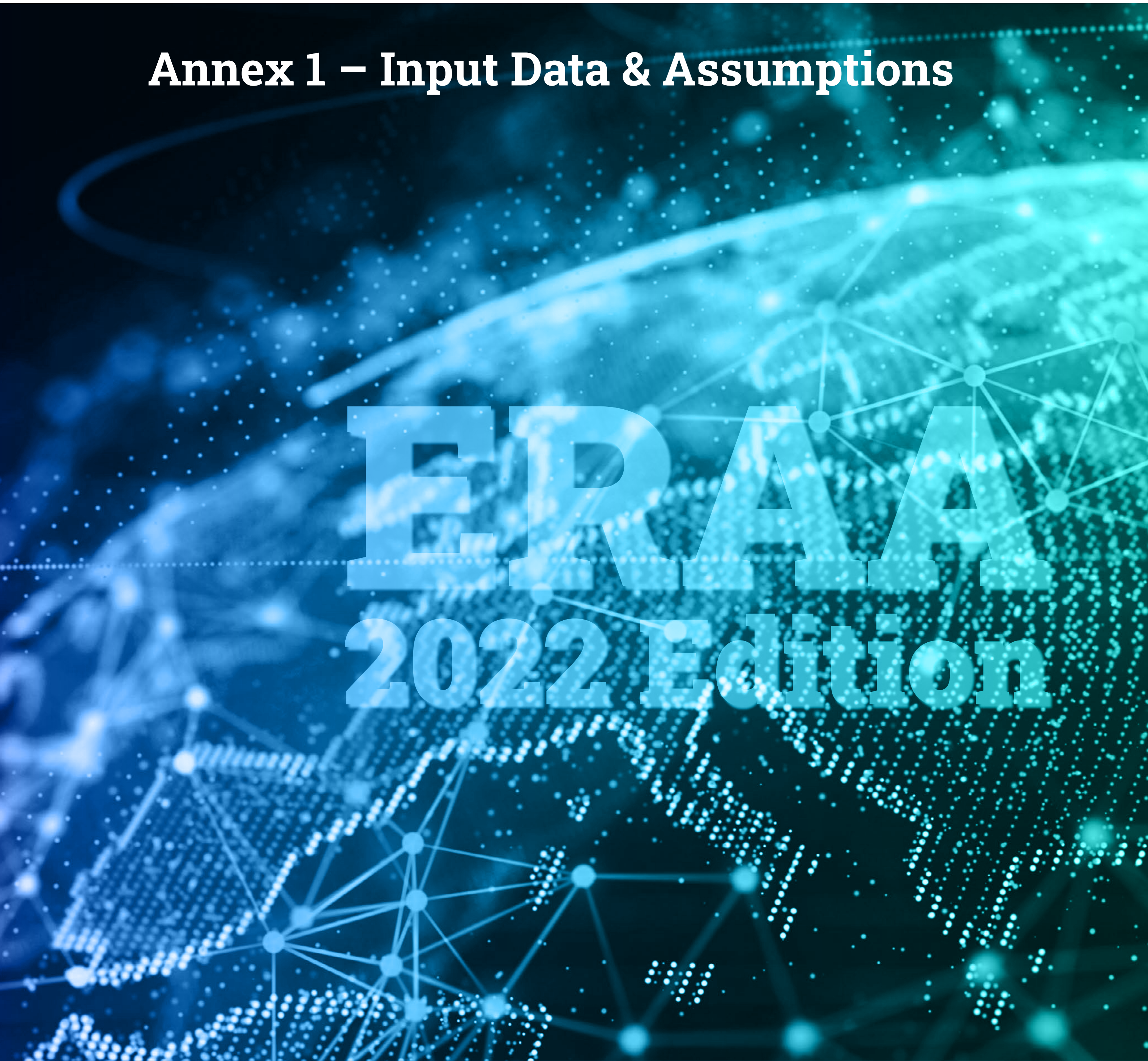
European Resource Adequacy Assessment

2022 Edition

Annex 1 – Input Data & Assumptions



entsoe

Table of Contents

1 ERAA 2022 Scenarios

1.1 Scenario description

The starting point for a probabilistic adequacy assessment such as the present one is the definition of the study scenarios. The European Resource Adequacy Assessment (ERAA) scenarios build on the most up-to-date expectations of the selected target years, guided by policy frameworks and stakeholders' expert views. ENTSO-E carries out an extensive data collection exercise, during which Transmission System Operators (TSOs) provide their views and estimations of the trajectories of demand, resource capacities and grid elements. The input data gathered from TSOs, referred to as the National Estimates Scenarios, constitute ENTSO-E's Pan-European Market Modelling Database (PEMMDB). The data collection for the ERAA 2022 began in autumn 2021 and ENTSO-E provided guidance to TSOs on the assumptions for each scenario as well as the data required to ensure a common understanding of all underlying assumptions, targeting a consistent data set among all modelled zones. Quality checks and reviews were carried out continuously throughout this process, with updates being integrated into the assessment until the launching of the study's main simulations in spring 2022. Impacts of the latest country-specific updates that could not be accounted for is discussed – when relevant – in the Annex 4.

A pan-European study naturally requires an extensive amount of input data, which is usually calculated by respective TSOs, but also centrally by ENTSO-E, and which is based on national policies and trends. Data collection assumptions can be found in the ERAA 2022 website. The National Estimates Scenarios of the ERAA 2022 are mainly based on the National Energy and Climate Plans available at the time of the data collection and, wherever possible, reflect the ambitions of the Fit for 55 package (FF55). For more information on the drivers of the National Estimates scenarios, please see the detailed TSO survey in the next section.

The ERAA methodology defines two Central Reference Scenarios:

1. **Central Reference Scenario Without Capacity Mechanism (CM)**: This scenario spans the 2024–2030 time horizon. It is based on the National Estimates Scenario and is updated through the application of the Economic Viability Assessment (EVA). The scenario without CMs still *accounts for CMs that already hold a CM contract* granted in any previous auction of any existing or approved CM at the time of the assessment.

2. **Central Reference Scenario With CM**: This scenario is, in principle, based on the National Estimate Scenario and is updated through the application of the EVA considering countries with approved CMs that meet their reliability standards.

ERAA 2022 does not include the Central Reference Scenario With CM, which, regrettably, could not be incorporated into the report due to increased computational complexity and important time constraints. ERAA is still in the implementation phase, and ENTSO-E is committed in its continued efforts to deliver both Central Reference Scenarios in future editions.

More details on the methodology used to implement the EVA and the adequacy assessment for both Central Reference Scenarios can be found in Annex 2.

1.2 TSO Survey on the scenario drivers

Eight scenario elements deserve an elaborate description of the different view of TSOs and their impact on the ERAA 2022, namely: compliance with FF55, capacity projections, demand forecasts, interconnection data, efficiency, the consideration of 'Recovery and Resilience Facility', out-of-market measures available to TSOs, the latest market reforms in each country, and the evolution of trajectories and potential impact on adequacy. The sections below summarise TSOs' views on the aforementioned topics. The interested reader can consult Appendix 1 for detailed TSO feedback.

1.2.1 Compliance with Fit for 55 (FF55)

According to the TSO survey, 18 out of the 24 TSOs submitted data for the National Estimates Scenarios that are considered to be either partially or fully compliant with FF55. For most TSOs that submitted 'partially compliant' data, the data provided are in line with the NECP, which has not been reviewed at the time of the data collection to consider the FF55 objectives. Although several TSOs affirm that their submitted data are in line with FF55, no detailed assessment was conducted. A few TSOs submitted data presumed to be non-FF55-compliant; this is because objectives at the national level had not yet integrated FF55 purposes at the time of data collection.

1.2.2 Capacity data drivers

1.2.2.1 Conventional generation data drivers

For most TSOs, either FF55 or NECP is the primary driver for the data related to conventional generation. Some Member States have updated the NECP based on more recent inputs coming from stakeholders and market parties. Other drivers usually refer to TSOs' best estimates, input from the market participants, national laws or the national TYNDP.

1.2.2.2 RES data drivers

Most TSOs have provided RES data that are primarily driven by either NECP or the FF55. When FF55 is the driver, it's mostly the NECP that is being updated to integrate FF55 objectives but which has not yet been approved. For NECP, updates have been brought to the NECP based on the latest market data and/or TSO best estimates. Other drivers usually refer either to corrected NECP with investment plans or used data from market parties directly.

1.2.3 Demand data drivers

The main drivers of demand-data reshaping are energy efficiency, electrification and an increase of the data centre consumptions. Twelve TSOs have submitted data that are primarily driven by the NECP; five are primarily driven by FF55. In other cases, TSOs usually refer to national studies and national resources adequacy assessments. Prior demand figures are often updated to consider GDP increases.

1.2.4 Interconnections

1.2.4.1 Fulfilment of the 70% cross-border capacity rule

Article 16 (8) of the Electricity Regulation sets a minimum threshold of 70% for cross-border capacity to be available for market participants. This relates to both Net Transfer Capacities (NTCs) and Flow-Based (FB) parameters. For regions with an FB approach already implemented, it builds on a minimum Remaining Available Margin (minRAM) requirement. Compliance with the requirement is assessed by the NRA of each Member State.

The 70% requirement is currently not applicable between EU and non-EU borders or between non-EU borders (e.g. Albania, Bosnia and Herzegovina, Serbia). For borders between EU members and non-EU members, the inclusion of third-country flows on the 70% RAM depends on the existence of an agreement between the Capacity Calculation Region and the third country that shall also cover other topics, such as the cost-sharing of remedial actions. For the purpose of this exercise, third-country flows are included in the 70% minRAM.

Regarding the FB market coupling geographical areas, the 70% requirement is integrated into the calculation of the FB domains, ensuring that all EU–EU borders modelled with FB comply with a 70% minRAM (see Annex 2, section 4). In contrast, NTC values are collected from TSOs; thus, provision of compliant assumptions depends on the border. For more information on the border per border compliance, c.f. Appendix 8.

1.2.4.2 Primary drivers for interconnection data

The submission of interconnection data is driven by a combination of the 70% requirements, FF55, National Development Plans, or delays in projects of new capacity calculation methodologies. Most NTC values are coordinated between neighbours. Note that the final value for each interconnector shall account for the feedback of both relevant TSOs, which in principle should be coordinated. In the absence of an agreed value, the most conservative view is adopted for the study.

1.2.5 Efficiency

The large majority of TSO anticipate a reduction of emissions through an increase in efficiency by heating technologies. Member States intending to reduce emissions through an increase in efficiency mainly do so based on regulation and subsidies to electrify heating by installing heat pumps. Other technologies sometimes mentioned by TSOs include district heating system, insulation of houses and cogeneration.

Most TSOs mention that an improvement of building insulation is foreseen to increase energy efficiency. Key drivers for improving building insulation are the policies defined by governments and subsidies set up to support insulation. Notably, Norway and the Netherlands plan to update their law/building code to include more stringent requirements.

Almost all Member States expect the electrification of transport to reduce emissions. For most, EV adoption is the key driver to electrify transport, often introducing subsidies for EV or deploying charging infrastructure to remove the barriers. Some Member States focus on rail transport (e.g. Greece, Spain) or by improving public transportation (e.g. Lithuania, Hungary).

Numerous TSOs expect to reduce emissions by reducing the temperature dependent load, although many others see no such plans in their respective countries. Remaining TSOs mentioned a lack of information or of specific targets related to this. This question is strongly linked to insulation and heating upgrades for TSOs.

1.2.6 Consideration of ‘Recovery and Resilience Facility’ programme

Few TSOs confirmed that their submission accounts for the Recovery and Resilience Facility.

1.2.7 Out-of-Market Measures

This chapter provides a systematic characterisation of out-of-market measures as provided by TSOs (e.g. those that are characterised ‘out-of-market’ or have not been considered available for adequacy purposes). In addition, a quantification of out-of-market measures that could address adequacy crises (e.g. a reduction of demand through voltage reduction), without necessarily modelling all of them, is also reported.

Most TSOs that have out-of-market measures to deal with shortages use active power reserves (predominantly FCR and FRR) as out-of-market measures. DSR and voltage reduction as well as strategic reserves are also mentioned regularly by TSOs. Other out-of-market measures include market suspension and restoration rules (Spain), emergency contracts with TSOs (France), and national safeguard regulation (Romania). Lastly, Elering operates an emergency power plant in Estonia.

In general, frequency reserves (FCR, FRR) and voltage control are operational measures and as such are not considered for solving adequacy issues in the future. Albania mentioned that the indicated FCR and FRR capacity reserves contribute to the system adequacy. Capacity reserves in Germany are activated based on DA and/or ID prices (3000 €/MWh for DA and 9999.99 €/MWh for ID).

The Central Reference Scenario Without CMs still *accounts for CMs that already hold a CM contract* granted in any previous auction of any existing or approved CM at the time of the assessment. This includes strategic reserves and is relevant for Poland and Sweden in Target Year 2025 in ERAA 2022.

For a detailed table on out-of-market measures per country or zones, please c.f. section 8.1.9.

1.2.8 Market Reforms

Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Most of these reforms are captured through the collected input data. TSOs provided their feedback on whether their country was initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing) and how these were considered when providing the ERAA input data (see Appendix 1). TSOs also commented on the market reform plans that have not been considered, providing proper justification for their exclusion.

Most Member States/TSOs have no plan for potential market reform; some Member States consider that this question is not applicable to their context (e.g. Norway, Luxembourg, the Czech Republic, Slovenia). For some TSOs, Article 20(3) of the Electricity Regulation does not apply, whereas for others, no market reforms are deemed necessary because recent pan-European resource adequacy assessments have not yet indicated any adequacy issues (e.g. Slovakia).

Other Member States expect to carry out a number of market reforms in the coming years, and are still assessing which measures would be applied as well as to what extent – and in what ways – their execution will affect the market situation (e.g. Finland). Examples include pricing reforms and price caps.

Finally, some Member States report that market reforms were either already included in the data collected for the ERAA or will not significantly affect them (e.g. Italy, Spain).

1.2.8.1 Measures related to interconnection capacity

Slovakia will remove market barriers in the day-ahead and intraday timeframe by joining the 4M Market Coupling (4M MC) Member States, interconnecting with the Europe-wide Multi-Regional Coupling (MRC), integrating wholesale markets, and increasing interconnection capacity with Hungary. Italy, for its part, will increase interconnection capacity.

1.2.8.2 Measures related to balancing energy and the procurement of balancing and ancillary services

The Finnish TSO expects significant market reforms in upcoming years as a consequence of an EU-wide harmonised balancing market, imbalance settlement, and requirements for the procurement of reactive power. The latter reforms are driven by the Nordic Balancing Model programme and are relevant for the countries of the Nordic region. Market reforms in Italy will enable self-generation, energy storage and demand-side measures. In Spain, demand-side facilities and storage facilities have been able to participate in balancing services since January 2020 and begin participating in the redispatch market in 2022. The participation of independent aggregators in the markets is also foreseen for 2022. Sweden will transition to a 15-minute imbalance settlement period in 2024.

For a detailed table on the market reforms per country or zone, please c.f. section 8.1.8 at the end of this document.

1.2.9 Drivers of evolution

ERAA 2022 focuses on three target years (TYs) for the adequacy assessment. Therefore, a qualitative understanding of the key capacity and energy-mix evolution drivers (policy or otherwise) for the coming decade can provide valuable insight. Important drivers can be plans for coal phase-out, RES deployment targets, demand-side response (DSR) deployment, battery deployment, etc. Country energy-mix trajectories are generally in line with national development plans, national studies, and national energy and climate plans (NECP). Where NECPs are not yet available, TSO estimates were used.

2 Inelastic demand profiles

In the context of the ERAA 2022, inelastic demand (or 'load') is active power required by any end user installation/appliance connected to the grid that may not be moved to another point in time by price incentives such as DSR, but may be curtailed. For more details on demand, please refer to the demand methodology (published on the ERAA 2022 downloads section). Electric vehicles, heat pumps and household batteries are considered partly inelastic and partly elastic in the ERAA 2022. The inflexible parts are thus included in the demand profiles.

High demand levels – especially peak demand levels – usually coincide with moments of scarcity/ adequacy risk. Figure 1 illustrates the distribution of the yearly demand (YD) (top left) and peak demand values (bottom left) of the ERAA explicit region for each CY (35 dots) and TY. In addition, the pie chart on the right shows the countries with the largest YD averaged across CYs and TYs.

The demand profiles generated for the TYs combine historical data from 2016–2019, and are forecasted based on the climate years from 1982–2016 (c.f. demand methodology).

The figure shows a clear increase of both YD and PD levels throughout the TYs in the ERAA explicit region with a clear dependence on CYs. As shown in the bar plots, Germany (DE), France (FR) and Türkiye (TR) are amongst the countries with the highest average YD.

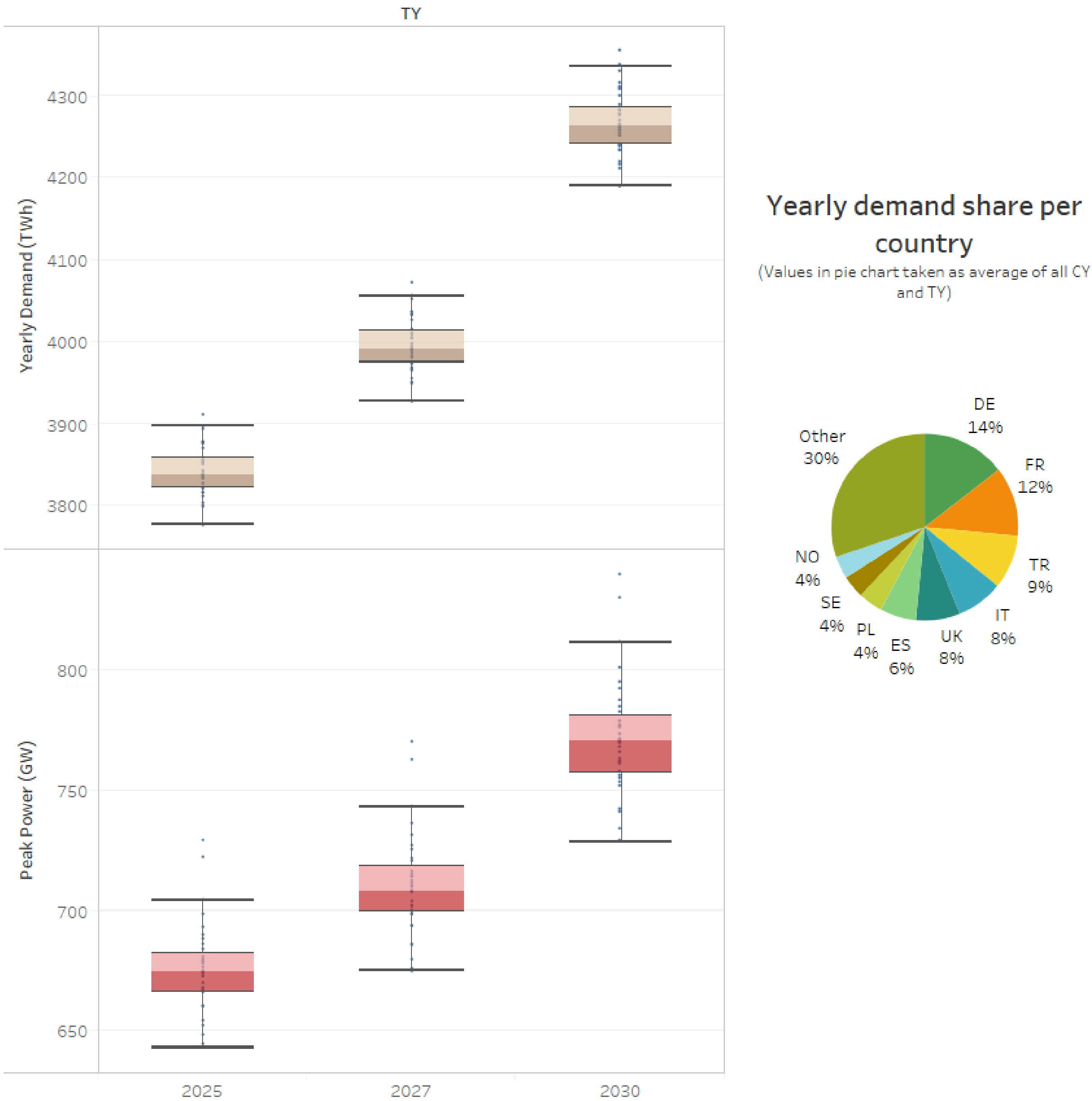


Figure 1: Yearly demand [TWh] and peak demand [GW]

3 Climate data

Climate data is a pivotal dataset for any power system assessment. Because the European power system is highly interconnected – which means the situation in one region can influence neighbouring regions – it is necessary to have a comprehensive dataset describing possible operational conditions across Europe at different hours of the year, and in different areas. First, this dataset must be sufficiently granular, both spatially (e.g. pan-European average temperature is not suitable for all Bidding Zones individually) and temporally (e.g. annual average temperature is not suitable to represent different seasons). Furthermore, the climate data as a whole must represent a coherent set[1], ensuring that it represents reasonable situations in space (e.g. the temperatures in neighbouring Bidding Zones should be similar) and in time (e.g. temperature does not change drastically from one hour to another). The Pan-European Climate Database (PECD) was developed to meet these requirements and was used in the ERAA 2022 assessment. The PECD is based on historical reanalysis data, for which possible operational conditions are based on past weather conditions and should be considered as a collection of weather variables or energy variables derived from weather variables.

