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Barriers for demand response

participation in electricity markets and State aid support

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Final Report

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Barriers for demand response participation in electricity markets and State aid support

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Glossary

Acronym	Description
ACER	Agency for the Cooperation of Energy Regulators
ARERA	"Autorità di Regolazione per Energia Reti e Ambiente": the Italian Regulatory Authority for Energy, Networks, and the Environment
aFRR	Automatic Frequency Restoration Reserve
BRP	Balancing Responsible Party
BSP	Balancing Service Provider
CCGT	Combined Cycle Gas Turbines
CDS	Closed Distribution System
CEEAG	Guidelines on State aid for Climate, Environmental protection, and Energy 2022
CM	Capacity Mechanism
CMU	Capacity Mechanism Unit
CNMC	"Comisión Nacional de los Mercados y la Competencia", the Spanish national authority for markets and competition
CONE	Cost of new entry
CRU	Commission for Regulation of Utilities
DEP	Dynamic Electricity Prices
DER	Distributed Energy Resources
DG COMP	Directorate General for Competition, European Commission
DR	Demand Response
DSO	Distribution System Operator
EEA	European Economic Area
EEAG	Guidelines on State aid for Environmental Protection and Energy 2014-2020
EMD	Electricity Market Design Directive
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
FCR	Frequency Containment Reserve
FFR	Fast Frequency Response
GW	Giga Watt
IEM	Internal Market for Electricity
LOLE	Loss of Load Expectation

Acronym	Description
mRR	Manual Reserve Restoration
MW	Mega Watt
NEBEF	Notification d'Échange de Blocs d'Effacement, the Block Exchange Notification of Demand Response mechanism in France
NRA	National Regulatory Authority
OCGT	Open Cycle Gas Turbine
RES	Renewable Energy Sources
RPG	Reserve Providing Groups
RPU	Reserve Providing Units
SA	State Aid
SO	System Operator
SP	Service Provider
SRAD	Spanish mechanism for active demand response service
TSO	Transmission System Operator
VoLL	Value of lost load
VPP	Virtual Power Plant

Executive Summary

This report presents the findings of the study "Barriers for demand response participation in electricity markets and State aid support" conducted by a consortium comprising BIP, Grimaldi Alliance, and MRC Consultants and Transaction Advisers for the Directorate-General for Competition of the European Commission.

The Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity ("Electricity Directive") defines demand response (DR) as the change of electricity load by final customers from their normal or current consumption patterns in response to market signals, including in response to time-variable electricity prices or incentive payments (i.e. implicit DR), or in response to the acceptance of the final customer's bid to sell demand reduction or increase at a price in an organised market, whether alone or through aggregation (i.e. explicit DR). DR is one of the technologies that can provide flexibility services to the electricity system, which is necessary to support deployment and integration of intermittent renewable energy sources.

The study aims to provide input relevant to identifying the barriers for DR resources participation in electricity markets and State aid support. The study focuses on explicit DR across the 27 EU Member States, with a particular emphasis on the role of DR in electricity markets, the barriers to its development, and the performance of current State aid measures in supporting DR in a sample of eight EU Member States.

The report is structured into six main chapters. Chapter 1 introduces the methodology and objectives of the study, while Chapter 2 reviews the fundamentals of electricity DR and its role in the electricity sector. Chapter 3 presents the results of the investigation into the barriers for demand side participation in electricity markets, highlighting the key issues and challenges faced by DR operators and aggregators. Chapter 4 analyses the barriers hindering a fair competition of DR operators with other competing technologies in State aid measures implemented by 8 EU Member States, while Chapter 5 investigates the cost of and revenues from the supply of DR services. Finally, Chapter 6 provides a review of the EU legal framework on State aid for flexibility measures and a list of aspects that Member States could consider before putting into place a measure supporting DR.

Barriers to the development of the DR sector

The EU electricity system of the future is expected to feature multiple sources of flexibility providers, including different types of energy storage systems and DR. Investment in those resources, as well as their operations is expected to be market driven. The study identifies several key barriers to DR participation in electricity markets, including regulatory and legislative barriers, market and financial barriers, as well as technical barriers.

Stakeholders highlighted the following barriers as the main inhibitors of the development of the DR, which are difficult to remove in the short-term:

- Uncertainty over the future spot electricity and ancillary service prices, the main drivers of the value of flexibility and therefore of investment in the DR sector.
- Incomplete arrangements for integration of demand side in the electricity markets, and in particular regulatory arrangements to enable i) independent balancing service providers (BSPs) to operate and ii) aggregation of small resources in order to offer balancing services, which are still being developed in most countries.

- Difficulties in the mobilisation of consumers capable of providing DR services, since active participation of consumers in wholesale power markets is an innovative feature.

Currently, the participation of DR in electricity markets varies across the EU Member States, due to differences in national regulatory frameworks, market structures and the scope of support measures. The level of integration of DR into the electricity markets also varies between the Member States. Only France and Belgium have already fully implemented independent balancing service provision, together with a clear framework for DR participation in all markets, including balancing market. In most other markets, DR cannot participate in ancillary service markets and, even when possible, like in Germany for industrial consumers, actual participation is limited in most analysed countries, comprehensive data on the current levels of flexible available capacity and the electricity delivered by consumers through DR programs is either limited or entirely unavailable. This makes it difficult to provide a fact-based assessment of state of development of the DR sector.

However, in countries where participation of DR in the market is hindered by regulatory or market barriers, the removal of those barriers is a prerequisite to ensure that financial support measures may be effective, and their cost be limited as possible.

Existing State aid schemes for DR

DR support measures have been already integrated with capacity remuneration schemes and strategic reserve procurement mechanisms in several Member States. The special technical features of DR providers are addressed by setting requirements which are different from those placed on conventional generators, for instance in terms of frequency and duration of the balancing actions that they must be available to carry out.

All analysed schemes are auction based. Price caps are implemented to avoid unwanted rent for the DR service providers. All schemes remunerate DR providers for the capacity they provide; in Italy and Belgium, revenue clawback provisions are implemented to avoid that DR service providers are over-remunerated. Only in France, the compensation mechanism provides specific incentives to encourage activation of DR even below a pre-defined price-threshold. In addition, France introduced a new non-fossil flexibility support scheme, which supports only DR and storage and is combined with the capacity mechanism (CM) remuneration.

The support mechanisms were implemented in the EU Member States with a different degree of success, attracting volumes of DR, ranging from 0 in Italy, to few hundreds MW in France, Belgium, Ireland and Finland. The reasons for the different performance of the schemes may be different: these include too demanding performance requirements for the DR providers, too tight caps to the remuneration granted by the scheme; the existence of more attractive schemes (for instance interruptibility schemes or schemes supporting aggregation) rather than traditional generation capacity support schemes.

Cost and revenues for DR providers

The scarcity of substantial quantitative data on costs and revenues for DR in Europe, coupled with the challenges faced during data collection through public consultations, underscores the complexity of quantification of cost and revenues of DR providers at this stage of DR development.

Operational costs are the most significant expense for DR service providers participating in electricity markets. The main costs include commercial costs for customer’s acquisition, hardware and software expenses for enrolling and preparing consumers to provide DR services, investments in control systems to interact with markets, consumers, and system operators (SO), as well as settlement activities to compensate consumers for the flexibility service provided. Such cost structure suggests that there are significant scale economies for BSP.

However, the costs of providing DR services can vary substantially depending on the type of consumer and their specific production processes. Some consumers may need to adapt their technology or install specific hardware and software to participate, while others might experience losses in productivity, rescheduling costs or require alternative energy sources. The harmonization of standards for DR services and avoiding customizations for each market would help reducing the costs.

Furthermore, consumers and DR providers exhibit varying degrees of flexibility potential and employ diverse means and technologies to respond, making their costs difficult to compare. Certain industrial sites are better suited for providing DR due to their technologies and processes which can accommodate production interruptions or equipment shutdowns upon request with minimal impact.

By providing different services, DR may benefit from different revenues streams, such as: the sale of electricity on spot markets, the ancillary services, balancing, capacity mechanisms. Those sources of revenue reflect the comprehensive value provided by this asset to the electricity systems.

The potential revenues for DR providers are linked to the value of flexibility for the electricity system, and as such they are largely dependent on the market design model.

A limited availability of data on DR services hinders the understanding of costs, revenues, and volumes that could be available. To address this, a methodological approach for strawman consumers was developed by the authors of the study to model illustrative DR operators, estimating their costs and revenues and providing an insight into the potential economics of DR services. Simulation of costs and revenues for strawman consumers suggest that given current electricity prices in the EU, DR service provision is unlikely to be profitable for several categories of industrial activities. Even in cases where the simulations indicated potential for profitability, specifically for industrial sites with adaptable processes and technologies that can accommodate both short and long interruptions, the lack of substantial quantitative data on costs and revenues hindered the ability to determine the actual profitability.

Requirements for the State aid mechanisms for supporting electricity flexibility

Identified barriers to DR participation in the electricity markets, including financial barriers, may trigger State intervention, such as regulatory reforms or financial support mechanism. Several Member States have already introduced State aid measures which involve support for DR.

However, the State aid framework is evolving, following the energy crisis and the sectoral legislation. The recent revision of the Electricity Directive and of the Regulation (EU) 2019/943 (the "Electricity Regulation") provides a legal framework for assessing the needs and development of flexibility services at the national and European level, which can be addressed through storage and DR. In accordance with Regulation (EU) 2024/1747, Member States should aim to remove existing barriers and, only if necessary, consider introducing flexibility support schemes. It is important to note that the State aid measures can create significant competition distortions and must therefore be scrutinized by DG Competition to ensure that the aid is necessary, proportionate, and does not lead to undue competition and trade distortions within the EU.

Currently, the main basis to approve State aid measures involving DR, remain the same: the Guidelines on State aid for climate, environmental protection, and energy 2022 (CEEAG) and its section 4.8. on the security of supply. The new Electricity Regulation provisions complement the CEEAG and require a more integrated and holistic approach to the planning of flexibility measures.

The final chapter of the report offers practical recommendations for stakeholders involved in developing flexibility support measures, highlighting key considerations to ensure fair participation of DR in these initiatives.

In particular, before introducing State aid support for DR and other flexibility technologies, Member States should consider the following:

- a review of the existing barriers for DR, including an assessment of measures addressing these barriers and the implementation of the EU legal framework specifically on DR or on flexibility services;
- an evaluation of existing support schemes that DR can participate in (such as a market-wide Capacity Mechanism) and their interaction with the proposed State aid measure;
- analysing whether DR participation in existing State aid measures can be improved;
- a cost-benefit assessment of alternative measures to achieve the Member State’s objectives;
- indicators of the current state of the flexibility sector in the country, including: the share of flexibility provided by the main types of non-fossil fuel resources in the recent years; the volume of price dependent DR or storage bids in the day-ahead and intra-day markets and the balancing market.

As a result of the study, it is clear that DR is a crucial resource for balancing supply and demand in the electricity system, but it is still at a very early stage of development. Regulatory barriers are the main obstacles to DR participation in electricity markets, and therefore should be removed in the first place.

Moreover, State aid measures implemented in the eight countries on which the study focuses are not all effective in attracting DR in the market. This highlights the need for a more harmonized approach to DR policy and harmonisation of rules across the EU.

A more comprehensive approach is needed to support the growth of DR in the EU, including a technology-neutral approach, a level playing field for all market participants and a more effective and efficient design of the support mechanisms.

In this context, Member States are encouraged to address the existing barriers to DR in the electricity markets and improve the design of the Capacity Mechanism that is already in place (if any), before considering the introduction of additional non-fossil flexibility support schemes.

1. Project objectives, methodology and organisation of the Report

1.1 Project Objectives

This report presents the findings of the project, "Barriers for DR participation in electricity markets and State aid support" conducted by a consortium comprising BIP, Grimaldi Alliance, and MRC Consultants and Transaction Advisers (hereinafter, "the Consortium") for the Directorate-General for Competition (DG COMP) of the European Commission.

The primary objective of this study is to provide DG COMP with factual, analytical, and data-driven input relevant to identifying the barriers for DR resources participation in electricity markets and State aid support.

To achieve this objective, this study provides input on the following three (3) study items:

1. Barriers for DR participation in electricity markets and State aid measures.
2. Costs and revenues of DR operators in electricity markets and State aid measures.
3. Participation of DR in State aid measures.

Moreover, the study aims at addressing the following study questions:

1. What are the legal and regulatory, financial, market and technical barriers for DR participating or, if not participating, willing to participate in electricity markets and State aid mechanisms?
2. What are the revenues for DR operators participating in electricity markets electricity markets and State aid measures?
3. Are individual DR operators and DR aggregators able to participate in calls for tenders organized under the respective State aid measures on the same level playing field as other technologies? For the State aid measures where DR is a technology eligible for participation, are the DR units interested in participating?

This study examines these barriers within the context of the specific electricity market framework, to support DG COMP in assessing State aid measures in line with the relevant State aid framework, and particularly the Guidelines on State aid for climate, environmental protection and energy 2022 (CEEAG), as well as sector-specific legislation[1]. The overall objective of the study is to provide the Commission with factual, analytical data input that is relevant for identifying the barriers for DR participation in electricity markets and State aid support.

The Terms of Reference requires the study to be focused on explicit DR[2] across the EU 27 Member States. The analysis concerning State aid mechanisms covers a sample of eight (8) Member States for which State aid decisions on a Capacity Mechanism or a flexibility measure were adopted by the European Commission at the

[1] *Directive (EU) 2024/1711 of the European Parliament and of the Council of 21 May 2024 on common rules for the internal market for electricity (amending Directive 2019/944) (OJ L 158, 14.6.2024) and Regulation (EU) 2024/1747 of the European Parliament and Council of 21 May 2024 on the internal market for electricity (amending Regulation 2019/943) (OJ L 158, 14.6.2024).*
[2] *See chapter 2.3 for the definition of explicit DR.*

time of the selection of the consultant for this study: Belgium, Finland, France, Germany, Greece, Ireland, Italy, and Poland[3].

1.2 Methodology

The development of DR ultimately depends on the cost and expected revenues, or savings, that market participants expect to respectively bear and generate by exploiting the consumer flexibility. In this respect, any factor increasing these costs or reducing these revenues and savings acts as a barrier to the development of DR. From a policy perspective, though, different types of blockades might have diverse implications and call for different measures.

In this report, we refer as market failures the factors that may prevent the usual market dynamics from delivering the socially and economically optimal level of DR - or more generally flexibility - once all frictions that are reasonably under the public authorities' control have been removed. Market failures may provide justification for public financial support, as addressed in chapter 2 of this report, while covering in chapter 4, factors that may produce the same detrimental effects on investment in DR that one would expect to be under public authority control. These factors, that we refer to as barriers, may include for example unnecessarily demanding licensing conditions or flaws in the market design. The implementation of financial support in order to offset the effects of the barriers on the incentives for DR development may be undesirable, provided they can be removed by direct public intervention. When this is the case, the removal of such barriers may be considered as a pre-condition for the implementation of efficient and effective public support. The distinction between market failures and barriers may reflect the analyst judgement and needs to be assessed on a case-by-case basis.

Barriers can potentially impact DR operators in the following way:

- Hindering the development of price signals, which play a crucial role in encouraging DR resources to adapt their consumption behaviours. This, in turn, promotes the economic and technical feasibility of the flexibility services they aim to provide.
- Influencing the investment decisions of demand-side response providers concerning the assets and activities required to participate in electricity markets and State aid mechanisms. Such barriers are assessed in accordance with the technological and commercial maturity of these assets, preventing the burden of unreasonable and unjustified costs.
- Compromising the level playing field within electricity markets and CM. This may impede DR providers from benefiting fully from non-discriminatory, transparent, and cost-reflective requirements, potentially affecting their participation and success in these markets.

To identify and classify the barriers currently hindering the development of DR across the EU and to address the study questions, the Consortium followed these methodological steps:

1. conducted a comprehensive review of the literature on DR;
2. engaged stakeholders through surveys and interviews;
3. performed independent analyses.

The methodology to identify and classify the barriers is described in more details in the following sections.

[3] *See Chapter 4 and Annex II for a link to the respective State aid decisions.*

1.2.2 Literature Review

An exhaustive literature review served as a basis for the analysis and identification of the existing barriers. The Consortium conducted the review of more than 200 public sources, as presented in Annex II, including national government reports, National Parliament reports, conference papers, conference presentations, European Commission, ACER and JRC research reports, EU Parliament reports, consultancy and university research reports, graduate or PhD thesis, academic papers, research reports (other than ACER, JRC, EU Parliament, EC, consultancy or university research report), European Commission decisions and country reports.

After the collection of known reports and literature by the Consortium and DG COMP, the results were consolidated. As a result, already-identified market barriers have been collected, described, fed into a database, and cross-referenced to the reports.

1.2.3 Feedback from Market Actors

To corroborate the conclusions drawn from the literature review, and to merge these findings with practical insights from EU markets, market actors were engaged to provide their insights for this project. Engagement points included a survey, interviews and a workshop. To promote widespread involvement and guarantee equitable awareness for all stakeholders, they were asked to take part in the research via a dedicated website. See Figure 1 for more information on the participation of market actors in the study.

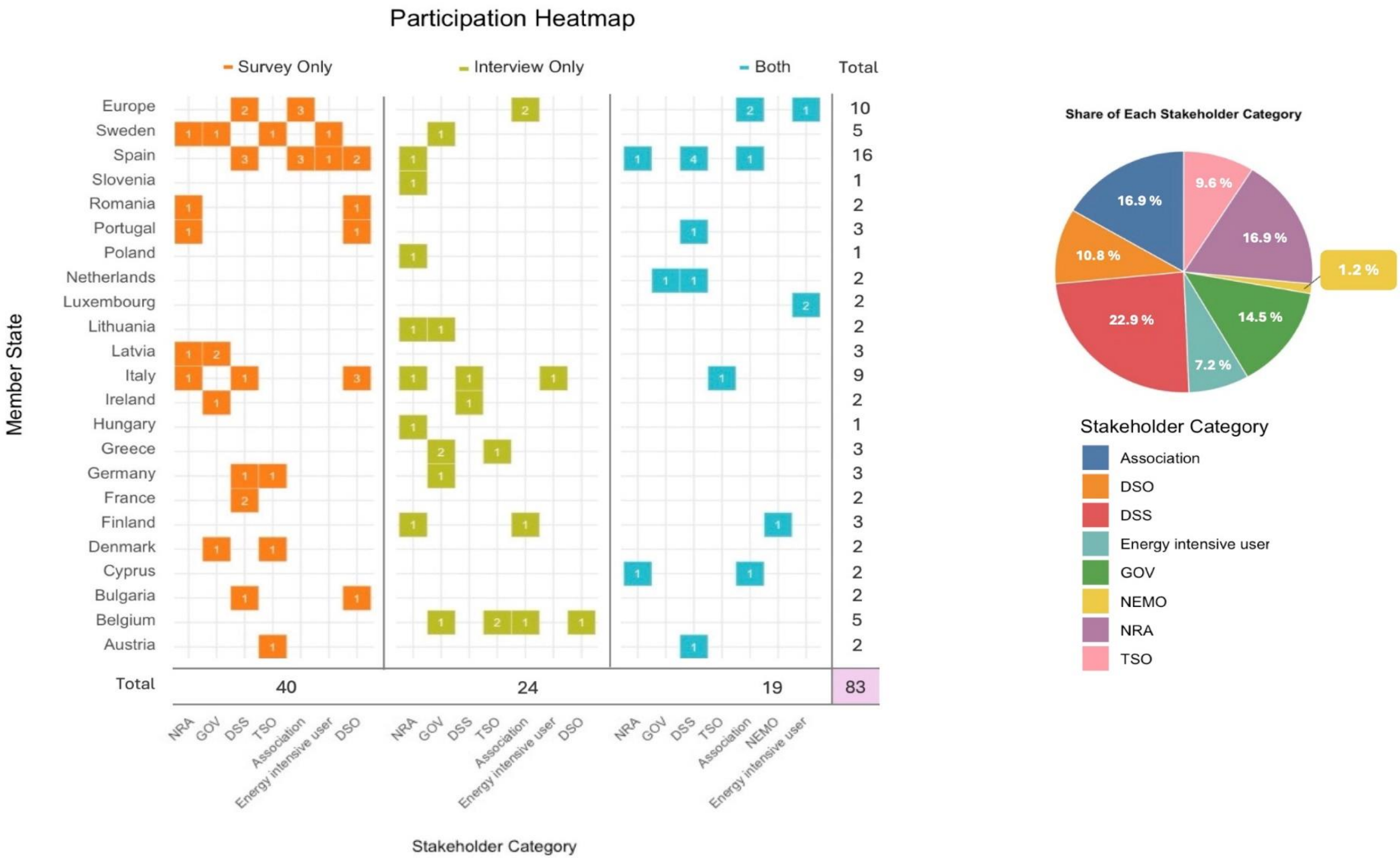

Figure 1: Participation Heat Map of Market Actors
(Source: Consultant's own analysis)

Online Survey and Interviews

The primary research media used in the project were an extensive online survey and in-depth interviews which were carried out between November 2023 and May 2024.
The purpose of the survey was to provide structured identification, weighting and magnitude of the barriers, as experienced and perceived by the market actors. As mentioned above, a dedicated website was developed (https://eu-demandresponsebarriers-project.eu/) to allow the market actors to complete the survey online[4]. The survey additionally facilitated the identification of barriers that were not revealed by the literature review, or which were country specific.

The survey was publicly and widely promoted to potential respondents from 10 October 2023 until late November 2023 (via the project website, social media, emails and by other direct means) and remained open until late February 2024. As of May 2024, fifty-nine (59) market actors have completed the survey, and twenty-four (24) additional market actors have been interviewed. Participation to the interviews was promoted during the survey period. However, some market actors participated either to survey only or to interview only, while other participated in both. A total of eighty-three (83) surveys and interviews were conducted. A total number of forty (40) stakeholders completed both a survey and interview. Survey presents the list of questions covered by the survey.

Survey Design

The survey design was based on the project's literature review, alongside the insight and experience of the Consortium in electricity markets and survey design. Based on the barriers identified through this initial input, the survey was structured around four main categories: "Legal and Regulatory barriers", "Market barriers", "Technical barriers" and "Financial barriers". Within each category, numerous specific qualitative and quantitative questions were formulated to explore in detail the barriers that had already been identified, along with the provision for qualitative comments.

The number of questions was kept to a minimum to reduce the workload on respondents and enhance the chances of survey completion, while still encompassing all possible barriers. The Consortium chose a tool named "JotForm"[5], following a market scouting on the most effective and suitable solutions for the initiative.

Quantitative questions were formulated to be applicable to all relevant types of market players across all electricity markets. The same structure was used for each barrier category: one overall question for the category, followed by a list of more specific questions to be graded. All questions used a Likert scale, i.e. a grading from 1 (no effect) to 5 (large effect), formulated broadly as "According to your opinion, please rate from 1 (low) to 5 (high) to what extent do the following barriers…" All questions had a "Don't know / Not applicable" option outside of the Likert scale. In addition, distinct sets of questions were tailored for each stakeholder category and participants were presented only with questions pertinent to their specific role or involvement in the electricity market.

Workshop

On 21 March 2024, DG COMP and the Consortium presented a summary of the initial findings from the project to approximately 370 electricity market actors and stakeholders. Following initial interviews, this workshop was leveraged as an opportunity for further engagement used to gather feedback on the initial project findings that contributed to the development of this final report.

[4] *This website provides all the relevant information on the project and the link to the survey.*
[5] *JotForm website, https://www.jotform.com/faq/.*

1.2.4 Expert Knowledge

Throughout the project, the extensive expertise within the Consortium and the established network of Consortium partners provided an in-depth understanding of all relevant facets of the study. Crucial insights were gleaned from the Consortium experience in various projects involving clients who encountered these barriers in the respective markets. This approach facilitated a well-rounded perspective on the barriers raised during the study.

1.2.5 Classification of Barriers

The approach for identifying legal and regulatory, market, technical and financial barriers, includes a triple-layered classification, beginning at very general level of barrier blocks, then a level of barriers' areas and gradually narrowing down to more specific issues encountered in the EU Member States. The three layers and their categorization are as follows:

1. **Barrier blocks**: the types of sources which may affect the participation of DR to electricity markets. Four (4) blocks were identified: legal and regulatory, market, technical and financial.

1- Legal and regulatory barriers

- Member States' legislative and regulatory framework may entail provisions which introduce discriminatory or disproportionate requirements, obligations, or provisions more in general which may discourage the participation of DR, DR operators and DR aggregators to electricity markets. Legal and regulatory barriers may also include the lack of transposition of EU Directive and Regulations considered as best practices to promote the participation of DR, DR aggregators, and DR operators to electricity markets. The unpredictability of the legal and regulatory framework concerning enabling factors of DR may be considered a form of legal and regulatory barrier as well.

2- Market barriers

- Factors related to the market structure and the market design and which may prevent the participation to electricity markets of DR, DR operators, DR aggregators by promoting the emergence of barriers to entry or by encouraging anticompetitive practices

3- Technical barriers

- Member States' legislative and regulatory provisions, smart technologies' maturity and deployment, TSOs', DSOs', and market operators' technical rules concerning the technical capabilities and technical performances of demand facilities which may affect the participation of DR, DR aggregators and operators to electricity markets.

4- Financial barriers

- Regulatory and legal provisions, market design characteristics, technical requirements and policies which may affect the economic dimensions of DR services (i.e. revenue streams and costs) and, therefore, affect the participation of DR facilities, aggregators and operators to electricity markets.

Figure 2: The four (4) identified blocks of barriers
(Source: Consultant's own analysis)

2. **Barrier areas**: for each block of barriers a sub-category has been identified. Each refers to a specific enabling factor for DR which might not be appropriately addressed by Member States.

3. **Single barriers**: in every barrier block, a single barrier has been identified as a specific key performance indicator.

The four (4) blocks of barriers are assessed separately throughout this report. Block 4, Financial barriers, is assessed separately through the chapter (5) on Costs & Revenues chapter.

The literature review on DR revealed a wide variety of barrier areas**,** among which, the following major barriers were identified for each category:

LEGAL AND REGULATORY BARRIERS

1. **Participation of active customers in electricity markets**: Active customers may act as a single customer or as a group of jointly final customers and have the right to participate in all electricity markets and flexibility schemes without being subject to disproportionate or discriminatory conditions (Article 15 of the Electricity Directive). However, the regulatory and legislative framework of Member States may entail provisions which impose unduly discriminatory and disproportionate obligations, costs, prohibitions, and discriminatory requirements to active end-customers and demand-side response providers, who are willing to participate in electricity markets.

2. **Participation of DR operators and DR aggregators in electricity markets:** The establishment of an ad hoc legal framework for DR operators and aggregators consistent with the EU legislation (including Articles 13 and 17 of the Electricity Directive) may encourage their participation in electricity markets. However, Member States may not adopt specific rules for DR operators and aggregators or if they have established a legal framework for DR actors, it may include discriminatory or non-transparent requirements, obligations, and conditions.

3. **Switching process**: Switching supplier or DR provider engaged in aggregation shall be carried out in a timely manner and without imposing to end-customers disproportionate or discriminatory conditions. Member States' regulatory and legislative frameworks may lack the adoption of provisions (i.e. Article 23 of the Electricity Directive) minimizing the duration of the switching procedures, and/or ensuring that suppliers or aggregators do not impose discriminatory or disproportionate conditions, and/or that adequate information about switching procedures are provided to clients. Such limitations in the legislative and regulatory framework may discourage end-customers to enter in a contract with a DR operator or DR aggregator.

4. **Transmission System Operators (TSOs) and Distribution System Operators’ (DSOs) network plans**: Regulatory and legal frameworks of Member States should provide a clear identification of flexibility needs and how they can be met in the DSOs' and TSOs' plans (Article 32 of the Electricity Directive). Such an indication would allow identifying the most appropriate policy interventions to foster DR and the operations of DR aggregator/operators. The lack of this type of requirements in Member States' legal and regulatory framework may lead to the underestimation of the relevance and contribution of DR in flexibility services and, more in general, to the role of DR as an alternative to network reinforcements.

5. **Access to end-customers´ data**: The access of customers to their metering data is essential to make sure that they are exposed to price signals and become aware of the benefits of DR services (Article 23 of the Electricity Directive). However, Member States´ legal and regulatory framework may impose requirements, charges and other obligations which might limit the access of end-customers to their metering data.

A number of EU legal provisions mentioned above, which are aimed at defining roles and responsibilities of market participants, should have been transposed into national legislation already by 31 December 2020, pursuant to the Article 71(1) of the Electricity Directive. However, as indicated in the 2023 ACER Market Monitoring report on barriers to DR[6], multiple Member States are still lagging with a full implementation of those provisions in the national legislation. According to ACER, a secondary legislation defining more detailed rules and procedures for these new actors is also needed.

MARKET BARRIERS

1. **Participation of Distributed Energy Resources (DERs) in flexibility markets and capacity markets:** Enabling the procurement of flexibility services from DERs, including DR, is a relevant enabling factor to encourage the participation of DR operators and DR aggregators to electricity markets. Market-based, non-discriminatory, and technology-neutral procurement procedures may encourage end-customers to provide DR services and stipulate contracts with DR aggregators and DR operators (Articles 22 and 32 of the Electricity Directive). However, Member States may not have a mature electricity market design[7] according to which DERs are eligible to offer flexibility services at both the global and local level. The same analysis of formal eligibility has been performed with respect to CM and interruptibility schemes (this aspect will be discussed under the State aid mechanisms section).

2. **Eligibility of DR in flexibility service markets**: Flexibility products should be characterized to promote the participation of each eligible technology that could provide flexibility services based on identified needs. Therefore, the lack of definition of appropriate bid thresholds and other product characteristics reflecting DR technical capabilities may prevent the fair participation of DR in flexibility markets (Article 3 and 17 of the Electricity Directive). Member States' electricity market rules may not consider appropriately the differences among market products and technologies. This, in turn, may prevent the participation of DR facilities to the electricity markets.

3. **Eligibility of DR and its participation in State aid mechanisms' products (discussed under State aid mechanisms section)**: Availability products traded in Capacity Mechanisms might not fully consider the technical specificities of DR, thus discouraging their effective participation in such State aid schemes despite being formally eligible. The discriminatory applications of the following conditions between DR resources and other type of resources have been investigated (Article 22 of the Electricity Directive and CEEAG), e.g.: size of the auction bids, lead time between the auction and the delivery period, duration of capacity contracts, requirements in terms of availability, strike price (if applicable), etc. With the due distinctions, the same barrier has been investigated for interruptibility schemes.

4. **Perimeter of aggregation for the participation in flexibility markets:** The possibility to aggregate different technologies and resources located in different balancing areas (Article 17 of the Electricity Directive) or having different technical capabilities and presenting bids in flexibility markets is important to encourage the participation of DR units, especially those of small size. Market rules may limit the possibility of aggregation and pooling of facilities which might

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[6] *Removing barriers to demand response and other distributed energy resources, ACER - 2023 Market monitoring report, ACER_MMR_2023_Barriers_to_demand_response_Infographic.pdf.*

[7] *Referring to a market design that has evolved to a point where DERs are recognized and eligible participants in offering flexibility services. In these cases, the term "mature" suggests that the market rules, regulations, and infrastructure have sufficiently progressed to accommodate and integrate DERs, enabling them to contribute to flexibility services at both the global (larger scale) and local (smaller scale) levels.*

potentially discourage the participation of new technologies and assets to electricity markets.

5. **Role of Balancing Service Providers (BSPs) in flexibility markets**: The possibility to have BSP entities differentiated from Balancing Responsible Parties (BRPs) and the possibility for demand-side response providers to act as BSP encourages the diffusion of DR (Article 13 of the Electricity Regulation). However, some Member States' electricity wholesale markets may still oblige market operators to act also as BRPs in order to provide flexibility services.

6. **Comparison tools**: Comparison tools may allow end-customers to subscribe the commercial offer that better fits to its consumption habits (Article 11 of the Electricity Directive). When comparison tools include Dynamic Electricity Prices (DEP) contracts[8], they can exert a further leverage for the diffusion of demand-side response and, thus, of DR providers. Comparison tools can be provided by various entities (third-party SPs, electricity retailers, or DSOs). The key is to ensure that these tools are accessible and provide accurate information to help end-customers make informed decisions regarding commercial offers and demand-side response options. The choice of provider for comparison tools may depend on the regulatory framework and market structure in a particular region.

7. **Effectiveness of market liberalization:** The effectiveness of the liberalization process is important to ensure a level playing field among market participants and encourage the participation of new technologies and new actors in both wholesale and retail electricity markets (Articles 6 and 35 of the Electricity Directive). However, in some Member States, the market structure and the implementation of unbundling regimes highlight the likely absence of an effective level playing field so that DR operators and aggregators may be discouraged to participate to electricity markets.

TECHNICAL BARRIERS

1. **Status of deployment of smart metering:** Smart metering deployment is an essential pre-requisite to promote customers' exposure to price signal and awareness about their consumption behaviours. Therefore, the limited deployment of smart meters (Article 19 of the Electricity Directive) and/or limitations concerning their performances, may hinder the diffusion of DR services and the role of DR operators and aggregators.

2. **Metering requirements for the participation in flexibility markets**: Metering requirements for the provision of ancillary services must consider the specific technical capabilities of demand facilities (Article 20 of the Electricity Directive). If this does not happen, metering requirements may represent a relevant barrier to entry for ancillary services markets for DR, DR aggregators, DR operators.

3. **Definition of the baseline methodology for the participation in flexibility markets:** The methodology for the definition of the consumption baseline should consider the specificities of DR facilities as well as the type of flexibility services to be provided. If this does not happen and a standardized and mandatory

[8] Dynamic Electricity Price (DEP) contracts offer cost savings by allowing consumers to adjust electricity usage during lower-priced periods. They promote flexibility, efficient energy use, and encourage participation in Demand-Side Response programs, contributing to grid stability and environmental sustainability.

methodology is established, DR could be discouraged to participate in flexibility service markets.

