ACER

European Union Agency for the Cooperation of Energy Regulators

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Security of EU electricity supply in 2021:

Report on Member States approaches to assess and ensure adequacy

October 2022

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Foreword

As we head into Winter in the midst of an energy crisis, the European Agency for the Cooperation of Energy Regulators (ACER) is hereby publishing its first stand-alone report on the performance of Member States in the area of security of electricity supply focusing inter alia on the methodologies adopted and approaches pursued[1]. The report focuses on developments during 2021[2].

The situation has changed drastically since the conception of this report, a year ago. Today, its publication comes while the severe impacts of Russia's invasion of Ukraine influence the lives of millions. The weaponisation of energy supply by Russia has not only impacted energy prices globally but it also increased uncertainties about the security of energy supply for the coming winter and beyond. It has altered the context of the longer-term EU energy and climate policy goals uniting Europe's leaders around the European Commission's RePowerEU plan to phase out Europe's dependency on Russian fossil fuels long before 2030, staring with gas. European and national authorities have implemented targeted measures to mitigate the effects of the energy crisis. ACER is one the many voices that point to the importance of countries working together to keep electricity and gas flowing across Member States borders to secure electricity supplies for all European citizens.

Some of the challenges are not new but seem to persist and compound the current emergency war time situation. For example, the concern related to low nuclear output in France for the coming winter or the system alerts issued in Ireland in the beginning of August 2022 echo risks flagged by past seasonal adequacy outlooks of the European Network of Transmission System Operators for Electricity (ENTSO-E). When issues of the past meet with unfavourable new circumstances the risks to the reliability of the electricity system compound.

To cope efficiently with these challenges, there is significant benefit in joint targeted action across Member States. Taking advantage of the size and flexibility of its integrated electricity market, the EU can absorb shocks by sharing resources and through its ability to import energy resources via diverse routes from outside the EU. Enhanced integration efforts can facilitate a faster deployment of technologies such as renewables, storage and demand response essential for the energy transition up ahead..

While ACER works to strengthen Europe's energy security of supply and resilience, this report looks back at 2021. Its aim is to take stock of how Member States assess the expected level of security of supply from the short to the long term as well as the electricity adequacy indicators coming out of these assessments. Establishing the baseline helps to understand potential gaps and how to close them, where relevant, and provides a basis for the discussion on what kind of security of supply measures are needed.

Well-implemented European-level adequacy assessments of different time horizons are important to inform national decision-making. These assessments enable appropriate policy responses and shed light on which emergency mitigation measures may alleviate security of supply concerns and which may risk inadvertently aggravating them.

1 Previous Market Monitoring Reports had already covered aspects of security of electricity supply.

2 ACER is also following closely developments in the gas and electricity markets. The wholesale gas market volume of the annual market monitoring report was published in July 2022 and the energy retail markets and consumer protection volume was published on 6 October 2022.

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Executive Summary

1 The Clean Energy for All Europeans Package enhanced ACER's role in monitoring security of electricity supply. In order to best serve this role ACER will publish dedicated reports on the developments in the field of security of electricity supply in Europe. This is the first such publication.

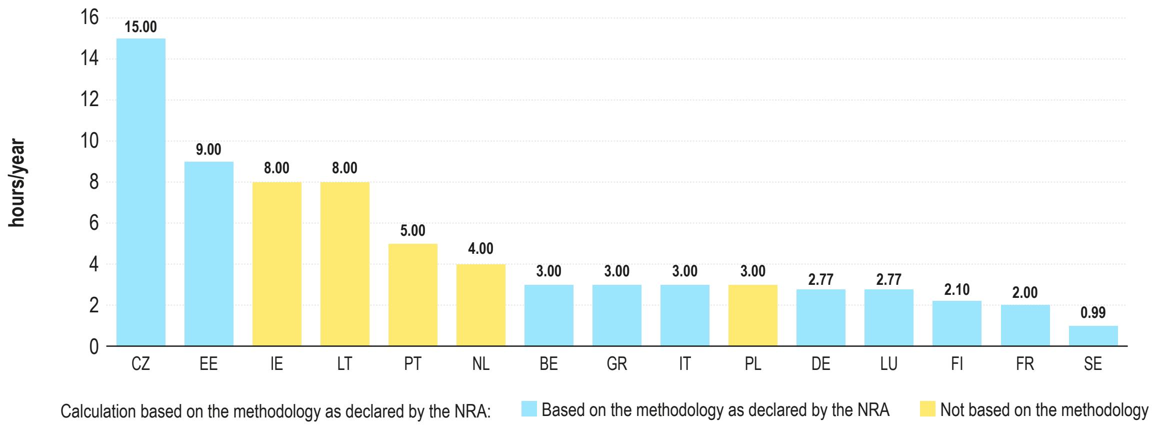
2 ACER has already reported on security of electricity supply to some extent in the previous editions of the Electricity Wholesale Market Monitoring Volume of the annual Market Monitoring Report (MMR). This dedicated report extends the depth and scope of past reporting on the subject. It provides a more in-depth assessment of the security of electricity supply topics already covered therein and expands to new areas. These include the definition of the necessary level of security of electricity supply (the so-called reliability standard), the adequacy assessments at national and regional level and all time-frames, as well as measures to address relevant security of electricity supply issues, such as capacity mechanisms, interruptibility schemes and network reserves. The report does not cover security of supply incidents related to the operation of the electricity system. The current edition focuses primarily on the status and developments during 2021, and includes some relevant 2022 updates.

Members States identify the necessary level of adequacy via a harmonised methodology.

3 Following ACER's approval of the EU-wide methodology for calculating the value of lost load (VOLL), the cost of new entry (CONE) and the reliability standard (collectively VOLL/CONE/RS methodology) in October 2020, the Member States gradually proceeded with its implementation in order to define the necessary level of security of supply. Eleven Member States have already calculated the VOLL with results ranging from four thousand euros/MWh in the Czech Republic to nearly sixty-nine thousand euros/MWh in the Netherlands. As shown in Figure i, fifteen Member States have set a reliability standard defined as loss of load expectation (LOLE). The most common LOLE value is three hours per year implying that in 99.97 percent of the time there is sufficient capacity to meet demand.

4 Strong differences, especially in the VOLL estimate, and divergent approaches chosen by the Member States in the calculation of the reliability standard, indicate non-uniform implementation of the VOLL/CONE/RS methodology across the EU. ACER intends to examine Member States' assessments of the VOLL, CONE and reliability standard to identify different practices and better understand potential challenges for implementing the methodology. In the meantime, **ACER highly recommends that Member States devote sufficient resources to conduct the necessary VOLL related surveys and studies and that the methodology is followed in its entirety when defining the reliability standard metrics.** If recent calculations include significant simplifications that deviate from the methodology, ACER suggests that competent national authorities proceed with recalculating the reliability standard without such simplifications.

Figure i: Reliability standard as LOLE – status as of July 2022 (hours/year)



Source: ACER based on NRA data.

Notes: Implementation of the VOLL/CONE/RS methodology based on NRA declarations; the actual degree of compliance is not examined.

The short-term and seasonal adequacy assessments framework is in place.

5 The Electricity Regulation and the Risk Preparedness Regulation set up a framework of adequacy assessments that stretches out to the future as far as ten years ahead, down to the assessment of the coming seven days. The potential range of applicable mitigation measures varies according to the specific timeframe.

6 ACER has approved the methodology for short-term and seasonal adequacy assessments in March 2020 (STSAA methodology). The European winter and summer adequacy assessments carried out by ENTSO-E are largely in line with the methodology. **ACER understands that ENTSO-E is finalising the implementation of the STSAA methodology.** Seasonal assessments over the past couple of years identified limited risks for Europe, with some exceptions. The potential stress conditions identified in the seasonal outlooks were limited in number and scope. Even in these cases, load shedding did not occur following mitigation actions by the relevant TSOs.

7 In the shorter term, ENTSO-E and regional coordination centres (RCCs) perform a daily pan-European adequacy assessment for the subsequent seven days. More detailed regional assessments are performed if adequacy concerns are identified, and the concerned RCCs and TSOs coordinate to mitigate risks and achieve overall adequacy. In 2021, the pan-European short-term adequacy assessment indicated resource adequacy risks for six days[3]. In all these cases, coordinated mitigation measures, including cross-border support, helped eliminate risks and avoid supply disruptions.

8 Using probabilistic assessment, the short-term and seasonal outlooks identify adequacy risks taking into account best available forecast and the likelihood of a large number of possible situations for the electricity system. Yet, it is sometimes not possible to address the likelihood of specific low probability-high impact events, such as the one of an extreme drought. It is however possible to prepare for such events. The risk preparedness plans of Member States[4] provide a blueprint to manage crisis scenarios in a spirit of trust and solidarity. The current crisis may put these plans to the test.

Implementation of the methodology for long term resource adequacy is ongoing.

9 The assessment as to whether the energy market can provide the required level of adequacy on a long-term basis is based on the single European resource adequacy assessment (ERAA), performed by ENTSO-E. The Member States may complement the ERAA with their own national resource adequacy assessments (NRAAs). Both ERAA and NRAAs must be based on the ERAA methodology, approved by ACER in October 2020.

10 ENTSO-E published its first ERAA in November 2021 and submitted it to ACER for approval. After a thorough examination, ACER identified a number of shortcomings, which compromise its accuracy and reliability. As a result, ACER decided not to approve the ERAA and provided a number of recommendations to help ENTSO-E implement the methodology in future ERAA editions. ACER is committed to working together with ENTSO-E to deliver robust future ERAA editions and to fully implement the ERAA methodology by 2024.

11 At the national level, the majority of the Member States undertake a regular NRAA. In 2021, thirteen national assessments took place and seven of them identified adequacy concerns in at least one of the next ten years. Until ERAA is approved, NRAAs remain the basis for long-term adequacy analysis. In the absence of an approved ERAA, the European Commission has asked ACER to review the NRAAs against the ERAA methodology whenever these assessments are used to support national security of supply aid measures notified to the Commission under the State aid rules. Regardless of the State aid processes, ACER encourages all Member States and their designated bodies responsible for the NRAAs to ensure compliance of the assessments with the ERAA methodology.

3 As RCCs were not fully operational in 2021, this task was performed by the regional security coordinators.

4 Pursuant to Chapter III of the Risk Preparedness Regulation Member States must develop risk preparedness plans containing the measures and actions to prevent, prepare for and mitigate the impact of potential electricity crises. Risk preparedness plans are not covered further in the report.

Costs of capacity mechanisms increase, supporting largely traditional thermal generation.

12 The total cost of capacity mechanisms has been increasing steadily over the period of 2021-2023. In 2021, capacity payments amounted to 4.7 billion euros and are projected to reach 6.8 billion in 2023. The public investment needed to mitigate the impact of the ongoing energy crisis puts the level of the subsidies provided via capacity mechanisms in context. On the one hand increased security of electricity supply risks call for measures to ensure readiness of all available resources. At the same time, record high wholesale prices lead to unexpectedly high profits, prompting the building of new resources (e.g. renewable generation, storage, demand response) and making some others profitable again (e.g. lignite, coal).

13 The majority of the capacity payments, more than two thirds, are directed to traditional thermal generation capacity. Long-term capacity contracts, with average annual value of more than one billion euros, support mainly coal- and natural gas-fuelled generation capacity. This practice might hamper the energy transition and the EU carbon-neutrality targets. **ACER recommends that Member States analyse potential lock-in effects stemming from long-term contracts and examine whether capacity mechanisms are in line with the European and national decarbonisation targets**.

Implementation of cross-border participation in capacity mechanism progressing at different speeds.

14 Participation of cross-border resources in capacity mechanisms in line with the Electricity Regulation is still in the implementation phase. While, in most cases, there are no explicit legal barriers for cross-border participation in the existing capacity mechanisms, detailed implementing arrangements enabling such participation in practice are largely lacking. These arrangements are to be specified in bilateral agreements between the TSOs. The Italian and Polish TSOs have already progressed and contracted foreign capacity for their capacity mechanisms. Several other TSOs are still negotiating their agreements. In parallel, ENTSO-E has already set up a digital platform for the registration of foreign capacity providers, a pre-requisite for the direct participation of foreign resources into capacity mechanisms. **ACER urges the TSOs to conclude bilateral agreements for cross-border participation in a timely manner. ACER also urges ENTSO-E and RCCs to accelerate the implementation of the methodology for calculating the maximum entry capacity which will enable the TSOs to determine how much foreign capacity can participate in a given capacity mechanism.**

Interruptibility schemes under change.

15 Once a means for early demand response development, some of the interruptibility schemes are now merely tools to complement capacity mechanisms, network congestion measures or balancing services. Some other schemes (sometimes inter alia) provide frequency related ancillary services to tackle low probability - high impact contingency events. During 2021, these services were activated twice to support the restoration of frequency impacting the whole of the Continental Europe Synchronous Area. In line with the recommendations of the 2020 MMR[5]. **ACER calls ENTSO-E and TSOs to further harmonise these fast response frequency support services and coordinate their procurement to exploit synergies and potentially save costs. Where the interruptibility schemes complement existing services ACER suggests to integrate them into the standard market procurement channels to ensure level playing field.**

Charges financing security of supply measures need to provide adequate signals.

16 In order to finance security of supply measures, such as capacity mechanisms, interruptibility schemes and network reserves, most Member States pass the costs directly to consumers via network charges or special levies. ACER intends to further investigate whether the relevant charges incentivise market participants to react so as to mitigate the relevant security of supply concern addressed by the measure. **ACER recommends that Member States avoid flat rates and allocate the costs to the market participants who contribute the most to the need for the measure.**

5 Also in line with recommendation R-17 of the final report of ICS Investigation Expert Panel on the continental Europe synchronous area separation on 08 January 2021.

ACER to enhance the monitoring of security of electricity supply.

17 Considering the current geopolitical context affecting the security of energy supply in Europe, ACER intends to intensify its relevant monitoring efforts. As a first step, ACER intends to examine the measures adopted by Member States to cope with security of supply consequences of the current energy crisis. ACER will continue to engage in discussions with the Commission and ENTSO-E on how the seasonal outlooks could better take into account the new circumstances brought by the current crisis. In this context, it is important that the ENTSO-E coordinates with ENTSOG the set of input assumptions and output results used for their respective seasonal outlooks in order to provide consistent results.

18 ACER will also continue to monitor the implementation of the adequacy-related methodologies both at European and Member States' level. Table i summarises the implementation status of the relevant methodologies based on the currently available high level information. ACER will enhance its monitoring activities, in particular regarding the implementation challenges faced by Member States during the single VOLL and reliability standard calculations, and present its findings as they become available in the next editions of the security of electricity supply reports.

Table i: Implementation status indication of ACER`s adequacy related methodologies

ACER Methodology	Target Output	Status indication	Explanation	Reference	Action/ Recommendation
Seasonal and short term adequacy assessments	ENTSO-E seasonal outlooks	**Pending divergences from methodology**	The outlooks are broadly in line with the methodology. However, ACER has repeatedly pointed out compliance gaps in its opinions e.g.: lack of flow-based modelling.	ACER Opinion No 07/2021, 01/2021, 07/2020 Also see Chapter 3.2.1	ACER to continue monitoring seasonal outlooks and issuing opinions when relevant. ENTSO-E to implement pending improvements.
	RCCs' short-term assessments	**To be evaluated in the future**	Implementation of the methodology to be monitored when RCCs become fully operational.	See Chapter 3.2.2	ACER to initiate assessment of the implementation.
Value of Lost Load (VOLL) Cost of New Entry (CONE) Reliability Standard (RS)	National single VOLL	**Different implementation approaches between Member States**	Ten Member States have calculated the single VOLL and CONE values. While VOLL values are expected to vary across Member States the large difference between the highest and lowest value indicate the possibility of potential implementation challenges of the methodology.	Implementation of methodology according to NRAs reporting. Level of implementation of methodology not examined by ACER. Also see Chapter 2	ACER to look into applied practices and implementation challenges.
	National CONE values				
	National reliability standards		Member States apply the methodology gradually. Fifteen Member States have a LOLE type of reliability standard in place, nine of which used the methodology. Four Member States have other types of reliability standards in place.		
European Resource Adequacy Assessment	ENTSO-E 2021 European resource adequacy assessment	**Improvements needed**	Among other shortcomings, ERAA 2021 underestimates the level of profits that resources could make in the market; underestimates the volume of capacity available for cross-zonal trade; and does not recognise the value of demand-side response sufficiently.	Decision No 02/2022	ACER to assess ERAA 2022 and continue to engage with ENTSO-E on the delivery of a fully compliant ERAA by 2024.

ACER Methodology	Target Output	Status indication	Explanation	Reference	Action/ Recommendation
	National adequacy assessments	**To be evaluated in the future**	ACER to issue opinions whenever national resource adequacy assessments identify a concern where ERAA does not. In the absence of an approved ERAA, the European Commission has requested ACER to review NRAAs for compliance with the ERAA methodology for the purpose of State aid assessment.	Article 24(3) of Electricity Regulation. At the time of publication, ACER has not issued any opinions on this matter.	ACER to review national resource adequacy assessments upon European Commission's request and issue opinions as required.
Cross-border participation in capacity mechanisms	Calculation of minimum entry capacity	**To be evaluated in the future**	Implementation by ENTSO-E ongoing. Full implementation is conditional on RCCs being in operation.	Article 26(7) and Article 37(1)(o) of the Electricity Regulation. Title 2 of the Technical Specifications	ACER to monitor implementation when RCCs become fully operational.
	Registry of eligible foreign capacity providers	**Implemented**	The Registry, set up by ENTSO-E, is in operation since 2022. ENTSO-E to report annually on the registered capacity to ACER. TSOs to report to their competent regulatory authorities.	Article 26(15) of the Electricity Regulation. Article 25 of the Technical Specifications Also see Chapter 4.1.4	ACER to follow annual reporting by ENTSO-E. NRAs to follow reporting of their respective TSOs.