Figure 2 shows the available yearly RES energy in the ERAA explicit region that can be injected into the grid for all CYs and TYs, provided there is sufficient demand (left side). The pie charts on the right show the countries and technologies with the highest shares of available RES energy averaged across CYs and TYs. The available energy is calculated based on the installed capacities of the reported technologies as well as wind & solar load factor profiles. Consequently, for a given TY, an increase in installed capacity would increase the available energy proportionally while keeping the load factors unchanged. Because these technologies do not assume any energy storage, if specific hours' demand is too low to absorb a portion of the available energy, the available energy will be curtailed.

As suggested by the figure, the available RES energy is forecasted to increase significantly under each CY throughout the TYs. The figure also suggests a clear dependence on CYs. Germany (DE), the United Kingdom (UK) and Spain (ES) are forecasted to have the largest shares of averaged available RES energy, while the technology expected to play the most significant role is onshore wind.

[1] Often referred to as 'spatial and temporal correlation'.

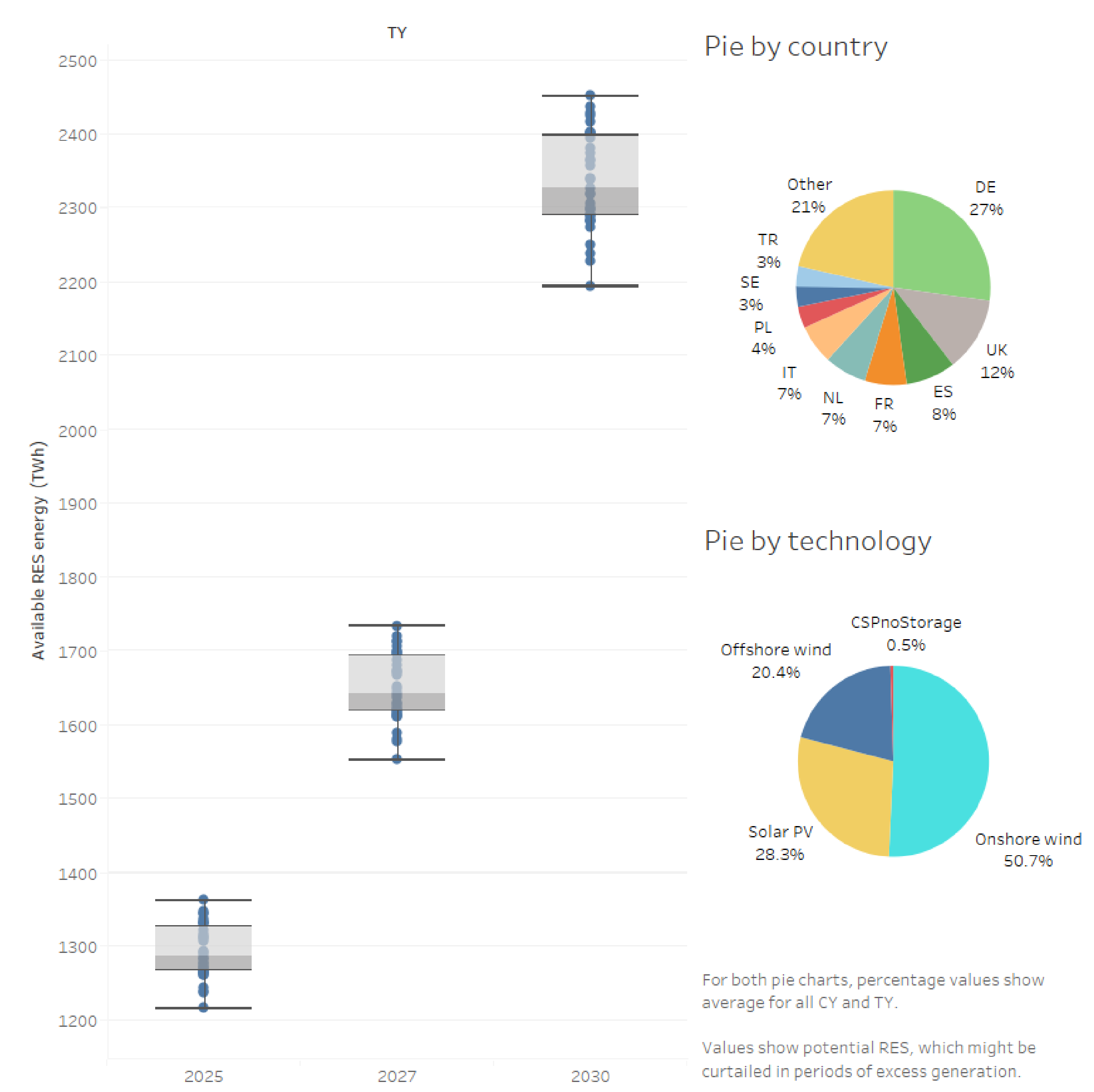


Figure 2: Yearly available RES energy [TWh] and distribution across countries and technologies

Similarly, Figure 3 shows the yearly energy content of water inflows in the ERAA explicit region (either injected into the grid or stored) for all CYs and TYs. The pie charts on the right show the countries and technologies with the highest shares of available RES energy averaged across CYs and TYs. Contrary to wind or solar technologies, an increase in installed hydro turbining capacity would increase the available energy only if associated with a new water catchment. The load factor is defined as the water inflow summed to the difference in reservoir levels between the beginning and end of the year over the energy produced under nominal turbining assumptions over the year. The figure shows the hydro categories run-of-river (RoR) and pondage, traditional reservoir and open pumped storage plant (Open PSP).

As suggested by the figure, the yearly hydro inflow is forecasted to increase under each CY throughout the TYs. The figure also suggests a clear dependence on CYs. Norway (NO), Sweden (SE) and Türkiye (TR) are forecasted to have the largest shares of averaged yearly hydro inflow, while the technology expected to play the most significant role is the traditional reservoirs.

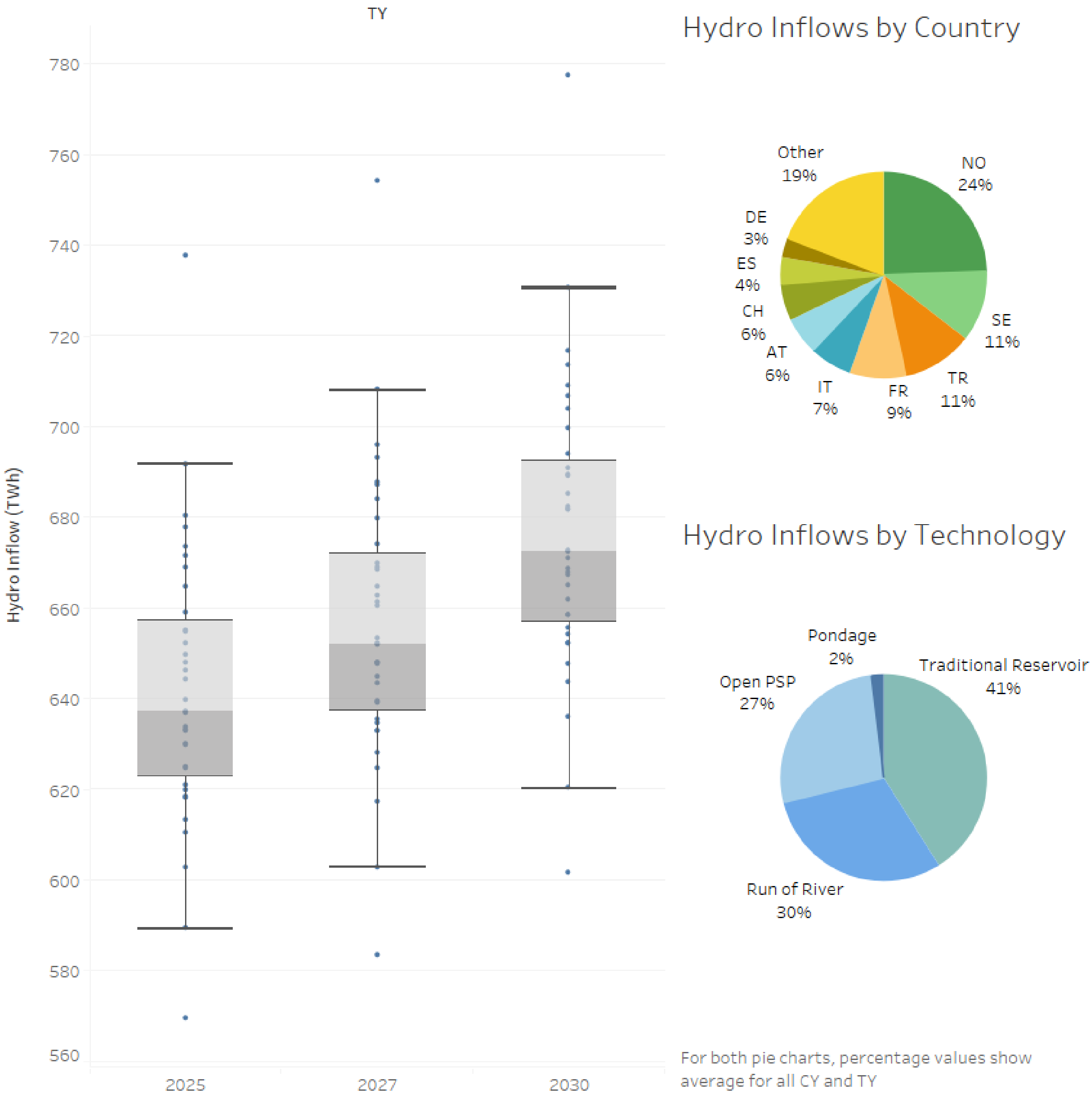


Figure 3: Yearly available hydro inflows [TWh] and distribution across countries and technologies

4 Resource capacities of National Estimates Scenario

As described in section 1.1, the National Estimates Scenario is the starting point for the Central Reference Scenario Without CM on which the EVA is applied. The EVA modifies the resource capacities between scenarios while the rest of the assumptions under the National Estimates Scenario remain applicable.

In the context of the ERAA 2022, a market resource (also called 'resource' for simplicity) is a market-participating unit that may be scheduled to meet demand at any point in time. Market resources include technologies that inject power into the grid as well as technologies that reduce or shift the demand to be met, such as DSR (only load-reducing DSR is accounted for in ERAA 2022).

The table below details the technology aggregations used in the figures of this section.

Table 1: Technology aggregations and classification used in installed capacity figures

Technology aggregation	Underlying technologies
Hydro	RoR & Pondage, Traditional reservoir, Open PSP, Closed PSP
Other RES	Geothermal, Marine, Small biomass, Waste
Solar	PV, CSP
Wind	Onshore wind, Offshore wind
Coal	Hard coal, Lignite
Gas	Conventional, OCGT, CCGT
Nuclear	N.A.
Other non-RES	Heavy oil, Light oil, Shale oil, Other
DSR – Explicit	N.A.
Battery	N.A.

4.1 Resource capacities for National Estimates Scenario

Figure 4 shows the resource capacities (net generation capacity and DSR) by technology aggregated for the ERAA explicit region for each TY (left part). The right side of the figure shows the countries with the highest shares of resource capacities averaged across all TYs. The figure accounts for capacities that are available in the market for at least 1 day during each TY.

As suggested by the figure, total resource capacities increase throughout the TYs. The technologies with the largest capacity increases are solar and wind. Germany (DE), France (FR), Italy (IT) and the United Kingdom (UK) are forecasted to have the largest shares of averaged resource capacities. The column labelled '2022 – SO values' refers to the installed capacities used in the Seasonal Outlook 2022 published by ENTSO-E.

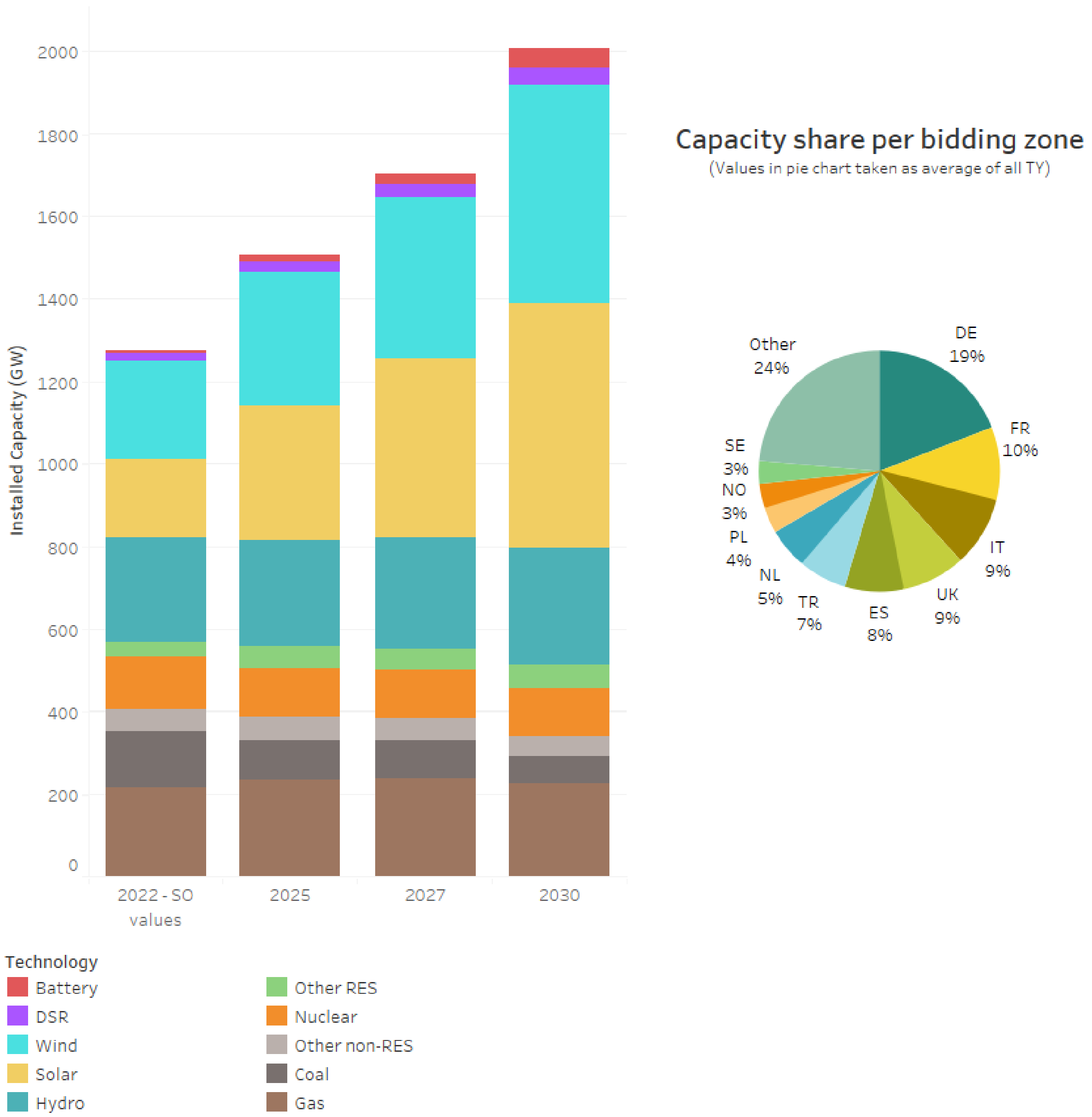


Figure 4: Resource capacity [MW] and distribution across countries

4.2 Storage capacities

Figure 5 shows the storage capacities by technology for each TY aggregated on the ERAA explicit region (left part). The right side of the figure shows the countries with the highest shares of storage capacities averaged across all TYs. The figure accounts for capacities that are available in the market for at least 1 day during each TY.

The vast majority of the total storage capacity in the ERAA's explicit scope is composed of hydro technologies and, more precisely, traditional reservoirs and open PSPs – whereas closed PSPs, pondage and batteries represent only a small proportion of the overall storage capacity. Türkiye (TR), Norway (NO) and Sweden (SE) are forecasted to have the largest shares of averaged storage capacities.

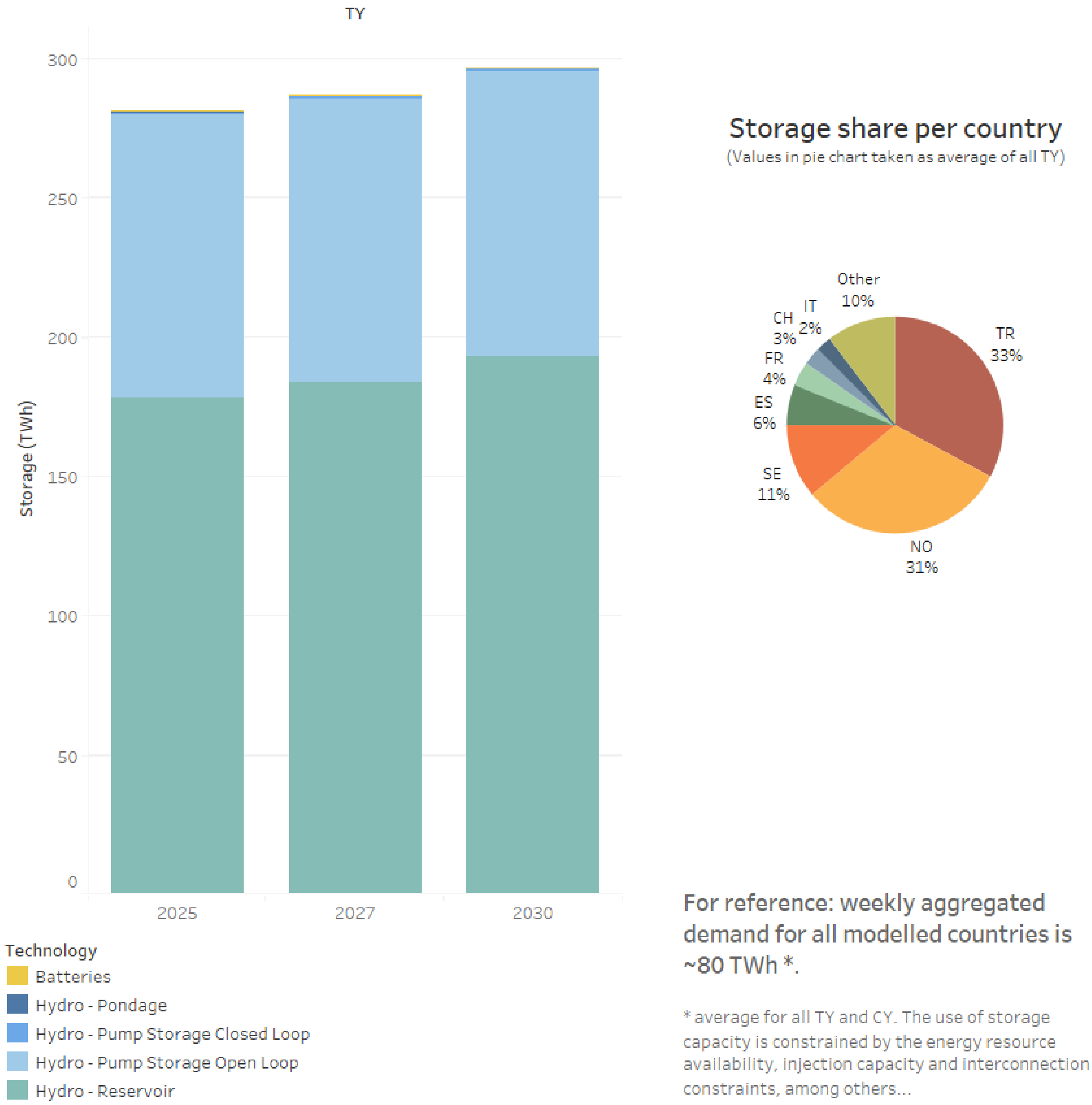


Figure 5: Storage capacity [TWh] and distribution across countries

4.3 Reserve requirements in all scenarios

Some FCR and FRR contracts have already been awarded, while others will be awarded in future auctions to satisfy Member State reserve requirements. Awarded/known capacities are deducted from the net generating capacities (NGCs) of thermal generation units or from DSR units as reported by TSOs. The remaining capacity must be accounted for by withholding thermal capacities from the wholesale market and/or by decreasing available hydro turbining capacity (see Annex 2).

Figure 6 illustrates the FRR and FCR requirements of the entire system for all TYs as well as the amount of the requirement accounted for by each method. Lastly, the black dots indicate the amount of awarded reserves and are consequently not explicitly modelled by either of the two methods.

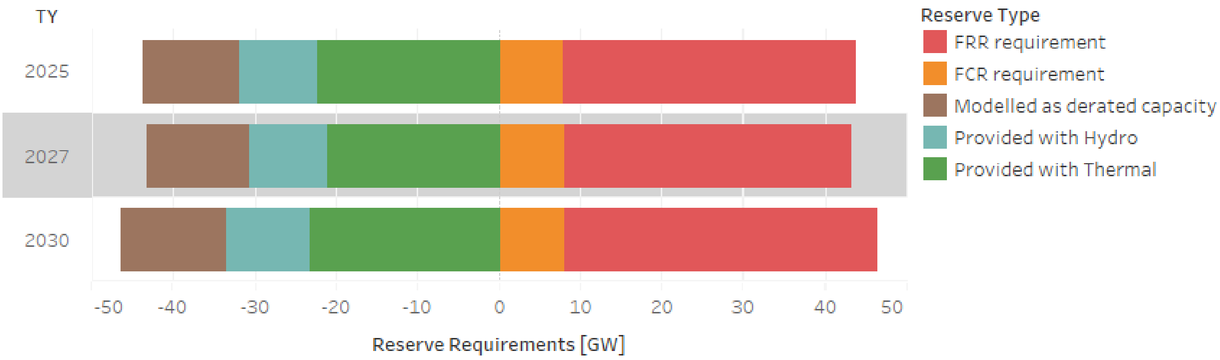


Figure 6: Reserve requirements [GW] for TY 2025, 2027 and 2030

As illustrated in the figure, FRR (larger portion) and FCR are either increasing or remaining steady throughout the TYs. The same can be observed for the reserves provided by thermal (larger portion) and hydro. The figure also indicated that the awarded capacity is higher for later TYs.

