack of competition.

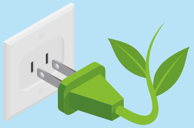
There used to be an annual tender for demand response; the last one was held in spring 2019 before the implementation of the Electricity Regulation.

In 2016, the Swedish government decided that the strategic reserve should take environmental aspects into account, but allowed the system operator to deviate from environmental requirements if this significantly reduces the costs of procurement.[7] Environmental aspects were considered in the evaluation of the capacity procured during the last tender for generation in 2017 and in the tender that was cancelled in 2019.

[7] Pär Holmberg and Thomas Tangerås, Strategic Reserves versus Market-wide Capacity Mechanisms (2021).

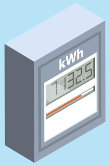
The reserve has been activated around ten times since 2009, most recently in December 2012. The costs incurred by the strategic reserve during winter 2020/21 were 14300 €/MW. The capacity procured in the strategic reserve cannot participate in any other market during the winter period.

Participating assets



Historically, both demand-side units and generation have participated in the strategic reserve. The rules state that at least 25% of the reserve should be assigned to DR. Nevertheless, the last tender for DR was held in 2019 and the reserve currently consists only of a single oil-fired generation plant.

Participation requirements



Even though they are open to demand-side units, the strategic reserves cannot be considered technology-neutral in practice. The minimum size of the offers and the availability requirements make participation possible only by conventional generation and big industrial consumers.

The requirements for participation in the Swedish strategic reserve are different for demand-side units and generators. DR units must make their capacity available for 2 hours with a recovery period of 6 hours.[8] They must provide their response within a maximum of 30 minutes. These requirements would in theory make participation of all type of demand-side units possible, but further requirements exclude them. Reserve capacity has to be available 95% of the time during the winter period, which is a difficult commitment to make six months in advance even for energy-intensive industries. This has been partially ameliorated by moving the procurement of DR closer to the delivery period.[9] Smaller demand-side units are excluded from participating because 10 MW is the minimum capacity that must be offered in the tender and aggregation is not allowed.

[8] Ei, Measures to increase demand side flexibility in the Swedish electricity system (2017).
[9] Pär Holmberg and Thomas Tangerås, Strategic Reserves versus Market-wide Capacity Mechanisms (2021).

BULGARIA — Snapshot

The Bulgarian electricity market does not have any resource adequacy mechanism at the moment because the previous mechanism (cold reserves) was phased out at the end of 2020. These have not yet been replaced by a new scheme. The Bulgarian government issued an implementation plan in accordance with the Electricity Regulation to identify potential resource adequacy concerns and propose a market reform to the EU Commission. The plan foresees, among many other interventions, the adoption of a capacity remuneration mechanism (CRM). The EU Commission held an open consultation in January 2021 to gather stakeholders' views on the Bulgarian plan.[10] The implementation plan does not contain specific information regarding what type of CRM will be implemented, the assets able to participate and how the mechanism will be generally organised.

Implementation timeline

The implementation procedure of the new CRM is currently frozen mainly due to the lack of a regular government and therefore an active legislative body.

[10] https://ec.europa.eu/energy/consultations/consultation-bulgarian-market-reform-plan_en#how-to-submit-your-contribution.

LITHUANIA — Snapshot

Lithuania is currently implementing a new capacity mechanism that will ensure resource adequacy in its electricity system. It is quite far through the process of evaluation by the European Commission, and the Lithuanian government adopted legislation with details on the new scheme in late 2020. The RAM will take the form of a capacity mechanism based on yearly capacity auctions. The scheme is designed to be technology-neutral and open to both generation and demand-side units, which can also participate as aggregated loads.

Implementation timeline

The Lithuanian government started the development of a new capacity mechanism in 2019. The planned scheme will entail technology-neutral capacity auctions, open not only to electricity generating units but also storage and independent aggregators. A public consultation on the mechanism was held in 2019 and one with the neighbouring Member States in 2020.

The Lithuanian Electricity Market Development and Implementation Plan was submitted to the EU Commission, which issued its opinion in April 2020. The Commission provided some recommendations to include additional measures to promote more efficient market development.