1 Introduction

19 The Clean Energy for All Europeans Package (Clean Energy Package, CEP)[6] enhanced ACER's role in monitoring the electricity market. This includes the topic of security of electricity supply that the CEP explicitly mandates ACER to monitor[7]. In order to best serve this role, and following the practice of monitoring other topics (e.g., margin available for cross-zonal electricity trade), ACER has decided to publish dedicated annual reports on the developments in the field of adequacy and security of electricity supply in Europe[8]. The reports will focus on the short- to long-term security of supply, not covering incidents that relate to the operation of the electricity system[9]. They will also provide information on the implementation status of the various methodologies that ACER has issued on the topic pursuant to the CEP[10].

20 ACER has already reported on security of electricity supply to some extent in the previous editions of the Electricity Wholesale Market Monitoring Volume of the annual Market Monitoring Report (MMR). The current report extends the scope and depth of past reporting on the subject and expands to new topics. These include the definition of the necessary level of security of electricity supply (the so-called reliability standard), the adequacy assessments at national and regional level and all time-frames, as well as measures to address relevant security of electricity supply issues, such as capacity mechanisms, interruptibility schemes and network reserves.

21 According to Regulation (EU) 2019/943 on the internal market for electricity (Electricity Regulation) the necessary level of security of electricity supply is set by the individual Member States on the basis of a properly defined reliability standard. The assessment whether the energy market can deliver the required level of long-term security of electricity supply is based on a single European resource adequacy assessment (ERAA). Member States may complement the ERAA with national resource adequacy assessments (NRAA).

22 In case Member States identify adequacy concerns, they first need to identify the root causes leading to the concerns, including any potential regulatory or market distortions. Consequently, Member States have to develop appropriate market reforms to eliminate the identified market distortions. If necessary, they may introduce temporary and properly designed capacity mechanisms to cope with remaining adequacy concerns[11].

6 The Commission's Clean Energy for All Europeans legislative proposal covered energy efficiency, RES generation, the design of the electricity market, security of electricity supply and governance rules for the Energy Union. Relevant material along with the adopted directives and legislation are available here.

7 For example, see Article 18 of Regulation (EU) 2019/941 and Article 15 of Regulation (EU) 2019/942.

8 In this report, EU-27 refers to the 27 Member States after Brexit, i.e., after the UK left the EU on 31 January 2020. As a consequence of Brexit, ACER did not have access to all UK-related data. Therefore, while UK remained an EU member in 2020, it is excluded from the scope of this MMR for the country-specific figures. EU-wide figures still include 28 Member States, unless specified otherwise. Several aspects of the report cover Norwegian and Swiss markets. For simplicity, the scope of the analysis is referred to as 'the EU' or 'Europe'. Norway enforces most of the EU energy legislation, including legislation on the internal energy market, and is included in the data reported in several sections of this report. Switzerland has been included in some parts of the wholesale sections on the basis of a voluntary commitment of the national regulatory authority. Consequently, the terms 'countries' and 'Member States' are used interchangeably throughout this report, depending on whether the particular section/graph also covers Norway or Switzerland or not. Several maps included in this report show Kosovo*. In this context the following statement applies: "This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Advisory Opinion on the Kosovo declaration of independence".

9 These are currently covered in detail in ENTSO-E's incidents classification scale annual reports and in dedicated incident investigation reports in case of extensive incidents (scale 2).

10 See Box 1 for a description of the relative ACER methodologies.

11 In its 18 May 2022 communication on short-term energy market interventions and long-term improvements to the electricity market design, the Commission suggests it will further assess whether capacity mechanisms have to become a long-term feature of the electricity system and what this would mean for their integration into the electricity market.

Box 1: ACER's adequacy related methodologies

Pursuant to the Electricity Regulation and Regulation (EU) 2019/941 on risk-preparedness in the electricity sector (Risk Preparedness Regulation) ACER approved a number of methodologies to ensure short and longer-term security of electricity supply:

- the methodology for short-term and seasonal adequacy assessments (**SSTAA methodology**) focuses on assessing adequacy risks in the short-run i.e. from week ahead to six months ahead, available here.
- the methodology setting reliability standard for adequacy based on the calculation of the value of lost load (VOLL) and the cost of new entry (CONE) (**VOLL/CONE/RS methodology**), available here,
- the methodology for the European resource adequacy assessment, (**ERAA methodology**) sets the framework to assess potential resource adequacy gaps across Europe for the next ten coming years, available here, and
- the technical specifications for cross-border participation in capacity mechanisms (**Technical Specifications**) set a framework allowing for participation of capacity providers in capacity mechanisms of other Member States, available here.

23 When assessing the need for resource adequacy related measures, Member States are required to use the results of the ERAA[12]. ACER is responsible for approving the inputs and results of the ERAA every year[13]. ENTSO-E published its first ERAA in November 2021. ACER examined the submitted assessment thoroughly and identified a number of shortcomings in the report, which compromised its accuracy and reliability. Consequently, ACER did not approve the ERAA. In its Decision,[14] ACER highlighted the importance of a robust ERAA and provided recommendations to ensure that forthcoming ERAAs progressively align with the requirements of the agreed methodology. This report does not elaborate further on the inputs and results of the ERAA, although future editions may include relevant sections.

24 National measures that provide financial support to individual sectors or market entities may be considered State aid, and, as such, they must be assessed and approved by the European Commission. On 18 February 2022, the European Commission published the revised guidelines on State aid for climate, environmental protection and energy (CEEAG), setting the criteria for its assessment. As far as security of electricity supply is concerned, the CEEAG expands the types of the measures covered by the State aid process, for example including interruptibility schemes and network reserves[15]. It also incorporates the relevant provisions of the Electricity Regulation, such as the principle of limiting market distortions imposed by the measures. Notably, the CEEAG introduces an ex post evaluation of the measures to verify the necessity and effectiveness of the measure and the achievement of objectives, and to assess the impact of the measure on competition and trade. It further aligns with the Green Deal and Fit for 55 packages by requesting that Member States demonstrate compatibility of the measures with the EU climate targets. In addition, the CEEAG requires from Member States to demonstrate the necessity of security of supply measures by means of a proper assessment and with reference to a properly defined reliability standard. Pursuant to the Electricity Regulation and the CEEAG, if Member States want to introduce measures targeting adequacy, such as capacity mechanisms, the identification of relevant concerns needs to be consistent with the latest ERAA. Member States may still demonstrate adequacy concerns and the need for measures via complementary NRAAs[16].

12 And possibly the results of an NRAA.

13 Article 23(7) of the Electricity Regulation.

14 The Decision is available here and the Annexes here and here.

15 The scope is even broader. According to paragraph 326 of the CEEAG, it *"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 demand response, interconnection, as well as network congestion measures which aim to treat the insufficiency of electricity transmission and distribution networks"*.

16 According to Article 24(1) of the Electricity Regulation the NRAAs shall be based on the ERAA methodology.

25 In the absence of an approved ERAA, the European Commission has requested ACER to issue opinions on whether the ERAA methodology has been correctly applied by the NRAAs, and whether the adequacy concerns identified are justified. At the time of publication of this report, ACER has not issued any opinion on this matter.

26 To be able to consider appropriate mitigation measures at all-time horizons - alongside the long-term adequacy assessment (ERAA and NRAAs) – the Risk Preparedness Regulation sets up a coordinated framework of short-term adequacy assessments that works on different time and geographic scale. It comprises of a seasonal outlook, providing best estimates of the coming summer or winter periods on a European level, complemented by regional assessments up to week-ahead and day-ahead timeframes[17].

27 This report first looks into the Member States' progress in defining the level of adequacy for their systems (Chapter 2). It continues with an overview of the long-term NRAAs and the European seasonal and regional short-term resource adequacy assessments (Chapter 3). Finally, it examines security of electricity supply measures implemented in Europe, including capacity mechanisms, interruptibility schemes and network congestion measures (Chapter 4).

17 Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation defines additional assessment requirements for transmission system operators within their control area.

2 Adequacy metrics

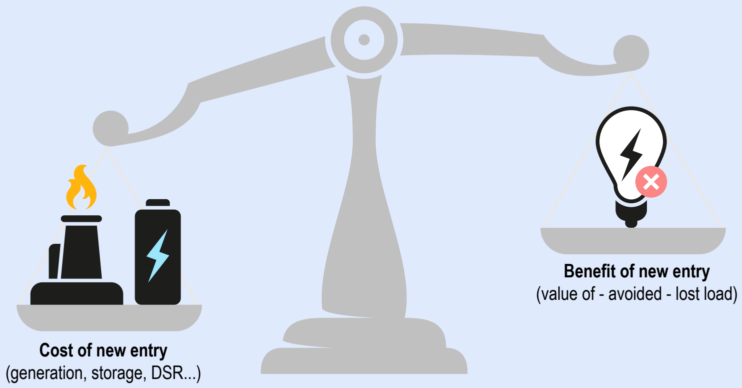
28 According to Article 25(1) of the Electricity Regulation, when applying capacity mechanisms, Member States must have a reliability standard in place, which indicates the necessary level of security of electricity supply. Article 25(2) of the Electricity Regulation further requires that the reliability standard is based on the VOLL/CONE/RS methodology and that the NRAs submit a proposal of the reliability standard to the Member State or the designated authority. Furthermore, pursuant to Article 11(1) of the Electricity Regulation, for the purpose of defining the reliability standard, Member States have to determine a single estimate of the VOLL calculated based on the relevant methodology.

29 The competent bodies responsible for the calculation of the VOLL and the reliability standard vary among Member States. In general, NRAs are highly involved in the process of adopting the value for the VOLL. On the other hand, in most cases, Member States maintain the responsibility for setting up the reliability standard while transmission system operators (TSOs) and NRAs have a supportive role[18]. Table 3 in the Annex provides more information on the division of competences within the Member States.

30 Member States have been gradually applying the VOLL/CONE/RS methodology. This chapter offers an overview of the VOLL, CONE and reliability standard metrics as a result of the implementation of the applicable methodology, based on information collected from NRAs. High-level aspects of the VOLL/CONE/RS methodology were included in the information collected and are discussed hereafter. At this stage, ACER did not examine in detail the implementation level of the relevant calculations vis-a-vis the methodology[19].

Box 2: How the reliability standard is calculated

A socioeconomically efficient reliability standard is calculated based on the VOLL, which represents the value that consumers place on an uninterrupted service, and the cost of new entry (CONE), which represents the cost of adding incremental capacity in the system to reduce the level of demand disconnections. The reliability standard essentially strikes a balance between the cost of having additional capacity in the system against the benefits of having less demand disconnections (or energy non-served).

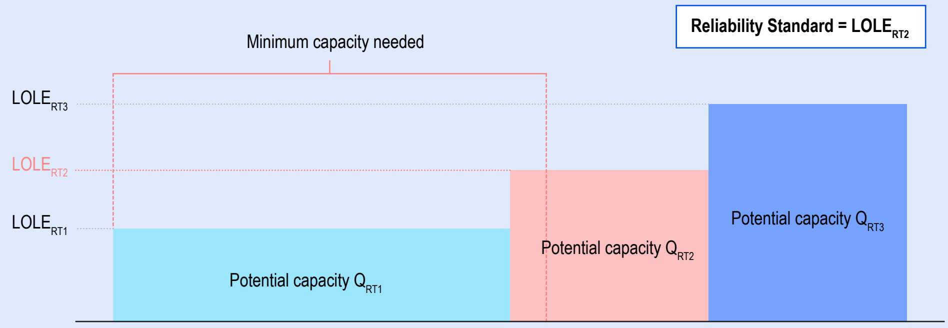


VOLL estimates are based on appropriate surveys asking different types of electricity consumers about how they value uninterrupted electricity supply in specific critical periods of time. The values of various consumer groups are then appropriately weighted to calculate the single VOLL. CONE estimates are based on techno-economic information of all possible resources (reference technologies) that can be deployed in order to reduce demand disconnections.

18 The role of the TSOs may actually be substantial. For example, in Italy the TSO has conducted the calculations and submitted them to the NRA. The NRA then proposed the reliability standard to the relevant Ministry taking into account the TSO's analysis.

19 In ACER's view, when proposing the reliability standard, NRAs should assess whether the VOLL/CONE/RS methodology is properly implemented.

Once the two parameters are identified, a target loss of load expectation per reference technology (LOLERT) is calculated (in its simplest form as the ratio between the CONE of the reference technology and the VOLL). Reference technologies are then ranked according to their LOLERT value and their available potential for additional capacity. The reliability standard is the target LOLE of the reference technology that is necessary to provide the minimum capacity need to achieve the required adequacy level.



2.1 Value of lost load

31 As of July 2022, eleven Member States have determined the single VOLL. These are: Belgium, the Czech Republic, Finland, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Slovenia and Sweden[20]. As depicted in Figure 1, the single VOLL varies significantly among Member States, ranging from 4,000 euros/MWh in the Czech Republic to nearly 69,000 euros/MWh in the Netherlands.

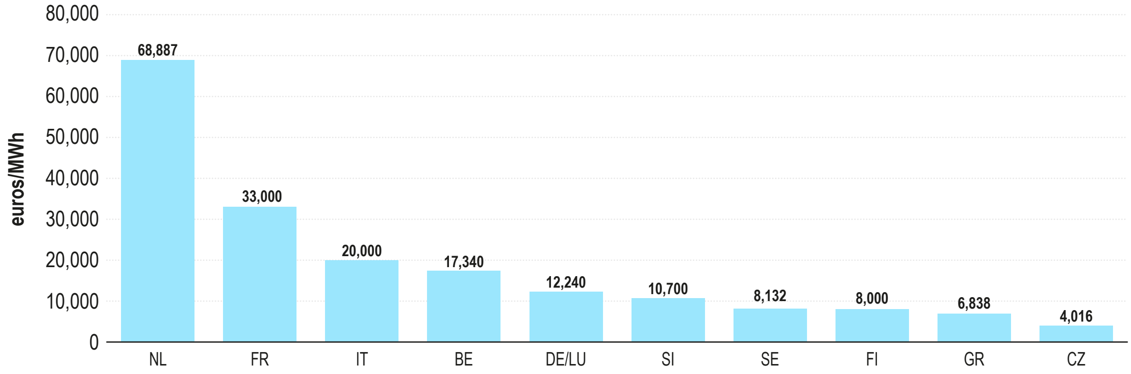
32 It is difficult to identify the reasons for such strong differences with certainty at this stage. The wide range may highlight stark differences in the perceived value of adequacy between Member States. VOLL estimates reflect generic economic characteristics of a Member State, for example gross domestic product per capita, economic structure or electrification level. Since the single VOLL is calculated on the basis of the VOLL of a number of sectors, the examined sectors and their electricity consumption pattern bear influence on the results. VOLL calculations also need to take into account the specific mechanisms for controlling load-shedding[21].

33 Given, however, the seventeenfold difference between the highest and lowest VOLL and comparisons between Member States with similar economic characteristics, it is possible that the significant differences are also driven by methodological choices. Divergent approaches related to the cost-estimation methods, details about the sectors assessed and the inclusion (or not) of price-responsive and protected consumers indicate non-uniform implementation practices between Member States. Table 4 in Annex 5.1.2 provides high-level information on the implementation of the methodology. ACER will follow up on the recent VOLL studies to better understand potential challenges implementing the methodology.

20 The Czech Republic, Greece and Slovenia do not have a capacity mechanism in place. In Ireland, Lithuania, Poland and Spain the calculation was ongoing at the time of publication of this report.

21 According to Article 7 of the VOLL/CONE/RS methodology, the individual load-shedding plans need to be taken into account when calculating the single VOLL. Implementation of this specific provision varies. For example, in Finland large industrial enterprises and transport sector were not considered in the calculations as they are excluded from the load-shedding during hours of inadequacy. In Sweden, on the contrary, load-shedding is largely coordinated at distribution level and so the provision was not implemented due to lack of specific information.

Figure 1: Single VOLL for the calculation of the reliability standard – status as of July 2022 (euros/MWh)



Source: ACER based on NRA data

Notes: Germany and Luxembourg proceeded with a common calculation of the single VOLL as they belong to the same bidding zone. Calculations of the single VOLL for France and the Netherlands were concluded in 2022.

2.2 Cost of new entry

34 The CONE is the second component used in the calculation of the reliability standard. According to the VOLL/CONE/RS methodology, the calculation of CONE has to consider all possible resources (so-called reference technologies) that have the potential to contribute to adequacy, i.e., generation (including renewal and prolongation of existing units[22] and renewable energy resources), demand response and storage[23]. As depicted in Box 2, the reliability standards are defined based on the CONE of the marginal resource available to provide additional capacity. Figure 2 shows the fixed CONE[24] and the relevant reference technology that defined the reliability standard as calculated for ten Member States. In six cases, the most efficient resource to provide additional capacity is low-cost demand response[25].

35 The inclusion of demand response (as well as storage and renewable energy resources) in the calculations of CONE was a key methodological improvement introduced in the Electricity Regulation and further developed in the VOLL/CONE/RS methodology. The emergence of demand response as a potential least costly technology comes as a result of the gradual enabling of its implementation, for example via the deployment of smart meters and the participation of demand response in the electricity market via aggregators. The introduction of environmental criteria for supporting new investments also contributed by providing space for less polluting resources, such as demand response[26].

22 In these cases, the VOLL/CONE/RS methodology refers to the cost of renewal and prolongation (CORP). In this report, the term CONE is used to include also the notion of CORP.