4. **Performance requirements for the provision of flexibility services**: Performance standards for the provision of ancillary services should consider appropriately the technical capabilities of demand facilities to avoid obstacles for the participation of DR to electricity markets (Article 18 of the Electricity Regulation).

5. **Data exchange between SOs and the SOs and the SPs:** The adoption of provisions defining in a clear and transparent manner the rights, obligations and procedures for the exchange and validation of data between System operators (SOs) (DSOs and TSOs) and the Service Providers (SPs) is an enabler for the cost-effective participation of DERs (and DR in particular) to flexibility markets (Article 23 of the Electricity Directive). This can streamline rules and operations, leading to more efficient interactions, contributing to a reduction in transaction costs, including administrative and compliance expenses, thereby enhancing the economic viability of market participation. However, Member States' legislative and regulatory provisions may lack such a framework, or they may adopt provisions which make data exchange more difficult and less efficient, to the detriment of the diffusion of DR services.

FINANCIAL BARRIERS

Consulted stakeholders have identified as a financial barrier the fact that they do not generate enough revenues by selling DR services. The issues raised under this category are analysed in chapter (5) on the cost of and revenues from DR and in the chapter (3) on barriers for the participation of DR in State aid mechanisms.

1.3 Organisation of the Report

In Chapter 1, we describe the methodology followed for the analysis.

The other chapters of this Report are organised as follows:

- in Chapter 2, taxonomy and the fundamentals of electricity demand response are introduced;
- in Chapter 3, the results of the investigation into the barriers for demand participation in electricity markets are presented;
- in Chapter 4, the results of the investigation into the performance of the current State aid measures in supporting the development of demand response are presented;
- in Chapter 5, the cost of and revenues from the supply of DR services are investigated;
- in Chapter 6, State aid measures related to demand response in the context of the EU Legal Framework are assessed, considering recent legislative amendments such as Directive (EU) 2024/1711 and Regulation (EU) 2024/1747. This chapter is divided into sections that review the legal basis for existing SA measures, analyse the implications of new legislative provisions for future assessments, and provide suggestions on critical issues in evaluating the State aid measures for supporting demand response;
- in Annex I: Barriers’ relevance by type of barrier and Member State, more details on the barriers’ relevance by barrier and Member State are presented;

- in Annex II – Bibliography / Literature Review a bibliography of the documents reviewed for the study is presented;
- in Annex III – Market Actors' Online Survey, market actors' online survey questions are presented.

2. The economics of electricity demand response

In this report, DR is referred to as the ability of an electricity consumer to change the level of consumption in a controlled way at short notice[9]. The Electricity Directive provides a definition of 'demand response' as the "*means the change of electricity load by final customers from their normal or current consumption patterns in response to market signals, including in response to time-variable electricity prices or incentive payments, or in response to the acceptance of the final customer's bid to sell demand reduction or increase at a price in an organised market […], whether alone or through aggregation*".

By integration in the electricity market, we mean that the level of consumption is made contingent on prices, particularly those clearing wholesale spot electricity and ancillary service markets.

2.1 The role of demand response in the electricity sector

Several features distinguish electricity from the other commodities. Electricity cannot be economically stored on a scale consistent with the requirements of large electricity systems. It must be produced constantly and in the same quantity as it is consumed; any deviations of injections and withdrawals of seconds may cause widespread service disruption. Firstly, this means that the market supply curve is fully inelastic in the short term, beyond the level of installed capacity. Secondly, electricity demand varies significantly during the day and across the seasons. Thirdly, a large portion of the demand is currently price-inflexible, at least in short timeframes.

Figure 3 illustrates the special features of electricity demand and supply.

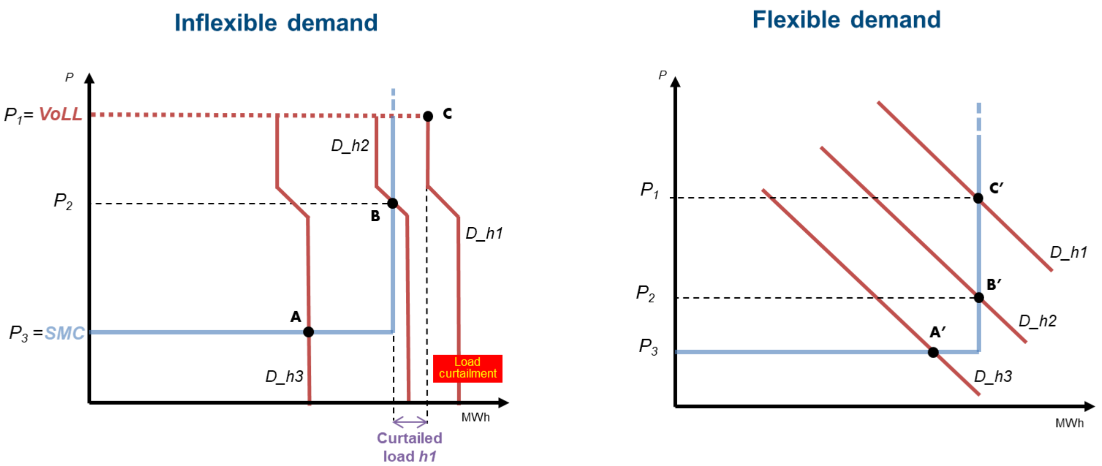


Figure 3: The special features of electricity demand and supply
(Source: Consultant's own analysis)

The figure presents the equilibrium of an electricity market in normal and in scarcity conditions. In competitive markets, the supply curve corresponds to the variable costs of generators. Some renewable generators, most notably solar and wind ones that are

[9] *In the industry jargon, demand-side flexibility is often intended to encompass a broader set of resources, having in common the fact that, traditionally, their flexibility was not exploited, let alone integrated in the market. These resources include, for example, electricity storage system, back up diesel generators and heat and power generators.*

expected to account for increasingly larger shares on the pathway to decarbonisation by 2050[10], have almost zero incremental cost.

In Figure 3, demand is represented at different times, h1, h2 and h3. Note that generation capacity can be used either to produce electricity or to provide operating reserve. Therefore, generation scarcity must be assessed by comparing the supply of generation capacity with the sum of the demand for energy expressed by the consumers and operating reserve, expressed by the SO. For the sake of simplicity, and unless otherwise indicated, in this section demand is referred to as the sum of the demand for electricity and the operating reserve requirement.

In the left panel of Figure 3, the large price inelastic segment of the demand represents customers whose short-term consumption decisions are not affected by price changes. Points A, B in the figure represent the market equilibrium at times in which available generation capacity is larger than demand. Point C represents a scarcity event, i.e. a situation in which demand is greater than the available generation capacity. At times of scarcity, some consumers are disconnected, and the market price is administratively set equal to the value of lost load (VoLL), estimated as three orders of magnitudes greater than the market clearing price in normal conditions.

The special characteristics of electricity short term demand and supply result in:

- part of the generation fleet being activated only in a small share of hours of the year;
- a price pattern characterised by a large number of low-price hours, that provide little or no contribution to covering the generators’ fixed cost;
- involuntary disconnections, or curtailment, of consumers in case of generation scarcity.

Those features are undesirable for multiple reasons including the following.

Firstly, uniformity of variable cost across generators (i.e., a flat supply curve) and lack of demand flexibility make the share of the profit collected by generators in normal market conditions small, and the share of the generators’ fixed costs that must be recovered during the rare scarcity events large. This makes investment in electricity generation capacity particularly risky, because even moderate distortions in the electricity prices during scarcity hours, or in the number of scarcity events that occur during a certain period, may have a dramatic impact on the generators’ profitability. Concerns that these features of the electricity markets may lead to underinvestment in generation capacity have motivated the introduction of capacity remuneration schemes, or other measures supporting the generators’ income and/or reducing their risk.

Secondly, ensuring that (price-inelastic) peak demand is met at all times requires that a potentially large share of capacity to be idle at non-peak times. Further, being demand price-inelastic, the volatility of renewable primary sources, mainly sun and wind, must be entirely addressed by keeping operating reserves active. This adds to the capacity requirement of the electrical system and may have an adverse impact on the emissions, since a large share of operating reserve is currently provided by gas-fired units.

Thirdly, consumers’ curtailment is a matter of political concern. For this reason, governments, regulators, and SOs are reluctant to rely on market forces to determine the size of the generation fleet and politically acceptable capacity targets may even

[10] It is currently estimated that a 65% renewable penetration in the electricity mix at 2030 is needed to meet the European climate targets.

entail some excess capacity, i.e., be above the standards that would result from conventional cost-benefit calculations[11].

The right-hand side of Figure 3 shows how that price-responsive demand mitigates the undesirable features of the market outcome discussed above. With flexible demand, other things equal:

- the time-pattern of prices is smoother; prices rise above the variable production cost more frequently, reducing the risk for generators, but without reaching the extreme level of VoLL;
- involuntary disconnections of consumers do not occur since price increases cause a voluntary reduction of demand to the level of available generation capacity;
- the operating reserve requirement reduces, since demand flexibility off-sets at least part of the volatility of renewable available capacity;
- smaller total capacity is necessary to serve demand and ensure politically acceptable level of service continuity.

Hence, other things equal, DR would reduce total electricity supply cost and, by reducing generation investment risk, the need for public intervention to govern the development of the generation fleet.

2.2 Trading arrangements for demand response

2.2.1 Explicit and implicit DR

Two types of arrangements for delivering DR services, the so called implicit and explicit model, are identified in the industry jargon[12]. The **implicit model** corresponds to the way all goods and services are usually traded. In the implicit model, the information on the consumer's availability to pay for different volumes of electricity is conveyed to the market via the usual price-dependent demand.

In the **explicit model**, the consumer's preferences are conveyed to the market in the form of the consumer's availability to reduce consumption, from a given starting level, in exchange for a price; in other terms, the consumer's flexibility is traded as a stand-alone product. The distinguishing feature of explicit DR is that firstly, the consumer obtains the right to consume a certain volume of electricity, called the **baseline** volume, in ways that we discuss later in this section; secondly, having acquired the right to the baseline consumption, the consumer is then able to deliver DR by forgoing part of the baseline consumption. This makes the corresponding electricity injected in the network available to the system operator and, therefore, to other consumers whose consumption is not being offset by production.

In both the implicit and the explicit model, the flexible consumer obtains a monetary benefit from giving up consumption when the value of electricity in the market is high. The difference between the two approaches is that in the implicit model the benefit takes the form of a "procurement cost saving", while in the explicit model it takes the form of a trading profit.

[11] *For instance, a 2015 study reported that the reliability standard set in 2001 in Great Britain implied a VoLL higher than direct estimates of the consumers' willingness to pay to avoid disconnections. See David Newbery, 2015, Missing money and missing markets: Reliability, capacity auctions and interconnectors, Cambridge Working Papers in Economics, 1513, p. 8.*

[12] *See for example https://www.smarten.eu/wp-content/uploads/2016/09/SEDC-Position-paper-Explicit-and-Implicit-DR-September-2016.pdf.*

As mentioned in the methodology chapter, in this report the focus is on explicit DR transactions, and the discussion is on the institutional arrangements implemented in the EU markets to enable such transactions.

2.2.2 Explicit DR transactions: wholesale electricity markets

In this section, explicit DR transactions in the forward timeframe are illustrated. In particular, we consider a consumer that:

- procures the volume of electricity corresponding to his expected consumption via a forward purchase, e.g. a yearly or quarterly product;
- then sells in the day-ahead or intraday market part of that volume, and reduces his consumption correspondingly, because the clearing price in that market turns out high enough to make it more profitable for the consumer to forego consumption and cash-in the value of the electricity that he sells.

In order to carry out such transactions the consumer must be able to buy and sell electricity at the prices prevailing in the wholesale markets. Direct access to wholesale markets is possible only for large consumers, due to the minimum size of wholesale products and the transaction costs that direct participation in organised markets entail, including for IT systems, personnel, and financial collaterals.

Instead, indirect access to wholesale markets is usually made available by aggregators to medium and large consumers. The aggregator, that typically acts also as BRP, offers indirect market access, by allowing the consumer to hold an electricity portfolio and adjust its position by trading against the aggregator at the prevailing wholesale market price, plus a fee for the service. The aggregator, that acts as the consumer's counterparty in those adjustments, hedges its own net position by trading on his own account in the wholesale markets. All the regulatory and institutional arrangements necessary to implement indirect access to forward wholesale electricity markets are already in place in the EU.

Note that this approach requires that the consumer is able to forecast his consumption when buying the electricity that he might later resell as DR. This is what, normally, electricity suppliers do since they take the responsibility to procure a volume of electricity equal to the expected consumption of their clients. In other terms, when the consumer has wholesale market access, he acts as his own supplier.

In the next section, in the context of explicit DR provision in the real-time/balancing timeframe, we discuss a mechanism, involving a certain degree of regulatory intervention, that decouples the supplier role from the provision of DR. In such model a party acts as the consumer's electricity supplier, i.e. takes responsibility for procuring electricity matching the consumer's expected consumption; the consumer itself, or a third party acting on its behalf, exercises the right to resell part of that electricity as DR.

Finally, the possibility to trade at wholesale market prices is generally neither sought by, nor offered to the smaller consumers. In some countries, small consumers may make their electricity procurement cost depend on wholesale prices by subscribing retail supply options with, typically, day-ahead market indexed prices. With this option, the price paid by the consumer, in each hour, is indexed to the clearing price of the day-ahead market for that hour. This approach delivers implicit DR, as the consumer reacts to high spot prices by reducing his consumption, as opposed to reselling electricity purchased at an earlier market stage. We understand that the use of such spot-price indexed retail tariffs is currently very limited.

According to the ACER-CEER Market Monitoring Report (ACER-CEER, 2023[13]), the adoption of dynamic pricing tariffs, including day-ahead market (DAM) indexed tariffs, remains low across most EU countries. The report indicates that only a small fraction of household consumers has access to or is utilizing these tariffs.

Furthermore, Article 11 of the Electricity Directive establishes a legal framework for EU Member States to ensure that final customers are entitled to contract with suppliers that offer dynamic electricity price contracts. This directive required that by January 2020, all Member States should have ensured that customers are informed of the benefits and risks of such contracts, and suppliers must provide this option where smart metering systems are deployed.

2.2.3 Explicit DR transactions: balancing/real time markets

In the balancing market, changes in consumption with very short notice, i.e. between seconds and minutes before the time delivery are purchased by the SO.

A feature of the market design mandated by the EMD, particularly relevant for DR, is that, for each consumer, the rights and obligations related to balancing and those related to the provision of balancing services are separately defined, so that each of the two activities may be carried out by a different party. These parties are:

- the **balance responsible party (BRP)**: the BRP is responsible, vis a vis the SO for matching with injections the consumer's electricity consumption, reduced by the electricity purchased by the consumer in the balancing market and increased by the electricity sold by the consumer in the balancing market. For the purpose of this report, the BRP can be identified as the consumer's electricity retailer, even if in practice the retail activity may be carried out by a different agent.
- the **balancing service provider (BSP):** the BSP bears the responsibility, vis-a- vis the SO, that the consumer keeps the commitments to increase or decrease consumption when his balancing bid or offer is accepted.

Both the BSP and the BRP aggregate consumers for the purpose, respectively, of balancing and delivering balancing services.

We illustrate these arrangements with an example, in which, for simplicity, we refer to a single consumer, rather than to a set of consumers whose DR capabilities are offered in the market by the same BSP. At a certain time t, the SO accepts an offer for upward regulation presented by the consumer's BSP, with immediate execution.

Figure 4 shows how the consumer's BSP actual delivery of the DR service to the SO is assessed. We consider a setting in which the consumer consumption at the moment of the call is regarded as the ***baseline***; the baseline is intended to measure the consumption by the consumer in case he had not received the SO request to reduce consumption. Setting the baseline equal to actual consumption at the time of the call is conventional, in that one might say that, absent the call, the consumer might have spontaneously decreased or increased consumption in the following half-hour. However, it is a reasonable assumption. A discussion of the issues related to the selection of the baseline is beyond the purpose of this report.

As shown in Figure 4, since the consumption by the consumer at the moment in which the call to reduce consumption was issued by the SO was 7 MW, the baseline consumption to assess how much electricity was delivered by the consumer in response to the call is 3.5 MWh, corresponding to a constant consumption of 7 MW for half-hour.

[13] *Removing barriers to demand response and other distributed energy resources, ACER - 2023 Market monitoring report, ACER_MMR_2023_Barriers_to_demand_response_Infographic.pdf.*

It turns out that consumer's actual consumption in the half hour following the call is 1.8 MWh, or 1.7 MWh less than the baseline; therefore, the consumer failed to deliver 0.3 MWh balancing electricity. This will generally turn into a penalty for under delivery.

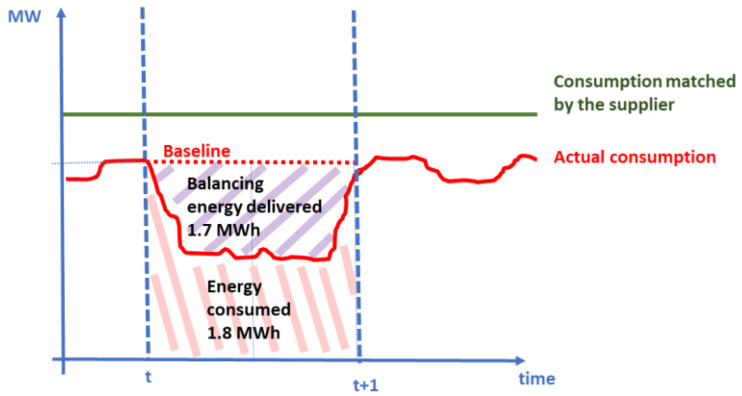


Figure 4: How the consumer's actual delivery of the service sold to the SO is assessed (Source: Consultant's own analysis)

Note that, for the purpose of assessing the volume of electricity delivered in response to the balancing call, it does not matter if the consumer's consumption was above or below the volume of electricity that was being injected by his BRP/supplier in the system to match his consumption.

That matching is assessed independently, by comparing the injection occurred on the consumer's behalf with the consumer's actual consumption, increased by the 1.7 MWh that his BSP (sold and) delivered to the SO as balancing energy.

For example, say that the consumer's BRP/supplier had estimated that – absent the balancing call – consumption would be 4 MWh, and therefore the supplier had purchased 4 MWh in the market to match the consumer's consumption. At the settlement stage, the supplier will be assessed by the SO an imbalance equal to [4 MWh – (1.8 MWh+1.7 MWh)] = + 0.5 MWh; in this example the imbalance is an energy credit that the SO will pay the supplier.

At the settlement stage, the monetary transactions shown in the following table will take place.

Transaction	Volume	Price	Notes
SO pays BSP for balancing energy delivered by the consumer	1.7 MWh	P_{Bal_Up} , balancing energy (market clearing) price	
BSP pays to SO the penalty for under delivery	0.3 MWh	$F_{Underdelivery}$ Penalty for under-delivery	This price is not meant to reflect the value of the electricity that was not delivered. It is just a penalty for not having performed at the SO's call.

Transaction	Volume	Price	Notes
Consumer pays BRP for energy consumed	1.8 MWh	P_{Retail} , the electricity supply price, agreed between the consumer and his supplier, that we take to coincide with the BRP	This volume is the one read at the consumer's meter[14].
BSP pays BRP for balancing energy sold in the balancing market.	1.7 MWh	P_{BRP_BSP}	Agreed between the BSP and BRP, or regulated
SO pays the *BRP* for the positive energy imbalance.	0.5 MWh	P_{Imb} , the imbalance price	

Table 1: Example of a BSP-BRP transaction
(Source: Consultant's own analysis)

In Table 1 we do not present the transaction between the BSP and the consumer, through which they share the profit collected by the BSP by selling in the balancing market the consumer's flexibility. This profit is:

$$V = \left[P_{Bal\_Up} - P_{BRP\_BSP}\right] \times 1.7\ MWh - F_{Underdelivery} \times 0.3\ MWh$$

We can observe, incidentally, that assigning to independent agents balancing responsibilities (BRP) and the supply of balancing services (BSP) is relatively straightforward in the real-time/balancing timeframe of electricity market operations.

This happens because in that time frame there is a reasonably undisputable[15] way to assess the baseline consumption, which is key to computing:

- the volume of electricity that the consumer has delivered to the SO in the real time stage, which determines the BSP's rights and obligations;
- the volume of electricity that the BRP is responsible for injecting in the system, equal to the sum of actual consumption and the volume delivered to the SO.

2.3 Explicit DR support schemes

Most support schemes for DR are capacity based, i.e. they provide additional compensation based on the consumer's ability to reduce consumption in response to price signals, rather than based on the actual delivery of such performance[16]. This is consistent with the nature of the market imperfections that such schemes intend to make up for, which mostly relate to uncertainty on the future profitability of DR supply, as well as on the cost structure of DR service providers, featuring a high share of fixed cost.

The key elements of explicit DR support mechanisms are:

a) the volume of consumption that the consumer can reduce, which we call the consumer's **DR capacity**;

[14] *But for loss, that we neglect here.*
[15] *Although conventional.*
[16] *An energy-based support scheme would inflate the price received by DR provider for the electricity sold.*

b) whether the consumer makes available such volume to the system;
c) whether the consumer delivers the volume of DR, in case of activation.

Next, we address the three key elements.

a) *The consumer's DR "capacity".* Assessing the consumer's capacity to deliver DR requires evaluating:

- the consumer's consumption at times when he does not deliver DR, i.e. the baseline; and
- the consumer's ability to reduce actual consumption below the baseline.

Setting the baseline is necessary to ensure that the consumer, or more precisely his BRP, delivers to the system a volume of electricity at least equal to the baseline. This enables the consumer to supply the DR service by foregoing consumption of part of the baseline when prices rise.

Consider first the case of a **forward DR product**, i.e. a product that places on the consumer the obligation to offer DR in a forward electricity market, the day-ahead market, or the intra-day market. Supplying this kind of product requires that the consumer is able to commit to a consumption level below the baseline well ahead of the time of consumption; in particular, at a time consistent with the participation in the forward electricity markets.

In this case, the baseline consumption is typically based on the consumer's historic consumption, in the expectation that this level of consumption will be matched by injections by the consumer's BRP. Alternatively, it is possible to require the consumer himself, or by his BRP or BSP[17], to state his baseline, in the expectation that arrangements are in place ensuring that the BRP will match the declared baseline[18].

We will now consider a **balancing/real time DR product**, i.e. a product that places on the consumer (via his BSP) the obligation to offer DR in the balancing/real time market; supplying this product requires that the consumer is able to reduce consumption after being instructed to do so by the SO[19].

In the previous section we argued that, normally, the consumption level at the moment in which the consumer receives the SO call to reduce consumption is a plausible baseline. Refinements are possible to reflect in the baseline level further information on the consumer's intended consumption over the period in which his DR performance is activated. For instance, if we consider the case of a consumer whose consumption is reducing in the 5 minutes before the SO's call, one may want to interpret that consumption behaviour as signalling that, without the SO, the consumer would have further reduced his consumption. In that case, the baseline would be set smaller than the consumption level at the time of the SO's call.

Once the baseline is set, the consumer's **DR capacity** is the largest consumption reduction from the baseline that he commits to perform. A capacity-based incentive support scheme will then compensate DR providers based on their DR capacity.

We do not address here the important dimensions of a consumer's ability to control his consumption that may determine his contribution to the system's flexibility. These

[17] This is for example the setting foreseen in Italy.
[18] In fact, such coordination might be mandated; more generally, enforcement mechanisms further then that imbalance pricing regime may be devised to ensure that the consumer's baseline consumption is matched by injections.
[19] The system operator issues the instruction by accepting the consumer or BRP's offer in the balancing market.

dimensions include, for example, the minimum number of times over, e.g. a year or a month in which the consumer can reduce consumption, or the maximum duration of the call reductions that the consumer may perform. In principle, the capacity-based financial support might be differentiated based on those dimensions too.

b) *The DR level made available to the system*. In exchange for financial support, the DR provider is bound to make his DR capacity available to the system. The way to verify that the consumer abides to this obligation depends on the type of DR product.

For a **forward DR product**, a consumer makes his DR capacity available to the system by implementing a bidding strategy in the forward market, so that his position when negotiations end (i.e. at **gate closure**) is consistent with his DR commitment. For example, a consumer with 10 MW baseline and DR capacity of 4 MW must implement a bidding strategy in the day-ahead and intraday markets, so that his position at gate closure is no more than 6 MW in case the clearing prices of the day-ahead and intra-day market sessions are sufficiently high above a pre-defined threshold[20]. In EU forward markets, where portfolio bidding is extensively implemented, it is impossible to single out the offers and bids corresponding to a specific consumer or set of consumers offering. This makes it hard to verify whether the bidding strategy reflects the DR commitments. However, as we show next in point c), it is possible to verify ex-post if the forward DR capacity was activated to deliver flexibility.

For a **balancing/real time DR product,** verifying that the DR capacity was made available to the system is straightforward. This happens because DR capacity is made available just by placing an offer in the balancing real/time market. The observation of an offer in the balancing/real-time market by the consumer, or more generally a BSP, with volume equal or greater than the DR capacity, is therefore evidence that the requirement to make DR capacity available the system was met.

c) *DR delivery*. The DR service is delivered if the consumer's consumption actually falls below the baseline, by the consumer's DR capacity, when the market clearing price is above a certain level.

For a **forward DR product**, DR delivery can be verified based on the metered consumer consumption at each time and the corresponding forward market clearing prices. It is typical for DR support scheme to set a maximum activation price for the DR service; when the clearing price of the day-ahead market is higher than the maximum activation price the DR provider is expected to have activated his DR capacity. In this case, DR delivery is verified ex-post by checking that the DR provider consumed less than his baseline, reduced by the DR capacity he is being paid for by the support mechanism.

The same logic applies to the delivery of a **balancing/real time DR product**, keeping into account the corresponding baseline.

2.4 Aggregation

The possibility for the BSP to aggregate multiple consumers for the purpose of participating in the balancing market is a distinguishing feature of the model for demand integration in the markets being developed in the EU. Figure 5 illustrates the main elements of the model.

[20] *The sequential features of forward markets introduce a conventional element in the assessment of the "forward price" of electricity, for the purpose of triggering the DR. This happens because the clearing prices of the different market sessions may differ.*

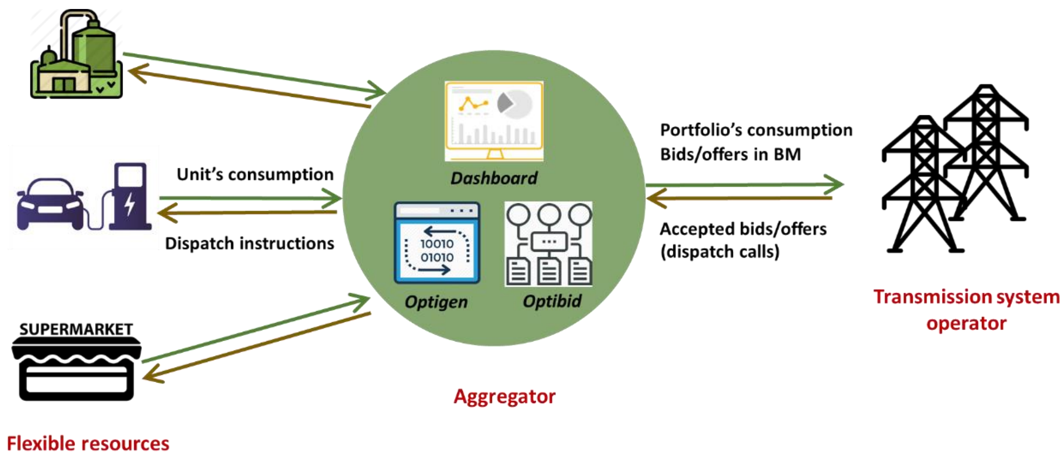


Figure 5: Demand response model
(Source: Consultant's own analysis)

The BSP, indicated in the figure as **aggregator**, manages a portfolio of flexible consumption or generation assets, each one too small to participate individually in the balancing markets. Such portfolios are sometimes referred to as **virtual power plants** (VPP). In the rest of the section, we cast our presentation in terms of consumption units, although a typical VPP may generally include different sorts of flexible resources, including generators and storage systems.

The BSP:

- connects to each consumer belonging to the VPP to:
  1. know at each time its status, including at least its current consumption level and its availability to modify it;
  2. send orders to change the asset's net injection level;
- connects to the SO to:
  1. enable the SO to know at each time the status of the VPP, i.e. the actual aggregate consumption of all consumers belonging to the VPP and their aggregate capacity to increase and decrease consumption at the SO's request;
  2. place the VPP's bids and offers in the ancillary service and balancing markets, in competition with the stand-alone large generation units;
  3. receive dispatch instructions to change the VPP's consumption level, every time a bid or offer of the VPP is accepted in the balancing market.

Interposing the aggregator between small flexible resources and the SO has the following benefits.

First, granting direct access to ancillary services and balancing markets to small flexible resources would require major updates in the rules and systems implemented by the SO. In the model based on aggregators, the system operation processes are basically unchanged. The same holds, to some extent, for the design of the products procured by the SO in the balancing and ancillary services markets. This is the case because the aggregator can package the contributions of many small consumers into the same product that the SO currently purchases from the traditional suppliers of flexibility, the large generators. This means that the products traded in the balancing and ancillary services market can be designed based on the size – typically in the order of some MWs – and technical constraints of the VPP as a whole and not that of individual components of the VPP – which could be consumers with connection power as low as few tens of

KWs. For example, eight consumers, each one available to reduce consumption by 250 kW for 15 minutes, can be aggregated to offer to the SO a 1 MWh balancing energy for 30 minutes.

Secondly, allowing direct access to ancillary services and balancing markets for small assets would provide little contribution to the development of flexible capabilities. Unlike the SO, the BSP has the sole objective of maximizing the flexibility potential of his VPP; this can be achieved, for example, by working with the resource owners to maximize the capabilities of individual resources.

Finally, one of the key benefits of aggregation is the diversity of the aggregated portfolio (i.e. many small loads building one large resource), which ensures that the committed capacity will be delivered by the aggregator even when some individual consumers may not be able to perform.

Electricity markets in the EU are being updated to allow independent agents to take on supply/BRP and BSP responsibilities for the same consumer. A possible rationale for allowing a party different from the supplier to act as BSP is that this could bring more competition and innovation in the development of additional flexible resources. Developing flexibility requires:

i) an understanding of processes and needs that drive individual user's consumptions, in order to identify each unit's potential flexibility;
ii) commercial skills necessary to convince consumers to become providers of flexibility; and
iii) technical competencies to support consumers in setting up their organization and appliances to deliver flexibility at minimum cost.

This mix of competencies has little or no overlap with that of electricity suppliers, who are basically sellers of a commodity. It might instead overlap with the competencies required by other businesses, such as, for example: building maintenance, energy services, or supply of industrial appliances. By allowing companies active in those businesses to develop into aggregators one would expect this market to develop at a faster pace, rather than if only traditional electricity retailers acted as aggregators.

The point in time where responsibilities on the consumer's behaviour are handed-over to the BSP reflects the different organisational set-ups necessary to exploit demand price-responsiveness in different timeframes. At the forward stage, which in the European market extends until 1 hour before the time when consumption takes place (or real time), procurement of electricity takes place based on the consumption plans (or forecasts); therefore, the interaction between the consumer and his supplier is limited and at arm's length.

On the contrary, when it comes to modifying consumption in real time in response to a call that may come with a notice of minutes or seconds, the interaction between the consumer and the BSP gets more sophisticated, as it involves the exchange of information on the actual state of the consumer's equipment and the possibility to have it remotely controlled.

2.5 DR operators

We call **DR operators** the agents that act as interface between electricity consumers and the market on the provision of flexibility services. DR operators perform one or more of the following activities:

- development and management of flexible assets;
- supply of access to the (flexibility) markets;
- supply of flexibility services.

2.5.1 Development and management of flexible assets

Some DR operators perform typical energy service company (ESCo) activities, i.e. they help energy consumers to optimise their consumption. In this context, DR operators identify the current flexibility margins available to the consumer and opportunities to expand them, for example by changing some equipment or modifying the production processes for which electricity is an input. In some cases, usually as a part of multiservice agreements including electricity supply and the provision of access to the market, ESCo participates in financing investments necessary to modify the consumer's equipment and processes to enable flexibility.

As part of the ESCo activities, the DR operator may take responsibility to manage and maintain the consumer's equipment that deliver the consumer's flexibility, for example electric boilers, climatization and ventilation systems, refrigerators, recharging points for electric vehicles.

2.5.2 Supply of access to the (flexibility) markets

Supplying flexibility to the electric system is not the primary activity for consumers. Therefore, it is common for them to delegate this activity to a third-party professional operator, the DR operator.

In carrying out this activity, the DR operator interacts with:

- the consumer's supplier or the BRP, for example to convey the information necessary to place price-dependent bids and offers and relay to the consumer the expected consumption schedule, based on the wholesale market outcome;
- the SO, in case the consumer is a large stand-alone participant in the balancing market;
- the BRP, on matters related to electricity that the consumer sold to or purchased from the SO in the balancing market.

The distinguishing feature of this business model is that the DR operator acts as a SP for the consumer, taking no responsibility vis a vis the consumer's counterparties (supplier, SO, BRP) related to the consumer's actual behaviour. For example, the consumer bears the cost of the penalties administered by the SO in case he fails to deliver a balancing action.