4.4 Planned maintenance

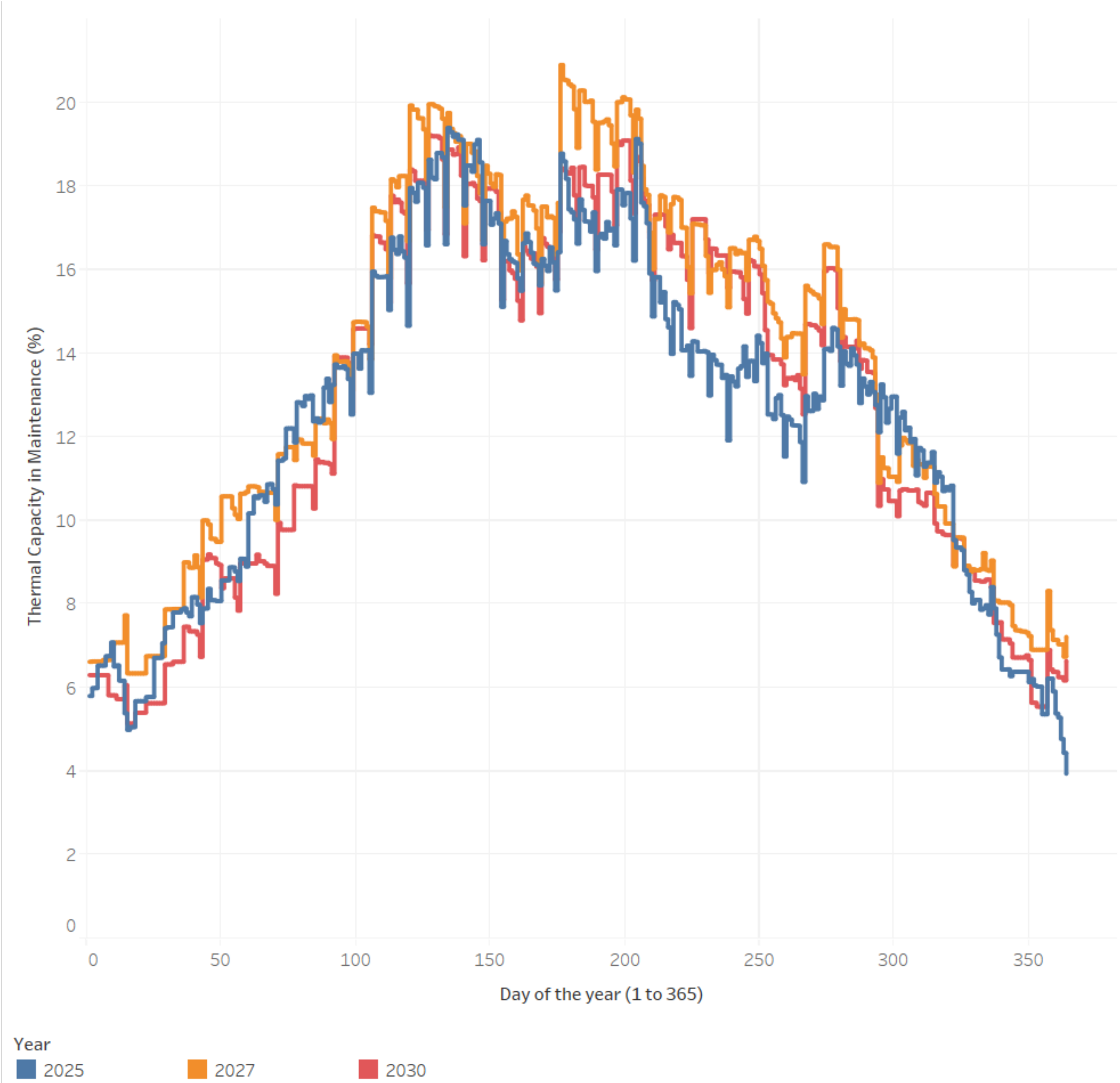


Figure 7: Pan-EU thermal capacity maintenance ratio

4.5 Forced outage rates

As described in Annex 2, ERAA 2022 models forced outages only for thermal assets (also called unplanned outages); RES generation profiles are considered to already account for outages. By nature, outages are random and can take units out of the market at any moment. As illustrated in Table 2, the ratios are very specific to the fuel types, and their distribution remains quite similar across the TYs. Gas and nuclear technologies show the lowest ratios on average, with a ratio around 5%. Coal technologies are slightly more subject to forced outages on average, with a ratio around 7%. Other non-RES are the technologies with the highest forced outage ratios, at around 11%.

Table 2: 10th and 90th percentiles and average of forced outage ratios (%) per TY and generation technology aggregation type

TY	Coal			Gas			Nuclear			Other non-RES		
	10th	90th	Avg	10th	90th	Avg	10th	90th	Avg	10th	90th	Avg
2025	2.1	10	7.7	5	8	5.8	2	5.3	4.6	7.5	12	11.2
2027	2.1	10	7.4	5	8	5.8	2	5.3	4.8	7.5	12	11.2
2030	1.4	10	7	5	8	5.7	2	5.3	4.8	7.5	12	11.3

5 Network inputs

5.1 Net import/export capacities

NTC values represent the theoretical maximum commercial flows between two Member States in one of the two directions and under specific conditions. Figure 8 illustrates the average import and export NTCs per country and TY in the ERAA explicit region.

As suggested by the figure, the maximum net import and export capacities increase in most countries throughout the TYs. The countries with the highest import and export NTC capacities are as follows.

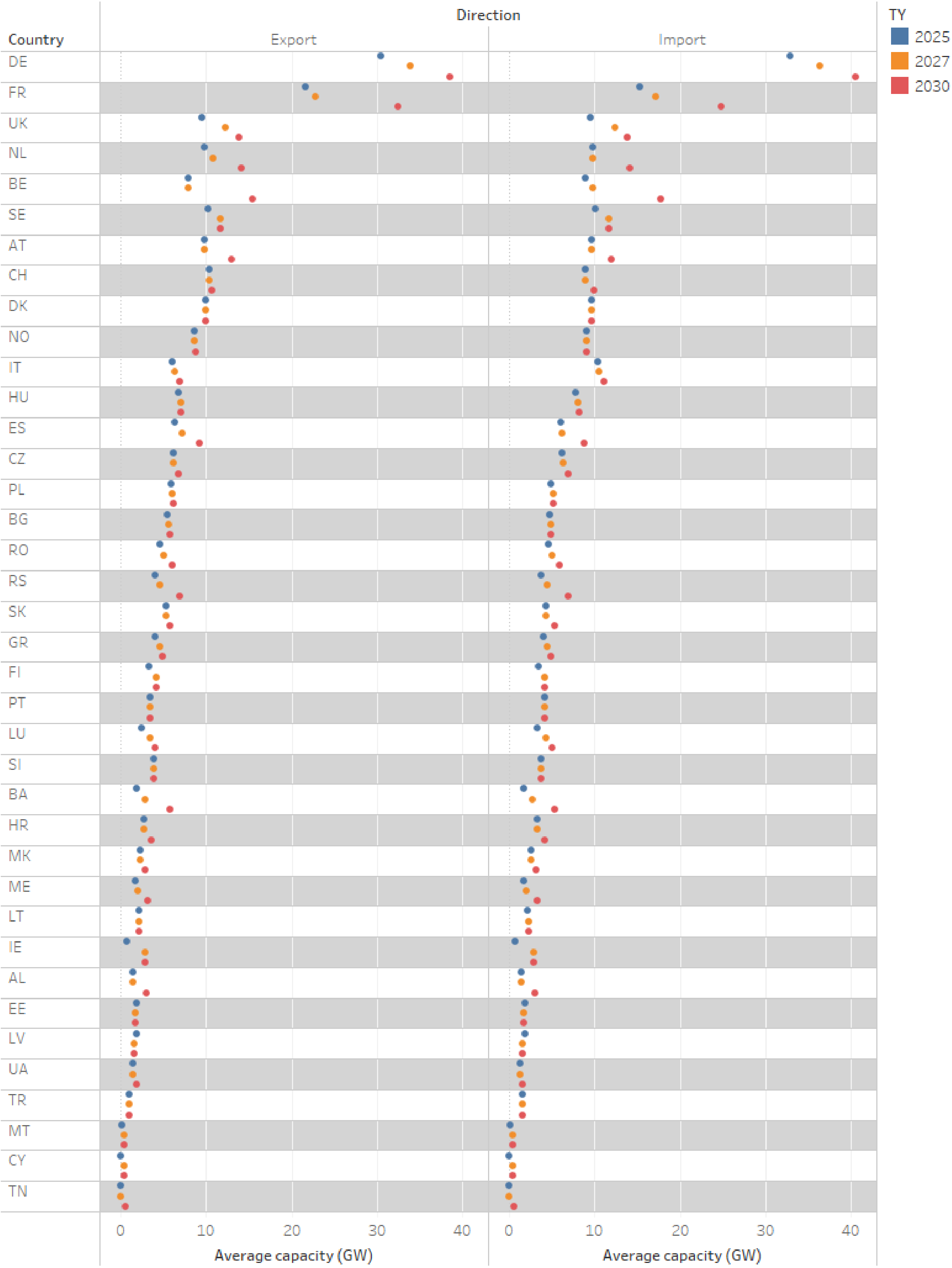


Figure 8: Maximum net import and export capacity [GW] by country for each TY

5.2 Exchanges with implicit regions

As described in section 1 of the Executive Report, the regions modelled implicitly are accounted for thanks to fixed exchanges with countries within the ERAA explicit region. Figure 9 illustrates the aforementioned hourly exchanges per border. Following the Russia–Ukraine conflict, all exchanges with Russia (RU - including Kaliningrad) are set to zero for all concerned neighbouring countries of the ERAA modelled area. Sicily (ITSI) and Tunisia (TN00) are expected to exchange energy following the commissioning of an interconnector.

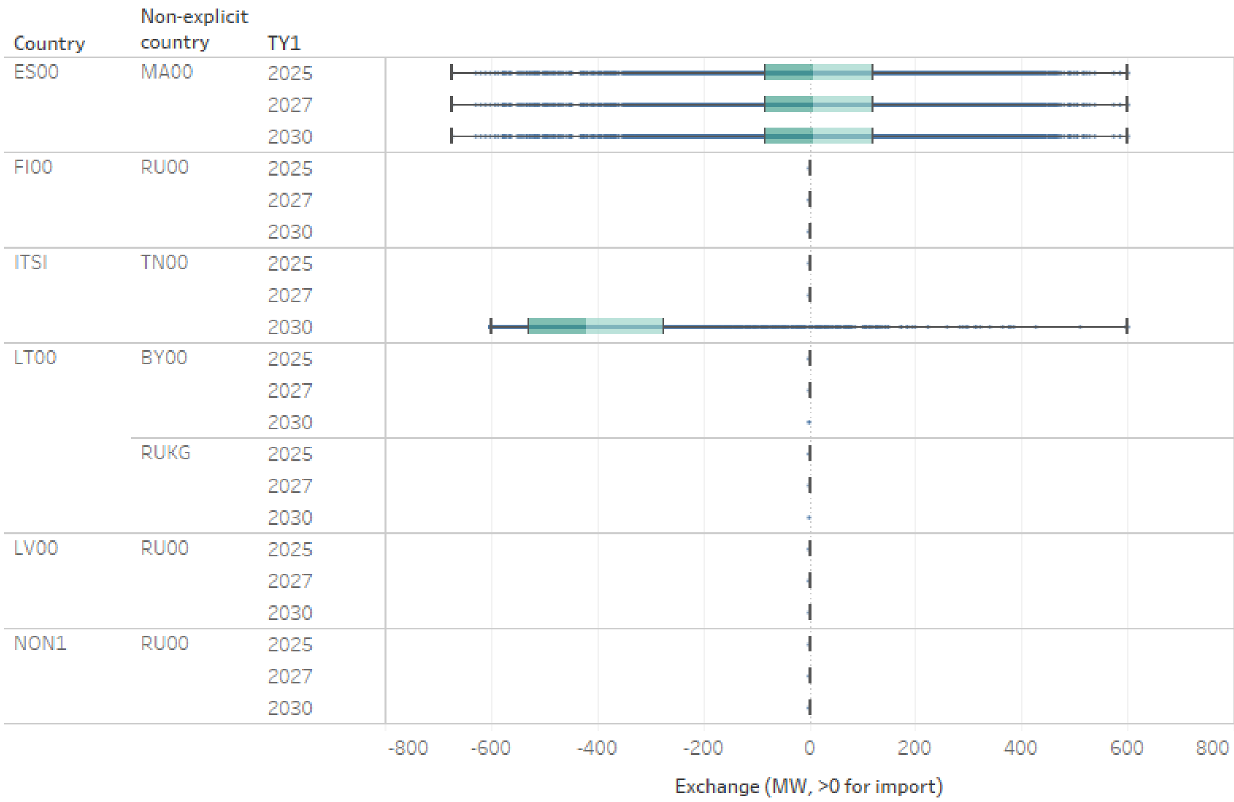


Figure 9: Fixed exchanges between implicitly modelled countries and the ERAA explicit region

6 Economic assumptions

6.1 Fuel and CO_2 prices

Fuel and CO_2 prices have become key inputs due to the market developments in 2022. Table 3 summarises the price assumptions used in the ERAA 2022:

- Natural gas: current prices are considered to be at a peak, so they are expected to decrease steeply at first, and then more gradually.
- Nuclear, lignite, light oil and heavy oil prices are stable across the TYs.
- Hard coal and shale oil prices are (slightly) rising across the TYs.

Table 3: Fuel cost [€/net GJ] per TY

Fuel Type	2024	2025	2026	2027	2028	2029	2030	Reference
Nuclear	0.47							TYNDP 2022[2]
Lignite	1.4–3.1							TYNDP 2022
Hard coal	2.99	2.99	3.00	3.01	3.02	3.03	3.05	RePowerEU[3]
Natural gas	14.28	12.95	12.80	12.65	12.50	12.35	12.20	RePowerEU
Light oil	19.25							RePowerEU
Heavy oil	15.79							RePowerEU
Shale oil	1.56	1.56	1.62	1.68	1.74	1.80	1.86	TYNDP 2022

The CO_2 prices are calculated by interpolating between the average of the last four months of 2022 (84 €/ton) and the 2030 price of the World Economic Outlook (WEO) under the scenario of 'advanced economies with net zero pledge'. The CO_2 prices assume a steady price increase of approximately 3 €/ton per year.

Table 4: CO_2 price [€/ton] per TY

TY	2024	2025	2026	2027	2028	2029	2030	Reference
Price	90.50	93.75	97.00	100.25	103.50	106.75	110.00	WEO 2021

6.2 Technologies and capacities subject to the EVA

As described in Annex 2, the EVA's objective is to identify and decommission non-economically viable capacity from the system, add additional economically viable capacities to the system, and add sufficient additional capacity to achieve the reliability standards (in the Central Reference Scenario With CM). As presented in Annex 2 (section 10.1.4), the technologies and capacities considered eligible for retirement by the model are limited to thermal hard coal and lignite, natural gas, and oil. The capacity of nuclear and RES is based on the National Estimates Scenario provided by individual TSOs (see Annex 2, section 3) on the basis of specific Member State policies. For this reason, nuclear and RES capacity are not subject to EVA. Other considerations in EVA are (i) (de-)mothballing of unviable capacity, as an alternative to permanent retirement; (ii) consideration of heat and steam revenue stream for CHP units; (iii) lifetime extension and (iv) battery storage expansion.

Figure 10 illustrates the installed capacity subject to the EVA as well as the capacity excluded from it. As described in Annex 2 (section 10.1.4), the units with a CM contract in place are not subject to the EVA, nor are the units subject to a must-run commitment or the policy units. Overall, in 2025, 130 GW of gas-fired units (60% of the total gas capacity) are assessed during the EVA, 40 GW of coal units (40% of the total coal capacity), 7 GW of other non-RES units (70% of the total oil capacity) and 2 GW of bio-fuel-powered units (30% of the total bio-fuel-powered capacity), whereas nuclear is not subject to the EVA. The share of capacity subject to EVA remains stable throughout the full horizon.

[2] Scenario Building Guidelines: https://2022.entsos-tyndp-scenarios.eu/wp-content/uploads/2022/04/TYNDP_2022_Scenario_Building_Guidelines_Version_April_2022.pdf
[3] RepowerEU was only consulted for fuel prices in ERAA 2022.
These prices are based on the value of the euro in 2015; thus, a 5% inflation rate is applied to convert the value of the euro to the year 2020 in line with the VO&M values in section 6.4.5.

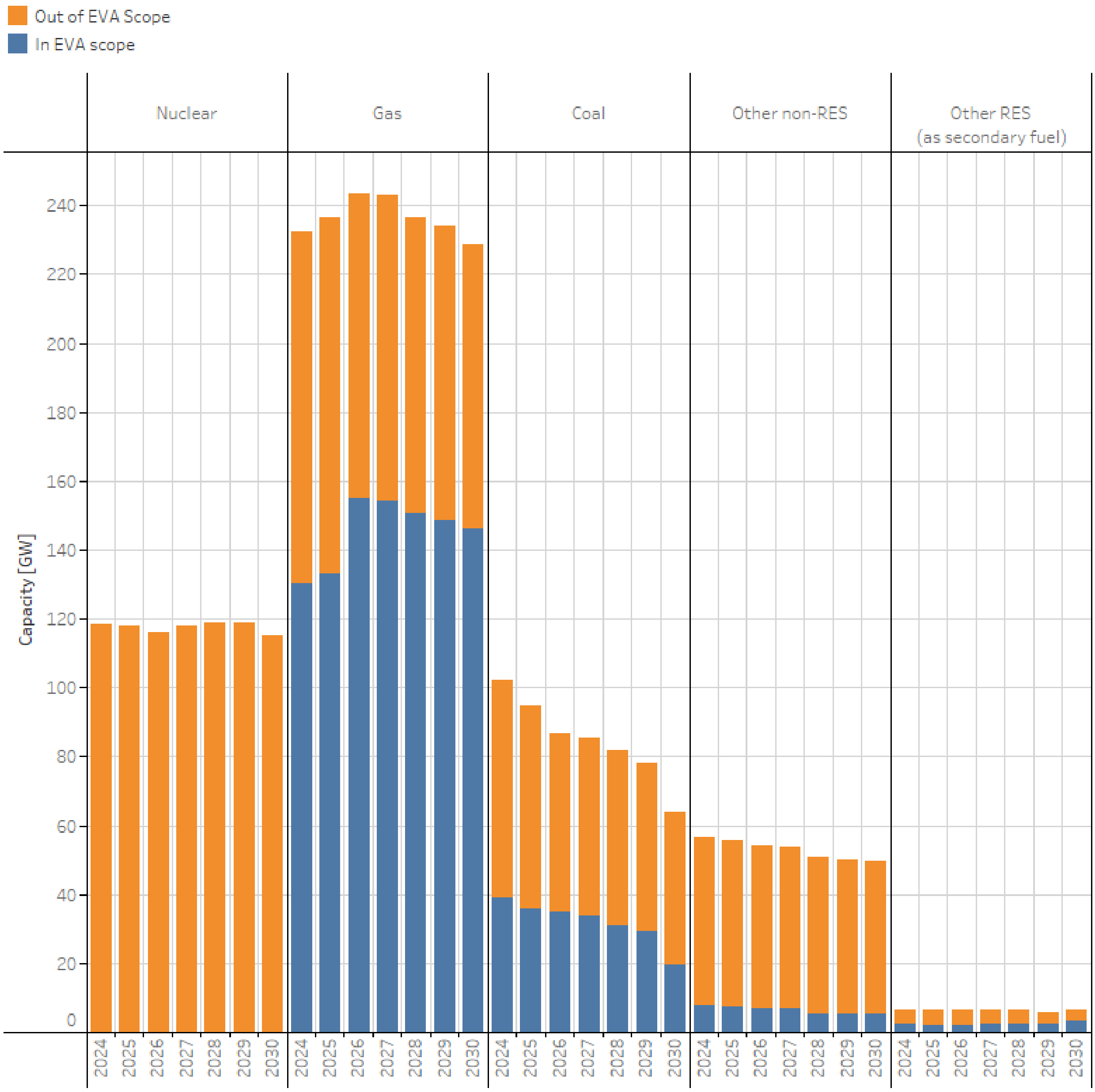


Figure 10: Share of thermal capacity subject to EVA.

6.3 Cost of new entry

According to Regulation (EU) 2019/943, having a reliability standard (RS) in place is a necessary condition for implementing capacity mechanisms in any given Member State. This reliability standard shall be based on the value of lost load (VoLL), cost of new entry (CONE) and the reliability standard methodology proposed by ENTSO-E and approved by ACER in October 2020.

For the EVA simulation, available national data prepared by regulators was used, while an estimated average value was used for countries for which data has not yet been calculated/published.