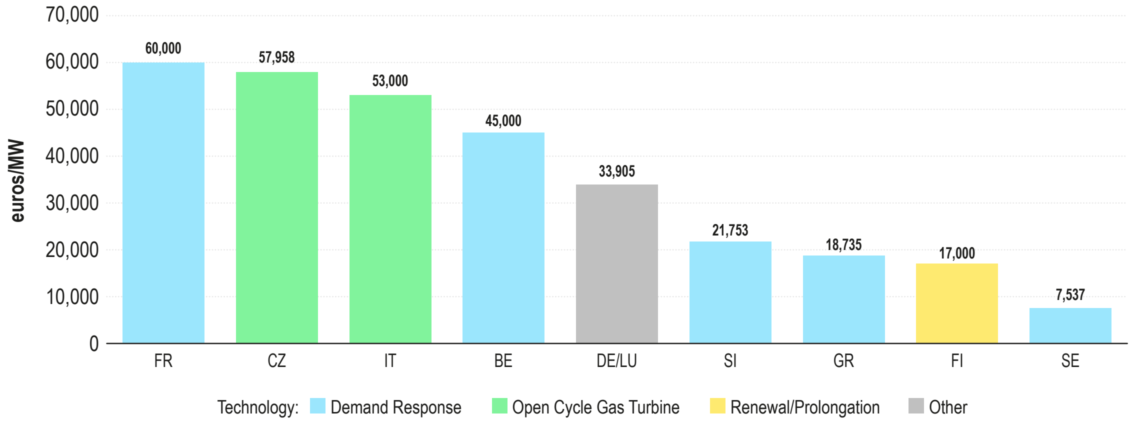
23 Additional information about the technologies examined and the relevant cost parameters are provided in Annex 5.3.

24 Fixed CONE refers to the total annual net revenue per unit of de-rated capacity (net of variable costs) that a new capacity resource would need to receive over its economic lifetime, in order to recover its capital costs and annual fixed costs and is calculated according to Article 15 of the VOLL/CONE/RS methodology. While the variable costs may also be taken into account in the calculation of the reliability standard, the fixed CONE is generally the most decisive parameter of the two.

25 In Italy, demand response was not examined in the calculations as it was considered that it did not fit the definition of reference technologies due to unavailability of reliable and generalised information on construction and operating costs. In the common German and Luxembourg case, the open cycle gas turbine technology becomes the one setting the CONE in years when the potential for additional demand response is exhausted.

26 For example, in France fossil-fuelled electricity generation is excluded from any new investment support.

Figure 2: Fixed CONE and technology defining the reliability standard – status as of July 2022 (euros/MW)



Source: ACER based on NRA data

Notes: When information was not directly available, the fixed CONE values were calculated based on the value of the reliability standard and the VOLL. For Germany and Luxembourg, the reliability standard is an average of relevant annual calculations for the years 2023-2031 and includes years when the resource defining the reliability standard is an open cycle gas turbine and years when it is demand response. For Slovenia, the minimum CONE value is presented.

2.3 Reliability standard

36 Pursuant to Recital 46 of the Electricity Regulation, it is a Member State's right to set its own desired level of security of supply. At the same time, Member States that have a capacity mechanism in place (or want to introduce one) need to express the necessary level of security of electricity supply in terms of a reliability standard calculated according to the VOLL/CONE/RS methodology.

37 The reliability standard defines the level of security of supply which maximises the socioeconomic surplus, where the incremental cost of additional capacity (expressed via the CONE) helping to avoid load-shedding is equal to the incremental cost of load-shedding to society (expected energy not served[27] valued at VOLL). The reliability standard is expressed as loss of load expectation (LOLE) indicating the upper boundary of the expected number of hours in a year, during which energy is not served as supply is insufficient to meet the demand.

38 As depicted in Figure 3, fifteen Member States have set the reliability standard as LOLE, ranging from one hour in Sweden to fifteen hours in the Czech Republic. As of July 2022, nine Member States have calculated the reliability standard based on the VOLL/CONE/RS methodology (as declared by the NRAs). Six additional Member States have a LOLE-type reliability standard in place set before the adoption of the methodology. Alternative reliability metrics are in place in Bulgaria, Cyprus, Denmark and Spain.[28, 29]

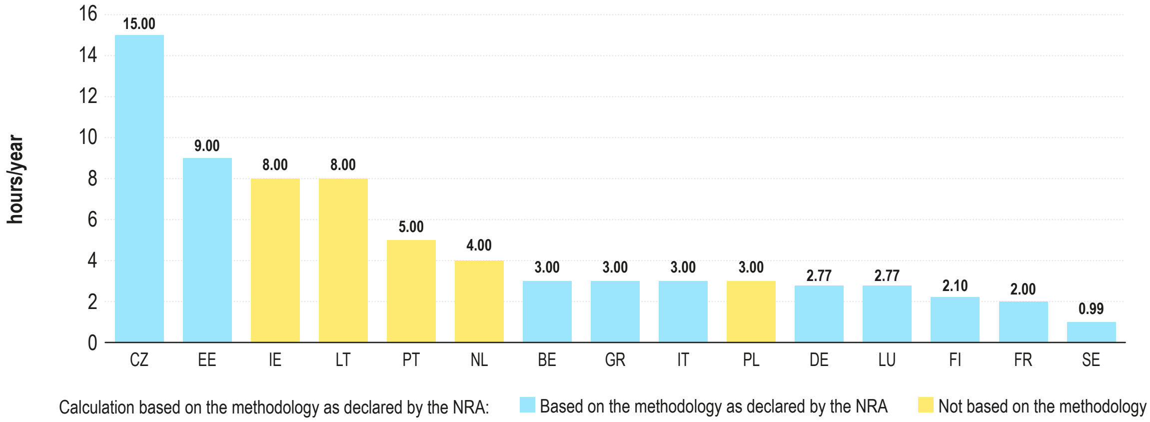
39 The most common LOLE value is three hours per year. As an example, the three hours of reliability standard indicates a level of security of supply, where it is expected that during the year in 99.97 percent of the time there is sufficient capacity to meet the demand. While ACER did not examine the actual degree of compliance with the methodology, the great divergence in VOLL results in Member States (see Chapter 2.1) may indicate that implementation may differ across Member States.

27 Energy not served (ENS) refers to the difference between the expected demand for electricity and the available resources.

28 Member States with no capacity mechanism in place are not obliged to calculate the reliability standard on the basis of the VOLL/CONE/RS methodology. Cyprus is also exempted from obligations to define a reliability standard pursuant to Article 64(2) of the Electricity Regulation. The reliability standard is established by a legal or regulatory act in Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Lithuania, Luxembourg, Poland and Sweden.

29 In Bulgaria a system adequacy index (SAI) is used based on the loss of load probability (LOLP) defined as SAI=1-LOLP = 0.99815. In Cyprus three reliability metrics are set: LOLE of 3 hours per year, reserve margin of 189MW and expected energy not served at 0.001% of annual demand. In Denmark a 7 'outage minutes' (OM) per year metric is used, estimated on the basis of the demand and the expected unserved energy (EUE) as OM = 8760 * 60 * EUE / Demand. In Finland an additional reliability standard expressed as EENS equal to 1,100 MWh/year is in place. Finally in Spain a 10% reserve margin for mainland and a LOLE of 2.4 hours per year for non-mainland is used.

Figure 3: Reliability standard as LOLE – status as of July 2022 (hours/year)



Source: ACER based on NRA data.

Notes: Implementation of the VOLL/CONE/RS methodology based on NRA declarations; the actual degree of compliance is not examined.

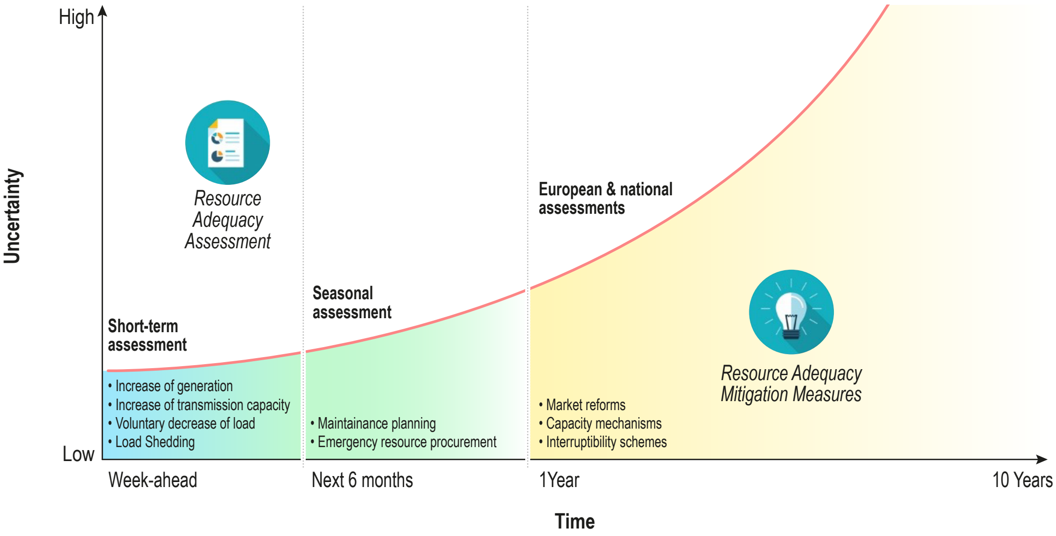
3 Resource adequacy assessments

40 The Electricity Regulation and the Risk Preparedness Regulation determine a framework of adequacy assessments that stretch out to the future as far as ten years ahead, down to the assessment of the coming seven days. The potential range of applicable mitigation measures varies according to the specific timeframe. The coordinated cascade of assessments of different time horizons allows all relevant measures to be considered at the right time to ensure the appropriate level of adequacy in the EU. Figure 4 provides a schematic representation of the described framework.

41 Resource adequacy is assessed over the longer term from ten-year-ahead to year-ahead with a view to ensure investment into electricity resources meet demand. ERAA – which may be complemented by national assessments – ensures that decisions as to possible investment needs are made on a transparent and harmonised basis.

42 The common European framework for short-term adequacy assessments is used to detect possible adequacy-related problems in shorter time-frames, namely seasonal adequacy assessments (six months ahead) and week-ahead to at least day-ahead adequacy assessments.

Figure 4 Schematic representation of adequacy assessments and mitigation measures of different time horizons



Source: ACER.

43 This chapter first looks at the implementation of national resource adequacy assessments (Section 3.1). It then provides background information and an overview of the results of the past four seasonal adequacy assessments that were based on a new methodology (Section 3.2.1) and ends with a discussion of the short-term adequacy assessments performed at pan-European level in 2021 (Section 3.2.2).

3.1 Long-term national resource adequacy assessments

44 Member States monitor resource adequacy within their territory on the basis of the ERAA. For the purpose of complementing ERAA, they may also carry out NRAAs[30]. In most Member States it is usually the TSO who performs the assessment which might then be approved by the Government or, in some cases, by the NRA[31].

45 ACER decided not to approve the first ERAA developed by ENTSO-E in 2021 due to a number of shortcomings. Consequently, until ERAA is approved, national assessments remain the basis for long-term adequacy analysis. As required by the Electricity Regulation, NRAAs must be based on the ERAA methodology approved by ACER in 2020[32].

30 According to Article 24(1) of the Electricity Regulation, national resource adequacy assessments shall be based on the ERAA methodology and shall contain the ERAA's reference central scenario.

31 See Table 6 for the competences regarding NRAAs in Europe.

32 Pursuant to Article 24(1) of the Electricity Regulation.

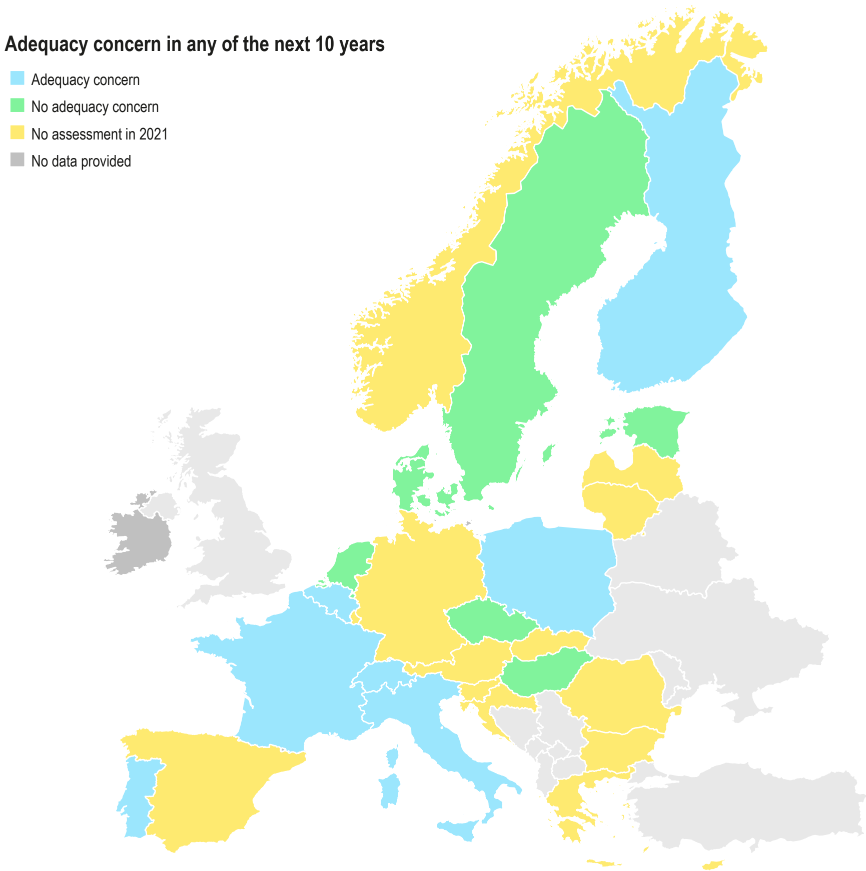
Box 3: Select methodological highlights for national resource adequacy assessments

- The national assessment must have a regional scope;
- The national assessment must rely on a robust central reference scenario which reflects the most likely pathway weighted with probabilities;
- The central reference scenario must reflect the impact of the market reform plan on market functioning;
- The central reference scenario must include an economic viability assessment, assessing market entry/exit of all technologies;
- The national assessment and the reliability standard calculation must be fully consistent regarding all assumptions and input data.

46 According to the ERAA Methodology, an adequacy concern is identified – for a given target year and modelled zone – if the LOLE estimated by the adequacy assessment is higher than the target set by the reliability standard[33]. As shown in Figure 5, thirteen Member States performed a national adequacy assessment in 2021. Seven of these assessments identify adequacy concerns in at least one of the coming ten years, i.e., the LOLE calculated for the year is higher than the reliability standard of the Member State allows at least for one of the studied years.

33 The reliability standard should be based on the VOLL/CONE/RS methodology.

Figure 5: Adequacy concern in Member States in any of the next 10 years indicated by the national resource adequacy assessment performed in 2021



Source: ACER based on NRA data.

Notes: ACER has not examined the degree of compliance of NRAAs with the ERAA methodology. In Germany, the NRAA is ongoing at the time of producing this report. ACER is aware that in Ireland the All-Island Generation Capacity Statement is produced by the TSOs, however, information was not provided by the NRA via the MMR survey. The Irish authorities have identified adequacy concerns and they are currently engaged in a programme of actions to address it. In the case of Italy, the resource adequacy concern is indicated for the bidding zones IT-North, Sardinia and Sicily.

3.2 Seasonal and short-term resource adequacy assessments

47 Both short-term and seasonal adequacy assessments rely on the short-term and seasonal adequacy assessment methodology (STSAA) approved in 2020 by ACER. It aims to monitor whether available supply and transmission are sufficient to cover demand under various weather and operational conditions. The seasonal adequacy assessments are used to alert to risks that are likely to result in a deterioration of the electricity supply situation up to six months ahead. Short-term adequacy assessments are used in the context of system operation from the week-ahead to day-ahead timeframe.

3.2.1 Seasonal adequacy assessment

48 ENTSO-E carries out a European winter and summer adequacy assessment to alert Member States and the TSOs of risks related to the security of electricity supply. The results for the winter adequacy assessment are published in a Winter Outlook Report by 1 December each year and for the summer adequacy assessment in a Summer Outlook Report by 1 June each year.

49 To facilitate the implementation of the STSAA, ACER issued opinions on the subsequent ENTSO-E seasonal assessments[34]. In all its opinions, ACER found that these assessments were broadly consistent with the objectives of non-discrimination, effective competition and efficient and secure functioning of the internal market for electricity. ACER's opinions also suggested improvements. Amongst others, ACER highlighted the importance of flow-based modelling that would enable a more accurate assessment of the transfer capacities between the relevant modelled zones, and therefore enhance the quality of the results.

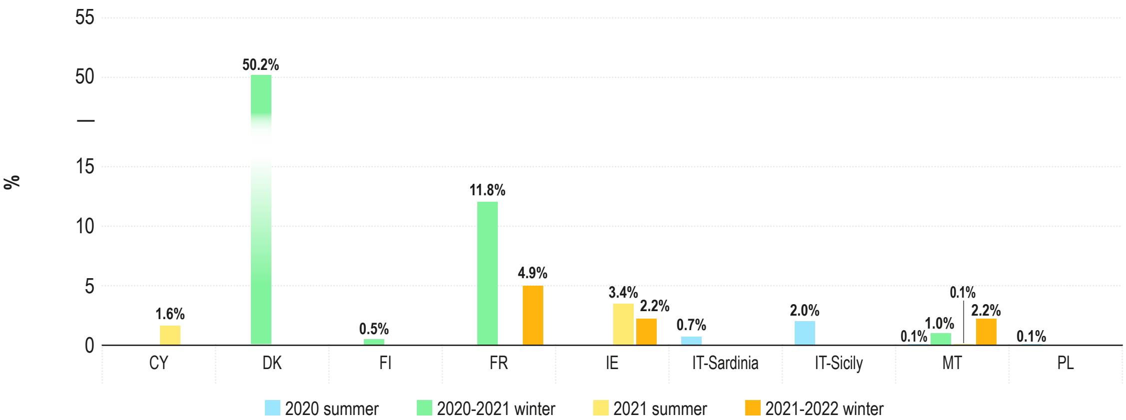
50 Since the adoption of the STSAA, ENTSO-E has published four seasonal Outlook Reports[35]. As depicted in Figure 6 they identified adequacy risk in eight countries. Particularly impacted are islands with limited interconnection (Malta, Sardinia, Sicily and the island of Ireland) or no interconnection (Cyprus), although – with the exception of Malta[36] - these risks are sporadic. The risks identified often remain mild, in most cases under three percent maximum weekly LOLP, indicating a very low expectation of lack of supply[37]. The assessments also identified higher risks for France and Denmark for the winter period.