2.5.3 Supply of flexibility services

The distinguishing feature of this business model is that the DR operator takes responsibility for delivery of flexibility services to the SO and the BRPs. This model is the obvious choice in combination with the DR operator acting as aggregator, as illustrated in the previous section.

In this model the DR operator:

- manages the VPP technical infrastructure;
- aggregates the capabilities the VPP members into products suitable to be offered in the balancing markets or to BRPs for own-balancing purposes;
- is the BSP for the VPP, and therefore submits offers in the balancing market, collects the corresponding revenues in case they are accepted and is liable for penalties in case of under delivery.

In this framework the consumers participating in the VPP are providers of an input to the DR operator. The corresponding rewards and obligations are negotiated between them and the DR operator.

From this cursory presentation of the DR operator business models, we draw the following conclusions. First, the DR operator has a pivotal role in taking additional flexibility to the market, in particular by relatively small consumers. Second, the extraction of flexibility from electricity consumers is typically one of multiple outcomes resulting jointly from the optimisation of the customer's electricity consumption. This exercise has technical, organisational, and economic dimensions and more importantly, it is generally highly consumer specific. For this reason, it is hard to provide indications on the cost of flexibility, with some general value.

2.6 Market failures that might lead to inefficient supply of DR in liberalised electricity markets

According to the standard market paradigm, the expectation of frequent price spikes and valleys in the forward markets should provide incentives for consumers to develop the efficient level of forward flexibility. This happens because flexibility allows minimising electricity procurement cost, by allocating consumption away from high-price hours. In the same way, the expectation of frequent spikes and valleys in balancing prices should provide incentives for consumers and other flexibility providers to develop the efficient level of real-time flexibility. This would enable them to compete to supply balancing services.

Efficient risk reallocation – from those who invest in developing flexible capabilities and DR, to BSP – would take place via suitably designed long-term contracts.

In fact, despite the wide-spread perception that additional flexibility is, and will in the foreseeable future be largely needed, because of the increasing share of generation capacity powered by intermittent renewable sources, DR is not taking off and nor are other forms of flexibility.

The relevant policy question, then, is - what causes the market mechanism to fail in delivering an adequate volume of flexibility?

As we will illustrate in chapter 5, the supply of DR services requires material investments. Therefore, uncertainty on future profitability may increase the cost of capital, with less than friction-less capital markets, thus preventing desirable investments to take place.

The value of DR services depends on the frequency and width of the spikes of forward (day-ahead and intraday) electricity prices, balancing prices and imbalance prices. Such volatility is highly uncertain, as even small changes of demand and supply conditions may cause large changes in the price path, and in the number of scarcity events.

A large part of such uncertainty relates to the operations of the SO and to decisions of public authorities, that may be hard to predict. For example, each of the following decisions may have a dramatic impact on the value of DR services:

- new transmission connections may affect the price path, by allowing larger flows between areas where demand and supply shocks are not fully correlated.
- installing smart-network equipment may reduce the need for regulation services.

- an increase in generation capacity triggered by politically set support measures may affect the price path as well as the demand for balancing services.
- the delay in the retirement of old thermal capacity, possibly mandated by the SO to ensure system security, may jeopardize the revenue expectations of DR providers.

A further source of uncertainty of DR profitability relates to the current and future cost of competing sources of flexibility. Technological development may change the relative cost of delivering flexibility via DR or storage devices.

The impact on investment of uncertainty about the future path of electricity prices has been recognised by governments in most countries. It prominently features among the motivations for the introduction of generation capacity support schemes, like capacity remuneration mechanisms, strategic reserves and contracts for differences to drive investment in renewable generation capacity.

Because of the innovative nature of DR services, their supply cost might materially reduce as the market for such services expands. For example, most electricity consuming production processes have not been designed with a view to regulate electricity consumption in response to varying electricity prices. Most existing electric equipment is not designed for being remotely controlled, or it uses non-standardised communication protocols. If flexibility becomes one of the design features of production processes and standardised remote monitoring and control protocols are implemented, the cost to provide DR services might significantly reduce.

Even final consumers, who are ultimately the suppliers of flexibility might need time and learning to internalize the DR business. This might hold in particular for smaller suppliers, who have limited control on the technology deployed to control their consumption. Consider for example a large food supplier: in deciding whether to entrust DR service provider to control his refrigerating units to provide DR service, the food supplier will compare the compensation that he will receive from the DR service provider with the losses he would suffer in case a failure in the control system causes some stored food to go off. For those reasons, some reluctance by consumers to participate in (even profitable) DR programs can then be expected, in particular at the early stage of development of the industry.

Externalities

Environmental externalities provide justification for most of the measures being undertaken in the electricity sector in the EU, as they are unlikely to be fully accounted for in market transactions. DR is a source of flexibility with low carbon impact, compared to thermal generators, traditionally used for the same purpose. Further, the development of DR capabilities usually takes place in the context of an overall optimisation of the consumer electricity consumption, which may lead to identifying and exploiting energy saving and on-site renewable generation opportunities that might otherwise go overlooked.

Investors myopia

Public authorities may consider that market investors fail to correctly anticipate the value of investment in flexibility, including DR. For example, market investors discount too heavily the DR revenues they will obtain once the decarbonisation targets for the generation fleet are fully achieved.

Political cost of curtailment and aversion to price spikes

Demand curtailment in a scarcity situation is commonly regarded as politically unacceptable. The same holds for extreme price spikes. For this reason, relying on electricity price spikes and scarcity events to attract investment in flexibility may be unpalatable, for governments, regulators and SOs.

Avoiding extended periods of extreme prices and curtailment requires that the replacement of the traditional sources of flexibility, the thermal generators, with carbon-free ones, takes place in a situation of excess supply. This requires that DR is financially supported during the transition.

2.7 The governance of investment in the electricity sector in the EU

In the EU, investments in basically all areas of the electricity value chain are driven, to a smaller or larger extent, by public decision making.

First, public intervention appears to drive investment decisions in generation capacity. Renewable support measures are evolving into structured arrangements to govern the development of the generation fleet. **Contracts for differences** awarded via auctions appear to have been selected as the main mechanism to support investment in power generation in the EU. **Capacity remuneration mechanisms** or **strategic reserves** are deployed to integrate and/or stabilize the income of traditional generators, and in some cases to attract investments in additional capacity.

Second, smart-network technologies are being implemented by transmission SOs, operating as regulated monopolies.

Third, new uses of electricity, for example for low-temperature heating and transportation, benefit in some cases of public support.

All those streams of policy intervention ultimately have an impact on electricity prices and therefore on the profitability of the investment in DR, or more generally, flexible capabilities.

3. Barriers for demand side response participation in electricity markets

The findings of the literature review and consultation process with stakeholders on the barriers for DR participation in electricity markets are presented in the following sections. In particular, the findings concerning the stakeholders' perspectives on the significance of barriers in electricity markets associated with the legal and regulatory framework, market barriers, and technical barriers are presented.

3.1 Barriers' Relevance

The literature review provided a list of the prevailing barriers in the 27 EU Member States. As required by the terms of reference of this study, the list of barriers for DR participation in electricity markets was organized by blocks, areas, and single barriers, as illustrated in the infographic below and discussed in the following sections.

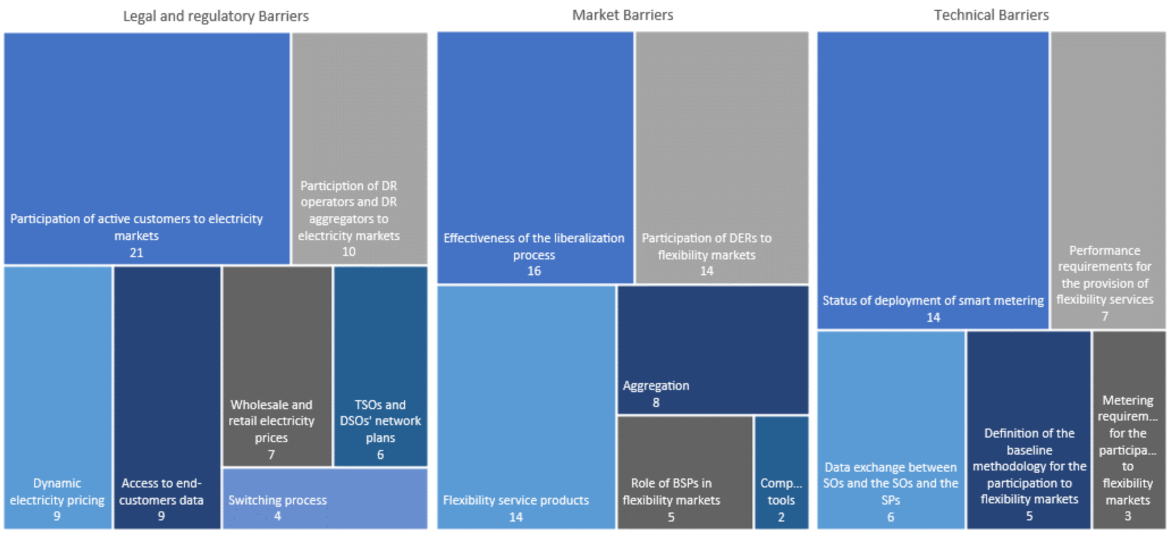


Figure 6: The number of times a country has been spotted within each barrier area (Source: Consultant's own analysis)

Of the three main blocks, the Legal and Regulatory barriers emerged as the most relevant barrier block, with barriers regarding the engagement of active customers, DR operators and DR aggregators in the electricity market reported as the most prevalent (21 and 10 out of the 27 EU Member States).

The literature review also identified Market barriers as the second most substantial barrier block, with market liberalization and barriers related to flexibility service products being the primary challenges, observed in 16 and 14 EU Member States, respectively. Technical Barriers, although less frequently encountered overall, were found by the Consortium quoted in some Member State' documents, despite not being as prominently featured as those in the first two barrier blocks.

As explained in the methodology section above, the Consortium cross-referenced and validated the outcomes derived from the literature review by comparing them with the results obtained from the survey and interviews conducted with stakeholders. The tables presented below show the outcome of this exercise as the overview of the perception of the most prominent barriers affecting the participation of DR in electricity markets.

The following tables list the areas of barriers within each block, detailing the number of specific barriers (flagged by the "B.") identified within the corresponding area.

Table 2 below illustrates how the Legal & Regulatory block emerged again as the most relevant block of barriers, confirming the initial findings of the literature review. Both the survey and interviews identified a total of five (5) most prominent barrier areas within this block. As a final result, the first two areas, pertaining to the participation of DR operators and aggregators, and active customers in electricity markets, revealed 5 and 3 individual barriers, respectively. Additionally, relevant barriers were identified within the areas of switching process, meaning when the consumer switches supplier or DR provider, TSOs and DSOs' network plans and access to end-customer data.

Block	#	Area	B.
Legal & Regulatory Barriers	1	Participation of DR operators and DR aggregators to electricity markets	5
	2	Participation of active customers to electricity markets	3
	3	Switching process	1
	4	TSOs and DSOs' network plans	1
	5	Access to end-customers data	1

Table 2: Overview of the most prominent barrier areas under the Legal & Regulatory block
Note: "B." label indicates the number of barriers.
(Source: Consultant's own analysis)

Table 3 and Table 4 depict the equal relevance of the Market and Technical blocks within the barriers' framework, with 4 barrier's areas reported as the most prominent within these two blocks.

Table 3 reports the barrier area related to flexibility service products emerging as the most relevant. Within this specific barrier area, 2 individual barriers were highlighted as particularly important (the complete list of barrier areas is presented in Annex I).

Block	#	Area	B.
Market Barriers	1	Flexibility service products	2
	2	Perimeter of aggregation for the participation to flexibility markets	1
	3	Role of BSPs in flexibility markets	1
	4	Effectiveness of the liberalization process	1

Table 3: Overview of the most prominent barrier areas under the Market barriers block
Note: "B." label indicates the number of barriers.
(Source: Consultant's own analysis)

Table 4 reports the barrier area related to performance requirements for the provision of flexibility services as the most relevant. Within this specific barrier area, 2 key barriers were highlighted as particularly important (the complete list of barrier areas is presented in Annex I).

Block	#	Area	B.
Technical Barriers	1	Performance requirements for the provision of flexibility services	2
	2	Status of deployment of smart metering	1
	3	Metering requirements for the participation to flexibility markets	1
	4	Definition of the baseline methodology for the participation to flexibility markets	1

Table 4: Overview of the most prominent barrier areas under the technical barriers block.
Note: "B." label indicates the number of barriers.
(Source: Consultant's own analysis)

Throughout our analysis, we observed that, firstly, the perception of the relevance of different barriers varies significantly across EU Member States. Annex I provides qualitative insights of the importance of these barriers across the 27 EU Member States. Secondly, we have identified that these barriers are multidimensional in nature, often encompassing legal, technical, and market-related challenges. While categorizing the barriers into these distinct blocks and areas helps in simplifying their description, it is less effective for assessment purposes. In the following sections, we elaborate on the key barriers to accessing electricity markets and propose recommendations for their removal.

3.1.1 Key barriers´ to access electricity markets and recommendations for removal

DR participation in electricity markets requires that consumers are able to place bids and offers in all relevant markets – including spot electricity markets and ancillary service markets - either directly or through their supplier, or via an independent aggregator. As the results from the consultation exercise show, currently, many stakeholders from different EU Member States identify the lack of access to electricity markets as a barrier that hinders the development of DR.

This challenge arises because many Member States have not yet defined the main roles and responsibilities of DR market actors, nor have they fully opened their wholesale electricity markets and SO services to all types of DERs, either individually or aggregated[21]. Furthermore, almost half of the Member States do not define an aggregation model within the same markets. This lack of uniformity limits the effectiveness and scalability of DR initiatives across Europe[22].

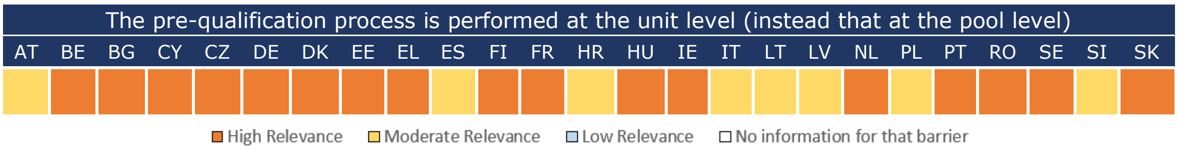
To ensure that DR resources, individually or aggregated, have non-discriminatory access to all electricity markets, including wholesale and SOs service markets, EU Member States' legal frameworks need to fully transpose the requirements of the Electricity Directive and the Electricity Regulation, including the roles and responsibilities of new market participants as active customers and aggregators.

In the following sections, a subset of barriers was selected and analysed. In particular, the study examined an impact of those barriers on the necessity and proportionality of financial support measures. Another subset of barriers of more regulatory or technical character was analysed from the perspective of its impact on the development of DR and its participation in electricity markets.

3.1.2 Legal and regulatory barriers to entry into the ESCo, BSP and aggregation businesses

Stakeholders seem to consider as a relevant barrier that affects the participation of DR in electricity markets **the pre-qualification process being performed at the unit level instead that at the pool level**. In reporting this barrier, stakeholders highlight this challenge as the limitation in the prequalification process that hinders DERs of any size from accessing balancing services.

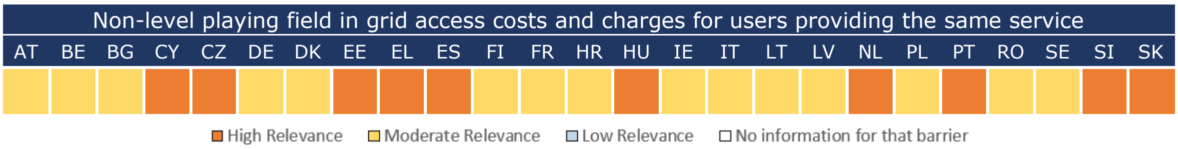
[21] *Removing barriers to demand response and other distributed energy resources, ACER - 2023 Market monitoring report, ACER_MMR_2023_Barriers_to_demand_response_Infographic.pdf.*
[22] *Ibidem.*



Recommendation 1

To enable the full potential of DR in all electricity markets, it is crucial to promote the aggregation of smaller units. This would mitigate the potential disadvantages for new market entrants and prevent undue advantages for incumbents with large portfolios. In this way, BSPs have the flexibility to aggregate various units, including generation, demand, and energy storage. However, SOs must maintain the possibility to know and check details on the performance of the units belonging to the pool of units. Over time, as trust in the aggregated portfolio builds, SOs could reduce the granularity of their control, focusing more on aggregate performance outcomes.

The lack of a level playing field in grid access costs and charges for users providing the same service has been reported as a barrier in some EU Member States. This issue arises because, when contributing to system services - such as participating in balancing markets or providing non-frequency services - generation and storage facilities may be exempted from grid access costs and charges associated with grid access.

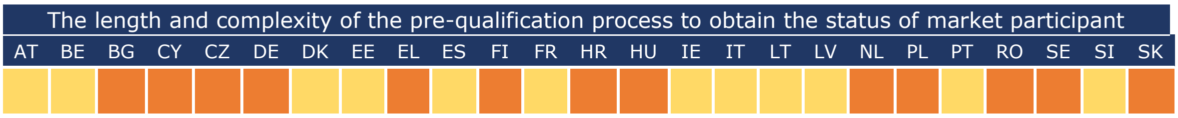


Recommendation 2

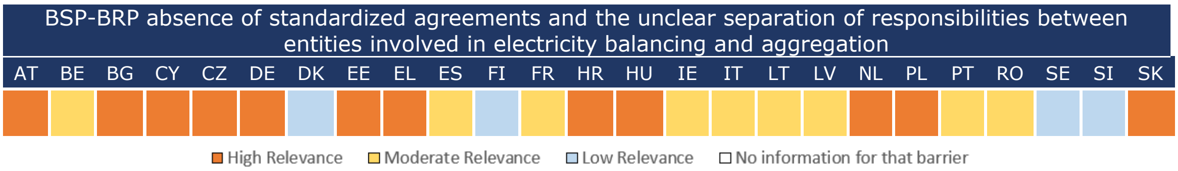
To ensure a level playing field in the provision of system services, when exemptions from grid access costs are granted to generation and storage facilities, they should equally apply to DR providers when providing the same services . This will promote fair competition and foster the participation of all resources, including DR, in balancing markets and the provision of non-frequency ancillary services.

3.1.3 Avoidable transaction cost (e.g. standardisation of the BSP/BRP contract)

The following barriers relate to the **high administrative and legal burdens** that independent SPs face when registering as market participants, and with the **BSP-BRP separation and absence of standardized agreements between entities involved in electricity balancing and aggregation**. Regarding the administrative burden, stakeholders highlight that participation of all resources in the electricity markets is not guaranteed on a level playing field, while the requirement of the registration as a supplier and as a BRP is restrictive for market entrance. These two barriers show a non-alignment with the IEM Directive[23] and the Commission Regulation on balancing[24].



[23] *Article 13, Directive (EU) 2019/944 for the internal market for electricity.*
[24] *Commission Regulation (EU) 2017/2195 establishing guidelines on electricity balancing.*



Recommendation 3

The introduction of streamlined procedures and clear guidelines can reduce the length and complexity of the pre-qualification process, encouraging greater participation in the market.

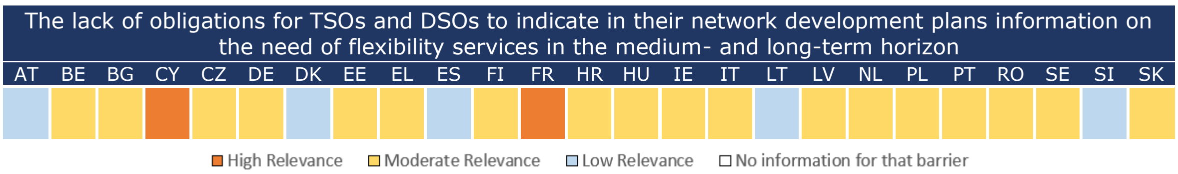
Standard bilateral agreements between BRP, BSP and aggregators can solve the market design issues generated by the non-integration of DR with supply. Bilateral agreements can unlock DR potential, increase competition in electricity markets and guarantee a lower degree of complexity for aggregators. Goodwill of the supplier/BRP and the economic conditions are key when a supplier/BRP decide to enter into an agreement with an aggregator. However, the impact of confidentiality should be also considered. More specifically, to protect aggregators' core business of identifying and developing DR potential, notifications of DR activations at the individual level should remain confidential to prevent suppliers from benefiting without cost.

Introducing standard contract templates through regulation can streamline agreements and facilitate market entrance and lower transaction costs for aggregators. In cases where aggregators are also consumers, these agreements can be part of the supply contract. To manage electricity transfer and BRP imbalance risks, the agreement should include terms for electricity settlement during DR activation, typically with an agreed transfer price. These provisions can delegate balancing responsibility from the BRP source to the aggregator.

Finally, it is important to establish a transparent information exchange protocol between BRPs and BSPs to avoid penalties (i.e. imbalance charges, failure to meet contractual obligations, non-compliance with grid codes, inaccurate data reporting, operational failures, late or incomplete market settlements).

3.1.4 Obstacles to assessing the future value of flexibility (e.g. lack of clarity on future requirements for flexibility and on SO expectations as to the future sources of flexibility)

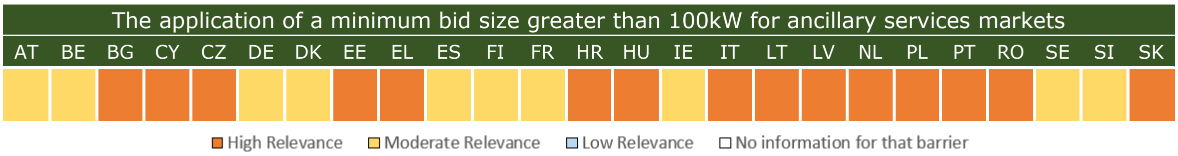
The lack of obligations for TSOs and DSOs to indicate in their network development plans information on the need of flexibility services in the medium- and long-term horizon is perceived as a relevant barrier. This lack of obligation is seen by stakeholders with low and medium relevance in most EU Member States as a factor that hinders effective planning and provision of flexibility services within the electricity infrastructure.



Recommendation 4
With TSOs and DSOs including information about the need for flexibility services in their long-term network development plans, it would provide clarity and foresight for DR actors. An obligation to include this information in the planning material of TSOs and DSOs would enable DR actors to better understand and anticipate the demand for flexibility services, allowing them to strategically plan and tailor their offerings to meet the expected requirements. It could enhance the overall efficiency and effectiveness of the DR market by aligning it more closely with the evolving needs of adequacy and flexibility of the electricity infrastructure.

3.1.5 Obstacles to bringing flexibility to the market (e.g. design of balancing products, requirements on communication systems)

Within the Market barriers block, the area of flexibility service products and the area related to the role of BSPs in flexibility markets are those that stakeholders were highlighting the most. Stakeholders seem to consider as most relevant in affecting the participation of DR in electricity markets the barrier on **application of a minimum bid size greater than 100kW for ancillary services markets.** This barrier relates to the lack of definition of appropriate bid thresholds and other product characteristics reflecting DR technical capabilities hindering the participation of DR, DR operators and aggregators to flexibility markets. Particularly, a minimum bid size higher than 100kW for ancillary service market, according to consulted stakeholders, establishes an entry barrier, and therefore limits DR participation for small-scale stakeholders.



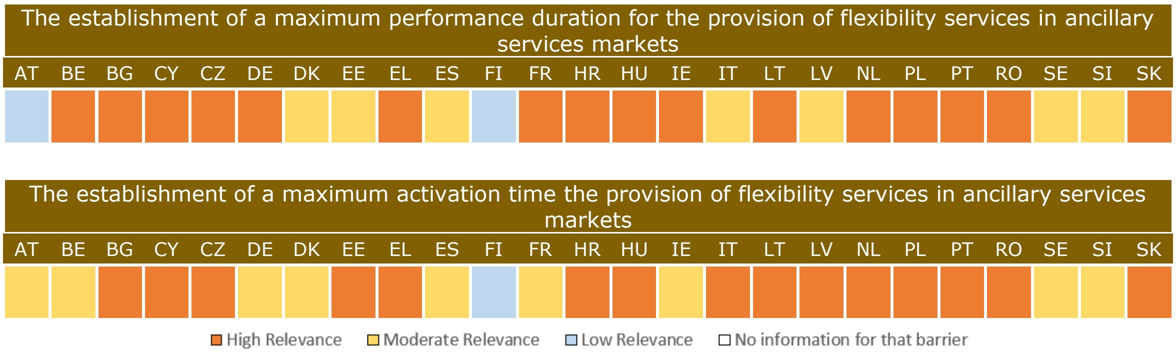
Recommendation 5
In most EU electricity and ancillary service markets, minimum bid sizes are typically set in the order of megawatts (MW), a threshold that aligns with current operational needs of SOs. If minimum bid size in the order of MW is considered too big, aggregation can bridge the gap between the limited DR capacity of individual consumption units and the larger scale required for efficient market participation. Aggregation allows smaller units to pool their flexibility, meeting the MW-scale bid requirement, while optimizing the efficiency of DR providers. Therefore, the recommendation is to maintain minimum bid sizes in the order of MW and in the meantime ensuring aggregation.

Regarding the Technical barriers' areas, the establishment of a maximum performance duration for the provision of flexibility services in ancillary services markets has been identified as a major technical barrier. Another major technical barrier identified is the establishment of a maximum activation time for the provision of flexibility services in ancillary services markets.

Stakeholders have identified performance requirements for flexibility services as the main barriers, emphasizing the need to consider the technical capabilities of DR providers.

First, these barriers, reported with medium-high relevance across most EU Member States, highlight the necessity of reducing delivery periods. Longer delivery periods restrict DR participation, especially since residential, commercial, and industrial consumers typically activate flexibility for only 1-2 hours.

Second, activation times for flexibility services in ancillary services markets vary by region and service type. Current activation times and unregulated intermediate steps can introduce uncertainty for BSPs, affecting their ability to deliver services promptly and impacting revenue and customer base. This issue is particularly significant for BSPs prequalifying RPGs with multiple units, such as aggregators, leading to an uneven playing field among SPs.

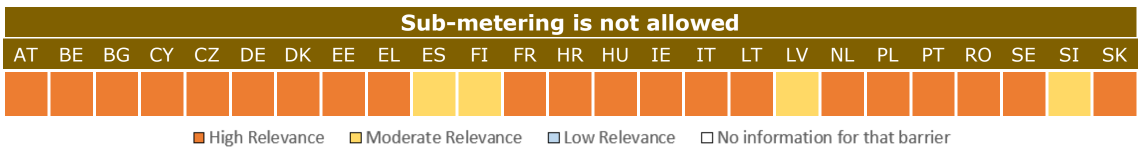


Recommendation 6

Delivery periods and activation times should align with the operational characteristics and specific requirements of DR providers. Delivery periods should be tailored to match the actual capabilities and activation patterns of residential, commercial, and industrial consumers, who typically engage in flexibility for shorter durations, usually ranging from 0 to 2 hours. Also, standard activation times across different regions and service types help to align the qualification process, including intermediate steps, with the SO regulation. This can ensure transparency, minimizing uncertainty for BSPs, and enhances the prompt provision of balancing services. By creating a level playing field among service providers, particularly for BSPs with multiple units like aggregators, market regulatory frameworks can foster a more effective, responsive, and competitive ancillary services market, safeguarding revenue streams and maintaining customer bases for SPs.

Stakeholders have highlighted **sub-metering** as a relevant Technical barrier. EU-wide permitting of sub-metering is inconsistent, with some regions prohibiting it entirely. Where allowed, sub-metering devices lack customization for diverse asset characteristics and sizes, leading to reliance on main meters for performance measurement. This broader approach can hinder precise electricity management and optimization.

Also, the presence of standby generators often leads to the exclusion of sites from using sub-metering, as it is not seen as a viable solution in these cases.



Recommendation 7

Sub-metering should not be prioritized as an urgent measure in a context where the lack of clarity in the relationship between BSPs and BRPs across several EU Member States still prevails. However, it is advisable that policies should foster maximum participation. Thus, where necessary, submeters should be utilized where the contribution of DR needs to be clearly distinguished from that of fuel-based generators. To support a harmonized approach across the EU, sub-metering should be permitted with customization of metering devices to accommodate the diverse characteristics of different assets. Although the Electricity Directive does not explicitly refer to 'sub-metering,' it advocates for the deployment of advanced metering systems under Article 14, including smart meters. This provision can be interpreted to encompass sub-metering capabilities, thereby offering consumers detailed insights into their electricity usage patterns. An effective implementation can ensure that diesel generators are not considered as DR solutions.

4. Barriers for demand-side response participation to State aid mechanisms

In this Chapter we review a sample of State aid measures from 8 Member States (Belgium, Finland, France, Germany, Greece, Poland, Italy, and Ireland). Those State aid measures include capacity remuneration mechanisms, strategic reserve schemes, interruptibility schemes, and other measures aimed at supporting the provision of flexibility, as shown in the table below.

Country	Decision	Type of State aid Mechanism	Duration
Belgium	SA.54915[25] (2021) amended by SA.104336[26] (2023)	Market-wide Capacity Mechanism	10.2021-10.2031
Belgium	SA.48648[27] (2018)	Strategic reserve	11.2017 – 03.2022[28]
France	SA.39621[29] (2016)	Market-wide Capacity Mechanism	01.2017 - IQ 2026[30]
France	SA.107352[31] (2023) [replacing SA.48490[32] (2018) and SA.62006[33] (2021)]	Other flexibility measure - Measure to support short-term non-fossil flexibilities in France through calls for tenders	2023 – 2025 State aid will be provided over the period 2024-2034.
Finland	SA.55604[34] (2022)	Strategic reserve	10.2022 – 10.2032

[25] *Commission Decision of 27.8.2021 on the aid scheme SA.54915 - 2020/C (ex 2019/N) - Belgium – Capacity remuneration mechanism, available online at: https://ec.europa.eu/competition/state_aid/cases1/202137/288236_2313671_226_2.pdf.*

[26] *Commission Decision of 29.9.2023 on the aid scheme SA.104336 (2023/N) – Belgium - Amendments to the capacity remuneration mechanism, available online at: https://ec.europa.eu/competition/state_aid/cases1/202340/SA_104336_B04EFF8A-0000-CDF2-866E-13BF028481FA_65_1.pdf.*

[27] *Commission Decision of 7.2.2018 on the aid scheme SA.48648 (2017/NN) - Belgium - Strategic Reserve, available online at: https://ec.europa.eu/competition/state_aid/cases/272020/272020_1964726_118_2.pdf.*

[28] *The Strategic Reserve in Belgium has not been activated since its approval.*

[29] *Commission Decision of 8.11.2016 on the aid scheme SA.39621 – France – Market-wide capacity mechanism, available online at: https://ec.europa.eu/competition/state_aid/cases/261326/261326_1840296_301_2.pdf.*

[30] *The French authorities plan to revise the capacity mechanism in 2026 to adjust it to the Electricity Regulation.*

[31] *Commission Decision of 21.12.2023 on the aid scheme SA.107352 (2023/N) – France - Mesure de soutien aux flexibilités décarbonées de court terme en France par appels d'offres, available online at: https://ec.europa.eu/competition/state_aid/cases1/202405/SA_107352_70255A8D-0000-CC37-8D71-46CB470EBA1A_49_1.pdf.*

[32] *Commission Decision of 7.2.2018 on the aid scheme SA.48490 (2017/N) – France - Soutien de l'effacement en France par appel d'offres, available online at: https://ec.europa.eu/competition/state_aid/cases/272157/272157_1966994_95_2.pdf.*

[33] *Commission Decision of 29.10.2021 on the aid scheme SA.62006 (2021/NN) – France - Modification du soutien de l'effacement en France par appel d'offres, available online at: https://ec.europa.eu/competition/state_aid/cases1/202151/SA_62006_7088B87D-0000-CD61-9EA9-9176C58E0A67_155_1.pdf.*

[34] *Commission Decision of 11.10.2022 on the aid scheme 5604 (2022/N) – Finland - Finnish strategic reserve, available online at: https://ec.europa.eu/competition/state_aid/cases1/202246/SA_55604_A0135C84-0100-CF24-849C-1B860AD7D2C5_151_1.pdf.*

Country	Decision	Type of State aid Mechanism	Duration
Germany	SA.45852[35] (2018)	Strategic reserve/ German capacity reserve	2018 – (no end date)[36]
Germany	SA.43735[37] (2016)	Interruptibility scheme/ AbLaV	2016 – expired on 01.07.2022[38]
Greece	SA.56103[39] (2020)	Interruptibility scheme	2020 – expired on 30.09.2021
Poland	SA.46100[40] (2018)	Market-wide Capacity Mechanism	First auction autumn of 2018 to the last auction in 2025. State aid clearance is provided for 10 years.
Italy	SA.42011[41] (2018) amended by SA.53821[42] (2019)	Market-wide Capacity Mechanism	02.2018 – (no end date)[43]
Ireland	SA.44464[44] (2017)	Market-wide Capacity Mechanism	10.2018-10.2028

Table 5: State aid measures in a sample of eight (8) Member States
(Source: Consultant's own analysis)

Each sub-chapter covering each State aid measure covers (i) the main design features; (ii) the auction results and (iii) the identified barriers. The objective is to assess the participation of DR in each SA measure.

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[35] *Commission Decision of 7.7.2018 on the aid scheme SA.45852 - 2017/C (ex 2017/N) [which Germany is planning to implement for Capacity Reserve], available online at:* https://ec.europa.eu/competition/state_aid/cases/269083/269083_1983030_171_13.pdf.