6.4 Techno-economic assumptions

This section describes the techno-economic values used in EVA. While country-specific assumptions are used for the commissioning of new units when available, common assumptions are used for the rest of the possible resource capacity outcomes (referred to as 'decision variables'). For more details on the possible outcomes per technology, refer to Annex 2, section 11.1.4.

6.4.1 Economic commissioning candidates

The CAPEX, FOM, economic life and WACC values used in the ERAA 2022 are taken from the aforementioned MS CONE studies. When such values were unavailable, default values were calculated and applied by ENTSO-E.

For most studies, the values were given for a specific forecasted year and are then assumed to be representative for the entire horizon. The charts below illustrate the CAPEX, FOM, economic life and WACC changes from TY 2024 to TY 2030. (The values for the rest of the target and non-target years are not shown.) Battery candidates are defined by the ratio of energy capacity over output power passed as label *E/P = ratio*, representing the time to completely discharge a fully charged battery at max power. The ratio of 2 is not labelled in the charts and is considered as the default value. Only the default value and the information provided in the available CONE study are shown.

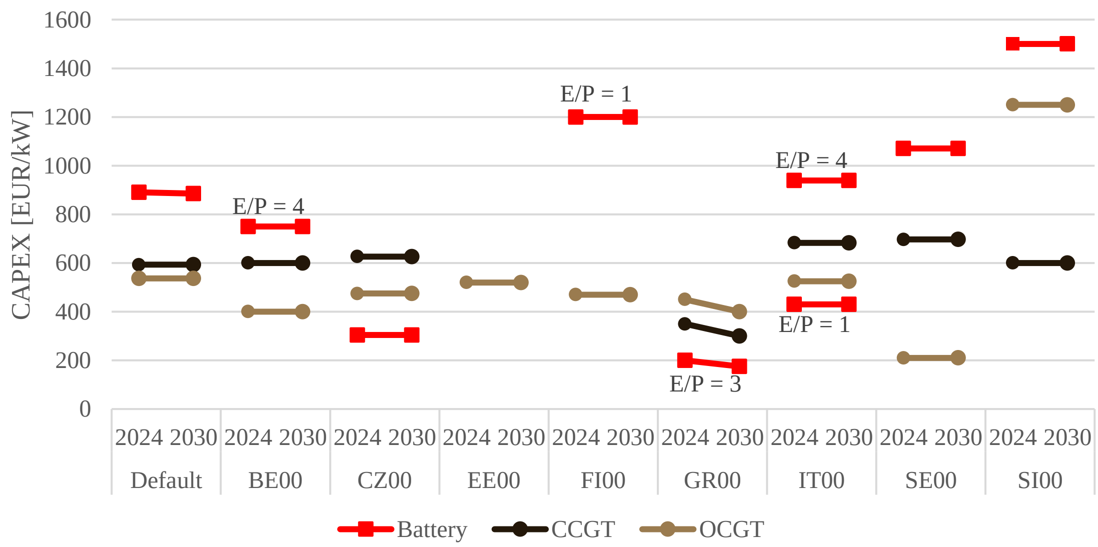


Figure 11: Default values and CONE values for CAPEX

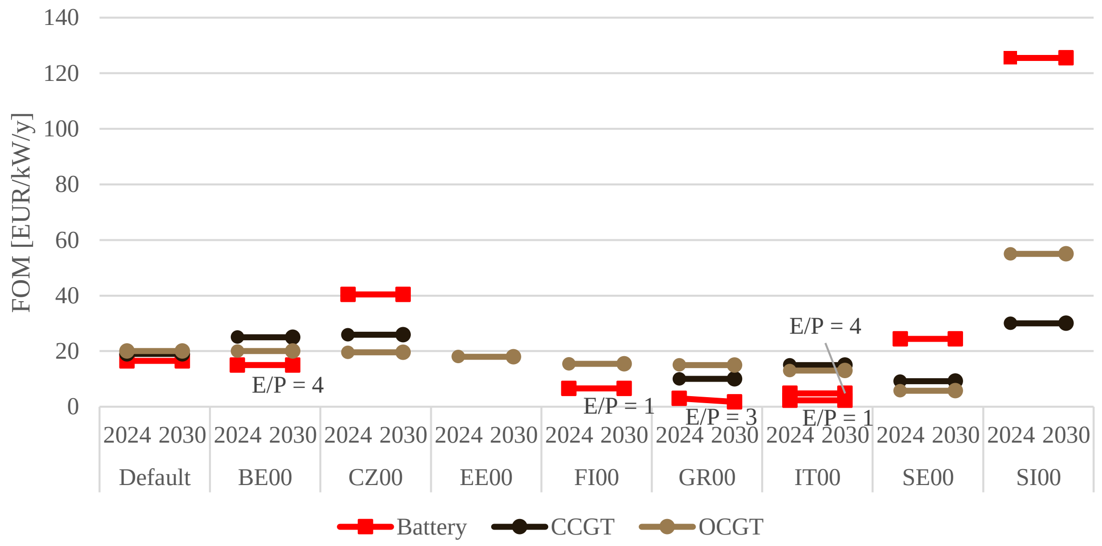


Figure 12: Default values and CONE values for FOM

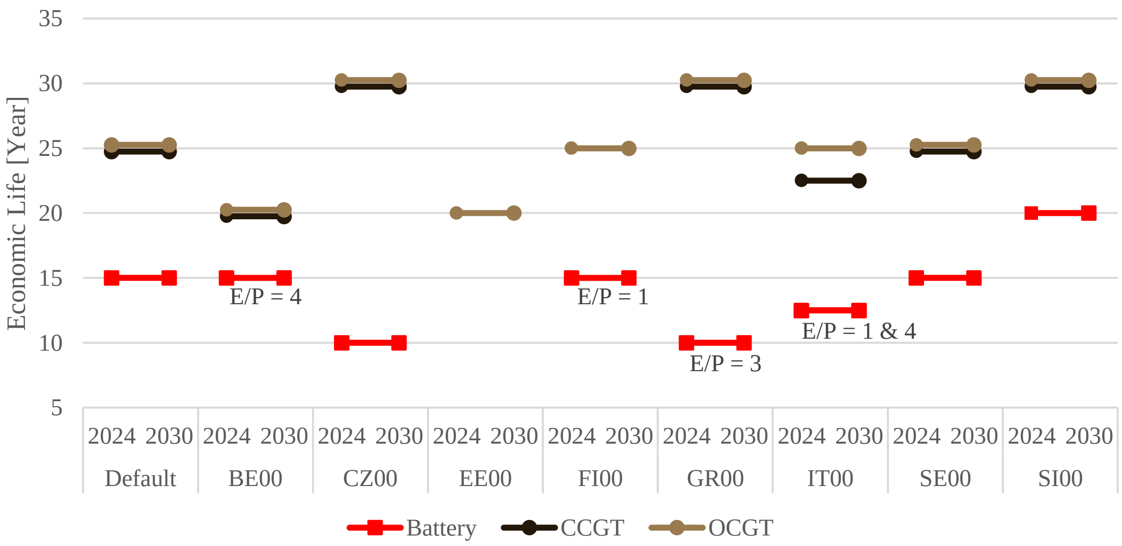


Figure 13: Default values and CONE values for economic life

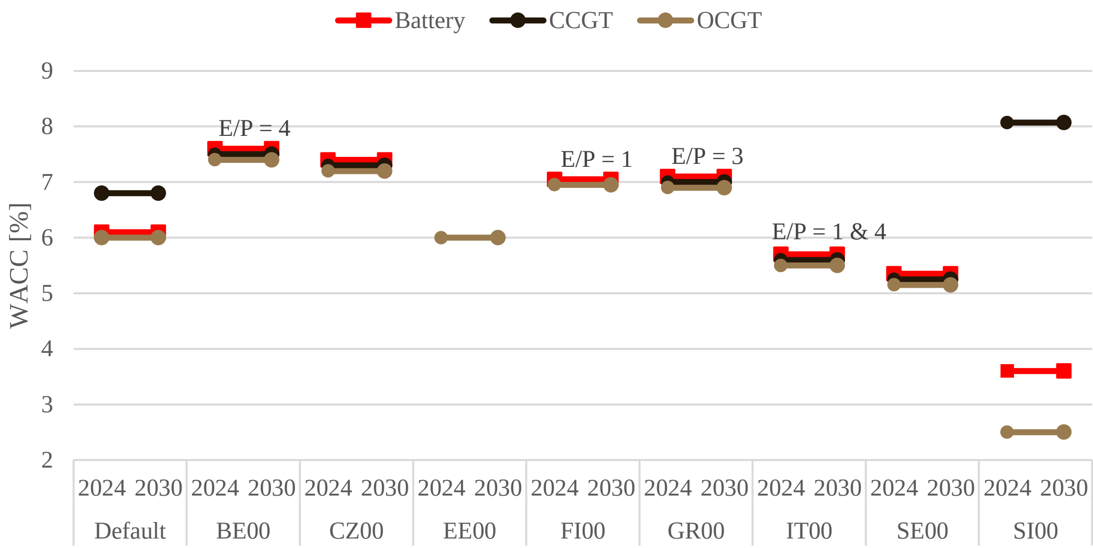


Figure 14: Default values and CONE values for WACC

The hurdle premium values used to compute the hurdle rate together with the WACC (shown in Table 5) differ only by technology (see Annex 2, section 10.1.13).

Table 5: Default values for the hurdle premium [%]

Battery	CCGT	OCGT
8.5	6.5	8.5

6.4.2 Economic decommissioning candidates

A resource unit is considered not viable when its net revenues are lower than its fixed operation and maintenance (FOM) costs, which are independent of the unit's usage. The net revenues depend on random events and are subject to risks that are considered by the hurdle rate.

Table 2 lists the techno-economic parameters specifically used to assess the viability of existing and planned thermal units. The source of the FOM cost is given in the table. WACC values come from CONE for gas-powered technologies and are assumed to be the same for the other technologies. The value used for hurdle premium comes from the Elia study.[6]

Table 6: Economic parameters for thermal economic units in the EVA

Resource Unit Category	FOM cost [€/kW/y]	WACC [%]	Hurdle Premium [%]	Source of the Fixed Cost Value
Hard Coal	25–40	6	1.5	EU reference scenario 2020[4]/ASSET 2018[5]
Lignite	32–46	6	1.5	EU reference scenario 2020/ASSET 2018
CCGT	19	6.8	1.5	Average of CONE
OCGT	20	6	1.5	Average of CONE
Light Oil	21	6.8	1.5	EU reference scenario 2020/ASSET 2018
Heavy Oil	21	6.8	1.5	EU reference scenario 2020/ASSET 2018
Oil Shale	21	6.8	1.5	EU reference scenario 2020/ASSET 2018

6.4.3 Lifetime extension of thermal units

Units approaching their decommissioning date can be refurbished to remain operational for an extended period of time; this requires additional investment. The ERAA 2022 assumes a single CAPEX, lifetime extension duration, hurdle premium and WACC value for each technology across all TYs.

The values were extrapolated from the Elia adequacy and flexibility study[6], the EU Reference Scenario[4] and the ASSET study[5].

Table 7: Economic parameters for lifetime extension in the EVA

Resource Unit Category	CAPEX [EUR/kW]	Life Extension [years]	Hurdle Premium [%]	WACC [%]	Sources
CCGT	100	15	4	10.8	Elia[6]
OCGT	80				Elia
Lignite	275				Extrapolation
Hard Coal	241				Extrapolation
Oil	187				Extrapolation

The modelling specificity of the lifetime extension is that it can only be triggered the year following the decommissioning year of the unit as provided by the TSOs. The chart below shows how much capacity can be extended each specific year.

[4] https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en
[5] https://asset-ec.eu/home/advanced-system-studies/cluster-3/technology-pathways-in-decarbonisation-scenarios/
[6] https://www.elia.be/-/media/project/elia/shared/documents/elia-group/publications/studies-and-reports/20210701_adequacy-flexibility-study-2021_en_v2.pdf

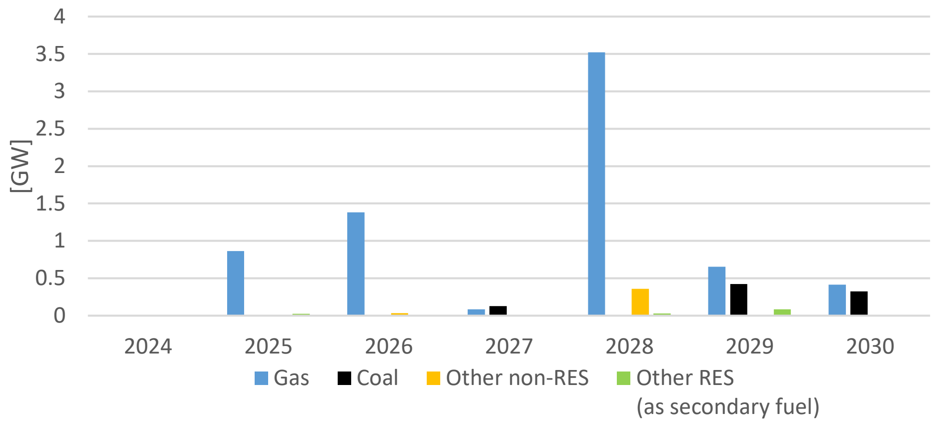


Figure 15: Capacity subject to lifetime extension decision

6.4.4 Mothballing of thermal units

Thermal units can be mothballed for brief or extended periods of time (up to several years) before being decommissioned. The costs involved arise from the preparations needed to put the unit out of operation for a long period of time as well as the preparations needed to put the unit back to operation (e.g. water, grid, new staff). The cost of de-mothballing is significantly higher than for mothballing. For the duration of mothballing, fixed costs are significantly reduced. These decisions are impacted by risks that are considered through the hurdle rate. The values are extrapolated from the TenneT *Monitoring Leveringszekerheid 2021* study[7] following the same approach as that used for the lifetime extension. Amongst the different types of mothballing introduced in the study – defined mainly by the duration of mothballing – the *Dry* modus has been used. Under this assumption, the duration of mothballing is assumed to be at least one year. Any mothballing situation that would last less than a year is not considered, the capacity change being assessed on a yearly level of granularity. The ERAA 2022 assumes the following values for each technology across all TYs.

Table 8: Economic parameters for (de-)mothballing in the EVA

Resource Unit Category	Mothballing CAPEX [EUR/kW]	De-mothballing CAPEX [EUR/kW]	Fixed cost [EUR/kW/y]	Hurdle premium [%]	WACC [%]	Source
CCGT	2.50	18.75	0.60	1.5	8.3–9.3	TenneT
OCGT	2.30	17.26	0.55	2.5	8.3	Extrapolation
Lignite	6.87	51.55	1.6	1.5	8.3	Extrapolation
Hard Coal	6.01	45.10	1.4	1.5	8.3	Extrapolation
Oil	4.69	35.15	1.1	1.5	8.3	Extrapolation

The capacities that are evaluated for (de-)mothballing (besides being subject to EVA for decommissioning) are ~50 GW gas and ~1 GW coal.

[7] https://tennet-drupal.s3.eu-central-1.amazonaws.com/default/2022-07/TenneT_Rapport_Monitoring_Leveringszekerheid_2021.pdf

6.4.5 Short-run marginal cost of thermal units

The Short-Run Marginal Cost (SRMC) is the cost for a unit to generate electricity. This cost is derived from three main components:

- Variable Operation and Maintenance (VOM) cost;
- CO_2 price; and
- Fuel prices.

These costs are then linked to the operation of the unit with the efficiency and the CO_2 emission factor of the unit. The SRMC is then described as presented in the equation below:

$$\text{SRMC} = \text{VOM [EUR/MWh]} + \frac{\text{CO}_2 \text{ emission factor } [\text{tCO}_2/\text{GJ}] \times 3.6 \text{ [GJ/MWh]}}{\text{efficiency [\%]}} \times \text{CO}_2 \text{ price } [\text{EUR/tCO}_2] + \frac{\text{fuel price [EUR/GJ]} \times 3.6 \text{ [GJ/MWh]}}{\text{efficiency [\%]}}$$

The VOM, unit efficiency and CO_2 emission factor values below are applicable for all units. The VOM is the operation cost of unit (excluding the fuel cost, CO_2 emission cost and fixed costs). The assumptions used in ERAA 2022 come from the EU Reference scenario[4] and the ASSET report.[5] The values are reported in the table below.

Table 9: VOM [EUR/MWh]

Generation Unit Category	2024	2030
CCGT	1.96–2.31	1.9–2.31
OCGT	2.8	2.8
Lignite	2.76–3	2.76–3
Hard Coal	2.4–3.59	2.4–3.51
Oil	2.76	2.8
Nuclear	6.8	7.4

The efficiency of the generators drives the impact of CO_2 and fuel cost. The values used for ERAA are computed internally in ENTSO-E. The table summarising the values is shown below.

Table 10: Efficiency [%]

Generation Unit Category	Efficiency
CCGT	40–60
OCGT	35–42
Lignite	35–46
Hard Coal	35–46
Oil	29–40
Nuclear	33

The CO_2 emission factor represents the rate of CO_2 emission when the fuel is burnt to power the unit. The values used for ERAA are computed internally in ENTSO-E. The table summarising the values is shown below.

Table 11: CO_2 emission factor [CO_2kg/GJ]

Generation Unit Category	CO_2 emission factor
Gas (OCGT & CCGT)	57
Lignitew	101
Hard Coal	94
Oil	78–100
Nuclear	0

The figure below shows the SRMC of the technologies used in the study. Although gas technologies are heavily penalised by high gas prices in the earlier years, they become more competitive in the later years thanks to gas price decreases as well as CO_2 and hard coal. For each fuel and technology shown in the figure, only the cheapest (plain line) and most expensive (dashes) types of units are shown. The marginal price of the other technologies will fall between those two lines.

The marginal price of the CHP units is lower because the additional heat and steam revenues must be considered in the calculation. Because the spread of these additional revenues is wide, this chart does not show the marginal price of CHP units.

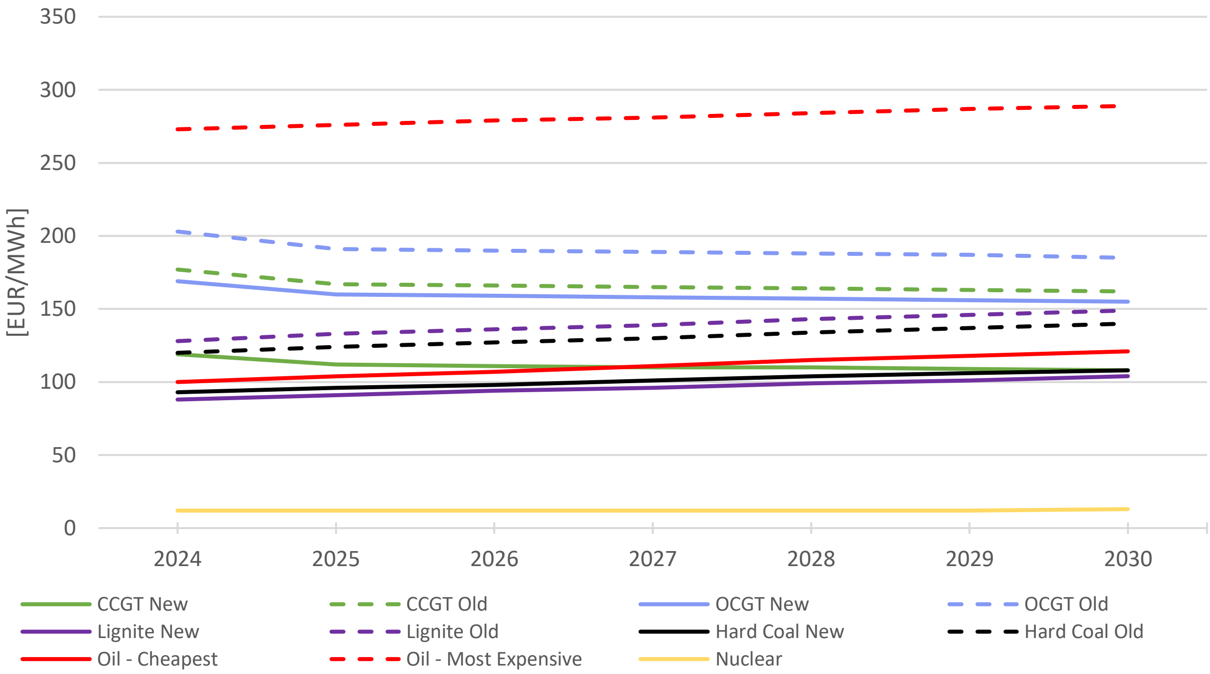


Figure 16: Marginal cost of thermal units

6.5 Explicit DSR commissioning potential

A stepwise approach is used to determine the additional DSR potential beyond the assumptions of the National Estimates Scenario, depending on available country data, in the following order:

- A **published VOLL/CONE study** conducted according to the ACER methodology[8] that includes DSR as a reference technology with additional potential;
- Another **national study** of DSR potential provided by TSOs or ACER; and
- A **centralised bottom-up methodology** described in Annex 2.

Table 12 shows which approach is used per country, as well as the net additional DSR potential that can be invested in by the EVA for selected target years above what is considered in the National Estimates Scenario. Note that these are total non-cumulative potentials covering the full horizon until 2030 (e.g. capacity invested in 2025 reduces the potential for 2030. For the countries of AL, BA, CH, ME, MK, NO, RS, TR, UA and UK, no additional DSR investments are considered, either because the centralised approach couldn't be applied due to insufficient data, or because the estimated potential was lower than the assumed capacity by TSOs in the National Estimates Scenario. Note that retirement of DSR capacity is not considered; this is due to the assumption that investments intended to make processes more flexible and responsive to market prices would not be decommissioned.