51 Relatively high maximum weekly LOLPs were indicated for France during winter 2020-21 and 2021-22. The risks were associated with cold weather conditions as demand in France is temperature-sensitive, primarily due to the widespread use of domestic electric heating. When unfavourable weather conditions overlap with higher nuclear planned outages it can lead to adequacy concerns.

52 In the past four outlooks, the highest LOLP was assessed for Denmark for winter 2020-21. The underlying reason for the adequacy risk was an expected low import availability due to a planned outage on an interconnection between the Denmark East bidding zone and Germany. Following the assessment, however, the Danish TSO rescheduled the planned outages on its network in order to reduce risks.

53 None of the forecasted adequacy risks manifested during the assessed years. Equipped with the results of the seasonal analysis, the TSOs can take coordinated actions to mitigate adequacy risks ahead of time, such as by rescheduling planned maintenance of critical grid and resource assets.

Figure 6: Maximum loss of load probability (LOLP) taking into account non-market resources in the past four ENTSO-E seasonal adequacy assessments (%) – 2020-2022



Source: ACER based on the results of the seasonal resource adequacy assessments.

Note: Weekly LOLP represents a probability that lack of supply could be expected for at least one hour and for any amount of energy. LOLP under normal market conditions represents the probability that TSOs would need to identify non-market resources. Weekly LOLP with non-market resources represents the probability that the power system may face a lack of supply. TSOs may need to identify non-market measures and, if none are available, partial and controlled demand-shedding for a limited duration will be necessary to restore power balance.

34 See ACER Opinion No 07/2021 on the ENTSO-E Summer Outlook 2021, ACER Opinion No 01/2021 on the ENTSO-E Winter Outlook 2020-2021, ACER Opinion No 07/2020 on the ENTSO-E Summer Outlook 2020. All ACER opinions on ENTSO-E's seasonal assessments are available on ACER's website.

35 The fifth report on Summer Outlook 2022 was published in July 2022 and, while it identified adequacy risks in Greece, Denmark, Ireland and Malta, its main conclusion was that there would be no major risk for electricity supply in Europe during the summer period.

36 In Malta, the assessment shows adequacy risk repeatedly, indicating structural issues. To temper risks, the system relies on reserves (out-of-market counter-measures) during tighter supply moments and especially during the outages of its interconnection with Italy.

37 I.e.: Out of the 1400 scenarios modelled with different climate conditions and outage patterns, lack of supply appeared in 42 cases.

3.2.2 Short-term resource adequacy assessment

54 Regional Coordination Centres (RCCs)[38] perform daily adequacy diagnosis on a rolling basis for the subsequent seven days using local inputs and cross-border exchanges. The first step is to perform a pan-European assessment led by the RCCs on a rotational basis. If the results of this step show adequacy concerns for a bidding zone, or if it is requested by TSOs, a regional assessment is performed focusing on the critical time periods identified in the pan-European results. The RCCs provide recommendations to TSOs to mitigate risks and achieve overall adequacy.

55 In 2021, the regional short-term adequacy ('STA') assessment indicated the risk of lack of adequacy on 6 days during the year, representing a total of more than 7,000 MWh of expected energy not served which, for the sake of comparability, is roughly the amount of energy 700,000 EU households consume in one day[39]. For one of these days, the main affected TSO was the French TSO and the issue was resolved in cooperation with the Swiss TSO. The other five days – falling on a single week in December – the Polish TSO was mainly affected. Box 4 explains the latter event in more detail.

56 The fact that during 2021 the STA assessment indicated adequacy risk only in six days for two Member States suggests in general, for the analysed period, an adequate state of resilience of the power system. TSOs, however, remain alert to mitigate risks manifesting sporadically. In December 2021, for the first time since its implementation, coordinated cross-border remedial actions were triggered by the STA process to mitigate adequacy risk.

Box 4: Short-term adequacy concern successfully handled with cross-border cooperation

The Polish power system came under stress in the beginning of December 2021, mainly as a result of emergency shutdowns of several generating units. The regional assessment and cooperation on mitigation measures was important in supporting PSE taking the necessary measures to ensure the operational safety of the national power system.

The short-term adequacy assessment performed on 5 December 2021 indicated a risk of 440 MWh energy not served for the day. After the results of the D-1 market, the forecasted imbalance increased to 1700 MWh as there was no physical import to Poland and all power from the synchronous border was transited to the north interconnections: to Sweden and Lithuania. PSE applied the necessary countermeasures, also including inter-operator emergency assistance from neighbouring systems.

For certain hours on 6 December both day-ahead and intraday prices were lower in Poland than in Sweden and Lithuania which translated to commercial flows toward these countries. Prices not reflecting the actual lack of adequate supply in Poland may have aggravated the situation.

Poland and Sweden are connected via an undersea interconnector. At PSE's request, the Swedish strategic reserve was activated. The activation of 330 MW reserve helped reduce flows from Poland towards Sweden by increasing generation in Sweden, contributing to the resolution of the adequacy risk. Strategic reserves are typically established and dimensioned to resolve potential adequacy situations within the territory of a Member State. However, on this occasion, the Swedish reserve was effectively used in solidarity with a neighbouring interconnected system contributing to the mitigation actions.

On the same day PSE also received emergency help from the neighbouring German, Lithuanian and Ukrainian systems. In total, the cross-border support amounted up to around 1200 MWh import in certain hours of the day. This international support as well as actions taken internally allowed PSE to keep operational reserves at required level that day.

In the following five days, until 11 December, the short-term adequacy assessment still indicated adequacy risk for Poland. PSE executed national mitigation measures, including the increase of generation as well as cancellation of planned maintenances of generators.

38 As RCCs were not fully operational in 2021, this task was performed by the regional security coordinators.

39 Final energy consumption in households by type of fuel, by Eurostat. Number of households in the EU-27, by Eurostat.

4 Security of supply measures

4.1 Capacity mechanisms

57 Member States are required to monitor resource adequacy for their territory through the ERAA and may complement this assessment with a NRAA. When these assessments indicate resource adequacy concerns[40], Member States must first identify any potential regulatory or market distortions that create or exacerbate these concerns. They then need to develop a reform plan[41] with a timeline for adopting measures to remedy these regulatory distortions or market failures.

58 In case of residual adequacy concerns, Member States may implement temporary capacity mechanisms. In this case, they need to evaluate whether a capacity mechanism in the form of a strategic reserve is capable of addressing the identified resource adequacy concerns in the first place. Only where this is not the case, Member States may implement a different type of capacity mechanism[42].

59 The Electricity Regulation also defines high-level design principles for capacity mechanisms. For example, amongst others, capacity mechanisms must be transparent, competitive and must not go beyond what is necessary to address the adequacy concerns. Box 6 provides further details on the design of capacity mechanisms.

60 This chapter first presents the current status of capacity mechanisms in Europe (Section 4.1.1). It then provides an overview of their associated costs (Section 4.1.2) and describes the technologies that are remunerated through the capacity mechanisms together with the long-term commitments (Section 4.1.3). Finally, it presents the current status of cross-border participation in capacity mechanisms (Section 4.1.4).

4.1.1 Status of capacity mechanisms

61 In 2021, there were some important developments in relation to national capacity mechanisms. The European Commission approved the Belgian market-wide capacity mechanism in August 2021, and the first auction took place in October 2021. This was the first capacity mechanism approval since the CEP came into force. In addition, the Bulgarian and Greek capacity mechanisms were phased out[43].

62 As Figure 7 shows, there are eight Member States with active capacity mechanisms in Europe, namely: Belgium, Finland, France, Germany, Ireland (I-SEM)[44], Italy, Poland and Sweden. While Portugal and Spain do not have an active capacity mechanism in place, legacy contracts are still valid. Five Member States have market-wide capacity mechanisms and additional three have strategic reserves in place as of the end of 2021[45, 46].

63 All but the Finnish and Swedish capacity mechanisms were approved by the European Commission under the State aid rules. Additional Member States are currently examining the possibility to introduce a capacity mechanism, while plans for the introduction of a capacity mechanism in some cases have at this time been frozen[47].

40 As per Article 8 of the ERAA methodology, an adequacy concern is identified by comparing the resulting adequacy indicator (LOLE) of the assessment for the reference case scenario with the reliability standard defined according to the VOLL/CONE/RS methodology.

41 Timeline for adopting measures to eliminate market distortions is defined in the published national implementation plan. Information on the implementation plans can be found here.

42 Article 21(3) of the Electricity Regulation.

43 The Bulgarian capacity mechanism was active from November 2013 ending in August 2020 with an amendment to the Energy Act. The capacity mechanism was entirely phased out in 2020.The Greek “transitory” capacity mechanism was active from February 2018 and was subject to specific market reforms. Auctions were suspended since March 2019 due to delays in the implementation of those reforms.

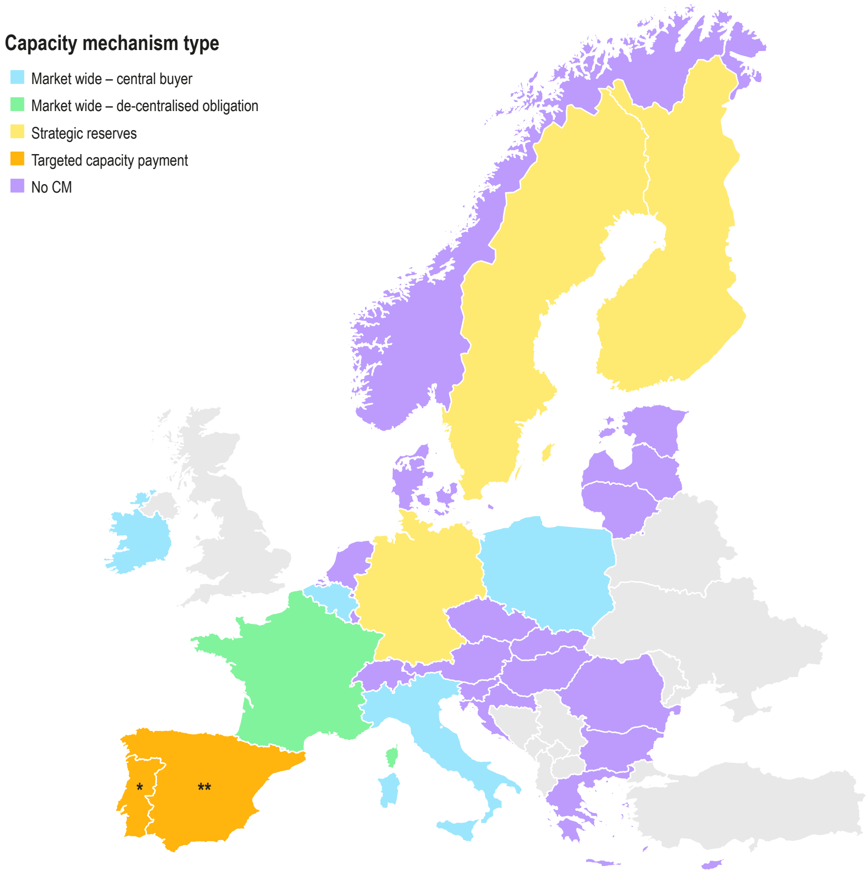
44 I-SEM refers to the Irish single energy market that includes the electricity systems of both Ireland and Northern Ireland.

45 The categorisation of capacity mechanisms is based on the taxonomy in the EC’s staff working document accompanying the document Final Report of the Sector Inquiry on Capacity Mechanisms sector inquiry, available here.

46 In France a complementary scheme targeting demand response is in place from 2018 and until the end of 2023. See Box 6 for further details.

47 For example, Finland and Sweden are developing a new mechanism and Greece and Spain have publicly consulted on the idea, while in Lithuania the relevant initiative is stalled.

Figure 7: Capacity mechanisms in the EU-27 – 2021



Source: ACER based on NRA data.

Note: The first auction of the new Belgian capacity mechanism took place in October 2021. In Bulgaria, the capacity mechanism was phased out in 2020. In Greece, auctions were suspended since March 2019 and last delivery period included 2020. In France a complementary scheme targeting demand response is also in place since 2018. The first delivery of the new Italian capacity mechanism started in 2022. Contracts of the previous targeted capacity payment scheme were still valid in 2021. A new auction was held in February 2022 for delivery in 2024. In Portugal, a targeted capacity mechanism was introduced in 2017, and has been revoked since 2018, yet some capacity payments are provided to hydro power plants due to "legacy" contracts. In Spain**, the capacity mechanism used to comprise of "investment incentives" and "availability payments". Such availability payments were removed in June 2018, and investment incentive payments still apply only to generation capacity installed before 2016.*

4.1.2 Costs and financing of capacity mechanisms

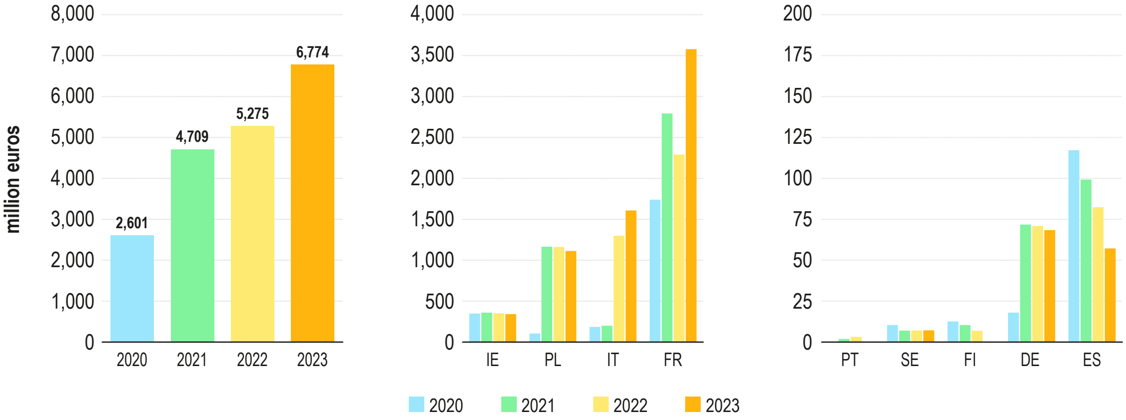
64 This section presents analyses of the cost associated with capacity mechanisms for past and future years, across the EU and Member States, as well as for different technologies.

65 Figure 8 presents the total incurred or projected costs of capacity mechanisms in EU-27 and per Member State, spanning from 2020 until 2023. Total costs in 2021 reached nearly five billion Euros and are expected to increase to seven billion Euros in 2023[48], confirming observed trends in 2020 MMR. The observed threefold increase in total costs between 2020 and 2023 is mainly driven by the introduction of the Polish and Italian market-wide capacity mechanisms, in 2021 and 2022 respectively, as well as the increased costs of the French capacity mechanism[49].

48 Projected costs for 2023 do not include potential T-1 auctions.

49 The projected 2023 costs for the French scheme are based on the results of the first auction for that year and reflect the market participants' perceived risks at that time. Therefore, the actual costs may vary.

Figure 8: Costs incurred or projected to finance capacity mechanism in the EU-27 (left) and per Member State (right) – 2020–2023 (million euros)

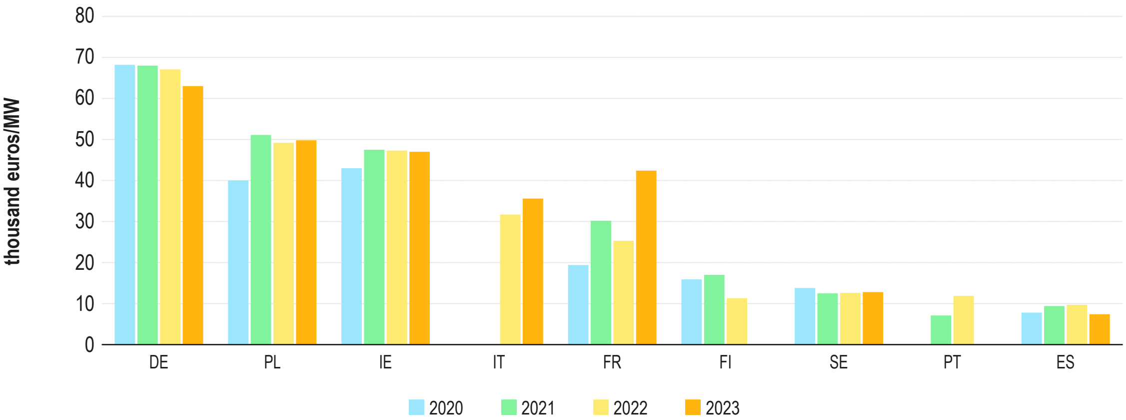


Source: ACER calculations based on NRA data.