[36] *The German authorities have indicated that the aid scheme will end once it has been established on the basis of the assessment of the required size of the Capacity Reserve that there is no longer a need to maintain a reserve. The most recent tender for the provision of the capacity reserve from October 2024 till September 2026 was announced in December 2023. Available at: Tender for the capacity reserve 2024 - 2026 - Bid deadline: December 1, 2023 (netztransparenz.de).*

[37] *Commission Decision of 24.10.2016 on the aid scheme SA.43735 (2016/N) – Germany - ABLAV Interruptibility Scheme, available online at:* https://ec.europa.eu/competition/state_aid/cases/264060/264060_1841480_86_2.pdf

[38] *However, according to Section 13 (6) of the Energy Industry Act ("EnWG"), TSOs may continue to conclude contracts with interruptible loads. The present voluntary commitment ("FSV") regulates the processes of system services in the real-time range from interruptible loads ("SEAL").*

[39] *Commission Decision of 29.9.2020 on aid scheme SA.56103 (2020/N) – Greece - Second prolongation of the interruptibility scheme, available online at:* https://ec.europa.eu/competition/state_aid/cases1/202045/286568_2204650_196_2.pdf

[40] *Commission Decision of 7.2.2018 on aid scheme SA.46100 (2017/N) – Poland – Planned Polish capacity mechanism, available online at:* https://ec.europa.eu/competition/state_aid/cases/272253/272253_1977790_162_2.pdf

[41] *Commission Decision of 7.2.2018 on the aid scheme SA.42011 (2017/N) – Italy – Italian Capacity Mechanism, available online at:* https://ec.europa.eu/competition/state_aid/cases/270875/270875_1979508_218_2.pdf

[42] *Commission Decision of 14.6.2019 on the aid scheme SA.53821 (2019/N) – Italy - Modification of the Italian capacity mechanism, available online at:* https://ec.europa.eu/competition/state_aid/cases1/201932/279418_2088284_196_2.pdf

[43] *COM SA.42011, Rec. 106: The Italian Authorities have not set an end-date since the measure is a long-term intervention intended to complement the energy-only markets.*

[44] *Commission Decision of 24.11.2017 on the aid scheme SA.44464 (2017/N) – Ireland - Irish Capacity Mechanism, available online at:* https://ec.europa.eu/competition/state_aid/cases/267880/267880_1948214_166_2.pdf

4.1 Belgium SA. 54915 amended by SA.104336–Market-wide Capacity Mechanism

4.1.1 Main design features

Capacity remuneration mechanisms remunerate capacity providers for making capacity available to the system. The SO procures, via the capacity remuneration mechanism, a volume of capacity equal to the system's requirement (i.e. they characterize as market-wide mechanisms).

The main features of the Belgian Capacity Mechanism are the following:

i. Access to the mechanism: The mechanism is open to all resources that can contribute to system adequacy, including existing and new generation capacity, storage, and DR.
   The minimum threshold for participation is 1 MW of eligible capacity. For DR resources the amount of eligible capacity is based on historic consumption and technical information on the ability of the consumption unit to reduce load. Aggregation of multiple resources providing capacity, across all technologies, is allowed for the purpose of participation in the mechanism.
   Capacity suppliers, and in particular DR suppliers, may be awarded support also for "unproven capacity"[45] i.e. before enrolling the consumers that will provide flexibility. Unproven capacity can only be offered in the Y-4 auction (see next sections) and can only be assigned a 1-year contract.
   Different derating factors are applied to account for the contribution of each technology to the reduction of security of supply concerns.

ii. Rights and obligations of capacity providers (including generators, storage, and explicit DR) under the mechanism: The capacity provider is assigned several "reliability options" corresponding to the awarded capacity. The reliability option:
   a. entitles the holder to a per MW (per year) premium.
   b. commits the holder to pay to the SO any positive difference between the spot market clearing price and a predetermined strike price (so called "pay-back obligation"). The pay-back provision aims to protect consumers against possible high electricity prices in scarcity situations.

   In addition, the capacity provider must make physically available the volume of DR that he was granted support for. For a DR provider this means that the consumption must fall below a certain threshold in case the spot price is above the strike price.
   Failure to make available capacity according to the provisions of the service level agreement results in penalties. Recurrent lack of availability results in an escalation of such penalties and eventually in the termination of the contract.

iii. Procurement mechanism: Reliability options are assigned via auctions, in which capacity providers compete on the required level of the premium. The pricing rule in the auction is pay-as-bid.

[45] *See recital 74 of the Commission Decision of 27.8.2021 on the aid scheme SA.54915 - 2020/C (ex 2019/N) - Belgium – Capacity remuneration mechanism: "The category [unproven capacity] is open to all technologies and aims at fostering the participation of capacities which may have more difficulties to already provide the standard required maturity level in Y-4. Unproven capacities represent less mature projects, e.g. when the delivery point is not known yet; no project execution plan is available, and the project only matures further during the predelivery period. The Belgian authorities explained that the concept of "unproven capacity" was introduced at the request of the market and might particularly be of use to aggregators/DSR providers, which consider being able to find such a capacity over the pre-delivery period, but e.g. still have to finalise agreements with demand sites/are considering multiple prospects."*

Two price caps are implemented, an intermediary price cap (around 20 000 €/MW-year) for 1-year contracts, mostly involving unproven capacity, and a larger one (75 000 €/MW-year) for contracts with longer duration for capacity justifying a significant level of investment[46]. Capacity providers can be exempted from the lower price cap by CREG (case-by-case approach), if they manage to prove that their annual capacity costs are above the intermediary price cap.
Auctions are held 4 years before the time when the capacity must be delivered. (e.g. the capacity auction for the delivery period 2025-26 was held in 2021). However, part of the total capacity requirement is reserved for shorter-term procurement, to take place the year before delivery.

iv. Contract duration: Capacity providers may choose among contracts of different duration ranging from 1 to 15 years. Access to longer term contracts (3, 8 or 15 years) is subject to the commitment by the provider to an investment level above a minimum per-MW threshold; higher thresholds condition access to contracts with longer duration.

4.1.2 Auction results

Auction year	*Delivery period*	*Total capacity awarded*	*DR capacity awarded*
2021	2025-2026	4 447,7 MW	287,07 MW
2022	2026-2027	6 681,79 MW	138,92 MW
2023	2027-2028	1 576,29 MW	49,38 MW

Table 6: Belgium - Capacity Remuneration Mechanism – Auction Results.
(Source: Elia Auction results for the Belgium Capacity Remuneration Mechanism)

4.1.3 Identified barriers

While the payback obligation may reduce the revenue uncertainty for capacities whose marginal costs are below the payback obligation strike price, the revenue uncertainty may increase when this provision is applied to capacities facing marginal costs above the strike price. This is notably the case of technologies such as storage and DR, that may have difficulties to anticipate the energy revenues (or loss) they will benefit from over the delivery period and therefore make the bidding strategy particularly complex for these technologies.

On the other hand, softening or removing the pay-back obligation for some technologies and not for others means that some technologies would get more valuable contracts than others, while providing the same service, thus distorting the competitive bidding process to which all technologies participate. For these reasons, the Capacity Mechanism framework (the Electricity Regulation and section 4.8 of the CEEAG) does not allow to positively discriminate a technology based on its costs' specificity. To ensure a level playing field among technologies, discrimination between technologies should be justified by a technical need (linked to the security of supply issue assessed) or by an environmental concern.

Therefore, contracts without payback obligation (if any) should ideally be allocated in a dedicated competitive bidding process open to all relevant technologies, to reflect the market value for such contracts.

[46] *Chambre des représentants de Belgique, July 2020, Résolution relative au mécanisme de rémunération de capacité pour l'électricitéen ce qui concerne la transparence, le coût, le mode de financement, le fonctionnement du marché et de notification à la Commission européenne.*

4.2 Ireland SA. 44464 – Capacity remuneration mechanism

4.2.1 Main design features

The main features of the Irish Capacity Mechanism, relevant for our analysis, include:

i. Access to the scheme: all potential capacity providers, including renewables generators, storage operators, consumption units, new capacity, and interconnectors, individually or in aggregated form, are allowed to participate in the scheme. Different derating factors apply to capacity delivered by different technologies. Aggregation is allowed. DSUs must have a minimum demand reduction capability of 4 MW. There is no lower limit to the demand reduction capability of individual sites comprising a Demand Side Unit ("DSU"), provided that the combined demand reduction capability is 4 MW or greater. Sites with a demand reduction capability of 10 MW or greater must participate individually.

ii. Rights and obligations for the capacity providers: reliability options are allocated to capacity providers. In addition, capacity providers are subject to the obligation to make the flexible capacity available to the system by offering it in the electricity and ancillary service markets, when eligible for participation. No pay-back obligation is placed on DR units that comply with the physical obligation to reduce consumption in case market prices rise above the strike price. However, difference payments apply when the demand reduction is not delivered at times of scarcity.

iii. Procurement mechanism: reliability options are allocated via auctions that run from 4 to 1 year in advance of the start of delivery. The pricing rule in the auction is pay-as-cleared.
Different provisions apply to existing and new capacity. To qualify it as "new", an investment above a certain threshold must be necessary to make the capacity available. A global price-cap, equal to an estimate of the cost for the new entrant (or CONE) is enforced. In addition, existing capacity, with the exceptions of DR capacity, is subject to a lower price cap.

iv. Contract duration: Existing capacity is entitled to a 1-year contract. New capacity is eligible to up to 10-year contracts.

4.2.2 Auction results

Auction	*Delivery period*	*DR capacity awarded*	*Total capacity awarded*
2018/2019 Y-1	2019/2020	619 MW	9 065 MW
2019/2020 Y-1	2020/2021	693 MW	8 533 MW
2020/2021 Y-1	2021/2022	552 MW	7 605 MW
2021/2022 Y-2	2023/2024	635 MW	7 511 MW
2022/2023 Y-4	2026/2027	600 MW	7 412 MW
2023/2024 Y-4	2027/2028	744 MW	7 322 MW
2024/2025 Y-4	2028/2029	532 MW	6 138 MW

Table 7: Ireland - Capacity Remuneration Mechanism – Auction Results.
(Source: SEM website - https://www.semcommittee.com/about-us)

4.2.3 Identified barriers

We have not identified any barriers to DR participation specific to the Irish Capacity Mechanism.

4.3 Italy SA. 42011, amended by SA.53821 – Capacity Remuneration Mechanism

4.3.1 Main design features

The design of the Italian Capacity Mechanism is largely similar to the Capacity Mechanisms implemented in Belgium and Ireland. The main features of the Italian Capacity Mechanism, relevant for our analysis, are:

i. Access to the scheme: all potential capacity providers, including renewables generators, storage operators, consumption units, new capacity, and interconnectors, individually or in aggregated form, are allowed to participate in the scheme. Different derating factors apply to capacity delivered by different technologies. For existing units, derating is calculated unit-by-unit based on the historical performance; for storage, derating is determined based on the energy/power ratio. The minimum bid size for participation in the mechanism is 1 MW.

ii. Rights and obligations for the capacity providers: reliability options are allocated to capacity providers. In addition, capacity providers are subject to the obligation to make the capacity available to the system by offering it in the day-ahead or in the ancillary service markets, when they are eligible for participation. For DR, the obligation entails the participation to the ancillary services market and the submission of balancing offers for the awarded capacity, during pre-defined ‘peak hours’.
In case an operator manages different units within a portfolio, it can meet the capacity obligations with any unit in the portfolio (nomination of units is done ex-post). This holds if the units are within the same market zone and are of the same technology (for instance, renewables cannot ‘substitute’ thermal capacity, and so on).
Unlike generators providing capacity, the DR provider is not paid the auction clearing price (see below). Instead, DR providers are compensated by being exonerated from the charges levied on all other consumers to cover the cost of the Capacity Mechanism. For instance, if we consider a consumer that sells in the action a volume of capacity equal to 20 % of his average historic demand at the system’s peak, that consumer is compensated with a reduction of 20 % of the use-of-system tariff component that covers the cost of the Capacity Mechanism. Intuitively, we could assume that the provider of DR capacity is paid the average savings on capacity procurement cost that the consumer’s flexibility allows the SO to achieve.

iii. Procurement mechanism: reliability options are allocated via auctions, run from 4 to 1 year in advance of the start of delivery. The pricing rule in the auction is the marginal price.

iv. The strike price is representative of the system generation cost (associated to a open-cycle gas-fired turbine, OCGT) – and not the variable cost for DR resources.

v. Contract duration is 1 year for existing capacity and 15 years for new capacity. DR resources may be qualified both as ‘existing’ or ‘new’; in the latter case, they must meet the investment threshold requirement (see below).

vi. Different bid caps and price caps for new and existing capacity (bid caps limits the offer price submitted in the auction. Price caps limit the remuneration in case the marginal price is above the bid cap. Bid caps and price caps are set equal for existing and new resources). For the 2025 auctions, these caps are set at 85 000 €/MW for new capacity (increased to 86 000 in 2026, 2027 and 2028), and 45 000 €/MW for existing capacity (increased to 46 000 €/MW, 47 000 €/MWh and 48 000 €/MW for 2026, 2027 and 2028). Therefore, existing generators will not receive the auction clearing price if that price is set by new capacity. When that happens, the average cost of procuring capacity per MW will be lower than the marginal cost, i.e. the auction clearing price.

vii. An investment threshold of 215 000 €/MW must be passed for capacity to be considered as new and access 15-years contracts.

4.3.2 Auction results

Delivery period	*Total capacity awarded (de-rated)*	*DR capacity awarded*
2022	40 919 MW	0 MW
2023	43 411 MW	0 MW
2024	41 541 MW	0 MW

Table 8: Italy - Capacity Remuneration Mechanism – Auction Results.
(Source : Terna website - https://www.terna.it/en)

4.3.3 Identified barriers

There are various possible explanations for the lack of interest of the DR providers in the Italian Capacity Mechanism:

i) The compensation mechanism: in the Italian Capacity Mechanism, DR resources are paid the average cost of capacity (instead of the marginal); such level of compensation may be too low to attract consumers; this holds all the more since, unlike in Belgium, in Italy DR providers are subject to a pay-back obligation with the same strike price applied to generators. The level of such a strike price, that is meant to reflect the variable cost of an OCGT unit, might be above the variable cost incurred for a DR provider to reduce consumption, which might make it more complex for DR to evaluate the risks of participating in the Capacity Mechanism.
ii) DR resources that happen to be unavailable cannot be substituted by generation capacity to meet the capacity obligations.
iii) Schemes through which the Italian SO procures interruptibility services compete with the Capacity Mechanism. For instance, in 2023, the interruptibility scheme procured 528 MW of interruptible loads. Such scheme may be more attractive to consumers than participating in the Capacity Mechanism, since it pays more in exchange for performances that are more challenging for consumers to deliver (as interruptibility entails instantaneous remote disconnection), but that in practice is almost never activated.
iv) A support scheme to aggregate small, dispersed generation and consumption units into virtual power plans (UVAM scheme) competes with the Capacity Mechanism. The UVAM scheme has been operating for some years and is based on monthly auctions. For instance, in July 2024, 152.6 MW of UVAM capacity – including DR – has been procured. The UVAM scheme is expected to cease in the next years following the implementation of an ongoing electricity market reform.

4.4 Poland SA.46100 – Capacity Remuneration Mechanism

4.4.1 Main design features

The main features of the Polish Capacity Mechanism, relevant for our analysis, are:

i. Access to the scheme: all potential capacity providers, including renewables generators, storage operators, consumption units, new capacity, and interconnectors, individually or in aggregated form, are allowed to participate in the scheme. The minimum bid size is 2 MW.

ii. Rights and obligations for the capacity providers: in exchange for a per MW payment, capacity providers commit to making their capacity available to the system by offering it in the central balancing market, during the events of system stress. A system stress event is defined as an hour in which the planned dispatchable capacity reserve available to the SO is lower than the level of reserve margin required to safely operate the grid. A system stress is announced by the SO at least 8 hours in advance. Unlike in the Belgian, Irish and Italian systems, no pay-back obligation is placed on capacity providers in Poland.

iii. Procurement mechanism: capacity compensation is awarded via auctions that run 4 and 1 year in advance of the start of delivery. The pricing rule in the auction is the marginal price. An overall price cap is applied. In addition, some types of capacity providers are subject to a lower bid cap (set at 45 000 €/MW year). These are basically the existing generators that don't need to incur additional capital expenditures. DR providers are not subject to the bid cap.

iv. Contract duration is 1 year for existing capacity that does not need to incur additional capital expenditure; 5-year contracts are available to generators and DR resources who need to incur CAPEX in excess to a threshold; 15-year contracts are available to generators who need to incur CAPEX in excess to a further (higher) threshold.

4.4.2 Auction results

Auction	*Delivery period*	*Total capacity awarded*	*DR capacity awarded*
2023	2028	21 151 MW	978.5 MW
2022	2027	18 822 MW	1 504 MW
2021	2026	18 822 MW	1 470 MW
2020	2025	21 473 MW	949 MW
2019	2024	22 108 MW	1 029 MW
2018	2023	23 215 MW	791 MW
2018	2022	23 039 MW	761 MW
2018	2021	22 427 MW	604.6 MW

Table 9: Poland - Capacity Remuneration Mechanism – Auction Results
(Source: URE website - https://www.ure.gov.pl/en)

4.4.3 Identified barriers

SmartEn[47], the European association of DR service providers, points at the following features of the Polish Capacity Mechanism that may make it moderately attractive for DR capacity:

i. DR units do not receive electricity payments, which makes participation not convenient or very risky for consumers with a cost of foregoing consumption materially higher than their electricity procurement cost.

ii. Since submetering is not allowed and sources with high emissions cannot participate in the Capacity Mechanism, consumers that share the site with a high emitting generator are excluded from the Capacity Mechanism.

[47] *https://smarten.eu/wp-content/uploads/2022/01/the_smarten_map_2021_DIGITAL_final.pdf.*

iii. The Capacity Mechanism requires multiple tests in each delivery year. These tests are not remunerated and therefore can be very costly for some DR providers.
iv. Participation in the Capacity Mechanism is alternative to the participation in an interruptibility scheme that features less demanding technical requirements.

4.5 Finland SA.55604 – Strategic reserve

4.5.1 Main design features

Finland deploys a strategic reserve, the 'peak load reserve'[48]. The peak load reserve capacity is used to ensure that the balance between supply and demand can be achieved if the day-ahead market or balancing market fails to reach a balance during winter period. However, the peak load reserve capacity is not allowed to participate and bid on the commercial market, and it is activated only after the market does not reach balance. The main features of the Finnish strategic reserve, relevant for our analysis, are:

i. Access to the scheme: generators and DR providers may participate in the strategic reserve. The minimum offer size is 1 MW.

ii. Rights and obligations for the capacity providers: During the winter period, from December to end of February, power plants participating in the strategic reserve are in 12 hours' readiness to start electricity production. For the rest of the time, power plants are in one-month readiness. When in production, power plants participating in the strategic reserve are required to be able to increase power output by 10 MW within 10 minutes after request and be ready for 200 hours continuous power production with full capacity during the winter period.
DR facilities are activated from the balancing market platform at the price of EUR 3 000 per MWh, or at the actual costs provided by the capacity holder in the tender if it is higher than EUR 3 000 per MWh. The compensation comprises a €/MW component, which is the competitive variable in the tender, and a price for activation (€/MWh), which is supposed to reflect the actual activation cost. The activation of the power plants happens when the day-ahead market clears at the technical price limit of EUR 3 000 per MWh.

iii. Procurement mechanism: tendering process.

iv. Contract duration: 1 year.

4.5.2 Auction results

Delivery period	Total capacity awarded	DR capacity awarded
2017-2020	729 MW	22 MW
2020-2022 *	611 MW	0 MW
2023-2024 **	0 MW	0 MW

Table 10: Finland – Strategic Reserve – Auction Results.
(Source: Energiavirasto website - https://energiavirasto.fi/en/frontpage)

* DR capacity providers were not competitive in this tendering round.
**No strategic reserve capacity is procured, because no adequacy issues are identified.[49]

[48] *The mechanism is based on the Peak Load Reserve Act 117/2011.*
[49] *Energiavirasto, Decision on the amount of power reserve for the period 1 November 2023 – 31 October 2024.*

4.5.3 Identified barriers

We have not identified any barriers to DR participation in the Finnish strategic reserve.

4.6 Germany SA. 45852 – Strategic reserve

The main features of the German strategic reserve (termed 'capacity reserve' in the German application for State aid approval) are:

i. Access to the scheme: generating plants, storage facilities, and DR may participate in the strategic reserve. Aggregation is allowed. In order to be eligible to provide capacity reserve, DR units must be connected at either the high- or medium-voltage power grid. The scheme targets inflexible loads only; this is obtained by requiring that the participating consumer have not provided interruptibility services or participated in the balancing market for 36 months before becoming a supplier for the capacity reserve[50]. The minimum size for participation in the scheme is 5 MW.

ii. Rights and obligations for the capacity providers:
Capacity providers are entitled to a per MW/year compensation; they do not receive compensation in case of activation. This means that their bid in the auction (see below) includes both their fixed cost and their expected variable costs, which depend on the expected number of activations[51].
Capacity providers must always make available the capacity to the SO but for planned and accidental outages.
The capacity reserve is dispatched when the market does not clear, i.e. when there is insufficient supply to meet demand. The market is deemed not to have cleared when, at the electricity exchanges, the day-ahead or the intra-day market do not clear at a price below or equal to the technical limit (3 000 €/MW or 10 000 €/MWh respectively). TSOs can dispatch the capacity reserve as a last resort only after all other system services have been exhausted. Capacity providers, but those providing DR capacity, are not allowed to sell their reserve capacity on the electricity market. They are also not allowed to return to the market once their reserve contract ends (the 'no-return' provision).

iii. Procurement mechanism: marginal-price (pay-as-clear). Auctions run every two years; participants in the auction compete on the level of the per MW-year compensation they ask to receive for maintaining their capacity available; a 100 000 €/MW-year price cap is enforced.

iv. Contract duration: 2 years (October to September).

4.6.1 Auction results

Delivery period	Total capacity awarded	DR capacity awarded
2020-2022	1 056 MW	0 MW
2022-2024	1 086 MW	0 MW

https://energiavirasto.fi/documents/11120570/12872579/P%C3%A4%C3%A4t%C3%B6s+tehoreservin+m%C3%A4%C3%A4r%C3%A4st%C3%A4+kaudelle+1.11.2023-31.10.2024.pdf/ecb924ee-669a-56ad-f09e-88c87b815593/P%C3%A4%C3%A4t%C3%B6s+tehoreservin+m%C3%A4%C3%A4r%C3%A4st%C3%A4+kaudelle+1.11.2023-31.10.2024.pdf?t=1682511619401.

[50] See recital (83) (f) of the Commission Decision of 7.7.2018 on the aid scheme SA.45852 - 2017/C (ex 2017/N) [which Germany is planning to implement for Capacity Reserve].

[51] See recital (82) of the Commission Decision of 7.7.2018 on the aid scheme SA.45852 - 2017/C (ex 2017/N) [which Germany is planning to implement for Capacity Reserve].

Delivery period	Total capacity awarded	DR capacity awarded
2024-2026	1 205 MW	0 MW

Table 11: Germany – Strategic Reserve – Auction Results
(Source: bundesnetzagentur website - https://www.bundesnetzagentur.de/EN/Areas/Energy/start.html)

4.6.2 Identified barriers

The lack of interest of the German strategic reserve for DR providers may be the consequence of the following features:

i. the strategic reserve targets inflexible loads only. Note, however, that this feature is consistent with the very nature of strategic reserves, whose effectiveness and market neutrality properties depend crucially on the strategic reserve being (irreversibly) segregated from the market; as pointed out by Germany in response to the Commission's concern, this implies that DR should not be allowed to participate in the Capacity Reserve but should instead be fully at the disposal of the market[52].
ii. the compensation structure of the strategic reserve, based entirely on a capacity component (€/MW year). This means that the participants in the strategic reserve have to cover their variable activation costs, which depend on the number of times in which the strategic reserve is activated, through a per MW fee, which places risk on the supplier. This happens because the number of actual activations may differ from the number of activations expected by the supplier at the time of bidding, whose cost has been included in the €/MW bid.

4.7 Greece SA. 56103 – Interruptibility scheme

4.7.1 Main design features

Through this scheme, that has operated from to 2014 to 2021[53], the Greek SO procured from electricity consumers regulation services, in particular manually activated frequency restoration service ('Type 2', in the notification by the Greek government), and replacement reserve, or tertiary reserve service ('Type 1', in the notification).

The scheme was meant as a bridge measure before Greece activated a balancing market in which those services can be offered by consumers in competition with generators and other flexible resources.

The main features of the Greek interruptibility scheme are[54]:

i. Access to the scheme: consumption units connected to the high- or medium-voltage network. The minimum size for participation is 2 MW. Aggregation is not allowed.

ii. Rights and obligations for the capacity providers: Capacity providers are entitled to a per MW compensation; they do not receive compensation in case of activation. The TSO can dispatch loads participating in the scheme only in emergency situations. The following table summarises the characteristics of the products that DR providers must deliver.

[52] See recital (73) of the Commission Decision of 7.7.2018 on the aid scheme SA.45852 - 2017/C (ex 2017/N) [which Germany is planning to implement for Capacity Reserve].
[53] SA.560103 constitutes the second prorogation of the scheme introduced in 2014 and granted a first prolongation in 2018.
[54] We present the most recent version of the mechanism, implemented in 2021.

Product type	Type 1	Type 2
Notice time	5 min	1 min
Duration of each power reduction order	48 hours	1 hour
Maximum number of power reduction orders per month	3	5
Maximum duration of load shedding per year	288 hours	36 hours
Minimum period between two consecutive power reduction Orders	1 day	5 days

Table 12: Main features of the Greek interruptibility scheme
(Source: Recital (13) of the Commission Decision of 29.9.2020 on the aid scheme SA.56103 (2020/N) – Greece - Second prolongation of the interruptibility scheme)

iii. Procurement mechanism: marginal-price (pay-as-clear) auctions run every three months; participants in the auction compete on the level of the per MW compensation they ask to receive for providing the service. A price cap is enforced for each service.

iv. Contract duration: 3 months.

4.7.2 Auction results[55]

Delivery period	*Type 1 capacity awarded*	*DR capacity awarded*
2018-2019	600-620 MW	430-450 MW
2020-2021	400 MW	400 MW

Table 13: Greece – Interruptibility Scheme – Auction Results
(Source: Recital (9) of the Commission Decision of 29.9.2020 on the aid scheme SA.56103 (2020/N) – Greece - Second prolongation of the interruptibility scheme)

4.7.3 Identified barriers

We have not identified any barriers to DR participation in the Greek interruptibility scheme.

4.8 France SA. 39621 – Capacity Remuneration Mechanism

4.8.1 Main design features

The French Capacity Mechanism, operating since January 2017, differs from those implemented in the other EU countries in that the demand for capacity is not set by a central entity. Instead of procuring capacity directly, the French SO sets a capacity obligation that load serving entities must meet by purchasing capacity certificates. These certificates are supplied by the TSO to capacity providers, based on the level of capacity they certify and can be freely exchanged on a dedicated market.

The main features of the Capacity Mechanism are presented next:

i. Access to the scheme: generators and DR providers may operate as capacity-providers, independently to the connection voltage, individually or aggregated. The minimum size of capacity guarantees is 0.1 MW.

ii. Capacity obligations: electricity suppliers, consumers (for consumption outside a supply contract) and network operators (for losses) must prove every year that their consumption at peak times is covered by a certain volume of capacity. Such obligation is discharged by registering with the SO a corresponding volume of capacity guarantees.

[55] The auction results are available at: https://www.admie.gr/en/market/market-mechanisms/interruptibility-mechanism#tab-985-2.

The supplier capacity obligation depends on his consumer's consumption during the set of so called 'PP1-days', between 10 and 15 each year. The load serving entity is notified by the system that a day is PP1 one day in advance.
A supplier's capacity obligation is reduced if some of his consumers can provide DR (implicit DR). Therefore, DR capacity may alternatively be used to reduce a supplier's capacity obligation or to obtain capacity guarantees from the SO and sell them in the market (explicit DR). The contribution of DR to reducing the capacity obligation is assessed ex-post, based on actual consumption of flexible consumers in PP1 hours.
Deviations between the capacity obligation and the volume of capacity guarantees procured by each supplier (or 'imbalances') are settled financially with the SO. The imbalance price is market-based if security of supply was not at risk when the imbalance took place. It is administratively set if security of supply was at risk when the imbalance occurred. Such administrative imbalance price acts as a ceiling to the market price for capacity.

iii. Capacity certification: capacity guarantees are issued to capacity providers by the SO, at the end of a certification process assessing the projected contribution of the provider's resources to meeting demand at peak time. The certification process aims at identifying the volume of capacity that the provider can make available in the so called 'PP2 days', a set of 10-25 days in the year that includes (but it is possibly large than) the PP1 set.
Note that, due to the different methods to compute the capacity obligation and the capacity eligible to obtain guarantees, the DR capability of a consumption unit may be assessed differently depending on whether it is used to reduce the supplier's capacity obligation or to acquire capacity guarantees.

iv. Procurement mechanism: capacity guarantees are traded in the market. In such a market, the supply of guarantees is determined by the volume of guarantees issued by the SO, and demand for guarantees by the capacity obligation placed on load serving entities.

v. Contract duration: Capacity guarantees are awarded to capacity providers 4 years in advance of the year of delivery. DR capacities may be certified up to two months before the start of the delivery period.
An additional mechanism is implemented to provide new capacity with longer-term revenue insurance. 4 years before the start of delivery, the developer of projects that will result in new capacity can submit to the SO bids in the form of (capacity volume, target capacity price). The SO selects the bid to minimise the cost of enduring long term capacity adequacy. An accepted bid entitled the owners, for 7 years, to a payment equal to the difference, if positive, between his bid target price, and an index of the price for capacity guarantees, based on yearly auctions run annually by EPEX[56]. In other terms, the mechanism awards 'one-way contracts for differences' on the price of capacity guarantees. In combination with the sale of guarantees in the market, the contract for differences ensures that the holder obtains a total per MW revenue not less than the bid target price for the first seven years of operation of the new capacity.

We will discuss actual and identified barriers for DR participation in the following section, where we assess this scheme together with other measures that have been jointly deployed by France to support development of DR and flexibility.

[56] *The capacity market reference price ('CREP').*

4.9 France SA. 48490 – load shedding; SA.62006 – load shedding; SA.107352 – non fossil flexibility

4.9.1 Main design features

The first DR specific measure in France (SA.48490), adopted in 2018, complemented the French Capacity Mechanism. The purpose of the scheme was to provide DR facilities additional remuneration to that obtained from the Capacity Mechanism.

Two reasons are identified by the French government for granting different (greater) support to DR providers, compared to generators:

- Externalities: DR capacity is meant to avoid construction of peak thermal generation capacity, reducing emissions; this benefit will be reaped via the base Capacity Mechanism presented in the previous section, as the SO's demand for multi-year contracts – the support tool targeting new capacity – will be reduced, other things equal, by the volume of DR capacity.
- An 'infant industry' argument: DR is a new sector, that market participants perceive as high risk. Kick-starting activity in the sector by an injection of subsidies will spur a virtuous cycle, by enabling technology developments, reducing cost and uncertainty. Consistent with this objective, the support measure was meant to be temporary (initially up to 6 years) with the expectation that the load shedding sector will be able to compete with carbon-based production without support by 2020-2023.

The main features of the 2018 scheme SA.48490 are presented next:

i. Access to the scheme: all DR resources. Capacity provided by back-up diesel generators was initially eligible for participation. However, the compensation was structured in such a way to incentivise such fossil fuel DR capacity to offer high-value fast reserve services; DR capacity based on diesel generators could not participate in the mechanism beyond 2019, and their bids in the auction was progressively penalised. Participation is not allowed to consumers participating in the interruptibility scheme.

ii. Rights and obligations for the capacity providers: In exchange for the per MW remuneration received, the beneficiary must offer the corresponding DR capacity in the markets. The capacity must be offered in at least 20 critical days in the balancing mechanism or in the electricity markets. If the beneficiary makes his capacity available on the fast and complementary reserves, the operator must be available on 120 days among the working days of the year.

iii. Procurement mechanism: annual marginal-price auction; the required level of remuneration (€/MW-year) was the competitive variable in the auction; separate auctions were held for sites above and below 1 MW subscribed power. Bid caps of 30 000 €/MW-year and 35 000 €/MW-year are implemented respectively for sites below and above 1 MW subscription power.
The auction clearing compensation level acted as the strike price in a contract for difference, between the beneficiary and the SO, in which the reference price is the market price for capacity entitlements, as it happens with multiannual capacity contracts. DR providers were allowed (and expected to) participate in the tender and in the Capacity Mechanism.

iv. Contract duration: The auctions were awarding annual contracts. DR capacity provided by consumers with subscribed power above 1 MW were eligible for up to 4 years of support; consumers with subscribed power below 1 MW for a maximum of 6 years.

4.9.2 Auction results

SA Measure in operation	Delivery year	Capacity targeted	Capacity tendered	Capacity awarded
SA.48490	2018	2 200 MW	849 MW	733 MW
	2019	2 500 MW	971 MW	590 MW
	2020	2 900 MW	863 MW	769 MW
SA.62006	2021	7 507 MW	1 785 MW	1 366 MW
	2022	7 940 MW	2 792 MW	1 982 MW
	2023	8 011 MW	2 811 MW	2 702 MW
SA.10735	2024	3 900 MW	2 922 MW	2 922 MW
	2025	4 800 MW	-	-
	2026 (Q1)	5 800 MW	-	-

Table 14: DR capacity awarded and tendered in France
(Source: RTE website - https://www.services-rte.com/en/home.html)

4.9.3 Identified barriers & amendments to the scheme

DR pays an important role in the French energy policy. Since 2018, DR targets have been set in the multi-year energy strategy with the 4.5 GW target for 2023 and 6.5 GW target for 2028. The SA.107352 scheme was implemented with a reference DR capacity target of 12.5 GW by 2030[57]. More importantly, the tendered volume of capacity in the support schemes were set consistent with those targets.