Table 12: Net additional explicit DSR potential assumed per target year per zone

Zone	Approach	Net additional DSR potential (non-cumulative) [GW]		
		2025	2027	2030
AT00	Centralised approach	0.92	0.92	0.92
BE00	National VOLL/CONE study	0.50	0.50	0.50
BG00	Centralised approach	0.70	0.70	0.70
CY00	Centralised approach	0.11	0.11	0.11
CZ00	National VOLL/CONE study	0.07	0.07	0.07
DE00	National VOLL/CONE study	0	0.31	0.83
DKE1	Centralised approach	0.29	0.29	0.29
DKW1	Centralised approach	0.50	0.50	0.50
EE00	Centralised approach	0.20	0.20	0.20
ES00	Other national study	2.60	2.60	2.60
FI00	National VOLL/CONE study	0.12	0.12	0.12
FR00	Other national study	0	0	0
GR00	National VOLL/CONE study	1.25	1.48	1.78
HR00	Centralised approach	0.32	0.32	0.32
HU00	Other national study	0.06	0.06	0.06
IE00	Other national study	0	0	0
IT00	National VOLL/CONE study	0	0	0
LT00	Centralised approach	0.27	0.27	0.27
LU00	National VOLL/CONE study	0	0	0
LV00	Centralised approach	0.19	0.19	0.19
MT00	Other national study	0	0	0
NL00	Other national study	2.93	2.93	3.12
PL00	Other national study	0	0	0
PT00	Centralised approach	1.32	1.32	1.32
RO00	Centralised approach	1.23	1.23	1.23

[8] ACER Decision of 2 October 2020 on the Methodology for calculating the value of lost load, the cost of new entry, and the reliability standard in accordance with Article 23(6) of Regulation (EU) 2019/943 on the internal market for electricity.

Zone	Approach	Net additional DSR potential (non-cumulative) [GW]		
		2025	2027	2030
SE00	National VOLL/CONE study	5.54	5.54	5.54
SI00	National VOLL/CONE study	0.09	0.09	0.09
SK00	Centralised approach	0.74	0.74	0.74

6.6 Wholesale market price cap

In ERAA 2022, the wholesale market price cap (i.e. the highest bid/offer that market players can submit) is a single value used across all bidding zones for each TY. The maximum price cap (referred also as 'maximum technical bidding limit') for the wholesale Single Day-Ahead Coupling (SDAC) market is set to 4,000 €/MWh at the time of writing,[9] as the relevant threshold was recently reached in one bidding zone. Following the approach proposed in Annex 2, the price cap evolutions over all the target years to be considered in EVA and adequacy simulations are estimated.

Table 13 shows the price cap evolution used in ERAA 2022.

Table 13: Price cap [€/MWh] per TY

2024	2025	2026	2027	2028	2029	2030
5,000	5,000	6,000	6,000	7,000	8,000	8,000

7 Additional assumptions

7.1 Electrolyser data

Hydrogen production efficiency was adopted on the basis of data provided by the TSO and ranged between 68–80%. Table 14 presents hydrogen price per target year assumptions. The approach used to compute these prices is described in Annex 2 (section 7).

Table 14: Hydrogen prices [€/GJ] per target year

2024	2025	2027	2030
30.17	30.17	29.79	29.21

[9] https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/NC%20CACM/SDAC%202022/SDAC_Comm._Note__HMMP_-_4000_clean.pdf

8 Appendix 1: TSO survey on scenario assumptions

8.1 Complete TSO feedback

8.1.1 Compliance with Fit for 55

The question aimed to understand the extent to which the data delivered are compliant with Fit for 55 (FF55) and the rationale behind the scenarios.

According to the TSO survey responses, 18 out of the 24 TSOs submitted data for the National Estimates Scenarios that are considered to be either partially or fully compliant with FF55. For most TSOs that submitted 'partially compliant' data, the data provided are in line with the NECP, which has not been reviewed at the time of the data collection to consider the FF55 objectives. Although several TSOs affirm that their submitted data are in line with FF55, no detailed assessment was conducted. A few TSOs submitted data presumed to be non-FF55-compliant; this is because objectives at the national level had not yet integrated FF55 purposes at the time of data collection.

Country	**Was data you submitted for ERAA 2022 compliant with FF55?**	**Please further explain the level of compliance with FF55.**
AL	Not relevant to my country	Albania is not an EU member. However, data provided of future generation consists of almost only renewable energy sources with zero emissions.
AT	Yes	Data for ERAA 2022 are agreed between the TSO and the Ministry. However, the Ministry is currently evaluating whether these values need to be updated.
BA	Not relevant to my country	Not an EU member.
BE	Partially compliant - explain	Some elements of the data submitted use the EU Fit for 55 MIX scenario from EC impact assessment as guidance. The submitted data still does not represent the official BE national targets regarding Fit for 55 as these are not yet known at the time of the data collection.
CY	Yes	RES penetration as per relevant Ministry of Energy Directions and plans.
CZ	Not relevant to my country	Even though CEPS tries to provide as much up-to-date data as possible for the ERAA 2022 data collection, the fact that the legislative proposal Fit for 55 was introduced in July 2021 did not provide with sufficient time to adapt for ERAA 2022 data collection. All the essential national studies and surveys had already been completed or are in the process of preparation beyond the point of changing their scope.

Country	Was data you submitted for ERAA 2022 compliant with FF55?	Please further explain the level of compliance with FF55.
DE	Yes	The delivered scenario for 2030 reflects the key facts of the coalition treaty of the new German government. The German Ministry assured that this update is compliant with Fit for 55. The key facts are a coal phase out of the market until 2030 and a substantial increase of renewables.
DK	Partially compliant - explain	Energinet has been in contact with the Danish Energy Agency, our regulator, who provides us with the scenario that is reported as the National Trends scenario for Denmark (Project Assumptions 2021). Generally, Project Assumptions 2021 do not take into account the proposals included in the Fit for 55 packages. The package was presented by the European Commission in July 2021, when the work on the Project Assumptions 2021 was at an advanced stage. At present, it is not possible to assess whether the Project Assumptions 2021 are compliant with all the suggested measures in the package, and Energinet is not able to confirm the compliance with Fit for 55.
EE	Yes	Estonian power production will follow decarbonisation plans and will significantly cut down on emissions.
ES	Partially compliant - explain	In overall, the ERAA 2022 data has been based on the Spanish NECP. This NECP was more ambitious than the past European targets, and it already meets the Fit for 55 objectives – except for the efficiency target, but it is foreseen that the next NECP will be in line with the corresponding Fit for 55 targets.
FI	Yes	In general, Fingrid data are compliant with Fit for 55, as the data submitted refer to an ambitious scenario on electrification, fossil fuel decommissioning and RES development. However, this data submission is according to the policy decisions announced at the time of the data collection.
FR	Partially compliant - explain	Load + P2G: RTE used the trajectory ‘Electrification+’ from RTE studies. This scenario is, in theory, compliant with Fit for 55, but has not actually been decided by the NECP.
GR	Partially compliant - explain in question below	The submitted data is compliant with Fit for 55, but it is preliminary. In specific, it is based on the first scenarios examined by the Ministry of Environment and Energy.
HR	Partially compliant - explain	This still has to be investigated by the TSO – no response yet.
HU	Partially compliant - explain	Data provided is based on the National Ten-Year Network Development Plan process. TSO and DSOs make their assumptions on capacity and demand evolution based on NECP, National Energy Strategy, recent regulations, ongoing and planned state aids and investment plans. As highly ambitious PV development is ongoing in Hungary, we consider this as a factor helping to achieve Fit for 55 targets.

Country	Was data you submitted for ERAA 2022 compliant with FF55?	Please further explain the level of compliance with FF55.
IE	Partially compliant - explain	EirGrid data are partially compliant with Fit for 55. For ERAA 2022, EirGrid has used the ambitious targets that are part of the government's Climate Action Plan (CAP) 2019 – which amounts to 70% RES-E by 2030. This is improved to 80% RES-E in the latest CAP 2021, which is aligned with 'Fit for 55'. This will form the basis of EirGrid's next submission for ENTSO-E studies.
IT	Partially compliant - explain	Exact targets have not yet been defined at national level, nor is there an updated NECP available. The 2030 RES installed capacity roughly corresponds to a 65% share of renewables in electricity consumption, which is a minimum condition for reaching the 'Fit-for-55' goals. All data are subject to significant changes: new TSO scenarios will be released by end of July 2022. New grid development plan to be released in 2023.
LT	No	Litgrid has not yet carried out compilation is planning a significantly faster development of RES than provided in the NECP. Planned electrification of transport - railway electrification project has already been initiated, development of electric vehicle infrastructure, support schemes for the purchase of electric vehicles (EVs).
LU	Partially compliant - explain	RES generation adapted to comply with Fit for 55 targets.
LV	Yes	The generation source development is according to National Energy and Climate Plan as well as driven by EU targets for Fit for 55.
MK	Not relevant to my country	Not an EU member.
MT	No	Data provided for ERAA 2022 is based primarily on the NECP and a national electricity supply study carried out in 2020/21 (National Resource Adequacy Assessment).
NL	Yes	Analysis on reduction of CO_2 emissions of the energy system has been carried out. To be compliant with Fit for 55, clear corresponding detailed data is required, which also must be approved and validated by the Member State in order to be available to the TSO to be able to submit. Most recent data from national plans have been used.
NO	Not relevant to my country	Not relevant for Norway, but the data (scenario) are compliant to national goals, as well as Fit for 55.
PL	No	There is no final regulation referred to Fit for 55.
PT	No	Data submitted is based on the Portuguese NECP and on the most recent National Adequacy Assessment Report. No further information regarding national Fit for 55 plan is available.

Country	Was data you submitted for ERAA 2022 compliant with FF55?	Please further explain the level of compliance with FF55.
RO	Partially compliant - explain	The submitted data are in line with the current RES targets established in the Romanian NECP. However, these may be increased in response to Fit for 55, but no specific data are available yet.
RS	Not relevant to my country	Not an EU member.
SE	Partially compliant - explain	The submitted data fulfil the Swedish climate ambitions of net zero emissions by 2045. This ambition should be aligned with Fit for 55 but has not been explicitly analysed yet.
SI	No	Data provided for ERAA 2022 are primarily based on the NECP and on the study provided for ELES by an independent institute, which considered projections and NECP in their study.
SK	No	The data provided are not compliant with Fit for 55

8.1.2 Capacity data drivers

This set of questions aimed to understand the drivers behind the data TSOs provided on conventional generation capacity and RES capacity.

8.1.2.1 Conventional generation data drivers:

For most TSOs, either FF55 or NECP is the primary driver for the data related to conventional generation. Some Member States have updated the NECP based on more recent inputs coming from stakeholders and market parties.

When ‘other source’ is mentioned, it usually refers to the TSO’s best estimates, input from the market participants, national laws or the national TYNDP.

8.1.2.2 RES data drivers:

Most TSOs have provided data that are primarily driven by either NECP or the FF55. When Fit for 55 is mentioned, it most often means the NECP that is being updated to integrate Fit for 55 objectives but that has not yet been approved. When NECP is mentioned, updates have been brought to the NECP based on latest market data and/or TSO best-estimate scenarios.

TSOs mentioning 'other' either corrected NECP with investment plans or used data from market parties directly.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
AL	Other (please specify)	NECP was not finalised by the time of ERAA data collection. Primary drivers are strategy documents and, to some extent, the Albanian Gas Master Plan.	Other (please specify)	National Transmission Network Development Plan and other relevant strategic documents.
AT	Other (please specify)	In 2030, Austria will probably still depend on gas power to ensure the security of supply (for transmission adequacy issues in Austria and neighbouring Member States).	NECP	The stated installed capacities for renewables are coordinated with the national energy and climate plans 2030 where the Austrian power supply is projected to be climate-neutral.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
BA	Other (please specify)	NECP is not yet finalised, so data from Indicative Generation Development Plan 2021–2032 were used. It is expected that some old thermal units in TPP Tuzla and TPP Kakanj would be put out of operation if the new unit in TPP Tuzla were to be built.	Other (please specify)	NECP is not yet finalised. Some predictions and data from the Indicative Generation Development Plan were used.
BE	Other (please specify)	Official nuclear closure announcements and CM auctions.	Fit for 55	Data submitted use the EU's Fit for 55 MIX scenario from the EC impact assessment as guidance regarding RES. Also, the recent announcements regarding offshore wind for Belgium by 2030 are considered.
CY	Fit for 55	Until international interconnections are constructed, conventional generation is needed for security of supply because the electricity system of Cyprus is isolated.	Fit for 55	Based on Ministry of Energy RES plans, taking into account the security of supply.
CZ	Other (please specify)	Submitted data respect strategies and plans of electricity producers partially reflecting switching from coal to gas heat production. To obtain the most recent data related to conventional generation, CEPS conducted an annual data survey that included generation sources above the net installed capacity of 10 MWe (incl.).	Other (please specify)	In relation to renewable energy, the study concerning their evolution in the mid-term horizon was conducted, taking into account the potential impact of the Modernisation Fund and other financial support tools that could increase the installed capacity of RES. Furthermore, this study also accounts for the fact that the opt-out enabling solar farms to use agricultural land will not be extended further. The study is compliant with NECP and reflects other national as well as EU regulations and policies.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
DE	Other (please specify)	National law (e.g. nuclear phase-out), coalition treaty (coal phase-out until 2030 – in contrast to the current phase-out law: KVBG) set the frame, as well as the published power plant list information from the BNetzA (https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/start.html) and TSO internal information	Other (please specify)	Data submitted are the result of interpolation between national study (*Systemanalyse*), coalition treaty and Fit for 55.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
DK	NECP	The Danish scenario reported to the ERAA (i.e. the 'Project Assumptions for Energinet of 2021'), provided by the Danish Energy Agency, is the best estimate for a likely development pathway for the Danish energy system until 2040. The scenario is constructed around Danish targets such as 70% greenhouse gas emission reductions in 2030 compared to 1990 levels and a climate-neutral society by 2050. Additionally, the scenario is constructed around assumptions that onshore wind and photovoltaic capacity will enter the market without subsidies/on market terms beyond capacity additions already agreed upon as of now.	NECP	The Danish scenario reported to the ERAA (i.e. the 'Project Assumptions for Energinet of 2021'), provided by the Danish Energy Agency, is the best estimate for a likely development pathway for the Danish energy system until 2040. The scenario is constructed around Danish targets such as 70% greenhouse gas emission reductions in 2030 compared to 1990 levels and a climate-neutral society by 2050. Additionally, the scenario is constructed around assumptions that onshore wind and photovoltaic capacity will enter the market without subsidies/on market terms beyond capacity additions already agreed upon as of now.
EE	Other (please specify)	Data for conventional generation plants have been gathered from market participants who are providing their best knowledge about when the plants are amortising. The same is valid for their fuel transitions and technical parameters.	NECP	There are two renewable procurement auctions coming up that aim to reach the NECP RES targets. Furthermore, a memorandum of understanding is signed between Estonia and Latvia to develop a joint offshore wind project by 2030.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
ES	NECP	The values given for 2030 in the ERAA 2022 dataset are those defined in the NECP approved by the Spanish government. However, for 2024 and 2025, some differences have been included in light of the best information available from the stakeholders and the evolution of the installed capacities since the approval of the NECP. The decommissioning of coal capacity is proceeding faster than expected in the NECP.	NECP	The values provided for 2030 are those defined in the NECP approved by the Spanish government. For 2024 and 2025, some differences can be observed due to the best information available from the stakeholders and the evolution of the installed capacities since the approval of the NECP. The growth foreseen for thermal solar, wind and hydro-pump capacity in those years is slower than expected in the NECP.
FI	Fit for 55	In addition to NECP and Fit for 55, market-based drivers because of high CO_2 price (partly due to Fit for 55) were also considered. Finland also has specific policies such as coal phase-out in energy and halving peat use.	Fit for 55	Market-based wind power is the main driver of development.
FR	NECP	Nuclear capacity evolution is decided by NECP; no new thermal fossil plant except for one CCGT in 2022; coal decommissioning, CHP and small units not driven by NECP; assumptions based on public consultation.	NECP	NECP

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
GR	Other (please specify)	The main driver for the conventional generation data is availability of data (e.g. there is a retirement schedule for all existing lignite units), realistic and conservative estimates on new entries, and performing of EVA by ENTSO-E without bias. The relevant data submitted are based on (a) lignite units' retirement schedule and (b) assuming no conventional generation is taken out of service before its end of lifetime.	Fit for 55	RES generation is based on initial scenarios for Fit for 55 examined by the Ministry of Environment and Energy.
HR	Other (please specify)	Regarding conventional power plants in ERAA 2022 assumptions, data were obtained from the power plant owners.	NECP	Data related to RES reflect the interests of individual RES investors and developers with a view toward the NECP.
HU	Other (please specify)	Permits, investment plans and consultation.	Other (please specify)	Data provided take into account NECP and National Energy Strategy, corrected with investment plans (geothermal capacity was provided due to this higher PV capacity, but lower biomass).
IE	NECP	The NECP assumes a certain growth in electricity demand from heat pumps and EVs. This then drives the demand forecast, which informs the capacity market, leading to assumptions of (new and existing) conventional capacity in the future. In addition, the CEP informs the market in relation to emissions targets and associated shutdowns of conventional generating units.	NECP	The wind and solar capacities are informed by the government's Climate Action Plan 2019.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
IT	Other (please specify)	Complete coal phase-out by 2025 within the Italian mainland and by 2028 in Sardinia (where the coal phase-out will be completed only after the 'Tyrrhenian Link' becomes operational); decommissioning of oil units by 2028; and new thermal capacity according to national capacity market auctions for 2022 and 2023 (the 2024 auction was not considered due to the data-collection deadline).	Other (please specify)	Italy's target is to achieve a 65% share of renewables in electricity consumption by 2030. Accordingly, the following assumptions have been made for submitting RES: - Onshore wind: installed capacity 2030 in line with NECP - Offshore wind: additional developments by 2030 - Solar: additional installed capacity to reach the RES target in 2030
LT	Other (please specify)	Data are obtained through an annual survey of major electricity producers about their development/mothballing/decommissioning plans for a minimum 10-year period. Decommissioning of old fossil-fuel generating units before 2026 (~480 MW) and 510 MW - not available in the market due to limited recourse.	Other (please specify)	Taking into account the ongoing projects and the interest of investors in the development of RES energy in Lithuania, even more ambitious RES targets have been set and at the time of data collection, the NECP was being updated. Even more ambitious RES targets, agreed upon with the Lithuanian Ministry of Energy, were submitted to PEMMDB.
LU	NECP	Data for conventional generation are based on NECP.	Fit for 55	According to NECP, the more ambitious target scenario is in line with Fit for 55 and mainly pushes for PV and onshore wind. However, the values were not confirmed by national authorities as the Fit for 55 update of the NECP is under preparation.
LV	NECP	The conventional generation is provided according to NECP and the best-estimate scenario.	NECP	The data provided were in line with the NECP and TSO best-estimate scenario.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
MK	NECP		NECP	
MT	NECP	Generation capacities are based on NECP and Electricity Supply Study for the period 2020–2025.	NECP	Solar PV capacity projections are based on projections developed for the purpose of Malta's NECP.
NL	Other (please specify)	Towards the National Climate Agreement Scenario - updated NECP. Data are also collected from electricity generator companies, NECP, as well as government decisions on coal phase-out.	NECP	Extension of growth of renewables compared to National Climate Agreement.
NO	Other (please specify)	Almost no fossil generation.	Other (please specify)	More renewables are needed due to electrification and new industries.
PL	NECP	Compliant with the latest national policies and updated by the information about current state.	Other (please specify)	Updated NECPs by current development trends. Forecasted values are higher than these ones from NECP.
PT	NECP	Data submitted is based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding national Fit for 55 plan is available.	NECP	Data submitted is based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding national Fit for 55 plan is available.
RO	NECP	Lignite and hard coal phase-out, following the decarbonisation goals of the Romanian system, and the envisaged new capacities on gas to replace the decommissioned capacity.	NECP	The wind and solar capacities are in line with the RES indicative trajectory included in NECP.
RS	Other (please specify)	Data gathered from all power utilities and third parties in country as well as the national Network Development Plan.	Other (please specify)	Data gathered from all power utilities and third parties in the country.

What is your country?	What were the primary drivers for conventional generation data?	Explain.	What were the primary drivers for RES generation data?	Explain.
SE	Other (please specify)	Sweden has few conventional fossil-fuelled plants, and the plant owners have published plans for their decommissioning. Regarding Swedish nuclear power, the assumption is that the reactors will close when they reach a 60-year lifespan.	Other (please specify)	For the scenario on which the data are based, there is a major expansion of both on- and offshore wind power to cover the great increase in electricity demand and the decommissioning of nuclear power. Swedish RES data are based on scenario analyses as well as profitability assumptions and calculations.
SI	NECP	Regarding conventional power plants in PEMMDB for ERAA 2022, data were obtained from their owners.	NECP	RES capacity projections are based on projections developed by independent research institutions for ELES and are based on NECP.
SK	NECP	Up-to-date information on conventional sources of electricity was provided by their operators.	NECP	Except the NECP, forecasts of the RES evolution for longer time horizons (after 2030) are based on the assumed RES realisable potential with regard to currently available information.

8.1.3 Demand data drivers

The aim of this question was to understand the drivers behind the demand data provided by TSOs. Most TSOs have submitted data that are primarily driven by the NECP and the Fit for 55. In other cases, NECPs are updated to consider new information, while the main drivers of demand are energy efficiency, electrification, and an increase of the data centre consumptions. Previous values are often updated to take GDP increase into consideration.