Note: Costs are based on the total annual realised or projected payments to capacity providers for delivery of capacity in the relevant year. The costs do not account for side effects such as impacts on energy prices or additional costs or benefits derived from the capacity mechanisms. In Belgium, the new capacity mechanism payments start from 2025 onwards. No auctions for the previous capacity mechanism took place for 2020 and 2021. The overall costs for France are an approximation due to the specifics of the capacity mechanism design (see also note 2 under Figure 10). For 2023, costs are based on the results of the first relevant auction held in 2022. For Ireland, data was not provided this year, so 2020 MMR data was considered. Cost data for Italy up to 2021 refer to 'legacy' capacity payments from the previous capacity remuneration scheme. For 2022, they refer to both the new capacity mechanism and the relative legacy contracts, while for 2023 only to the new capacity mechanism. For Portugal, costs refer to capacity payments provided to hydro power plants due to legacy contracts. For Spain, the depicted costs refer to the remaining long-term investment incentives awarded to installations before these incentives were cancelled in 2016.

66 Figure 9 presents the incurred or projected costs of capacity mechanisms per unit of capacity procured calculated as the ratio of total payments over total procured volumes. The resulting unit costs range from 7,000 to 68,000 euros per MW.

Figure 9: Unit cost of capacity mechanisms – 2020-2023 (thousand euros per MW)



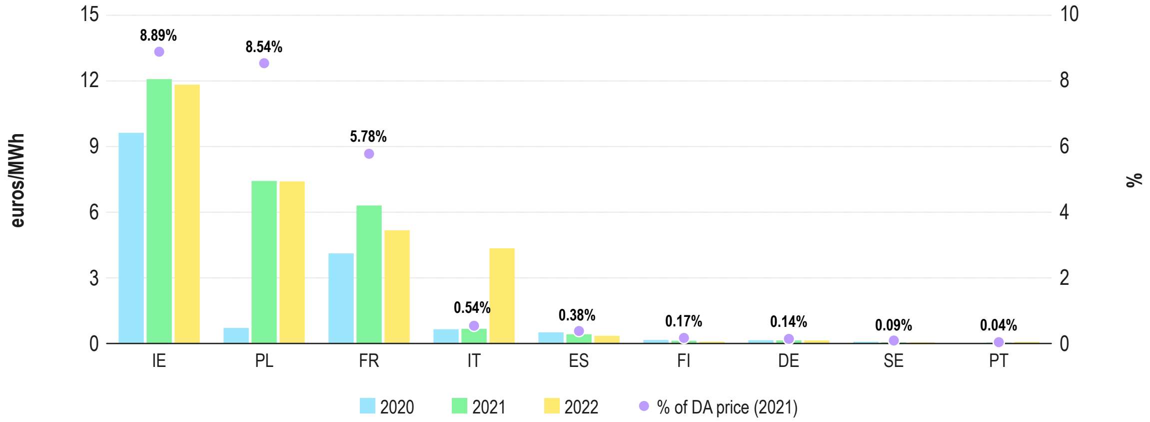
Source: ACER calculations based on NRA data.

Note 1: The unit costs are calculated by dividing total annual payments and total annual volumes remunerated and hence do not necessarily accurately depict auction results. In Belgium, new capacity mechanism payments start from 2025 onwards. No auctions for the previous capacity mechanism took place in 2020 and 2021. The overall costs for France are an approximation due to the specifics of the capacity mechanism design (see note 2 under Figure 10). For Ireland, data was not provided this year so 2020 MMR data was considered. For Italy, no information on the capacity (MW) remunerated in 2021 under the previous mechanism was provided. For 2022 and 2023, costs refer only to the new capacity mechanism.

67 Figure 10 presents the relative cost to finance capacity mechanisms, expressed per unit of demand[50], and as a share of the annual average day-ahead price (black dots)[51]. Apart from the cost of capacity mechanisms, two more factors influenced these values. In 2021, the economic recovery drove the EU demand higher[52] compared to 2020. At the same time, the day-ahead spot prices in 2021 reached unprecedented heights due to the natural gas price crisis[53]. The latter was more influential compared to the demand increase and the changes in costs of capacity mechanisms, causing the costs per unit of demand and relative shares to decrease compared to 2020 MMR values and projections[54].

68 The costs per unit of demand are, in general, higher in Member States with market-wide capacity mechanisms. Strategic reserves inhibit lower cost per unit of demand. The big increase in Italy in 2022 is due to the new capacity mechanisms.

Figure 10: Costs incurred or projected to finance capacity mechanisms per unit demand – 2020-2022, and expressed as a percentage of the annual average day-ahead price in Europe – 2021 (euros per MWh of demand and %, respectively)



Source: ACER calculations based on NRA and ENTSO-E data.

Note 1: Costs expressed as percentages of average day-ahead prices refer to 2021 data. Costs per unit demand are based on total annual realised or projected payments to capacity providers for delivery of capacity in the relevant year. Demand data is derived from Eurostat data or ENTSO-E Transparency Platform. Demand in 2021 was used for 2022 calculations.

Note 2: In Belgium, the new capacity mechanism payments start from 2025 onwards. No auctions for the previous capacity mechanism took place for 2020 and 2021. The overall costs for France are an approximation considering that all capacity certificates are valued at the market reference price (PRM). A significant share (which varies year-on-year) of the capacity certificates is implicitly valued through the "Accès Régulé à l'Electricité Nucléaire Historique" (ARENH) mechanism, a scheme that enables suppliers to purchase electricity from nuclear generators at a regulated price. Therefore, the actual costs for France are dependent on the reference used to value the capacity certificates related to the ARENH mechanism. For Ireland, cost data was not provided this year, so 2020 MMR data was used. Cost data for Italy up to 2021 refer to 'legacy' capacity payments from the previous capacity remuneration scheme. For 2022, they refer to both the new capacity mechanism and the legacy contracts while for 2023 only to the new capacity mechanism. For Portugal, costs refer to capacity payments provided to hydro power plants due to "legacy" contracts. For Spain, the depicted costs refer to the remaining long-term investment incentives awarded to installations before these incentives were cancelled in 2016.

50 Demand data is initially based on Eurostat data and alternatively on data from the ENTSO-E Transparency Platform. Demand data is defined with a methodology based upon the demand data for the Member State and the observed year. For the observed years when Eurostat data was absent and ENTSO-E Transparency Platform data was available, two approaches were applied in order to derive the demand data. Initially, for Member States where ENTSO-E Transparency Platform and Eurostat data was available for the two preceding years of the observed year, a correction factor was calculated. The correction factor is defined as the ratio between the two preceding years of aggregated ENTSO-E Transparency and Eurostat data. The demand data was calculated by multiplying the ENTSO-E Transparency Platform data with the correction factor. Alternatively, if Eurostat data was absent for the two preceding years of the observed year, the demand data equals ENTSO-E Transparency Platform data.

51 Another way to "read" this share is as a share of the total cost of the capacity mechanism compared to the cost of energy if it was fully valued at the average day-ahead price alone.

52 The demand increased by 4.2% from 2020 to 2021.

53 For more information on the energy prices, see ACER's interactive energy market dashboards here. ACER's preliminary assessment of the high energy prices are available here. ACER/CEER report on the Wholesale Electricity Markets Monitoring 2021 is available here.

54 For example, for Ireland and France the relative shares decreased to 9 % and 6% respectively, compared to 26% and 13% in 2020 MMR. Also the share for Poland for 2021 is actually half the estimated in 2020 MMR (9% compared to 18% respectively).

4.1.3 Technologies remunerated under capacity mechanisms

69 This section presents the recent evolution of the capacity contracted under capacity mechanisms per technology. It also provides an overview of the long-term contracted capacity and the relevant costs.

70 Figure 11 shows the breakdown of technologies remunerated through capacity mechanisms from 2019 to 2022. Total capacity increased by roughly a third during this period. The share of fossil fuelled power plants increased from 34% in 2019 to 46% in 2022 respectively. Natural gas-fired capacity, in particular, nearly doubled in the same period, overtaking nuclear power as the resource with the highest share. In total, the share of traditional thermal generation accounted for nearly 70% in 2022.

71 In the same period, capacity of renewable energy sources other than hydro power plants doubled but still remained low at nearly 6 GW or just three per cent of the total. Cross-border capacity, either in the form of interconnectors or in the form of direct foreign capacity, nearly doubled, exceeding twelve GW in 2022, increasing its share to seven percent of the total capacity under these mechanisms. Demand response increased less prominently by a quarter to over four GW, while storage is still at very low levels (below 300 MW in 2022).

Box 5: Demand-side response participation receives dedicated incentives in France

Demand side response (DSR) providers can support the electricity system by reducing their consumption at peak hours among others. Demand response is typically a fast and environmentally friendly way to provide additional flexibility to the system.

In France, the participation of consumers in balancing and wholesale markets is further boosted by dedicated capacity payments. As a temporary measure, demand response providers are remunerated via regular, competitive tenders. The volume contracted through the tenders is subtracted from the capacity requirement of the market-wide capacity mechanism. On this DSR-specific auction, the level of remuneration is generally higher than the remuneration received through the market-wide capacity mechanism. This may reflect the additional incentive needed to nudge consumers to participate in the energy markets.

During the COVID-19 pandemic, the price cap for the auction was increased from 35,000 to 60,000 euros/MW to reach an increased contracted volume. As a result, contracted volumes doubled along with a roughly twofold increase in their remuneration but remained below the target.

Tender for year	Contracted volume (MW)	Remuneration (euros/MW)
2018	733	24,000
2019	590	26,800
2020	770	24,400
2021	1,366	55,700
2022	1,982	59,600

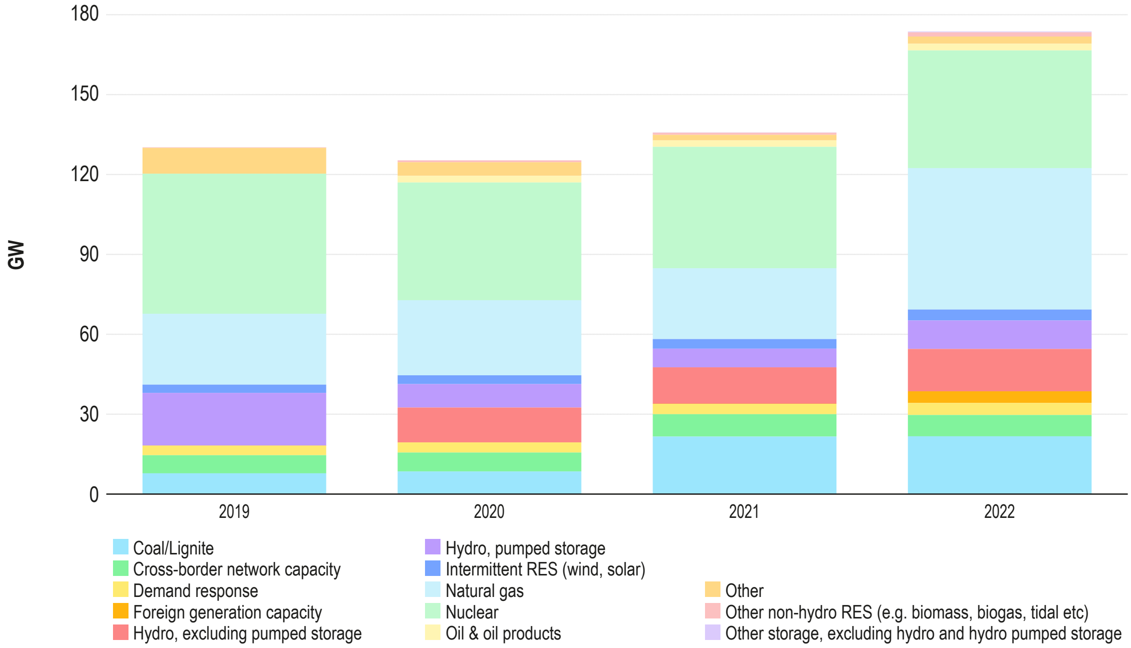
72 Following the introduction of requirements regarding CO_2 emission limits in capacity mechanisms[55], it is expected that the capacity of coal- or lignite-fired power plants remunerated under capacity mechanisms will be reduced in the long run. However, the very low shares of capacity contracts for new resources indicate a potential need for adjustment of their design and applicable implementation rules to remove remaining barriers[56] and increase participation of these low-carbon resources[57].

55 Pursuant to Article 22(4) of the Electricity Regulation, generation capacity exceeding emission limits set therein shall not be eligible for payments or commitments under a capacity mechanism.

56 See for example Section 7.7 of the 2020 MMR on restrictive requirements for new entrants and small actors to participate in capacity mechanisms and interruptibility schemes.

57 As per the recent communication from the European Commission on short-term energy interventions and long-term improvements to the electricity market design, capacity mechanisms *"would need to be designed to endure investment in firm renewable and low carbon capacity compatible with the Union's climate targets"*.

Figure 11: Capacity remunerated through capacity mechanisms per type of technology in EU-27 – 2019-2022 (GW)



Source: ACER calculations based on data from NRAs and, in the case of Italy, also from publicly available information on auction results.

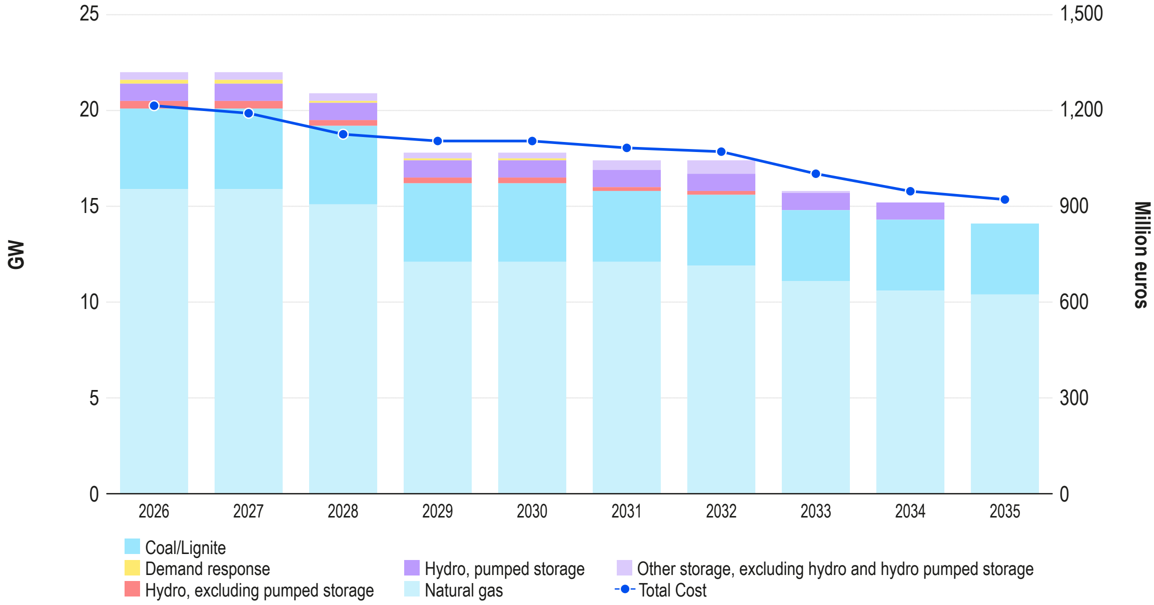
Note: For the year 2019, no breakdown between hydro power plants with and without pumped storage was available. For Italy, no information on the capacity (MW) remunerated in 2021 under the previous mechanism was available. Since the Italian capacity mechanism auctions are portfolio-based, distribution of the capacity procured per technology in 2022 is an approximation based on the results of the capacity auctions and the breakdown of the 2022 generation fleet in Italy according to ENTSO-E transparency platform. For Ireland, data were not provided this year so previous MMR data was used.

73 Figure 12 shows the capacity under long-term contracts alongside their associated costs. Such contracts exist in six Member States: Belgium, France, Ireland, Italy, Poland and Spain. Compared to the situation as depicted in 2020 MMR[58], new long-term contracts with the start of delivery in 2026 of 4.3 GW were concluded in 2021 between Belgium and Poland.

74 Long-term contracts facilitate the commissioning of new capacity by reducing risks for investors, addressing future security of supply concerns. At the same time the long term support of conventional resources may also have market implications as it may result in a barrier to entry for new future players and raise affordability issues for consumers. Moreover, the majority of the long-term contracted capacity is allocated to natural gas and coal/lignite power plants. Capacity mechanisms are thus expected to continue to support fossil-fuelled power plants way beyond 2030. This might compromise the EU emission and climate-neutrality targets and hamper the EU attempt to become carbon neutral. Finally, capacity resources may continue to receive support for periods with no foreseen adequacy-related issues.

58 Figure 46 on page 76.

Figure 12: Long-term contracted capacity and relevant costs by type of technology in the EU-27 – 2026-2035 (GW and million euros, respectively)



Source: ACER calculations based on data from NRAs and, in the case of Italy, also from publicly available information on auction results.

Note: Long-term contracts exist in Belgium, France, Ireland, Italy, Poland and Spain. For Ireland, data was not provided this year, so 2020 MMR data was considered.

4.1.4 Cross-border participation in capacity mechanisms

75 As per the findings presented in Section 4.1.3, cross border participation in capacity mechanisms[59] is currently limited, yet some progress can be observed. Table 1 provides an overview of the characteristics of cross-border participation for the various capacity mechanisms in place.

76 Market-wide capacity mechanisms in Belgium, France, Ireland, Italy and Poland have relevant provisions in place, however, implementation varies. In the Belgian capacity mechanism, foreign capacity can currently participate only in the T-1[60] auction, with the exception of foreign capacity directly connected to the Belgian network that can participate in the T-4 auction as well. No foreign capacity participated in the first T-4 auction held in October 2021. The French capacity mechanism still relies on temporary provisions that enable interconnectors to participate by directly selling the certificates provided by their interconnection's capacity.. Foreign capacity was awarded contracts in the Italian capacity mechanism auctions held in 2019. Obligations and requirements are less stringent for foreign providers compared to domestic ones. For example, the former only have financial obligations while the latter have to prove physical availability by participating in the electricity market. Foreign capacity was contracted for the first time in the T-5 auction of the Polish capacity mechanism held in December 2021. Finally, while the Irish capacity mechanism is currently de-facto exempted from the relevant provisions due to the lack of interconnection with the EU, interconnectors with Great Britain already participate in the capacity mechanism auctions.