To date, the French electricity market design allows for participation of DR and storage in all electricity and ancillary service markets. The “Notification d'Echanges de Blocs d'Effacement” (NEBEF), the platform allowing service providers other than the consumer’s supplier to place demand bids in the markets, backed by the consumer’s DR capabilities, has been in operation since 2013.

Multiple amendments to the original scheme were implemented to improve is effectiveness. We discuss them next.

To conclude, the FR capacity market allows an efficient participation of DR as the calculation of availability builds upon electricity markets which have been substantially opened to DR over the past years.

Some DR stakeholders push for the development of more sophisticated baseline methodology to better reflect their energy contribution to the energy and capacity markets.

a) The SA.62006 scheme (running until 31 December 2023)

Under the previous scheme (SA.48490 from 2018), awarded volumes of DR capacity fell largely below the tendered volumes from 2018 to 2020, and supply did not increase over the same period.

Absent institutional or technical barriers to DR participation in the markets, the French authorities assessed that the reason for the inadequate supply of DR capacity was larger

[57] *See recital (22) of the Commission Decision of 21.12.2023 on the aid scheme SA.107352 (2023/N) – France - Mesure de soutien aux flexibilités décarbonées de court terme en France par appels d’offres.*

than the maximum available support. On that basis, some elements of the scheme were updated in 2021, with the provisions approved by the Commission in the case SA.62006, in order to increase remuneration of DR capacity. Such modifications include:

i. Increase the price cap to 60 k€/MW-year.
ii. Relax the eligibility period so that consumers with subscription power above 1 MW that have won tenders since 2017 would be able to bid up to and including 2023.
iii. Access for consumers with subscription power below 1 MW to multi-year contracts of up to 10 years.

b) The SA.107352 scheme

The measure replaces the SA.62006 scheme for the period 2024-2026 (Q1), while retaining its general design. The main innovative features of the SA.107352 are:

i. Access to the scheme: besides implicit and explicit DR capacity, storage capacity[58] can participate in the new scheme. Fossil DR capacity cannot participate in the scheme; however, only "new" capacity is eligible for participation, defined as capacity for which construction work has not yet begun at the time of the auction's award[59].

ii. Procurement mechanism: The price cap in the auction is increased to 65 000 €/MW-year. Additional compensation, in the form of a bonus of up to 20 000 €/MW-year, is granted to capacities whose offer price on the electricity markets is low enough to make it realistic that they be dispatched in non-extreme market conditions[60].

iii. Contract duration: the contract duration for DR capacity provided by consumers with subscription power above 1 MW is increased to 16 months.

Finally, in the notification of the SA.107352 scheme, we note a change of justification by the French authorities with respect to DR support, compared to the notification of SA.48490. The original notification stressed that the need of support for DR providers was temporary. In particular, support was necessary to stimulate investment that would bring a first wave of DR capacity in the market. Such capacity would then become financially self-sustaining. Additional capital would be attracted in the sector by: (i) the cost reduction resulting from the learning curve and (ii) the reduction of uncertainty obtained by demonstrating economic viability of the DR business.

In the SA.107352 application, though, the infant industry argument is not used; if anything, recital (23) contains a statement in the opposite direction: "*… The French authorities also explained that, in the absence of a DR tender in the period 2024, France was likely to see a drop in the volume of active DR capacity on the markets and that this would be detrimental to the development of flexibilities in France in the medium term*."

Further, recital (21) casts SA.107352 as temporary "*pending the reform of the French capacity market*", and recital (16) states that "*For the future, … the French authorities*

[58] Storage was not admitted in the auctions for delivery in 2024, that took place in 2023, on the basis that the time required to implement new capacity would be longer than a year.
[59] See recital (62) of the Commission Decision of 21.12.2023 on the aid scheme SA.107352 (2023/N) – France - Mesure de soutien aux flexibilités décarbonées de court terme en France par appels d'offres.
[60] See recital (88) of the Commission Decision of 21.12.2023 on the aid scheme SA.107352 (2023/N) – France - Mesure de soutien aux flexibilités décarbonées de court terme en France par appels d'offres.

are exploring several options, including that of having a single support measure capable of ensuring the security of supply in France during 2026."

Those statements point at a structural role of a support measure for security of supply in France (including financial support for DR).

4.10 Lessons from the survey of State aid measures to ensure security in the electricity sector

This section contains indications from the analysis of the State aid measures presented in this chapter.

4.10.1 Participation of DR in Capacity Mechanisms

With regard to market-wide Capacity Mechanisms, we observe that:

i. the derating factor – a mono-dimensional measure used by the SO to make different forms of capacity comparable for the purpose of selecting the offers that are granted support – may not be able to capture all the differences in performance of DR and generation capacity; if that happens, the merit order of capacity providers (in particular DR and generation) might be distorted;
ii. the level of support granted to generation capacity, especially the existing capacity, is generally smaller than that required by DR capacity.

However, strategic reserves operate by taking capacity away from the market. For the mechanism to be effective, then, it is necessary that strategic reserve capacity be removed from the market for good; otherwise, the possibility of "re-entry" in the market of current strategic reserves may discourage investment. Committing DR-based capacity to exit the market at the end of the support period is clearly not feasible; DR-based strategic reserve may therefore end up displacing generation capacity investment in the long-term.

4.10.2 The supply of DR may be inelastic in the short-term

The supply of DR may be fixed for a large range of support levels. It can therefore happen that the auction to select the scheme's beneficiaries is not competitive, i.e. that the auction price cap sets the value of actual support. When that happens, the tender-based award mechanism cannot be relied upon to (a) discover the minimum level of support necessary to achieve the policy objective and (b) avoid unwanted wealth transfers to the DR-capacity providers. In this situation, one option is to increase the support level, but support levels should be limited to what is cost-effective in relation to the security of supply objective. Competition in tenders can also be increased (and better value for money for consumers delivered) by broadening eligibility to include storage and non-fossil generation where capable of providing equivalent security of supply benefits.

4.10.3 Aggregation, minimum bid size and the optimal scale of DR capacity providers

Too large minimum bid sizes have been mentioned, in our interactions with the stakeholders, as a potential barrier for DR participation in the market and in the support schemes.

In fact, the minimum bid sizes implemented in the EU electricity and ancillary service markets are way smaller than any reasonable measure of the DR provider's optimal scale of operations[61].

Aggregation must bridge the gap between, on the one side, the DR-capacity of a single consumption unit, and, on the other side, the minimum size of the flexibility service that makes it useful for the SO, and (above all) the minimum optimal scale of operations for a DR service provider.

In this respect, the French experience highlights the importance of a fully developed institutional framework for aggregation, comprising regulation and the organisational arrangements necessary to integrate the operations of aggregators in the existing retail and settlement arrangements[62].

4.10.4 Price-range for activation of DR

Although data on actual activation of DR resources are not available, there are indications that the price level that induces consumers to give up consumption is generally larger than the marginal generation cost of OCGT units, the typical marginal technology. For example, the Italian Capacity Mechanism based on reliability options with the same strike price for generators and DR providers, proved unattractive for DR providers. It is also indicative, in this respect, the French SA.107352 non-fossil flexibility scheme provides additional economic incentives, on top of the capacity mechanism, for DR units that are available for dispatch.

If the reservation price of DR is materially higher than thermal generators, until these units are price setting, no activation of DR takes place. Once DR becomes price setter, which is expected to happen more frequently as the thermal generation fleet is replaced by renewable generators, electricity spot price volatility increases.

[61] On this aspect, see Chapter 5, on the DR provider's cost. Our assessment is confirmed by the French authorities indication, reported in recital (56) of the Commission Decision of 21.12.2023 on the aid scheme SA.107352 (2023/N) – France - Mesure de soutien aux flexibilités décarbonées de court terme en France par appels d'offres, that the number of beneficiaries of the tenders is between 13 and 16 for the delivery period 2024, for which the DR capacity target is 3000 MW , and between 10 and 20 for the delivery period 2025-Q1 2026, for which the DR capacity target is 4800-5800 MW.

[62] In France this is obtained by the NEBEF, the Block Exchange Notification of Demand Response mechanism. (https://www.services-rte.com/en/learn-more-about-our-services/participate-nebef-mechanism#:~:text=The%20Block%20Exchange%20Notification%20of,area%20to%20the%20balancing%20mechanism).

5. Costs and revenues for demand-side response providers

5.1 Types of costs borne by the DR operator

The provision of DR results in costs both for the end-consumers providing the service as well as aggregators. Two different cost perspectives are considered in this chapter. The first (consumer-specific costs) regards the costs incurred by consumers willing to engage in explicit DR by increasing or decreasing consumption and earn from their flexibility individually or by pooling their resources and contracting with an aggregator, who will represent them and act on their behalf. The second (costs for DR providers) concerns the costs of a demand service provider (SP) that combines multiple and aggregated short-duration consumer loads for sale or auction in organized electricity markets.

5.1.1 Customer specific costs

The costs borne by consumers to become flexible and to deliver DR services **are largely unknown** and can be **expected to be very different for different types of consumers**. However, some **fixed and operating costs** may be incurred regardless of the scale of the consumers (i.e. small-end residential and non-residential consumers, medium/large consumers which can offer a meaningful DR service only if aggregated or large consumers that can individually supply DR).

Figure 7 below reports the main cost categories for consumers to provide DR services:

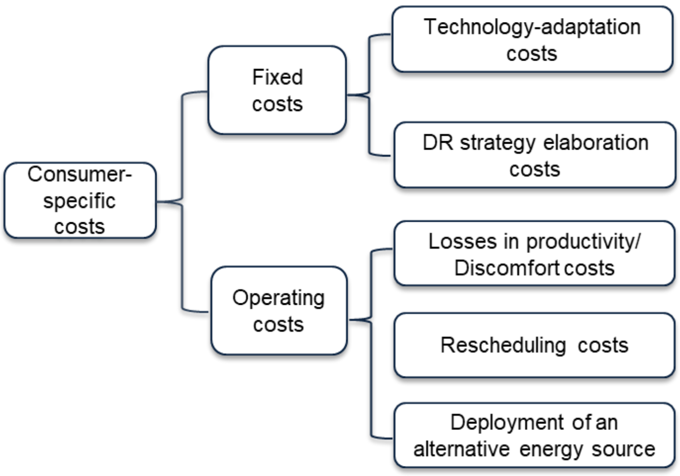

Figure 7: Consumer-specific costs: cost breakdown
(Source: Consultant's own analysis)

From **smaller consumers' perspective**, i.e. residential consumers, the challenge for the aggregator is widely perceived as being able to optimise the use of the consumer's electric appliances in such a way as to minimize any potential costs to the consumer from participating in DR. In fact, small end-consumers incurring costs from loss of comfort or loss of leisure time due to their participation in explicit DR may be less inclined to continue participating or could choose to limit their engagement in the DR market.

From **industrial consumers' perspective**, initial fixed costs for consumers may include the expenses to evaluate their DR potential and elaborate a DR implementation strategy, or the costs for determination of environmental compliance. They might also include **opportunity costs** associated with the missed potential of commodity production in order to facilitate DR, **and,** above all, **investment costs** for **technology and organisational adaptations**.

5.1.2 Costs for DR providers

The **main activities** of an aggregator generating the different **categories of costs** identified in this study are illustrated and detailed next.

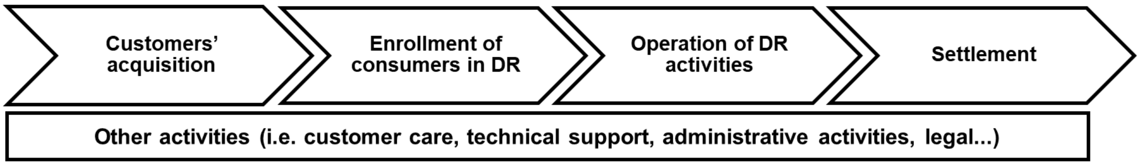

Figure 8: DR providers' main activities generating costs.
(Source: Consultant's own analysis)

1. **Customers' acquisition**: these activities are needed to reach consumers interested to provide flexibility services. They **encompass commercial costs**, i.e. for outreach campaigns, customer education, assessment of customer eligibility according to the potential load reduction capability, contracting with the customer.
2. **Enrolment of consumers in DR**: the activities involve the preparation of a consumer to provide DR services. They include **meter installation at the consumer's premises and connection to an aggregated** pool of resources, enabling real-time data exchange and coordination with the BSP operating centre. Fixed costs are incurred by DR providers for these activities, such as **hardware and software costs** necessary for metering and data communication, and **operating costs** such as labour cost for metering installation and maintenance.
3. **Operation of DR activities**: these activities are integral to the operation of the aggregated pool. They include the **operation of a central control system**: the central unit interacts with the SO dispatching centre and with the flexible consumers of the VPP. The control system presents bids in the ancillary service market, optimizes the activation of resources in case of accepted bids, and transmits to the SO the information about the status of the VPP and of individual connected consumers. Finally, it records all the transactions with the SOs and with the connected consumers. Fixed costs are incurred by DR providers for **hardware and software costs** to develop a control logic or building automation systems in some cases. **Operating costs** are also incurred for the activities linked to the activation in a DR event for measurement and verification.
4. **Settlement**: these activities are conducted based on the metering data and contracts signed with consumers, after the conclusion of a DR event. Performance data is verified by the BSP, which then calculates the payments to the consumer. Fixed costs are incurred by DR providers for the **software for accounting and billing**, and operating costs include for example awarding flexible consumers their compensation and payment to the BRP or retailer.
5. **Other activities:** The DR provider undertakes these activities to ensure the seamless operation of its business. Those activities include **operating costs** such as legal expenses, fees, collaterals for participation in organized markets, and costs for customer care.

The main categories of costs investigated in this study are **fixed** (**commercial, hardware, software) and operating costs**. For each of them, a **detailed cost breakdown** has been applied with the objective to allow for an assessment of their impact on participation in DR and quantification by the actors involved.

Figure 9 below reports the **main sources of costs** for DR providers:

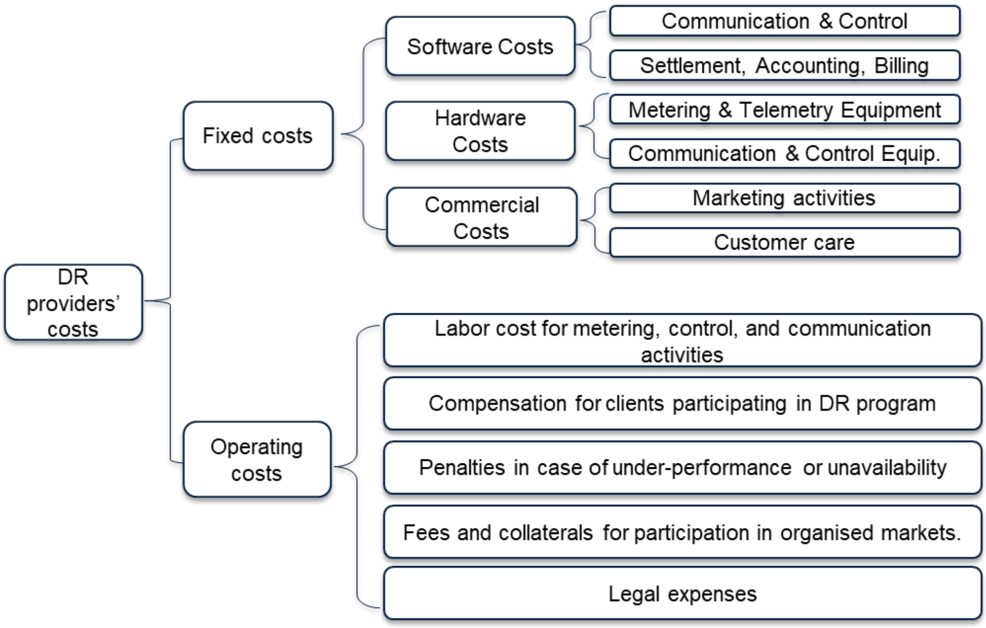

Figure 9: DR providers' costs: cost breakdown
(Source: Consultant's own analysis)

5.2 Evidence from the literature/interviews

The **scarcity of publicly available quantitative data** on costs and revenues related to DR in the EU, as sourced from reputable sources active in this domain, serves as **an indicator of the complexity of quantification at this stage of DR development**. Currently, accurately quantifying the costs and revenues poses significant challenges for several reasons, such as limited number of diverse DR installations —each contributing to the creation of distinct flexibility products — within different markets. Furthermore, consumers and DR providers exhibit varying degrees of flexibility potential and employ diverse means and technologies to respond.

Moreover, the attempt to procure significant quantitative data pertaining to costs through interviews and surveys posed intrinsic difficulties. The challenges arose from the significant variation in underlying attributes for DR operations across different DR operators when answering the questions. Finally, it should be pointed out that many stakeholders interviewed chose not to provide any quantitative data on costs and revenue streams.

Notwithstanding the above consideration, additional targeted interviews allowed to collect relevant data which is presented in the following sections.

1. Customers' acquisition

These activities undertaken by DR providers are needed to reach consumers interested to provide flexibility services. They generate **commercial costs** for DR providers, which may cover market research and targeting, outreach campaigns, customer education to explain the benefits of DR participation, acquisition costs, assessment of customer eligibility according to the potential load reduction capability, contracting with the customers, etc.

Customers acquisition and marketing investment were explicitly addressed by the stakeholders as some of the **main potential sources of costs, especially when considering reaching many small end-consumers.** With regard to **marketing expenses**, DR providers consider that the lack of knowledge that consumers have on flexibility is one of the factors contributing to the relatively high commercial costs. Small BSPs indicate that a significant portion of the costs are allocated towards the dissemination of highly educational content about the benefits of DR for their customers.

Costs incurred per customer for activities related to acquisition and labour for customer-base management **may vary consistently** depending on the size of the DR stakeholders, the number and type of customers in their portfolios, the countries in which they are operating. Based on the information collected through the interviews, these costs range from few hundreds of euros to several thousand euros per customer per year, with a customer churn rate[63] comparable to the one of electricity retailers.

2. **Enrolment of consumers in DR**

The activities for meter installation and connection involve **integrating DR systems** to the customer's existing infrastructure, by installing the meter at the consumer's premises and connecting its assets to a VPP network, enabling real-time data exchange and coordination. The costs incurred by DR providers for these activities are mostly **hardware and software costs necessary for metering and data communication**, and **operating costs such as labour cost for metering installation and maintenance.**

The costs of the equipment will depend on the type of installation, the service provided, and whether they are intended for a domestic or industrial customer.

On this point, the results of the interviews highlight that **the high costs are mostly linked to system automation, control, and telemetry that might be needed for some DR products**, rather than the cost of smart meters *per se* (that never exceed 800 €/unit in the worst case)[64] or the sub-metering devices (ranging from few dozens to hundred euros per unit, based on the data collected from the interviews). The fact that the costs of smart metering for residential consumers are not significantly high was also confirmed by several DR associations interviewed, which also reported that the highest cost may arise from prequalification requirements (such as mandatory testing to be done to obtain certifications).

3. **Operation of DR activities**

These activities include the setup and operation of the controllable units. They include the **operation of a control system**: the central unit interacts with the SO dispatching centre and with the flexible consumers of the controllable units. The control system **presents bids in the ancillary service market**, optimizes the activation of resources in case of accepted bids, and transmits to the SO the information about the status of the controllable units and of individually connected consumers. Finally, it records all the transactions with the SOs and with the connected consumers.

63 The customer churn rate, also known as the rate of attrition, is the rate at which customers stop doing business with an entity.

64 Parežanin, M. (2023). Costs and benefits of the implementation of smart grids in the European Union. E-Business Technologies Conference Proceedings, 3(1), 28–33. Retrieved from https://www.ebt.rs/journals/index.php/conf-proc/article/view/193.

First of all, these activities include **hardware and software costs**. For the hardware needed to setup a platform to manage the controllable units, the main features shall be the following:

- Bidirectional, real-time communication between the control system and every connected facility, ensuring security.
- Capability to handle all types of field-generated data effectively.
- Optimized dispatch of connected units, considering various unit-level technical constraints.
- Reporting and invoicing features.
- Scalability across the entire system.

Based on the information collected from industrial hardware/software providers and DR operators that acquired such systems, the costs of a platform to manage the controllable units in an EU country might range between 500 000 € and several millions of euros, depending on the features required, the IT development team involved, the requirements in terms of security for the connection to the SO platform, the costs for data centre hosting, the operation and maintenance from specialized technicians. There is a consensus among the interviewed entities that an expenditure of less than 2 000 000 € typically results in a system that may not function optimally. Also, the interviews highlighted that the operational expenditure does not vary much when the number of clients increases over time.

Software used by DR operators or aggregators must be able to establish a connection between the aggregators and the assets, optimize the market operations and send the instructions to the equipment to carry out the indicated operation. The software should enable continuous and bi-directional communication and ensure high visibility to the aggregator on the availability and injections from DR assets. The interviews conducted with DR providers operating in different countries and/or markets highlighted that one of the major costs consists in the specific developments of their software to take into account each market specificity. Also, another factor that was pointed out in the interviews is that **lack of uniform pan-European technical standards for functionalities of the equipment** increases the software costs, making it expensive to develop, maintain and implement market applications and services that are based on smart meter data. The costs of software **may vary subsequently depending on the complexity of the system, the number of devices to connect to, the hardware required, and the type of software licenses**.

As far as the communication and control systems are concerned, a stable and secure Internet connection to connect to the VPP application may be considered sufficient. In some cases, according to the specific requirements, certain communication channels may lead to additional costs, although the trend is to shift towards internet and Virtual Private Networks (VPNs) to make communication more streamlined. Interviews with experts of VPP software development also highlighted that cybersecurity requirements from SOs may require sophisticated system protection that could increase the overall costs. In case of DR to be provided through interruptibility schemes or in Capacity Mechanisms that are designed to ensure the adequacy of the electricity system, automation of system control, real time monitoring, specific equipment for remote measurement or even direct connection to the control centre to be automatically disconnected by the SO may be required. In this case, **TSOs may require additional requirements that may result in costs for DR operators and aggregators.** Certain programs, such as UVAM in Italy, may require telemetry with data latency of 4 to 60 seconds, depending on the size of the customer site. Such resolution can represent a cost for participants, in particular small sites. DR operators and aggregators identify a challenge in meeting specific requirements, such as low latency and real-time data.

As far as the operating costs are concerned, the research pointed out **the complexity in quantifying them**, as they may vary according to the size, the number of countries in which they are active, the rules and conditions of each market in which they propose their services. According to DR operators, the highest operating costs will be those that involve labour for metering, control and communication, especially when field action requires a disproportionate level of effort for the specificities of DR. For instance, one Irish DR operator interviewed for this study considers manual real-time data input for availability of DR to the TSO platform as very costly in terms of workload, especially when DR actors aggregate numerous resources.

4. Settlement

These activities are conducted based on the metering data and contracts signed with consumers, after the conclusion of a DR event. Performance data is verified by the BSP, which then calculates the payments to the consumer. Fixed costs are incurred by DR providers for the **software for accounting and billing**, and operating costs include for example **awarding flexible consumers their compensation** and **payment to the BRP or retailer,** and **penalties in case of under-performance** or unavailability.

According to the data collected through the survey, the cost of software needed to perform accounting and billing operations potentially varies from 30 000 € to 100 000 €. These costs are included in those mentioned above for the VPP.

Concerning **financial compensation paid by DR aggregators to suppliers for procuring electricity that was not consumed,** electricity undertakings or participating final customers are required to pay financial compensation to other market participants or to the market participants' BRPs, if those market participants or BRPs are directly affected by the DR activation. The compensation value is highly fluctuating from a year to the other. The table below shows quantitative data collected from stakeholders on this item:

Demand side stakeholder	Type of customers	Country of activity	Costs incurred	Detail of the expense
Small/Medium DR operator	Small end consumers	France Estonia Finland Poland, Sweden	200 €/MWh	Estimated cost of financial compensation paid to suppliers being charged to DR aggregators

Table 15: Examples of financial compensation paid by DR aggregators to suppliers (Source: Information provided by stakeholders consulted during this assignment)

As far as **penalties in case of under-performance or unavailability** are concerned, no quantitative data emerged from the survey and interviews. Some of the interviewed stakeholders believe that the complexity of the rules creates a lot of risk for the aggregators, and strong penalties for imbalance would be more noticeable to consumers than to producers, which might render DR less favourable in comparison to alternative technologies.

Another source of **operating costs** that emerged from the survey is linked to the **network tariffs and charges to be paid when consuming additional electricity, providing services in balance markets or non-frequency services**. In fact, depending on the regulation, generation and storage (pumping) might not be subject to the costs of network tariffs and charges when they participate in the provision of system services, which could create unequal competition with DR providers.

5. Other activities

The DR provider undertakes other activities to ensure the seamless operation of its business. Those activities include **operating costs** such as legal expenses, fees, collaterals for participation in organized markets, and costs for customer care.

As far as the **existence of fees or guarantees to obtain the status of market participant**, no quantitative data was provided by DR operators and aggregators, but most of the time data is publicly available from market operators website. In Italy for instance, for local flexibility markets, the access and yearly fixed fees are free of charge, whereas a variable fee of 0.04 €/MW of power negotiated in the market is expected to be paid. The examination of literature substantiated that prequalification procedures might be identified as a potential source of costs in **Ireland**, where aggregators are not able to shield consumers from technically demanding, difficult and costly procedures, hampering consumer engagement, and in **Slovakia**, where the rather costly and cumbersome entry requirements may hinder the proliferation of DR services.[65] On this point, interviews with DR associations also confirmed the high costs of prequalification procedures and suggest to reduce the costs by harmonizing the requirements for similar products in the EU. Ensuring compatibility between products is important, as the lack of standardisation across the EU leads DR operators or aggregators operating in multiple countries to customize their hardware, software, operating and commercial models.

When DR services are intended to provide security of supply, especially through participation in interruptibility schemes or in Capacity Mechanisms that are designed to ensure the adequacy of the electricity system, **operating costs might be higher** for stricter requirements for pre-qualification, guarantees, etc. Nevertheless, some of those extra costs incurred by DR operators might be compensated by the availability payments or partial or total exemption from the capacity market fees, which still makes it interesting for them to participate. In Italy for instance, participation of customers to the interruptibility scheme is rewarded in the form of a partial exemption from the adequacy fees that customers should otherwise pay to the TSO.

5.3 Revenue sources for DR providers

Most consumers do or will offer their flexibility in the market via a DR service provider. That DR service provider often acts also as aggregator. In Chapter 2 we noted that in some cases the DR service provider supplies a range of electricity services to the consumer. When that happens, the sharing of the revenues obtained by selling flexible services is a component of a possibly complex agreement between the consumer and his electricity service provider. In this section we address the ways such flexibility services are traded in the market, without investigating how the revenues generated by those transactions are split between the consumer and the DR service provider. In other terms, we consider the consumer and the DR service provider as one entity.

In the rest of this section, we review the sources of revenue for flexible consumers and justify our assumptions for the straw-man example presented in section 5.4. Flexible consumers have the ability to implement a level of consumption that depends on the price of electricity. Therefore, the sources of revenues they have access to depend on their ability to deliver the products traded in the electricity and ancillary service markets.

[65] *Bertoldi, P., Zancanella, P., Boza-Kiss, B. (2016), Demand Response status in EU Member States.*

On that basis, we identify the following sources of revenues. While the revenue sources identified below are found in the context of the EU market model, different national markets will differ in the way the value of flexibility can be extracted: for instance, where reserve capacity is procured via capacity products priced in €/MW (e.g. Germany), DR operators will extract the value of flexibility via a combination of revenues from the sale of reserve capacity in the day-ahead (in MW) and balancing electricity at real-time (in MWh). In other markets (e.g. Italy, used in the strawman examples in the next section), the reserve capacity is not defined as a product in MW, so that reserve is procured by the TSO by modulating the injections and withdrawals of the resources in the redispatch phase – procuring products in electricity (MWh) to create "headroom" and "footroom". In this case, the value of flexibility is extracted only via transactions for modulations in the electricity injected/withdrawn (i.e. via sales and purchases for products priced in €/MWh, both in the redispatch and the real-time phases). However, it is important to note that potential revenues for DR operators are ultimately linked to the value of flexibility for the electricity system, and, as such, they are largely independent on the market design model.

5.3.1 Revenues from the sale of electricity in the day-ahead market

A consumer can sell electricity in the day-ahead market if he can commit a day in advance to the level of consumption implemented in the real time. If, for example, the day-ahead price for consumption in hour H of the following day is particularly high, a flexible consumer may opt not to consume in hour H. Whether such choice results in revenues for the consumer or just in a cost-saving, it depends on the consumer's endowment of electricity before the day-ahead market is cleared:

- If the consumer purchased the volume of electricity corresponding to his typical consumption before the day-ahead market session, which typically happens via long term fixed price contracts aimed at hedging the consumer's expected consumption, he can place a sale-offer in the day ahead market for a volume equal to the consumption he is able to forego. In that case, the consumer will obtain a revenue if his offer is accepted, and a profit equal to the difference between the price he paid for the electricity procured via the long-term contract and the day-ahead market clearing price that he collects from the sale.
- If the consumer has not acquired electricity prior to participating in the day-ahead market session, his ability to not consume in hour H may result in a cost saving, since the flexible consumer may submit in the day-ahead market a price-dependent demand-bid, with bid-price equal to the value he assigns to consuming; in that case, the flexible consumer will obtain a net saving, equal to the difference between the day-ahead market clearing price and his availability to pay for electricity.

The flexible service that the consumer trades in the day-ahead (and more generally forward) market is delivered by programming the consumption for the following day according to the results of the day-ahead market. If the consumer's offer in the day-ahead market is accepted, the consumer will have to make the necessary arrangements to not consume in hour H in the following day. This does not require any interaction between the consumer and the SO further than those that already take place to settle the consumer's imbalances. In particular, no real-time communication infrastructure connecting the consumer and the DR service provider, or the consumer and the SO, is necessary for flexible consumers to participate in forward electricity markets. This happens because the commitment taken by the flexible consumer in the forward market has the same nature as the commitment taken by a non-flexible consumer. Both commitments are enforced financially via the imbalance settlement system.

The design of forward markets in the EU is currently very similar, and in all EU markets price-dependent bids or offers may be backed by consumption units. Only in some markets, and only for large consumers, the bid must be unit-based, i.e. explicitly associated to the consumption unit that will consume (or forego consumption) of the volume that is being bid or offered. Generally, though, bidding in forward electricity market is portfolio based, so that the price-dependent bids or offers by consumers are nested in the larger bid of the portfolio. However, the ability of a consumer to take advantage of his flexibility by participating in the forward markets is independent on this feature of the market design. This holds because the consumer can valorise its flexibility either:

- Within its own portfolio, contributing to the overall reduction of the portfolio imbalances (i.e. reducing imbalance costs for the portfolio); or
- Outside of its portfolio, via transactions between different BRPs (or traders managing their portfolios).

5.3.2 Revenues from sales of electricity in intra-day markets

The description of how flexible consumers can obtain profits, or cost savings, by operating in the day ahead market applies identically to trading intraday markets.

5.3.3 Revenues from sales of hedges to traders

Because of limited storability, the price of electricity to be injected and consumed at a certain time H may be very different depending on the time when it is sold and bought. Such volatility of the forward price of electricity creates opportunity for speculative trading: traders buy and sell electricity to be delivered at time H multiple times before the time of delivery, trying to take advantage of the price volatility.

A 1 MW flexible consumer, like a generating unit, in a trader's portfolio provides a hedge against price volatility. Say that the trader sold 1 MWh for delivery at time H of electricity one week before H, betting to be able to close his position at a later time by purchasing the same volume at a lower price. If instead the market price for hour H increases as that time approaches, buying in the market the 1 MWh necessary to close his position comes with a loss to the trader. In that case, being able to call the flexible consumer to reduce consumption by 1 MWh in hour H may turn out the cheapest option for the trader to balance his position.

A source of revenues for flexible consumers may then come from selling options to reduce consumption on demand to traders. It goes without saying that selling flexibility services to traders is alternative to selling it in the electricity and ancillary service markets. It is for the DR service provider to select the profit maximising use of his flexibility endowment.

5.3.4 Revenues from sales of electricity in ex-ante ancillary service markets

Some EU (Italy, Spain, Greece and Ireland) implement a market design called 'central dispatch'[66]. Such design is characterised, among other by redispatch sessions that take place in the ex-ante time frame, i.e. up to hours ahead of real-time.

In those market sessions, the SO accepts buy-bids and sell-offers from consumers and generators to address network related constraints and achieve the target reserve

[66] *In Italy known as the Mercato Servizi Dispacciamento (MSD), in Spain known as the Mercados de Restricciones (Constraint Markets). In Greece, ancillary service market sessions include "Balancing Market," "Replacement Reserves," and "Frequency Containment Reserves". In Ireland, the main ancillary services market framework is known as DS3 (Delivering a Secure, Sustainable Electricity System).*

margins. Given the forward nature of the transactions taking place in those markets, participation of flexible consumers in those markets has the same form, and is subject to the same condition, as participation in day-ahead and intra-day markets.