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If 'other', please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
AL	Other (please specify)	National Development Plan	Data are based on the Load Forecast Report, part of the National Development Plan – developed based on projected macroeconomic and demography future trends.
AT	Other (please specify)	NECP, Fit for 55, international scenarios	The causes of future electricity consumption were analysed in detail in an APG-commissioned scientific work. Based on this, APG has calculated load time series up to the year 2040.
BA	Other (please specify)	NECP is not yet finalised.	Used demand forecasts from Indicative Generation Development Plan by ISO. These forecasts are based on historical data, transmission network users' plans and ISO predictions.
BE	Fit for 55		Extrapolation due to additional EV and HP from the EC Fit for 55 MIX scenario.
CY	Fit for 55		Fit for 55

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If 'other', please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
CZ	NECP		The demand forecast and demand profiles reflect significant growth in electricity demand, which is due to evolution of socioeconomic indicators (such as GDP or population growth, including recovery from the COVID-19 pandemic), but also to expected electrification, especially in sectors of transportation (incl. electromobility) and heating (heat pumps). The additional increase in consumption concerning hydrogen production is not considered.
DE	Other (please specify)		Given scenario by the German ministry (incl. assumptions about heat pumps, electromobility, electrolysers). ENTSO-E demand profile modelling tool – Trapunta was used to calculate the time series.
DK	NECP		Total Danish demand reported to ERAA 2022 increases significantly, and steadily, towards 2030. In this period, the total Danish electricity demand is also expected to increase even further in the ERAA22 due to including the Power-to-X/electrolysers demand modelled this year. The main drivers for the overall demand increase (besides PtX) are the electrification of heating (heat pumps and electric boilers) and transport through large increases in the number of EVs. Additionally, large-scale data centres are assumed to contribute to the increase in demand.
EE	NECP		Main expected driver of demand increase is electrification of transport.

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If ‘other’, please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
ES	NECP		The trajectory provided for the electricity demand and demand profiles are defined in the NECP approved by the Spanish government. It considers a moderate evolution of demand. Although hydrogen does not play a key role in the Spanish NECP, in October 2020 the Spanish government published the Hydrogen Road Map, which takes into account in the ERAA 2022 data but not in the demand forecast and profile. Demand growth affecting system adequacy could arise due to installation of new data centres, additional industrial consumers linked to decarbonisation efforts, the evolution of electromobility, or extreme weather events.
FI	Other (please specify)	The Finnish climate target of carbon neutrality by 2035.	Electrification of industries, heating and transport are the main drivers. These have been based on the latest ambitious government/industry scenarios, which take into account the carbon neutrality target and are adjusted in line with the latest developments seen in the market.
FR	Fit for 55		In order to be Fit-for-55-compliant, the main drivers for the forecast are energy efficiency and electrification.
GR	Fit for 55		Demand forecast is based on initial scenarios for Fit for 55 examined by the Ministry of Environment and Energy. The specific scenario assumes ambitious energy efficiency targets.
HR	NECP		NECP

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If 'other', please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
HU	Other (please specify)	National Energy Strategy and DSO assumptions on the evolution of e-mobility, heat pump, etc. (These assumptions were based on recent regulations as well as ongoing and planned state aids, including those based on Fit for 55.)	Demand is based on the National Ten-Year Network Development Plan process. Input data takes into account National Energy Strategy and DSO assumptions on the evolution of e-mobility, heat pump, etc. (These assumptions were based on recent regulations as well as ongoing and planned state aids, including those based on Fit for 55.)
IE	NECP		The NECP assumes a certain growth in electricity demand from heat pumps and EVs; this, in turn, drives EirGrid demand forecast. Historical trends, economic growth, and the growth of large energy users are also considered.
IT	Other (please specify)	Reaching the 65% share of renewables in electricity consumption in 2030	Previous demand forecasts have been adjusted to reflect a higher level of electrification and updated GDP estimates.
LT	Other (please specify)	Targets set in National Energy Independence Strategy; measures provided for in the plan for the implementation of the measures of the strategy; development of the Lithuanian economy in 2021–2024; scenario data, NECP, Plan for the Implementation of the Provisions of the Program of the 17th Government of the Republic of Lithuania.	The demand forecast is updated annually in light of the guidelines set out in the documents listed below (GDP, efficiency, EV, heat pumps, etc.) and the latest available information. Targets set in National Energy Independence Strategy; measures provided for in the plan for the implementation of the measures of the strategy; development of the Lithuanian economy in 2021–2024; scenario data, NECP, Plan for the Implementation of the Provisions of the Program of the 17th Government of the Republic of Lithuania.
LU	NECP		The basic drivers for the demand forecasts and demand are the NECP estimations. Nevertheless, additional demand for e.g. data centres has been considered in the PEMMDB data.

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If 'other', please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
LV	Other (please specify)	National TSO forecast based on official GDP increase in Latvia	Demand projections are based on National TSO forecasts based on the official GDP increase in Latvia.
MK	NECP		
MT	Other (please specify)	National resource adequacy assessment carried out in 2020/2021.	Demand projections are based on scenarios developed for the purpose of the national resource adequacy assessment (e.g. electricity supply study). Demand projections were developed under low-, central-, and high-demand scenarios for multiple climatic years. For the purpose of the ERAA 2022 data collection, the high-demand scenario was submitted.
NL	NECP		Ambitions according to the National Climate Agreement and increased ambition level of new Dutch coalition agreement regarding growth of EV and HP demand; adding electrolysers, data centres, and batteries.
NO	Other (please specify)	Further electrification, but mainly new industries like battery factories, data centres, and hydrogen production.	Further electrification, but mainly new industries like battery factories, data centres, and hydrogen production.
PL	Other (please specify)	Close to NECP	Latest national policies updated based on current trends.
PT	NECP		Data submitted is based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding national Fit for 55 plan is available.
RO	Other (please specify)	The expected growth in demand is mainly driven by the expected economic growth. Also, the expected penetration of EVs is reflected in the demand profile.	The expected growth in demand is mainly driven by the expected economic growth. Also, the expected penetration of EVs is reflected in the demand profile.

What is your country?	What were the primary drivers for the data related to demand forecasts and demand profiles?	If 'other', please specify.	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted for ERAA 2022.
RS	Other (please specify)	National TYNDP	Demand forecast was based on historical demand, historical growth of GDP and new industrial consumers.
SE	Other (please specify)	The Swedish climate target of net-zero emissions by 2045.	Electricity demand in the transport and industry sectors will increase substantially as fossil fuels are phased out. The TSO also assumes a higher demand flexibility in the future scenarios. The driver of demand figures is the Swedish climate target of net-zero emissions by 2045.
SI	NECP		Demand projections are based on projections developed by independent research institutions for ELES and are based on historical demand, BDP projections and NECP.
SK	NECP		The trajectory of electricity demand until 2050, which was provided during the data collection for PEMMDB, is in line with the National Development Plan of the Slovak transmission system. The electricity demand evolution reflects the expected evolution of Slovakia's national economy. All relevant factors known at the time of providing data for ERAA 2022 that could have a significant impact on the electricity demand evolution (such as the impact of COVID-19) were considered.

8.1.4 Interconnections

The aim of this set of questions was to understand whether cross-border capacities proposed by TSOs can be considered compliant with the 70% target for all borders.

8.1.4.1 Compliance with the 70% rule

Summary table of 70% compliance according to TSOs' responses	
Fully compliant	**15**
Partially compliant	**5**
Not compliant	**1**
Cannot be assessed	**4**
N/A	**1**

Country (EU only)	**All compliant borders**	**All non-compliant borders**	**All borders that cannot be assessed**	**EU Member States assessment**
AT	See explanation in next section.		CH (no EU Member State)	Partially compliant
BE	BE-FR, BE-DE, BE-NL, BE-LU, BE-UK			Fully compliant
CY	CY-GR03			Fully compliant
CZ			PL, SK, DE, AT	Cannot be assessed
DE			all	Cannot be assessed
DK	DE, NO, SE, UK, NL			Fully compliant
EE	EE-LV, EE-FI			Fully compliant
ES	ES-FR and ES-PT		Spain-Morocco is not affected	Fully compliant
FI	FI-SE, FI-EE			Partially compliant
FR	BE, DE, CH, IT, ES, IE, GB			Fully compliant

Country (EU only)	All compliant borders	All non-compliant borders	All borders that cannot be assessed	EU Member States assessment
GR	BG, IT		AL, CY, MK, TR	Partially compliant
HR			RS, BA	Cannot be assessed
HU			AT00-HU00, HU00-SI00, HR00-HU00, HU00-RS00, HU00-RO00, HU00-UA01, HU00-SK00	Cannot be assessed
IE	IE00-UK00			Fully compliant
IT	ITN1, ITCA, ITCN, ITCS, ITN1, ITS1, ITSA, ITSI			Fully compliant
LT	LT-PL, LT-LV, LT-SE			Fully compliant
LU			Does not apply to Luxembourg as LU does not limit market exchanges between borders	N/A
LV	LV-EE and LT-LV			Fully compliant
MT	ITSI			Fully compliant
NL	All			Fully compliant
PL	LT, SE, technical profiles with DE, CZ, SK		UA02 (radial connection with Dobrotvirska PP)	Partially compliant
PT		PT-ES		Not compliant
RO	RO-HU, RO-BG	RO-RS, RO-MD, RO-UA		Partially compliant
SE	All			Fully compliant
SI	All			Fully compliant
SK	SK-CZ, SK-HU, SK-PL, SK-UA			Fully compliant

8.1.4.2 Primary drivers for interconnection data

The primary drivers for TSOs’ NTC submissions are explained in the table below for each TSO. Note that the final value for each interconnector shall account for the feedback of both relevant TSOs, which in principle should be coordinated. In case it is not, the most conservative view is kept. Refer mostly to sources other than the 70% target as the primary drivers for data on this question. Drivers for the submission of these data are a combination of the 70% requirements, Fit for 55, National Development Plans and anticipated delays in commissioning projects.

Country	What were the primary drivers?	Please further explain the primary drivers for the data related to interconnection submitted for ERAA 2022 - In particular, provide further details on your country's borders compliance with the 70% target.	Are the submitted NTC values coordinated with the neighbouring TSO and, thus, consistent? If not, indicate the interconnections for which this is not the case and explain.
AL	Other (please specify)	National Development Plan	Currently, around 30% of cross-border nominal transmission capacity is offered to market participants in the case of Albania.
AT	Other (please specify)	NECP, Fit for 55, permitting process, 70% target	For Austria, there exists an action plan for fulfilling the 70% target. Compliance assessment will be performed annually, starting in 2022.
BA	Other (please specify)	NECP is not yet finalised	Data related to interconnections are mainly from CSE RgIP and Transmission Network Development Plan.
BE	Other (please specify)	CORE CCM (including the 70% target in FBMC)	All BE borders should be considered in FB according to the FBMC CORE CCM, which properly accounts for the 70% target.
CY	Fit for 55		RES integration
CZ	70% target		All provided NTC values are meant to be compliant with the minimum 70% interconnection capacity requirement. However, due to the monitoring methodology setup, it is difficult to estimate whether a certain value will be compliant. It should also be emphasised that the given time periods occur after the go-live of the Core flow-based capacity calculation as well as that the Clean Energy Package itself is designed to make all TSOs compliant with the 70% minRAM requirement by the end of 2025.
DE	Other (please specify)	Based upon national studies and current project state in TYNDP	NTC values provided by German LACs for the ERAA process are not guaranteed to be CEP-compliant. This is because the German TSO does not have a consistent method to determine the NTC values that take into account the 70% minRAM requirements.
DK	NECP		For the ERAA 2022, interconnectors have been reported in compliance with the Project Assumptions for 2021 as the rest of the scenario.

Country	What were the primary drivers?	Please further explain the primary drivers for the data related to interconnection submitted for ERAA 2022 - In particular, provide further details on your country's borders compliance with the 70% target.	Are the submitted NTC values coordinated with the neighbouring TSO and, thus, consistent? If not, indicate the interconnections for which this is not the case and explain.
EE	Other (please specify)	Regional grid development plans and synchronisation project with central EU	EE-FI HVDC is expected to work at full capacity. After 2025, on the EE-LV interconnector, there must always remain free capacity for sharing reserves according to the Baltic LFC block concept document.
ES	Specific project delays		SWE TSOs are currently implementing a new capacity calculation methodology that covers the 70% criteria for FR–ES and PT–ES borders. With this achievement, SWE TSOs expect to significantly increase the level of compliance during the year 2022. In the meantime, a derogation was granted for 2022 establishing an intermediate target.
FI	Other (please specify)	Current capacities and known projects, and assumption on Russian imports to be zero for the adequacy analysis.	Aurora Line project between FI–SE1 assumed to finish by 12/2025 and increase the transfer capacity. FI–RU interconnection is assumed to be 0 MW due to the risks related to import availability. In reality, there is 1300 MW import capacity (from RU to FI) and 320 MW export capacity (from FI to RU), but the import capacity has been limited to 900 MW for now.
FR	Other (please specify)	Specific network projects planning	The provided NTC are not calculated according to a specific CEP70% methodology. However, the exchange capacities today do obey the CEP70% criteria on all the borders except for France–Spain, on which it is compliant more than 80% of the time. Given the limited evolution of grid and production, it is assumed that it will remain valid for the years to come.
GR	70% target		Primary drivers for the data on interconnection are compliance with the 70% target and the trend to increase the country’s interconnectivity (15% target for 2030) to facilitate RES integration (Fit for 55).
HR	70% target		Action plan in line with Article 15 of Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.
HU	Other (please specify)	Best estimation based on existing NTCs and new interconnection projects.	The data is based on best estimation. Hungary has an Action Plan to achieve CEP70-compliance by the end of the derogation period (2025). The linear path is based on flow-based compliance instead of NTCs; therefore, no effects on long-term NTCs can be estimated.

Country	What were the primary drivers?	Please further explain the primary drivers for the data related to interconnection submitted for ERAA 2022 - In particular, provide further details on your country's borders compliance with the 70% target.	Are the submitted NTC values coordinated with the neighbouring TSO and, thus, consistent? If not, indicate the interconnections for which this is not the case and explain.
IE	Other (please specify)	A limited number of interconnectors are in place or in the planning stages.	N/A
IT	NECP		The NTC values sent by Terna to ENTSO-E during the data collection are compliant with the 70% minRAM requirement. Variations of these values are allowed by the ERAA methodology (e.g. adopting a conservative approach in case a neighbouring TSO communicates lower NTC values). In the future, Italian NTC values could be further upgraded in light of upcoming energy scenarios.
LT	Other (please specify)	Lithuania has quite strong connections with LV, SE and PL. Over the next decade, the country expects to significantly reduce its import dependence through ambitious RES development.	All interconnection data provided are coordinated with neighbouring TSO.
LU	Other (please specify)	N/A	N/A
LV	70% target		According to NECP and TSO best-estimate scenario
MK	Other (please specify)	NTC forecast	N/A

Country	What were the primary drivers?	Please further explain the primary drivers for the data related to interconnection submitted for ERAA 2022 - In particular, provide further details on your country's borders compliance with the 70% target.	Are the submitted NTC values coordinated with the neighbouring TSO and, thus, consistent? If not, indicate the interconnections for which this is not the case and explain.
MT	Other (please specify)	National Resource Adequacy Assessment, which identified the need for a second electricity interconnector with Italy by 2026.	The expected increase in Malta's population, labour force and tourism is expected to drive energy demand even higher in the coming years. As a result of this expected increase in demand, Malta has carried out a national adequacy study with the aim to present cost-optimal solutions to meet the expected growth in electricity demand and tackle any projected future shortfalls. Based on the study, Malta's government decided to invest in a second electricity interconnector linking Malta to Sicily, which is expected to be commissioned in 2026, with an additional capacity of 200MW.
NL	Other (please specify)	National investment plan	70% included in FB calculations
NO	Other (please specify)	Security of supply	Years with low precipitation
PL	70% target		There is agreed trajectory for the period 2020–2025, specified in the Polish Action Plan (https://www.gov.pl/attachment/8f1ecddb-e974-4562-8768-219f7051a8cf) to be fully compliant with 70% minRAM criteria by 2026. Level of transmission capacities in 2025 resulting from the CNEC list provided for FB purpose in PEMMDB 3.4 (ERAA 2022) is consistent with Polish Action Plan. 2024 and 2025 NTC values do not consider the 70% minRAM criteria for technical profiles with DE, CZ, SK, due to including an unscheduled flow through Poland in the calculations, which limits the NTC level.
PT	Other (please specify)	Data submitted are based on most recent REN's Grid Investment Plan.	Regarding the 70% minRAM requirement within the NTC simulations, and with respect to Portugal, the medium- to long-term NTC values do not yet consider the 70% minRAM requirement. The available values were calculated in joint studies with the neighbouring TSO before the publication of this rule. New studies considering more recent information on future scenarios are planned; these will also consider the 70% minRAM requirement.

Country	What were the primary drivers?	Please further explain the primary drivers for the data related to interconnection submitted for ERAA 2022 - In particular, provide further details on your country's borders compliance with the 70% target.	Are the submitted NTC values coordinated with the neighbouring TSO and, thus, consistent? If not, indicate the interconnections for which this is not the case and explain.
RO	70% target		For the 2022–2025 period, the NTCs values provided for the EU borders are in line with the Action Plan developed by Romanian TSO in accordance with the provisions of Art. 15 of Regulation (UE) 2019/943 and the Derogation 2022. A linear trajectory was considered for capacity on each of the two borders (RO–HU and RO–BG) in order to gradually achieve the 70% percent target by the year 2026. Starting from 2026, the values are compliant with the 70% minRAM requirement. For non-EU borders, an NTC calculation is applied.
RS	Other (please specify)	National TYNDP	Not relevant
SE	Other (please specify)	Planned projects and investments.	Driving forces: the project and investment drivers can be divided into Connection (large scale producers and consumers), Market Integration, System Reinforcement and Reinvestment. All Swedish borders are compliant with the 70% rule.
SI	Other (please specify)	NECP, Fit for 55, permitting process, 70% target	The NTC values sent by ELES to ENTSO-E during the data collection are compliant with the 70% requirement. Variations of these values are allowed by the ERAA methodology (e.g. adopting a conservative approach in case a neighbouring TSO communicates lower NTC values).
SK	Other (please specify)	NECP, National Ten-Year Network Development Plan (which is based on National Development Plan)	The primary drivers for the data related to interconnection are specified in the National Ten-Year Network Development Plan (which is based on National Development Plan).

8.1.5 Efficiency

The aim of the following questions is to gain insights into each Member State's targets for reducing their emissions through increase in efficiency (e.g. by converting/upgrading heating technologies, electrifying transport, improving building insulation, reducing temperature dependent load).

8.1.5.1 Efficiency increase by converting/upgrading heating technologies

The large majority of TSOs (26 of 31) anticipate a reduction of emissions through an increase in efficiency. Member States intending to reduce emissions through an increase in efficiency do so primarily via regulation and subsidies to electrify heating by installing heat pumps. Other technologies that are sometimes mentioned include district heating system, insulation of houses and cogeneration.

What is your country?	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies.
AL	No		Upgrading heating technologies will be possible from market incentives – reduced heating costs for consumers from new efficient technologies.
AT	Yes		Austria invests in climate-friendly technologies for heating (e.g. heat pumps, biomass) by financially supporting the switch from fossil fuels and will continue to do so in the future.
BA	No		This would be considered in NECP.
BE	Yes		Assumptions provided in relation to HPs.
CY	Yes		Through dispersed PV generation.
CZ	Yes		The reduction of emissions related to heating is to be achieved in part by increasing penetration of heat pumps.
DE	Yes		Based on subsidies.
DK	Yes		The project assumptions include electrification of heating (heat pumps and electric boilers).
EE	Yes		Support schemes for introducing heat storage units into district heating systems are one way to reduce emissions. Households with local biomass (e.g. wood-based) heating are invited to electrify their heating by installing heat pumps.
ES	Yes		The NECP includes measures in the residential sector for installations of heating and air conditioning. The measures contemplate the incorporation of renewable energy sources to cover demand in accordance with the final renewable energy consumption objectives considered in this plan. These measures include hybridisation of renewable technologies in converting/upgrading heating technologies.
FI	Yes		Heat pump technology develops and replaces not only fossil-fuel generation and direct electric heating, but also older heat pump technologies.
FR	Yes		Target: 22% of buildings using heat pumps by 2030.