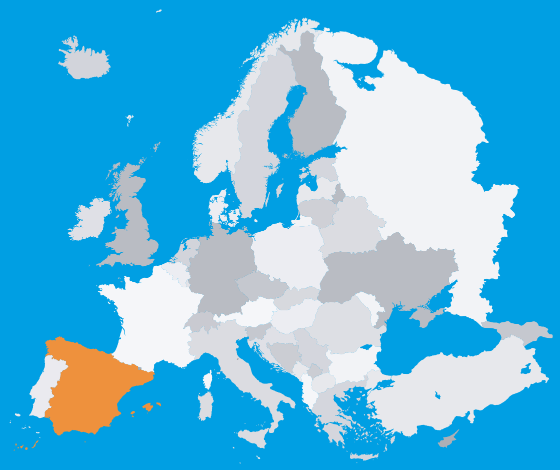
In November 2020, the Lithuanian government adopted the legislation "Capacity Mechanism Implementation Rules of Procedure". This legislation establishes procedures for implementation of the capacity mechanism in general, methods for capacity allocation during capacity auctions, terms and conditions of contracts on capacity delivery, and payment arrangements for delivered capacity.

At the time of writing, the development of the capacity mechanism is in the adjustment phase. The TSO is implementing the new European Resource Adequacy Assessment (ERAA) methodology.

Participation requirements

Based on the 2020 law, the new capacity mechanism will entail yearly capacity auctions open to both generation and demand-side units, which can participate as single or aggregated assets. Both existing and planned facilities will be able to participate in the auctions. The minimum bid size will be 1 MW, the length of procurement will be one, five or twelve years, based on the capital investment costs of the capacity provider. This provision is likely to prevent demand-side units from benefiting from multi-year contracts, as their capital expenditures are lower. In addition to the tests performed in the prequalification phase, units will be also tested at least one month before the start of the delivery year. The costs of these tests have to be covered by the capacity provider.

Participation of aggregated loads in the Lithuanian capacity mechanism will be also facilitated by the new framework for independent aggregators introduced in 2020. The Lithuanian law allows aggregation of electricity consumers regardless of their supplier. At the moment of writing, there is one independent aggregator in the market, still in the prequalification phase with the TSO; no commercial bids have yet been entered into the balancing market.



SPAIN — Snapshot

The Spanish government is currently working on a new proposal for a capacity market. So far, the proposal has been reviewed by the Spanish regulator (CNMC), which asked for amendments, but overall had a positive view on the proposal. The proposed capacity mechanism would be directed at generation assets, storage, and demand response.

Two types of tenders are envisioned: one main tender with a five-year duration, and secondary adjustment tenders with a duration of one year, based on the need for further capacity.

The participation requirements are in principle technology-neutral, but some of the obligations for demand units could be limiting. Demand units participating in the capacity mechanism must consume 51% of their normal level of demand during the timeframe between 00:00 and 8:00. This limitation excludes most of the smaller demand units, leaving only energy-intensive industry as potential participants, and defeats the purpose of using distributed resources to deal with times of congestion. This requirement was also criticised by the CNMC. An alternative to this approach would be to include a derating factor that accurately reflects the capability of these resources to adjust their demand during congestion periods.

The current proposal does not allow for independent aggregators, and the report of the CNMC also does not suggest their inclusion.

Implementation timeline

In July 2021, the CNMC published an opinion and request for amendments of the government's proposal. These comments are currently being incorporated into the draft, but there is no definitive date by when the revised proposal will be presented. A lengthy process lies ahead, with the first step being a resource adequacy assessment report by the system operator to justify the need of this mechanism. It is also unclear when the necessary steps will be performed by the TSO, the Ministry, and the EU Commission, leading to full implementation of the capacity market.

List of Acronyms

BRP	Balancing Responsible Party
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CRM	Capacity Remuneration Mechanism
DER	Distributed Energy Resource
DSF	Demand Side Flexibility
DSO	Distribution System Operator
DR	Demand Response
ERAA	European Resource Adequacy Assessment
ETS	Emissions Trading Scheme
LER	Limited Energy Reservoir
NRA	National Regulatory Agency
OCGT	Open Cycle Gas Turbine
OTC	Over The Counter
RAM	Resource Adequacy Mechanism
RES	Renewable Energy Source
SCADA	Supervisory Control and Data Acquisition
TSO	Transmission System Operator

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