Country	TSO	DR Programs	Evidence	Volumes	Sources
Italy	Terna	UVAC, UVAP	UVAC units provided significant balancing services during high-demand periods	Approx. 100 MW	Terna 2022 Annual Report
Spain	Red Eléctrica de España (REE)	Tertiary Reserve Market	DR resources participated in the tertiary reserve market	Approx. 200 MW	REE Balancing Services Report 2023
Greece	ADMIE	Frequency Regulation, Reserve Markets	Implemented programs for frequency regulation and reserve markets	Data not specified	ADMIE and RAE publications
Ireland	EirGrid	Demand Side Units (DSUs)	DSUs provided over 200 MW of reserve capacity during peak times	Over 200 MW	EirGrid System Performance Report 2023

Table 16: Preliminary data on ex-ante ancillary service markets.

5.3.5 Revenues from sales in short term reserve markets

Some EU, notably Germany, procure reserve capacity in ad-hoc market sessions, which take place the day-ahead of delivery. In those markets, the SO procures commitments, by generator and possibly flexible resources, to provide regulation and balancing services, if activated. Therefore, the commitments negotiated in these markets are for capacity, while activation of the service takes place in the regulation or balancing markets.

Participation of DR in these markets is conditional to the flexible consumer meeting the technical requirements to deliver the corresponding regulation/balancing service.

Germany has adapted its market structures to include DR in the balancing and reserve markets. However, in practice, effective participation of DR in these markets seems to remain limited. There is a lack of comprehensive data on the actual participation rates of DR, and several barriers still hinder its widespread adoption. These barriers include technical requirements, market design issues, and the need for clearer business cases and incentives for DR providers[67].

5.3.6 Revenues from sales in regulation and balancing markets

Finally, flexible consumers may be able to offer ancillary services to the SO. These include regulation services with different modes and times of activation. They include:

- Primary regulation (or frequency containment): supplying primary regulation requires that the consumer appliances continuously reduce (increase) consumption in response to the system's frequency. The system's frequency reflects the balance of injection and withdrawals in the network. The system's frequency drops from the target value of 50 Hz when withdrawals exceed injections; in that case, consumers providing primary reserve automatically reduce consumption. The response to the frequency deviation by primary

[67] *https://e3p.jrc.ec.europa.eu/articles/demand-response-status-member-states-mapping-through-real-case-experiences.*

regulation providers takes place in the order of the milliseconds and must be effective for up to about 30 seconds.

- Secondary regulation (or automatic frequency restoration): supplying secondary regulation requires that the consumer appliances reduce (increase) consumption in response to a signal issued by a central regulator. After primary regulation delivers the first reaction to the frequency deviation, the secondary regulator activates the resources providing secondary reserve in order to restore the system frequency; the activation of secondary reserve takes place within seconds from the frequency shock and lasts until tertiary reserve kicks in to balance the system, freeing up the faster regulation resources. Some interruptibility services, traditionally, provided by very large consumers in some countries, can be interpreted as single shot secondary regulation, to be activated only during extreme system conditions, basically as a substitute to uncontrolled service interruptions.
- Tertiary regulation (or manual frequency restoration or balancing): supplying tertiary regulation requires that the consumer appliances reduce (increase) consumption in response to a call by the SO in the real-time/balancing market; activation times for balancing services are in the order of some minutes.

As our brief description of the regulation services suggests, the technical requirements of the faster regulation services, primary and secondary, appear to limit the range of consumers that can effectively provide those services.

Note, finally, that the same flexible consumer can sell both in forward electricity markets and in ancillary service markets. For example, a consumer that can reduce his consumption by up to 3 MWh, compared to his consumption needs at normal price levels, might sell 2 MWh in the intraday market in case of a price spike, and then offer the remaining 1 MWh in the balancing market.

5.4 Strawman DR operators

Justification of the methodology

Little information is available on the cost and the potential volumes of different DR services that consumers can provide. Further, information on the scope of actual DR participation in the forward electricity and the ancillary service markets is unavailable for most countries because portfolio bidding does not allow identifying the share of price-dependent bids corresponding to consumption units within the portfolio of the bidder.

For this reason, we developed a methodological approach to present some strawman DR operators in order to illustrate, by order of magnitudes, the relationship between costs and revenues of DR operators. The crucial difference between our strawman and a real business case is that we do not model explicitly all the constraints that determine the technical capability of the consumer to provide DR services. Instead, we make assumptions directly on the ability of the consumer to take advantage of the highest balancing prices observed in the market for a certain number of hours.

We focus on participation of consumers to balancing market because:

- The literature we reviewed, and information collected during the project indicate that most large and medium customers already optimize their consumption based on forward (day-ahead and intraday) market prices, to the extent that their production and processes allow it. This means that their potential to provide DR services in that timeframe is already, at least to some extent, exploited.
- More importantly, no evident barriers to active participation of DR in forward markets are found in the EU markets and, as we indicated in the previous section, such participation does not require material additional cost to those

already incurred to supply electricity to those consumers. Therefore, the fact that such participation is currently limited, is by itself evidence that, at the current electricity prices, the cost for most consumers to increase flexibility of electricity consumption in the day-ahead or intraday-timeframe more than outweighs the expected benefit.
- The information available does not allow us to assess the potential contribution of "typical" consumers to the supply of other regulation services, such as primary and secondary reserve, that are characterised by strict technical requirements.

First of all, to consider the viewpoint of aggregation, we propose a case study for a hypothetical **DR aggregator of several refrigeration storage sites**. Secondly, a case study of a **cement production site** is analysed with the aim of capturing the costs for consumers providing individually DR services. Finally, a case study will consider the aggregation of **small-end residential consumers**.

The data used for the strawman DR comes from literature review and desk research of real business cases. Also, relevant data was collected from the interviews with the stakeholders and previous experience of the study team. Each situation reflects the specificities of the electricity markets, and characteristics of the DR products allowed on those markets. Moreover, for the purposes of the study, only actions on load will be considered, and the use of backup generators from the customers' side to provide DR services is ruled out.

5.4.1 Case Study 1: Aggregator of refrigerated warehouse facilities

In this first case study, we consider a DR aggregator of 30 cold storage sites, operating freezers at a temperature around -18° throughout the entire year, 24h/7. Those facilities are needed to ensure product conservation until delivery, requiring a considerable amount of electricity for refrigeration through cooling and freezing. These industrial sites are suitable to provide **forward DR services**, assuming sufficient advance notice of an event to pre-cool. In fact, thanks to thermal inertia, load-shifting DR may be achieved through pre-cooling, capacity limiting, and battery charger load management for the electrical equipment needed to move the products in the storage site. Also, assuming short notice of an event, they can provide load shedding through lighting reduction, refrigeration interruption (shall be done infrequently and for a short duration), shutting down of battery chargers for forklifts and pallet lifts, process loads, heating, ventilation and air conditioning (HVAC) and lighting for office space, HVAC for other storage spaces and shutting down miscellaneous equipment.

Each cold storage site considered for this case study features a baseline consumption of 400 kW in an hour. We assume that the baseline pattern of electricity consumption, set at the forward (up to intraday) stage, minimises the cost of meeting expected electricity consumption at the forward market prices. In other terms, the consumer has already exploited his flexibility in the forward markets.

In the real-time timeframe, the consumer is able to reduce consumption in response to a balancing activation by the transmission SO. Such consumption reduction must be matched by a subsequent increase in consumption, to bring the refrigerators' temperature back within the acceptable range.

As far as the costs to be borne for the single cold storage site to enrol in DR programs, we will consider an initial cost to elaborate a DR strategy, to determine the load that can be shed in a DR event, the frequency and the duration that the facility can tolerate, and other parameters needed to estimate the potential of the existing assets. We will then consider other investments that are needed on the consumer electric appliances to make the load flexible. In fact, the refrigeration control system may need adaptations for automatic DR programming, and sometimes improvement of existing equipment to increase the DR potential. Based on this, considering the findings in literature and consortium experience, we provide in the following table the main fixed cost items per site, one-off expenses:

Type of cost	Item	Sub-item	Cost
Fixed	• DR strategy elaboration costs	N.A.	• 10 000 €
	• Technology-adaptation costs	Refrigeration control system	• 35 000 € Automatic DR Strategy Programming, Start-up, fine-tuning, ongoing performance monitoring, DR equipment and installation materials
		Improvement of existing equipment	• 25 000 € (not mandatory but it increases the DR potential)

Table 17: Main fixed cost items per site, one-off expenses
(Source: Information provided by stakeholders consulted during this assignment)

Thus, a total one-off expense per site in providing DR services is estimated to range between 45 000 € to 70 000 €. This range aligns closely with the figures documented in similar case studies in literature.[68] As far as the operating costs, we will consider that the costs for manual adjustment for refrigeration when needed will be negligible, and that the operation of DR will not generate any loss of production or any other cost for the cold storage site. Also, rescheduling and utilisation of an alternative electricity source are not needed and thus will not generate additional costs for the site.

Using specific equipment installed at each site (such as centralized control systems, variable speed motor controls, and improved temperature instrumentation) up to 40 %[69] of the consumption of each site can be offered in the balancing market to provide frequency services. Assuming an average value of 25 %, we can define the DR potential of the aggregator as 25 % × 400 kWh × 30 sites = 3 000 kWh = 3 MWh. Otherwise stated, the aggregator can provide up to 3 MWh of upward balancing electricity over one hour (corresponding to a coordinated reduction of 100 kWh at all the cold storage sites consumption). We assume that this consumption reduction can be sustained for up to 30 minutes – afterwards, the temperature drop at the cold storage site becomes excessive and electricity consumption must be restored. This leads to 1.5 MWh (obtained as 3 MWh × ½ hour) potential that contributes to the demand-side margin potential, in each hour.

Additionally, when viewed from the standpoint of a DR aggregator, in the scenario where an operator begins the provision of services from the start, it is pertinent to take into account the preliminary expenditure incurred at the start of their offerings, (i.e. for defining the business model for establishing the customer portfolio, market research and targeting, estimating resource flexibility and assessing profitability, identification and selection of the supplier of the hardware technology required, etc.) and commercial operation needed to get new customers. We will then consider the costs of conducting site inspections to assess the customer eligibility, providing and installing the metering devices, and configuring the communication channels from the sites to the VPP control centre. We will then consider the costs to operate the DR activities, and settlement. The

[68] *Scott, D., Castillo, R., Larson, K., Dobbs, B., & Olsen, D. (2015). Refrigerated Warehouse Demand Response Strategy Guide:. Lawrence Berkeley National Laboratory. LBNL Report #: LBNL-1004300. Retrieved from https://escholarship.org/uc/item/26m0w16p.*
[69] *Northwest Power & Conservation Council, Regional Technical Forum, Idaho, Montana, Oregon, and Washington, https://rtf.nwcouncil.org/demand-response-refrigeration-warehouse-controls/.*

costs considered below result from the data collected through the interviews and from consultants' experience.

Activity	Cost item	Cost
Setup for new/existing operator wishing to start offering DR services	• All initial investment costs (i.e. for defining the business model for establishing the customer portfolio, market research and targeting, estimating resource flexibility/resource aggregates, and assessing profitability, identification and selection of the supplier of the hardware technology required	• 100 000 € overall, one-off expense
	• Commercial operation needed to get new customers	• 750 000 €/per year, overall
Enrolment in DR	• Assessment of customer eligibility with site inspection • Metering device • Meter installation	• 10 000 €/site, one-off expense
	• Communication channel to the VPP centre	• 0 € (if based on internet connection)
Operation of DR activities	• Development of a software/hardware solution for the management and dispatch of multiple assets	• 2 000 000 € overall
	• Labor cost for metering, control, and communication activities, & interaction with the SO platform	• 800 000 € /year (considering 10 full-time equivalent people for forecasting, market and bidding, asset prequalification)
	• Penalties in case of under-performance or unavailability	• Negligeable (considering a low probability that the client is not able to deliver)
	• Fees and collaterals for participation in organised markets.	Example for the Italian markets: For local flexibility market - Access fee: 0 € - Yearly fixed fee: 0 € - Variable fee: 0.04 €/MW of power negotiated in the market For day ahead intraday - Access fee: 7 500 € - Yearly fixed fee: 10 000 € - Variable fee: 0.04 €/MW of power negotiated in the market
Settlement	Hardware and Software: • to do settlement (starting from metering data, and records of calls) • to carry out payments to consumers and BRPs • to collect payments from SO and BRPs • to handle credit and guarantees for participation in the organised markets • to handle consumer's queries, consumer entering, leaving, changing BRP	• Hardware and software costs are included in the costs of development of VPP

Table 18: Costs for an aggregator of refrigerated warehouse facilities
(Source: Information provided by stakeholders consulted during this assignment)

Considering these main cost elements, and assuming a depreciation rate of 20 % for the CAPEX needed to start the business (e.g. developing the software/hardware solution for the management and dispatch of multiple assets, the procurement of metering devices, etc.) the yearly expenditures for DR service provision by an aggregator are anticipated to exceed 2 000 000 € taking into account solely the costs directly associated with the provision of DR services. This estimation shall be regarded as exclusive of all operational variable costs associated with the fees incurred for participation in organized markets, which are contingent upon the annual volumes of DR, as well as other expenses that are integral to the routine operations of the company, such as legal and administrative activities, employee training, and any other costs that contribute to the overall business efficacy.

To estimate the potential margin that can be extracted by the aggregator via the DR activity, we considered the aggregator to be located in the North market zone of the Italian market – this market zone providing a highly liquid market for balancing services throughout the EU. Taking as reference the year 2022, Figure 10 displays the monthly DR margin potential (in €) attainable by selling, for each day, 1.5 MWh of balancing electricity at the highest price throughout the day in the ancillary services market (*Mercato del Bilanciamento*, MB), and buying back the same electricity at the lowest price in the day-ahead market (*Mercato del Giorno Prima*, MGP) – in the figure, this is shown by the "min DAM" line (monthly averages). We assume that frequency services are sold in the balancing market at the highest price between tertiary reserve (so-called Replacement Reserve, RR service) and secondary reserve (so-called automatic Frequency Restoration Reserve, aFRR service) – in the figure, this is displayed by the "max BM" line (monthly averages).

This 'DR event' is applied to the entire DR potential of the aggregator (1.5 MWh over a 30-minute period), for every day of the year.

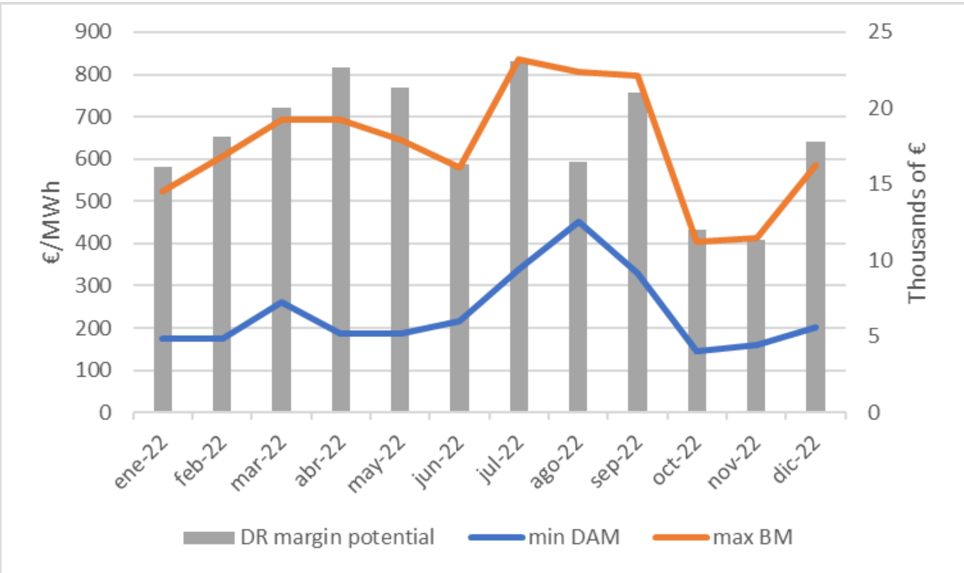

Figure 10: DR margin potential of the aggregator
(Source: Consultant analysis on ENTSO-E data)

It is important to note that these assumptions overestimate the margin that can be extracted via the DR activity, since:

- It assumes that the aggregator can "select" which service to provide between the RR service and the aFRR service – that have heavily different technical constraints – purely based on the price of each service in each hour.
- It imposes very mild constraints on when the electricity consumption that is foregone during the DR event is bought back – constraints that could be met only having

perfect foresights on the prices and might not meet the technical requirements to maintain the temperature of the cold storage sites within an acceptable range.

- It assumes that a DR event occurs every day of the year, for the entire DR potential of the aggregator (1.5 MWh over 30 minutes). Even if the aggregator bids very aggressively in order to be consistently called to provide frequency services by the SO, this is not equivalent to having multiple, smaller balancing activations, since we are assuming that a single activation is capable of capturing the maximum profit for each day. In case of two 0.75 MWh activation within a single day, for example, only the first one would capture that profit – while the second one would capture a lower profit.
- It assumes a perfect ability by the aggregator to deliver the balancing activations 24h/7, avoiding any errors and the corresponding imbalance costs or penalties for missed delivery.

Further, we specifically chose 2022 as a reference year characterized by unprecedented levels in the electricity prices as well as in their volatility. For the case at hand, this implies that – compared to the previous years – in 2022 the differential between upward balancing prices and the day-ahead prices has been materially larger. This holds even more within our methodology, since we assume that the profitability of the aggregator is driven by the differential between the largest upward balancing price and the lowest day-ahead price.

Since we adopt a "conservative" approach, that is likely to overestimate the profitability of the DR activity, we will refer to "DR **marginal potential**". The "potential" refers to the fact that we shall be looking at the highest possible margin achievable by the DR service provider, under all the assumptions described. The "margin" is determined as the difference between the revenues from the sale of DR services, and the costs associated to the restoration of the electricity consumption level needed to operate the consumption facilities in the absence of the DR service delivery. Given this definition, a "margin" can be obtained by the DR service provider calculated as:

- the revenues from the sale of upward balancing energy to the SO, delivered via a reduction in consumption close to real-time, minus the cost for restoring the required electricity consumption (e.g., by purchasing it in the day-ahead market);
- the revenues for selling the excess consumption (e.g., in the day-ahead market), minus the cost for an increase in consumption close to real-time to deliver downward balancing services.

Under all these assumptions, for the case study analysed in this section we find a DR margin potential of 216 397 € for the year 2022. In order to fully appreciate how this figure is transposed into economic value for the resources providing DR, consider that the electricity supply cost for the 30 storage sites under consideration would be in the range of 32 000 000 € for the year 2022. DR revenues would be less than 0.7 % of the wholesale cost of the electricity consumed by the consumer. If also the other cost elements of the consumer's bill were considered, that share would further reduce. Note that under the assumption that electricity procurement is already optimized in the forward timeframe, this analysis includes the energy and ancillary services (balancing) market.

5.4.2 Case Study 2: Large industrial consumer (cement plant)

In this case study, we consider a large industrial site (a cement plant), featuring a 182 500 MWh consumption across the year divided as follows:

- 25 MW from 12 AM to 8 AM

- 20 MW from 8 AM to 12 PM
- 15 MW from 12 PM to 6 PM
- 20 MW from 6 PM to 10 PM
- 25 MW from 10 PM to 12 AM

Compared to the aggregator in the previous case study, the industrial site can only provide a limited number of 'DR events' through the year (where again we choose 2022 to avoid underestimating the DR margin potential). However, such events are larger in size: we assume that up to 10 MWh can be shed to provide frequency services through an upward 1-hour long balancing activation.

A cement plant can provide load-shifting at a programming stage through shifting electrical usage in numerous processes: "*[…] quarrying operations, raw mix grinding, fuel grinding, clinker grinding*",[70] etc. Unlike the processes involving the kiln, these are non-continuous and can-do quick stop and restarts without having an impact on the production. Assuming a short notice of an event, cement plants can also provide load shedding through interrupting electrical usage of some equipment. According to the literature, "*The raw mill and cement mill are the largest interruptible loads. If the raw mill can be stopped, rock crushers and conveyors from the quarry as well as raw material homogenization can also be shut down and the kiln can be fed by raw mix from storage silos.*"[71]

Several use-cases of cement plants providing flexibility to the electricity system already exist in Europe, as this industrial activity is considered having high potential for DR short-term load reduction/increase.[72]

Applying the same methodology as in the above section, the costs for a cement plant to provide DR will be the following:

[70] *Daniel Olsen, Sasank Goli, David Faulkner, Aimee McKane, Opportunities for Energy Efficiency and Demand Response in the California Cement Industry, Lawrence Berkeley National Laboratory, December 2010*

[71] *Ibidem*

[72] *EUROFER, Position Paper – The European steel industry recommendations on Industrial Demand Side Response, publication date March 2024, https://www.eurofer.eu/assets/publications/position-papers/the-european-steel-industry-recommendations-on-industrial-demand-side-response/202403-EUROFER-Position-Paper-Industrial-Demand-Side-Response_Final.pdf.*

Type of cost	Item	Sub-item	Cost
Fixed	DR strategy elaboration costs	N.A.	• 10 000 €
	Technology adaptation costs	Automated DR client metering. Installation on site	• 15 000 €
		Asset prequalification	• 10 000 €
		Increasing the size of silos (eliminating the silo constraint, and allowing the mills to operate only on lowest cost days)	• 50 000-70 000 €
Operating	Manual adjustments (when needed)	N.A.	• Negligible
	Discomfort or loss of production or any other cost suffered by the consumer in case he must deliver the flexible performance		• No losses
	Rescheduling costs		• Variable
	Utilisation of an alternative electricity source		• Case not to be considered for the study purpose

Table 19: Costs for a cement plant to provide DR
(Source: Information provided by stakeholders consulted during this assignment)

Consequently, it is projected that the aggregate initial expenditure for each site to be equipped for DR services will exceed 35 000 €. Should additional technological modifications be required to increase the DR potential, this figure may escalate to more than 100 000 € per site. It is important to note that this estimate does not encompass the variable rescheduling costs, which are dependent on the frequency and length of activation and can be substantial.

For the revenues, applying the same methodology as in the above section and extracting the 10 days where the margin is highest, the DR margin potential is equal to 275 404 €. Figure 11 below displays the DR margin potential in each day of 2022, highlighting in red the 10 days of highest margin. While the absolute value obtained for the DR margin potential is higher than in the aggregator case study above (275 404 € *vis-à-vis* 216 397 €), the business case for DR for the industrial consumer example is not more compelling since the supply cost for the industrial consumer (considering only the commodity cost) is larger, equal to 55.8 M €. As a result, DR can contribute up to ~0.5 % of the total supply cost for the consumer.

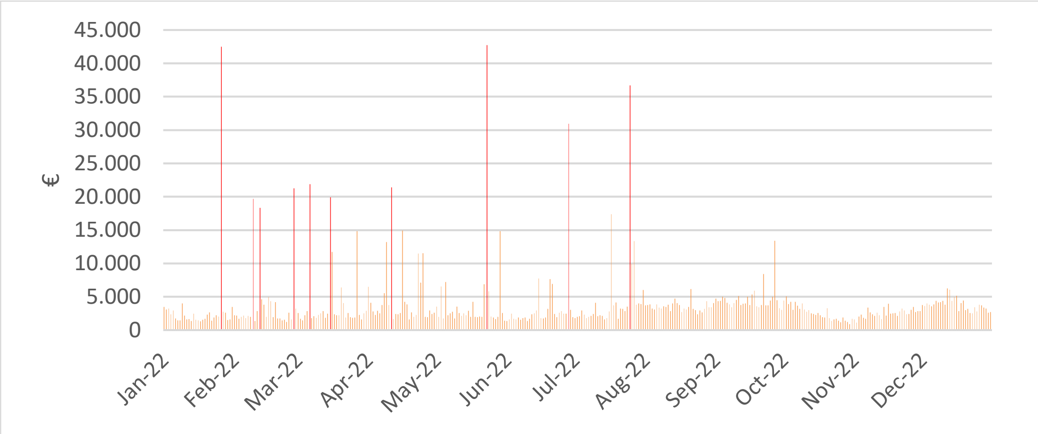

Figure 11: DR margin potential for a large industrial consumer
(Source: consultants' analysis of ENTSO-E data)

5.4.3 Case Study 3: Automatic frequency restoration reserve via aggregation of household consumers

In this case study we consider an aggregator of household consumers, aiming at providing automatic frequency restoration reserve to the SO (aFRR). Consumers can provide DR services at a balancing stage assuming a short notice of an event, load reduction through turning off /on appliances, HVAC, charging and discharging home batteries, etc.

Based on the information gathered in the interviews with a major residential DR aggregator, on a winter day, up to 1 000 household consumers can be aggregated to provide 1 MW of aFRR capacity, that can be activated to provide frequency services through 1-hour long balancing activations.

Most of the cost items for small-end residential consumers will be limited to the devices connecting to the consumer wi-fi to the (existing) smart-meter and sub-metering devices and to the smart HVAC.

Type of cost	Item	Sub-item	Cost
Fixed	• DR strategy elaboration costs	N.A.	• 0 € for the consumer
	• Technology-adaptation costs (Investment on the consumer electric appliances/equipment to make load "flexible")	Device connecting to the consumer wi-fi and to the (existing) smart-meter and sub-metering devices	• 50 €/each smart plug • 150-200 € submetering devices (for instance to connect to the HVAC and boilers)
Operating	• Discomfort costs		• No discomfort costs
	• Rescheduling costs		• Negligible
	• Utilisation of an alternative electricity source	N.A.	• N.A.

Table 20: Costs for small-end residential consumers to provide DR
(Source: Information provided by stakeholders consulted during this assignment)

From the aggregators' perspective, the costs are like those presented in case study #1. Some costs may differ as there is a shift from a "business-to-business" to a "business-to-consumer" perspective. For instance, the costs of installation for metering devices at the final consumer premises is estimated to amount between 200 € - 1 000 € per customer, but those costs may be higher as interviews revealed that there is a 20 % chance for a “no-show” to an appointment with the aggregator technician. It is thus advisable to estimate an annual expenditure in the proximity of 2 000 000 € to provide DR services.

As already shown by the analysis in the previous sections, in a market such as the Italian one, the value of flexibility is not sufficient to support a strong DR case, since price differentials between the aFRR electricity activation (in €/MWh) and the price of electricity in the electricity markets (using the day-ahead market as a proxy) is insufficient to reach a sizeable profitability for the aggregator. In this section, we assess the German market. In this market, flexibility is procured by the TSO both by procuring reserve capacity (in MW) and then balancing electricity (in MWh). Reserve capacity effectively entails the ‘option’ for the TSO to activate the capacity at real-time: for instance, the TSO purchases 1 MW of aFRR upward reserve capacity from a resource. Then such a resource provider may not sell in the day-ahead/intraday markets more than its technical capacity, minus 1 MW. In the real-time phase, if needed, the TSO will modulate the resource by requesting (and paying for) up to an additional 1 MW of balancing electricity.

It is important to realize that, while the German market model is different from the Italian one (where no capacity products are defined), the value of flexibility that is extracted via the sale of reserve capacity in the German market is not “additional” to the one that is extracted in the Italian market via the sale of redispatch services. Given a certain market design, participants will adapt their bidding strategies and maximise the value of flexibility (that is, under hypothesis of perfect competition, the same under both designs).

In the German market, auctions for reserve capacity are held one day before the delivery and remunerate the capacity of the aggregator to provide aFRR electricity – i.e., they remunerate the fact that the aggregator can provide a “capacity band” within which the consumption of the consumers can be reduced (providing upward modulations). The delivery period of each activation that effectively constitutes the product being offered in the market, is the capacity band over a 15-minute period.

The following Figure 12 shows the result of the German auctions for aFRR reserve capacity in 2022, for the aFRR upward capacity band. The figure shows the so-called price duration curve, i.e. it displays the aFRR capacity prices from the highest to the lowest one in each of the 35 040 quarter-hour periods of the year.

As the figure shows, the price duration curve is rather ‘steep’, so that high prices for the aFRR capacity (up to about 50 €/MW) can be achieved in a limited number of periods. For most periods, the revenues from the sale of aFRR capacity is below 10 €/MW (i.e., in our case, 10 € per 1 000 consumers).

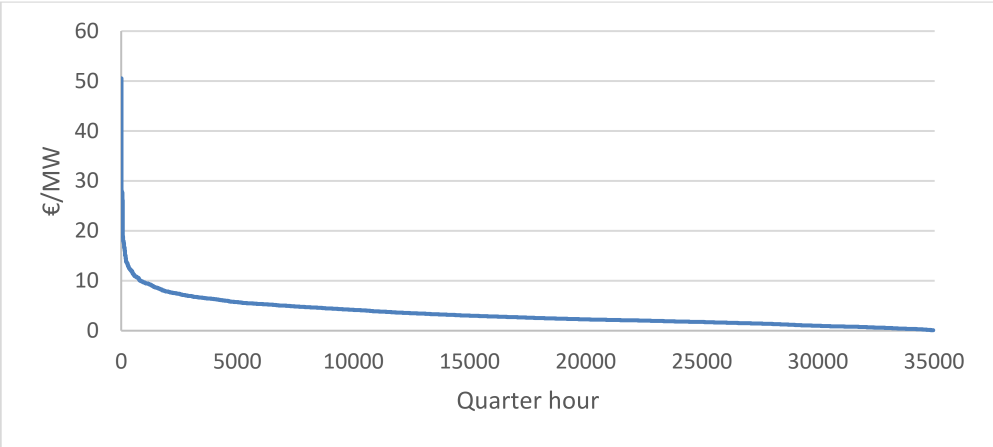

Figure 12: Price duration curve for aFRR reserve capacity in Germany, 2022
(Source: ENTSOE)

Assuming that the aggregator sells 1 MW of capacity for all the 15-minute periods in the year, the revenues from the sale of aFRR capacity in 2022 are equal to 117 277 €. On top of this, we assume that:

- the SO activates the (upward) secondary reserve for 10 % of the contracted capacity (100 kWh per hour), and
- the aggregator matches these modulations with increased purchases in the day-ahead market.

Assuming that aFRR activations do not follow a specific temporal pattern, the profit attainable via the sale of aFRR electricity is given by the differential between the average aFRR electricity price and the day-ahead price – which equalled 63.78 €/MWh in 2022 in the German market. Applying this value to 100 kWh over 8 760 hours, a profit of 55 870 € is obtained.

In conclusion, the total DR potential margin for an aggregated pool of 1 000 consumers delivering 1 MW of aFRR reserve capacity through the entire year equals 117 277 € + 55 870 € = 173 147 €. In order to compare this to the commodity supply cost, consider that assuming an average yearly consumption of 5 000 kWh/client, supplying the portfolio of consumers amounts to a cost of about 1 130 976 €, so that the DR margin potential represents a 15 % share of the electricity supply cost.

5.5 Cost revenue comparison: assessment

The empirical assessment of the revenue gap for DR providers that might justify financial support has proven to be a difficult exercise because of the lack of public information and a large heterogeneity of the reference scenario that the people we interviewed appear to have in mind, for an activity that in most EU countries is at these early stages of development.

Several challenges occurred during the study. The main ones are presented in the following list:

- The quantitative data collected through literature review and desk research was limited: while there is a wide range of papers aimed at assessing the DR potential in several EU Member States, a small number of papers provides a quantification of the main costs and revenues of DR operators. Similarly, costs for DR services are usually assessed at an aggregated level that provides only indirectly an idea about the costs and revenues of DR operators for single customers.

- In literature, the quantification of costs and revenues is more readily accessible in relation to markets like the United States and Australia. However, those markets are characterized by a different stage of development of DR and a markedly different configuration of the electricity markets.
- Accurately quantifying the costs and revenues through the public consultation posed significant challenges for several reasons. As mentioned above, many interviewed respondents chose not to provide any quantitative data on costs and revenue streams. Moreover, those who answered did not provide mutually comparable information on the cost of providing DR. The challenges arose from the significant variation in underlying attributes for DR operations across different DR operators when answering the questions.
- The products of DR provided in the different countries are very heterogeneous according to their characteristics (e.g. optional/compulsory, manual/automatic activation, moment to present bids, response time, duration, capacity, frequency of activation, etc.) within different markets. As a result, consumers and DR providers exhibit varying degrees of flexibility potential and employ diverse means and technologies to respond, whose costs may not be directly comparable.

The scarcity of publicly available information on costs and revenues related to DR in Europe, as sourced from reputable sources active in this domain, and the attempt to procure significant quantitative data pertaining to costs through interviews and surveys served as an indicator of the inherent complexity of quantification at this stage of DR development.

The following table compares expected costs and DR net revenue potentials for our strawman examples.

Use case	Costs (for 5 years)	Net revenue potentials (for 5 years)
DR operator aggregating refrigerated warehouses	10 190 000 €	1 081 985 €
Standalone cement production plant providing DR	105 000 €	1 377 018 €
DR operator aggregated small end-users	10 890 000 €	865 735 €

Table 21: Expected costs and revenues comparison for a period of 5 years
(Source: Information provided by stakeholders consulted during this assignment)

The table shows a systematic gap between the revenues that our strawman DR service providers would collect by selling DR services in the ancillary service markets and the corresponding cost.

The gap is even more striking because we have systematically selected our cost and revenue assumptions biased in the direction of overestimating the DR provider returns. In particular, on the cost side:

- assumption that the small end-consumers do not bear any cost from loss of comfort, loss of leisure time or loss of flexibility due to their participation in explicit DR. Also, for refrigeration sites we considered that the costs for manual adjustment for refrigeration when needed will be negligeable, and that the operation of DR will not generate any loss of production or any other cost for the cold storage site. Also, rescheduling and utilisation of an alternative electricity source are not needed and thus will not generate additional costs for the site. Finally, for cement plants, variable costs due to rescheduling of production or use of alternative electricity source were not considered.

- set-up costs of consumer productive processes set-up were not considered.
- consumer acquisition and enrolment costs were assumed at the lower end of the spectrum of available estimates.
- assumption that the relationship between BSP, BRP and the supplier is costless.
- corporate costs such as legal and administrative expenses were not considered for the estimation provided.