What is your country?	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies.
GR	Yes		Several relevant measures are envisaged, such as: - Incentives for installing heat pumps and replacing air-conditioning units. - Replacing oil-fired heating systems with gas-fired heating systems. Already, the scenario of the NECP includes an increase of RES share in final consumption for heating and cooling from 30.6% in 2020 to 43% in 2030, which is attributed to a projected 42% increase in the direct use of RES in the final consumption of energy (e.g. thermal solar, geothermal, heat pumps, bioenergy), in parallel with a significant decrease in the direct use of oil products as well as a significant rise in the direct use of natural gas. Specifically, in the NECP scenario, the RES for heat pumps (ambient heat and low-enthalpy geothermal energy) is shown to increase from 126 ktoe in 2020 to 336 ktoe in 2030. NECP of Greece: https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pdf
HR	Yes		Some highly efficient cogenerations are in the process of revitalising and increasing efficiency.
HU	Yes		Help households switch from wood-based heating to heat pumps combined with PV panels (Recovery and Resilience Plan).
IE	Yes		Promote heat pumps, insulation of houses, etc.
IT	Yes		Gradual transition from boiler heating to heat pumps for residential installations.
LT	Yes		The main goal of the strategy is to achieve consistent and balanced modernisation (optimisation) of district heating systems; ensuring efficient heat consumption as well as reliable, economically attractive (competitive) supply and manufacturing; enabling the introduction of modern and environmentally friendly technologies; using indigenous and renewable energy sources to secure systems' flexibility; and creating a favourable environment for investment.
LU	Yes		Energy renovation of buildings and switching gas/fuel heating systems to heat pumps.
LV	Other (please specify)	No clear decision yet	Increase RES in energy profile and reduce conventional production.
MK	Yes		N/A

What is your country?	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies.
MT	Yes		Malta promotes a number of different renewable heating technologies, which include solar water heaters (SWHs), heat pump water heaters (HPWHs) and air-to-air heat pumps. Given the high solar intensity prevalent in Malta, SWHs are considered a viable renewable source. In fact, the Maltese government provides financial support for the purchase of SWHs and HPWHs. Furthermore, reversible air-to-air heat pumps are a well-established technology in Malta and are considered by many to be essential for thermal comfort. The number of air-to-air heat pumps is projected to increase without the need for policy intervention. The impact of these technologies is reflected in demand projections.
NL	Yes		Targets are to be met via ETS and regulations as well as governmental stimulation to reform gas-firing processes toward electrifying processes.
NO	Other (please specify)	Yes, to some degree. However, most of the potential for increase in efficiency is already realised.	See above.
PL	Yes		Targets are to be met by converting and upgrading heating technologies.
PT	Yes		For the purposes of demand scenarios, electricity savings resulting from energy efficiency measures were considered according to Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018.
RO	Yes		No specific, detailed data are included in NECP.
RS	No		N/A
SE	Yes		Some efficiency improvements are expected (e.g. converting direct heating to heat pumps).
SI	Yes		NECP includes the necessary measures. Slovenia invests in the renovation of old houses and the use of climate-friendly technologies (e.g. heat pumps, biomass) to heat new dwellings by providing financial support.
SK	Yes		Information about reduced emissions through an increase in efficiency by converting/upgrading heating technologies in detail are specified in NECP and Slovakia's recovery and resilience plan.

8.1.5.2 Efficiency increase by electrifying transport

Almost all Member States expect to reduce emissions by electrifying transport. For most, EV adoption is the key driver of transport electrification, often introducing subsidies for EV or deploying charging infrastructure to remove the barriers. Some Member States focus on rail transport (Greece, Spain) or by improving public transportation (Lithuania, Serbia, Hungary). The Netherlands, for its part, intends to make fossil fuels more expensive.

What is your country?	Does your country intend to reduce emissions through an increase in efficiency by electrifying transport?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by electrifying transport.
AL	Yes		Currently, there is no official strategy regarding EV market penetration.
AT	Yes		Austria invests in electrifying transport by financially supporting the switch from fossil-fuel-driven transport to E-Mobility and will continue to do so in the future.
BA	No		This would be considered in NECP.
BE	Yes		Assumptions provided in relation to EVs.
CY	Yes		Generous subsidies for buying electric cars are already provided by the Ministry of Energy.
CZ	Yes		It is intended to reduce emissions through the increase of electromobility.
DE	Yes		Based on subsidies
DK	Yes		The Project Assumptions contain assumptions regarding electrification of transport.
EE	Yes		Transition to electric public transportation and subsidies for purchasing personal EVs.
ES	Yes		Some important measures regarding this issue are included in the demand forecasts, including: promotion of the modal shift towards more efficient modes of transport, accelerated introduction of EVs, and increased mobility through electrified rail transport.
FI	Yes		Finland has introduced mechanisms to support EV adoption. Finnish government scenarios consider these and possible future mechanisms (WAM scenario: With Additional Measures).
FR	Yes		Load Fit for 55 Electrification +»: 13 million EVs by 2030.
GR	Yes		Ambitious targets have been set for electric mobility (trains, buses, cars, etc.), which are expected to grow even more ambitious in the framework of Fit for 55. A 20% RES share in final consumption for transport is foreseen in the scenario of Greece's NECP, according to which electrification of the transport sector will mainly be achieved by rail; the share of electricity for road and rail transport is expected to grow from 0.4% in 2020 to 4% in 2030. The NECP has also set a target of 30% for the share of electric passenger vehicles in the number of new registrations in 2030.
HR	Yes		New charging stations for EVs are constantly being built. The state subsidises the purchase of EVs.

What is your country?	Does your country intend to reduce emissions through an increase in efficiency by electrifying transport?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by electrifying transport.
HU	Yes		Reducing transport emissions by improving rail transport, operating zero emission buses (Recovery and Resilience Plan, Green Bus programme), state aid for buying EVs.
IE	Yes		There are targets for more EVs.
IT	Yes		
LT	Yes		The directions envisaged in the National Energy Independence strategy are: to renew the car fleet, encourage the transition to modern and efficient public transport, optimise transport and alternative fuel infrastructure by electrification or using alternative fuels.
LU	Yes		Deployment of charging infrastructure for light duty and heavy-duty vehicles (buses)
LV	Yes		Governmental support for electrical vehicles, subsidy scheme
MK	Yes		N/A
MT	Yes		The projected increase of EVs in Malta is based on assumptions undertaken for the national electricity supply study. The Government promotes the uptake of EVs through financial grants.
NL	Yes		focus on emission levels, making fossil fuels expensive and subsidise EV
NO	Yes		Support schemes for EVs. Fossil cars will probably be forbidden in a few years
PL	Yes		Support schemes for EV
PT	Yes		With regard to electric mobility, estimates based on NECP were taking into account the expected evolution of the number of light passenger vehicles with Plug-in Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) technologies, of light goods vehicles with BEV technology, heavy passenger and freight vehicles with BEV technology, as well as electric passenger river ships.
RO	Yes		No specific data are available.
RS	Yes		New subway system will be built in Belgrade.
SE	Yes		
SI	Yes		Slovenia is investing into electrifying transport by providing subsidies. New charging stations for EVs are constantly being built, especially a lot of effort is being made for building fast charging stations near the highways, especially for e-trucks. Slovenia also promotes usage of public transport.
SK	Yes		Information about reduce emissions through an increase in efficiency by electrifying transport in detail are specified in NECP and Slovakia's recovery and resilience plan

8.1.5.3 Efficiency increase by improving building insulation

Most TSOs mention that an improvement of building insulation is foreseen. Key drivers for improving building insulation are the policies defined by governments and subsidies set-up to support insulation. Notably, Norway and The Netherlands plan to update their law/building code to include more stringent requirements.

What is your country?	Does your market node intend to reduce emissions through an increase in efficiency by improving building insulation?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by improving building insulation.
AL	Yes		According to new legislative packages, all existing and new buildings must be certified to be energy efficient.
AT	Yes		Austria has been investing for years in improving house insulation (often combined with switching to climate-friendly heating systems) by providing financial support for loan repayments and will continue to do so in the future. However, an increase in the annually implemented house insulation is necessary to achieve climate neutrality in 2040.
BA	No		This would be considered in NECP.
BE	Yes		Assumptions provided in relation to EE in buildings
CY	Yes		Subsidies for building insulation materials are given from Ministry of Energy.
CZ	Yes		By expanding the number of buildings insulated.
DE	Yes		Based on subsidies, policy
DK	No		The Project Assumptions do not contain assumptions regarding improving specifically building insulation.
EE	Yes		National building renovation strategy requires majority of renovated buildings to have a minimum energy performance level by issuing energy performance certificates
ES	Yes		The objective of the NECP is to promote the installation of thermal insulation in 1.2 million homes by 2030, a measure that is included in the section dedicated to energy efficiency in existing buildings in the residential sector and to which 5,509 million will be allocated of euros of public support until 2030. The impact of these plans in the demand has been taken into account in the demand values considered.
FI	Yes		There are ambitious government targets on reducing emissions though increased efficiency in buildings. Improving building insulation is one of them.
FR	Yes		Target for 2030 for improving insulation: 700,000 dwellings/year
GR	Yes		Incentives for buildings renovations.

What is your country?	Does your market node intend to reduce emissions through an increase in efficiency by improving building insulation?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by improving building insulation.
HR	Yes		Every year, the state significantly co-finances the energy renovation of buildings. Due to the earthquake in Croatia in 2020, the European Union is also co-financing the energy renovation of buildings in Zagreb and the Banovina.
HU	Other (please specify)		There is no specialised state aid program of building insulation in progress, but households can utilise financial support for renovation projects.
IE	Yes		By offering grants and incentives
IT	Yes		Other: The Italian policy scenario foresees and applies a given yearly ratio refurbishment of buildings, which is responsible for energy savings due to energy efficiency in buildings
LT	Yes		By promoting the comprehensive renovation of multi-apartment residential and public buildings.
LU	Yes		National regulation includes high financial subsidies for energy renovation of buildings
LV	Other (please specify)	Partly	In details not assessed yet
MK	Yes		N/A
MT	No		
NL	Yes		Making fossil fuels expensive, subsidising insulation and electrification, and changing building codes
NO	Yes		More stringent building codes. Some support from governmental bodies (Enova)
PL	Yes		Support schemes for building insulations
PT	Yes		The national Long-Term Strategy for the Renovation of Buildings 2050 (ELPRE 2050) was taken into account, with a view to renovating the national residential and non-residential, public and private buildings, to convert it into a decarbonised and highly energy efficient real estate park.
RO	Yes		No specific data are available.
RS	Yes		The government is giving incentives to the population.
SE	Yes		
SI	Yes		Slovenia is promoting and financially supporting the renovation of buildings/apartments/houses.
SK	Yes		Information about reduced emissions through an increase in efficiency by improving building insulation in detail are specified in NECP and Slovakia's recovery and resilience plan

8.1.5.4 Efficiency increase by reducing temperature dependent load

According to the responses, 14 TSOs expect reduction of emissions by reducing the temperature dependent load while 11 see no such plans by their country. Remaining TSOs answered 'Other' due to a lack of information or no specific target related to this. For TSOs, this question is strongly linked to the insulation and upgrade of heating.

What is your country?	Does your county intend to reduce emissions through an increase in efficiency by reducing temperature dependent load?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by reducing temperature dependent load.
AL	Other (please specify)	Using gas as an alternative form of heating.	Using gas as an alternative form of heating will be more widespread in the future and the possible growth of industrial consumers may both reduce the temperature dependent load.
AT	Yes		Yes, by an increase of heat pumps and their availability to shift the load.
BA	No		This would be considered in NECP.
BE	Other (please specify)	NA	N/A
CY	No		
CZ	No		N/A
DE	No		The opposite effect is expected: The trend is to electrify residential heating with heat pumps, coming from mostly combustible heating.
DK	No		The Project Assumptions do not explicitly contain assumptions regarding temperature dependent load. On the contrary, temperature dependent load is expected to increase as per the data reported for ERAA 2022.
EE	Yes		District heating plants are made more efficient. Renovated houses need sufficient insulation to reach minimum energy performance levels.
ES	Other (please specify)		Efficiency is the basis of all national policies although no concrete measures are considered currently in the NECP and thus has not been considered in the demand values.
FI	Other (please specify)	See explanation below.	Main way to reduce temperature-dependent load is to replace direct electric heating and old heat pumps with more efficient heat pumps. Overall, however, temperature-dependent load might increase as heating is electrified both in small-scale and large-scale (district heating). In district heating development is seen driven by the industry, where electric boilers or large-scale heat pumps are planned to be commissioned. At the same there are plans to increase energy storages in DH, which in turn might add flexibility. Flexibility is also assumed to increase in small-scale household heating. Increased flexibility is considered in the inputs.
FR	Yes		Increasing heating efficiency and insulation achieves the desired result.

What is your country?	Does your county intend to reduce emissions through an increase in efficiency by reducing temperature dependent load?	If 'other', explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by reducing temperature dependent load.
GR	Yes		Mainly by increasing efficiency and building renovations.
HR	Yes		Low-emission technologies related to temperature-dependent load will be promoted.
HU	No		N/A
IE	Yes		Overall emission will reduce with the electrification of heating and increase insulation of homes
IT	Yes		Improving building insulation reduces its temperature – dependency.
LT	No		No such intention yet
LU	No		N/A
LV	No		N/A
MK	Yes		/
MT	Yes		For the ERAA 2022 data collection, temperature-dependent load was considered as the space heating and cooling and water heating electricity portion. As explained in previous questions, efficiency increases are achieved through the deployment of more efficient renewable heating and cooling and water heating technologies in the end-use sectors, such as heat pumps, SWH and HPWH.
NL	No		
NO	Other (please specify)	See above. But there is more focus on load shifting through tariffs	See previous answers
PL	Other (please specify)	No information available	
PT	Yes		For the purposes of demand scenarios, electricity savings resulting from energy efficiency measures were considered according to Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018
RO	Yes		No specific data are available.
RS	No		/
SE	Yes		
SI	Yes		Renovation of buildings and installation of efficient heat pumps decreases the temperature dependent load.

What is your country?	Does your county intend to reduce emissions through an increase in efficiency by reducing temperature dependent load?	If ‘other’, explain.	Please further explain how your country intends to reduce emissions through an increase in efficiency by reducing temperature dependent load.
SK	Yes		Introduction of low carbon alternatives like heat pumps. Information about reduced emissions through an increase in efficiency by reducing temperature dependent load in detail are specified in NECP and Slovakia's recovery and resilience plan

8.1.6 Consideration of 'Recovery and Resilience Facility' programme

The question aimed to understand whether the data provided considered the 'Recovery and Resilience Facility'. Only a few TSOs confirmed that their submissions consider the Recovery and Resilience Facility. Specific responses are listed below.

What is your country?	Did your country consider the Recovery and Resilience Facility in the completion of this data?	If 'other', explain.
GR	Other (please specify)	Using gas as an alternative form of heating.
SI	Yes	
LT	No	
MT	Other (please specify)	N/A
LV	No	
AT	No	
DE	No	
IT	No	
ES	Yes	
FR	Other (please specify)	Efficiency is the basis of all national policies, although no concrete measures are considered.
PL	No	
RO	Yes	
EE	Yes	
BE	Yes	
SE	No	
FI	Yes	
CZ	Yes	
IE	No	
NL	No	
PT	No	
BA	Yes	
AL	Yes	
MK	No	
LU	Other (please specify)	See above. But there is more focus on load shifting through tariffs
HR	Other (please specify)	No information

What is your country?	Did your country consider the Recovery and Resilience Facility in the completion of this data?	If 'other', explain.
RS	Yes	
SK	Yes	
NO	No	
HU	Yes	
CY	Yes	
DK	Yes	

8.1.7 Drivers of evolution

The next question aims to understand whether the data provided would still be valid in November 2022 in the opinion of each TSO, and what factors would influence eventual evolutions.

What is your country?	Do you expect that the assumptions of the key drivers (policy or not) of the capacity and energy mix evolution for the data provided will continue to be valid in November 2022?	If 'other', explain.	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
AL	Yes		National RES strategy and targets.
AT	Yes		NECP.
BA	Other (please specify)	The NECP is expected to be finalised.	After finalising NECP, some provided data would not be valid.
BE	Other (please specify)	Maybe not. Some changes might occur due to the results of new CRM auctions and upcoming electrification from industry.	New CRM auctions and upcoming electrification from industry.
CY	Yes		Satisfying demand in the next decade and meeting the RES targets set.
CZ	No		Even though the number of prosumers and level of energy efficiency is expected to rise, the data related to the demand indicate that electricity demand is expected to grow due to increasing electrification, mainly in the sector of transport (electromobility) and heating (heat pumps). All relevant factors that may have an impact on electricity demand are also considered; these include the evolution of the Czech Republic's national economy as well as how the country recovers from the COVID-19 pandemics. Concerning the supply side, a gradual decommissioning of all lignite units is expected by the end of 2038; this should be partially compensated with greater penetration of RES (in compliance with national and EU climate targets) and by switching from coal to gas production of electricity and heat.
DE	Yes	Unless there are changes due to the war in Ukraine.	Policy, subsidies.

What is your country?	Do you expect that the assumptions of the key drivers (policy or not) of the capacity and energy mix evolution for the data provided will continue to be valid in November 2022?	If 'other', explain.	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
DK	Yes		Over time, installed thermal capacity is expected to decrease due to a gradual coal phase-out towards 2030, whereas gas-, oil-, and biomass-fired thermal power are expected to remain relatively constant towards 2030. Installed capacity of photovoltaics and wind power is expected to increase significantly towards 2030.
EE	Yes		The transitioning of existing power plants' fuels from oil shale to biofuel. Ambitious renewable energy targets and subsidising of RES projects.
ES	Other (please specify)	The drivers of Spain's ERAA 2022 data are the NECP target and the best information available; however, unexpected economic, political and social issues in the short term may impact the data provided between now and November.	The ERAA 2022 dataset reflects the rapidly energy evolving and consider the best data right now and always seeing the current Spanish NECP target. We could expect that a future update of the NECP could introduce enforcement and / or additional targets for the fulfilment of the European energy objectives.
FI	Yes		Market-based development is the main driver (high fossil fuel and CO_2 prices drive the development of RES and storages). There are also government policies including phase-out of coal in energy use by 2029 and supporting the transition to clean sources if the phase-out is done by 2025. Many energy companies have published their plans to phase-out of coal. There are many confirmed and expected investments on onshore wind power (as well as solar to some extent) that are done on market basis. These have been considered in the capacity and energy mix evolution.
FR	Other (please specify)	New NECP is under discussion – but will be published in 2023. Also, nuclear maintenance planning should evolve throughout 2022.	NECP for nuclear capacity, thermal generation capacity and energy, RES capacity and energy, DSR capacity. Assumption Fit for 55 for load and P2G transparency for nuclear energy.
GR	Yes		The main drivers for all the data provided are the country's NECP and its ongoing revision in view of the Fit for 55 targets, which include energy security, GHG emissions reduction, low cost, and reduction of energy dependence.

What is your country?	Do you expect that the assumptions of the key drivers (policy or not) of the capacity and energy mix evolution for the data provided will continue to be valid in November 2022?	If 'other', explain.	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
HR	Yes		In Croatia, the share of conventional power plants in installed capacity and energy production is continuously decreasing. However, the share of wind and solar power plants is growing significantly. Croatia already has a large installed capacity of hydropower plants, which will continue to increase in the coming years. Croatia is expected to achieve its decarbonisation goals without major problems.
HU	Other (please specify)	See question 25.	The yearly process of gathering input data and assumptions for the National Ten-Year Network Development Plan (every year from August to December) could overwrite the provided data because this process is designed to take into account changing policy drivers, investment plans and all relevant factors.
IE	Other (please specify)	Updated CAP 2021 will be used.	CAP 2019
IT			General drivers for collected data: - 2030 RES capacity: new policy targets - 2030 demand: updated to reflect increase in GDP growth and further electrification - New storage capacity is in line with NECP - Demand-side response is in line with the actual capacity qualified for participating in the ancillary services market for the mid-term; increase projected by 2030 due to new sources becoming available - Complete coal phase-out by 2025 – except for Sardinia, where the coal plants will be phased out by 2028 after Tyrrhenian Link enters into operation - New thermal capacity in line with capacity market results with delivery year 2022/2023
LT	Yes		The majority of fossil generation capacity (mainly gas) is quite old; by 2025, it will reach the end of its useful lifetime and be decommissioned. The strategic target is to derive 100% of electricity consumed from RES by 2050; however, it appears likely that this target can be reached ahead of schedule.

What is your country?	Do you expect that the assumptions of the key drivers (policy or not) of the capacity and energy mix evolution for the data provided will continue to be valid in November 2022?	If 'other', explain.	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
LU	Yes		The key capacities provided are compliant with the target scenario published in the NECP. Fit-for-55-compliant updates are being prepared by national authorities. Fulfilment of target scenarios depends on subsidies and national tenders (for large solar farms).
LV	Other (please specify)	Some updates on conventional generation (i.e. reduction) appear likely.	National development plans and long-term strategies, TSO forecast and the best-estimate scenario, current situation and long-term prognoses.
MK	Yes		N/A
MT	Yes		Capacity and energy mix evolution submitted for the PEMMDB is based on the national electricity supply study. Additionally, Malta uses an N-1 system/generation adequacy standard. This requires that, even when losing the largest piece of power generation infrastructure (e.g. interconnector or gas facilities), the system must be sufficiently resilient to meet maximum electricity demand. Malta also fulfils its obligations under the Renewable Energy Directive, which requires continuously increasing deployment of renewable energy technologies.
NL	Other (please specify)	Yes, but at every time stamp for data collection, new insights and policy can be incorporated into new data sets.	The national climate and energy outlook, as well as sustainable-future policies aiming for CO_2 reductions by 2030 and zero CO_2 emissions by 2050.
NO	Yes		Existing hydro will still be most important. In the future, more solar and onshore wind are expected, with huge quantities of offshore wind from 2030.
PL	Other (please specify)	May not be valid	Changing policies and RES development.
PT	Other (please specify)	A new National Adequacy Assessment Report with updated data is expected to be delivered before the end of 2022.	- Decommissioning of all existing coal power plants by the end of 2021 (1.7 GW) - New large hydro power plants (1.2 GW; 0.9 GW with pumping) by 2023 - Decommissioning of old CCGT (1 GW) in 2029 - 12.1 GW of new RES between 2020–2030 (of which 8 GW are solar)

What is your country?	Do you expect that the assumptions of the key drivers (policy or not) of the capacity and energy mix evolution for the data provided will continue to be valid in November 2022?	If 'other', explain.	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
RO	Other (please specify)	The trajectory data provided in the current NECP (related to the evolution of RES capacity and the penetration of Electrolyser/DSR/Batteries in the market) are expected to be adjusted in response to Fit for 55. However, no specific data are yet available.	See above.
RS	No		Interest of the investors in RES, due to incentive system.
SE	Other (please specify)	As the data (and scenarios) are based on uncertainties and assumptions, they may have changed by November 2022.	National climate and energy targets. Decommissioning of nuclear power plants at the end of 60-year lifespans.
SI	Yes		The main driver is NECP, supplemented by the information gathered by plant owners, investors, policymakers, projections, etc. However, the provided PEMMDB data are continuously updated, and some of the provided data could always be overwritten by the latest.
SK	Other (please specify)	The assumptions of the key drivers of the capacity and energy mix evolution probably will continue to be valid in November 2022.	The trajectory of electricity demand until 2050 provided during the data collection for PEMMDB is in line with the National Development Plan of the Slovak transmission system. The electricity demand evolution reflects the expected evolution of the national economy in Slovakia. All relevant factors known at the time of providing data for ERAA 2022 that could have a significant impact on the electricity demand evolution (such as the impact of COVID-19) were considered. The resource energy mix evolution in the EERA reflects the national policies translated into the Integrated NECP (INECP). A significant development in increasing production capacity is expected in nuclear technology. In addition, a significant increase in RES (especially solar and wind) is expected. This is also in line with the INECP. The assumed evolution of the energy mix, affected by an increase in nuclear capacity, indicates an increase of resource adequacy margins.