77 For strategic reserves, the regulatory framework stipulates that cross-border participation is mandatory only if technically feasible[61]. None of the strategic reserve schemes in place allow for it at the moment.

59 Article 26 of the Electricity Regulation requires that CMs are open to direct participation of foreign capacity providers and sets out high-level principles for such participation. These principles are further developed and specified in the Technical Specifications adopted by ACER in December 2020. According to Article 22(5) in joint reading with Article 26 of the recast Electricity Regulation, Member States are required to adapt their capacity mechanisms (in effect since 4 July 2019) in order to allow direct cross-border participation, without prejudice to commitments or contracts concluded by 31 December 2019. Article 26(2) allows those Member States to temporarily enable interconnectors to participate directly in the same competitive process as foreign capacity providers, until 22 December 2022.

60 T refers to the delivery year; T-4 refers to auctions held four years prior to the delivery year

61 Article 26(1) of the Electricity Regulation.

78 To enable cross-border participation, relevant TSOs (and/or capacity mechanism operators if different from TSOs) need to establish effective cooperation between them via bilateral agreements. These agreements need to be in line with the requirements of the Technical Specifications. So far, only the Polish TSO has signed such agreements with its Czech, Lithuanian and Swedish counterparts, while the agreement with the neighbouring German TSO is being finalised. The French TSO is also reportedly in discussions with the Belgian TSO. So far, foreign capacity in the Italian capacity mechanism has solely financial obligations, hence there was no actual need for further agreements between the Italian and the neighbouring TSOs.

Table 1: Cross-border participation in capacity mechanisms

Member State	Participation	Auctions	Eligibility criteria	Obligations	TSO-TSO agreements
BE	Foreign capacity directly connected to the BE grid for T-4 auctions; Foreign capacity of neighbouring systems for T-1	Single auction	Similar to domestic providers	Similar to domestic providers	No
DE	Not included in the capacity mechanism				
FI	Not included in the capacity mechanism				
FR	Interconnectors (current)	Single auction	Similar to domestic providers	Similar to domestic providers	No (ongoing discussions with BE)
	Foreign capacity providers (foreseen)	Two-step approach			
IE	Interconnectors	Single auction	Similar to domestic providers	Similar to domestic providers	Not applicable (no interconnection with EU yet)
IT	Foreign capacity providers (simplified)	Single auction	Simplified compared to domestic providers	Only financial obligations	No
PL	Interconnectors (for delivery period 2021-2024); not implemented	Single auction	Similar to domestic providers	Similar to domestic providers	Yes, for CZ, LI, SK, SE (pending for DE)
	Foreign capacity providers of neighbouring countries (from delivery period starting from 2025 onward) implemented in 2021 auctions	Two-step approach			
SE	Not included in the capacity mechanism				

Source: NRAs.

79 Pursuant to Article 26(7) of the Electricity Regulation, regional coordination centres (RCCs) are responsible for calculating the maximum entry capacity[62] available for the participation of foreign capacity providers in a given capacity mechanism and issue a recommendation to the relevant TSOs. According to the Technical Specifications, the RCC calculation must be consistent with the ERAA methodology and for this, ENTSO-E must provide the necessary input data used in ERAA to the RCCs. The above provisions can only apply once the RCCs are fully operational and ERAA results are available. So far, the TSOs have used their own methodologies in order to calculate the relevant maximum entry capacity.

62 The maximum entry capacity is the maximum allowed entry capacity on a given capacity mechanism border for a given delivery period.

Box 6: Design principles of capacity mechanisms

In order to reduce any distortive effects, capacity mechanisms must be designed to address the specific nature and magnitude of the individual adequacy concern, be competitive and not lead to over-procurement or over-compensation.

According to the Electricity Regulation, strategic reserves, designed so as to minimise interference with the market, should be the first capacity mechanism under consideration. Member States are therefore required to assess whether a strategic reserve is capable of addressing their identified adequacy concerns, before introducing other types of capacity mechanisms (Article 21(3)).

Article 22 of the Electricity Regulations sets out the design principles for capacity mechanisms. In particular, Article 22(1) stipulates that capacity mechanisms shall be temporary, proportional and not create undue market distortions or limit cross-zonal trade. The procurement selection shall be transparent, non-discriminatory and competitive, while appropriate incentives to be available at times of expected system stress and penalties for non-availability shall be in place. Article 22(2) defines specific characteristics for strategic reserves, in order to ensure that market distortions are minimised and that price signals and incentives remain broadly unaffected. For capacity mechanisms other than strategic reserves, Article 22(3) requires that they ensure proportionality and reduce overcompensation risks, do not affect optimal operations in the short-term and enhance efficiency by enabling transferability of obligations. Furthermore, Article 22(4) aligns capacity mechanisms with the wider EU environmental targets by defining emission limits for capacity that can be remunerated via capacity mechanisms. Lastly, Article 22(5) also requires that existing capacity mechanisms (i.e., in place when the Regulation entered into force) must be adapted to comply with the above provisions.

The CEEAG also addresses design principles of the Electricity Regulation. It emphasises that any security of supply measure (including interruptibility schemes and network reserves) must be designed to maintain the efficient functioning of markets and preserve efficient operating incentives and price signals (par 369 of the CEEAG).

High-level information reported by the NRAs confirms that in most cases, the existing capacity mechanisms are broadly in line with the relevant design principles set out in the Electricity Regulation. In some cases, capacity mechanisms have not yet been fully adapted to the current framework. For example, the German mechanism does not have an explicit provision for emission limits in place. The same was true for the Finnish mechanism, that ended in 2021, The penalty system of the Irish scheme appears to dampen the pricing signals to market participants. Also, information collected for Sweden suggests that the activation practices of strategic reserves and imbalance settlement in such periods might still need to be adapted to the current legal framework.

ACER intends to continue and enhance the assessment of this topic in future editions of this report, including in the context of monitoring interventions preventing efficient price formation and barriers for new market entrants and smaller actors (see also previous work on this topic under Section 7.7 of 2020 MMR).

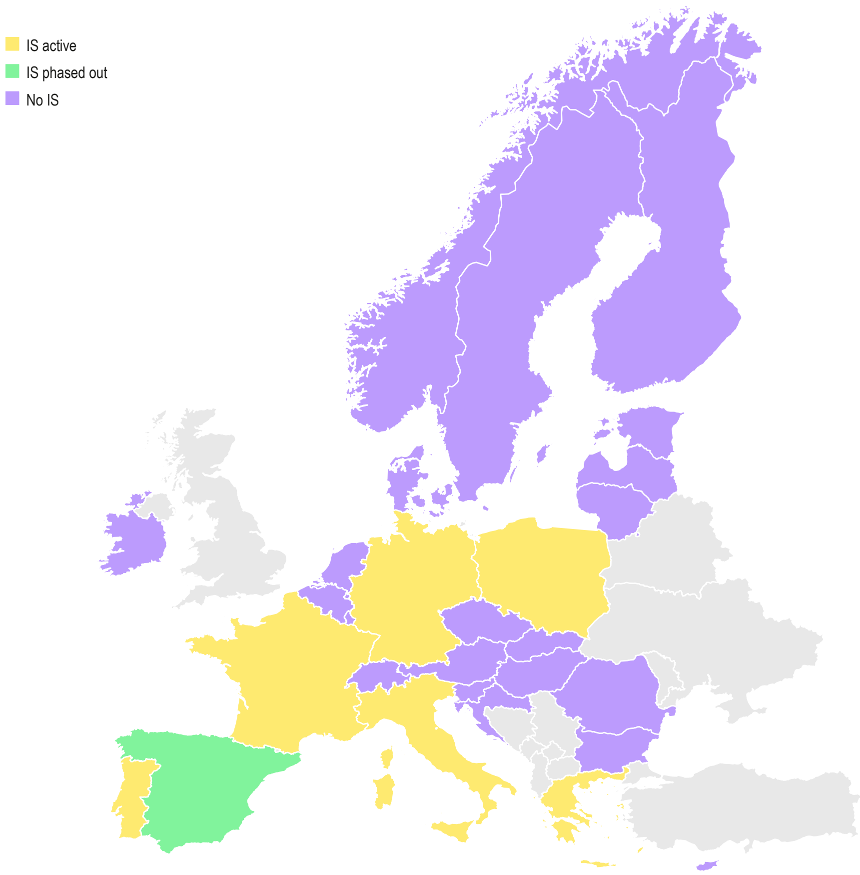
4.2 Interruptibility schemes

80 Interruptibility schemes normally refer to national programmes dedicated to demand response, organised by TSOs for temporary load interruption or reduction. An interruptibility scheme typically pools large industrial consumers from energy intensive industries with processes that can be suspended for a limited amount of time. Interruptibility schemes provided an early example of demand response[63], in the absence of a wide participation of consumers in the electricity market[64]. According to the CEEAG, interruptibility schemes aim to ensure a stable frequency in the electricity system or address short-term security of supply problems.

81 Interruptibility schemes can provide services[65] from a pre-notified reduction of consumption during times of scarcity, to an automatic response to an unexpected disturbance in the system (see Paragraph (69)). In this overview, four interruptibility scheme services are identified: adequacy, balancing, congestion management and contingency reserves[66]. Some interruptibility schemes are multi-purpose vehicles (Germany, Poland, Portugal) while other focus on providing a single service (France, Greece, Italy). More information on the characteristics of the interruptibility schemes are provided in Annex 5.3.

82 Figure 13 presents interruptibility schemes that have been in place in Europe for the past two years. In 2021, interruptibility schemes were operational in six Member States: France, Germany, Greece, Italy, Poland and Portugal. The Spanish scheme was phased out mid-2020.

Figure 13: Interruptibility schemes in Europe - 2021



Source: ACER based on information provided by NRAs and, in case of France, by the TSO.

Note: The German scheme expired in July 2022, with renewal being under consideration. The Greek and Portuguese schemes expired in September 2021 and December 2021 respectively. In Poland, the interruptibility scheme was terminated in November 2020 and replaced by a new demand response scheme in April 2021. The Spanish scheme was phased out in July 2020.

63 See the findings of the Final Report of the Sector Inquiry on Capacity Mechanisms available here.

64 See Recital 10 of Directive 2019/944

65 ACER did not assess the relevance of the underlying need for these services, or the justification for individual interruptibility schemes.

66 Ancillary services other than for balancing purposes.

4.2.1 Size, cost and activation of the interruptibility schemes

83 In all the interruptibility schemes, except for the Portuguese one, participating consumers are remunerated via competitive auctions. In Portugal, participants receive for their service an administratively set price. Participating consumers are remunerated for their availability in all countries but Poland, where they are remunerated for the energy provided (curtailed) upon activation. In Germany and Italy, participants also receive a utilisation payment for the amount of energy interrupted. The minimum eligible capacity varies from one MW in Poland and Italy to twenty-five MW in France. Participation of aggregators is only allowed in the German and Polish schemes.

84 The size of the schemes varies across Member States. Similar to the 2020 MMR findings, in 2021 the Italian scheme was the biggest in size with 4,425 MW[67], while the Polish scheme the smallest with 656 MW[68]. For efficient procurement of IS services, it is important to ensure that the procured quantity is commensurate with the purpose of the scheme.

85 The combined cost of the interruptibility schemes in the six Member States was more than half a billion Euros in 2021[69]. The Italian scheme was again the costliest one, accounting for 59% of that cost. Figure 14 shows the cost evolution of the interruptibility schemes over the last five years along with projections for 2022[70].

86 When comparing unit cost, i.e., costs divided by total contracted capacity, for 2021 the Portuguese scheme comes on top at around 157 thousand euros/MW, the Italian scheme being second reaching approximately half of that amount at around 78 thousand euros/MW, while the German scheme is the cheapest at 20 thousand euros/MW[71].

87 Figure 15 shows the number of activations of ISs for the period of 2018-2022. The German[72] and Italian schemes were used regularly during this period, while the other schemes were not used at all until 2021 (Poland, Portugal) or only used sporadically (France, Greece[73]). Interruptibility schemes may play a considerable role in resolving frequency deviation situations, as evidenced by two recent separation events in the Continental Europe Synchronous Area. On 8 January 2021, the French and Italian interruptibility schemes were automatically activated to support the restoration of frequency[74]. On 24 July 2021, it was the Portuguese interruptibility scheme which supported the resolution of the system separation of the Iberian Peninsula from the Continental Europe Synchronous Area [75].

67 Considering mainland Italy, Sicily and Sardinia.

68 More information is included in Table 8 of Annex 5.3.

69 Typically, the costs of the schemes are recovered through special charges levied on some or all of the network users, imposed on producers, balance responsible parties, or consumers.

70 Poland implemented a new scheme in April 2021, therefore there are no current data available.

71 The cost figures are indicative, since the underlying products are different. The total cost reflects only availability payments, activation payments are not included. All the values refer to 2021.

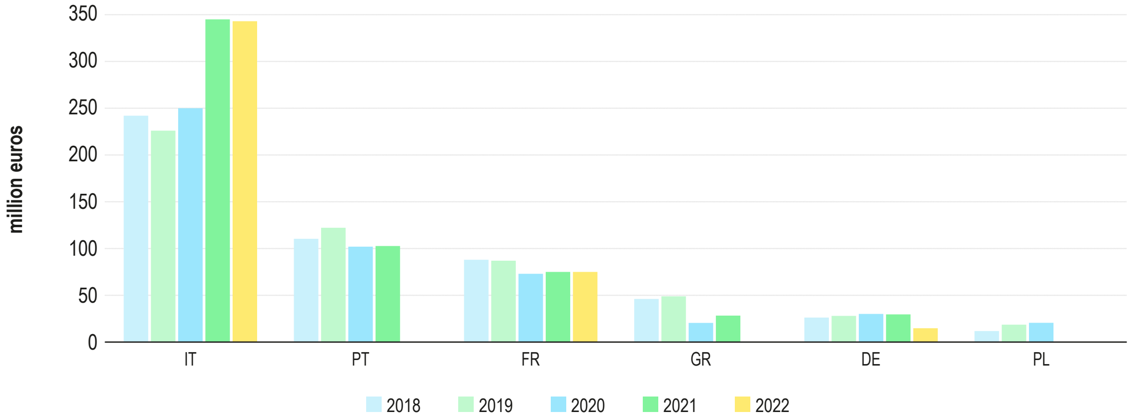
72 Heavy imbalances resulting from issues with the balancing market design led to an increased usage of the scheme in 2019. Activation for re-dispatching purposes occurred once in 2017 and five times in 2018, according to this source. Changes in the balancing market framework introduced in 2020 reduced the need for the activation of the scheme for balancing purposes.

73 Only used four times. All four times appeared in the winter crisis of 2016-2017.

74 See ENTSO-E's final report on the incident here.

75 See ENTSO-E's final report on the incident here.

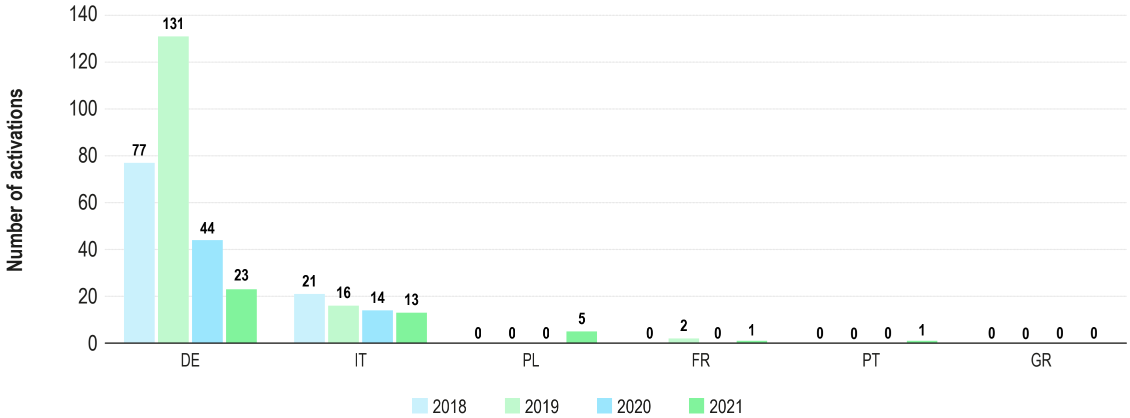
Figure 14: Realised and projected costs of the interruptibility schemes – 2018-2022 (million euros)



Source: ACER based on information provided by the NRAs and, in the case of France, also by the TSO.

Note: Realised (2018-2021) and projected (2022) payments per delivery year irrespective of the procurement date. For France, the cost for 2022 is an estimate. The German scheme expired in July 2022, with renewal being under consideration. The Greek and Portuguese schemes expired in September 2021 and December 2021 respectively. In Poland, the interruptibility scheme was terminated in November 2020 and replaced by a new demand response scheme in April 2021.

Figure 15: Number of interruptibility scheme activations over 2018 – 2021



Source: ACER based on information provided by NRAs and, in case of France, also by the TSO.

Note: The German scheme expired in July 2022, with renewal under consideration. The Greek and Portuguese schemes expired in September 2021 and December 2021 respectively. In Poland, the interruptibility scheme was terminated in November 2020 and replaced by a new demand response scheme in April 2021.

Box 7: The Portuguese interruptibility scheme supported the resolution of the system separation in the Continental Europe Synchronous Area on 24 July 2021

From Portugal to Turkey, interconnected transmission grids of Continental Europe operate synchronously. On 24 July 2021, this synchronous area was separated into two parts due to cascading tripping of several transmission network elements, caused by a fire near transmission lines in southern France. As a result, the Iberian Peninsula was separated from the rest of Continental Europe.