Further, on the demand side, we tried to err in the direction of:

- overestimating the volume of DR services that consumers are likely able to deliver, especially in terms of the number of times in the year in which they can modify consumption;
- overestimating the volatility of the prices of electricity and the ability of DR providers to profit from it.

6. The EU legal framework and key considerations when implementing State aid for flexibility measures

The chapter is organised in four sections as follows. The first section reviews the legal framework under which the existing State aid measures discussed in Chapter 3 were adopted and approved.

The second section discusses the provisions of the Electricity Directive and Electricity Regulation that are relevant to the assessment of State aid measures for DR. In this part, we summarise the main provisions related to the flexibility measures under Directive (EU) 2024/1711 of the European Parliament and of the Council of 13 June 2024, amending Directives (EU) 2018/2001 and (EU) 2019/944 as regards improving the Union's electricity market design ("**new Electricity Directive**") and Regulation (EU) 2024/1747 of the European Parliament and of the Council of 13 June 2024, amending Regulations (EU) 2019/942 and (EU) 2019/943 as regards improving the Union's electricity market design ("**new Electricity Regulation**"). Finally, we highlight the Guidelines on State aid for climate, environmental protection, and energy 2022 ("CEEAG")[73] and its relevant rules.

The third section provides key considerations related to the implementation of the EU legal framework on State aid for flexibility services, including DR.

The fourth section puts forward a set of basic information requirements that stakeholders could consider when planning to put in place State aid measures for flexibility services.

6.1 Legal basis for the approval of State aid measures

The approval of the existing State aid measures took place on the basis of an evolving legal framework, namely the Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU ("**Electricity Directive**") and the "**Electricity Regulation**"), in line with the Guidelines on State aid for environmental protection and energy 2014-2020 ("EEAG") that were replaced in 2022 by the CEEAG.

6.1.1 Electricity Directive

The provisions of the Electricity Directive should have been transposed into national legislation of the Member States by 31 December 2020. The 2024 recast introduces additional principles that are applicable for DR, which are presented in the next chapters.

The Electricity Directive establishes common rules for the generation, transmission, distribution, energy storage and supply of electricity, together with consumer protection provisions, with a view to creating truly integrated competitive, consumer-centred, flexible, fair, and transparent electricity markets in the Union (Article 1).

Article 2(20) of the Electricity Directive defines DR as *"the change of electricity load by final customers from their normal or current consumption patterns in response to market signals, including in response to time-variable electricity prices or incentive payments, or in response to the acceptance of the final customer's bid to sell demand reduction or increase at a price in an organised market as defined in point (4) of Article 2 of Commission Implementing Regulation (EU) No 1348/2014 (17), whether alone or through aggregation"*. Moreover, Article 20 (48) provides that 'ancillary service' *"means a service necessary for the operation of a transmission or distribution system, including*

[73] *Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01).*

balancing and non-frequency ancillary services, but not including congestion management".

In this perspective, according to the general rules for the organisation of the electricity sector foreseen by the Electricity Directive, Member States shall ensure *"that their national law does not unduly hamper cross-border trade in electricity, consumer participation, including through DR, investments into, in particular, variable and flexible energy generation, energy storage, or the deployment of electromobility or new interconnectors between Member States, and shall ensure that electricity prices reflect actual demand and supply"*, granting *"that no undue barriers exist within the internal market for electricity as regards market entry, operation and exit […]"* (Article 3).

The directive requires indeed Member States to develop a regulatory framework to effectively enable the active participation of DR, through aggregation or individually, in the energy markets as well as flexibility schemes and energy efficiency schemes (Articles 13, and Articles 15-17).

Articles 31 and 40 set the legal basis for SOs to access and use flexibility services (for ancillary services). According to article 3 of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing, the procurement of these services must be *"fair, objective, transparent, and market-based […] while ensuring [DR] compete[s] with other balancing services at a level playing field […]".*

Article 32 requires MSs to develop a regulatory framework for enabling and incentivizing DSOs to procure flexibility services (including congestion management) as an alternative to grid expansion. Distribution network plans shall provide transparency on flexibility needs and the planned investments for the next 5-10 years.

In particular, transmission SOs (TSOs) must *"procure ancillary services to ensure operational security…subject to…transparent, non-discriminatory and market-based procedures [and] the participation of all qualified electricity undertakings and market participants, including market participants offering energy from renewable sources, market participants engaged in DR, operators of energy storage facilities and market participants engaged in aggregation"* (Electricity Directive Art 40).

Furthermore, the national regulatory authorities (NRAs) are responsible for fixing or approving sufficiently in advance of their entry into force at least the national methodologies used to calculate or establish the terms and conditions for *"[…] the provision of ancillary services which shall be performed in the most economic manner possible"* and *"shall be provided in a fair and non-discriminatory manner and be based on objective criteria"* (Electricity Directive Art 59).

6.1.2 Electricity Regulation

Pursuant to Article 20 of the Electricity Regulation, *"Member States with identified resource adequacy concerns shall develop and publish an implementation plan with a timeline for adopting measures to eliminate any identified regulatory distortions or market failures as a part of the State aid process. When addressing resource adequacy concerns, the Member States shall in particular take into account the principles set out in Article 3 and shall consider:*

(a) removing regulatory distortions;

(b) removing price caps in accordance with Article 10;

(c) introducing a shortage pricing function for balancing energy as referred to in Article 44(3) of Regulation (EU) 2017/2195;

(d) increasing interconnection and internal grid capacity with a view to reaching at least their interconnection targets as referred in point (d)(1) of Article 4 of Regulation (EU) 2018/1999;

(e) enabling self-generation, electricity storage, demand side measures and energy efficiency by adopting measures to eliminate any identified regulatory distortions;

(f) ensuring cost-efficient and market-based procurement of balancing and ancillary services;

(g) removing regulated prices where required by Article 5 of Directive (EU) 2019/944".

According to Article 21 of the Electricity Regulation, *"Member States may, while implementing the measures referred to in Article 20(3) of this Regulation in accordance with Articles 107, 108 and 109 TFEU, introduce capacity mechanisms".*

Article 22 of the Electricity Regulation set certain constraints on the design of State aid measures for capacity mechanism, including that they shall:

- be approved by the Commission for no longer than 10 years; the 2019 Regulation also required that those measures are temporary, however that condition was removed with the 2024 recast;
- select capacity providers (and determine the price) through a transparent, non-discriminatory and competitive process; and
- be technology neutral (including being open to cross-border participation).

Article 24 (1) of the Electricity Regulation foresees that *"national resource adequacy assessments shall have a regional scope and shall be based on the methodology referred in Article 23(3) in particular in points (b) to (m) of Article 23(5)"*.

According to Article 26 (1) (2), *"1. capacity mechanisms other than strategic reserves and where technically feasible, strategic reserves shall be open to direct cross-border participation of capacity providers located in another Member State, subject to the conditions laid down in this Article. 2. Member States shall ensure that foreign capacity capable of providing equivalent technical performance to domestic capacities has the opportunity to participate in the same competitive process as domestic capacity. In the case of capacity mechanisms in operation on 4 July 2019, Member States may allow interconnectors to participate directly in the same competitive process as foreign capacity for a maximum of four years from 4 July 2019 or two years after the date of approval of the methodologies referred to in paragraph 11, whichever is earlier.*

Member States may require foreign capacity to be in a Member State that has a direct network connection with the Member State applying the mechanism".

6.2 The Electricity market reform

This section discusses the provisions, focused on the flexibility measures, of the new Electricity Directive and of the new Electricity Regulation, introduced by the 2024 reform of the electricity market design as well as the CEEAG.

6.2.1. The new Electricity Directive

In particular, according to recital 8 of the new Electricity Directive, *"**the current electricity market design has, inter alia, helped the emergence of new and innovative products**, services and measures on retail electricity markets, supporting energy efficiency and the uptake of renewable energy and enhancing choice to help consumers reduce their energy bills **including through small-scale generation installations and emerging services for providing DR** […]"*.

Article 6a of the new Electricity Directive, amending article 11 of the Electricity Directive, provides that *"**Member States shall ensure that final customers with fixed-term, fixed-price electricity supply contracts are not excluded from their participation, when they so decide, in DR** and energy sharing and from actively contributing to the achievement of the national electricity system flexibility needs"*.

6.2.2. The new Electricity Regulation

Furthermore, recitals 46-48 of the new Electricity Regulation provide the following:

*"46. The accelerated deployment of renewable energy sources necessitates a growing availability of flexibility solutions to ensure their integration to the grid and to enable the electricity system and grid to adjust to the variability of electricity generation and consumption across different time horizons. In order to foster non-fossil flexibility, the regulatory authority or another authority or entity designated by a Member State should periodically assess the need for flexibility at national level in the electricity system on the basis of the input of transmission SOs and DSO and a common European methodology that is subject to public consultation and approval by ACER (Article 19e). **The assessment of the flexibility needs of the electricity system should take into account all existing and planned investment**, including existing assets that are not yet connected to the grid, with regard to sources of flexibility such as flexible electricity generation, interconnectors, DR, energy storage or the production of renewable fuels, because of the need to decarbonise the energy system. […]*

*47. **To achieve the indicative national objective for non-fossil flexibility, including the respective specific contributions of DR and energy storage, and where flexibility needs are not being addressed by the removal of market barriers and existing investment, Member States should be able to apply non-fossil flexibility support schemes consisting of payments for the available capacity of non-fossil flexibility**. Furthermore, Member States that already apply a capacity mechanism should consider promoting the participation of non-fossil flexibility such as DR and energy storage by redesigning criteria or features without prejudice to the application of Article 22 of Regulation (EU) 2019/943. Member States that already apply a capacity mechanism should also be able to apply non-fossil flexibility support schemes if those schemes are necessary to achieve the indicative national objective for non-fossil flexibility, in particular while adapting their capacity mechanisms to further promote the participation of non-fossil flexibility such as DR and energy storage. Those schemes should cover new investment in non-fossil flexibility, **including investment in existing assets, including those aimed at further developing DR flexibility**.*

48. To support environmental protection objectives, the CO_2 emission limit, set out in Article 22(4) of Regulation (EU) 2019/943, should be seen as an upper limit. Therefore, ***Member States could set technical performance standards and CO2 emission limits that restrict participation in capacity mechanisms to flexible, fossil-free technologies in full alignment with the communication of the Commission of 18 February 2022 on 'Guidelines on State aid for climate, environmental protection and energy'*** *which encourage Member States to introduce green criteria in capacity mechanisms".*

Moreover, Article 19 f (Indicative national objective for non-fossil flexibility) of the new Electricity regulation foresees that:

"*No later than six months after the submission of the report pursuant to Article 19e(1) of this Regulation, each Member State shall define, on the basis of that report, an indicative national objective for non-fossil flexibility, including the respective specific contributions of both DR and energy storage to that objective. Member States may achieve that objective by realising the identified potential of non-fossil flexibility, via the removal of identified market barriers or via the non-fossil flexibility support schemes referred to in Article 19g of this Regulation. That indicative national objective, including the respective specific contributions of DR and energy storage to that objective, as well as measures to achieve it shall also be reflected in Member States' integrated national energy and climate plans as regards the dimension "Internal Energy Market" in accordance with Articles 3, 4 and 7 of Regulation (EU) 2018/1999 and in their integrated national energy and climate progress reports in accordance with Article 17 of that Regulation. Member States may define provisional indicative national objectives until the report is adopted pursuant to Article 19e (1) of this Regulation".*

6.2.3. The Commission Guidelines on State aid

In order to prevent State aid from distorting competition in the internal market and affecting trade between Member States in a way which is contrary to the common interest, Article 107(1) of the Treaty on the Functioning of the European Union ('the Treaty') lays down the principle that State aid is prohibited. In certain cases, however, State aid may be compatible with the internal market under Articles 107(2) and (3) of the Treaty. Based on Article 107(3)(c) of the Treaty, the Commission may consider compatible with the internal market State aid to facilitate the development of certain economic activities within the European Union, where such aid does not adversely affect trading conditions to an extent contrary to the common interest.

It should be noted that the majority of the existing State aid measures included in the sample of this study have been approved under the EEAG. The very few measures assessed and approved under the CEEAG include the modification to the Belgian Capacity Mechanism, the strategic reserve in Finland as well as the new measure to support short-term decarbonised flexibilities in France.

The CEEAG that entered into force on 27 January 2022, include important adjustments to align the rules with the Commission's strategic priorities, in particular those set out in the European Green Deal, and with other recent regulatory changes and Commission proposals in the energy and environmental areas, including the Fit-for 55-package.

These Guidelines set the conditions under which State aid granted by Member States in the field of climate, environmental protection and energy may be considered compatible with the Single Market and the criteria that the Commission applies to assess support by Member States in these areas. The provisions of the Guidelines are complemented by the General Block Exemption Regulation ("GBER"), which lays down ex ante compatibility conditions on the basis of which Member States can implement State aid measures without prior notification to the Commission.

In particular, section 4.8 of CEEAG provides a legal framework for any aid ensuring the "security of electricity supply". This includes Capacity Mechanisms and any other measures for dealing with long and short-term security of supply issues resulting from market failures preventing sufficient investment in electricity generation capacity, storage or DR, interconnection, as well as network congestion measures which aim to treat the insufficiency of electricity transmission and distribution networks. The flexibility measures, introduced in the new Electricity Regulation, may fall in this scope and could be therefore assessed under section 4.8 of the CEEAG.

6.3 Key considerations on the implementation of the EU legal framework on State aid for flexibility measures

In this legal context, before designing State aid measures aimed at increasing the security of electricity supply, such as flexibility measures, Member States should look at a number of key considerations highlighted in this chapter. They should identify first the economic activities that will be developed as a result of the aid, and they should demonstrate that those measures fulfil the following conditions.

Incentive effects[74]

Member States should highlight that the State aid measure has an incentive effect, leading the beneficiary/ies of the measure to engage in an activity which it would not carry out without the State aid or would carry out differently. The State aid measure should incentivize DR with the necessary market, technical and/or financial conditions that would not otherwise exist without the introduction of the State aid measure.

Chapters 3 and 4 present barriers for the participation of the DR operators in the electricity markets and State aid measures. The analysis in Chapter 5 suggests the possible existence of material cost-revenue gaps for the provision of DR services, given the current demand/supply fundamentals of EU electricity market, even after the market design barriers to the development of DR are removed. Based on the given premise, it seems probable that without support measures DR development would be limited in the immediate future.

Minimisation of distortions on competition and trade

The requirements of section 4.8 of CEEAG that DR support mechanisms minimise distortions on competition and trade, are discussed below. This includes (a) necessity; (b) appropriateness; (c) eligibility; (d) proportionality; and (e) avoidance of undue negative effects on competition and trade and balancing.

a) Necessity

The necessity requirement relates to justification of the non-fossil flexibility target that the Member States pursue through the State aid measure.

The following provisions of the new Electricity Regulation should contribute to the assessment of the measure's necessity:

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[74] *CEEAG, section 4.8.3.*

i. The reports by the national authorities presenting estimates of needs for flexibility on a 5–10-year horizon (mandated by Article 19 e of the new Electricity Regulation).
ii. The indicative national objectives for non-fossil fuel flexibility, including DR and energy storage (mandated by Article 19 g of the new Electricity Regulation); this will be helpful, among other things, to identify any gaps between national objective and the actual level of flexibility available to each system,.

b) Appropriateness

The appropriateness requirement, in section 4.8.4.2 of CEEAG, centres on the assessment of alternative ways of achieving security of electricity supply, including, for instance, incentivising and integrating DR and storage.

In this respect, the new Electricity Regulation requires that the national flexibility reports evaluate the barriers for flexibility in the electricity market and propose relevant mitigation measures and incentives, including the removal of regulatory barriers and possible improvements to markets and system operation services or products (Article 19e.2(c) of the Electricity Regulation).

The new Electricity Regulation does not explicitly cast the removal of the barriers that prevent the energy and ancillary service markets to deliver the adequate volume of flexibility as a strict pre-condition for admissibility of support schemes. However, such interpretation, appears reasonable both on economic grounds, and by the combination of (at least) the following requirements, featuring in both the CEEAG and in the New Electricity Regulation:

i. the State aid measure to be designed in such a way to prevent undue distortions to the efficient functioning of the electricity markets and to provide incentives for the integration in the electricity market in a market-based and market-responsive way (Article 19h(f) and Article 19f(g) of the new Electricity Regulation);
ii. the principle of proportionality, since in case participation of DR response in the market is hindered by regulatory barriers or inadequate market-design, financial support measures may turn out to be ineffective, or more expensive than necessary.

c) Eligibility

The requirements related to eligibility, in Section 4.8.4.3 of CEEAG, provide that the State aid measure should be open to all beneficiaries or projects technically capable of contributing efficiently to the achievement of the security of supply objective, including generation, storage and DR, both individually and aggregated.

The new Electricity Regulation provides further structure to the set of support mechanisms that Member States may implement, by distinguishing:

1. capacity remuneration mechanisms.
2. new mechanisms to support investment in renewable generators, based on contracts for differences or equivalent measures, targeted to low carbon, non-fossil fuel technologies, with low and stable operational costs and to technologies which typically do not provide flexibility to the electricity system.

3. support mechanisms targeting flexibility, addressed to non-fossil-fuel suppliers of flexibility, including DR and energy storage technologies[75].

By restricting the requirement of technological neutrality to non-fossil-fuel suppliers of flexibility, those technologies can be shielded from the competition exercised by traditional generators, while DR and storage systems would still compete with each other (and with flexible non fossil generation) to provide flexibility. In addition, point 346 of CEEAG requires that, where technically feasible, measures for security of electricity supply must be open to direct cross-border participation of capacity providers located in another Member State.

Article 19h (j) of the new Electricity Regulation promotes the opening to the cross-border participation of non-fossil flexibility that are capable of providing the required technical performance, subject to the condition of a positive cost-benefit analysis.

EU forward electricity markets are currently integrated via market coupling and integration of balancing is being pursued through platform integrating the SOs' real time operations. Those platforms, once fully operational, will ensure technical feasibility of cross-border supply also of non-fuel flexibility services in all time frames.

d) Proportionality

A necessary condition for a State aid measure on flexibility to meet the proportionally criteria is that reliability standards on which the demand for those services is based be determined with a cost-benefit analysis.

Further, the proportionality requirement is satisfied providing that the aid amount per beneficiary is limited to the minimum needed for carrying out the aided project or activity. To this purpose, Article 19h(e) provides that that flexible capacity providers be selected by means of an open, transparent, competitive, voluntary, non-discriminatory and cost-effective process. Providing that this requirement results in the implementation of competitive tenders, the presumption is that the cost of support measure is minimised holds. When such presumption holds, national authorities proposing the State aid measure are exonerated to estimate the cost of delivering the DR services, for the purpose of demonstrating that the aid is proportional. Using tenders to discover the (minimum) volume of needed financial support might be particularly valuable for DR, given the high uncertainty on cost and revenues at the current stage of the sector's development, as we discussed in Chapter 5.

e) Avoidance of undue negative effects on competition and trade and balancing

Section 4.8.5. of CEEAG and the new Electricity Regulation are in line on the requirement that flexibility support schemes must be designed to maintain the efficient functioning of markets and preserve efficient operating incentives and price signals.

The new Electricity Regulation qualifies that requirement:

i. in Article 19h (f), indicating that the scheme must provide incentives for the integration of DR in the electricity market in a market-based and market-responsive way. As we mentioned earlier, reading Article 19h(f) in conjunction with Article 19c2 (c) of the EMD on regulatory barriers and improvements to the market arrangements, may provide grounds to consider full integration of

[75] *With the explicit exclusion of fossil fuel-based generation located behind the consumer's metering point.*

flexibility products in all markets, including real-time and ancillary service markets as a pre-condition for admissibility of the scheme.

ii. in Article 19e, indicating that compensation under the scheme must be based on the capacity provided by the flexibility supplier, while Article 19f (g) recognises that DR performances differentiate not only in term of capacity but also in terms of electricity that the unit can deliver. Reading Article 19e in conjunction with Article 19f (a) on minimisation of the support cost, provides grounds to consider that the scheme compensates differently DR resources, besides for their DR capacity, based on other dimensions of performance, such as total electricity deliverable or maximum number of activations during a pre-defined time interval (for example a day, or a month).

6.4 Practical considerations for design of State aid measures for flexibility

This section presents the set of information that, based on our analysis, are relevant at different stages of the process of preparing the design and implementation of support schemes for flexibility that include DR.

6.4.1 Objectives and role of the proposed measure within the broader energy policy of the country

Multiple public measures are being implemented by Member States to steer investment decisions in the electricity sector. Those measures produce effects in multiple areas, including the level and mix of generation capacity, the capacity of national and cross-border interconnections, the capacity of distribution networks, smart grid functionalities, energy conservation, and the deployment of alternative sources of flexibility, including storage systems, and of ancillary services. Those areas are connected to DR by complex substitutability and complementarity relationships.

As noted in the previous section, once the new Electricity Directive and Regulation are fully implemented the information contained in the flexibility reports[76], the adequacy reports[77], the network development plans[78], and the integrated climate and energy national plans ("NECP")[79] can be expected to provide a comprehensive representation of each State's energy policy measures.

However, at least until the new legal framework is fully implemented, some *ad-hoc* analyses and information may be necessary to assess consistency of the proposed measures with the broader national energy policy framework implemented in that country, in accordance with the CEEAG, the new Electricity Regulation, and the new Electricity Directive. To show such consistency, Member States planning to implement a State aid scheme may provide the following set of information:

1. A cost benefit assessment of alternative measures (alternative measures to State aid measures) to achieve the Member State's objectives.
2. Forecasts of the available flexibility endowment of the Member State, with and without the measure.
3. A description for the status of implementation of the EU legal framework.

[76] Electricity Regulation, Art. 19 of the Electricity Regulation.
[77] Electricity Directive, Art. 40(k).
[78] Electricity Regulation, Art. 51.
[79] Electricity Directive, Article 51, para. 2 "The competent national authorities shall examine the consistency of the ten-year network development plan with the national energy and climate plan in accordance with Regulation (EU) 2018/1999".

4. A description of any other measures already implemented by the Member State to support development of flexible resources and/or of generation capacity and of an assessment of the interaction those measures with the proposed State aid scheme.
5. Indicators of the current condition of the flexibility sector in the country, including the current share of flexibility provided by the main types of non-fossil fuel resources in the recent years. For example:
   a. maximum and average capacity bid, and volume of electricity delivered, in the balancing market by each type on non-fossil fuel resources.
   b. volume of price dependent DR or storage bids in the DAM and ID markets.
6. The Member State's expectations on how the previous figures would be impacted by the proposed State aid measure.

6.4.2 Technical, regulatory and financial preconditions for the development of the DR sector

In Chapter 4 we identified the following areas of the regulatory system and the market design such barriers are more likely to show:

1. Aggregation for the purpose of participating real-time/balancing and ancillary service markets.
2. Institution of balancing service provider (BSP).
3. The design of the real-time/balancing and ancillary service markets.

The following set of information could be assessed by the Member State in order to identify any remaining barriers. In particular, to assess effectiveness of the aggregation arrangements:

1. Products that can currently be supplied by aggregations of consumption and/or production units (real time/balancing actions, ancillary services, including short term reserve markets).
2. Number of aggregators (distinguishing between independent and integrated with suppliers or BRP) operating in the country.
3. Distribution of the aggregators by size.
4. Distribution of the aggregators by share of DR and other non-fuel flexible resources in their portfolio.
5. Distribution of the DR providers by technology and, for consumers, by type of consumers (industrial, commercial, residential…).

The development of independent balancing service providers can be evaluated based on the following information:

1. Whether the BSP/BRP architecture is currently implemented in the regulatory framework, in the network code and in the settlement system.
2. Whether the relationship among the flexible the BSP and the BRP is regulated or left to the negotiation between the parties.
3. The number of consumption or production units whose BSP is not the same company (nor belong to the same group of companies) as the BRP and the

average size of those units (for example expressed in terms of annual electricity consumption or production).

In order to assess to what extent the current design of the real-time/balancing and ancillary service markets is compatible with DR participation, the following set of information would be relevant:

1. The design of the products traded in each of those market, including at least:
    a. the minimum bid/offer size;
    b. technical features that define the performance that the unit will deliver;
    c. these may include:
        i. notification time;
        ii. maximum activation time, or maximum electricity delivered, or (potentially relevant for DR) maximum number of activations in a given period of time;
        iii. maximum ramp rates;
        iv. connection level (transmission, distribution).
    d. The minimum requirements, related to those technical features that a unit must meet in order to be allowed in the market, indicating if different thresholds apply to different types of units.
2. The design of the bid/offer selection algorithm, in particular:
    a. how the algorithm addresses the trade-off between the bid/offer price and the technical features of the unit that will deliver the service; for example, how the algorithm selects between a (more expensive) balancing offer by an electricity unconstrained unit and (cheaper) multiple electricity constrained offers submitted by different electricity-constrained units;
    b. what may be reasons for out of merit bid/offer selection and how often those selection occurs, (for example in terms of share of volume of annual electricity procured coming from out-of-merit accepted offers).
3. How distribution-level constraints, if any, are kept into account in the selection process run by the SO and, more generally, what is the involvement of DSO in the procurement of balancing and/or ancillary services.
4. Actual participation of DR and other non-fossil fuel flexibility providers in real-time/balancing and ancillary service markets, and in particular:
    a. volume of offers and bids submitted in each market by DR and other non-fossil fuel flexibility providers, in the recent years (in absolute terms and as a share of the total volumes procured traded in those markets);
    b. volume of the offers and bids by DR and other non-fossil fuel flexibility providers that were accepted, in each market in each year;
    c. how the baseline consumption is computed for consumers participating in those markets.

Finally, the supply side constraints are likely to limit the ability of the tendering process to discover and implement the minimum level of aid necessary to achieve the DR target. This happens when the auction clears at the administratively set price-cap. Member States might then want to set the level of the price cap implemented in case demand and supply of DR capacity do not cross in the auction based on an assessment of the revenue gap for the typical DR providers, through a comparison of expected revenues in the markets for energy and ancillary services and the provider's expected cost.

6.4.3 Adverse effects of State aid measures on competition in the DR or in the wholesale electricity markets

A necessary condition for a DR support measure to be non-distortive of competition in electricity wholesale and ancillary service markets is that support is capacity based, while leaving the supported capacity fully exposed to the volatility of spot prices[80].

The same holds for integration within the real-time/balancing and ancillary service markets, which guarantees that the DR service provider will compete on a levelled playing field with the other flexibility providers for activation.

6.4.4 Effectiveness of the DR support mechanism

The analysis in Chapter 2 suggests that, once the barriers to the functioning of the DR market are removed, inadequate supply of DR or other non-fossil fuel flexibility services is most likely to be caused by the unwillingness of market participants to take risks. In fact, making the consumer appliances and production processes fit to provide DR services and setting up aggregations of multiple consumers and other flexible assets entails fixed cost. As discussed in Chapter 2, multiple factors make recovery of such cost through participation in electricity and ancillary service markets uncertain.

For those reasons, it is reasonable to expect that support schemes based on capacity remuneration are more effective compared to schemes that increase the revenues when DR resources are activated. Further, the risk-reduction effect of the mechanism is maximised if compensation is granted for several years consistent with what developers target for the recovery of investment at the consumer site, which may depend on the type and size of consumers.

Supply-side constraints may prevent the support scheme to deliver the target level of DR capacity and, if the selection of the beneficiaries takes place via an auction, may result in unwanted rents for the selected suppliers[81]. This possibility is not remote, because delivering DR services requires the involvement of end consumers that may be difficult to mobilize into suppliers of flexibility. Consistency between the DR volume targets pursued via the support measure and the potential of the market to develop additional resources may be assessed, for example by:

i. assessing the volume of flexibility that the DR scheme is intended to deliver with the historic growth of the DR capacity in the country and in countries with comparable structure of consumption;
ii. market tests, in the same logic of the open seasons, through which national authorities collect non-binding manifestations of interest by DR developers, under different assumptions as to the timeframe for delivery of the additional DR capacity.

[80] Note incidentally that the pay-back mechanisms implemented in some capacity remuneration schemes meet this requirement.
[81] This is also noted in CEEAG, para 49 (c).

The results of such market test should be included in the application package, as evidence that the DR capacity increase sought via the support scheme is feasible.

6.4.5 Minimisation of the cost of DR support

Multiple features of the support mechanism may impact the cost of achieving a given non-fossil flexibility objective or a specific DR objective.

First, the cost of procuring the target level of flexibility would be minimised by technology neutral support schemes, allowing all technologies capable of delivering flexibility to compete for support. This can be achieved by setting the volume of flexible capacity that each technology can deliver, and for which it can receive support, based on the same standardised flexibility product; all participants granted financial support will then have to offer that product in the ancillary service or balancing market. Verifying if the previous requirements are met can be done based on the description of the support scheme, whose content that we address at the end of the section.

Second, the design of the support mechanism may have an impact on its efficiency. In particular, as discussed in the previous section, one would expect that the cost of support is minimised by capacity-based remuneration schemes, with a duration consistent with the recovery of a large part of the DR supplier's fixed cost, and with lead time long enough to allow DR suppliers to expand their endowment of flexible consumers. Such design can be expected to minimise the cost of support because it tackles directly the risk-related difficulties that appear to the growth of the DR sector.

Third, auction-based mechanisms to select the beneficiaries of public support measures are recognised as effective in order to achieve the public policy objectives at minimum cost.

BOX: Characterisation of the flexibility support mechanism

In this box we present a minimal set of information allowing to characterize a support mechanism for flexibility open to DR.

As the purpose of the information has been discussed in the body of the report, here we limit to listing and, where necessary, clarifying, the information that characterise the support mechanism.

1. Flexibility product

We call flexibility product the set of obligations taken by the beneficiary of the support scheme (for example the DR provider). The information necessary to characterise the flexibility product include:

- Markets (e.g. day-ahead, intra-day, real-time/balancing, ancillary service markets, redispatch market) in which the DR provider submits offers to reduce consumption.
- Technical features (minimum requirements) attached to offers submitted by the DR provider in those markets; for example, for balancing offers, minimum notice time, maximum duration of the balancing action provided over a certain time period.
- Constraints to the price offered in the above markets by the flexibility providers.

- In case delivery of flexibility services takes place out of the previous markets or with special rules within those markets, which might be the case for interruptibility services and strategic reserve, description of the flexibility performance required, conditions for their activation and any other relevant arrangements governing delivery of the service.

2. DR capacity

We call flexible capacity the maximum volume of flexibility product for which a flexibility provider is eligible to apply for support. The information necessary to characterise the flexible capacity include:

- Methodology to compute each provider’s flexible capacity, based on the characteristics of the flexible resources under his control, for example differentiating the contribution to the provider’s flexible capacity of different types of consumers, storage systems, etc.
- Methodology to verify, ex-post, that the actual contribution of the different types of resources was in line with the assessment carried out to set the provider’s capacity.

3. Design of the support mechanism

- Basis for compensation (e.g. electricity delivered, capacity made available).
- Payback obligations, if implemented.
- Duration of support.
- Arrangements to verify that the obligations of the flexibility provider to make flexible capacity available are actually fulfilled, including the methodology to compute underdelivered volumes.
- Penalties in case of under-delivery of flexible capacity under the support scheme (additional to charges and penalties in case of the flexibility provider does not comply with an activation order according to electricity and ancillary service market rules).
- Arrangements, if any, allowing the obligations assumed by a flexibility provider that is awarded support to be transferred to a different party.

4. Award methodology

Under the assumption that the beneficiaries of support are selected via a tendering process, the minimum set of information necessary to characterize and assess such mechanism includes:

- Requirements for participation (technical, financial, etc.).
- Special requirements, if any, for participation by aggregators.
- Special requirements, if any, for participation by flexibility providers whose resources are connected to a foreign network.
- Minimum volume of flexible capacity that the supplier must offer to participate in the tender, and minimum bid size.
- Lead time between the award and when the beneficiary must start delivering the DR service.
- Price formation mechanism, including price caps, price floors, bid caps and any arrangements resulting in different types of providers to receive

different support (as it happens for existing and new capacity in some capacity remuneration schemes).

- Frequency of the tenders.

Annex I: Barriers' relevance by type of barrier and Member State

The following tables offer a summary of the identified relevant barriers, within each barriers' area and on a per-member state basis. Utilizing a color-coded scheme, the tables present the relevance of each barrier determined through the survey results[82]. Additionally, a coefficient was used to incorporate qualitative insights from interviews into the quantitative data derived from the Likert scale questions in the survey[83]. This approach guaranteed a cohesive representation of the acquired values and information[84]. Categorization was then possible using the color-codes reported in the table below.

Colour Code	Rating	Description
White	**-**	No answers were recorded for that barrier and for that country.
Light Blue	**Low**	The barrier has little to non-significance in the country.
Yellow	**Moderate**	The barrier has medium relevance in the country.
Orange	**High**	The barrier has high relevance in the country.

Table 22: Description of the colour-code to rate the barriers
(Source: Consultant's own analysis)

It is important to note however, that if no answer was recorded for a barrier or for a market in the tables does not necessarily imply its nonexistence; rather, it indicates that the barrier was not identified. Conversely, where barriers are identified they will be supported by varying degrees of certainty.

Therefore, it is imperative for the reader to recognize that the tables only reflect the barriers indicated through the research and consultation processes for this study. Nonetheless, the researchers confirm that the tables offer a comprehensive overview of the barriers experienced across the 27 EU markets.

Legal and Regulatory barriers by barrier area and by Member State

Overall, the results of stakeholders' consultation point out that the legal and regulatory framework established for DR aggregator/DR operator is incomplete or unclear, with a market design that favours generation over DR, with unclear roles and responsibilities for both traditional and emerging market players. With the absence of standardized framework for DR measurement, verification, and flexibility in tariff structures, preventing the development of demand-side flexibility and the effective operation of aggregators.