8.1.8 Market reforms

The question aimed to understand whether national market reforms were initiated in the different Member States, which reforms and in what extend they were considered in the data provided. Most TSOs have not started a reflection on a potential market reform. Some Member States consider that this question is not applicable to their context (e.g. Norway, Luxembourg, the Czech Republic, Slovenia). Detailed answers can be found below.

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
AL	There are not any future plans for these market reforms.	-	-
AT	No plans yet.	-	-
BA	No specific market reforms are considered when providing the data.	-	-
BE	Automatic increase of SDAC technical bidding limits (60% increase rule).	-	Automatic increase of SDAC technical bidding limits relates to the modelling rather than to the data provided.
CY	Full market software will be operational in October 2022.	-	-
CZ	N/A	At the moment of providing the ERAA input data, no national market reforms (according to Article 20(3) of the Electricity Regulation) were considered in the Czech Republic.	-
DE	Can't provide feedback on this topic.	-	-

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
DK	The scenario (Analysis Assumptions for Energinet of 2020) provided by the Danish Energy Agency to the ERAA is the best guess for a likely development pathway for the Danish energy system until 2040. The scenario is constructed around Danish targets such as 70% greenhouse gas emission reductions in 2030 compared to 1990 levels and a climate-neutral society by 2050. Additionally, the scenario is constructed around assumptions that onshore wind and photovoltaic capacity will enter the market without subsidies/on market terms beyond capacity additions already agreed upon as of now.		
EE	Introducing ancillary services market after 2025. There will also be a transition to 15-minute market time unit (from 1 hour).	Ancillary services market adoption.	Sharing of reserves between LV and LT, which follows the Baltic LFC block concept document. This means that some of the capacity is reserved for ancillary services only.

ES	Input data provided in line with market arrangements expected from 2022 onwards. - Market reforms recently carried out: *Demand-side and storage facilities can participate in balancing services (after the corresponding prequalification process) since January 2020. *Modification of price caps and floors have been modified to +3000 €/MWh and -500 €/MWh in day-ahead market and to +/-9999 €/MWh in intraday market. *Connection to the European RR platform (March, 2020). *Integration into Imbalance Netting process through IGCC platform (October 2020). - Foreseen reforms: *Interconnection reinforcement; however, interconnection targets as set out in Art. 4 of Regulation (EU) 2018/1999 are not expected to be reached in the 2030 timeframe, although significant progress is expected with the new Bay of Biscay and Transpyrenean projects. *Imbalance Settlement Harmonisation in April 2022. *Programming QH in real-time markets: National approaching to the mFRR standard product (foreseen in Q2 2022). *Participation of demand-side and storage facilities in the redispatch market (foreseen Q4 2022). *Participation of independent aggregators in the markets (foreseen in Q4 2022). *Market for voltage control (foreseen in Q3 2022). *National project approaching the aFRR standard product (foreseen in Q2 2023). *Connection to mFRR European platform (MARI) in Q3 2023 and aFRR European platform in Q2 2024	All Market reforms mentioned have been considered when providing data for ERAA 2022.	Interconnection reinforcements already considered in the future expected NTC values in the different time horizons of the study. The possibility for DSR to participate in the markets opens the possibility that new developments may play a role in adequacy.

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
	Implementation of Imbalance Settlement Period = 15 min in Q4 2023.		
FI	Significant market reforms expected in the upcoming years are consequences of an EU-wide harmonised balancing market, imbalance settlement and requirements for the procurement of reactive power. In addition, the recast or the national regulation on strategic reserve is under preparation.	The direct effect of the market reforms cannot be precisely quantified; however, e.g. balancing market reforms are expected to support price signals that incentivise DSR development in the balancing timeframe. Some reforms, such as price cap rules, should be modelled within the ERAA EVA but were not considered in the provided data. The recast of the national regulation on strategic reserve has also been done and noted, although it does not directly impact the data. Finland has also set a new reliability standard of LOLE 2.1 hours/a and EENS 1 100 MWh/a (previously 3 h/a and 1800 MWh/a) based on an updated analysis.	The reforms were not considered when providing data for ERAA 2022 for the aforementioned reasons. The new reliability standard will be included in the ERAA analysis.

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
FR	France is submitted to the price-cap rules, not to scarcity pricing. NECP also forbids the construction of new fossil plants	NECP interdiction of new fossil plants. Impact of price-cap rules on the provided data not seen.	No new fossil plant can be invested in (EVA).
GR	Greece has submitted a Market Reform Plan for approval by the EU Commission.	Mainly the reforms that will enable participation of DSR in electricity markets.	By providing estimates on DSR potential.
HR	The electricity market in Croatia is continuously improving.	A new law on the electricity market was adopted at the end of 2021.	ERAA 2022 data are in line with the provisions of the new electricity market law.
HU	No information.	-	-
IE	- The SEM already incorporates scarcity pricing. - There are some non-energy reforms that could have an impact on the business cases for investment in new capacity, such as: o Significant systems service changes o RAs are leading a review of network tariffs.	-	-
IT	Yes. Market reforms will be considered according to the plan.	Increase of interconnection capacity, enabling self-generation, energy storage and demand-side measures and the promotion of European Market Integration.	Data for demand, interconnection and storage capacity updated according to the planned market reforms.

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
LT	No plans to initiate market reforms.	No market reforms considered.	No market reforms considered.
LU	No, Luxembourg is part of the DE/LU market. Market reforms should be agreed upon and established jointly by the relevant authorities.	-	-
LV	N/A	-	-
MK	-	-	-
MT	No national market reforms currently envisaged.	-	-
NL	Currently not foreseen.	-	-
NO	Not relevant to Norway.	More flexibility from demand, ability to reduce (shift) demand at high prices.	Assumptions that there is a reasonable national balance between demand and generation in average climate years.
PL	To be developed on MS level	-	-
PT	No market reforms were considered	-	-
RO	N/A	-	-
RS	Serbia is not currently initiating national market reforms.	-	-

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
SE	With regards to adequacy purposes, it is believed that the transition to a 15-minute imbalance settlement period (scheduled launch 2024) may have an impact. Scenarios beyond 2024 may require additional considerations. Other national market reforms (with respect to Article 20.3 of the Electricity Regulation) relate more to balancing markets and should not have a significant impact on the ERAA input data.	-	-
SI	-	-	-

What is your country?	Market reforms (Article 23(5)(e) and Article 20(3) of the Electricity Regulation) shall be considered in the ERAA scenarios. Please provide your feedback on whether or not your country is initiating (currently or in the future) national market reforms (e.g. price cap rules, scarcity pricing).	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for ERAA 2022? Please list the reforms.	How were the reforms listed above considered when providing data for ERAA 2022?
SK	So far, the results of the adequacy calculations at the European level (as well as Slovakia's own calculations at the national level) do not point to problems with the adequacy of resources in Slovakia. For this reason, it was not necessary to apply the principles (market reforms) of Article 20(3) of Regulation (EU) 2019/943 in order to eliminate possible regulatory distortions.	The application of market reforms is mainly perceived in the INECP (NECP of Slovakia), which corresponds in its content to the relevant European regulations and directives, e.g. from the point of view of removing market barriers in the time frames of the daily and intraday market by joining the 4M Market Coupling (market coupling between the Czech Republic, Hungary, Romania and Slovakia) and subsequent interconnection with the pan-European MRC, as well as the integration of wholesale electricity markets. A significant contribution in the area of integration of wholesale markets, in terms of reducing price differences between market areas, was the commissioning of new 400 kV lines on the SK–HU border. The commissioning of these new 400 kV cross-border lines results in an increase in cross-border transmission capacity on the SK–HU profile and makes a positive impact on the release of capacity for the connection of new RES.	For example, increasing NTC on SK–HU interconnection profile.

8.1.9 Out-of-market measures

The question aimed to understand which out-of-market measures TSOs have at their disposal, what their volume is, and how they contribute to the adequacy of their system.

Twelve TSOs don't have out-of-market measures to address potential shortfalls in supply. Most of the remaining TSOs use active power reserve (mainly FCR and FRR) as out-of-market measures. DSR, voltage reduction and strategic reserves are also mentioned regularly. Other measures that were \ mentioned include market suspension and restoration rules (Spain), emergency contracts with TSOs (France) and national safeguard regulation (Romania). Elering operates an emergency power plant in Estonia.

In general, frequency reserves (FCR, FRR) and voltage control are operational measures and are not considered to solve adequacy issues in the future. Albania mentioned that the indicated FCR and FRR capacity contribute to the increase of system adequacy. Capacity reserves in Germany are activated based on DA and/or ID prices (3000 €/MWh for DA and 9999.99 €/MWh for ID). As part of CM auctions, DSR will contribute to the adequacy assessment scenario with CM. In Sweden, only strategic reserves and disturbance reserves (albeit partially) are considered for adequacy.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
AL	FRR and FCR.	FCR requirement is 6 MW and FRR needs are evaluated at 144 MW.	The above measures contribute to the increase of the system adequacy.
AT	None.	-	-
BA	None.	-	-.
BE	Previously relevant out-of-market measures for BE were the strategic reserves (SRs). However, the SR mechanism is no longer relevant for BE (i.e. no longer approved under EC State Aid Guidelines).	-	-
CY	Full market software will be operational in October 2022.	Based on predicted peak demand in MW and relevant reserves.	Full market software will be operational in October 2022. Until then, and when results and drivers are generated, out-of-market measures will be the main driver for designing the adequacy of the country.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
CZ	Currently, the country does not have any out-of-market measures at its disposal. The reserves are modelled as increased load (extra load) so that power plants conventionally delivering reserves are made part of the dataset and are available on the market.	-	-

DE	The out-of-market resources for Germany include: - Capacity reserve: Reserve for unforeseeable events, which are activated in case of a lack of market clearance (D-1 and ID). They can also be used to resolve grid congestions. - Grid reserve: Used to resolve congestions and contains different types of power plants located in Germany. In emergency situations, it can be used for adequacy in grid operation, if not needed for solving grid congestion. However, in terms of system forecasting, its availability is not sufficiently reliable to be counted on during national scarcity situations. Therefore, it is excluded here. - Out-of-market demand-side response: With the Ordinance on Interruptible Load Agreements (AbLaV), interruptible demand can be obliged to take measures to maintain grid and system security. For the purpose of AbLaV, interruptible demand is defined as consumption units that can reliably reduce their demand for a fixed capacity upon request by the German TSO. (If prices exceed 200 €/MWh, this reserve can bid in the market. Therefore, this reserve is, on the one hand, a TSO out-of-market measure; on the other hand, it is part of the ERAA simulation runs if prices exceed 200 €/MWh). - Lignite units in standby (*Sicherheitsbereitschaft*). - Frequency restoration reserves. - Special network equipment: used only for redispatch.	- Capacity reserve: Since 1 October 2020 and until 30 September 2022, a total capacity of 1056 MW of gas-fired power plants outside the market is available. These power plants have to be available within maximally 12 hours. 2025 & 2030: Dimensioning of capacity reserve is not done yet. Best guess of TSO: Same level as today. - Out-of-the-market Demand Side Response (AbLaV): For 2025, 1250 MW of interruptible load are considered; for 2030, 1758.9 MW. No other out-of-market resources should be taken into account for adequacy studies in 2025 and 2030. For information: Development of further reserves that do not directly contribute to national adequacy. - Lignite units in standby (*Sicherheitsbereitschaft*): Lignite-fired power plant blocks with a total capacity of 2.4 GW are currently in backup mode until 2023. The lead time in which the power plants are completely available is 240 hours. In addition, the TSOs may dispatch them only if the German government declares an energy crisis situation. The final shut-down of these plants will come gradually. After 30 September 2023, this reserve will be completely dissolved. - Grid reserve: Currently, it comprises a total capacity of 5.6 GW. The new capacity values are currently being determined in the ongoing national study. - Special Network Equipment: a total of 1200 MW are currently under construction and will be available for curative redispatch after 1 October 2022.	The capacity reserve contributes 1056 MW to national adequacy. Activation trigger: - Day-ahead price = 3000 €/MWh - Intraday price bid side over one hour = 9999.99 €/MWh No other reserves should be taken into account for adequacy studies.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
DK	Denmark has not reported any out-of-market measures as part of the ERAA dataset, because capacity mechanisms/capacity markets/strategic reserves are not utilised in the country. Reserve/ancillary service capacity is normally considered out-of-market (day-ahead market). Data for both FCR and FRR have been provided.	Total reserve requirements in the ERAA are 692 MW for DKE1 in 2021 and 712 MW from 2022 onwards. For DKW1, the requirement is 394 MW for the entire 2021–2031 period.	Within the hour of operation, FCR will be activated with the shortest possible response time (a few seconds), whereafter aFRR and mFRR will be activated further to meet any imbalance.
EE	Kiisa Emergency Power Plant.	250 MW	Will be used only after all available market-based resources are exhausted. It is the emergency reserve.
ES	In such cases, the market suspension and restoration rules stemming from Network Code Emergency and Restoration would be applied.	N/A, as no specific out-of-market products are available.	No specific products available for out-of-market measures.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
FI	Finland has a strategic reserve measure in place until 2032 to safeguard security of supply of electricity. However, the reserve is procured on an annual basis, and currently there is no capacity contracted to the reserve. According to the revised national regulation, Fingrid should primarily use mFRR capacity for potential shortfalls in supply to the extent that operational security can be upheld. The mFRR consists mainly of gas turbines, some of which are owned by Fingrid and some of which are leased by Fingrid.	Strategic reserve capacity was 611 MW as of the end of June 2022, but no capacity was contracted in the latest procurement of the reserve for the period 2022–2023. Therefore, reserve capacity for the upcoming years is unknown. The mFRR total capacity is currently 1218 MW: 927 MW owned; 291 MW leased. The development of the capacity is included in the data inputs.	Strategic reserve is used if a potential shortfall in supply is known in advance (>10–12 hours). The mFRR are mainly used for frequency restoration but can also be used for system adequacy for short periods of time.
FR	Eco gestures, voltage reduction, interruptible load contract with industries, emergency contracts with TSO, mfRR.	Eco gestures: dependent on the situation, so they cannot be modelled as a guaranteed amount of MW. Voltage reduction: 3–4% of peak demand (but decreasing after a few hours). Interruptible load contract with industries: 350 MW. Emergency contracts with TSO: dependent on the situation, so they cannot be modelled as a guaranteed amount of MW. mfRR: 1500 MW.	Eco gestures, voltage reduction, interruptible load contract with industries: reduction of load emergency contracts with TSO, mfRR: increase in production.
GR	No out-of-market measures are available.	-	-
HR	DSR, FRR, FCR, etc.	-	The out-of-market measures contribute positively to system adequacy.
HU	Balancing market products.	-	-
IE	Voltage reduction.	TBC	Voltage reduction can be used as a temporary relief measure in times of stress.
IT	At present, there is no strategic reserve in Italy.	-	-

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
LT	Active power reserve.	~520 MW until the end of 2025. From 2026 onward, total national reserve requirement will be 709 MW.	With the synchronous mode with continental Europe network (from 2026 onward), the country will be subject to the same rules as all EU Member States. Today, Lithuania is still part of the IPS/UPS system.
LU	None.	-	-
LV	Latvia is keeping FRR.	-	-
MK	-	-	-
MT	Capacity market strategic reserves.	215 MW.	These out-of-market reserves consist of gasoil-fired open-cycle gas turbines, which can be dispatched in case of any failures at other plants or potential shortfalls in supply. Gas turbines are always available for dispatch and take only 15 minutes from start to synchronisation.
NL	-	-	-
NO	It is assumed that the need for reserves will increase, but because this is not yet quantified, the same values are used for tomorrow and today.	See above.	Reduces capacity available for the day-ahead market.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
PL	1. DSR contracted for the period 2021–2026 as a part of already concluded Capacity Market auctions. 2. Voluntary DSR contracted with consumers for the period April 2021–March 2022. 3. Additional must-run understood as the increase of the contracted infeed of CHPs. 4. Administrative load reduction according to the national legislation: Regulation of the Council of Ministers of 23 July 2007 on the Detailed Principles and procedures of Introducing Limitations on Sale of Solid Fuels and Supply and Consumption of Electricity or Heat (Journal of Laws of 2007, No. 133, item 924). The description of this measure is also described in the draft of the Risk-Preparedness Plan (draft is not publicly available).	1. Average values: a) 2022: 847–889 MW, b) 2023: 801 MM c) 2024: 1039 MW c) 2025: 959 MW c) 2026: 1509 MW a) level dependent on season; b) values from main and additional CM auctions; c) reduction tests did not proceed yet, effective level may be lower. 2. Up to 100 MW, based on a recent PSE (Polish TSO) survey. Availability not guaranteed and depends on voluntary counterparty offers. 3. About 200 MW. Availability depends on weather conditions (heat demand). 4. Administrative load reduction refers to electricity consumers throughout the year, for which the contracted power is set above 300 kW. There are many exceptions among the above-mentioned consumers for whom load curtailment cannot be used.	The role of these operational out-of-market measures is to restore reserves in the system; therefore, not all of them contribute to the EVA (Economic Viability Assessment) of ERAA 2022 and the adequacy assessment of scenario without Capacity Market in medium- and long-term perspectives. DSR contracted for the period 2021–2026 (and estimated through 2030) as a part of already concluded Capacity Market auctions will contribute to the adequacy assessment of scenario with Capacity Market (after case-by-case quantification).
PT	For ERAA 2022 purposes, there were no out-of-market measures indicated by REN, according to the PT national adequacy assessment report.	For ERAA 2022 purposes, there were no out-of-market measures indicated by REN, according to the PT national adequacy assessment report.	For ERAA 2022 purposes, there were no out-of-market measures indicated by REN, according to the PT national adequacy assessment report.

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
RO	In crisis situations in the operation of the national power system, the Romanian TSO may apply the safeguard regulation issued by the NRA. The aim of applying this regulation is to balance production and consumption, as well as maintaining scheduled exchanges, by increasing production and reducing consumption. Consumption can be reduced by applying the Limitation Norm elaborated by TSO.	N/A	The role of these operational out-of-market measures is to restore reserves in the system; therefore, not all of them contribute to the EVA (Economic Viability Assessment) of ERAA 2022 and the adequacy assessment of scenario without Capacity Market in medium- and long-term perspectives. DSR contracted for the period 2021–2026 (and estimated through 2030) as a part of already concluded Capacity Market auctions will contribute to the adequacy assessment of scenario with Capacity Market (after case-by-case quantification).
RS	Voltage reduction and FRR.	With voltage reduction, peak demand can be reduced by 3%.	With voltage reduction, peak demand can be reduced by 3%
SE	Strategic reserve, disturbance reserve, FRR, FCR, FFR, disconnection of load.	Strategic reserve: 562 MW; disturbance reserve: 2000 MW; FFR: 100 MW; FCR-D: 580 MW; FCR-N: 240 MW; FRR: 140 MW.	The strategic reserve with a capacity of 562 MW in price area SE04 is contracted to March 2025 and could address adequacy problems within this period. A portion of the disturbance reserve (which has a total capacity of 2000 MW) might be able to help resolve adequacy problems temporarily, but this is not its intended purpose. Capacities for the other out-of-market measures (FRR, FCR and FFR) have not been included here due to low resilience.
SI	None	-	-

What is your country?	What out-of-market measures (e.g. capacity market strategic reserves, FRR, FCR) do you have at your disposal in order to address potential shortfalls in supply?	Quantification of the out-of-market measures that could be used to address potential shortfalls in supply. Please indicate whether the value is in MW or % peak demand.	Please explain how the out-of-market measures listed above contribute to system adequacy for your country.
SK	Measures to address decreases and increases in frequency; measures to address voltage drops and surges; measures to prevent overloading of elements.	With regard to FCR+/-, aFRR+/- and mFRR+/-, the total market node requirement in 2022 is as follows: - total market node requirement (positive): 793 MW - total market node requirement (negative): 681 MW	To prevent the emergence and spread of major system failures (management of critical conditions in the ES SR), a system of preventive measures (Defence Plan) has been created with the aim of keeping the power system of the SR in stable operation as much as possible. These measures are described in the Technical Rules of SEPS.