The French system remained connected to the synchronous area hence the French interruptibility scheme was not activated.

In Portugal, the frequency drop automatically activated power reduction of industrial interruptible consumers. The effective power reduction of the consumers participating in the interruptibility scheme reached a value of 394 MW which represents around 60% of the total contracted capacity.

Find out more about the event here.

4.3 Network congestion measures

88 According to the CEEAG, network congestion measures are aid measures targeting security of electricity supply. As such, they are subject to similar criteria as capacity mechanisms when it comes to assessing their compatibility with the internal market. The CEEAG defines network congestion measures as “measures for security of electricity supply designed to compensate for insufficiency in the electricity transmission or distribution network”. For a network congestion measure to be compatible with the internal market, Member States need to demonstrate the necessity of the measure via proper assessments[76] and demonstrate the improvements brought by the measure. In addition, any network congestion measure should not introduce undue market distortions, should be competitive and should ensure it does not incentivise polluting investments or replaces less polluting electricity production.

89 Network reserves are network congestion measures remunerating resources that provide the necessary reserves to mitigate local congestion issues, essentially enabling re-dispatching when existing capacity in the market is not sufficient nor in the right location. The resources are typically held out of the market and, according to the CEEAG, they cannot receive remuneration from the wholesale electricity market or balancing markets.

90 Network reserves exist in Austria and Germany. The Austrian scheme received State aid approval in June 2021 with an initial approval period until 2025[77]. A similar scheme existed from 2018 to 2021. The German scheme was approved in 2016[78] and continues to be in place. The cumulative capacity contracted for the two schemes in 2021 and 2022 was ten and seven GW respectively. As Figure 16 shows, almost the entirety of the procured capacity refers to fossil fuel generation units with only a small fraction of demand response occurring in 2021 (35 MW in Austria).

91 Figure 17 depicts the costs of the German scheme for the period of 2018-2020 and the costs for the two schemes for 2021. The cumulative costs for 2021 were 601 million euros. The German network reserve scheme has cost 1.5 billion euros in total for the past four years[79].

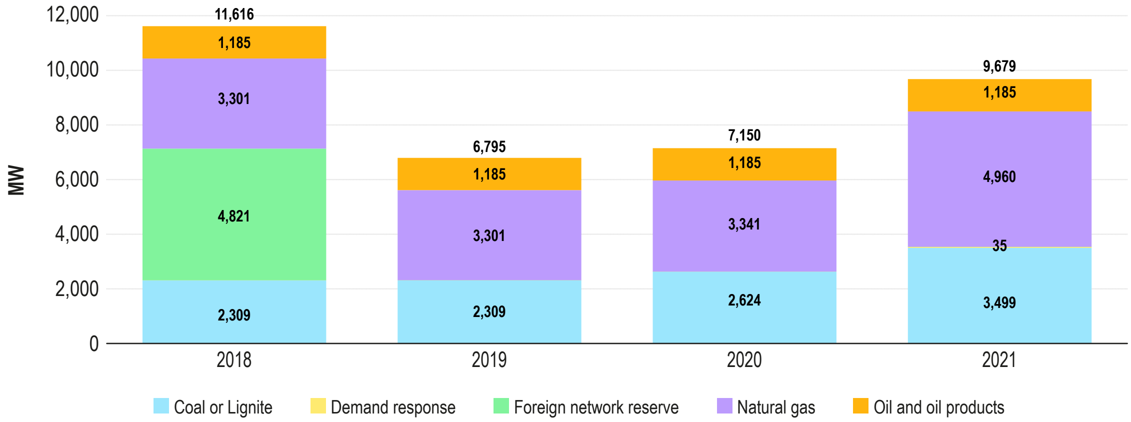
76 Pursuant to Paragraph 333 of the CEEAG, these assessments need to be reviewed or approved by the NRA.

77 See the decision here.

78 See the decision here.

79 This is only the cost for network reserves and is not the total cost for remedial actions (re-dispatching, countertrading and curtailment), which sums up to 530 million euros in Austria and to five billion euros in Germany for the last four years.

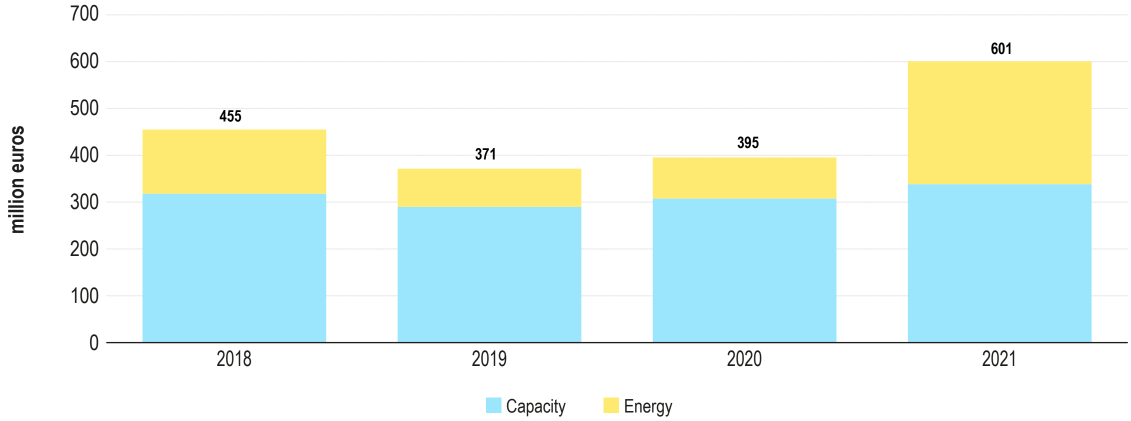
Figure 16: Total capacity contracted as network reserves in Austria (2021) and Germany – 2018-2021 (MW)



Source: ACER based on NRA data.

Note: The Austrian network reserve scheme was introduced in 2021. Information on capacity procured before that point for network congestion purposes is not available.

Figure 17: Total cost of network reserves in Austria and Germany – 2018-2021 (million euros)



Source: ACER based on NRA data.

Note: The new Austrian network reserve scheme was introduced in 2021. For Austria, costs for years 2018-2020 refer only to capacity payments of the previous network reserve scheme.

92 The two network reserve schemes ensure that enough re-dispatching capacity will be in place to resolve regional network congestion issues. Like in the case of strategic reserves, the contracted capacity is held outside the market. Under these conditions, the network reserves would likely not be eligible for deployment to resolve a general adequacy deficit occurred at bidding zone or national level. This clear distinction of the service provided by the network reserves enables proper definition of the specific need and effective procurement of the necessary capacity to address this need. At the same time, the potential support of the network reserve when capacity of available resources is not adequate could bring efficiency gains and might be a topic for further assessment in the future[80].

80 For example, it would be interesting to consider the potential contribution of network reserves in the resource adequacy assessment, e.g., as an out of market measure, and to determine the effect on the adequacy indicators.

4.4 Financing security of supply measures

93 Table 4 presents the cost recovery method for Member States with relevant payments in 2021. In most cases, costs are directly covered by consumers, either through network tariffs or special levies. In the remaining cases costs are passed through to electricity suppliers or balancing responsible parties (BRPs).

94 Flat charges may distort the price signals reflecting scarcity of resources, and prevent effective demand response, and should thus be avoided. This aspect is also addressed in Paragraph 367 of the CEEAG which states that *"the costs of a security of supply measure should be borne by the market participants who contribute to the need for the measure"*. As a positive example, the network charges for the Austrian network reserve scheme are calculated at a regional level via a method that allocates costs to the regions that contribute more to the relative network congestion. This provides an incentive to consumers to react in order to alleviate the problem.

Table 2: Cost recovery method for capacity mechanisms and interruptibility schemes

Member State	Capacity mechanism	Interruptibility scheme	Network reserves
Austria			Network tariffs
Belgium	Special levy to consumers		
Finland	Network tariffs		
France	Decentralised scheme – direct cost of suppliers	Network tariffs	
Germany	Network tariffs	Pass-through to BRPs or special levy to consumers	Network tariffs
Greece		Fee imposed to RES producers	
Ireland	Pass-through to suppliers		
Italy	Pass-through to BRPs	Pass-through to BRPs	
Poland	Network tariffs	Network tariffs	
Portugal	Network tariffs	Network tariffs	
Spain	Special levy to consumers		
Sweden	Pass-through to BRPs		

Source: NRAs and, in the case of France, the TSO.

Note: In Germany, costs of the interruptibility scheme are recovered in two ways according to the use of the load: Costs stemming from activations due to system balancing needs are recovered via the imbalance settlement of BRPs. Costs for capacity payments and activation costs stemming from congestion management are passed through to consumers via a special levy.

5 Annex

5.1 Adequacy metrics

5.1.1 Competences

Table 3: Competencies for calculation and determining VOLL, CONE and reliability standard - 2021

	VOLL		CONE		RS
	Calculation	Decision	Calculation	Decision	Decision
AT	NRA	Government	NRA	Government	Government
BE	Government in collaboration with the NRA and Federal Planning Bureau	Government	Government in collaboration with the Federal Planning Bureau	Government	Government
BG	NRA	NRA	NRA	NRA	Government
CZ	TSO	TSO	TSO	TSO	TSO
DE	NRA	NRA	NRA	NRA	Government
DK	Danish Energy Agency	Danish Energy Agency	Danish Energy Agency	Danish Energy Agency	Government
EE	NRA	NRA	NRA	NRA	Government
ES	Government	Government	Government	Government	NRA
FI	NRA	Government	NRA	Government	Government
FR	TSO	Government	TSO	TSO	Government
GR	NRA	NRA	NRA	Government	Government
HU	No set framework for VOLL, reliability standards calculations				
HR	No information available				
IE	No information available				
IT	NRA	NRA	NRA	NRA	Government
LT	TSO	NRA	NRA	NRA	Government
LU	NRA	NRA	NRA	NRA	Government
LV	No set framework for VOLL, reliability standards calculations				
NL	NRA	NRA	-	-	Pending
PL	NRA	NRA	NRA	NRA	Government
PT	Government	Government	Government	Government	Government
RO	Pending	Pending	Pending	Government	Government
SE	NRA	NRA	NRA	Government	Government
SI	TSO	TSO	TSO	Government	TSO
SK	NRA	NRA	Government	Government	Government

Source: ACER based on information from NRAs.

Note: Dark blue cells indicate Member States with capacity mechanisms in place in 2021. According to Article 25(2) of the Electricity Regulation, decisions on the reliability standards need to take into account a proposal by the NRA. Cyprus is exempted from adequacy-related provisions pursuant to Article 64(2) of the Electricity Regulation.

5.1.2 Value of lost load

95 The VOLL/CONE/RS methodology defines the main sectors that need to be examined when calculating the single VOLL. It also sets as the default method for the estimation of the sectoral VOLL a survey based on the willingness to pay[81]. Protected consumers and price responsive consumption should be excluded from the calculation of VOLL.

96 Table 4 provides information regarding these high-level implementation aspects of the VOLL/CONE/RS methodology. The information provided shows that the willingness to pay survey was not the followed approach in all Member States and sectors. Similarly, only four Member States excluded protected consumers from all sectors, while price-responsive consumers were considered only in the Netherlands (and even there not for the household sector).

81 This stems from the definition of the VOLL in Article 2 of the Electricity Regulation linking it to *"the maximum electricity price that customers are willing to pay to avoid an outage"*. According to Article 6(6) of the VOLL/CONE/RS methodology, the willingness to pay survey may be complemented with other types of research such as surveys based on willingness to accept (WtA), yet it is still a mandatory part of the sectoral VOLL estimation.

Table 4: Methodological aspects of the VOLL calculation - 2021

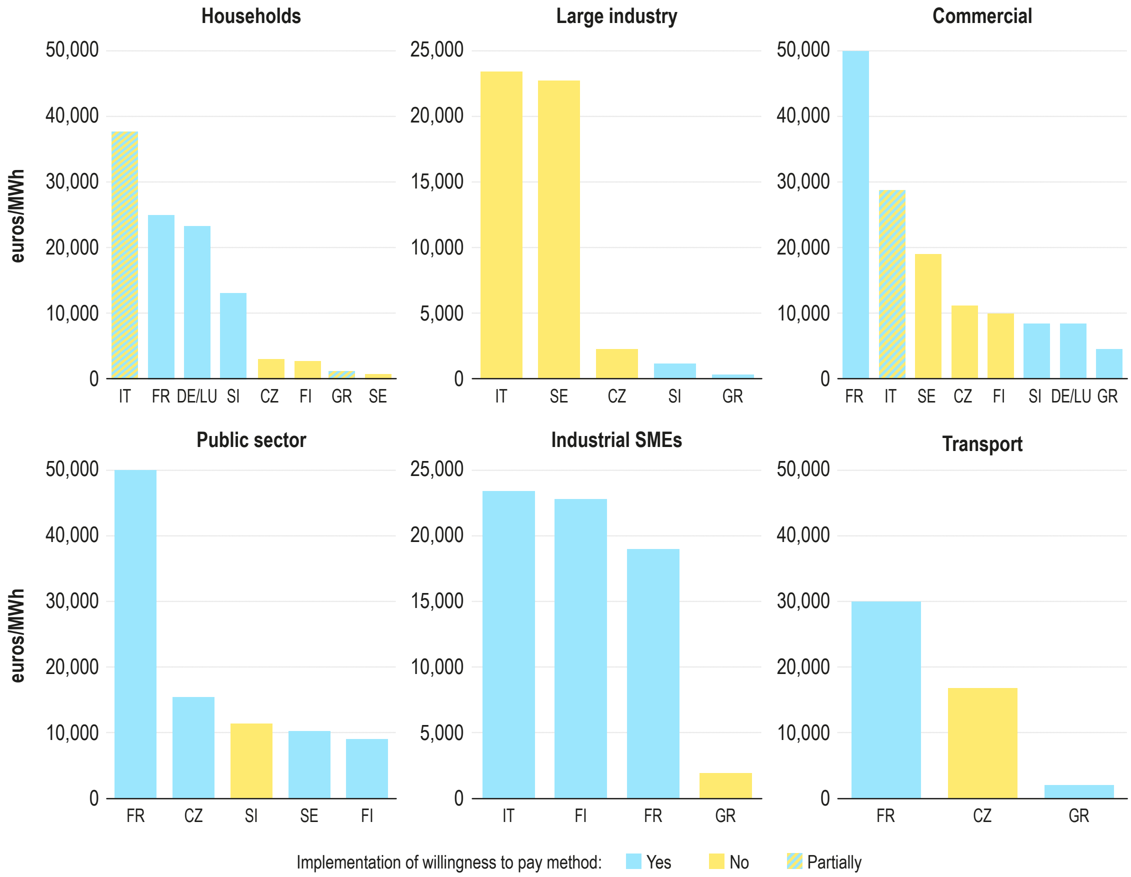
	CZ	DE/LU	FI	FR	GR	IT	NL	SE	SI
Is the sector assessed?									
Households	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Large industrial enterprises	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Commercial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Public services	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Industrial small & medium enterprises	Not separately assessed	Yes	Yes	Yes	Yes	Yes	Yes	Not separately assessed	Yes
Transport	Yes	Yes	No	Yes	Yes	No	Yes	Not separately assessed	No
Is the assessment based on a survey?									
Households	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Large industrial enterprises	Yes	No	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes
Commercial	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes
Public services	Yes	No	Yes	Yes	Not applicable	Not applicable	Yes	Yes	Yes
Industrial small & medium enterprises	Not separately assessed	No	Yes	Yes	No	Yes	Yes	Not separately assessed	Yes
Transport	Yes	No	Not applicable	Yes	No	Not applicable	Yes	Not separately assessed	Not applicable
Are price responsive consumers excluded from the survey?									
Households	No	No	Partially	No information	No	No information	No	No	No
Large industrial enterprises	Not applicable	No	NAP	No information	No	No information	Yes	No	No
Commercial	Not applicable	No	Partially	No information	No	No information	Yes	No	No
Public services	Not applicable	No	Partially	No information	Not applicable	No information	Yes	No	No
Industrial small & medium enterprises	Not separately assessed	No	Partially	No information	No	No information	Yes	Not separately assessed	No
Transport	Not applicable	No	Not applicable	No information	No	No information	Yes	Not separately assessed	Not applicable
What is the method for the VOLL survey(s) used?									
	WtP	Other	WtP/WtA	WtP/WtA and direct cost method	Other	WtP/WtA	WtP	WtP	Other
Was the single VOLL calculated only on the basis of a survey?									
	YES	NO	YES	YES	NO	YES	YES	YES	YES
Did VOLL calculation excluded protected consumers?									
	No informatin provided	No	For some sectors	Yes	Yes	Yes	Yes	For some sectors	No

Source: ACER based on information from NRAs.

Note: WtP refers to willingness to pay, WtA refers to willingness to accept. In the Czech Republic, the large industrial enterprises sector also includes industrial small & medium enterprises. In Finland, large industrial enterprises were excluded since they are protected from load-shedding. Also, only voluntary demand response was taken into account. For France, information was only partly available as the survey was not published at the time of the analysis. Some large consumers were not part of the survey since they are not included in the load-shedding plan. Germany and Luxembourg proceeded with a common calculation of the single VOLL as they belong to the same bidding zone. In this case, a macroeconomic approach based on production function was used. In Greece, a combined WtA and WtP survey was used for the household sector and values based on production function were merely used for the other sectors. Information on protected consumers was not available. In Italy, the public and the transport sectors were excluded since they are not included in the load-shedding plans. For the Netherlands, information was only partly available as the survey was not published at the time of the analysis. Demand response in households is limited and hence price responsiveness was not examined. In Sweden, the large industrial enterprises sector also includes industrial small & medium enterprises and the transport sector. In Slovenia, the VOLL calculation took place in 2019. The transport sector was not examined due to very low electricity consumption.