[82] *The intensity of each barrier is measured using an indicator ranging from 0 to 5 and qualified as, "Light-Blue, Low" (if it is below 2), "Yellow, Moderate" (from 2 up to 3.7), and "Orange, High" or highly restrictive (if it is above 3.7). For those cases where the indicator's value is 0, it does not necessarily indicate the absence of the barrier, but a lack of information available regarding the barrier in that Member State.*
[83] *The survey design is described in section 1.2 above.*
[84] *Malta, and Luxembourg were excluded from the results due to the unique features of their markets and a lack of pertinent information, i.e., Malta since they do not have a liquid wholesale electricity market.*

Area	Barrier	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	RO	SE	SI	SK
(1) Participation of DR operators and DR aggregators to electricity markets	The pre-qualification process is performed at the unit level (instead that at the pool level)																									
	The length and complexity of the pre-qualification process to obtain the status of market participant																									
	BSP-BRP absence of standardized agreements and the unclear separation of responsibilities between entities involved in electricity balancing and aggregation.																									
	Financial, honourability and technical requirements to operate in wholesale electricity markets as DR operator or aggregator																									
	The obligation to perform an ex-ante activation test to participate in ancillary services markets																									
(2) Participation of active customers to electricity markets	Non-level playing field in grid access costs and charges for users providing the same service																									
	End-customers are not entitled to delegate a third party for the management and dispatch of the installations required for their activities (i.e. production, storage, provision of flexibility services etc.)																									

Area	Barrier	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	RO	SE	SI	SK
	The lack of cost-reflective, transparent, and non-discriminatory network charges that account separately for the electricity fed into the grid and the electricity consumed from the grid																									
	The legislative and regulatory framework on energy communities and collective self-consumption according to the IEM Directive has been established																									
(3) Wholesale and retail electricity prices	Pricing mechanism of wholesale markets (explicit/implicit price caps)																									
	Pricing mechanism of retail markets (establishment of price regulation termination)																									
(4) Switching process	The application of discriminatory procedures, charges, commercial conditions, administrative requirements concerning the supply contract to end-customers engaged in an aggregation contract with a market participant different than the supplier																									
(5) Access to end-customers data	The rules and procedures on data access and exchange between market participants																									
(6) TSOs and DSOs' network plans	The lack of obligations for TSO and DSOs to indicate in their network development plans information on the need of flexibility																									

Area	Barrier	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	RO	SE	SI	SK
	services in the medium- and long-term time horizon																									

■ High Relevance ■ Moderate Relevance ■ Low Relevance □ No information for that barrier

Table 23: Legal & Regulatory barriers by market
(Source: Consultant's own analysis)

Market barriers by barrier area and by Member State

Within the Market barriers block, the area of flexibility service products and the area related to the role of BSPs in flexibility markets are those that stakeholders were highlighting the most. With respect to the barriers listed in the below Table 24, stakeholders seem to consider as most relevant in affecting the participation of DR in electricity markets those regarding the area of market products characteristics, as the minimum bid size to participate in ancillary service markets and those on BSP-BRP separation and qualification.

The first area of barriers relates to the lack of definition of appropriate bid thresholds and other product characteristics reflecting DR technical capabilities hindering the participation of DR, DR operators and aggregators to flexibility markets. Particularly, a minimum bid size of 100kW for ancillary service market, according to consulted stakeholders, establishes an entry barrier, and therefore limits DR participation for small-scale stakeholders.

The second one relates to the possibility of having BSP entities differentiated from BRP and the possibility for DR operators to act as BSP encouraging in this way the diffusion of DR.

Overall, these two barriers' area stand out with a medium to high relevance in all the Member States reported in table below.

Area	Barrier	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	RO	SE	SI	SK
(7) Flexibility service products	The application of a minimum bid size greater than 100kW for ancillary services markets	Moderate	Moderate	High	High	High	Moderate	Moderate	High	High	Moderate	Moderate	Moderate	High	High	Moderate	High	High	High	High	High	High	High	Moderate	Moderate	High
(7) Flexibility service products	The lack of possibility to present asymmetric bids in ancillary services markets	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	Low	Moderate	High
(8) Role of BSPs in flexibility markets	The obligation for BSP to also obtain the qualification of BRP to operate in ancillary services markets	High	Moderate	High	High	High	High	Moderate	High	High	Moderate	High	Moderate	High	High	Moderate	Moderate	Moderate	Moderate	High	High	Moderate	Moderate	High	High	High
(9) Perimeter of aggregation for the participation to flexibility markets	The lack of possibility to present bids with respect to a portfolio of different technologies	Low	Moderate	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	High	Moderate	Moderate	High
(10) Effectiveness of the liberalization process	The poor effectiveness of the liberalization	Low	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	Moderate	Low	Low	Low

High Relevance | Moderate Relevance | Low Relevance | No information for that barrier

Table 24: Markets barriers by market
(Source: Consultant's own analysis)

Technical barriers by barrier area and by Member State

Within the technical barrier area, the major barriers highlighted many times by stakeholders are under the area of barriers related to the performance requirements for the provision of flexibility services, i.e., the provision of flexibility services in ancillary services markets and the establishment of a maximum activation time for the provision of flexibility services in ancillary services markets. These challenges relate to the duration of the delivery period in balancing markets and their activation time, with extended periods that may create barriers for certain resources.

Other relevant barriers highlighted by stakeholders are related to sub-metering, to the deployment status of smart meters and to the definition of a baseline methodology for participation in flexibility markets.

Area	Barrier	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	RO	SE	SI	SK
(11) Performance requirements for the provision of flexibility services	The establishment of a maximum performance duration for the provision of flexibility services in ancillary services markets	Low	High	High	High	High	High	Moderate	Moderate	High	Moderate	Low	High	High	High	High	Moderate	High	Moderate	High	High	High	High	Moderate	Moderate	High
	The establishment of a maximum activation time the provision of flexibility services in ancillary services markets	Moderate	Moderate	High	High	High	Moderate	Moderate	High	High	Moderate	Low	Moderate	High	High	Moderate	High	High	High	High	High	High	High	Moderate	Moderate	High
(12) Metering requirements for the participation to flexibility markets	Sub-metering is not allowed	High	High	High	High	High	High	High	High	High	Moderate	Moderate	High	High	High	High	High	High	Moderate	High	High	High	High	High	Moderate	High
(13) Status of deployment of smart metering	The deployment status of smart meters	High	High	High	High	Low	High	Moderate	Low	Low	Moderate	Low	Moderate	High	Moderate	Moderate	Moderate	High	Low	High	High	Low	High	High	Low	Moderate
(14) Definition of the baseline methodology for the participation to flexibility markets	The obligation to adopt the Transmission System Operator (TSO) methodology for the calculation of the baseline instead of the DR operators' own baseline methodology	High	High	High	High	High	Moderate	Moderate	High	High	Low	High	Moderate	High	High	Moderate	Moderate	High	Moderate	High	High	Moderate	High	Moderate	High	High

High Relevance   Moderate Relevance   Low Relevance   No information for that barrier

Table 25: Technical barriers by market
(Source: Consultant's own analysis)

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Annex III – Market Actors' Online Survey

This Section presents the survey questions drafted by the Consortium team for feedback from the DR team. The Consortium team intends structuring the survey as follows:

- a general list of questions having the purposes of 1) collecting information on the characteristics of the respondents and 2) redirecting them to specific survey questions differentiated according to the role that the different stakeholders play with respect to electricity markets and State aid measures;
- a list of questions, differentiated per type of stakeholders, concerning the legal and regulatory, financial, technical and market barriers which might affect the participation of demand to wholesale electricity markets.
- two lists of questions: first, survey questions about the legal framework at EU level for State aid mechanisms regarding electricity security of supply (Table 29); second, a list differentiated per type of stakeholders, concerning the legal and regulatory, financial, technical and market barriers which might affect the participation of demand to State aid mechanisms (this list of questions will apply only to stakeholders active in the State aid mechanisms of Belgium, Finland, France, Germany, Greece, Ireland, Italy, Poland (Table 30);
- a list of questions, differentiated per type of stakeholders, concerning the costs emerging from the participation of DR aggregators and individual DR to electricity markets and State aid mechanisms.

For the sake of simplicity and clarity in the presentation of the survey questions to the DR team, the consortium team assumed that the following stakeholder categories share the same objective – i.e. promoting the diffusion of DR – despite tainted by interests (e.g. environmental sustainability of the energy sector, market liquidity, profits, etc.): Flexibility and/or gird/meter/market platform operator, EU associations, DR operators, Individual DR, Energy intensive users associations, Software developers for DR management and aggregation, Hardware manufacturers for DR appliances and control, Promoters of projects on DR.

Therefore, for the above-mentioned stakeholder categories, the tables below will present the same survey questions. To this purpose the following acronyms have been adopted (Table 26).

Acronym	Description
GOV	Government Body
NRA	National Regulatory Authorities
NCA	National Competition Authorities
NEMO	Nominated Electricity Market Operator
TSO	Transmission System Operator
DSO	Distribution System Operator
DSS	Demand Side Stakeholders (Flexibility and/or gird/meter/market platform operator, EU associations, DR operators, Individual DR, Energy intensive users associations, Software developers for DR management and aggregation, Hardware manufacturers for DR appliances and control, Promoters of projects on DR.)

Table 26: The list of acronyms used for the presentation of the survey questions
(Source: Consultant's own analysis)

General questions for all the respondent categories

Section below presents the collection of general questions on the respondent profile. The objective of this opening set of questions is to allocate the respondent to the correct stakeholder group, and consequently associate the path of the survey with the suitable set of questions designed for and dedicated to the identified stakeholder.

The general list of questions will be anticipated by the following sections of the survey:

- **Context:** description of the context and goals of with respect to which the survey is performed;
- **Background:** indication and link to the relevant legislative sources at the EU level concerning the topics addressed with the survey and any other relevant documents published in the consultation webpage:
- **Disclaimer on data protection/confidentiality:** Personal data of the respondents will be processed in accordance with Regulation (EU) 2018/1725, taking into account that this processing is necessary for performing the project and survey tasks. Personal data will be not published.

Question Description	Answer
Name of organization / company	Enter String
Name of the respondent	Name and surname
Email address *(This information will be not published)*	Enter String
Country of the company's seat	Enter String
Please select the category of stakeholder responding to this survey:	• Government Body • National Regulatory Authority • Nominated Electricity Market Operator • TSO • DSO • Demand Side Stakeholders

Question Description	Answer
What type of actor is your organization?	Select one or, if applicable, several of the following options: • Government Body • National Regulatory Authority • National Competition Authority • TSO • DSO • NEMO • Flexibility platform operator • Metering data platform operator • EU association of DR aggregators and/or DR operators • EU associations of traders • EU associations of environmental NGOs • EU associations of consumers • Individual DR • DR aggregator • DR operator • Energy retailer • Energy retailers'association • Energy intensive users' association • Software developers for DR management and aggregation • Hardware manufacturers for DR appliances and control • Promoter of projects on DR • Other civil society and non-state actors • Other market participant (please specify)
In which of the MSs your company is active?	Select one or multiple options: • list of 27 MSs countries • one of the above but considering one or more MS. If so, which one.
Which country, among those you operate in, are you answering this questionnaire for?	Select one or multiple options: • list of 27 MSs countries
If "DR operator", "DR aggregator" or "energy intensive user" does your company participate in wholesale electricity markets?	• 0 if Yes • 1 if No
If Yes, in which wholesale electricity market is your DR active?	• Day ahead market • Intra-day market • Ancillary services' markets • None of them (please explain)
If No, is that because the legal/regulatory framework currently does not allow for the participation of DR operators, DR aggregators or energy intensive users in wholesale electricity markets?	• 1 if Yes • 0 if No
If in the future the legal/regulatory framework would allow your company to participate in wholesale electricity markets, would you plan to participate?	• 0 if Yes • 1 if No

Question Description	Answer
If "DR operator", "DR aggregator" or "energy intensive user" and if you are answering with regard to any of the following Member States (Belgium, Finland, France, Germany, Greece, Ireland, Italy, Poland), does your company benefit of any of the State aid mechanisms active in your country?	• 0 if Yes • 1 if No • Not applicable (not answering for any of the listed countries)
If Yes, which one?	Select one or multiple options: • Capacity market • Strategic reserve • Interruptibility scheme • DSR calls for tenders • Others (please explain)
If No, is that because the legal/regulatory framework currently does not allow for the participation of DR operators, DR aggregators or energy intensive users to SA mechanisms?	• 1 if Yes • 0 if No
If in the future the legal/regulatory framework would allow your company to participate in State aid mechanisms, would you plan to participate?	• 0 if Yes • 1 if No
If No, is that because the legal/regulatory framework currently allow for the participation of DR operators, DR aggregators or energy intensive users to SA mechanisms but the participation was not successful?	• 1 if Yes • 0 if No

Table 27: The list of opening general questions of the survey on the respondent profile (Source: Consultant's own analysis)

Questions on barriers to the participation in electricity markets

The following Section contains an array of the survey questions focusing on the presence of legal and regulatory, market, financial and technical barriers for the participation of DR in electricity markets. The questions are collected in the groups that aimed at a dedicated stakeholder identified. The focus of this question classification of survey is to ensure the efficiency and usefulness of the responses for the future steps of the assignment.

Our goal with these questions is to gain insights from stakeholders and better understand the barriers. The information gathered will provide valuable input towards future findings on allowing DR to operate effectively within the electricity markets in the European Economic Area.

The column "multiple choice questions" of Table 28 will have a score from 1 to 5. Each question refers to a specific barrier identified under Task 1. In turn, each of them belongs to a specific barrier area and barrier category. The same scoring will be used, then, to develop the indicators on the relevance of the same specific barriers, barrier areas, and barrier categories. The higher the score for each barrier and the more prominent the barrier in limiting the participation of DR in CM.

Multiple Choice Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
According to your opinion, please rate from 1 (low) to 5 (high) to what extent do the following barriers discourage the participation of demand in wholesale electricity markets							
The length and complexity of the prequalification process to obtain the status of market participant	1 - 5 Don't know Not applicable (*DR is not allowed to participate in wholesale electricity markets*)	X	X	X	X		X
The prequalification process is performed at the unit level (instead that at the pool level)	1 - 5 Don't know Not applicable (*There is no such obligation/DR is not allowed to participate in wholesale electricity markets*)			X	X		X
The obligation to sign an agreement with the Balancing Responsible Party (BRP) to operate in wholesale electricity markets	1 - 5 Don't know Not applicable (*There is no such obligation/DR is not allowed to participate in wholesale electricity markets*)			X	X		X
The obligation for BSP to also obtain the qualification of BRP to operate in ancillary services markets	1 - 5 Don't know Not applicable (*There is no such obligation)*			X	X		X
Sub-metering is not allowed	1 - 5 Don't know Not applicable (*There is no such provision)*			X	X	X	X
The lack of possibility to present bids with respect to a portfolio of different technologies	1 - 5 Don't know Not applicable (*There is no such provision/DR is not allowed to participate in wholesale electricity markets*)			X	X		X
The obligation to perform an ex-ante activation test to participate in ancillary services markets	1 - 5 Don't know Not applicable (*There is no such obligation/DR is not allowed to participate in wholesale electricity markets*)				X		X
The obligation to adopt the Transmission System Operator (TSO) methodology for the calculation of the baseline instead of the DR operators' own baseline methodology	1 - 5 Don't know Not applicable (*There is no such obligation/DR is not allowed to participate in wholesale electricity markets*)				X		X

Multiple Choice Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
The establishment of a maximum activation time the provision of flexibility services in ancillary services markets	1 - 5 Don't know Not applicable (*There is no such provision/DR is not allowed to participate in wholesale electricity markets*)				X		X
The establishment of a maximum performance duration for the provision of flexibility services in ancillary services markets	1 - 5 Don't know Not applicable (*There is no such provision/DR is not allowed to participate in wholesale electricity markets*)				X		X
The application of a minimum bid size greater than 100kW for ancillary services markets	1 - 5 Don't know Not applicable (*There is no such provision/DR is not allowed to participate in wholesale electricity markets*)				X		X
End-customers are not entitled to delegate a third party for the management and dispatch of the installations required for their activities (i.e. production, storage, provision of flexibility services etc)	1 - 5 Don't know Not applicable (*There is no such provision/End customers are not allowed to participate in wholesale electricity markets*)		X		X	X	X
The lack of possibility to present asymmetric bids in ancillary services markets	1 - 5 Don't know Not applicable (*There is no such provision/DR is not allowed to participate in wholesale electricity markets*)				X		X
Multiple Choice Question	**Answer**	**GOV**	**NRA**	**NEMO**	**TSO**	**DSO**	**DSS**
The lack of cost reflective, transparent and non-discriminatory network charges that account separately for the electricity fed into the grid and the electricity consumed from the grid	1 - 5 Don't know		X	X	X	X	X
Length and complexity of the procedure to obtain the connection to the grid	1 - 5 Don't know		X	X	X	X	X
The legislative and regulatory framework on energy communities and collective self-consumption	1 - 5 Don't know	X	X	X	X	X	X

Multiple Choice Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
Financial, honourability and technical requirements to operate in wholesale electricity markets as DR operator or aggregator	1 - 5 Don't know Not applicable (*There are no such provisions/DR operators and aggregators are not allowed to participate in wholesale electricity markets*)	X	X	X	X	X	X
The application of discriminatory procedures, charges, commercial conditions, administrative requirements concerning the supply contract to end-customers engaged in an aggregation contract with a market participant different than the supplier	1 - 5 Don't know Not applicable (*There are no such provisions/end-customers are not allowed to enter an aggregation contract*)	X	X	X	X	X	X
Pricing mechanism of wholesale markets	1 - 5 Don't know	X	X	X	X	X	X
Pricing mechanism of retail markets	1 - 5 Don't know	X	X	X	X	X	X
Lack of possibility for suppliers to offer dynamic electricity price contracts to end-customers	1 - 5 Don't know Not applicable (DEP contracts are allowed)	X	X	X	X	X	X
The rules and procedures on data access and exchange between market participants	1 - 5 Don't know	X	X	X	X	X	X
The lack of obligations for TSO and DSOs to indicate in their network development plans information on the need of flexibility services in the medium- and long-term time horizon	1 - 5 Don't know Not applicable (TSOs and DSOs have this obligation)	X	X	X	X	X	X
The deployment status of smart meters	1 - 5 Don't know	X	X	X	X	X	X
The poor effectiveness of the liberalization	1 - 5 Don't know	X	X	X	X	X	X

Open Questions	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
Which changes in the legal/regulatory framework do you consider would encourage the participation of demand in wholesale electricity markets? Please provide an Indication of such changes	Max 400 words	X	X	X	X	X	X
In addition to the barriers mentioned in the previous questions, do you consider the presence of other barriers hampering the participation of DR in wholesale electricity markets? Please provide an indication of such barriers.	Max 400 words	X	X	X	X	X	X
In general, do you consider the legal and regulatory framework concerning the wholesale electricity markets in your country as sufficiently predictable?	Max 400 words	X	X	X	X	X	X

Table 28: The list of survey questions on barriers to the participation in electricity markets (Source: Consultant's own analysis)

Questions on barriers to the participation in State aid mechanisms

This Section illustrates the survey questions focusing on the presence of legal and regulatory, market, financial and technical barriers for the participation of DR in CM, in particular market-wide CM or capacity markets, strategic reserves, as well as interruptibility schemes and other DR measures.

The Section starts (in Table 29 below) with a few questions on the legal framework for the introduction of State aid mechanisms in the area of electricity security of Supply (Section 4.8 of the CEEAG), including the role of the European Commission ("**EC**") in State aid approval procedures. They can be asked to all stakeholders, regardless of the country in which they are active. They are questions to investigate the views about the legal framework for State aid mechanisms regarding electricity security of supply measures at EU level,

The scores in the column "multiple choice questions" of Table 29 and Table 30 can be explained in the same way as those in Table 28 (see corresponding explanation in Section 6.2 above).

Multiple choice questions	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
According to your opinion, please rate from 1 (low) to 5 (high) to what extent the following barriers discourage the participation of DR in electricity security of supply measures (State aid mechanisms)?							
The lack of transparency about Phase I State aid investigations (preliminary investigation) and weak participation rights for third parties in these procedures (when State aid mechanisms are introduced, although the Commission's Guidelines on State aid for climate, environmental protection and energy 2022 ("**CEEAG**") by now require under certain conditions a national public consultation about planned security of supply (State aid) measures, during the preliminary investigation procedure following the Member State's State aid notification, the discussion takes place exclusively between the European Commission and the Member State. Stakeholders are often not aware that such procedures are going on, they do not know the content of the Member State's State aid notification and do therefore only seldomly submit information to the EC (and on a poor information base)).	1 – 5 Don't know	X	X	X	X	X	X
In line with Article 3(1) of the Electricity Directive (EU) 2019/944 and Article 20(3) of the Electricity Regulation (EU) 2019/943, Member States planning to introduce a CM are required to provide the European Commission with an "*assessment of the impact of demand-side and storage participation, including a description of measures to encourage demand side management*" (para 339(b) of the CEEAG). How would you rate as a barrier the absence of an outright requirement for measures to actively remove barriers for DR participation (both in electricity markets and State aid measures) before a new security of supply State aid measure can be introduced?	1 – 5 Don't know	X	X	X	X	X	X
The absence of sharp price signals is seen as an obstacle to the development of business models based on explicit and implicit DR. In that sense, recital 24 of the Electricity Regulation (EU) 2019/943 states it is "*critical to ensure that administrative and implicit price caps are removed in order to allow for scarcity pricing.*" However, Article 20 of the Electricity Regulation merely requires Member States, when addressing resource adequacy concerns, to "*consider" removing price caps and introducing a shortage pricing function for balancing energy.*" How would you rate the absence of a mandatory requirement in this regard to be a barrier to further increasing DR participation (both in electricity markets and State aid mechanisms)?	1 – 5 Don't know	X	X	X	X	X	X
To become more concrete, how do you rate the absence of a requirement for Member States planning to introduce a CM to first implement market reforms that will require educating consumers with a smart meter in a way enabling them to take informed decisions about the benefits of choosing a variable over	1 – 5 Don't know	X	X	X	X	X	X

Multiple choice questions	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
a fixed pricing contract with their electricity supplier (to encourage the expansion of implicit DR) and that encourage explicit DR participation in electricity wholesale and balancing markets as a barrier to further increasing DR participation (both in electricity markets and State aid mechanisms)?							
How do you rate the absence of technology-neutral conditions for both implicit and explicit DR participation in a State aid mechanism as a barrier to DR participation (only the French call for tenders DR scheme (SA.48490 and SA.62006) foresees participation of implicit and explicit DR in competition with each other) in State aid mechanisms? Please note in this regard that sometimes, DR participation in a CM may be implicit (e.g. implicit DR may "participate" by reducing peak consumption and thus reducing the amount it pays for CM-related charges).	1 – 5 Don't know	X	X	X	X	X	X

Table 29: The list of survey questions about the legal framework for State aid mechanisms regarding electricity security of supply measures at EU level
(Source: Consultant's own analysis)

Table 30 contains the survey questions on the State aid measures in place in the countries listed in Annex 7 of the ToR. The scores in the column "multiple choice questions" of Table 30 can be explained in the same way as those in Table 28 (see corresponding explanation in Section 6.2 above). The column "SA MECHANISM" indicates to which SA measure the question refers ("SR" Strategic reserve, "CM" capacity market, "IS/ODRM" interruptibility schemes and other DR measures, "ALL").

Multiple choice questions	SA Mechanism	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
According to your opinion, please rate from 1 (low) to 5 (high) to what extent the following barriers discourage the participation of DR in the CM in place in your country. For Member States with two State aid mechanisms subject to the Study (such as Belgium (market-wide CM – SA.54915 and Strategic Reserve – SA.48648), France (market-wide CM – SA.39621 and specific DR Support Scheme via Tender – SA.62006) and Germany (Strategic Reserve – SA.45852 and Interruptibility Scheme AbLaV – SA.43735), please reply to these questions twice, each time initially indicating with relation to which scheme you are replying.								
The length and complexity of the prequalification process (e.g., regarding the French CM (SA.39621), comments are invited regarding the technical requirements according to article L.335-4 of the French Code de l'Énérgie for the 3-year-long certification procedure and whether it is considered a barrier (see open questions on next page)).	ALL	1 – 5 Don't know	X	X	X	X		X
The requirement to place a collateral or other type of guarantees and	CM, SR	1 – 5 Don't know		X	X	X		X

Multiple choice questions	SA Mechanism	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
financial conditions as a prerequisite for the participation in the SA mechanism								
The derating factor applying for the definition of the level of nominal capacity that can be offered for participation in the SA mechanism	ALL	1 – 5 Don't know Not applicable (A derating factor is not applied)		X	X	X		X
The performance/testing requirements to be performed ex ante to be successfully prequalified for participation in the SA mechanism (e.g., regarding the special French DR tender (SA.48490), comments are invited regarding the technical requirements and RTE's testing practice can be considered a barrier (see open questions on next page)).	ALL	1 – 5 Don't know Not applicable (An ex-ante test is not applied)		X	X	X		X
The time-horizon between the execution of capacity auctions and the period during which the committed capacity shall be made available	SR, CM	1 – 5 Don't know		X	X	X		X
The prohibition to aggregate consumption units for the presentation of bids in capacity auctions	CM	1 – 5 Don't know Not applicable (There is no such provision)		X	X	X		X
The prohibition to participate in the State aid mechanism with DR units that are at the same time also active on one (or several) electricity market(s).	ALL	1 – 5 Don't know	X	X	X	X		X
The application of a minimum threshold size (MW) with respect to the amount of capacity that can be offered in capacity auctions	CM	1 – 5 Don't know Not applicable (There is no such provision)		X	X	X		X
Lack of technology neutrality, e.g. only capacity units exceeding a certain size can participate (25 MW in the case of the French IS (SA.48490) or 10 MW in the case of the German IS (AbLaV	IS/ODRM	1 – 5 Don't know Not applicable (There is no such provision)	X	X	X			X

Multiple choice questions	SA Mechanism	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
– SA.43735, here also the AbLaV's required response time of 350 ms for immediately interruptible loads in the case of the German IS)								
The application of caps to the price (€/MW/year) that can be offered in capacity auction (e.g., regarding the Belgian CM (SA.54915), comments are invited regarding the derogation mechanism to the intermediate price cap for the one-year contract category (see open questions on next page)).	CM	1 – 5 Don't know Not applicable (There is no such provision)		X	X	X		X
The pricing mechanism applying for the determination of the capacity payment	ALL	1 – 5 Don't know		X	X	X		X
The duration of the period during which the committed capacity shall be made available (unlimitedly in each hour of the year, only a few hours before and during a scarcity event, only during a scarcity event etc)	ALL	1 – 5 Don't know		X	X	X		X
The absence of time-bound delivery options during a scarcity event (meaning that DR resources might not have the option to commit to be available for e.g. 2 hours only, but might have to commit to unknown availability times) or time-bound delivery options that only foresee too long delivery periods	ALL	1 – 5 Don't know Not applicable (i.e., there are appropriate time-bound delivery options)		X	X	X		X
The activation time between the TSO request to make the consumption unit available in presence of a scarcity event and the moment in which the unit shall be made available for delivery	ALL	1 – 5 Don't know Not applicable (There is no such provision)		X	X	X		X

Multiple choice questions	SA Mechanism	Answers	GOV	NRA	NEMO	TSO	DSO	DSS
The duration of the capacity contract i.e., of the period during which the capacity payment is obtained in exchange of the obligation to make the committed capacity available	ALL	1 – 5 Don’t know		X	X	X		X
The level of the strike price set for the capacity product exchange in capacity auctions	CM	1 – 5 Don’t know Not applicable (There is no such provision)		X	X	X		X
The application of a unique strike price for different wholesale electricity markets	CM	1 – 5 Don’t know Not applicable (There is no such provision)		X	X	X		X
The value of the penalties applying in the hypothesis of underperformances with respect to the availability obligation valid for the delivery period (e.g., regarding the French CM (SA.39621), comments are invited regarding the sanctions that the RTE can impose for non-compliance with imbalance settlement obligations, possibly also cumulative effects with sanctions possible under the French SR scheme (SA.48490), or the sanctions possible under the Belgian SDR (SA.48648) (see open questions on next page)).	CM	1 – 5 Don’t know Not applicable (There is no such provision) The technology is not yet competitive enough to compete with conventional technologies.		X	X	X		X

Open Questions (ALL State aid mechanisms)	Answer	Stakeholder To Whom The Question Is Assigned						
		GOV	NRA	NCA	NEMO	TSO	DSO	DS
Please share any observation you might have with regard to the barriers scored above that limit in your view the participation of DR in the CM in place in your country.	Max 400 words	X	X		X		X	X
Could you please indicate other additional barriers that to the best of your knowledge limit the participation of DR in the CM in place in your country beyond those scored above**?**	Max 400 words	X	X		X		X	X

Open Questions (ALL State aid mechanisms)	Answer	Stakeholder To Whom The Question Is Assigned						
		GOV	NRA	NCA	NEMO	TSO	DSO	DS
Which are the changes to the design of the CM in place in your country that you would consider desirable to encourage the participation of DR?	Max 400 words	X	X		X		X	X
In general, do you consider the legal and regulatory framework concerning the CM in place in your country as sufficiently predictable?	Max 400 words	X	X		X		X	X
Would you say that there has been/is a fair and non-discriminatory stakeholder participation in national discussions about possible resource adequacy concerns and what measures should be taken to tackle them, i.e. are the various groups of stakeholders properly represented in possible stakeholder meetings, workshops or working groups organised by the relevant authorities?	Max 400 words	X	X		X		X	X

Table 30: The list of survey questions on SA measures in place in Belgium, Finland, France, Germany, Greece, Ireland, Italy and Poland
(Source: Consultant's own analysis)

Questions on costs sources

This section presents the survey questions that probe into the particular emphasis on cost sources emerging for demand aggregators and individual DR from their participation in electricity markets and State-aid measures.

Multiple Choice Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
According to your opinion, please rate from 1 (low) to 5 (high) to what extent the following cost items remains too high to further develop DR in Europe.							
The cost of hardware appliances for DR (as e.g., costs for smart meters, communication infrastructure, control infrastructure)	1 – 5 Don't know	X	X	X	X	X	X
The cost of software applications for demand management (as e.g., costs for software licenses, technical support)	1 – 5 Don't know	X	X	X	X	X	X
Operational costs (as e.g., performance guarantees, administrative and transaction costs, costs of	1 – 5 Don't know	X	X	X	X	X	X

Multiple Choice Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
prequalification procedures, penalties…)							
Commercial costs (as e.g., costs for marketing and communication)	1 – 5 Don't know	X	X	X	X	X	X
What % of CAPEX is attributed to the hardware costs to operate as DR aggregator or individual DR? Is the communicated value considered high or not?	1- 0-10%; 2- 11-30%; 3- 31-50%; 4- 51-80%; 5- 81-100%				X	X	X
What % of CAPEX / OPEX is attributed to the software costs to operate as DR aggregator or individual DR? Is the communicated value considered high or not?	1- 0-10%; 2- 11-30%; 3- 31-50%; 4- 51-80%; 5- 81-100%				X	X	X
Which % represent the operational cost types of the total amount of costs borne to operate as DR aggregator or individual DR?	1- 0-10%; 2- 11-30%; 3- 31-50%; 4- 51-80%; 5- 81-100%				X	X	X
Which % represent the commercial cost types of the total amount of costs borne to operate as DR aggregator or individual DR?	1- 0-10%; 2- 11-30%; 3- 31-50%; 4- 51-80%; 5- 81-100%				X	X	X

Costs Indication Question	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
According to your experience, please provide a cost indication of the following items in use/present within your organization							
Communication equipment	€				X	X	X
Control equipment	€			X	X	X	X
Telemetry equipment	€				X	X	X
Communication software	€				X	X	X
Control software	€			X	X	X	X
Accounting software	€				X	X	X
Billing software	€				X	X	X
Financial compensation for suppliers	€/MWh			X			X
Marketing and communication activities	€/customer			X	X	X	X
Labor cost for metering, control, and communication activities	€/customer			X	X	X	X
Costs Indication Question	**Answer**	**GOV**	**NRA**	**NEMO**	**TSO**	**DSO**	**DSS**
Labor cost for customer-base management activities	€/customer				X	X	X
Compensation for clients participating in DR program (€/kW-year)	€/kW-year				X	X	X
Fees to obtain the status of market operator	€/year and/or €/MWh exchanged						X
Guarantees to obtain the status of market operator	€/year						X
Penalties in case of under-performance or unavailability	€/MWh				X	X	X

Open Questions	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
Please describe the hardware cost items that primarily constitute a barrier in the development of DR activities. Additionally, please describe and quantify any other potential hardware costs that could enable the development of DR operations..	Max 400 words	X	X	X	X	X	X
Please describe the software cost that primarily constitute a barrier in the development of DR activities. Additionally, please describe and quantify any other potential software costs that could enable the development of DR operations	Max 400 words				X	X	X
Please describe the operational costs primarily constitute a barrier in the development of DR activities. Additionally, please describe and quantify any other potential operations costs that could enable the development of DR operations..	Max 400 words	X	X	X	X	X	X

Open Questions	Answer	GOV	NRA	NEMO	TSO	DSO	DSS
Please describe the commercial costs primarily constitute a barrier in the development of DR activities. Additionally, please describe and quantify any other potential commercial costs that could enable the development of DR operations.	Max 400 words				X	X	X
Please describe any additional cost item your organization is incurring to that due to its magnitude is or will constitute a barrier for the deployment of DR services.	Max 400 words						X

Table 31: The list of survey questions on costs sources
(Source: Consultant's own analysis)

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