97 Figure 18 depicts the VOLL of the most commonly examined sectors in eight Member States that performed single VOLL calculations.

Figure 18: Sectoral VOLL values used in the calculation of the single VOLL – status as of July 2022 (euros/MWh)



Source: ACER based on NRA data.

Notes: Blue indicates cases where the willingness to pay survey method was implemented. Gradient colour for Italy (households and commercial sector) and Greece (households) indicates a combination of willingness to pay and willingness to accept method. No data for Belgium was available. France published the VoLL calculation in 2022. Some large consumers were not part of the survey since they are not included in the load-shedding plan. The remaining industrial sector is reported here under Industrial SMEs. Germany and Luxembourg performed a common VOLL calculation that was ultimately based solely on a macroeconomic assessment. It included only two sectors, households and commercial, the latter being a general category including all other sectors with a VOLL of 8,420 euros/MWh. A new calculation based on the relevant methodology is projected for 2023. In the Czech Republic the large industrial enterprises sector also includes industrial small & medium enterprises, while the administration sector was examined separately (1,800 euros/MWh). In Sweden, the large industrial sector includes industrial SMEs and the transport sector, while the agricultural sector was also examined separately (4,349 euros/MWh).

5.1.3 Cost of new entry

98 The VOLL/CONE/RS methodology requires that all technologies that are potentially available for increasing adequacy, and for which reliable data exists, should be examined when calculating the VOLL. Table 5 shows that in all Member States that calculated CONE except for Italy, demand response was taken into consideration in the CONE calculations. Similarly, Germany was the only Member State where storage, wind and solar technologies were not considered. Prolongation of the lifetime of existing units was examined only in the Czech Republic and Finland.

Table 5: Reference technologies examined in CONE calculations - 2021

	BE	CZ	FI	DE/LU	GR	IT	SI	SE
CCGT	YES	YES	NO	NO	YES	YES	YES	YES
OCGT	YES	YES	YES	YES	YES	YES	YES	YES
ICE gas	YES	YES	NO	NO	NO	NO	NO	YES
Batteries	YES	YES	YES	NO	YES	YES	YES	YES
Demand response	YES	YES	YES	YES	YES	NO	YES	YES
Wind onshore	YES	YES	YES	NO	YES	YES	YES	YES
Wind offshore	YES	NO	YES	NO	YES	NO	NO	NO
Photovoltaics	YES	YES	YES	NO	YES	YES	YES	NO
Renewal/Prolongation	NO	YES	YES	NO	NO	NO	NO	NO

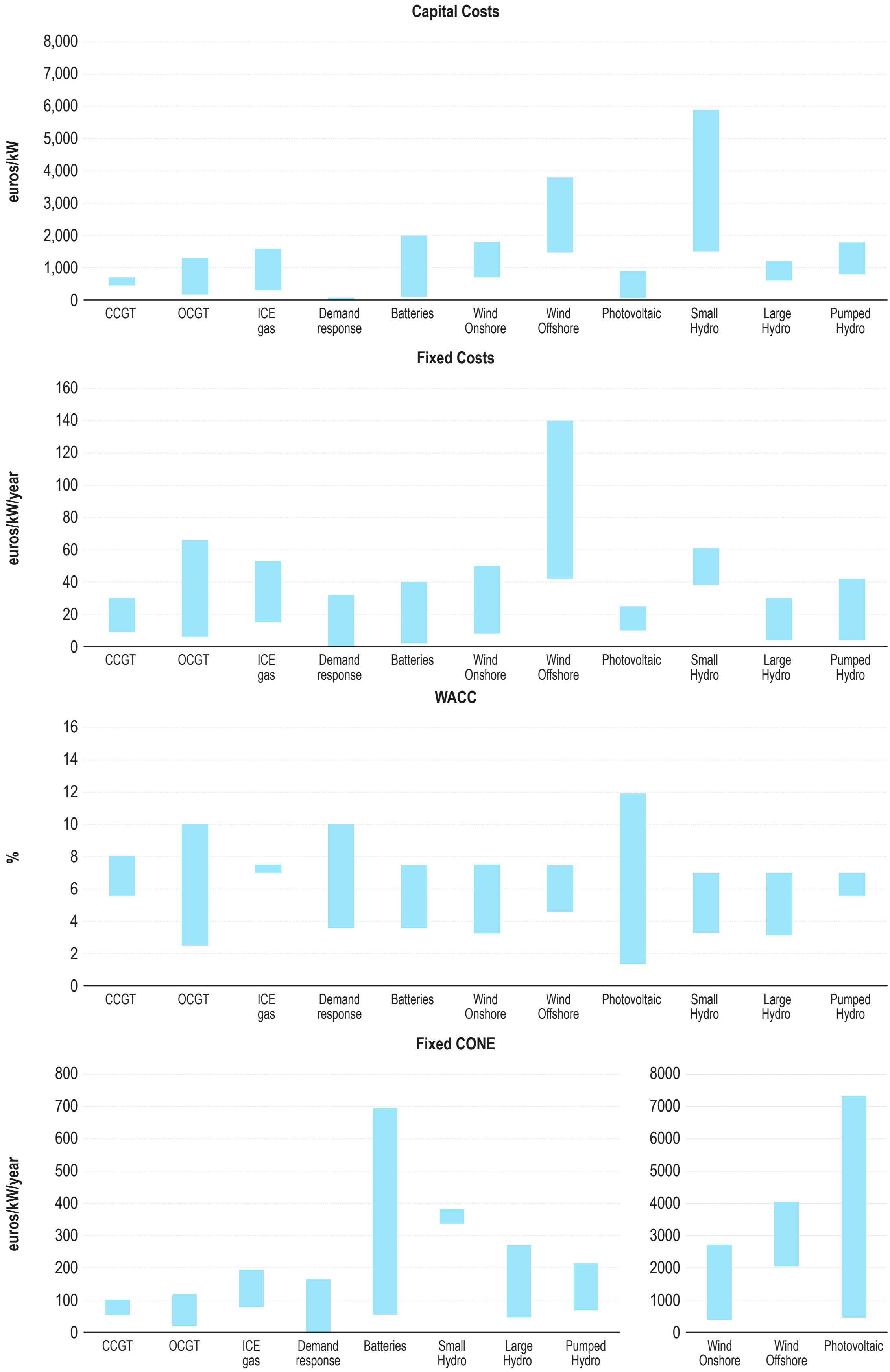
Source: ACER based on information from NRAs.

Note: Germany and Luxembourg proceeded with a common calculation of the single VOLL as they belong to the same bidding zone.

99 Figure 19 shows the range of the values of the main cost parameters used to calculate the fixed CONE (capital cost, annual fixed cost and the weighted cost of capital (WACC)[82]) for various technologies in the nine Member States that performed the calculations. It also depicts the range of the fixed CONE values. Evidently, demand response constitutes the cheapest choice overall and competes mainly with OCGT and CCGT units. Storage is still expensive, while renewable energy sources become expensive due to their low availability in times of expected scarcity.

82 For the definitions of these parameters see Article 2 of the VOLL/CONE/RS methodology.

Figure 19: Ranges of the capital cost, fixed cost and WACC for selected technologies considered in the CONE calculations – 2021 (euros/kW, euros/kW/year and % respectively)



Source: ACER based on NRA data.

Note: Data from Belgium, the Czech Republic, Finland, Greece, Italy, Slovenia and Sweden and the common German-Luxembourg calculation.

5.1.4 National resource adequacy assessments

Table 6: Competences for and status of the national resource adequacy assessments - 2021

Member State	Entity responsible for performing the NRAA	Entity responsible for approving the NRAA	NRAA implemented in 2021	Link to the published NRAA
AT	Government	Government	No	-
BE	TSO	No approval	Yes	-
BG	TSO	Government	No	-
CY	No information provided			
CZ	TSO	Government	Yes	Link
DE	NRA	Government	Ongoing	-
DK	TSO and Danish Energy Agency	Government	Yes	Link
EE	TSO	NRA	Yes	Link
ES	Government	Government	No	-
FI	NRA	NRA	Yes	Link
FR	TSO	No approval	Yes	Link
GR	TSO	No approval	Ongoing	-
HR	No information provided			
HU	TSO	NRA	No	Link
IE	No information provided			
IT	TSO	No approval	Yes	Link
LT	TSO	TSO	Ongoing	Link
LU	Government	Government	No	-
LV	No information provided			
NL	TSO	Government	Yes	Link
PL	Government	Government	Yes	Link
PT	Government	Government	Yes	Link
RO	Government and TSO	Government	No	-
SE	TSO	No approval	Yes	Link
SI	TSO	NRA	No	-
SK	TSO	Government	Ongoing	Link

Source: ACER based on information from NRAs.

Note: Cyprus is exempted from adequacy related provisions pursuant to Article 64(2) of the Electricity Regulation. In Latvia, there is no specific framework. ACER is aware that in Ireland the All-Island Generation Capacity Statement is produced by the TSOs, however information was not provided by the NRA via the MMR survey.

5.2 Capacity mechanisms

Table 7: Characteristics of existing capacity mechanisms in the EU – 2021

Member State	Type of CM[a]	State Aid approval	Start	End	Delivery period	Long-term contracts[b]	Eligibility		Auction lead time[c]	Frequency of auctions	Minimum bid size	Min. eligible capacity	Auction clearing method[d]	CO_2 limits[e]	Secondaty market	Cost recovery
							DSR, RES, Storage	Aggregators								
BE	MWCB	YES	2021	2031	1, 3, 8 or 15 years	YES	ALL	YES	T-1, T-4	annual	1 MW	1 MW	PAC	YES	YES	special levy
DE	SR	YES	2020	2025	2 years	NO	ALL[f]	DSR only	T-2, T-1	bi-annual	5 MW	5 MW	PAC	NO	NO	network tariffs
FI	SR	NO	2007	2022	3 winter months and 1 non winter	NO	DSR, RES	DSR only	T-1	every 4 years	10 MW	10 MW	PAC	NO	NAP	network tariffs
FR	MW-DCO	YES	2016	2026	15-25 days per year	YES (up to 7 years)	ALL	YES	T-4, T-3, T-2, T-1, T, T+1 and T+3	T-4 – annual, T-3 and T-2 four peryear, T-1 six per year	0.1 MW	0.1 MW	PAC	YES (only for new units)	YES	suppliers
I-SEM	MWCB	YES	2017	2027	annual	YES (up to 10 years)	ALL	YES	T-4, T-1	annual	NA[g]	No Data	PAC[h]	YES	No Data	suppliers
IT	MWCB	YES	2018	2028	annual[i]	YES (up to 15 years)	ALL	YES	T-4, T-3, T-2 and T-1 auctions possible	annual (two auctions in 2019 no auctions thereafter)	1 MW	1 MW	PAC	YES	YES	suppliers
PL	MWCB	YES	2018	2030	annual	YES (up to 17 years)	ALL	YES	T-5, T-1	T-5 annual, T-1 two/year	0.001 MW[j]	2 MW	PAC	YES	YES	network tariffs
SE	SR	NO	2003	2025	annual between 16 Nov to 15 Mar	NO	RES	YES	T-1	annual	5 MW	5 MW	PAC	NO	NO	BRPs

Source: ACER based on information from NRAs.

Explanatory notes: **a:** *The categorisation of the schemes is based on the taxonomy of the European Commission's sector inquiry. Abbreviations refer to strategic reserves (SR), targeted capacity payments (TCP), market wide central buyer (MWCB), market wide de-centralised capacity obligations (MW-DCO;* **b:** *Long-term contracts here mean contracts with a duration of more than three years;* **c:** *T refers to the delivery year the auctions are about;* **d:** *Auction clearing methods are pay-as-clear (PAC) and pay-as-bid (PAB);* **e:** *Relevant to Art. 22(4) of the Electricity Regulation;* **f:** *There are no legal restrictions for renewable energy sources (RES) participation, however, intermittent RES likely don't fulfil the technical requirements;* **g:** *In the I-SEM auctions, bids may consist of up to five quantity-price blocks with no minimum quantity size;* **h:** *If capacity is contracted to satisfy locational capacity constraints, then the offered price rather than the clearing price is given;* **i:** *RES and DR are obliged to be available during the peak hours of each working day, peak hours being the six hours with the highest load (they can change weekly);* **j:** *The minimum total net capacity for participation in the auction is 2 MW, however bid blocks may start from as low as 1 kW.*

Note: In France, a targeted capacity payment is also provided for the commissioning of a 442 MW CCGT plant in the Britany region following a State Aid approval by the European Commission (SA.40454 2015/C (ex 2015/N)). For the Italian CM auction, the pay-as-bid method is used in the cases capacity is cleared due to network constraints. In Portugal, a targeted capacity mechanism was introduced in 2017, and has been revoked since 2018, yet some capacity payments are provided to hydro power plants due to "legacy" contracts. In Spain, the capacity mechanism used to be comprised of "investment incentives" and "availability payments". Such availability payments were removed in June 2018, and the investment incentives payments still apply only to generation capacity installed before 2016.

5.3 Interruptibility schemes

Table 8: Interruptibility schemes summary table – 2021

Member state	Purpose	Product/ Programme	Activation criteria	Procurement	Remuneration	Total Contracted Capacity (MW)	Minimum Eligible Capacity (MW)	Aggregation	Availability	Maximum length/ number of interruptions	Number of participants	Status
DE	Adequacy/Balancing Reserves/Congestion Management/ Contingency Reserves	Immediately interruptible load	within 1 s at 49.7 Hz	Auction	Availability & Energy (pay-as-bid)	750	5	YES	Whole week except 120 quarters of an hour per week	1 to 32 quarters of an hour/week Min. 16 quarters of an hour a week	10	Expired Jul-22, renewal under consideration
		Quickly interruptible load	within 15 min			750						
FR	Contingency Reserves	Lot 1	Automatic activation upon frequency drop (49.82 Hz for 3 s).	Tender	Availability (pay-as-bid)	1301	25	NO	Availability at least 7500 hours / year	Activation in 5 sec., max 5 activations per year	16	In place since July 1, 2016. Changes in 2021.
GR	Adequacy	Product 1	Within 1 min	Auction	Availability (pay-as-clear)	400	2	NO	24 hours/day	Max 5 power reduction orders/month, max 36 hours/year	37	Expired Sep-21
		Product 2	Within 5 min			400				Max 3 power reduction orders/month, max 288 hours/year		
IT	Contingency Reserves	Mainland	Automatic within 200 ms at 49.8 Hz or upon TSO instruction	Auction	Availability (pay-as-clear) Energy (pay-as-bid)	4425	1	NO	24 hours/day	No maximum duration of interruptions / No max number of interruptions	190	Start of the scheme in 2004, approval by NRA every 3 years. Next approval in 2022.
		Islands of Sardinia and Sicily										
PL	Adequacy	IRP (Interventional Power Reduction)	Duration of reduction period from 1 to 15 hours within the range of 7:00 a.m. to 10:00 p.m.	Public tender with a price cap	Energy (bids optimised with algorithm)	Capacity becomes known to the TSO after a request for biding	Min. 1 Max. 100	YES	Request on previous day before 11:30 AM	voluntary response, no limit	5 (including aggregators)	New scheme since Apr-21, planed until March 31, 2022.
PT	Adequacy, Contingency Reserves	5 product types with different activation characteristics, i.e., from automatic activation to 2 hours pre-notification	Automatic at 49.2 Hz or pre-notification from 5 min to 2 hours depending on the product	Registry	Availability (Administrative price)	655.5	4	NO	24 hours/day	Max 12 / 8 / 3 / 2 / 1 hours at once, depending on the product, Max total 120 hours/year, max once a day and 5 times per week	46	Expired Dec-21

Source: ACER based on information from NRAs and, in case of France, by the French TSO.

Note: Contingency reserves refer to a service where interruptible demand with fast response capabilities is aimed at coping with unexpected events in near real-time. It is normally automatically activated at predefined frequency thresholds below normal operation.

5.4 List of acronyms

Acronym	Meaning
ACER	European Agency for the Cooperation of Energy Regulators
ARENH	Accès Régulé à l'Electricité Nucléaire Historique
BRP	Balancing responsible party
CCGT	Combined cycle gas turbine
CEEAG	Guidelines on State aid for climate, environmental protection and energy
CEP	Clean energy for all Europeans package
CM	Capacity mechanism
CONE	Cost of new entry
CORP	Cost of renewal and prolongation
D-1	Day ahead
DA	Day ahead
DR	Demand response
DSR	Demand side response
EC	European Commission
ENS	Energy not served
ENTSO-E	European network of transmission system operators for electricity
ENTSOG	European network of transmission system operators for gas
ERAA	European resource adequacy assessment
EU	European Union
EUE	Expected unserved energy
GW	Gigawatt
GWh	Gigawatt hours
Hz	Hertz
ICE	Internal combustion engine
ICJ	International Court of Justice
ICS	Incident classification scale
I-SEM	Irish Single Energy Market
LOLE	Loss of load expected
LOLP	Loss of load probability
MMR	Market monitoring report
ms	milliseconds
MW	Megawatt
MWCB	Market wide central buyer
MW-DCO	Market wide de-centralised capacity obligation
MWh	Megawatt hour
NRAA	National resource adequacy assessment
OCGT	Open cycle gas turbine
OM	Outage minutes
PAC	Pay-as-clear
PSE	Polskie Sieci Elektroenergetyczne (Polish TSO)
RCCs	Regional coordination centre
RES	Renewable energy source
RS	Reliability standard
SAI	System adequacy index
SME	Small and medium sized enterprises
SR	Strategic reserves
STA	Short-term adequacy assessment
STSAA	Short-term and seasonal adequacy assessments
TSO	Transmission system operator
UK	United Kingdom
UNSCR	United Nations Security Council Resolution
VOLL	Value of lost load
WACC	Weighted cost of capital
WtA	Willingness to accept
WtP	Willingness to pay
NRA	National regulatory authority